THE GEORGE WRIGHT

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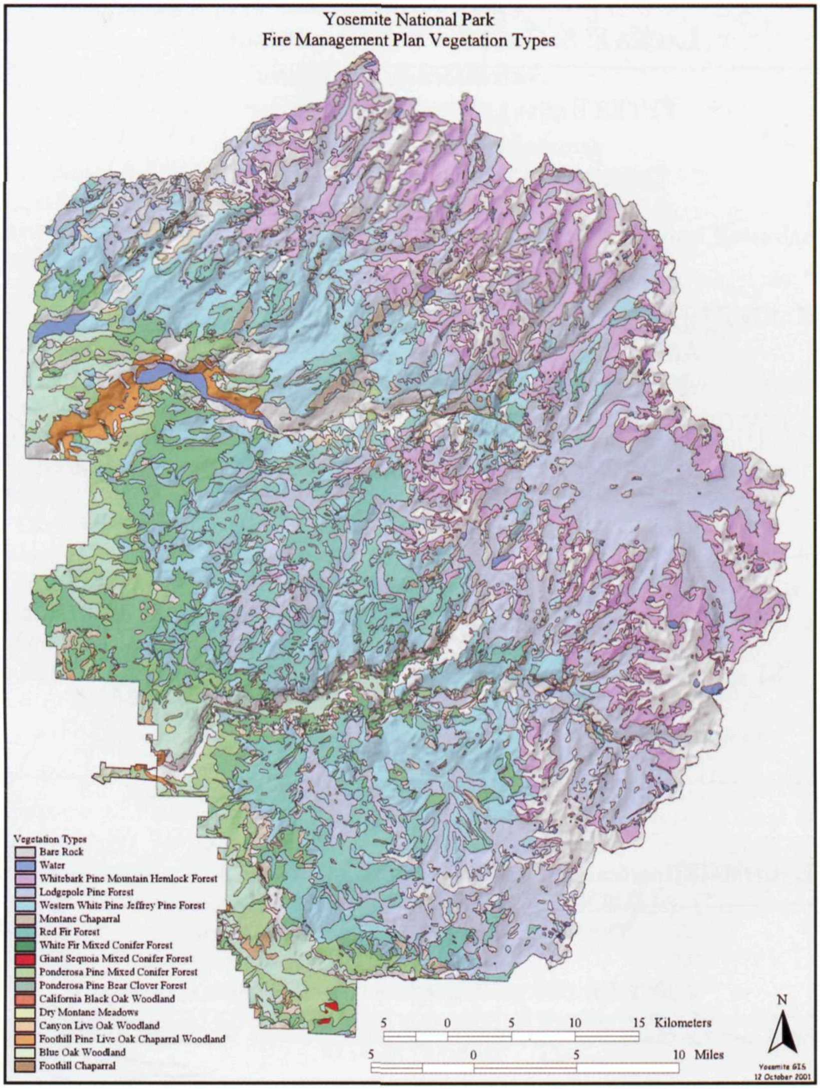

THE JOURNAL OF THE GEORGE WRIGHT SOCIETY

Dedicated to the Protection, Preservation and Management
of Cultural and Natural Parks and Reserves
Through Research and Education

The George Wright Society

Executive Office

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On the Cover: Vegetation types of Yosemite National Park. See article beginning on page 19.

Society News, Notes & Mail

Woodley Appointed to GWS Board

At its annual meeting in October, the GWS Board of Directors appointed Stephen Woodley, chief scientist of Parks Canada, to a three-year term on the Board. Stephen has worked in the field of environmental management for 25 years, including working in several national parks, as an environmental consultant, and as director of the Heritage Resources Centre at the University of Waterloo. He chairs the Greater Fundy Ecosystem Project, which aims to develop a sustainable landscape in an area that includes a core protected area (Fundy National Park) surrounded by lands managed for intensive forestry, agriculture, recreation, and tourism. Stephen served on the ministerial Panel on the Ecological Integrity of Canada's National Parks, whose landmark report, *Unimpaired for Future Generations? Conserving Ecological Integrity with Canada's National Parks,* was published in 2000. He is a member of IUCN's World Commission on Protected Areas. Stephen holds degrees from Mount Allison University, the University of New Brunswick, and a Ph.D. in environmental studies from the University of Waterloo.

2001 GWS Conference Proceedings Now Available; Mark Your Calendars for the 2003 Meeting

The 2001 GWS Conference proceedings book, *Crossing Boundaries in Park Management,* is now available for purchase in two formats: as a paperback book and on CD as a series of PDF files. The proceedings contains 71 papers, many with illustrations. The paperback book is 426 pages in length. The CD is packaged with a full-sized jewel case and printed insert, and includes each paper as a separate PDF files as well as the entire book as a single PDF file to facilitate whole-book searches. The paperback book is $20 and the CD is $10, postpaid to U.S. addresses (shipping charges apply elsewhere). GWS members get a 25% discount off these prices. For the complete table of contents and a link to a secure on-line order form, go to:

www.georgewright.org/2001proc.html

As an alternative to purchasing the proceedings, the individual-paper PDF files are available for free downloading from this page. You can also order by mail or phone from the GWS office (contact address and phone number are on the inside front cover of this issue).

The 2003 GWS Conference will be April 14-18 in San Diego—save the dates! Note that this is the week before Easter. A call for papers will go out in

August; all GWS members and 2001 conference attendees will receive one. More details will be forthcoming in the next FORUM.

Nominations Open for 2002 Board Election

The 2002 GWS Board election, which will take place this September, is for the seats of two retiring incumbents, Bob Krumenaker and Laura (Soullière) Gates. Both Bob and Laura are reaching the end of their second 3-year term on the Board and so are ineligible to run again. We are accepting nominations from those who seek these seats. The term of office runs from 1 January 2003 through 31 December 2005. Nominations are open through 1 July 2002. To be eligible, the nominator and nominee must both be GWS members in good standing (it's permissible to nominate one's self). The nominee must be willing to travel to Board meetings, which usually occur once a year; help prepare for and carry out the biennial conferences; and serve on Board committees and do other work associated with the Society. Travel costs and per diem for the Board meetings are paid for by the Society; otherwise there is no remuneration. Federal government employees who wish to serve on the Board must be prepared to comply with all applicable ethics requirements and laws; this may include, for example, obtaining permission from one's supervisor and/or obtaining a conflict of interest waiver. The Society can provide prospective candidates with a summary of the requirements. The nomination procedure is: members make nominations for possible inclusion on the ballot to the Board's nominating committee. The committee then, in its discretion, determines the ballot. Among the criteria the nominating committee considers when determining the ballot are the skills and experience of the potential nominees (and how those might complement the skills and experience of current Board members), the goal of adding and/or maintaining diverse viewpoints on the Board, and the goal of maintaining a balance between natural- and cultural-resource perspectives on the Board. (It is possible for members to place candidates directly on the ballot through petition; for details, contact the GWS office.) To propose someone for possible candidacy, send his or her name and complete contact details to: Nominating Committee, The George Wright Society, P.O. Box 65, Hancock, MI 49930-0065 USA. All nominees will be contacted by the nominating committee to get background information before the final ballot is determined. Again, the deadline for nominations is 1 July 2002.

Upcoming Conferences of Note

Making Ecosystem-Based Management Work: Connecting Managers and Researchers. *The Fifth International Conference on Science and the Management of Protected Areas (SAMPAA V).* May 11-16, 2003, University of Victoria, Victoria, British Columbia, Canada. Ecosystem-based management explicitly recognizes that protected areas are embedded within a broader landscape/seascape, emphasizing the need for understanding of the processes that link protected areas to the surrounding environment. The goal of this conference is to develop further the links between science and management of protected areas in the context of ecosystem-based management approaches.

Proposed papers should relate to the theme, in one of the following formats:

- Papers having a dominantly scientific aspect, but linked to management applications.
- Papers having a dominantly management emphasis (e.g., actual applications of ecosystem-based management), but linked to information needs.
- Papers that provide a mix of science and management applied to a specific case study.

E-mailed abstracts (no more than 300 words) due by December 31, 2002 to abstracts@sampa.org. Full details at www.sampa.org.

Choices and Consequences: Natural Resources and Societal Decision-Making. *The Ninth International Symposium on Society and Resource Management.* June 2-5, 2002, Indiana University, Bloomington, hosted by IU's Department of Recreation and Park Administration. Full details at www.indiana.edu/~issrm; queries to issrm@indiana.edu.

Our Protected Past. A Major European Conference on National Parks and Archaeology, July 13-17, 2002, University of Exeter. The conference will present and promote understanding and management standards of the historic environment not only in Britain, but also in similarly designated areas throughout Europe. It is being organized by the UK National Park Authorities and a consortium of government bodies (English Heritage, the Countryside Council for Wales. and the Royal Commission on Ancient and Historic Monuments of Wales). The program includes keynote addresses by prominent international speakers and a comprehensive timetable of lectures, workshops, and displays. Fieldtrips to the Dartmoor and Exmoor national parks are planned. Underlying themes will examine the nature and value of the historic environment, perceptions of landscape and the challenges of conservation and management, review mechanisms for designating protected areas throughout Europe, and a consideration of how best to integrate conservation of the natural and historic environments. Presentations of best practice in managing all aspects of the historic environment will cover archaeological sites, monuments, landscapes, settlements, and buildings. Application forms are available by post from OPP Conference, c/o CEDC, University of Exeter, School of Education, Heavitree Road, Exeter EX1 2LU, United Kingdom, or on-line at OPP-Conference@exeter.ac.uk.

Correction

In the last issue of THE GEORGE WRIGHT FORUM (Volume 18, Number 4), the e-mail address for Jerry Rogers was given incorrectly at the end of the two articles he co-authored. The correct address is nburgas@Phronesis.com.

Leslie Armstrong

Applied Geography

Editor's Note: A Sense of Place

Ever since I was a little girl, geography fascinated me. Whether I was riding through the Pine Barrens of New Jersey to visit my grandmother, observing the dollhouse-like towns from a jet plane, or browsing through picture books of beautiful landscapes and people, I was always striving to understand the patterns and complexity of what I saw. These personal perceptions became my world and part of a global geography that seemed intricately interwoven and interdependent. I could see and separate the different components of the landscape. And I became attached to certain places and patterns—some familiar, others exotic—places I wanted to visit or escape to for introspection. The wonder of places, time, and their significance is still with me, even more so now, since I am able to apply these geographical insights to managing special places in the U.S. National Park System.

Geography, and our identification with it, give us a sense of place. Geography also affects the American national identity, and for many national parks is the fundamental reason for their establishment. Therefore, the application of geographic concepts to park management is a natural step. Geography provides the framework, the lines of latitude and longitude, a unique position on the Earth's surface from which park resources can be studied and related. The modeling of landscapes can give us valuable information about the park ecosystem or historical setting, and help us visualize how it will look in the future under various management strategies. Geographic information systems (GIS) and related technologies, such as global positioning systems, are necessary tools for upholding the mandate of the National Park Service (NPS) to manage parks for future generations.

The articles included in this issue of THE GEORGE WRIGHT FORUM exemplify applied geography and originate from presentations made at Spatial Odyssey 2001, an NPS-sponsored GIS conference, held in December in Primm, Nevada. Although this was the such conference to be held by NPS in six years, the participants recommended that we repeat the gathering in 2003. NPS staff, professionals from international and state parks, and other federal agencies attended Spatial Odyssey 2001.

A consistent theme presented in the following articles is the acquisition of spatial (geographic) data in order to define and measure park systems. The first article, by Bob Johnson and Lee Thormahlen, cartographers with the Minerals Management Service (an agency of the Department of the Interior), educates us about marine boundaries of underwater parks and what happens when lines on a map are based upon the ever-changing natural shoreline. Like the Minerals Management Service, NPS employs cartographers who are responsible for portraying those lines on the maps and maintaining boundary information. These GIS boundary files are the data layer that all other park GIS data overlays and are the foundation of our geographic databases, or geodatabases. Other federal agencies, such as the Minerals Management Service, share the work and are dependent on the accuracy and accessibility of this data. Cartographers play a critical role in compiling legal jargon and survey information into understandable geographic representations, resulting in the imposition of policies and actions on delineated parcels of terrain. Cartographers can better plan land acquisition strategies and recommend the most appropriate boundaries for new parks and additions when they use automated systems to map and analyze the areas under consideration.

We generally think of geography in physical terms, but it also has a human or cultural component. Traditionally, geography is the means to quantify physical features—where the boundary lies and how many acres there are. It also presents a way to characterize an area or types of physical features, phenomena, or patterns. We can think of the varied academic endeavors in geography, such as human geography and demographics, or the use of geoindicators, such as glacial extent or newly formed landslides, to objectively measure physical change upon a landscape. A vegetation map intrinsically represents a habitat; e.g., a spatial pattern of dry hammocks and wetlands implies rich biodiversity. In the second article, the experienced GIS staff at Yosemite National Park—Jan van Wagtendonk, his son Kent van Wagtendonk, Joe Meyer, and Kara Paintner—present a vegetation-based model for fire return-interval analysis. They mapped and studied changes in landscape patterns, which were the direct effects of years of fire suppression policies. This led the team to develop GIS fire management planning applications, including prescribed burns, fuel treatment schedules, and geographic priorities. Similarly, damage to cultural resources in Yosemite can be more accurately estimated using the geophysical variables.

Cultural landscapes, such as national battlefields, archaeological sites, and historic trails, buildings, and landmarks, take into consideration the historical anthropogenic impacts upon the physical earth. They also take into consideration the human perceptions of and responses to the geography. This issue of the FORUM also contains articles focused on cultural geography studies. Curt Musselman's article walks us through development of a cultural geography study directly applied to park operations and long-term management. His use of scanned historic maps and surveys, global positioning systems, and GIS at Gettysburg National Military Park was key to analyzing the historic landscape. In another article, John Knoerl and Marisa Zoller's innovative work looks at the use of GIS to evaluate and model the impacts of federal legislation on historic districts in Chicago. He promotes the use of spatial provisions (GIS studies) during the development of any legislation to determine if it is appropriate and if it actually improves historic districts and our communities in general. John and Marisa conclude—as most who deal with data already know—that the GIS products and results are only as good as the data that go into the analysis. Danielle Berman develops this idea in her article about database integration. She asserts that open database architecture is a great improvement over the traditional, compartmentalized, stovepipe approach to information management.

The last article, by Yu-Fai Leung, Nigel Shaw, Keith Johnson, and Roland Duhaime, combines cultural and natural GIS applications, linked to the Visitor Experience and Resource Protection framework, to address social impacts on park resources. This model for decision support again demonstrates the role of GIS and geographic data for crossing disciplines and synthesizing disparate information that is more easily understood in a graphic or spatial format. GIS in NPS is, as the article describes, more than a database and has progressed beyond a simple map production tool to a common systematic and scientific way of working.

Applied geography in the National Park Service is indeed more than a database, but as you will learn, it all starts with expensive data collection. The data must be organized in a meaningful and easy-to-use structure. Nearly two hundred individual national park geodatabases have been constructed over the last ten years or so. They have been aggregated into a standardized system-wide geodatabase of points, lines, and polygons for display on the Internet. Because it is standardized, themes and issues that are common to two or more parks can be spatially studied and compared. This enterprise geodatabase can be used in myriad ways, and relates to millions of other data tied to that unique coordinate on the Earth's surface. Over the next few years, many applications like the ones described in this issue of the FORUM will be standardized for easy use and efficiency. The new Internet system is an interactive way to view and study the fantastic places, phenomena, cultures, and American heritage represented in the National Park System. As the National Park Service continues to develop and refine applied geography, it will become a national legacy of information about park landscapes and human interactions with them, and a tool for improving the success of parks around the globe.

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Robert E. Johnson
Leland F. Thormahlen

Underwater Parks:

Three Case Studies, and a Primer on Marine Boundary Issues

Introduction

Unlike boundaries on land, most marine boundaries are not marked with monuments or fences. But like a monument or fence, marine boundaries *do* require maintenance! Poorly maintained boundaries can impair enforcement of environmental, fishing, and other regulations along that boundary. Further, it must be recognized that no agency places a marine boundary that doesn't affect many other agencies. This paper presents a brief primer on marine boundaries, followed by three case studies.

Primer on Marine Boundaries

In the United States, most marine boundaries are projected from a baseline, which consists of discrete points selected along the shoreline. Figure 1 illustrates our first problem: Where *is* the shoreline? U.S. Geological Survey (USGS) topographic maps typically display either the mean sea level or the mean high-water line, while National Oceanic and Atmospheric Administration (NOAA) nautical charts typically show the mean lowest low-water line. (Always check your map to see which datum was used). Various states use different water levels to mark the division between private lands and state-controlled territory. Note that *federal* offshore boundaries are measured from the mean lowest low-water line.

Federal offshore limits and boundaries include (refer to Figure 2):

- ***State Seaward Boundary.*** The Submerged Lands Act of 1953 (43 U.S. Code 1301) grants most coastal states jurisdiction out to three nautical miles.
- ***Revenue Sharing Line.*** This line, also referred to the "limit of 8g," extends 3 nautical miles beyond the state seaward boundary. Revenues generated from resources such as oil and gas within this area are shared between the federal government and the coastal state. Note that these two

Shoreline Issues: Where is the shoreline?

Different interpretations of the shoreline

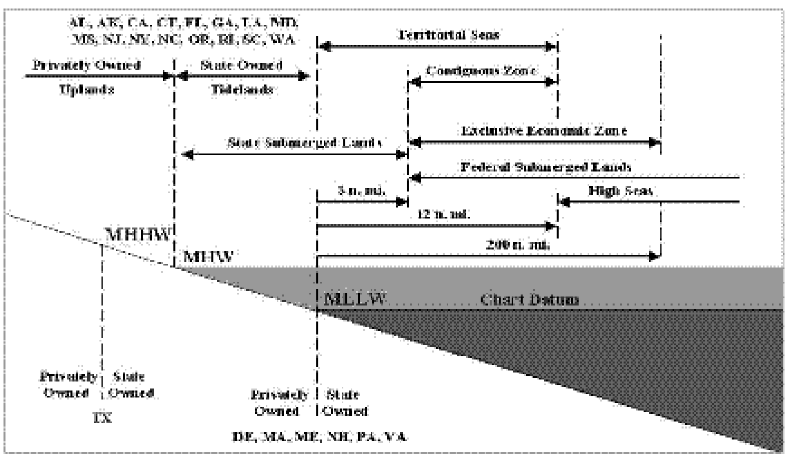

Figure 1. Where is the shoreline?

- lines are unique to the United States. In most countries, *all* o-ffshore territory is controlled by the federal government.
- ***Territorial Sea.*** This line was previously at 3 nautical miles, but was moved to 12 nautical miles by Presidential Proclamation 5928 in 1988, in accordance with the United Nations Convention on the Law of the Sea (UNCLOS). The U.S. claims sovereignty within this line from the air space down through the water column and into the subsoil.
- ***Contiguous Zone.*** Established by Presidential Proclamation 7219 in 1999, this 24-nautical mile buffer grants the U.S. the "control necessary to prevent infringement of its customs, fiscal, immigration or sanitary laws, and regulations within its territory or territorial sea."
- ***Exclusive Economic Zone (EEZ).*** Created by Presidential Proclamation 5030 in 1983, the EEZ claims for the U.S. exclusive rights to economic resources such as oil and gas out to 200 nautical miles.
- ***Article 76 Claims.*** Article 76 of the most recent UNCLOS allows countries to claim resources out to a maximum 350 nautical miles, depending upon the configuration of the continental shelf.

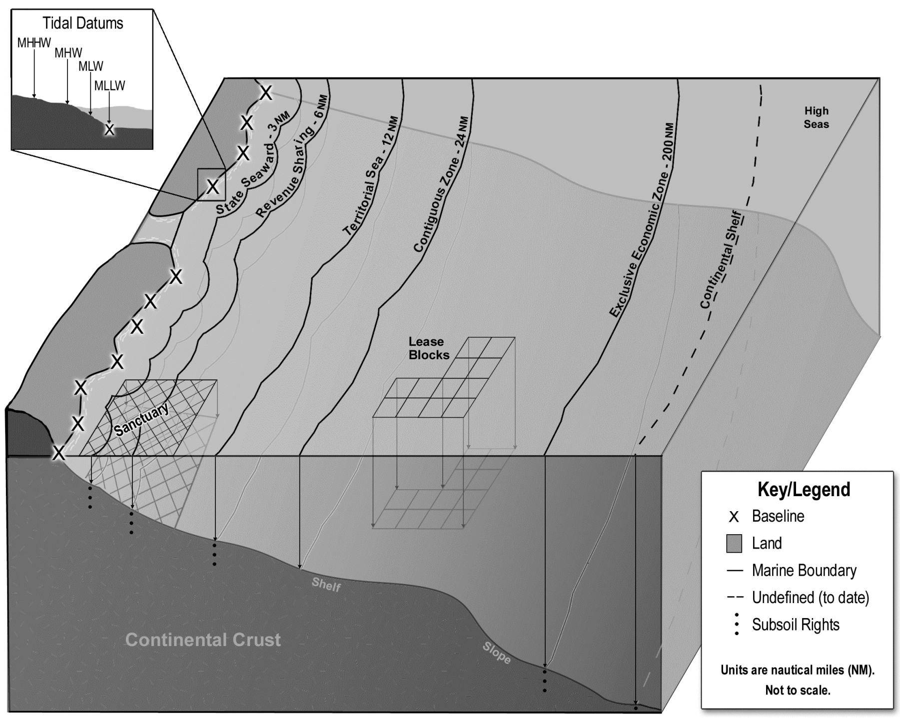

Figure 2. Federal offshore limits and boundaries.

Note that all these boundaries are measured from the baseline points, which are established along the mean lower low-water (MLLW) line, *which includes rocks and islands*. Remember too that, with erosion and accretion, the coastline can move. When that happens, the baseline and associated boundaries will all move with it. Finally, remember that all these boundaries are in nautical miles. A nautical miles equals one minute of latitude at the equator, or 6,076.103 feet, which is not the same as the statute mile commonly used on land—5,280 feet.

Other offshore boundaries include national parks, marine sanctuaries, lease blocks, etc.

Case Study 1: Park Expansions in the U.S. Virgin Islands

As it neared its end, the Clinton Administration was looking for ways to provide greater protection to the nation's coral reefs. Enlarging the boundaries of the existing park system in the U.S. Virgin Islands (i.e., Virgin Islands National Park and Buck Island Reef National Monument) appeared to be one way to accomplish this.

Obviously, the first step for any boundary development is to establish the baseline along the coast. UNCLOS Article 5 states that “the normal baseline for measuring the breadth of the territorial sea is the low water line along the coast as marked on large-scale charts officially recognized by the coastal State.” For the U.S., these would be the NOAA nautical charts; a detail from one is shown in Figure 3. Selecting the baseline simply requires that the seaward-most points along the coast, including rocks and islands, be identified, and coordinates obtained for them (usually through digitizing). A problem arises with “low-water features,” such as rocks, which are indicated on the charts with an asterisk. In the example shown in Figure 3, one rock (marked by the number 2 in parentheses) is indicated as being 2 feet above datum (MLLW). It can be included in the baseline. Another rock (marked by the number 1, overlined, in parentheses) is indicated as being 1 foot below datum. It does not qualify as a baseline point. But what about the other rocks that are undesignated? These need to be field-checked.

Once the baseline was established, the various boundaries could be calculated. As shown in Figure 4, which depicts the expansion of Virgin Islands National Park with a newly designated Coral Reef National Monument, those boundaries include: the Territorial Submerged Lands Act (TSLA) boundary at three nautical miles, the territorial sea boundary at 12 nautical miles, the equidistant line separating Puerto Rico and the Virgin Islands, and the international boundary separating the U.S. and British Virgin Islands. Coordinates for the international boundary had already been published by the U.S. Department of State in the *Federal Register*.

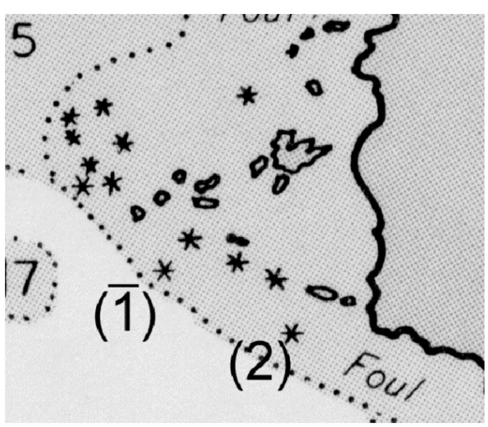

Figure 3. Chart detail.

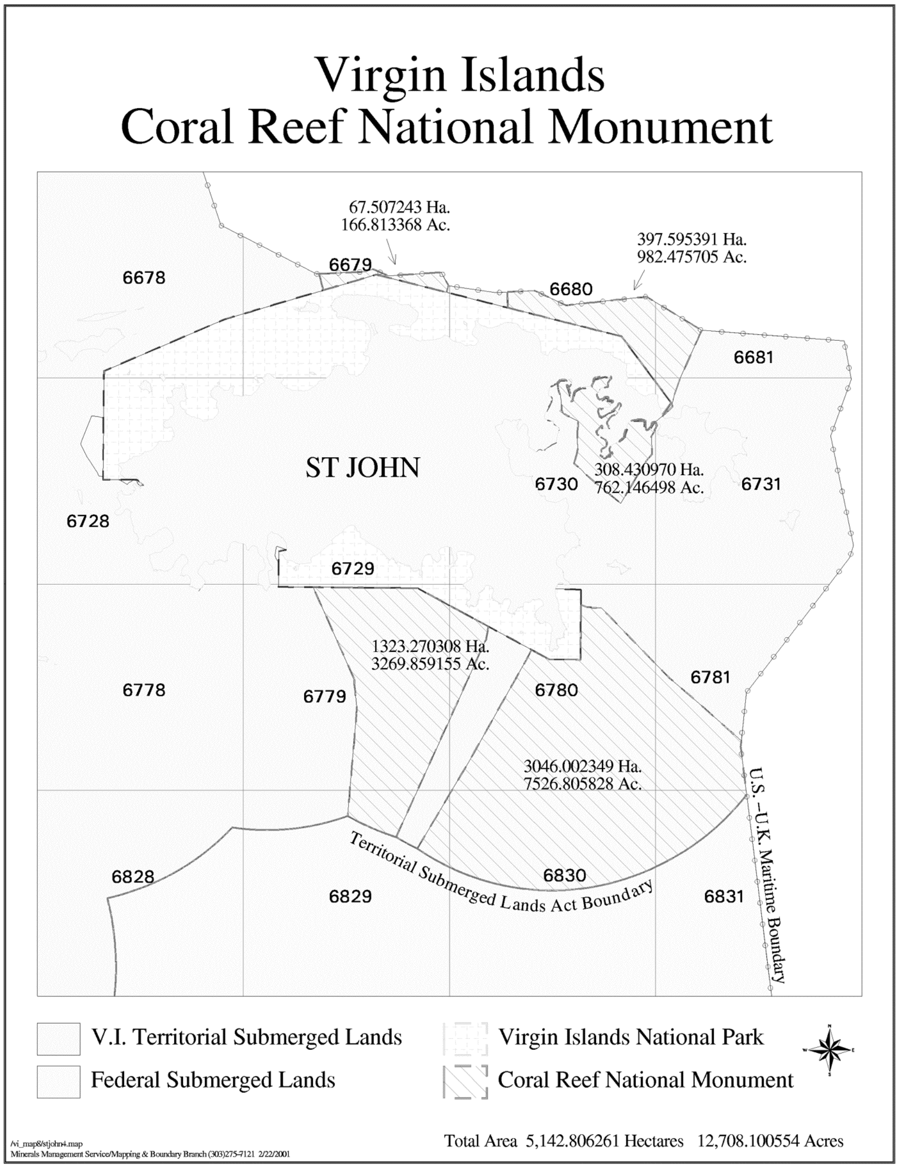

Figure 4. Virgin Islands Coral Reef National Monument.

While the Submerged Lands Act of 1953 granted the three-nautical-mile area to the states, it was the later, *Territorial* Submerged Lands Act (signed on October 5, 1974), that transferred control to the territories. But a careful reading of that act reveals that "all submerged lands adjacent to property owned by the United States above the line of mean high tide" were excepted from the transfer. This would indicate that there may be some areas within the three-nautical-mile line that were retained under U.S. jurisdiction and not relinquished to the territories. But to our knowledge, in over 25 years since the enactment of the TSLA, no one had ever mapped out these areas.

Mapping them first required a careful search of the land records to see which parcels were owned by the U.S. government as of the date of the enactment of the TSLA. Once those were identified, and precise coordinates determined, equidistant lines could be calculated to separate federal areas from those under territorial jurisdiction. Figure 5 shows an example from Buck Island Reef National Monument.

Having established federal ownership of these areas made it possible to then convert them to National Monument Status, which President Clinton did on January 17, 2001, with Executive Order 7392 and Executive Order 7399. These executive orders are still under review by the Government Accounting Office; however, in this case it appears that careful attention to boundary issues may prevail in bringing about an expanded park boundary—and greater protection to the delicate corals.

Case Study 2: Glacier Bay National Park

As in the Virgin Islands national park units, Glacier Bay National Park has both an onshore and offshore component. The latter is now being contested by the state of Alaska in the U.S. Supreme Court. In this case, Alaska asserts that it "took title to all lands underlying marine waters within the boundaries of Glacier Bay National monument at statehood, pursuant to the equal footing doctrine and the Submerged Lands Act" (U.S. Department of Justice 1999). But even if the National Park Service (NPS) is able to keep the offshore property after this case is settled, questions remain with the boundary. That boundary, as set forth by Executive Order 2330 (April 18, 1939, 53 Stat. 2534), goes (in part) from "Cross Sound to the Pacific Ocean; thence northwesterly following the general contour of the coast at a distance of three nautical miles therefrom to a point due west of the mouth of Seaotter Creek...."

This description raises a number of questions. What is meant by the term "the general contour of the coast"? Is it a high-water line? A low-water line? Does it include rocks and islands? The NPS map GLBA-90,004 shows the agency's original interpretation of this line. What further complicates the issue is a *Federal Register* notice published by NPS on September 30, 1992. The notice conflicts with Executive Order 2330 and the map GLBA-90,004. The *Federal Register* notice stated that the line runs "due west, 3 miles to a point on the line demarking the Territorial Sea of the United States...." If one uses the Territorial Sea line, then one has to use rocks and islands to determine the boundary. Figure 6 depicts both the park boundary (taken from map GLBA-90,004) as the innermost line and the

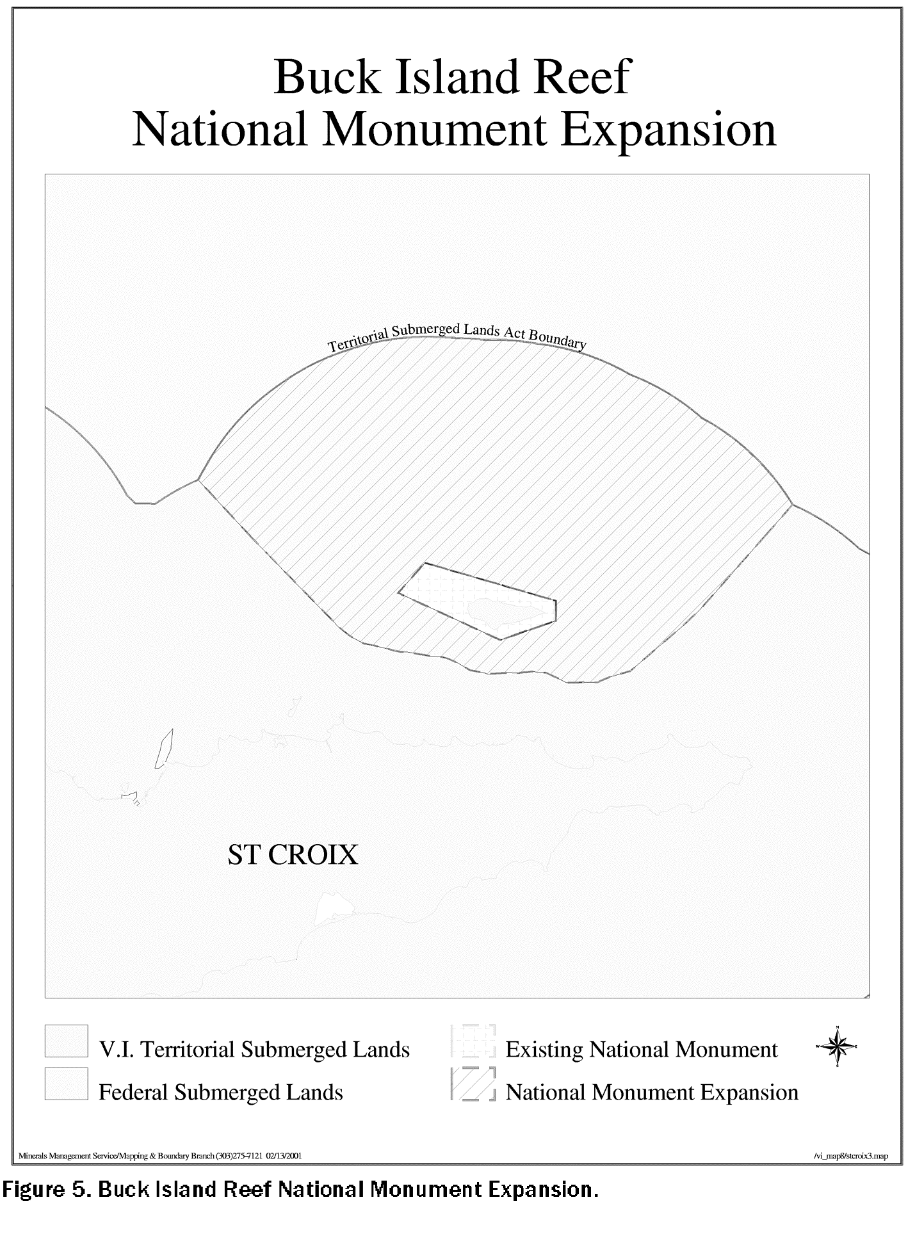

Figure 5. Buck Island Reef National Monument Expansion.

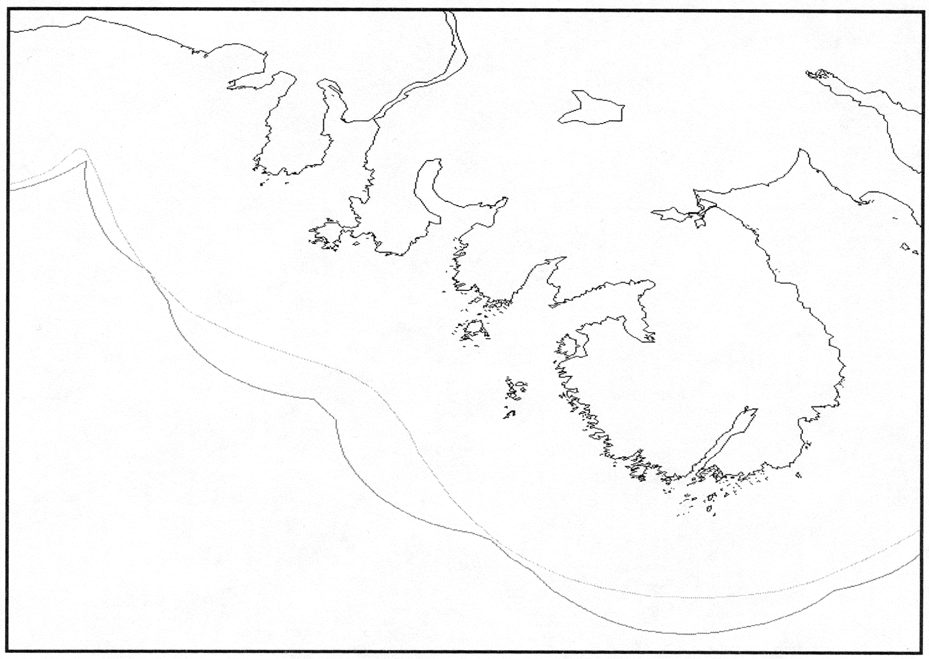

Figure 6. Two versions of Glacier Bay National Park boundary. Innermost line is the park boundary as shown on the map GLBA-90,004. Outermost line is the Submerged Lands Act three-nautical-mile line as calculated by the Minerals Management Service.

Submerged Lands Act three nautical-mile line (as calculated by the Minerals Management Service) as the outermost line. It is clear that rocks and islands were *not* originally used by NPS in determining the park's boundary. Also at issue here is the depiction of a median line through a number of straits within Cross Sound. To our knowledge, the Park Service has never issued official *coordinates* describing this boundary.

Case Study 3: The Florida Keys National Marine Sanctuary

In order to give greater protection to the marine resources of the Florida Keys, especially those that are not already protected by the existing patchwork of state and federal parks in the area, NOAA has established the Florida Keys National Marine sanctuary. This action will require other agencies, such as the Minerals Management Service, to withdraw the affected area from consideration for oil and gas development. Unfortunately, NOAA has been unable to complete a set of coordinates for the sanctuary. They have a gap where the sanctuary closes against the existing boundary for Everglades National Park. This is because NOAA has been unable to get precise coordinates for the Everglades boundary from NPS. Until such coordinates are provided, NOAA will be unable to finish its work on the sanctuary, and the Minerals Management Service will be unable to complete their withdrawals for the area within their cadastre. All of this helps to illustrate the point that *no one places a boundary out there that doesn't affect everyone else*.

Resolving Ambiguities

Clearly, it is not easy for GIS users to convert legal descriptions of boundaries into the precise coordinates needed to display them in GIS systems, especially when those legal descriptions are vague or inconsistent. Ambiguities in boundary locations could impede enforcement of those boundaries. Finally, ambiguous boundaries controlled by one entity can also negatively affect other agencies in performing their duties.

To deal with numerous issues such as these, the Marine Boundary Working Group was formed in 2001 under the Federal Geographic Data Committee. It includes representatives from nearly every federal agency (including NPS) that either creates or uses offshore boundaries. The purpose is as follows:

> The marine Boundary Working Group (MBWG) was formed to address a number of issues pertaining to legal and technical issues of marine boundaries. Because most maritime boundaries were defined prior to the advent of modern technology such as global positioning systems (GPS) and geographic information systems (GIS), many of the world's nautical charts, treaties, and regulations may contain marine boundary descriptions that are inaccurate, insufficient, and conflicting. In the United States, these discrepancies can negatively affect many ocean related activities, including oil and gas leases, open ocean disposal zones, and the enforcement of fishing and environmental laws (NOAA 2001).

Conclusion

Precise, unambiguous offshore boundaries can be an asset in protecting the valuable resources that have been placed under the care of the National Park Service. Failing to properly locate and maintain boundaries can negatively affect NPS enforcement, and also impedes the work of other federal agencies. The Marine Boundary Working Group is a valuable resource for resolving these problems.

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Kent A. van Wagtendonk
Joseph B. Meyer
Kara J. Paintner

The Use of Geographic Information for Fire Management Planning in Yosemite National Park

Fire has played a critical role in the ecosystems of Yosemite National Park for millennia. Before the advent of Euro-Americans, lightning fires and fires set by Native Americans burned freely across the landscape. These fires burned periodically, with the interval between fires dependent on the availability of ignition sources, adequate fuels, and weather conducive to burning. As a result, different vegetation types burned at different intervals.

Designation of Yosemite Valley and the Mariposa Grove as a state reserve in 1864, and of the remaining area surrounding the valley as a national park in 1890, led to an era of fire suppression. Landscape-scale changes resulted from decades of a management philosophy that excluded naturally occurring fires. These landscape-scale changes are characterized by departures from the natural fire-return interval—the number of years between successive naturally occurring fires for a given vegetation type. Prior to the exclusion of fire, intervals between fires ranged from a few years in the lower montane forests to centuries in the subalpine forests.

Interruption of the natural regime, reflected in the fire return-interval departure, is a major thrust in the development and analysis of the Yosemite fire management plan and environmental impact analysis. Areas that have missed multiple return intervals are more susceptible to stand-replacing wildland fires, which are uncommon in natural surface-burning fire regimes. The plan strives to restore and maintain the natural range of variability by focusing treatment of areas based on the fire return-interval departures.

Geographic Information

Geographic information systems (GIS) have been used in Yosemite National Park for fire research and management applications since the early 1980s (van Wagtendonk 1991). A GIS model was used for the fire return-interval departure analysis in the new fire management plan for the park. The analysis was originally developed in Sequoia and Kings Canyon National Parks (Caprio et al. 1997). It combines information on fire history and fire ecology to assess the ecological condition of all vegetation communities, using departures from the natural fire return intervals as an indicator of change. The analysis consists of four steps: (1) vegetation types are defined based on similar fuels and fire behavior, (2) fire return intervals are assigned to each type, (3) the number of years since an area last burned is determined from fire history maps, and (4) departures from the natural fire interval are calculated using the return interval. The results from this analysis are then applied to the fire management planning process.

Although the park is currently developing a new vegetation map, the most recent map dates from the 1930s and was compiled from field surveys and sample plots (van Wagtendonk 1986). This map was digitized and entered into a GIS in 1981. Over 6,500 polygons were assigned species names from over 1,200 unique combinations of species. These polygons were reclassified into 33 types as part of the park's vegetation management plan. Fire history maps and data have been collected in the park since 1930 and were also entered into a GIS in 1981. This GIS coverage has been updated after each fire season and includes the name, year, management type, and ignition source of each fire. Both the vegetation map and the fire history map were converted into ArcInfo raster data sets. The ArcInfo GRID module and the Spatial Analyst extension of ArcView were used to perform the fire return-interval departure analyses (ESRI 1996). These modules allowed multiple raster data sets to be analyzed simultaneously.

Vegetation Communities

The vegetation zones across the park follow general elevation bands across the Sierra Nevada from chaparral oak woodlands, through lower montane forests, upper montane forests, and subalpine forests, to alpine meadows. At the lowest elevations in the park (about 2,000 feet above mean sea level), the vegetation is chaparral and oak woodland. Lower montane mixed-conifer forests occur from about 3,000 to 6,700 feet. Upper montane conifer forests occur from about 6,000 to 10,000 feet. Subalpine conifer forests occur from 8,000 to 11,000 feet. Alpine communities dominate above 10,000 feet.

Fire professionals examined each of the 33 vegetation management plan types and reclassified them based on similar vegetation, fire behavior, and fuel loads. In most cases, the reclassification was a simple reassignment, but in a few cases vegetation types were lumped based on the characteristics of neighboring types.

For example, if a subalpine meadow adjoins a lodgepole pine forest, it would be lumped with the forest since the meadow would be likely to burn if the forest was ignited. If, however, the meadow was surrounded by barren rock, it would be lumped with the rock since it would be unlikely to be ignited. These neighborhood analyses were performed for meadows, riparian vegetation types, and western juniper.

The resulting 15 vegetation groups and the barren and water categories are shown in Figure 1 and listed in Table 1 for the 747,955 acres in Yosemite National Park and the 1,137 acres in the El Portal Administrative Site. The types are listed by zone, generally from higher to lower elevation. Table 2 includes information on fuel loads, fireline intensities, and typical fire behavior in each of the vegetation types. A description of each of the vegetation zones follows.

Subalpine forests. The subalpine zone includes whitebark pine and

Table 1. Vegetation zone, types, and acreage for Yosemite National Park and the El Portal administrative site.

Vegetation zone	***Vegetation type***	***Acres***
Subalpine forests	Whitebark pine–mountain hemlock forest	87,582
	Lodgepole pine forest	175,516
Upper-montane forests	Red fir forest	68,125
	Western white pine–Jeffrey pine forest	132,708
	Montane chaparral	15,137
Lower-montane forests	Giant sequoia–mixed conifer forest	218
	White fir–mixed-conifer forest	46,871
	Ponderosa pine–mixed-conifer forest	34,370
	Ponderosa pine–bear clover forest	33,846
	California black oak woodland	3,156
	Canyon live oak forest	21,473
	Dry montane meadow	1,530
Foothill woodlands	Foothill pine–live oak–chaparral woodland	7,130
	Foothill chaparral	1,785
	Blue oak woodland	473
Subtotal, Vegetation		629,920
Barren	Bare rock	112,022
	Water	7,150
Total		749,092

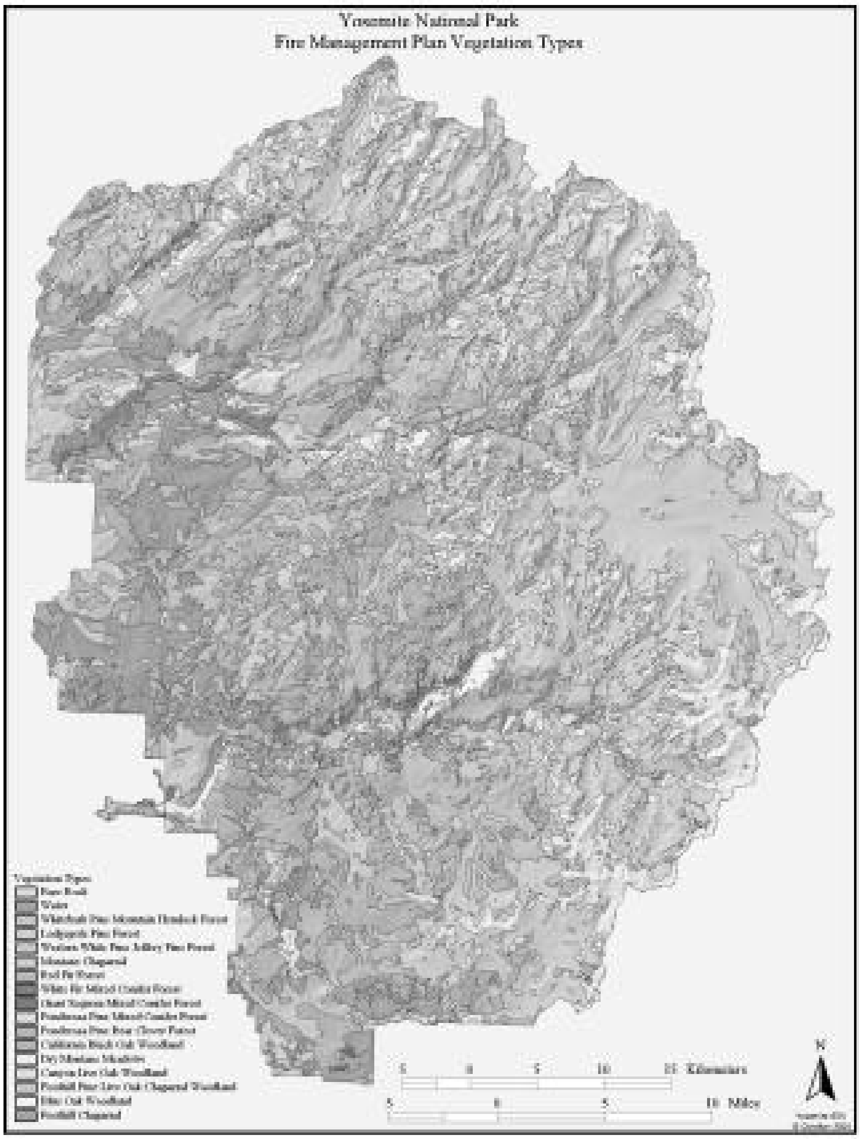

Figure 1. Vegetation types, Yosemite National Park and El Portal administrative site.

Mountain hemlock forests and lodgepole pine forests, which together occupy about 35% of the park. Characteristic trees include lodge-pole pine *(Pinus contorta),* mountain hemlock *(Tsuga mertensiana),* and whitebark pine *(Pinus albicaulis),* with smaller amounts of red fir *(Abies magnifica),* western white pine *(Pinus monticola)* and western juniper *(Juniperus occidentalis).* Although this zone receives approximately 35% of the lightning strikes in the park, fires are infrequent and do not become large (van Wagtendonk 1994). These fires usually smolder or spread as low-intensity surface fires.

Upper montane forests. The upper montane zone includes red fir forest, western white pine/Jeffrey pine forest, and montane chaparral, and makes up about 30% of park vegetation. Characteristic trees include red fir, western white pine, Jeffrey pine *(Pinus jeffreyi),* western juniper, and aspen *(Populus tremuloides).* Dominant shrub species in- clude greenleaf manzanita *(Arctostphylos patula),* pinemat manzanita *(Arctostaphylos nevadensis),* mountain white thorn *(Ceanothus cordulatus),* huckleberry oak *(Quercus vacinifolia)* and, at lower elevations, bitter cherry *(Prunus emarginatus)* and chinquapin *(Castanopsis sempervirens).* This zone receives 23% of the lightning strikes in the park, and fires are numerous, generally remain small, and are of low intensity (van Wagtendonk 1994). However, under extremely dry and windy conditions, large stand-replacing fires can occur.

Lower montane forests. The lower montane zone, which includes giant sequoia, white fir, and ponderosa pine mixed-conifer forests and ponderosa pine–bear clover forest, covers about 15% of the park. This zone also contains California black oak woodlands, canyon live oak forests, and dry montane meadows. Dominant tree species include ponderosa pine *(Pinus ponderosa),* sugar pine *(Pinus lambertiana),* incense-cedar *(Calocedrus decurrens),* white fir *(Abies concolor),* giant sequoia *(Sequoiadendron giganteum),* California black oak *(Quercus kelloggii),* and canyon live oak *(Quercus chrysolepsis).* The most common understory shrubs are bear clover *(Chamaebatia foliolosa),* whiteleaf manzanita *(Arctostaphylos viscida),* and deerbrush *(Ceanothus intergerimus).* Although the lower montane forests receive only 17% of the lightning strikes in the park, the mixed-conifer community experiences frequent, low-intensity fires (van Wagtendonk 1994). Many of these fire were suppressed, however, resulting in a change from open forest to dense thickets of shade-tolerant tree species, particularly incense-cedar and white fir in the upper part of the zone, and an increase in shrubs in the lower part. Under natural conditions, the median fire return interval is estimated at 8 to 12 years. Existing conditions,

Table 2. Fuel load, fireline intensity, and typical fire behavior for vegetation types in Yosemite National Park and the El Portal administrative site. Loads are from van Wagtendonk et al. (1998), intensities from Caprio and Lineback (1997), and typical fire behavior from Botti (1990).

Vegetation Type	*Fuel Load*		*Fireline Intensity*	*Typical Fire Behavior*
	Duff	*Woody*		
	-----Tons/ac-----		--Btu/ft/s--	
Whitebark pine–mountain hemlock forest	50.2	3.7	1-40 mean=10	Smoldering or low intensity, surface fire
Lodgepole pine forest	27.7	2.0	1-40 mean=10	Smoldering or low intensity, surface fire
Red fir forest	39.8	8.9	1-120 mean=25	Surface fire, flames <1 ft, flare-ups in heavy fuel
Western white pine– Jeffrey pine forest	41.7	1.5	1-60 mean=30	Moderate intensity fire, flames 1-4 ft, torching may occur
Montane chaparral	—	3.5	50-6,330 mean=3,000	Fast spread involving entire biomass, flames 20-30 ft
Giant sequoia–mixed-conifer forest	68.6	10.4	20-1,000 mean=100	Erratic spread, flames <2 ft, intense burning in heavy fuels
White fir–mixed-conifer forest	36.1	4.6	20-1,000 mean=100	Slow spread, flames <2 ft, intense burning in heavy fuels
Ponderosa pine–mixed-conifer forest	55.5	4.4	20-1,000 mean=100	Low intensity, surface fire, flames 2 ft
Ponderosa pine–bear clover forest	48.0	4.4	20-1,000 mean=100	Surface fire in shrub layer, flames 2 ft

California Black oak forest	10.0	2.0	1-120 mean=25	Low intensity, surface fire, flames <1 ft
Canyon live oak forest	—	25.0	50-6,330 mean=3,000	Torching of large trees, frequent crown fire
Dry montane meadow	3.0 (grass)		4-125 mean=100	Fast spread with wind, flames 2-10 ft
Foothill pine–live oak–chaparral	20.7	21.7	50-6,330 mean=3,000	Fast spread, torching and crowning in trees and shrubs
Foothill chaparral	—	14.0	50-6,330 mean=3,000	Fast spread involving entire biomass, flames 20-30 ft
Blue oak woodland	0.75 (grass)		4-125 mean=100	Fast spread in grass with wind, flames 2-10 ft

however, often generate fires of much greater intensity than would occur under a natural fire regime.

Foothill woodland. The foothill woodland zone includes foothill pine–live oak–chaparral woodland, blue oak woodland, and foothill chaparral. This zone covers about 5% of the park ranging from 1,700 to 6,000 feet. Dominant tree species include California black oak, foothill pine *(Pinus sabiniana)*, canyon live oak, interior live oak *(Quercus wislizenii)*, and blue oak *(Quercus douglasii)*. Many of the types are better recognized by the dominant shrubs, including mountain mahogany *(Cercocarpus betuloides)*, poison oak *(Toxicodendron diversiloba)*, whiteleaf manzanita, deerbrush, and buckbrush *(Ceanothus cuneatus)*. Lightning is not frequent in the foothill zone, receiving only 2% of the recorded strikes in the park (van Wagtendonk 1994). Even when made proportional to the size of the zone, only 8% of the strikes occur there. Consequently, lightning fires are not very frequent, but when they do occur, they spread quickly and are very intense.

Fire Return Interval

Fire plays a varying role in the vegetation types, characterized by the fire return interval. A fire return interval for a given vegetation type is defined as the number of years between fires at a specific location that is representative of that type. For example, a fire scar analysis of a sample of trees in a stand of ponderosa pines might show that fire has occurred in that stand from as frequently as every two years (minimum value) or as infrequently as every six years (maximum value). The average fire return interval is the arithmetic mean of all the intervals (mean interval); due to sampling techniques, it is usually closer to the minimum interval than the maximum. If fire return intervals for all trees are arranged from shortest to longest, the tree in the middle would have the median interval, which might be every four years (median value).

Table 3 lists the minimum, median, and maximum fire return intervals for each of the vegetation types and the sources for that information. In some cases, only the mean value was available; it is listed in table 3 in the median column. Skinner and Chang (1996) give a thorough discussion on return intervals and were the primary or secondary source for most of the entries. Caprio and Lineback (1997) provided additional sources. In cases where no specific studies existed for a species, the closest ecologically similar species was selected. The information from Table 3 was used to reclassify the park vegetation map into maximum and median fire return-interval maps. Maximum fire return intervals ranged from five years for dry montane meadows to 508 years for whitebark pine and western hemlock forests. These same types had the shortest (1 year) and longest (187 years) median intervals.

Fire History

Fire history maps dating back to 1930 for the park proper and to 1958 for the El Portal administrative site were used to develop information on ignition source, fire size, number of times a particular area has burned, the decade in which each burn occurred, and the last year in which a burn occurred within a particular area. The fire history data are as complete as possible, but there are a few historic fires that are incompletely documented, and it is suspected that there are a few historic fires that are totally undocumented. Table 4 shows the variation in the area burned over the decades. Reburns within a decade are not recounted, but reburns occurring in multiple decades are. During the 1930s, fuel accumulations had not become critical and most fires did not become large before they were suppressed. A single human-caused fire in 1948 accounted for most of the acres burned during that decade. Increased suppression efforts in the 1950s and 1960s, combined with new equipment and technology, resulted in a reduction in the acreage burned.

Table 3. Minimum, median, and maximum fire return intervals for the vegetation types in Yosemite National Park and the El Portal administrative site.

Vegetation type	***Return Interval***			***Source***
	Min.	***Med.***	***Max.***	
	---------Years---------			
Whitebark pine–mountain hemlock forest	4	187	508	Caprio and Lineback 1997
Lodgepole pine forest	4	102	163	Kiefer 1991
Red fir forest	9	30	92	Caprio and Lineback 1997
Western white pine–Jeffrey pine forest	4	12	96	Skinner and Chang 1996
Montane chaparral	10	30	75	Caprio and Lineback 1997
Giant sequoia–mixed-conifer forest	1	10	15	Swetnam et al.1991
White fir–mixed-conifer forest	3	8	35	Skinner and Chang 1996
Ponderosa pine–mixed-conifer forest	3	9	14	Kilgore and Taylor 1979
Ponderosa pine–bear clover forest	2	4	6	Caprio and Swetnam 1993
California black oak woodland	2	8	18	Stephens 1997
Canyon live oak forest	7	13	39	Skinner and Chang 1996
Dry montane meadow	1	2	5	Anderson 1993
Foothill pine–live oak–chaparral woodland	2	8	49	McClaran and Bartolome 1989
Foothill chaparral	10	30	60	Caprio and Lineback 1997
Blue oak woodland	2	8	49	McClaran and Bartolome 1989

The prescribed burning and wildland fire use programs began in 1970 and 1972, respectively, ushering in the era of fire management. The acreage burned increased dramatically as these programs began to allow fire to play its natural role in the ecosystem. This growth continued during the 1980s in spite of the moratorium on management fires in 1989 as a result of the Yellowstone fires. During the 1990s, three large lightning fires that were suppressed burned nearly 60,000 acres in the park and the administrative site. Only 47 acres were burned in 2000, the year of another moratorium, this one resulting from the Los Alamos fires.

Figure 2 shows the year of last burn by vegetation type for all ignition sources combined. This map is used in the calculation of fire return-interval departure as an indicator of the most recent fire to burn an area. Ecologically, it makes no difference whether the fire was ignited by lightning or by humans, on purpose or by accident. The large burns on the western edge of the park were suppressed lightning fires that occurred in 1990 and 1996. The area in the

Table 4. Acres burned of each vegetation type by decade, Yosemite National Park and the El Portal administrative site, 1930 through 2000. The acreages include overlap between decades.

Vegetation Type	*Decade*							
	1930s	***1940s***	***1950s***	***1960s***	***1970s***	***1980s***	***1990s***	***2000***
	----------Acres----------							
Whitebark pine–mtn. hemlock	16	0	0	2	23	31	3	0
Lodgepole pine forest	20	175	13	233	897	4,536	3,059	39
Red fir forest	6	744	48	576	1,435	7,706	7,466	4
W. white pine–Jeffrey pine	66	4,962	249	390	6,720	18,928	20,296	6
Montane chaparral	6	910	11	262	277	1,832	1,368	0
Giant sequoia–mixed-conifer	0	0	0	0	81	31	88	0
White fir–mixed-conifer	41	390	61	300	2,439	7,541	17,144	1
Ponderosa pine–mixed-conifer	6	381	468	817	4,796	4,641	14,956	3
Ponderosa pine–bear clover	11	481	832	794	4,604	4,602	18,055	0
California black oak forest	0	56	4	0	241	622	354	0
Canyon live oak forest	331	3,514	83	638	1,517	129	9,258	0
Dry montane meadow	0	36	5	30	197	125	434	0
Foothill pine–oak–chaparral	5	440	2,163	962	269	126	6,216	0
Foothill chaparral	0	0	0	32	0	63	363	0
Blue oak woodland	0	0	0	0	116	4	301	0
Total	508	12,089	3,937	5,036	23,612	50,917	99,361	53

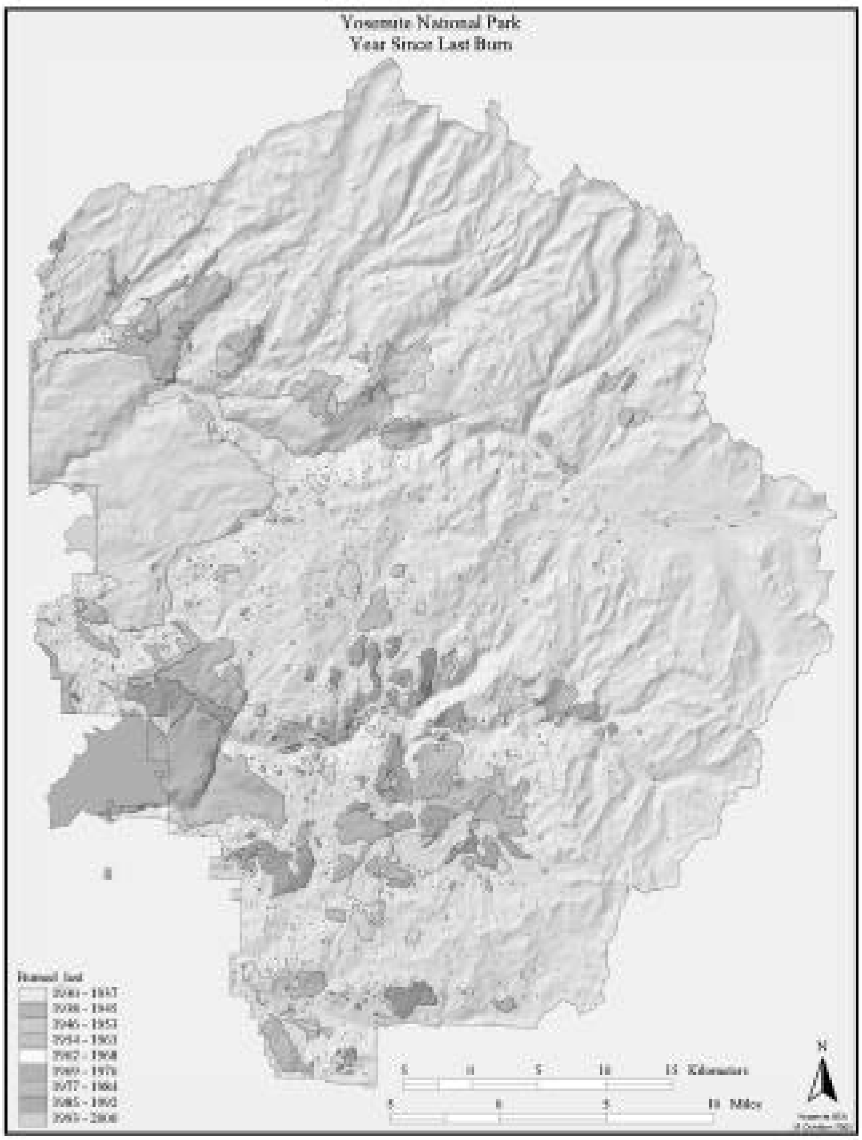

Figure 2. Area burned by vegetation type and decade, Yosemite National Park and El Portal administrative site, 1930 through 2000.

south-central portion of the park includes the Illilouette Creek basin where large lightning fires have been allowed to run their course since 1972 as part of the wildland fire -se program (van Wagtendonk 1994). Similar areas of large lightning fires occur in the Frog Creek drainage north of Hetch Hetchy Reservoir.

The ignition source data are shown in Table 5. Acreage numbers do not include areas that were reburned by fires of the same ignition source; however, areas burned by fires from more than one ignition source are counted two or three times. Lightning accounts for over 93% of the unplanned ignitions. The resulting fires have burned over 145,400 acres. Two hundred forty-five human-caused fires have burned nearly 18,600 acres; 12,000 acres burned in a single fire in 1948. Managers have ignited 399 prescribed fires between 1970 and 2000, and those fires have burned over 41,000 acres. Most of the prescribed burning has been conducted in the white fir and ponderosa pine types where fuel conditions have been affected by fire exclusion in the past.

When reburned areas are not recounted, a total of 160,511 acres (25%) of the vegetated areas of the park and the administrative site have burned during the past 71 years (Table 6). Over 469,400 acres have not burned; most of these are in the whitebark pine–mountain hemlock and lodgepole pine forest types in the subalpine zone. Only 877 acres have burned four or more times, while 6,880 acres have burned three times; 36,100 acres burned two times, and 116,653 acres burned only once. Reburns have been most common in the mixed-conifer types where prescribed burns have been set and in the Illilouette Creek and Frog Creek basins.

The largest number of acres burned by a single lightning fire in each vegetation type and the year of that fire are shown in Table 7; however, these data do not include the 1990 A-Rock and Steamboat fires or the 1996 Ackerson fire. Data collected in the field on the 1990 fires indicate that, in addition to unnaturally high fuel loads, atmospheric conditions combined with steep slope topography and local winds contributed to catastrophic fire behavior. Fire suppression activities, particularly back-firing on the Ackerson fire, have also increased the area burned beyond what might have done so naturally for all three fires omitted from Table 7. The 1953 fire was the only one that did not occur under the wildland fire-use program and indicates the maximum size that might be expected to burn in each vegetation type under natural conditions. Landscape-scale changes in the fire regime are characterized by an analysis of departures from the fire return interval that would have prevailed had fires been allowed to burn naturally.

Table 5. Number of fires and acres burned by vegetation type and ignition source, Yosemite National Park and El Portal administrative site, 1930-2000. The acreages include overlap between ignition sources.

Vegetation Type	***Ignition Source***					
	Lightning		***Human***		***Prescribed***	
	No.	***Acres***	***No.***	***Acres***	***No.***	***Acres***
Whitebark pine–mountain hemlock forest	56	121	0	0	0	0
Lodgepole pine forest	427	8,358	25	399	13	354
Red fir forest	591	16,767	18	1,004	5	307
Western white pine–Jeffrey pine forest	893	41,982	47	6,385	24	5,584
Montane chaparral	126	2,651	11	1,175	22	755
Giant sequoia–mixed-conifer forest	0	0	0	0	17	241
White fir–mixed-conifer forest	427	20,436	25	625	13	7,387
Ponderosa pine–mixed-conifer forest	341	15,545	19	809	88	10,976
Ponderosa pine–bear clover forest	247	19,160	59	1,494	121	11,619
California black oak woodland	24	353	3	81	22	868
Canyon live oak forest	108	10,510	21	5,001	22	2,025
Dry montane meadow	16	421	3	54	36	433
Foothill pine–live oak–chaparral woodland	34	8,555	8	1,424	3	302
Foothill chaparral	17	336	3	25	6	110
Blue oak woodland	2	315	3	120	7	62
Total	3,309	145,462	245	18,596	399	41,023

Table 6. Number of times burned in acres by vegetation type, Yosemite National Park and El Portal administrative site, 1930-2000. The total does not include bare rock and water areas.

Vegetation type	***Times Burned***					***Total***
	0	***1***	***2***	***3***	***4+***	
	-----------------------------Acres-----------------------------					
Whitebark pine– mtn hemlock	87,461	121	0	0	0	87,582
Lodgepole pine forest	166,903	7,467	989	157	0	175,516
Red fir forest	50,483	16,084	1,476	81	1	68,125
Western white– Jeffrey pine	88,668	34,477	6,884	2,423	256	132,708
Montane chaparral	11,285	2,787	874	185	6	15,137
Giant sequoia– mixed-conifer	36	88	81	9	4	218
White fir–mixed-conifer forest	22,426	20,000	3,979	448	18	46,871
Ponderosa pine– mixed conifer	14,744	12,609	6,178	792	47	34,370
Ponderosa pine– bear clover	12,168	12,411	7,201	1,731	335	33,846
California black oak forest	2,012	959	158	27	0	3,156
Canyon live oak forest	10,250	4,871	5,596	661	95	21,473
Dry montane meadow	911	402	154	38	25	1,530
Foothill pine–oak–chaparral	705	3,666	2,357	312	90	7,130
Foothill chaparral	1,243	503	39	0	0	1,785
Blue oak woodland	114	208	135	16	0	473
Total	469,409	116,653	36,101	6,880	877	629,920

Fire Return-Interval Departure

In general, the further that vegetation communities depart from their natural fire regimes, the more that unnatural conditions will prevail and the higher the risk of the occurrence of a stand-replacing wildland fire that is not natural to surface-burning fire regimes. Maximum fire return-interval departure represents the most conservative estimate of how severe the deviation from natural conditions might be in terms of fuels and vegetation. Median fire return-interval departure gives a more moderate view, while the minimum presents the most extreme situation of how far the stand is from its natural condition. For example, if fire suppression has been successful in excluding fire from the stand for sixty years, it would have missed thirty fires based on the minimum fire return interval of two years, fifteen fires based on the median interval of four years, and ten fires based on the maximum interval of six years. These departures from the normal fire regime are expressed in terms of fire return-interval departures of 30, 15, and 10 missed intervals, respectively.

The number of interval departures for both the median and maximum fire return interval departures is calculated using the following map algebra:

Fire return-interval departure = [fire return interval – (current year – year last burned)] ÷ fire return interval

The fire return-interval departure map is the absolute value of the fire return-interval map minus the value of the current year less the year-last-burned map all divided by the fire return-interval map. The return interval can be calculated for both the maximum and median interval. For areas that have not burned since 1930 in Yosemite National Park or 1985 for the El Portal administrative site, the year last burned was considered to be 1930 and 1958, respectively.

Maximum and median fire return-interval departures were grouped into three categories: 0-2 intervals missed, 3-4 intervals missed, and five or more intervals missed. These groupings are based on the assumption that fire exclusion increases surface and ladder fuels, greatly increasing the potential for catastrophic fire.

Table 7. Size and year of largest lightning fires by vegetation type, Yosemite National Park and the El Portal administrative site, 1930 through 2000.

Vegetation type	*Acres*	*Year*
Whitebark pine–mountain hemlock forest	20	1988
Lodgepole pine forest	773	1987
Red fir forest	1,265	1999
Western white pine–Jeffrey pine forest	3,274	1974
Montane chaparral	641	1999
Giant sequoia–mixed-conifer forest	0	1976
White fir–mixed-conifer forest	1,092	1988
Ponderosa pine–mixed-conifer forest	960	1999
Ponderosa pine–bear clover forest	1,247	1987
California black oak woodland	91	1999
Canyon live oak forest	3,517	1999
Dry montane meadow	35	1988
Foothill pine–live oak–chaparral woodland	1,909	1953
Foothill chaparral	43	1987
Blue oak woodland	5	1987

These high-intensity and severe fires are outside the natural range of variability. The rationale for the 0-2 departures-missed group is that, for most vegetation types, two median intervals lie between the minimum and maximum return intervals. For example, California black oak woodland has a median interval of eight years, and twice that interval (16years) falls between the minimum (two years) and maximum (18 years) fire return intervals. Areas that have missed two or fewer median fire return intervals are considered to be within their natural range of variability. For most vegetation types, a departure of three or more median return intervals was outside of the maximum fire return interval for the type. For example, the median fire return interval for lodgepole pine forest is 102 years. If a lodgepole pine stand has a departure value of three, it means that the area has not burned for at least 306 years. This length of time is much greater than 163 years, the recorded maximum return interval for the type. But in a few vegetation types, a return interval departure of three is still within the maximum fire return interval for the type. The red fir forest median return interval is 30 years, and 90 years will have passed before areas have missed three fire cycles. This value is less than the maximum return interval of 92 years.

Results of the analysis using the maximum fire return-interval departure indicate that 95% of the park and the administrative site had missed no more than two return intervals (Table 8). The remaining 5% was all in short fire return-interval types containing ponderosa pine or dry montane meadows. The median fire return-interval departure analysis is depicted in Figure 3. The analysis shows that 74% of the vegetation has missed no more than two return intervals and is considered to be in an acceptable ecological condition (that is, exhibiting little to no deviation from a natural fire regime) as of 2000 (Table 9). These areas are expected to remain in an acceptable ecological condition as long as the natural fire regime is maintained. Another 1% of the vegetation shows significant deviation from natural conditions, and 25% is considered highly compromised by past fire suppression. Most of the deviation from natural conditions occurs in the lower-to-mid-elevation conifer forests, including the giant sequoia groves. Despite ongoing reintroduction of fire to the groves over the past 30 years, progress has been slow—17% of the groves still contain unnaturally high levels of fuel. The analysis does show positive effects from fire management activities because many areas are in an acceptable condition, but also underscores the fact that large areas require attention.

Table 8. Acres of each vegetation type by number of maximum fire return intervals missed, Yosemite National Park and El Portal administrative site, 1930 through 2000. The total does not include bare rock and water areas.

Vegetation type	*Number of Maximum Return Intervals Missed*			*Total*
	0-2	*3-4*	*5+*	
	----------Acres----------			
Whitebark pine–mtn. hemlock forest	87,582	0	0	87,582
Lodgepole pine forest	175,516	0	0	175,516
Red fir forest	68,125	0	0	68,125
Western white pine–Jeffrey pine forest	132,708	0	0	132,708
Montane chaparral	15,137	0	0	15,137
Giant sequoia–mixed-conifer forest	182	36	0	218
White fir–mixed-conifer forest	46,871	0	0	46,871
Ponderosa pine–mixed-conifer forest	19,414	557	14,399	34,370
Ponderosa pine–bear clover forest	20,013	1,174	12,659	33,846
California black oak woodland	1,143	2,013	0	3,156
Canyon live oak forest	21,473	0	0	21,473
Dry montane meadow	545	27	958	1,530
Foothill pine–live oak–chaparral	7,130	0	0	7,130
Foothill chaparral	1,785	0	0	1,785
Blue oak woodland	473	0	0	473
Total	598,097	3,807	28,016	629,920

Fire Management Planning Applications

The fire return-interval departure analysis was used extensively in the development of a new fire management plan. Although the nature and extent of the unnatural build-up of fuels had long been recognized, the maps depicting the results of the analysis reinforced this recognition and communicated the extent and severity of the problem. The results of the analysis were an important tool in the development of the alternatives, because they identified the areas in greatest need of treatment. Areas that had missed numerous return intervals, and thus were in greatest danger of an undesired fire, were a focal point for analysis of environmental consequences.

Fire return-interval departures were used extensively to compare environmental consequences of different alternatives in the plan. The analysis of potential impacts on vegetation, wildlife habitat, watersheds, soils, and water quality used return-interval departures as a basis for determining if areas were within the natural range of variability.

The impacts on the ecosystem

Table 9. Acres of each vegetation type by number of median fire return intervals missed, Yosemite National Park and El Portal administrative site, 1930 through 2000.

Vegetation type	***Number of Median Return Intervals Missed***			***Total***
	0-2	***3-4***	***5+***	
	----------Acres----------			
Whitebark pine–mtn. hemlock forest	87,582	0	0	87,582
Lodgepole pine forest	175,516	0	0	175,516
Red fir forest	68,125	0	0	68,125
Western white pine–Jeffrey pine forest	40,970	3,035	88,703	132,708
Montane chaparral	15,137	0	0	15,137
Giant sequoia–mixed-conifer forest	182	0	36	218
White fir–mixed-conifer forest	23,871	374	22,626	46,871
Ponderosa pine–mixed-conifer forest	18,414	1,354	14,602	34,370
Ponderosa pine–bear clover forest	18,311	1,766	13,769	33,846
California black oak woodland	921	210	2,025	3,156
Canyon live oak forest	10,729	623	10,121	21,473
Dry montane meadow	251	101	1,178	1,530
Foothill pine–live oak–chaparral	6,272	1	857	7,130
Foothill chaparral	1,785	0	0	1,785
Blue oak woodland	338	21	114	473
Total	468,404	7,485	154,031	629,920

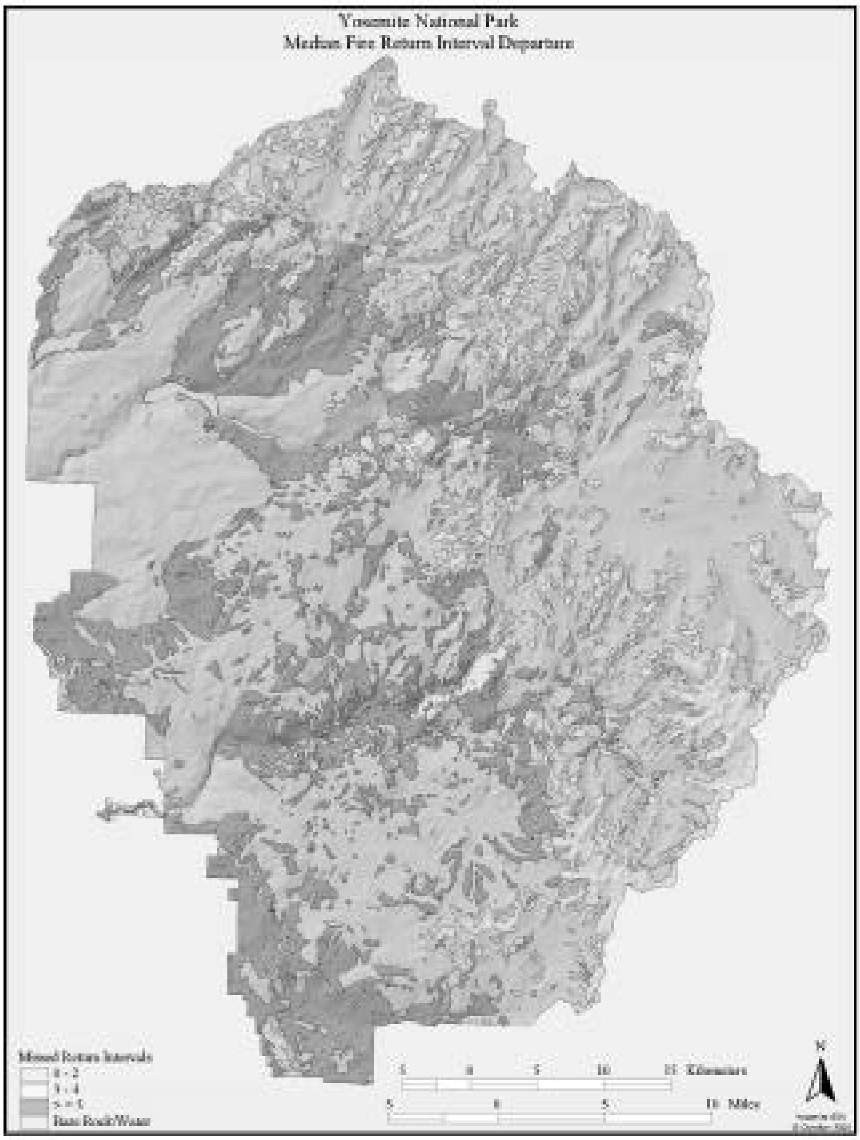

Figure 3. Number of median fire return intervals missed by vegetation type, Yosemite National Park and El Portal administrative site, 1930 through 2000.

were examined by looking at the number of departures. Similarly, analysis of cultural concerns used departures to determine the potential for damage by fire based on changes in fuel loading.

For prescribed burning operations, the fire return-interval departure analysis will be used to prioritize areas for treatment; i.e., those with the highest departure values would be burned first. In the wildland fire-use unit, the analysis would highlight areas where intensive monitoring might be necessary because of unnaturally high fuel accumulations or dense stands. Similarly, the analysis would aid fire suppression operations by indicating where wildland fires might be expected to be more intense than under natural conditions, and would help set priorities for fuel treatments in the wildland–urban interface.

Conclusion

An effective fire management program requires spatial and non-spatial scientific data. Therefore, an analysis of these data is essential for long-range fire management planning. The fire return-interval analysis is an excellent example of how scientific data and analyses were used in the fire management plan, resulting in a science-based plan. The analysis will continue to improve and evolve as other factors, such as slope, aspect, and elevation, are incorporated into the model. Additionally, the completion of a modern vegetation map for the park will better reflect current vegetative conditions, and the analysis will be updated annually based on future fires.

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Curt Musselman

Using Global Positioning System and Geographic Information System Tools in the Rehabilitation of Cultural Landscapes: Gettysburg's Codori Farm Lane Project

Background

Gettysburg National Military Park has made use of geographic information system (GIS) tools on a regular basis since 1996, when full-time staff and dedicated equipment were made a part of the park's resource planning division. The GIS equipment consists of Pentium-class computers running Microsoft Windows and ArcInfo/ArcView software from ESRI, Inc. Global positioning system (GPS) data collection is done using a Trimble ProXR receiver with a TDC1 data collector. GPS data is post-processed with Trimble's Pathfinder Office software.

Parkwide GIS data creation and integration efforts at Gettysburg were undertaken primarily to assist in the development of planning and archaeological studies. These included the National Park Service's (NPS's) archaeological inventory program, the white-tailed deer impact study, and the cultural landscape inventory. But completion of the park's new general management plan (GMP) and environmental impact statement in 1999 provided the greatest amount of support for collecting and integrating all of the existing geographic data for the park area and consistently organizing it in a GIS database.

The GIS was used extensively in the preparation of the GMP. First it was used to document conditions for the entire 6,000 acres of the park as of 1993 ("existing conditions"), 1927 ("commemorative era"), 1895 ("memorial association era"), and 1863 ("battle era"). Battlefield landscape changes were then analyzed within the GIS for both large- and small-scale features. The large-scale features consisted of woods, fields, orchards, and roads, while the small-scale features included fences, lanes, and individual trees. The significance of key landscape features was also analyzed based upon both the level of battle action that actually took place and the importance of the feature from a military point of view. Finally, the GIS was used to help develop and analyze six alternatives for the GMP. In addition to calculating areas and lengths, and providing map graphics, the GIS was used to identify the key viewsheds in the vicinity of the park. The GIS also provided information on the level of resource impacts for each of the GMP alternatives. The use of the GIS in the preparation of the GMP is discussed more fully elsewhere (Musselman 1998).

GMP Implementation

The demolition of the National Tower overlooking the Gettysburg Battlefield on July 3, 2000, was the inaugural event in the restoration of the battlefield. But even before that explosive event, Gettysburg's newly approved GMP had called for the rehabilitation of much of the battlefield to its condition as of July 1863.

NPS regularly rehabilitates designed and natural landscapes, but rehabilitation of a battle landscape is not an easy task (Latschar 2001). The overall philosophy guiding the rehabilitation work at Gettysburg is included in the GMP. It also includes management prescriptions that support appropriate parkwide preservation treatments and actions.

The Codori–Trostle Thicket area was the first part of the park where landscape rehabilitation efforts were planned for following the approval of the GMP in 1999. It was anticipated that this area would serve as the prototype for developing GMP implementation procedures that could then be followed elsewhere in the park. Working in cooperation with the Olmsted Center for Landscape Preservation, the park began work on a small cultural landscape report that was to include a detailed treatment plan. Eventually, the study area grew enough to warrant a change in the name of the project to the "Emmitsburg Road Ridge Cultural Landscape Report" (CLR). The northern boundary of this area was defined by the historic Codori Farm Lane, which was abandoned in the early twentieth century and largely forgotten since (Figure 1).

Cultural Landscape Feature Documentation

The GIS was used to support the production of the Emmitsburg Road Ridge CLR as much as it was used for the GMP. The GIS's mapping capabilities were put to use creating period plans for the battle, commemorative, and current periods. A series of battle action maps for the Emmitsburg Road Ridge area was automated and georeferenced and key battle landscape features were identified in great detail. But in addition to documenting conditions, analyzing landscape changes, and calculating viewsheds, GPS tools were combined with the GIS to provide control points for map registration and to navigate to feature locations in the field. Although the largest landscape feature being rehabilitated in this area is the Codori-Trostle Thicket, the first feature to be rehabilitated was the Codori Farm Lane, and it is upon the lane that the following discussion will focus.

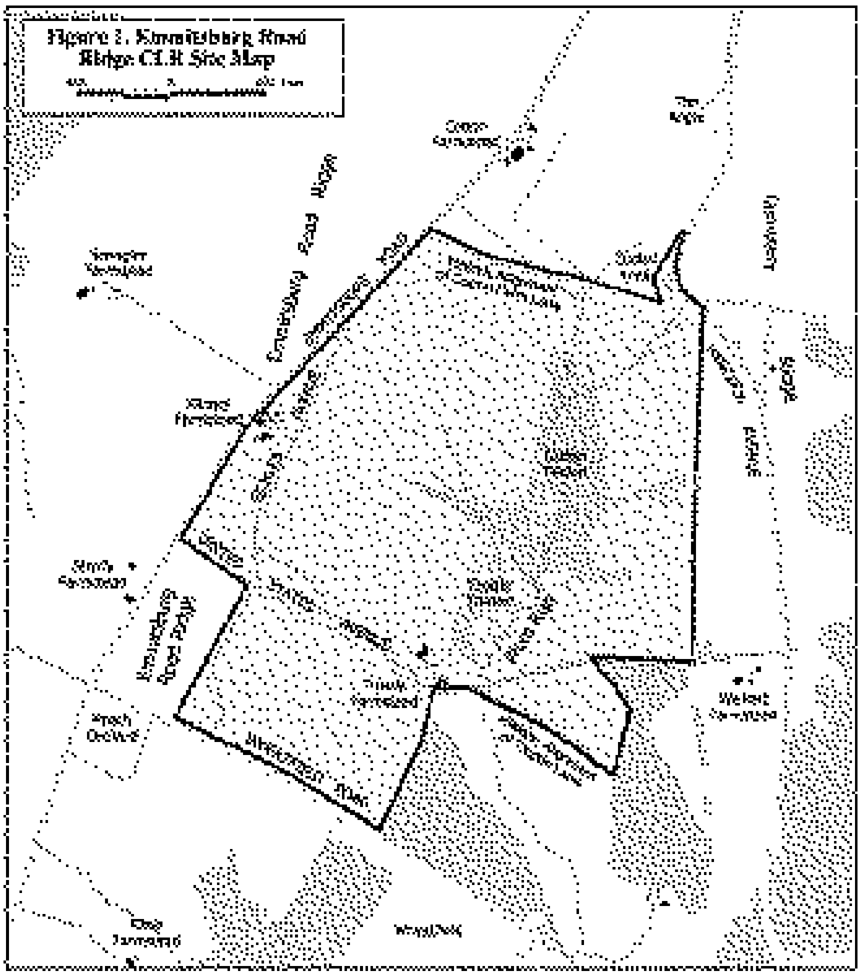

Figure 1. Emmitsburg Road Ridge CLR Site Map.

Numerous maps and photos document the existence of the Codori Farm Lane. But reconstructing the fences along its edges in the proper place required us to take great care in collecting and combining information from the historic maps with the existing-conditions maps. The sources that were used for documentation included 19th-century photographs, the G.K. Warren map of 1868-1869, the 1895 National Park Commission map, the Adams County 1996 orthophotograph, and a new set of existing-conditions maps. The existing-conditions maps contained one-foot contours and were created at a scale of 1:600 by a local engineering firm. Feature locations were based upon field measurements and photogrammetric compilation from 1998 black-and-white aerial photographs.

To register the historic maps to the existing-conditions maps, we used building corners and fence intersections as control points. Since the study area boundary had grown after the existing-conditions maps were contracted for, we only had smaller-scale (1:7200) base maps for some of the areas that we wanted to register the historic maps to. Therefore, we took GPS measurements at a number of the fence intersections and used those values for the existing-conditions control points. The positional accuracy of our existing-conditions control points was within two feet on the ground, regardless of whether the point had come from the 1:600 base maps or the GPS measurements.

We used the G.K. Warren maps of 1868-1869 to determine the location of the Codori Farm Lane at the time of the battle. Although the full set of original Warren maps is in the National Archives, the archives staff and their vendors could only provide a digital copy at a resolution of 72 dots per inch, which was too fuzzy for our purposes. Luckily, an exact tracing of the map of the part of the battlefield that we were studying had been made in 1886 by the U.S. Army Corps of Engineers and is now in the Library of Congress map collection. This map was scanned at 300 dots per inch by the Library of Congress as a part of the American Memory project and provided to the park (Figure 2).

The scanned historic-map images were first registered to the existing-conditions base maps using the ArcInfo command REGISTER. This command performs an affine transformation so that if more than three control points are used (we used nine) the image locations can not be exactly matched to the corresponding map locations (ESRI 1994). To get a more exact match of the historic data to the existing-conditions base map, we next digitized the historic features into a vector ArcInfo coverage. These features were then rubbersheeted while the control points were linked exactly using the ADJUST command. The advantage of using a vector coverage is that one can also use the HOLDADJUST command if there are arcs that one does not want to move when rubbersheeting.

Cultural Landscape Feature Analysis

Once the historic and existing features were registered to one another, we used the GIS to make calculations of lengths for fences and lanes and to determine the acreages of orchards, woods, thickets, and stream buffers. The measures were

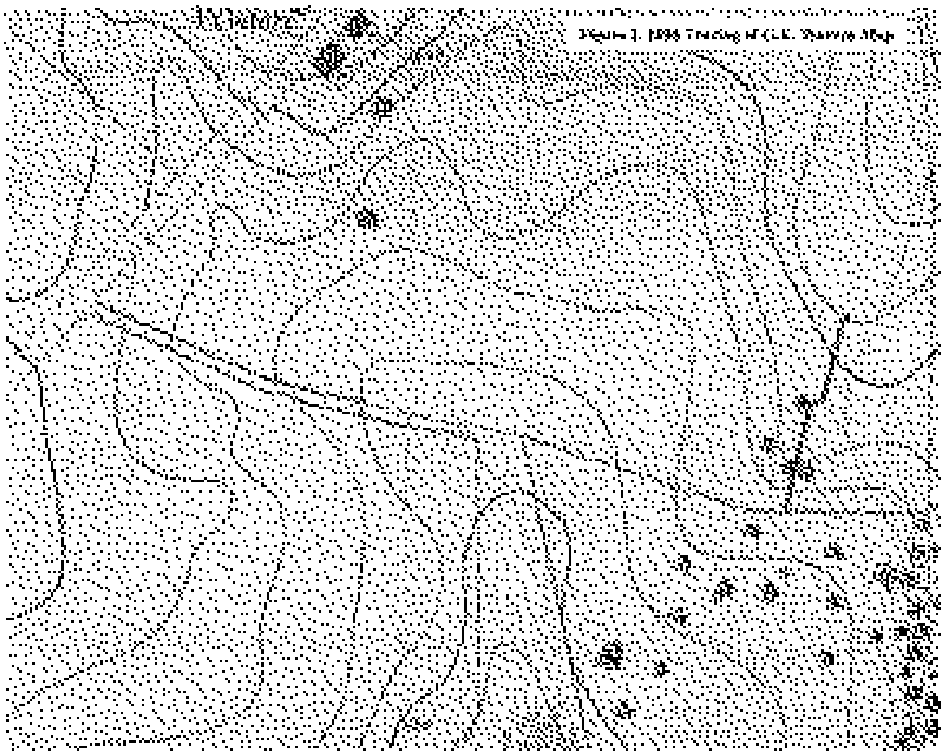

Figure 2. 1886 tracing of G. K. Warren map.

then used to help figure the costs for rehabilitating these historic features. A number of viewshed and line-of-sight analyses were also run to show the impact on the views of rehabilitating the historic Codori-Trostle Thicket at different heights.

Determining the location of 1863 features in relationship to the existing conditions was accomplished as a part of the map registration process, but it was a very important part of the analysis provided for this project by the GIS. The location of the Codori Farm Lane in 1863 was also overlaid with the digital orthophotos created by the Adams County GIS office. Produced from true color photos taken in the spring of 1996 to support mapping at a scale of 1:4800, these images have a pixel resolution of 2 feet on the ground. A linear, light-colored crop mark is visible on the orthophoto in the same location where the registered historic maps show the Codori Farm Lane.

Codori Farm Lane Location Layout

Having georeferenced the historic base maps, the next step was to create waypoints along the Codori Farm Lane so that we could navigate to them using the GPS data collector.

Only the fence location along the northern side of the lane was to be flagged. The fence on the southern side of the lane was simply built parallel to, and 20 feet to the south of the northern fence. We created waypoints at each end of the lane and at every point along the lane where it changed direction, where the type of fence changed, or where another fence intersected it. The waypoints were created as ArcView shapefiles and then imported to the Pathfinder Office software where they were uploaded to the GPS data collector (Figure 3).

Because we are within range of the Cape Henlopen DGPS radio beacon, it is possible for us to use real-time differential GPS at Gettysburg. Although not as important when we are collecting data (because we routinely post-process all the GPS files that we collect), DGPS is essential for navigating to and locating features when one wants to be within a meter or two.

There are a number of modes that can be used to navigate with the Trimble ProXR GPS unit, but we had the greatest success using the bearing and distance mode. Since a differentially corrected location is only calculated every five seconds, it is important to slow down one's walking pace when the GPS indi-

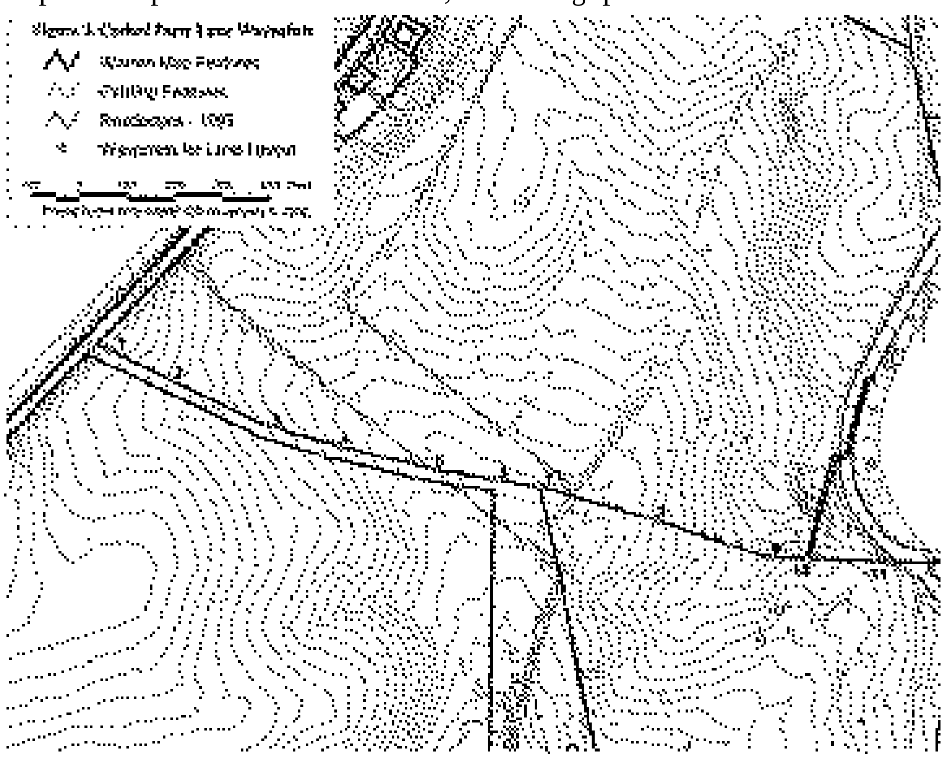

Figure 3. Codori Farm Lane Waypoints.

cates that one is within about 20 feet of the waypoint. We knew we were at the waypoint when the distance to go remained in the one- to two-foot range even though the bearing to the waypoint kept changing. We put flags at all the waypoints and in a straight line every fifty feet between the waypoints.

The year before this project we had done some navigation tests with our ProXR unit to determine how confident we could be in our ability to navigate to a given coordinate location. Earlier, a scenic easement boundary on Gettysburg College land had been marked by buried surveyor's pins whose coordinate locations had been determined to within one-half meter when the pins were put in. Over a year later, when there were no longer any visual marks on the ground to tell us where the pins would be found, we used the GPS unit to navigate to the pins. A metal detector was then used to find the buried pins. One hundred percent of the pins were found within six feet of the location we had navigated to using the GPS.

Fence Construction

Building the fences that defined the Codori Farm Lane was a cooperative project between the Friends of the National Parks at Gettysburg (FNPG) and the resource planning and maintenance divisions of the park. After the locations of the future post-and-rail and Virginia worm fences had been laid out using GPS, the park's landscape preservation team prepared the work site. Fence rails, posts, and cross-ties were delivered in bundles spread out along the line the lane was to follow. For the sections of the fence that were to be Virginia worm, flat stones to support the bottom rail were placed in a zigzag pattern every ten feet centered on the flagged line. Post-holes were drilled every ten feet along the part of the line that marked the post-and-rail fence. Actual construction of the fences was accomplished by a large number of FNPG volunteers during their spring workday. One observer reported that the scene resembled an ant colony as the volunteers, working in pairs, carefully placed hundreds of fence rails one by one along the now-reestablished Codori Farm Lane (Figure 4).

Figure 4. Codori Farm Lane fence construction.

The Future

Since Codori Farm Lane has been rehabilitated, we have begun landscape preservation treatments for the other historic features in the Emmitsburg Road Ridge study area following the recommendations in the CLR. A number of other fence lines have been rebuilt using the process that was developed for Codori Farm Lane, and in the coming year we expect to rebuild the part of the Trostle Farm Lane that was east of the Trostle Farm and south of United States Avenue. Rehabilitation of the Codori-Trostle Thicket as well as the Neinstedt Field has also begun.

On a parkwide basis, GIS tools have been used to help start work on a five-year implementation plan for rehabilitation of the major large-scale landscape features that were identified in the GMP. Additional treatment principles are also being developed that will be appropriate for use throughout the park.

One recent equipment upgrade that has been particularly valuable when laying out the location of historic features was the replacement of the TDC1 data collector by a TSC1 data collector. The TSC1 provides a map display, so that instead of loading waypoints, the entire georeferenced historic map can be loaded as a background. In order to navigate to locations of interest on the map, one just needs to observe the track of the GPS and keep walking until the track intersects the point of interest.

Conclusion

Using GPS and GIS tools to assist in the rehabilitation of the Codori Farm Lane and other historic features has proven to be very useful. At the beginning of the project, the GPS was used to collect control-point measurements that were then used in the rectification of historic maps and images. The ability to use GPS to navigate to waypoints for laying out the location of historic features was invaluable. Along with specialized map creation, the GIS provided integration of data collected in the field with the park's existing base maps. Image rectification tools made it possible to fit scanned historic maps to these base maps, too. Since all of this mapping was integrated using a consistent map projection, coordinates for waypoints could be derived and used in the field with the GPS data logger. GIS calculations for the lengths and areas of features helped to define the scope of work and costs that would be associated with various rehabilitation alternatives. Finally, viewshed and line-of-sight analyses were used to help confirm narrative and photographic evidence related to the height of the Codori-Trostle Thicket in 1863.

Having in-house GIS and GPS capabilities has made possible a quick turn-around on many of the tasks associated with carrying out a cooperative project such as the rehabilitation of the Codori Farm Lane. In addition, we were able to determine—with an appropriate level of confidence—the location of a missing historic feature, guided primarily by maps and photos.

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Mapping Historic Preservation Legislation

Historic Homeownership Assistance Act

Each year, millions visit Chicago to experience life in this dynamic city set against a backdrop of magnificent architecture. The towering creations of Louis Sullivan and William LeBaron Jenney began to punctuate the skyline in the late 1800s. In 1909, Daniel Burnham laid out the unique and visionary "Plan for Chicago." The city's residents continue to enjoy Burnham's plan, which prohibited construction along Lake Michigan's shore, thereby preserving that land for recreational uses. His firm, D.H. Burnham and Co., designed several of Chicago's landmark structures, including the Wrigley building, Union Station, the Civic Opera House, and the Museum of Science and Industry (Peters 2000). Other architectural masterminds found a setting for their designs in Chicago's residential neighborhoods. New York's Solon S. Beman designed the nation's first planned company town for the employees of George Pullman's railroad car manufacturing business. The Far South Side neighborhood of Pullman is now a registered historic district. Frank Lloyd Wright established his studio in the Chicago area in 1893. He went on to design homes in several Chicago neighborhoods, including Rogers Park, Hyde Park, and Beverly. His revolutionary Prairie style is marked by geometric-patterned windows, wide, overhanging roofs, and floor plans that "flow" from one room to the next (Peters 2000). Chicago's other distinct styles of residential architecture include the Worker's Cottage of Lincoln Park and the Lower West Side, the Craftsman of Albany Park and West Lawn, the Tudor revival, and the Eastlake styles (Figure 1).

As the population grew, middle- and upper-class families moved out from the city's core to the suburbs. Many historic houses fell into ruin and eventual abandonment when their poorer inhabitants could not maintain them. Such is the case with most historic homes in cities across America (El Nasser 2000). The city of Chicago is proud of its rich archi-

Figure 1. Some representative architectural styles of Chicago houses. Clockwise from upper left: Stick style (Emory B. Moore House); French Chateau Style (William W. Kimball House, 1890); Worker's Cottages (Old Town Historic District); Frank Lloyd Wright's Prairie style (Frederick Robie House, 1909).

tectural history, and several groups have organized to push for its preservation. Local groups such as the Chicago Landmarks Commission, Historic Pullman Foundation, and the Frank Lloyd Wright Preservation Trust are joined in the effort by the State of Illinois Historic Preservation Agency.

Prior to 1976, tax law encouraged destruction of older buildings and provided incentives for constructing new buildings in their place. Instead of restoring or rehabilitating aging structures, developers took advantage of the tax deductions related to demolition. Change began with the Tax Reform Act of 1976, which eliminated these deductions as well as some of the incentives for new construction. The notion of promoting rehabilitation through an income tax credit was first introduced in the Revenue Act of 1978, and expanded in the Economic Reform Tax Act of 1981 (National Park Service 2001b).

Under the Tax Reform Act of 1986, Congress eliminated many existing tax incentives across the board. The Rehabilitation Credit, however, survived. In its current form, it provides a credit equal to 20% of the expenditures for rehabilitation of qualified structures used for commercial purposes. It applies to National Register of Historic Places listings or structures in Registered Historic Districts.

This legislation has been successful in achieving its goal. Since its passage, preservationists have rehabilitated more than 27,000 schools, factories, churches, stores, hotels, and offices (National Park Service 2001a). The 1992 fiscal year report of the National Park Service (NPS) indicated that "the use of Federal Tax incentives to encourage private investment in historic rehabilitation has been one of the most effective Federal programs to promote both urban and rural revitalization.... [T]he completed projects have brought renewed life to deteriorated businesses and residential districts, created new jobs and new housing units, increased local and state revenues, and helped ensure the long-term preservation of irreplaceable cultural resources" (U.S. Department of the Treasury 1994).

Congress is presently considering the Historic Homeownership Assistance Act (HHAA), which is modeled after the Historic Rehab-ilitation Tax Credit and seeks to extend its incentives beyond commercial properties to the owners of historic homes. Legislators first introduced HHAA in the 104th Congress and each session thereafter. Its purpose, in the words of the bill itself, is "to amend the Internal Revenue Code of 1986 to provide a credit against income tax to individuals who rehabilitate historic homes or who are the first purchasers of rehabilitated historic homes for use as a principal residence" (U.S. House 2001). The

HHAA would give eligible homeowners a federal tax credit of 20% of their rehabilitation expenses. The credit cannot exceed $40,000, and at least 5% of the expenditures must go toward rehabilitation of the exterior of the home.

Representative Clay Shaw of Florida, along with 145 co-sponsors, introduced the Historic Homeownership Assistance Act (H.R. 1172), to the House of Representatives in the 107th Congress on March 22, 2001. Shaw pointed out that abandonment leads to the loss of many housing units. During the 1980s for example, Chicago lost 41,000 units. More than just the structures are at stake. We are also harming "the sense of our past, the vitality of our communities, and the shared values of those precious places." Through passage of this legislation, Clay explained, homeowners would be able to play an active role in stimulating economic development, revitalizing their own decaying resources, and restoring "a sense of purpose and community" to their neighborhoods (Shaw 2001). The House Ways and Means Committee will consider further legislative action although none has occurred so far .

Senator John Breaux of Louisiana, along with 10 co-sponsors, introduced the identical Senate version of the bill (S. 920) on May 21, 2001. He lauded the bill as being an effective antidote to urban sprawl, as it encourages rehabilitation of existing homes over construction of new ones. Breaux also referred to Section 25B(g)(1) of the bill, which states that buyers of newly rehabilitated historic homes, rather than the sellers, are the recipients of the tax credit. This makes some housing more affordable for lower-income buyers, while increasing the tax base of economically distressed urban areas (Breaux 2001). The Senate Committee on Finance will consider further legislative action on S. 920. The committee has 21 members, including Breaux and co-sponsors Bob Graham (Fla.), James Jeffords (Vt.), and Robert Torricelli (N.J.).

The National Trust for Historic Preservation, the National Conference of State Historic Preservation Officers, and the Washington-based organization Preservation Action are pushing to get this bill back to the floor of Congress in 2002. They urge each concerned constituent to contact his or her senator and representative and ask them to co-sponsor this bill. They believe it is important to make members of Congress aware of the ways the Historic Rehabilitation Tax Credit has been successful in their state or district's commercial areas, and how the HHAA could similarly improve the residential neighborhoods. Preservation Action believes that there are far-reaching economic, social, and cultural benefits of rehabilitating of our cities' historic homes (Gray 2000). Increased property values will attract investment to formerly depressed areas. This will provide jobs, and lead to more property tax and income tax revenues for state and local governments. It will create affordable housing and save culturally important structures (National Park Service 2001a).

Opponents of HHAA argue that the legislation may not necessarily help low-income residents. Instead, they fear, the historic areas will undergo gentrification and the poorer residents will be displaced (El Nasser 2000). NPS does not support the bill in its current form. First, it applies to too many structures. NPS argues that its scope should be narrowed to only buildings in Enterprise Communities and Empowerment Zones. Second, it does not provide enough benefit to the public. HHAA only demands that 5% of the expenditures be spent on the exterior of the structure. NPS argues that it should be raised to 25%. Third, Section 25B(d)(3) of HHAA gives state historic preservation officers (SHPOs) and certified local governments (CLGs) authority to approve projects. This dispersal of authority is too confusing, and will breed inconsistency in the review process. It is fair to taxpayers only if the secretary of the interior has authority (Park 2000). Lastly, NPS has used the secretary of the interior's standards for rehabilitation for over 25 years. Under these guidelines, all changes to a structure, including repairs, new additions, and chemical and physical treatments, must preserve the historic character of the property. This includes retention of all "distinctive materials, features, finishes, and construction techniques (National Park Service 2001a)." Taxpayers had to meet these guidelines in their rehabilitation work in order to benefit from the Historic Rehabilitation Tax Credit. These standards maintain consistency while providing flexibility to reviewers. Section 25B(d)(2) of HHAA would implement a separate set of review standards for residences located in target areas, enterprise communities, empowerment zones, or renewal communities. NPS feels that adding a new set of standards would destroy the credibility of the existing ones (Park 2000).

The Role of Geographic Information Systems

Both supporters and opponents of the HHAA rely on data to support their position. For example, Preservation Action pointed out that they could lobby Congress more effectively if they knew how many historic buildings would qualify under the bill (Gray 2001). Opponents might argue that too many buildings would be qualified relative to the number of older buildings in the country.

Data can also include spatial data. For example, the HHAA defines a "certified historic structure" as a building that is individually listed on the National Register or a contributing building in a registered historic district. In the latter case, only contributing buildings within a "qualifying census tract" (QCT) are eligible. A QCT is one in which the median family income is less than twice the statewide median family income. Consequently, we see that the location of a historic district in relation to a QCT is an important element in determining the eligibility of a contributing building (HHAA 2001).

Given HHAA's complex rules, analysts might find it difficult to manually estimate the number of eligible historic buildings. One would need to plot the census tracts onto a map and color-code each according to its median family income. Next, the boundaries of the historic districts would have to be plotted onto the same map. Then one would need to determine the number of contributing buildings in each district that were within a QCT. For those districts that partially overlapped a QCT, one would need to split the district to determine the number of contributing buildings falling into the tract.

Geographic information systems (GIS) can automate this process, saving time and creating new analytical possibilities. For example, GIS could easily include additional geographic areas in the analysis. It can also change the value of parameters and quickly rerun the analyses. Consequently, GIS can estimate the number of potential certified historic structures. GIS can also provide new insights on the viability of alternative modifications to the legislation such as those suggested by NPS.

The Park Service has argued that the number of potential certified historic structures will be too large, resulting in an unacceptable loss of revenue to the federal treasury. By NPS's estimate, approximately 971,000 buildings would meet the criteria for certified historic structures (Park 2000). This figure represents 3.5% of the nation's housing stock that was built before 1950, or 17,286,463 housing units (U.S. Census Bureau 2001). As an alternative to the QCT concept, NPS proposed that the credits apply only to historic buildings located in two existing tax-advantaged designations: enterprise communities and empowerment zones.

The Park Service also fears that the legislation might lead to gentrification (Park 2000). Gentrification occurs when historic buildings in a neighborhood are rehabilitated and the property values increase. The effect is to displace lower-income residents who cannot afford to pay the higher property taxes. HHAA discourages gentrification by giving the tax credit to homeowners instead of developers. But is there anything more that the legislation can do to target these benefits to lower- and middle-income neighborhoods?

Using Chicago as a study area and GIS as an analytical tool, we posed three questions. First, under current HHAA provisions, how many certified historic structures would there be in Chicago, and how many nationwide? Second, how many would there be under the NPS proposal of limiting certifications to empowerment zones and enterprise communities? Finally, how many would there be if we were to change the median family income level for QCTs?

GIS Analysis

To answer these questions we developed a "cartographic model" (Berry and Tomlin 1985) of the HHAA for Chicago. The cartographic model represents a selected portion of the real world, i.e., a simplified version of reality. By simplifying reality, we isolate and focus on those elements that we believe are necessary to predict or determine how things work: in our case, how the HHAA would work if enacted. The model identifies the data, the map operations, and the "solution map" needed to answer our questions (Knoerl 1991). The cartographic model is rigorous in the clarity it provides in showing how the data is manipulated to produce the solution map. Consequently, it provides a means by which others can recreate the analysis and evaluate for themselves the value of the model and its results (ESRI 2000).

There are five phases in this cartographic model. The first phase selects National Register properties and census tracts that are within the city of Chicago. The second phase further limits the National Register properties to those that are currently used as residences. It also flags a census tract as a QCT if its median family income is less than twice that of Illinois (i.e., $77,328). The third phase deals with those historic districts that are partially within a QCT. In these cases, we split the historic district into QCT and non-QCT portions. Figure 2 shows a typical split. Only contributing buildings in the QCT portion of the historic district can be considered for status as certified historic structures. The fourth phase estimates the number of contributing buildings in the QCT portion of the historic district by calculating the proportion of QCT area in the district and multiplying this percentage against the total number of buildings in the district. For example, 30% of the historic district in Figure 2 lies within the QCT area. There are 469 contributing historic structures in the entire district. By multiplying 469 by 0.30, we estimate that there are 141 contributing historic structures in the QCT portion of the district. In the final phase of the analysis, the number of contributing historic structures for individually listed National Register properties are added to the estimate derived above to arrive at the total number of contributing historic structures.

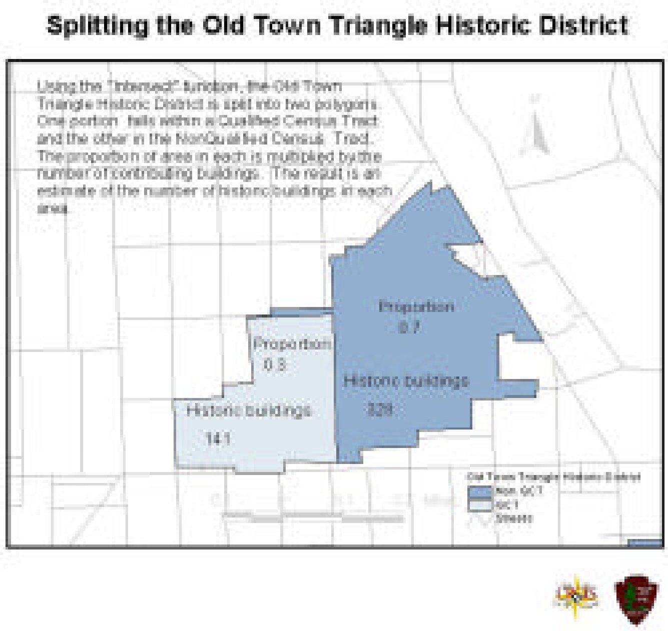

Figure 2. Splitting a historic district into QCT and non-QCT portions.

Before running the model, we had to collect and process the data. These tasks posed five challenges:

- First, at the time of the analysis the Census Bureau had not released the 2000 census data on median family income; therefore we used 1990 census data. Future analysis will use the newer data.
- Second, information on most of the historic districts did not include the street addresses of contributing buildings, and therefore we could not determine where each building was located relative to being within or outside of a QCT. Consequently, we used the proportional method described above in estimating the number of contributing historic structures in Chicago's historic districts.
- Third, the National Register data for the Pullman and Ridge historic districts did not indicate how many contributing buildings were in these districts. The Illinois Historic Preservation Agency (the state historic preservation office) and the Historic Pullman Foundation produced an estimate for the Pullman Historic District. We were unable to arrive at an estimate for the Ridge Historic District and therefore could not use it in the analysis.
- Fourth, because accurate bound-

aries were needed, we digitized each historic district boundary using the original U.S. Geological Survey 7.5-minute topographic map contained in the National Register file.

- Finally, most of the Chicago Landmark Commission historic districts overlapped the National Register historic districts, and therefore were not used. The remaining landmarks were not used because the number of contributing buildings in these districts was not known.

Once these challenges were met, we ran the model. Recall that our first question was: How many certified historic structures would there be under HHAA as currently written? The solution map appears in the upper left corner of Figure 3 and the numerical data in row 1 of Table 1. The potential number of certified historic structures in Chicago is 5,334, representing 0.8% of the city's houses built before 1950 (682,983). If we were use 0.8% as estimated proportion of the nation's houses built before 1950 (17,286,463), there would be 138,292 certified historic structures nationwide. The NPS estimate was 971,000 (Park

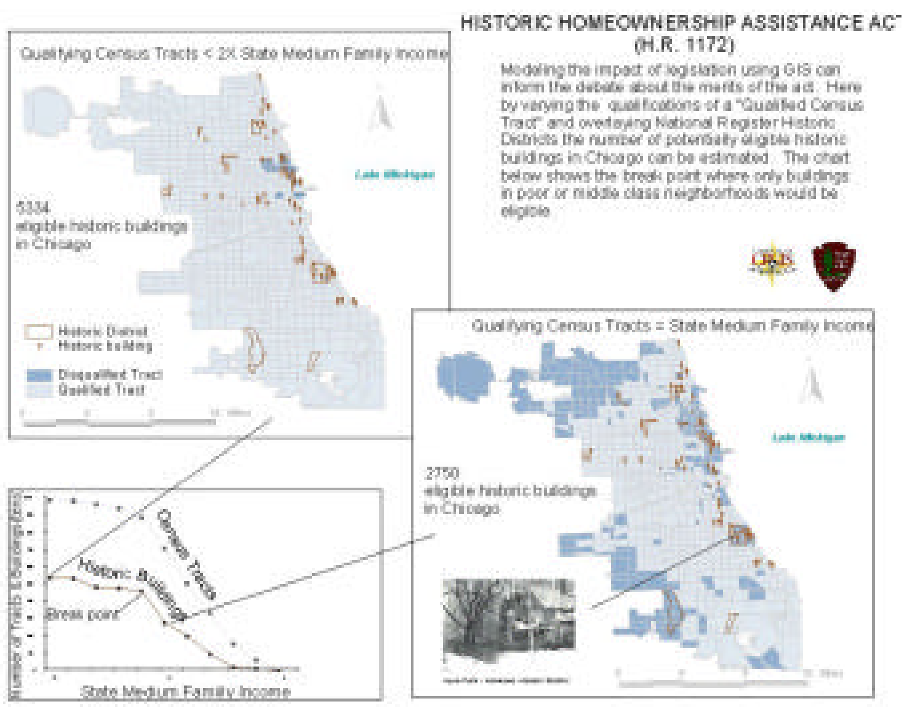

Figure 3. Number of certified historic structures under HHAA as currently written.

Table 1. Estimated number of potential certified historic structures in Chicago and the nation for each criterion.

Criterion	Chicago		Nation	
	Potential number of certified historic structures	Percentage of older housing units (n=682,983)	GIS estimated number of certified historic structures	NPS estimated number of certified historic structures
HHAA	5,334	0.800	138,292	971,000
EZ/EC (NPS)	9	0.001	173	?
Low/Middle Income	2,750	0.400	69,146	?

2000). If Chicago is representative of large urban areas, then the NPS estimate is inflated.

The second question was: How may certified historic structures would there be under NPS's proposed modifications to the HHAA? The answer is graphically shown in the solution map appearing in Figure 4, with the numerical data appearing in row 2 of Table 1. Under these conditions, the number of certified historic structures in Chicago would be limited to nine. This represents 0.001% of Chicago's older housing stock. Using this percentage for the nation, only 173 historic buildings would be eligible. Such a number does not seem credible. However, there are about 100 empowerment zones and enterprise communities nationwide, of which seven are in Chicago. Even if one were to take the highest number of certified historic structures in a Chicago empowerment zone, six, and multiply that number by 100, the national total would still be a very low number (i.e., 600).

Our final question concerned the issue of targeting low and middle-income neighborhoods. What median family income threshold for a census tract would best target these areas? To find the answer, we reiteratively decreased the QCT median family income threshold and reran the model. We then plotted the number of certified historic structures for each run (see chart in lower right portion of Figure 3). It is only when we set the QCT median family income threshold to less than Illinois' MFI ($38,664) that the historic districts in the higher-income neighborhoods become ineligible. The map in the lower right portion of Figure 4 shows this visually while, row 3 of Table 1 shows the numerical results. If the HHAA legislation

Figure 4. Number of certified historic structures under NPS's proposed modifications to HHAA.

set the QCT threshold to below Illinois' median family income, then Chicago would have 2,750 certified historic structures. This represents 0.4% of Chicago's older housing stock. If one were to apply this percentage nationwide, the number of potential certified historic structures would be 69,146 of the nation's older housing stock.

Although we encountered problems with the data, and one could reasonably argue that Chicago may not be representative of other urban areas of the country, the analysis has served to give some "ballpark" numbers to reflect on. Having said that, we believe that the Park Service's estimate of the number of potential certified historic structures to be too high with respect to HHAA's current provisions. We also believe that the use of empowerment zones and enterprise communities as qualifying criteria to be too restrictive and is not likely to encourage meaningful participation in the rehabilitation program. The analysis has shown that by lowering the threshold for QCTs below that of the state's median family income, the act would target lower- and middle-income neighborhoods more effectively.

Conclusion

The most serious barrier to using GIS in this study was the poor quality of data, not the GIS software or concepts such as the cartographic model. As we pointed out earlier, some historic districts in Chicago did not have basic information, such as the number of contributing buildings in the district or their street addresses. To create accurate map boundaries, we were forced to digitize them because most National Register boundary coordinates define a "circumscribed boundary," not the actual boundary of the district. The circumscribed boundary is often too inclusive of areas that are not part of the district. These problems are not limited to Chicago. There are more than 5 million historic properties listed on state historic preservation office statewide inventories, and there are more than 1 million contributing properties listed on the National Register (Knoerl 1998). Only 13% of the state inventories have been entered into a GIS, and none of the National Register contributing properties have been entered into one. If we are serious about using the data in these inventories, we need to be serious about investing more attention and funding to cleaning them up and moving them from paper files to digital files. It may not be glamorous work or the kind that generates instant gratification, but in our view it is an essential prerequisite to conducting the kind of analyses that this paper has highlighted.

Legislators, their staff members, and lobbyists rarely use GIS to analyze pending legislation. Yet many parts of proposed laws are replete with spatial provisions. For example, S. 445, "An Act to Provide for Local Family Information Centers," requires that, to be funded, information centers must serve a geographic area having between 15,000 and 25,000 students. H.R. 4, the "SAFE Act of 2001," calls for a water resource inventory in a geographic area within each state having consistent, emerging water supply needs. S. 1267, "The Conservation Extension and Enhancement Act of 2001", defines "eligible land" as that which is located in an area that has been historically dominated by natural grassland or shrubland and has potential to serve as habitat for animal or plant populations of significant ecological value if the land is restored to natural conditions. If GIS were used to evaluate or predict the intended (as well as unintended) effects of such proposed laws, then the legislative process would be well served. What we have tried to show in this paper is that GIS can be applied to modeling the impact of legislation. We hope those involved in the legislative process come to see how GIS can make their own work more effective, accurate, and visual.

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Danielle Berman

Integrating GIS and Traditional Databases with MapObjects Technology

The expanding presence of geographic information system (GIS) offices within organizations has helped to enhance the availability of GIS data and expertise, but not always to the benefit of the entire organization within which it is working. The separation— and frequently, isolation—of GIS specialists within agencies, institutions, and organizations often limits the potential usefulness of GIS technology. Establishing a GIS office requires significant financial investment in infrastructure, software, and highly trained professionals, and can seem unjustified when the benefits of the technology are not shared with the organization in general. However, there are many obstacles to achieving a wide user base for GIS. One primary obstacle is the expense of purchasing or licensing software for the entire organization and training employees in the use of this specialized technology. Another is the lack of perceived relevance or applicability of GIS to the work of other staff members and administrators. The third and often most problematic complication is personal resistance to the use of computer technologies in general or GIS specifically, often due to their being perceived as complex and difficult. The experience of developing integrated tools for accessing the data that will comprise the Consolidated American Battlefield Information Network (CABIN) and the Revolutionary War and War of 1812 Historic Preservation Study (Rev1812HPS) provide informative examples of how to expand the user base of GIS to the benefit of both the GIS office and others in an organization.

When the GIS office is not integrated with its organization, both may suffer. The separation between staff members contributes to divergent specialization and emphases of not only individual employees, but also the projects they undertake. This can lead to data creation and organization schemes that are increasingly incompatible. Given the speed of technological change, uncoordinated data compilation can severely restrict the future use and integration of information, to the point where extensive reorganization of the data eventually may be demanded. When only specialists use the GIS data, the benefits of a large organizational expenditure are limited to a small group of individuals and may never serve the organization as was initially intended. It may also be the case that without widespread and on-going organizational reliance on GIS, the quality of the data and its long-term management may be compromised as the need for systematic and standardized practices are not readily evident. This experience can contribute to the problems of "legacy data" (data that are no longer able to be used due to format, metadata, or other technical problems), inefficiency in data sharing, and conflicting assumptions about desired data availability.

The integration of GIS functionality in the database software used by staff outside the GIS office can help to address some of these problems. In this way, the costs of widespread adoption—software purchasing, the often-requisite upgrading of hardware, and training—can largely be avoided. While the initial investment in custom software may be high, this can also be minimized and the benefits optimized by working in-house to develop custom tools. Many organizations already use custom database systems for administrative and other day-to-day tasks. The addition of GIS functionality to a technology that is already in use can reduce the need for training because the introduction of GIS does not require learning a new software package; rather, only the few new functions and tools that are relevant to the work already being done. Particularly when the development occurs in-house, the relevance of the technology can be assured, as only those functions that would be useful to the organization are made available. The perception of the complexity of GIS technology and the resulting reluctance to use it can also be reduced in the development process by embedding it within a familiar software tool. The ability to automate data access and other common tasks can also help to lessen the sense that the technology is difficult to use.

The process of working with personnel in offices outside the GIS office to development the software may reveal a larger desire for GIS functionality than previously assumed. Increased coordination between offices can help illuminate shared goals and needs for GIS data and functionality. This dialogue can improve the coordination of data collection and management efforts throughout the organization to better ensure on-going integration of information. Increasing interdependence of data encourages standardization of collection and continuing communication and coordination of data development efforts. With widespread use, diverse program needs and perspectives are brought to bear on the work done by GIS specialists, allowing them to better target their efforts and to improve their ability to share the benefits of GIS with the larger organization. This increased understanding and appreciation of the relevance of GIS increases the value of these efforts and the return on the organization's investment.

The example I will use to illustrate this process is the work I was involved with in developing CABIN and Rev1812HPS, which will contribute to a large share of the network's data. CABIN is intended to integrate the wide variety of data available, and currently being created, about the nation's battlefields and associated historic sites, not only regarding their historic importance, but also their geographic location and preservation status. The data fall mainly into two categories: geographic and tabular, with additional related digital files such as photographs, planning documents, and digital publications.

It also so happens that these categories fall, for the most part, under the purview of two offices of the National Park Service (NPS): those of the Cultural Resources GIS (CRGIS) program and the American Battlefield Protection Program (ABPP). One of the primary aims of CABIN is to make data available to a wide range of users, including other NPS offices, individual battlefield parks, state historic preservation offices, and the general public (Figure 1).

The task, then, is to bring all of the data together in digital formats that can be linked, easily accessed, and systematically maintained. Much of what will become the bulk of the tabular data currently exists only on paper, or has not yet been generated at all. The ABPP needed a database system that would allow them to continue to use and add to existing data while providing the functionality they need for their everyday work of grant administration and public outreach. The process of discussing the potential for adding a GIS component to the ABPP revealed a real desire and need for true data integration.

In order for the GIS component to work in a straightforward manner, the GIS data needed to be organized and coded according to standards that made files easy to locate. This involves reorganizing and documenting the bulk of battlefield-related data compiled over the last 10-15 years, including those gathered from the Civil War Sites Advisory Commission study. A time-consuming process, this will be a project lasting well into the future. In coordination with this effort, many records of preservation projects and grant recipients are also being cleaned up and organized to ensure compatibility. All data related to any particular battlefield or site are coded to enable linkages across data and file types. The first (beta) version of CABIN was designed in Microsoft Access and made accessible to both offices on the Intranet. (The version being used at the time was Access 97, therefore the technology discussed is based in that setting. At this stage, the database works fine in the Access environment; however, as the data increase and are prepared for Web access, the database will most likely be transferred to a more robust environment, such as an SQL server.) CABIN incorporates the functionalities that the ABPP relied on from their previous database and adds modules for collecting additional data as well as accessing GIS data within the same system. It will also eventually include tools to assist in Web site maintenance to keep the data on the Web in synch with those being updated and generated by the ABPP or CRGIS offices.

The experience of organizing and standardizing the data collected prior to the establishment of CABIN

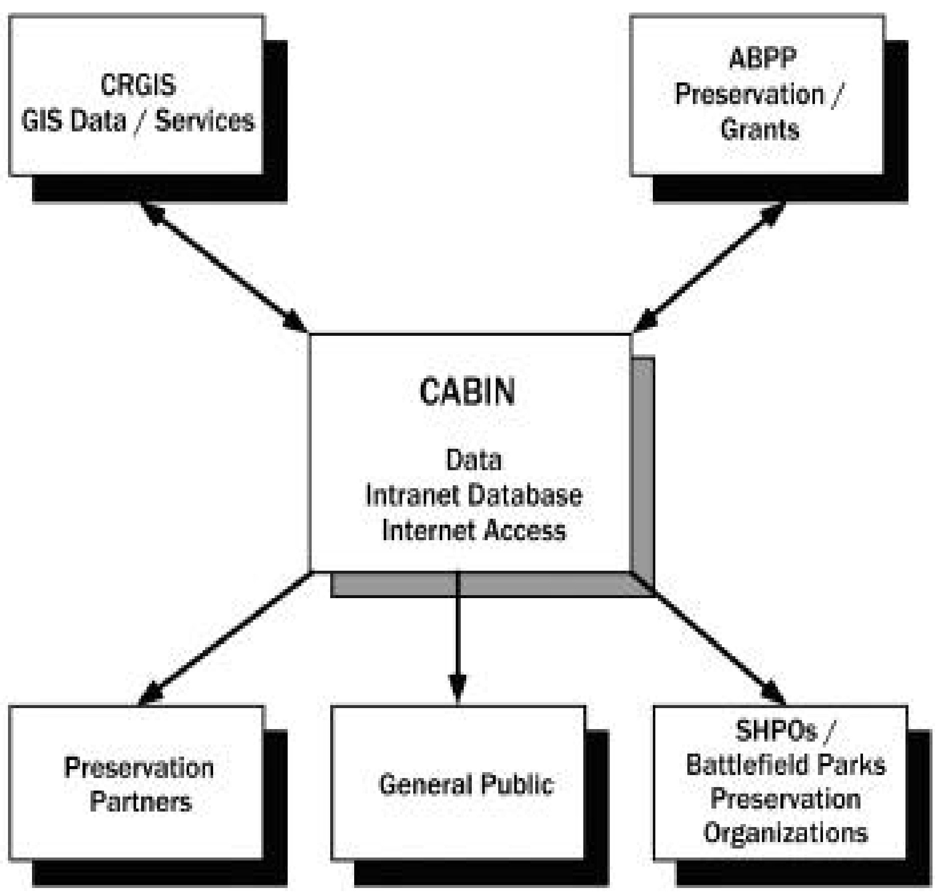

Figure 1. CABIN partnership network.

helped to inform the methods of data collection incorporated into Rev 1812HPS. It was clear from the beginning that the data collected through this study would be a large part of the CABIN, and that here was the unique opportunity to do it in a way that would facilitate incorporation into the system. The Rev1812 HPS relies on surveyors trained by CRGIS and ABPP staff to gather and submit the required data on their assigned battlefields and historic sites. With approximately 70 surveyors in the field, it was imperative that their data collection methods be standardized. By providing the surveyors with a custom database and a MapObjects-based GIS tool (developed by John Buckler of CRGIS), the data were ensured to not only be consistent, but digital as well. The database used by the CRGIS staff to assemble the survey data also has a MapObjects component to allow for automation of repeated functions and to test the functionality in preparation for its incorporation into CABIN.

A pared-down toolbar at the top provides data loading and basic GIS functions such as zooming, panning, and identifying features. The main tasks that need to be done in the process of assembling the data submissions are calculating the area of the boundaries, calculating the centroid position of the study area to add to the shapefile that will contain point locations for each site, and establishing the Universal Transverse Mercator (UTM) zone so that data will display properly for other users automatically. Each of these tasks is automated and requires only clicking a button and selecting the relevant polygon. Additionally, the database itself provides functions to catalogue other associated GIS files, including the appropriate digital raster graphs (DRGs) and the other shapefiles submitted by the surveyors. These shapefiles may contain global positioning system (GPS) data collected in the field or digitized defining features and troop movements.

For those interested in the technical specifics and challenges of creating an integrated system, it is important to emphasize that these databases were created in Access97 using the VBA scripting language embedded in that software. The database does not convert easily to newer versions of Access and this, admittedly, limits its versatility over time. Also, for some reason Access, at least the 97 version, is incompatible with the legend object available from ESRI. This necessitated some additional coding to turn a list box into a functioning "table of contents" for layer management. It would probably be best to design the interface completely in Visual Basic and refer to a back-end database system in Access or elsewhere.

The automation of data access,

which is a key aspect in making the GIS data readily accessible to non-GIS users, is completely dependent on filename and organization standards. The use of file naming conventions based on codes contained in the database and organized in a standard way made it possible to have all associated shapefiles loaded for the current site at the click of a button. This also depends on the LAN structure that provides access for all users to the data server. In order to deal with data that will be maintained off-line on CDs (due to lack of data storage space and the relatively infrequent accessing of particular files), a cataloguing system was introduced to provide a way to indicate what data are available for each site and where in the office they are located. The CDs can then be retrieved and the data loaded manually for viewing or use.

One last technical note regarding MapObjects is the complexity of dealing with projected data. The way these systems deal with the issue is by assuming the UTM projection and setting the relevant zone in advance of general use. This can be done largely because all the data digitized by the surveyors were in relation to background DRGs that display in UTM. This was a means of limiting the complexity in use as well as programming without sacrificing data accuracy. Data projected in other projections can still be displayed in the MapObjects component, but in order for data of varying projections to overlay properly, additional programming would be required.

My intentions in developing this integrated system were based on a desire to bridge the gap between the two offices in terms of data access, coordination, and development. By improving the access to the data, I hope that its relevance becomes more apparent to the work of non-GIS specialists and that this will translate into future coordinated efforts of data creation and analysis to better serve the program needs of both offices. The availability of the information will also improve the efficiency and accuracy with which the ABPP can respond to both internal and public requests for information. In this way the value of GIS to the organization could be greatly enhanced.

Though I no longer am directly involved in these projects, I hope that development continues on them in a way that further integrates the information around the content rather than the file or data type. Whether by maintaining and building on the Access databases or migrating them to more robust systems, I think that the usefulness of this kind of technology is clear. As program professionals, as opposed to technology specialists, have more exposure to and involvement with GIS, its use will become more sophisticated in addressing the problems and needs of the organization itself, rather than being an adjunct technology to display information or produce isolated reports. When both, or in other cases, multiple offices work together in developing custom tools such as this one, often the process itself can be informative and help to foster a cooperative and interdependent working relationship that improves the capacities of all involved. As CABIN progresses and moves to the Web, the combined input of both offices will be critical in making the information not just available, but meaningful and relevant to an audience of agencies, organizations, and the general public.

In conclusion, it will be interesting to see how the organizational relationship embedded in the software tool will shape future projects and affect the role of GIS in battlefield preservation efforts. By taking advantage of current technologies that allow for integration of these advanced systems in ways that make them accessible to non-specialists, organizations can expand the utility of GIS and address many of the issues that contribute to the disconnect between technology specialists and program staff. This can have big returns, not only in financial terms, but also by improving the capacity of the organization in general to apply the relevant aspects of GIS to its everyday work.

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More than a Database:

Integrating GIS Data with the Boston Harbor Islands Visitor Carrying Capacity Study

Introduction

Visitor carrying capacity has long been a management challenge in U.S. national parks (Manning 1998). This challenge is being intensified, as most national parks have witnessed a continual increase in visitation during the past two decades, prompting serious questions such as "Where is the limit?" and "How much is too much?" The development of the Visitor Experience and Resource Protection (VERP) framework in the early 1990s, and its recent incorporation into the National Park Service (NPS) general management plan process, are significant steps toward addressing visitor carrying capacity issues from a systematic and scientific approach (NPS 1997; NPS 2000b). The VERP framework emphasizes the importance of setting management objectives and zones, selecting indicators and standards, implementing a monitoring program, and developing management guidelines. First experimented with at Arches National Park in Utah, the VERP framework is being implemented in a number of national park units across the United States (Hof et al. 1994; Manning 2001). Substantial amounts of data are typically required in order to develop indicators and standards in any VERP implementation process. This is particularly true as the latest visitor carrying capacity research projects, including that presented in this paper, attempt to integrate social and resource concerns throughout the process.

The objectives of this paper are to outline the Boston Harbor Islands National Recreation Area geographic information systems (GIS) database and to illustrate its integration with an ongoing visitor carrying capacity or VERP research project. The paper first describes the Boston Harbor Islands and the GIS database development effort for this new NPS area, followed by an overview of the VERP project. We illustrate how the GIS database is being integrated with the VERP project by using resource-based indicators for social (or unofficial) trails.

The Boston Harbor Islands NRA and its GIS Database

Established in 1996, Boston Harbor Islands National Recreation Area is also known as the Boston Harbor Islands National Park Area. This new NPS unit consists of 34 islands and peninsulas (referred to collectively as "islands" herein) within the Greater Boston shoreline, encompassing 1,600 acres of land and spread over 50 square miles in a busy working harbor. The islands are managed by a partnership of 13 organizations and agencies, including NPS, island owners, state and local government agencies, and other interests on the islands. In addition to this unique arrangement, the islands' range of character and diversity of resources are striking. This park unit contains the only drumlin field in the United States that intersects a coast (NPS 2000a). There are a number of concerns about the sensitivity of the island resources. The resiliency of the natural environment—which is characterized by thin soils, abundant wildlife habitat, fragile incipient salt marshes, and coastal barrier beaches—to increased visitation is limited, but the limits are unknown. Currently there is no systematic method for assessing and managing visitor impacts on the park's natural and cultural resources.

The park is currently undertaking the preparation of its first general management plan (NPS 2000a). A number of assessment and research projects are also taking place on the islands to establish the "baseline" of natural and cultural resources on the islands. The general management plan and individual projects are supported by the NPS Boston Support Office and NPS Field Technical Support Center (FTSC) housed at the University of Rhode Island through the development of a comprehensive GIS database.

The park's GIS database was directed by the fourth author, an FTSC member who is responsible for designing the structure, researching, developing and converting spatial data, and coordinating support activities such as the "GPS [Global Positioning System] SWAT Team" and other student participation and training. Not surprisingly, there is a lot of existing digital spatial data for the Greater Boston area. In addition to standard U.S. Geological Survey (USGS) and state GIS programs, spatial data were also drawn from numerous other sources. Each data theme from each source was evaluated for relevance to the park's mission, quality, documentation thoroughness (e.g., metadata complying with Federal Geographic Data Committee standards), and convertibility. Data for the selected themes were acquired, converted, and fully documented. Data themes from these sources are listed in Table 1.

In addition to the above themes, two GPS SWAT teams were assembled by the second and fourth two

Table 1. Data themes included in the Boston Harbor Islands GIS database.

Theme	***Description***
d_abandoned_bogs	Based on the MassGIS (state of Massachusetts GIS) ab_cran coverage, no abandoned bogs are present within the study area.
d_acecs	Areas of critical environmental concern, from MassGIS.
d_boha_GPS_Themes _draft_1	Coverages created from field GPS data. These include: Built_Water_Features Flora-Fauna-Farm Memorials Other See d_paths Piers Recreation_Areas Roads Selected_Built_Features See d_social_trails Unauthorized_Recreation_Use Waste_Management
d_channels	Boston Harbor shipping channels digitized from National Oceanic and Atmospheric Administration (NOAA) nautical charts.
d_clipcovs	The clip coverages used to extract regionally specific data from MassGIS coverages.
d_coastline	Boston Harbor region coastline and islands.
d_color	Color orthophotographic mosaic of Boston Harbor.
d_discharge_points	Groundwater discharge points.
d_eelgrass	Eelgrass habitats.
d_elevation	Interpolated elevation grid for the region surrounding Boston Harbor.
d_esi	Coverages taken from NOAA Environmental Sensitivity Index records, listed below:
anadfish-	anadromous fish
birds-	bird habitats
esi	environmental sensitivity
fish-	marine fish
habitats-	habitat types
hydro-	hydrology
index-	boundaries
invert-	marine invertebrates
mgt-	managed lands
m_mammal-	marine mammal habitats
nests-	bird nesting areas
reptiles-	marine reptiles(sea turtles)
salinity-	salinity
sococon-	socioeconomic/human-use features
d_ferryroutes	Ferry routes accessing the Boston Harbor Islands.

d_geology	Surficial geology.
d_landuse	Land use/land cover data for the region.
d_moorings	Anchorage boundaries from NOAA lines from NOAA nautical charts
d_nigelcad	Computer-assisted drawing (CAD) files containing information on various aspects of the Boston Harbor Islands.
d_noaa	Digitized NOAA nautical chart of Boston Harbor.
d_panchromatic	Black-and-white orthophotographic mosaic
d_roads	Line coverage of roads in the region surrounding Boston Harbor, broken down as roads, street, route, CSN, admin.
d_shellfish_areas	Shellfish growing areas.
d_shellfish_stations	Sampling locations for shellfish toxins and/or general water quality.
d_soils	Soil types of the Boston Harbor region. See metadata for extent info.
d_streams	Rivers and streams in the study area (not merged due to errors with wetlands).
d_structures	Miscellaneous coverages of structures on the Boston Harbor Islands. The only coverage here presently is DOCKS, which shows docks and piers digitized from orthophotos.
d_usgs_bathy	Interpolated bathymetry of Boston Harbor, USGS
d_vernal_pools	Potential vernal pools and certified vernal pools from MassGIS.

GPS SWAT teams were assembled by the second and fourth authors to work on several other themes between November 2000 and July 2001. These themes were identified by principal investigators of individual research projects as the most critical additions to the available themes (Table 1). These additional themes include recreation facilities, official and social (unofficial) trails, roads, and seawalls. A total of 11 islands were mapped using GPS by the SWAT teams. Work on the remaining islands will continue as funding allows.

The Visitor Carrying Capacity Project

Visitor carrying capacity addresses the amount and types of visitor use that can be accommodated without causing unacceptable resource and social impacts (Shelby and Heberlein 1986). Examples of resource impacts include vegetation loss, tree damage, soil compaction, soil erosion, and wildlife disturbance, while perceptions of crowding, conflict, and excessive resource impacts are common forms of social impacts that may detract from visitors' experiences (Manning 1998; Leung and Marion 2000). Manning (2001) provides an overview of the visitor carrying capacity issue and the previous VERP implementations, and a recent issue of *The George Wright Forum* (Vol. 18, No. 3, 2001) was devoted to this topic. The

Boston Harbor Islands visitor carrying capacity project is a collaborative effort between North Carolina State University (for the resource component) and the University of Vermont (for the social component). The following discussion, however, focuses only on the resource component of the project.

Resource research within the VERP and other related management planning frameworks has focused on resource assessment, indicator identification and measurement, and standards formulation. Field surveys have been carried out to assess and monitor resource conditions on trails, campsites, and other recreation sites (Leung and Marion 2000; Marion and Leung 2001). Similarly, the resource component of this project was designed to help the park formulate resource-based indicators and standards of quality that are pertinent to management goals and objectives. The examples discussed in this paper are part of the first phrase of the research, which is the development of resource-based indicators.

A substantial number of potential resource indicators have been identified through review of scientific literature, a survey of local experts, and a visitor survey conducted by the University of Vermont. These potential indicators were evaluated and selected based on established criteria used in previous VERP implementation projects (Belnap 1998; Greater Yellowstone Winter Visitor Use Management Working Group 1999).

One interesting group of indicators is related to the extent and distribution of social or unofficial trails on these islands. Social trails can be defined as discernible and continuous trail segments that were created by visitors (not constructed) and which do not follow a park's formal trail system (Leung 2001). These trails are of increasing management concern since they are usually poorly located and aligned, are not maintained, and are often in a degraded condition. These trails can be a significant threat to the natural resources when they are in close proximity to sensitive habitats or resources (Belnap 1998). Measurements of social trails are relatively straightforward, low-cost, and low-impact—three important criteria for indicator selection.

Integrating with the Park's GIS Database

Most social trail indicators developed in previous studies are essentially spatial indicators, involving some measure of spatial quality, such as extent, density, and distribution(Belnap 1998; Leung and Marion 1998). Hence, the Boston Harbor Islands GIS database was identified early on as an important data source for developing social trail indicators for this project.

The first integration between the carrying capacity project and the GIS database development effort took

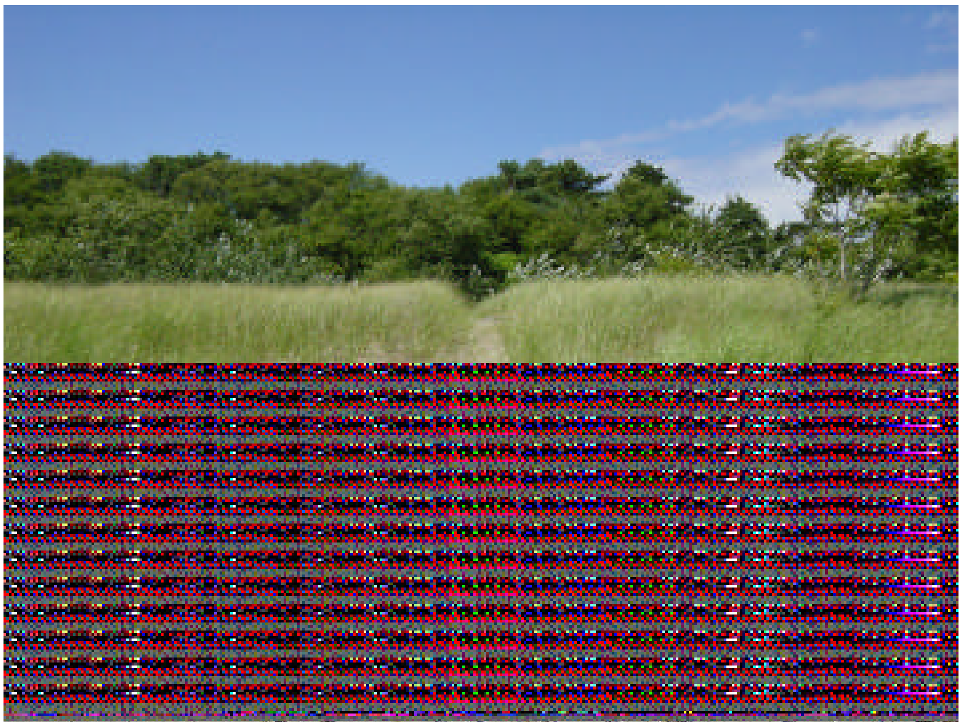

Figure 1. A social trail cutting through a sand dune on Lovells Island.

place before the GPS SWAT teams started field data collection. A condition-class rating system for social trails, which was adapted from an earlier study (Cole et al. 1997), was incorporated into the GPS data dictionary and applied directly in field mapping. All discernible social trail segments were mapped using a GPS unit. Each social trail segment was assigned to one of the following four condition classes:

- ***Class 1***. Trails are disturbed but not well established. They retain at least 20% of vegetation cover on the treads. The boundaries between trail treads and off-trail areas are often unclear.
- ***Class 2***. Trails are disturbed and well established. They retain less than 20% of vegetation cover on the treads. These trails are less than 1 ft wide. The boundaries between trail treads and off-trail areas are often discernible.
- ***Class 3***. Trails are disturbed and well established. They retain less than 20% of vegetation cover on the treads and are between 1 and 2 ft wide. The boundaries between trail treads and off-trail areas are usually discernible.
- ***Class 4***. Trails are disturbed and well established. They retain less

Figure 2. The third author mapped a social trail segment on Raccoon Island.

than 20% of vegetation cover on the treads and are more than 2 ft wide. The boundaries between trail treads and off-trail areas are usually discernible.

The second and ongoing integration involves the derivation of various resource impact indicators using data themes available from the park's GIS database. Table 2 provides an example of selected social trail indicators for Georges, Grape, and Peddocks islands. In addition to the social trail data set, two data themes from the GIS database were utilized to delineate zones that are sensitive to visitor impacts. The first data theme used was a land use–land cover (LULC) data set created using photo interpretation and automation by the Resource Mapping Project at the University of Massachusetts–Amherst. Interpretation was made from 1:40,000 color infrared aerial photos taken in summer 1985. The second data theme was the National Wetlands Inventory (wetlands) data set that was interpreted (again, by the university) using stereo photogrammetric techniques on 1:12,000 color infrared photographs. The delineation was based on a combination of the Anderson and

Cowardin classification schemes. Zones that are considered to be sensitive to visitor impacts include features such as barrier beach, coastal bank bluff or sea cliff, coastal dune, salt marsh, and shallow marsh meadow. While the criteria for defining sensitive zones may change in the future, the same approach and procedures can be applied to derive different resource-based indicators. Table 2 shows that most social trails are located outside the defined sensitive zones except on Peddocks Island, where more than 400 m, or about 44%, of social trails lie within sensitive areas. In addition, some of the social trails within sensitive zones are in Class 3 or Class 4 condition, indicative of widening treads and more human presence.

Another way of using the GIS database was the creation of new resource-impact indicators by on-screen or heads-up digitizing using 1:30,000 digital orthophotos of the islands. Figure 3 shows an example in which intersection points between official trails and social trails were digitized for Peddocks Island. The number of intersection points is being considered as an alternative social trail indicator, because it does not require time-consuming assessment of the entire social trail network.

Table 2. Conditions of selected social trail indicators on three islands. These indicators were derived using three data themes from the Boston Harbor Islands GIS database.
*** Zones that are considered sensitive to visitor impacts.**
**** Trail segment with a condition class of 3 or 4. Details of the condition class rating scale are described in the text.**

Island	***Location with respect to sensitive zones****	***Indicator***		
		Number of Segments	*Cumulative Length (m)*	*Length in poor condition (m) ***
Georges	Inside	6	56	0
	Outside	134	1,448	160
Grape	Inside	0	0	0
	Outside	33	475	68
Peddocks	Inside	28	466	89
	Outside	26	1,063	257

Concluding Remarks

This paper has provided an overview of the GIS database development for Boston Harbor Islands National Recreation Area and the resource component of the on-going visitor carrying capacity project. Examples of integration between the research project and the GIS database were also highlighted. Other natural resources assessment projects in this new park unit will similarly benefit from the wealth and quality of spatial data available in this database.

The addition of new data themes created by various on-going research projects will continue to expand the Boston Harbor Islands GIS database. It will provide an excellent opportunity for performing integrated evaluations of natural and cultural resources. For instance, intertidal and inland habitat data sets that are being developed by other research teams could be integrated with the trail and campsite assessment data sets to identify problem locations with respect to the protection of natural habitats. Within the carrying capacity research project, integration between the resource and social components is underway through the use of GIS (Newman et al. 2001). Such integration facilitates the formulation of indicators and standards of quality—a critical step in the VERP implementation process.

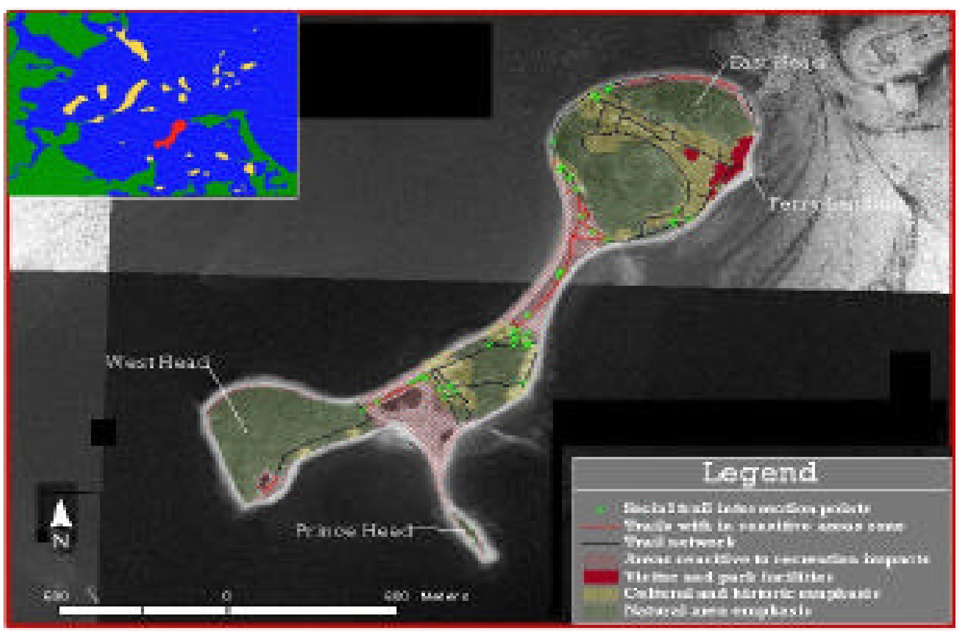

Figure 3. Developing new resource impact indicators, such as trail intersection points for Peddocks Island, using the Boston Harbor Islands GIS database.

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Ronald W. Johnson

The Success of Planning Partnerships: Three National Park Service Case Studies

The benefits of federal, state, local, and private partnerships that support National Park Service (NPS) planning have evolved rapidly in recent decades. For instance, park planning has been opened up to comprehensive public participation. This has not always been the case; historically Congress often designated new federal parks without eliciting much public comment. A more inclusive approach to park planning has developed from a host of diverse influences. Societal expectations that stemmed from of the tumultuous 1960s demands for participatory democracy prompted enactment of legislation to direct federal agencies and bureaus, including NPS, to encourage a host of external parties to involve themselves in the planning process. Park planning became interdisciplinary, driven by environmental compliance that dictates comprehensive public participation. The Park Service has an informal cadre of public involvement specialists who have developed a range of useful tools to assist the planning teams. Contemporary park and central-office managers have assumed a more supportive posture towards public participation duties mandated by Congress. Legislation such as the National Environmental Policy Act has been translated and codified at the departmental, agency, and bureau level into public policy. For example, NPS's 1988 *Management Policies* defined public involvement requirements:

> Throughout the planning process, opportunities will be provided for the public at the national, regional, and local levels to voice their concerns about planning and management of parks.... Those involved will include federal agencies, state and local governments, regional planning commissions, native Americans, state historic preservation officers, state liaison officers, advisory organizations, concessionaires, park users and their associations, owners and users of adjacent lands, and other interested parties.

The revised planning policy, Director's Order no. 2 on park planning (1999), further describes the partnership approach:

> Good planning helps provide everyone who has a stake in decisions with an opportunity to be involved in the planning process and to understand the decisions as they are being made.... Public involvement throughout the planning process provides focused opportunities for park managers and the planning team to interact with the public and to learn about public concerns, expectations, and values....

During the past two decades, NPS professionals have touched base with a variety of external parties to make sure the planning process provides a useful and beneficial result to all stakeholders. Contemporary NPS planning documents provide a valuable record of partnerships that have been nurtured and enhanced from a project's start through completion.

This paper will illustrate the value of the partnership approach to planning by examining three case studies whose success was influenced by the inclusion of external entities and augmented by continuing involvement throughout each project's lifecycle. The first two case studies deal with traditional National Park System units. The first, Sitka National Historical Park, was designated by President Benjamin Harrison as a public park in 1890; it then received national monument status in 1910 and was enlarged several times during the 20th century. The second, Dayton Aviation Heritage National Historical Park, earned its congressional blessing in 1992. The final case study describes the approach taken for a comprehensive management and development plan for Moccasin Bend, a tract of land originally considered for addition to Chickamauga and Chattanooga National Military Park some 50 years ago.

In each of the three projects, external groups, local residents, and commissions or advisory groups actively participated in the Park Service's planning scheme. This personal and professional commitment enhanced the usefulness of the product. Planners devised public outreach and participation strategies tailored to the individual needs of each project to generate the greatest amount of local involvement. This was accomplished to make certain that the widest range of input was elicited to create an effective plan as well as constructing a solid foundation for community buy-in at the approval stage. When it comes to public involvement, there is no "one size fits all" cookie-cutter approach. Regarding Dayton and Sitka, the approved general management plans provide blueprints for the management, interpretation, development, and preservation of the parks' resources for a 10-15 year interval. As for the Chattanooga study, the U.S. Congress will either consider or set aside the comprehensive management plan's proposals.

As its contribution to a partnership relationship, an NPS interdisciplinary team brings a respected cachet of interpretive, preservation, and resource management planning experience to the affected communities. Veteran professionals have honed a wealth of park planning experience gained from challenging assignments throughout the United States. Recent generations of well-trained planners have been introduced to public involvement methods and techniques in collegiate and graduate school planning programs. These enthusiastic but less-experienced planners have eagerly put planning theory to work in the following case studies.

Sitka National Historical Park

Between 1996 and 1998, planners completed a general management plan for Sitka National Historical Park. This 106-acre urban park celebrates the rich culture and heritage of the Northwest Pacific coastal Native Alaskans (the Tlingit), a large totem pole assemblage (Figure 1), and the Southeast Alaska Indian Cultural Center. NPS made a concurrent pledge to assist the city and borough of Sitka with gateway planning that linked the park to the city (not a difficult thing to undertake since the park is located just a half-mile from the central business district). This pilot project had been mandated through NPS's gateway community planning initiative, where selected parks collaborate with adjacent communities to address and resolve common issues. In Sitka, Park Service staff had the good fortune to work with an existing community entity created to take a fresh look at local planning—the Comprehensive Plan Implementation Team (ComIT). Part of the initial process to launch this collaborative effort involved the approval of a memorandum of understanding with the municipal government to codify what NPS would do in concert with the ComIT. This congruent planning and design process began in March 1996 and was completed by April 1997. As part of the gateway planning agreement, NPS pledged to assist the Sitka community with the following grassroots issues (among others):

- Assisting in planning for the preservation of the visual and environmental quality of the park and
- those community components shared with the park.
- Addressing visitor distribution, particularly related to overcrowding during the high visitor-use period from mid-May to mid-September caused primarily by cruise ship passengers.

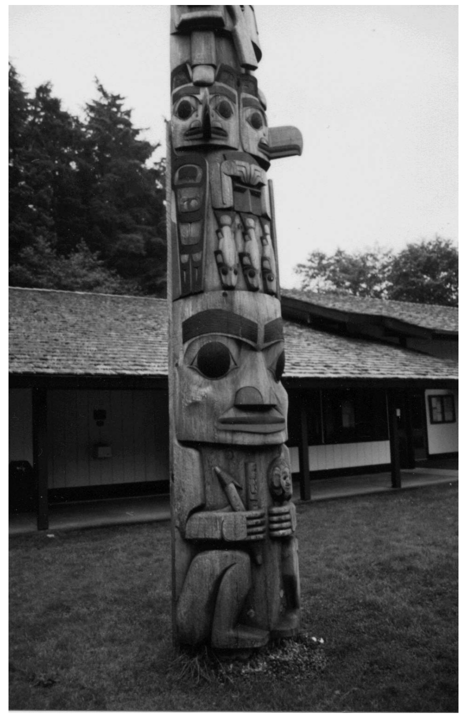

Figure 1. Totem pole on the grounds of Sitka National Historical Park's visitor center.

- Coordinating planning of the types and locations of Sitka visitor-use facilities, such as: orientation, interpretation, gift and book sales, restrooms, food service, emergency services, and transportation.
- Providing assistance in designing and locating orientation signs.
- Planning an orchestrated system of access and circulation, including auto, bicycle, and pedestrian traffic routes and linkages.
- Working with Alaska Natives to convey their cultural connections

to the park, including tourism, subsistence, and cultural center activities.

Workshops with Sitka area residents in 1995 and 1996 had identified numerous locally significant community attributes to be celebrated, issues to be addressed, and potential solutions that provided valuable input for the gateway planning process. In August 1996, NPS sponsored a week-long planning and design charette, an intensive and collaborative idea-generating exercise that challenged planners, designers, and community representatives to analyze Sitka's needs and develop a range of alternatives to address the issues identified above. The study document, entitled *Gateway Community Planning Assistance—Design Workshop Recommendations—Range of Alternatives,* illustrated ideas, values, and concerns expressed by Sitka residents, and provided additional recommendations from the objective viewpoint of planners and designers. The gateway plan was an attractively packaged document overflowing with maps, illustrations, and graphics displaying recommendations for future consideration by Sitka residents. Implementation of this cooperative effort will require the city and borough of Sitka, local interests, and other involved entities to reach consensus on the more thorny issues of desired futures for the community.

To accomplish this, NPS utilized funding allocated to complete the gateway plan, which was distributed in the late summer of 1997. Almost simultaneously, and perhaps coincidentally, positive results occurred, including placement of uniform directional and interpretive signage in Sitka, improved local interpretative programs, and support for a community-sponsored shuttle bus system operating during periods of high visitation. Indirect benefits also developed including more community awareness of the park's mission and goodwill for the Park Service.

Sitka National Historical Park management will continue its involvement with partnerships. In the face of limited or declining appropriations, and because recent federal budget surpluses that have not been translated into vast new pools of appropriations for NPS, viable partnerships have provided an effective method to achieve park objectives congruent with local aspirations. In the future, the park may partner with private or corporate entities or with Alaska Native groups (such as the Sitka Tribe of Alaska). The park could also develop and present interpretive programs in concert with the other National Park System units in Southeast Alaska, Glacier Bay National Park and Preserve and Klondike Gold Rush National Historical Park. The park may establish natural and cultural education programs with local institutions such as Sheldon Jackson College or the University of Alaska–Southeast. The city and borough of Sitka could share facilities with the park to benefit visitor orientation programs. The park might at some point share staff and programs with Alaska State Parks and Recreation or the Sitka Historical Society to present interpretive programs. These potential alliances with other partners who have a vested interest to implement new programs pose challenges as well as opportunities for park management.

The general management plan also introduced several additional partnership possibilities. For example, the expansion of a more permanent shuttle system provides a major opportunity to even the flow of visitors to the park, especially during peak times. An overwhelming percentage of park visitors arrive by large tour boats from mid-May to late August. To make peak demand times work efficiently, shuttle and tour operators would be given up-to-date information on capacity limitations at the park, especially the visitor center, so that they can brief visitors on their vehicles about other worthwhile experiences throughout the park or in the community. Collaborative partnerships can develop a more effective and safer physical link along a busy street between the park and the central business district. Another partnership arrangement may be created with various public and private organizations to establish an integrated environmental education program in Sitka. New programs for local and regional audiences and for national as well as international visitors could be geared to children, college students, families, senior citizens, and organized groups.

The park will continue its dialogue on a government-to-government basis with the Sitka Tribe of Alaska, a federally recognized tribe headquartered in town. Regular consultation will continue between the park and other local and regional Alaska Natives regarding visitor services and outreach programs focusing on ceremonial, interpretive, and educational functions. The Sitka Tribe of Alaska and the park have entered into preliminary discussions to determine the scope of the tribe's interest in performing components of park operations.

The long-term harmonious relationship between the park and the Southeast Alaska Indian Cultural Center will continue. Since 1969, the center, a nonprofit organization, has protected and perpetuated traditional art forms, all of which provide substantial enjoyment to park visitors. The cultural center's craft workers make and sell traditional objects serving as a key aspect of the park's interpretive programs. The cultural center will remain in the park's newly enlarged visitor facility, with Native Alaskan artisans demonstrating wood-carving, regalia making, and silver working—all of which provide an interpretive highlight to visitors and income for local residents. The park will continue consultations with the Alaska Native Brotherhood and Sisterhood, the Center Council of the Tlingit and Haida Indian Tribes, the Shee Atika Corporation, and the Sealaska Corporation.

In Sitka, several essentials were crucial to the success of the gateway and park management plans. Active and committed participation from community decision-makers was important to ensure eventual project completion. Interest and support from park staff and management, and interaction between park and community representatives provided an essential component for success. Such interaction may be enhanced when the park is small, and values inside and outside the park boundaries coincide. Finally, when preparing a plan or study directly for general distribution, it is important to include a great deal of preliminary graphic design strategies (maps, site drawings, future views) that can provide effective tools for the public to visualize future possibilities.

Dayton Aviation Heritage National Historical Park

The Dayton Aviation Heritage Commission provided oversight and input to the park's general management plan between 1994-1997. Partner representatives, site managers, and local citizens composed this commission, which was mandated in the 1992 legislation with a stipulated "sunset" to coincide with the completion of planning. During the planning phase, park management developed and nurtured an effective working relationship with the federally chartered commission, a 13-member group that provided worthwhile input at various key points. The cooperative relationship was especially noteworthy in identifying transportation links between the park's four scattered units. This topic, while not addressed in the enabling legislation, surfaced as a long-term need during planning. Presently, a successor to the original commission coordinates with park management.

Different partners manage the park's four units. Park Service management is legislatively limited to the Wright Cycle Shop, the nearby Hoover Block, and a small parcel of land between the two properties in West Dayton. The state of Ohio, through the Ohio Historical Society, manages the Paul Laurence Dunbar State Memorial, located about a half-mile from the core NPS facility. Carillon Historical Park manages the 1905 Wright Flyer III (the first heavier-than-air controllable aircraft) and Wright Hall, in which the National Historic Landmark plane is displayed. Wright-Patterson Air Force Base controls Huffman Prairie Flying Field (the first test field). Throughout the park's planning process, the planners collaborated with these external entities (Figure 2). At each milestone, workshops occurred, input was recorded, and results were circulated quickly among the partners for revision and follow-up. This generally occurred in two distinct phases: one with the partners and a second with the commission at its regularly scheduled meetings. Planners attended numerous commission meetings and held a

Figure 2. Community park planning forum being led by Dayton Aviation Heritage National Historical Park personnel.

half-dozen well-publicized workshops during all phases of planning.

Besides federal-level planning, the state of Ohio created the Wright-Dunbar State Heritage Commission to tackle grassroots economic and community development issues beyond the scope of the park and the commission. The state body had clearly defined but unrealized responsibilities, including preparation of a management plan for properties that should be "preserved, restored, developed, maintained, or acquired," emphasizing redevelopment and revitalization of the Wright-–Dunbar West Dayton neighborhood. This plan will be prepared in cooperation with the city of Dayton, which is currently implementing its own successful urban redevelopment plan for the neighborhood.

Within the framework of the partnership outlined in the 1997 general management plan, each site has maintained organizational and operational autonomy. The non-NPS partners have established goals and membership responsibilities and convene on a regular basis with park management to discuss and resolve common issues. As of summer 2001, this collaborative approach is working effectively in Dayton.

The challenge to NPS is to meld the newer non-traditional parks with the bureau's more conventional operational, resource stewardship, and outreach policies. While some of the newer historical parks such as Dayton Aviation have a small land base, their importance to and impact on their host communities often transcends the size of the acreage, annual operations appropriations, and visitation. Non-traditional parks give communities such as Dayton an overarching sense of local pride. Similar to the societal thrust for urban areas to attract Fortune 500 companies who intend to relocate, as well as footloose major-league sports franchises, non-traditional urban-based parks can help bolster a community's identity and sense of grassroots self-worth by attracting the attention of local residents, civic organizations, and the media.

Planners and park resource managers must take into account the intricacies of grassroots support and interest for this unique type of NPS endeavor. Local special interests, even those with widely differing agendas, often coalesce around a common mission. For example, a local historical society, Aviation Trail, Inc., took the lead to save the Wright Cycle Company building from possible demolition. Another aviation-related booster group, The 2003 Committee (created to plan for the 2003 Centenary of Flight) vigorously advocated National Park System status. Dayton-area private-sector opinion leaders lobbied for designation of a new park for seemingly conflicting motives, including heritage preservation, economic development, and urban renewal. Aviation history devotees in Dayton deserve recognition for their vigorous advocacy for designation and development of a new park, one that transcends legislated federal-sector contributions.

The process of implementing active partnerships as outlined in the general management plan has been a gradual process. Effective partnerships take time to evolve into mature relationships. In 1998, the commission had helped establish a Main Street Program for West Third Street, where the park is located. Since autumn 2000, the Main Street Program has acquired six properties and funding support from the federal government. Meanwhile, the commission had hired an executive director and with the addition of staff became an effective organizational structure. As a result of a boundary change, in 2000 Aviation Trail, Inc., added its new building to the park. All these partners are strong advocates for the park.

One area where the concepts outlined in the general management plan have taken a different course has been in the commission's development of a non-profit support group, the Aviation Heritage Foundation. Also, the commission has provided draft legislation to the Ohio congressional delegation to create a National Aviation Heritage Area that would have a core area in southwestern Ohio with links to aviation sites throughout the state. Broadening of the aviation heritage concept has received large-scale support, with the hope of eventual congressional passage.

In the management of nationally significant cultural resources, there is great deal of buzz about partnerships that sound useful in principle. Such partnerships can actually fall short when it is time for partners to fund capital-intensive development projects directly benefiting resources managed by non-federal owners. The Dayton model—fueled with a mix of federal, state, city, and private dollars—proves what can be accomplished. A partnership works if there is commitment from all partners to step forth. In Dayton, local and state governments as well as semi-private funders were available up front to get the project moving on a timely basis. New parks do not arrive in full bloom, but require a planning and development phase. When this urban park's administrative history is eventually written, the record will credit a diverse group of public- and private-sector individuals and organizations. Friends of Dayton aviation (both paid and volunteer) have spent countless hours to get the new park fully operational and to implement community improvements in the Wright Brothers' West Dayton neighborhood.

Moccasin Bend

In contrast to the Sitka and Dayton parks, Moccasin Bend is not currently a National Park System area. Moccasin Bend is a 956-acre national historic landmark situated on a narrow spit of land surrounded on three sides by the Tennessee River, adjacent to a Civil War battlefield. The study area is rich with highly significant prehistoric Native American sites illustrating occupation stretching back several thousand years. The site also contains Civil War-era resources including trench lines, artillery positions, and bivouac sites constructed by Federal troops who fought in the 1863 Chickamauga and Chattanooga campaign.

In 1950, Secretary of the Interior Oscar L. Chapman reported to the chairman of the House Committee on Public Lands that the "Moccasin Bend lands, which are now chiefly used for agricultural purposes, should be added to the Chickamauga and Chattanooga National Military Park for administration and protection in keeping with general objectives of national park administration...." That same year Congress enacted legislation that authorized the addition of 1,400 acres of Moccasin Bend to the nearby park. Property was acquired by state, county, and city governments but never transferred to NPS. In the late 1990s, various local entities reopened the Moccasin Bend issue and by 1998 Congress appropriated funding for another study. Currently the tract, officially known as the Moccasin Bend Archeological District National Historic Landmark, has several non-federal owners and managers, including the city of Chattanooga, Hamilton County, the state of Tennessee, and Star City Development Corporation; one parcel contains a private residence. The federal government owns no land at Moccasin Bend.

To fulfill the congressional mandate, new planning for Moccasin Bend was conducted by establishing an interagency team comprising representatives from the Chattanooga-Hamilton County Planning Agency, the state of Tennessee, and NPS. The team quickly developed working relationships with American Indian groups, the Friends of Moccasin Bend, local, state, and federal officials, the academic community, and the public—all of whom supported and endorsed some sort of future preservation. Planners initially elicited input from the city, Hamilton County, the local congressman, the governor's office, the state buildings authority, and local organizations and groups. American Indian groups, including tribal members and elected representatives augmented by contemporary non-native supporters of the Five Civilized Nations whose traditional heritage was linked to Moccasin Bend before their forced removal to Oklahoma during the Trail of Tears, provided noteworthy contributions.

Public involvement included a series of meetings, open houses, and workshops that attracted approximately 500 individuals in February, April, and October 1998. Informal settings at the initial open houses provided a comfortable venue for interested parties to raise questions and discuss issues with the planners. At two well-attended workshops held at the Chattanooga-Hamilton County Convention and Trade Center, approximately 100 individuals shared ideas and suggestions. A public meeting held at the Tennessee Aquarium provided planners with an opportunity to describe the purpose and background of the study process while presenting the audience with a platform to articulate comments and concerns about the future of Moccasin Bend. Thirty representatives of federally recognized tribes attended two meetings in Tulsa, Oklahoma, in July and November 1998. The Park Service recorded 50 responses to two newsletters sent out in February and April 1998, and another 43 comment sheets and letters on the draft document in October 1998. NPS also received approximately 3,000 signatures collected by the Friends of Moccasin Bend supporting the creation of a Moccasin Bend unit of the National Park System. Additionally, NPS received approximately 1,500 signatures demanding that the Moccasin Bend golf course be excluded from a possible new park. Thus, the planning work attracted a mixed reaction regarding the future status of the site from a committed and diverse clientele.

Park Service planners completed a comprehensive management plan during a thirteen-month span from mid-January 1998 to early February 1999. Planners who evaluated the site validated its national significance as well as its suitability and feasibility for inclusion in the National Park System, principally because of the site's American Indian history and relationship to the Civil War. The study recommended that Moccasin Bend be added to Chickamauga and Chattanooga National Military Park. Although there was much support for such action in Chattanooga, as of spring 2001 local boosters and political forces have not resolved future disposition of a state-run mental health hospital and the golf course at Moccasin Bend (Figure 3). Tennessee apparently is not ready to raze the hospital. A replacement elsewhere would saddle the state with a multi-million-dollar capital development project. If the state de-institutionalizes the Moccasin Bend facility, then perhaps the hospital will be relocated to a more central location. As noted above, 1,500 golfers signed petitions to oppose the elimination of a favorite, low-cost, conveniently located public course. The local congressman, an "on-the-record" supporter of the initiative, was not prepared to get too far out in front of divided public opinion to advocate designation of Moccasin Bend. Finally, the new Bush administration has already signaled that it may not be too keen on adding new units to the National Park System. These unresolved issues have delayed adding the site to the nearby park. Legislation to create Moccasin Bend National Historic Site (H.R. 980) was passed in the House of Representatives in late 2001, but no action has parks are not created by the Park Service's merely conducting a planning study, notwithstanding a tech nically proficient document, a solid record of effective partnering, and an

Figure 3. Aerial view of Moccasin Bend. The state mental hospital is in the clearing in the foreground of the bend; the golf course and a sewage treatment plant occupy most of the bend's neck.

extensive public involvement program. Planners evaluate such resources as Moccasin Bend at the behest of Congress. Once the planners complete their project, it is the responsibility of the local community to lobby the state's congressional delegation for further federal action.

Lessons for Planners

Planners learned a number of valuable lessons from the three projects. Although each general management plan or special study dealt with specific issues in three widely differing geographic and resource circumstances, some common observations emerged. Planners cannot expect or demand that local communities allocate much personal or professional time to a bureaucratic process. While the three planning projects had a great deal of involvement during the initial steps of the process, it was NPS planners who wrote and revised the documents. Representatives from local organizations and planning agencies best serve the process by opening doors to local constituencies, providing technical support, participating in the review function by vetting draft documents, and providing a supportive presence at public involvement milestones. Planners should not be reluctant to incorporate local input in planning documents. This indirect endorsement by an external entity of locally generated ideas, proposals, and alternatives is the essence of public involvement and partnership relationships and often pays large dividends. The planners must develop innovative methods to conduct traditional business or responsibilities. Even the inclusion of small items in a draft plan can serve as a symbolic victory to a partner with a specific agenda. This buy-in proves useful at the review and revision stage. Planners must make every effort to get a complete draft plan on the street before too much time passes—the public generally loses interest when not given a product quickly. Once a product is ready for review, the local community should receive credit for its participation, whether supportive or critical. People like to be acknowledged as having assisted the planners, who in actuality served as consultants to the community. Meetings, workshops, and other special events must be well publicized through various media in a community; yet despite these efforts, small turnouts at public meetings and open houses do occur. Planners should expect that only a small number of mail-back response sheets might be returned. If a project has gone well and is not controversial, responses may be quite limited. On the other hand, if, for whatever reason, the project blows up, the feedback numbers increase exponentially. Of great importance, funding at some level always fosters implementation. Studies should indicate that a useful level of financial support is appropriate for NPS to assume in conjunction with its partners—all the better if Congress is favorably disposed at some point. Further, there is always an expectation of future dollars in the pipeline through congressional appropriations during a plan's life span for an existing park unit. A plan should indicate this good news in general terms, knowing full well the vagaries of congressional funding.

Some observations about partnerships in the planning process as well as in the eventual implementation phases are appropriate. Partners often include local citizens and governments, trade associations such as the Chamber of Commerce, newspapers, cultural and historical organizations, grassroots and state history societies, as well as federally recognized Native American tribes and their allies, and federal agencies such as the U.S. Forest Service and U.S. Air Force. Other external influences include congressional, state, and local officials. During the average life of a planning project, alliances constantly shift and evolve. On many occasions those on the train at the beginning of the journey may, for one reason or another, step off or head in another direction. This is not something to dread; it is a realistic aspect. The most successful projects manage to keep a majority of the passengers on board until the journey ends. It is critical for the planning team to exert strenuous efforts to complete the project in a timely (and cost-effective) manner and, thereby keep the constituents enthusiastic (and on board). What many people outside of government fail to realize is that the federal bureaucracy really grinds onward at a glacial pace; occasionally other entities, especially in the private sector get out in front, change the direction and intent of a project, and charge ahead. In a busy, media- and market-driven society, the National Park Service is not the only game in town.

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The Hair of the Dog that Bit You:

Using Special Events to Help Understand and Manage Their Impacts—A Case Study of Crissy Field, Golden Gate National Recreation Area

Introduction

Though recreational activities have occurred along the San Francisco Bay waterfront at Crissy Field for over two centuries, dynamic changes, resulting in the restoration of natural processes, recently provided managers of the Golden Gate National Recreation Area (GGNRA) with an opportunity to re-evaluate the size, duration, and frequency of recreational activities allowed on-site. Paramount among concerns was the impact of large special events that had occurred historically along the Golden Gate Promenade, the main pedestrian and bicycle thoroughfare along the Crissy Field waterfront. Park managers were concerned that these special-event activities might conflict with the activities of other park users, as well as adversely affect resources. With the reintroduction of a 23-acre protected saltwater marsh on the site of a formerly paved event venue directly to the south of the promenade, and the establishment of a wildlife protection zone along the dunes and beach directly to its north, managers recognized the need to re-evaluate the scope of special events and to develop a policy that provided for the maximum amount of recreational use while protecting the area's newly restored natural systems.

Toward this end, the park's Office of Special Park Uses (OSPU), the office responsible for managing all GGNRA special-use permits, began revising the standard operating procedure (SOP) for special events at Crissy Field. Understanding that political sensitivities and realities ruled out any cancellation of historically occurring athletic events along the promenade to conduct an impact study, OSPU staff developed an innovative and cost-effective plan to complete such studies on the largest of these activities, the annual Bridge to Bridge Run.

The OSPU response, metaphorically similar to the belief from American folk culture that applying a few hairs from the dog that has bitten you to your wound would prevent evil consequences, is a management tool worthy of note. In order to provide data for the required SOP, OSPU staff employed non-traditional means to gain vital scientific documentation on the impacts of athletic events on the area's wildlife and vegetation *from the events themselves*. With this information, OSPU staff gathered essential baseline information for the park and avoided potential political difficulties that may have arisen had the promenade been closed to events for a period of study. Simultaneously, they field-tested a management innovation that can be adapted and used Servicewide at little direct cost to the National Park Service (NPS).

Site History

Crissy Field has a rich and long-standing cultural and natural history. Prior to Spanish, Mexican, and American habitation at the adjacent Presidio of San Francisco, the area today known as Crissy Field was formerly a vast tidal marsh that supported Native American tribal groups, including Ohlone and Coastal Miwok peoples. Following colonization by Spain in 1776, the Crissy Field vicinity became a strategic military site and the gateway between supply ships and the growing Presidio of San Francisco for Spanish, Mexican, and American administrations (Toogood 1980; Thompson and Woodbridge 1992). In addition to providing access, the wetland also represented an area of potential growth within the geographic boundary of the Presidio.

The wetlands at the northern border of the Presidio and the San Francisco Bay were first filled systematically to provide for the construction of the 1915 Panama Pacific Exposition. The U.S. Army provided the land for the exposition, and it was subsequently filled by dredging and used as an airstrip. Following the exposition the Army retained the airstrip, and named it Crissy Field in honor of Major Dana Crissy (Thompson and Woodbridge 1992).

In the 1920s, Crissy Field served as the only Army Air Service coast defense station in the western United States and figured prominently in the pioneering events of U.S. military aviation. Improvements and flights continued; by 1960, the Army had further extended the airfield to provide for larger and more powerful aircraft. Though restricted exclusively to helicopter landings in 1974, repair of the existing airplane runways continued into the 1990s (Thompson and Woodbridge 1992).

Despite maintenance efforts, Crissy Field fell into a state of disrepair. As one park document described in 1999:

> Only one third of the 100-acre site was available for use. Much of the area was a jumble of asphalt, open space created by building demolition, hard-packed earth, deteriorated paths and weeds, with almost 30 acres fenced off. Crissy Field's natural and cultural features lay dormant, difficult for the public to enjoy (GGNRA 1999).

Prior to the period of Spanish colonization, the sand dunes adjacent to the waterfront at Crissy Field were part of an extensive and balanced ecosystem highlighted by a vast dune field edged by lush salt marshes and lagoons. Presently, this area supports the only native foredune community in San Francisco (GGNRA 1999). It also supports a variety of recreational activities. According to GGNRA documents:

> Over the years, Crissy Field has been a much loved park destination—popular for jogging, cycling, dog walking, picnicking and boardsailing. Park visitors marvel at the beauty of the setting and the breathtaking views, dramatic weather and natural features. Perhaps above all, Crissy Field provides a welcome respite from nearby urban life (GGNRA 1999).

Recreation activities, especially athletic events, have a long history at Crissy Field. In 1876, to celebrate the nation's centennial, thousands of San Franciscans flocked to the area to watch a mock battle where the cannons of Fort Point and Alcatraz Island fired at whitewashed rocks along the Marin Headlands and a target ship moored offshore from Crissy Field. Following its closure in the 1880s, Fort Point became a popular recreation and picnic area, and many visitors would travel by carriage to the fort through Crissy Field along the same course as the present-day Golden Gate Promenade. Though no specific reports documenting Army recreation on the site were uncovered by the author, several post beautification engineering reports proposed that the area be filled in for recreational use and drill by Army soldiers (Thompson and Woodbridge 1992).

By the 1970s and 1980s organized recreational activities became increasingly popular in the San Francisco Bay Area, and, through agreements with the Army and the GGNRA, the Golden Gate Promenade began hosting a number of athletic events, including the San Francisco Marathon, the Escape from Alcatraz Triathlon, and the Bridge to Bridge Run.

Monitoring Recreational Impacts

Impacts of recreational activities. The field of recreation ecology, which emerged in the mid-1960s, studies the impacts of recreational activities, such as athletic events, on the vegetation, wildlife, and natural systems of the immediate ecosystem (Liddle 1991; Hammitt and Cole 1999). Though initial studies focused on the effects of recreation on vegetation, recent studies broadened the scope to include impacts on wildlife (Knight and Cole 1995). These studies demonstrate that the growth of recreational impacts pose a significant threat to landscapes and ecosystems (Cole and Landres 1996).

In addition, other research demonstrates a direct application to units of the National Park System. Sellars (1997) illustrates how NPS natural resource management was employed historically to serve tourism and recreation. Manning (1998) uses multiple examples to demonstrate that the resource and social impacts caused by recreationists are a growing management issue for the NPS. Some researchers, such as Leung and Marion (1999) recommend employing spatial strategies to manage recreational impacts in national parks, while others focus on other visitor management strategies (Chavez 1997; Jakes et al. 1990).

However, as Lowry (1994) noted, visitors to parks—especially national parks in the United States and Canada—are "seeking increasingly diverse forms of recreation." In direct proportion with this trend, large recreational activities with the potential for major impacts continue to increase in number, especially in the immediate vicinity of large urban areas. Recent studies examining the economic impact of athletic and sporting events on urban parks show a significant financial gain for surrounding businesses when such activities occur (Crompton and Lee 2000). Thus, as Moore and Barthlow (1998) proffered recently, managers of multiple-use trails such as the Golden Gate Promenade are challenged by many duties to protect natural resources, provide recreational experiences, and maintain safety.

Description of event. The Bridge to Bridge Run—beginning at the San Francisco Bay Bridge on the city's northeast side and traversing along the waterfront to the Golden Gate Bridge on its northwest side—is a 12-km road race that annually draws over 10,000 entrants (KNBR 1999). According to NPS documents, it has been permitted in the park since 1976 and "is the largest and oldest race that runs through the GGNRA" (Higgens-Evenson 2000).

The race's course traditionally follows the San Francisco waterfront and enters GGNRA property at Crissy Field approximately 5.4 km into the event. Prior to entering the Golden Gate Promenade at Crissy Field, runners are presented with the option to make a left turn and complete a shorter distance (7 km) to the finish or continue along the Golden Gate Promenade to Fort Point and then along other roadways to the finish line at the Presidio's Main Post. According to projections from the event coordinator, West End Management, following a traditional 9:00 AM start, runner impact at Crissy Field begins at 9:18 AM and continues to 10:38 AM (West End Management 2000).

Establishing a plan for vegetation and wildlife studies. In order for the Bridge to Bridge Run to receive approval through the park's National Environmental Protection Act (NEPA) review process, park management required that impacts on vegetation and wildlife be monitored along the Golden Gate Promenade at Crissy Field during the event.

In March 2000, OSPU staff began negotiating with Bridge to Bridge event managers for formal vegetation and wildlife monitoring studies after (a) recognizing the value of detailed scientific studies, (b) understanding the unavailability of NPS staff to complete such studies, (c) realizing the potential for political repercussions from the city of San Francisco if the activity were denied, and (d) being directed by park management to secure the studies. The OSPU solution was to require the studies as a condition of the Bridge to Bridge special-use permit, and the event organizers agreed to fund monitoring studies performed by plant ecologists and wildlife biologists.

Monitoring Recreational Impacts on Vegetation

Prior studies. The impacts of recreational activities on vegetation have been studied extensively since the early 1960s, and it is widely accepted that vegetation is susceptible to damage from a variety of recreational uses—especially trampling (Hammitt and Cole 1999). Studies show that the effects of trampling are both direct and indirect. When vegetation is trampled from recreational activity, most species directly demonstrate reduced abundance, height, vigor, and reproductive capacity (Hammitt and Cole 1998). Likewise, they also are indirectly affected by soil changes—particularly soil compaction, which increases the resistance of the soil to the plant's root penetration, reduces macropores and soil aeration, and reduces water infiltration rates (Hammitt and Cole 1998).

Along the Golden Gate Promenade, vegetation is protected on the south side by a low fence two feet in height, and along the north side by a similar fence as well as standard bollard and cable at a height of three feet. Despite these fences, park managers harbored legitimate concerns that many of the event's ten thousand runners might seek to leap the small fences in order to pass other runners if congestion occurred at this portion of the route.

Directly adjacent to both sides of the promenade are extensive areas of native plant revegetation, begun in the fall of 1998. According to data in the park's restoration database (as of 2000), a total of 64,154 native plants from 70 species were propagated in park nurseries and planted at Crissy Field through a high-profile public volunteer program launched in October 1998 (GGNRA 2000d). Approximately 15 yards south of the promenade is the marsh, bordered by tidal wetlands. According to one study, since the wetlands "are very sandy and lack the silt strata that allow marsh vegetation to return with the tides," low-growing pickleweed *(Salicornia virginica)* and salt grass *(Distichlis spicata)* were planted in and around the tidal wetlands to help other species take hold and grow (Gemmill 2000).

The area between this tidal wetland area and the promenade is marsh upland habitat. The plants in this environment differ from those in the wetland area. Species planted include deerweed *(Lotus scoparius),* sticky monkey flower *(Mimulus auranttiacus),* seaside daisy *(Erigeron glaucus),* mock heather *(Ericameria ericoides),* yarrow *(Achillea millefolium),* silver lupine *(Lupinus chamissonis),* beach strawberry *(Fragaria chiloensis),* beach sagewort *(Arteme-sia pycnocephala),* coffeeberry *(Rhamnus californica),* toyon *(Heteromeles arbutifolia),* coyote bush *(Bacharis piluris),* and coast buckwheat *(Eriogonum latifolium).*

These species from the coastal scrub and dune communities are especially sensitive to the impacts of trampling for several reasons. Liddle (1991) established the four biological features of small size, morphology, anatomy, and survival strategies as best promoting resistance and recovery from trampling. Applying Liddle's model to the native vegetation along the promenade in the marsh upland habitat, one can note that the majority of native species do not appear in low-growing forms, but in larger, shrub-like forms.

In addition, the morphological characteristics of several of these species—including deerweed, toyon, coffeeberry, and coyote bush—make them more susceptible and apt to incur fatal and irreversible damage when trampled. Location of the vegetative bud or the persistent stem apex of plants is critical to plant survival. Plants are more tolerant of trampling when their buds and meristems contact the surface of the soil and are protected by folding leaves (Liddle 1991). However, of the species planted along the promenade, few meet this condition. The more prominent plants, including coyote bush, deerweed, coffeeberry, and toyon are woody stemmed plants with their buds over 25 cm above soil level (phanerophytes), or above ground but below 25 cm (chamaephytes).

Similarly, the anatomy of the vegetation surrounding the promenade is less tolerant than that of other species. Most of the species have hollow or larger-celled stems. Studies show that plants with small-celled (<0.1 mm) stems withstand greater compression without distortion than larger-stemmed plants (Hammitt and Cole 1998). Also, since many of the plants possess lignified tissues, this lack of flexibility of leaves, branches, and stems leaves these plants more rigid and easily damaged by trampling (Hammitt and Cole 1998). Thus the majority of plants bordering the promenade are also more susceptible to life-threatening damage due to their size, morphology, and anatomical structure.

Scope of study. Prior to the day of the event, Lew Stringer, a professional naturalist and employee of the park's cooperating association, the Golden Gate National Parks Association (GGNPA), completed a detailed assessment of the event and its possible impacts on the adjacent plant communities. In addition, he initiated qualitative observations of the vegetative areas, including the fenced restoration areas on both sides of the promenade. Stringer also established monitoring positions for himself and his assistant, Betsey Eagon, at the "east and west ends of the north marsh upland along the promenade" (Stringer 2000). Stringer chose this area because it seemed "most likely to experience disturbance" since the height and location of the fence allowed for easy jumping by event participants (Stringer 2000).

Observations. At 9:15 AM on Sunday, October 1, 2000, Stringer and Eagon recorded the first event participants along the Golden Gate Promenade. At approximately 9:25 AM, as the mass of runners arrived, Stringer observed that they were "tightly spaced along the promenade" (Stringer 2000).

Stringer and Eagon noted two disturbances during the event. The first occurred when a pedestrian photographing the event entered one of the closed restoration areas. "Betsey and I observed a photographer jump the two foot fence and enter the north marsh upland," Stringer noted (Stringer 2000). He also observed that:

> While he [the photographer] was on the footbridge, a group of spectators jumped the ropes at the south end of the path leading onto the footbridge, and began to fol low him. I informed them that the area was closed to the public (Stringer 2000).

In addition, Stringer noted damage to 2 sq m of unfenced dune grass *(Leymus pacificus)* near the parking area adjacent to the eastern end of the promenade. "However," Stringer noted, "because the plant is rhizomatous it will probably recover" (Stringer 2000).

These two incidents represented the only impacts noted by Stringer and Eagon. The fenced restoration areas remained undamaged, and park management gained highly valuable insight into the impacts of large athletic events along the Golden Gate Promenade. "Overall the event went well," Stringer noted in his report. "Careful qualitative observations were made of vegetated areas before and after the event," he recorded, "and there was no notable damage done to plants within the fenced restoration areas" (Stringer 2000).

Study costs. Stringer and Eagon performed on-site observations over a period of three days, and worked eight hours for a total cost of $520. The study was funded by the permittee in accordance with the conditions of the special-use permit, and NPS incurred no direct costs.

Monitoring Recreational Impacts on Wildlife

Prior studies. The impacts of recreational activities on wildlife have been studied less extensively in comparison to vegetation, but it is now widely accepted that wildlife, like vegetation, is susceptible to impacts from a variety of recreational uses. In a seminal 1934 address to the American Society of Mammalogists, George M. Wright emphasized the need for managing impacts of tourism and recreation on wildlife, arguing that it was "undeniable that failure to maintain the natural status of national parks fauna in spite of the presence of large numbers of visitors would also be failure of the whole national parks idea" (Wright 1934). According to studies by Knight and Cole (1995), wildlife response is affected by six general factors of recreational activity: the type of activity, behavior of recreationists, the predictability of events and behaviors, the frequency and magnitude of activities, and the timing and location of the activities (Knight and Cole 1995; Hammitt and Cole 1998).

At Crissy Field, the wildlife most overwhelmingly encountered is avian. Species observed include brown pelicans, double-crested cormorants, great egrets, great blue herons, snowy egrets, five species of gulls (western, glaucus-winged, California, ring-billed, and Heermann), elegant terns, black-bellied plovers, killdeers, willets, sanderlings, three species of sand pipers (western, least, and pectoral) and dunlins (Evans 2000a). With the exception of small animals adapted to the urban interface, such as skunks and raccoons, the site is dominated by the shorebirds—especially along the beach on the north side of the promenade and the wetland and marsh area to the south. In response to this high visitation by shorebirds, GGNRA established measures onsite to protect them.

Concerned about the possibility of recreational impacts on avian species, and in the interest of standardizing avian studies, the park developed the guideline *Avian Monitoring Objectives for Crissy Field* (GGNRA 2000a). This document recommends three measures of use: abundance (number of individuals), richness (number of species), and diversity (GGNRA 2000a; Evans 2000a).

Directly to the north and south of the promenade, special restrictions have been made to accommodate wildlife. To the south, the large tidal marsh is fenced and posted as an area closed to all human and pet access. In addition to these restrictions, both the park's 1994 general management plan amendment and the *1996 Environmental Assessment for Crissy Field* called for the establishment of a wildlife protection area for the benefit of the site's bird species. Codified in the park's compendium amendment to the Code of Federal Regulations, this area's boundaries extend for several hundred yards from the southern border of the promenade to the north (GGNRA 2000b). This area is critical to many avian species. "The water and piers provide vital habitat for large concentrations of water birds, including grebes, cormorants, and terns. Reduced disturbance along the beach will provide a safer refuge for shorebirds such as willets and sanderlings," notes a fact sheet produced by the park (GGNRA 2000c). People are allowed to enter the wildlife protection area on foot, but pets (even on leash) are not allowed, nor is boating (GGNRA 2000c).

The establishment of the wildlife protection area is consistent with the findings of recreation ecologists. Studies show that the effects of recreation disturbance on wildlife are both direct and indirect. Harassment from humans and pets is a textbook example of a direct impact (Cole and Landres 1995). Though intentional harassment is certainly a concern, recent studies have shown that the major impact of recreational activities occurs when people unknowingly and unintentionally stress wildlife by disrupting their normal behavior patterns of feeding, nesting, and sheltering (O'Shea 1995; Hammitt and Cole 1998).

Scope of study. In consultation with NPS staff, Avocet Research Associates (AVA) designed a study to meet five key park goals. First, the study would compile existing data on avian use of the site during large special events. Such a study had never been performed. Second, the study would conduct three surveys to document avian use immediately prior to the event. This would set up a baseline against which data from surveys done during and following the event could be compared. Third, the study would observe incidents of disturbance, or lack thereof, that occurred during the event. Fourth, AVA staff would observe the timing and extent of avian re-use of the site following the event, in order to identify any longer-lasting effects of the special event. Lastly, AVA would prepare a memorandum for the park summarizing the findings of the event's impacts (Evans 2000a).

Observations. Staff from the AVA censused the tidal wetland area immediately adjacent to the promenade twenty, eighteen, eleven, four, and one day(s) prior to the event, on the event day, and the day following the event (Evans 2000b). They counted birds in the tidal wetland area only, and recorded all individuals and species that used the site during a 60-minute period, for a total coverage of five hours during rising and falling tides. On the day of the event, one AVA staff member recorded observations for 190 minutes, and on the subsequent day another took observations for 120 minutes and finished a complete bird count.

During the seven site visits constituting the study, AVA staff counted 20 species of water birds in the tidal marsh, with the number of species ranging from 3 to 17 and the number of individuals from 6 to 273 (Evans 2000b). In addition, they used a species diversity index to indicate species diversity. Of particular note on the day of the event, the AVA associate observed that a flock of twelve shorebirds entered the western tidal wetland area during the event. In addition, this associate also noted that three species, all Adreids, departed during the race. These included three great egrets, three great blue herons, and two snowy egrets. They concluded that:

> By each measure it appears that use of the site did not decrease as a result of the increase in human foot traffic around the marsh on October 1.... Measures that consider the avian community as a whole (abundance, richness, diversity) showed no decrease in bird use due to the increase in human use. The increases shown in all three measures are probably the result of seasonal changes in avian distribution rather than any changes in human use of the site.
> Based on the observations reported here, it appears that although intense human use the paths surrounding the wetland did not limit use of the site by small shorebirds, cormorants, or gulls, it did cause large waders (egrets and herons) to abandon the area (Evans

2000b).

Study costs. Charging costs at $150 per hour, AVA calculated the total cost of the study at $2,500. This projection was based on the cost of three surveys totaling eight hours prior to the event, one survey during the event, data compilation and analysis, and memorandum preparation. The study was funded by the permittee in accordance with the conditions of the special-use permit, and NPS incurred no direct costs.

Management Implications

As a result of these studies, park management benefited directly and indirectly from the "hair of the dog" innovation fashioned by OSPU. Most notably, the park received two detailed studies of the impact of this athletic event on the site's vegetation and wildlife. Due to increased workload and reduced staffing, it would have been impossible for park staff to take on these projects. Thus, at no direct cost to GGNRA, these valuable studies were completed by recognized subject-matter experts.

In addition, the park gained valuable insight into the impacts of recreational activities on park resources. Prior to this incident, there had been no substantive study of these effects. The findings have already proved valuable to park management by helping guide the formulation of the SOP for special events and filming on Crissy Field. The studies have also provided helpful information for the GGNRA Division of Natural Resource Management, the group responsible for managing and studying vegetation and wildlife within the park. Following this successful pilot program, OSPU has continued to require similar impact studies for all large athletic events proposed for the Golden Gate Promenade and Crissy Field. This will enable the park to observe the long- and short-term effects of events on the site's resources.

Indirectly, the park fostered a sense of resource stewardship among the event's managers and sponsors. Through several site visits, discussions of park resource management concerns with Natural Resource and OSPU staff, and direct contact with the observing specialists, the event managers became more aware of resource management issues at the site.

Event managers also gained substantive information about the site's resources to better serve their future marketing campaigns for the event. By noting in marketing information that a percentage of the participant's entry fee goes toward vegetation and wildlife studies, the event managers can potentially capitalize positively on the permit conditions, perhaps leading to greater financial support for (and return from) the event.

Additionally, by accommodating the event, the park avoided the potential for negative press coverage surrounding the denial of a popular and long-standing activity, reserved precious political capital, and strengthened the relationship with the city of San Francisco. The park also sent an important message to the leaders of the San Francisco Bay Area event-management community: NPS is serious about protecting the natural resources of the park—especially the recently restored Crissy Field area—and is willing to apply the "hair of the dog" and use special events as a tool to help study their impacts.

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