Introduction and Acknowledgments

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"People, Places, and Parks: Preservation for Future Generations" was the theme of the 2005 George Wright Society Biennial Conference on Parks, Protected Areas, and Cultural Sites. The conference took place April 14–18 in Philadelphia. It was the 13th in a series of conferences dating back to 1976.

GWS2005 comprised four plenary sessions, 137 concurrent sessions, and a poster / computer demo / exhibit session. Of special note at GWS2005 was the inauguration of a new scholarship program. The GWS launched the George Melendez Wright Student Travel Scholarship to encourage undergraduate and graduate students from diverse backgrounds to attend the conference. The scholarship program is part of the GWS's commitment to fostering more diversity in park-related professions. Scholarship winners participated in conference sessions and learning activities, networked with peers and new colleagues, and had the chance to see how a professional conference works. With the support of many individuals and organizations (acknowledged below), we were able to grant almost 30 scholarships to students from the USA, Canada, and other countries.

This proceedings volume consists of more than 80 papers that are widely representative of those presented at conference sessions. It is available in both paperback and CD-ROM editions.

The George Wright Society is grateful to many people who helped make GWS2005 happen. The Conference Committee (David J. Parsons and Dwight T. Pitcaithley, co-chairs; Gillian Bowser, Mary Foley, Sharon Franklet, Bonnie Halda, David Reynolds, Nina Roberts, Gay Vietzke, and William H. Walker, Jr.) is at the core of the effort: developing the conference theme and plenary sessions, planning logistical details, and selecting abstracts for the concurrent and poster sessions, among many other things. For securing vital funding for the conference, we thank Sue Haseltine (U.S. Geological Survey); Mike Soukup, John Dennis, Marie Rust, and Jan Matthews (National Park Service); Chesley Moroz (Eastern National); Brad Barr (NOAA National Marine Sanctuaries); and Destry Jarvis and Tonia Bleecher (Booz Allen Hamilton). Once again, Chuck Rafkind served as conference photographer. Special thanks go to all the people in the National Park Service Northeast Region who organized the slate of field trips. The photo of the Liberty Bell on the cover is courtesy of Independence National Historical Park.

We also thank all of the institutions and individuals who helped the GWS co-sponsor the inaugural round of George Melendez Wright Student Travel Scholarships: Pamela Wright Lloyd and James Lloyd, the national CESU Network, Texas A&M University, Yale University, University of Northern British Columbia, and Student Conservation Association. In addition, many other universities and organizations matched the GWS scholarship awards in order to enable their students to attend.

The next conference will be April 16–20, 2007, in St. Paul, Minnesota.

The Challenges of Creating an Integrated Approach—Nature, Culture, People—for the Conservation of the Fortifications of the Caribbean Coast of Panama

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Background

Fort San Lorenzo, a Spanish colonial fort built in 1597 near the mouth of the Chagres River (Figure 1), sits on the Caribbean shore of the San Lorenzo Protected Area in Panama. The Chagres River was a key element of the richest trade route of Spain. Portobelo, the site where exchange fairs between Spain and its colonies were celebrated for some 200 years, grew up at the end of the overland route nearby, and was the principal Spanish Caribbean port in Central America until the18th century. The historic town of Portobelo declined with the completion of the Panama Canal in 1913. The population as of 1997 was 3,300. To the west and south of the surrounding protected area are located several rural communities, where approximately 4,000 people live along the banks of Gatun Lake and on the road to the Costa Abajo of Colon. These communities are dedicated mainly to coffee farming, cattle raising and subsistence agriculture.[1]

Figure 1. Aerial view of Fort San Lorenzo.

The work

Portobelo and the San Lorenzo fortifications are a clear example of multi-dimensional sites with built heritage and natural resources of international importance. The fortifications were registered on the UNESCO World Heritage list in 1980 under the name of "Fortifications of the Panamanian Caribbean." According to the nomination, they represent an outstanding universal value since they are a magnificent example of military architecture of the 17th and 18th centuries and are part of the defense system developed by the Spanish Crown to protect the transit between the Atlantic and Pacific Oceans.

After years of unsteady management, the Fortifications of the Panamanian Caribbean were included in the World Monuments Fund's (WMF's) Watch List of 1998 as a result of the partial loss of the original fabric of Fort San Gerónimo in Portobelo. The extreme fragility of the military structures and the remarkable natural resources of both national parks were the appropriate scenario to research the connection of cultural and natural resources. People, a third mandatory element for the research, were added to the equation and included in the WMF–Panama's Pilot Project "Nature, Culture, and People—Portobelo-San Lorenzo: An Approach to Integrated Conservation for Sites Containing Endangered Cultural and Natural Resources."

The study was conducted by a multidisciplinary team which focused on diagnosing the present status of existing assets, learning how local people and visitors interact with these resources, and recommending follow-up actions to promote both mid- and long-term effective conservation of both cultural and natural resources.

The framework objective of the project was to help identify standardized work criteria and action plans that will promote integrated conservation of the natural and cultural heritage included in Portobelo and San Lorenzo. Specific objectives were: identification of cultural, physical, and biological resources in Portobelo and San Lorenzo National Parks, emphasizing their economic, ecological, and use values by neighboring communities; identification of physical, biological, and cultural elements that have a repeated influence on the conservation of the monuments; discussion and analysis of the influence of natural elements on the historic and cultural structures; discussion and analysis of the conservation problems of natural and cultural resources in these two sites; a proposal and recommendations for conservation measures and follow-up activities based on the study; and pilot conservation actions to solve the most urgent deterioration problems in the fortifications.

In the diagnostic phase of the project, baseline information on the current conditions of the resources and living communities was gathered to analyze the relationships between the natural environment and historical–cultural resources and with the living cultures of Portobelo and San Lorenzo. The management situation of the cultural heritage and national park agencies was also analyzed and evaluated. The initial development of a general public participation process to include local organizations and specialized groups was also promoted to raise awareness about the need to know and value heritage resources and nature and culture interrelation.

In Portobelo, the case study concentrated in the sector of Fort San Gerónimo and its immediate environment, which includes Guinea Creek, and the shantytown of La Estacada. In San Lorenzo, the analyses focused in the sector of the fortress itself and the rocky peninsula where this structure stands. The remainder of the two protected areas surrounding these monuments was considered as part of a second level of the milieu related to these monuments. Later conservation field work also focused on these two fortresses.

Risk assessment, a special component of the study, proved to be a useful tool to compare the relationship of historic structures with their surrounding natural environment. A broader picture was obtained when the interaction of neighboring populations was added to an evaluation matrix designed to examine all factors affecting building conservation. General conclusions of the risk assessment led us to conclude that the main threats to the resources at Portobelo are centered on human activity and the deficiencies of conservation. In the San Lorenzo sector the risks are centered on environmental factors and also on management deficiencies. It may be said that threats in specific places within Fort San Lorenzo and Fort San Gerónimo are due to two antithetical phenomena: human inaction and human action (in the surrounding environment). Their effects are equally noxious to the conservation of both resources.

Assessment of threats also led to the adaptation of tools and methodologies from the scientific realm to the cultural sphere to evaluate historic structures, analyze managerial conditions, and prioritize the actions required for their conservation and general improvement. Several other working methodologies were unified and tested as part of the study and proved to be useful in building a common language for integrated management.

The interdisciplinary exchange allowed us to make additional findings, besides the standardization of methodologies, which emphasize the unavoidability of an integrated management of compound heritage sites. Among the most relevant are:

- Destruction of nature has, in the context of our project, a negative influence on the conservation of historic structures. For example, destruction of the rainforest has provoked soil erosion that runs along the rivers and reaches the bay where fortresses are located, affecting water currents and reducing seabed depth, both of which threaten the forts.
- It is imperative to acknowledge the value added to national parks where historic sites and artifacts are located, and the responsibilities derived from their protection. On the same line of thought, natural landscapes and scenery increase the interest and potential of cultural sites and should be safeguarded as integral parts of the site.
- National parks and other protected areas have sheltered and guaranteed a long-lasting life to many historic relics[2] for which, while under regional or local protection, conservation has been consistently deprived.

Challenges

The work as previously described was a road paved with difficult but amazing challenges to find the way to switch from isolated to integrated management of heritage resources. Even though is not possible to assert that both are the same, it is incorrect to assume that is impossible to find a common ground on which to build integrated management. Some of the most relevant challenges were as follows.

Identification of common criteria for integrated conservation. The primary connection between natural and cultural heritage is a territorial matter since both Portobelo and San Lorenzo fortresses are located within natural reserves. Besides this obvious fact, the first challenge of the work was to understand further the complex relationships between natural and cultural resources. No attempt to protect them as related entities had been done before.

During the process of learning and understanding the sites, a strong and well-defined sense of place was recognized (defined by the cultural and natural dimensions of both sites), as well as the sense of time (derived from the historic features that represent the continuum of time) inherent to both sites. They together constitute the key factors that determine a cultural landscape. This conservation criterion allowed us to link these separated entities under one working philosophy which led us to place special emphasis on conservation of natural and historic–cultural assets, management, study, and research, educational opportunities and a controlled development.

Another essential matter to connect both natural and cultural heritage is the population and how they use and value their resources. Communities don't make a clearcut separation of heritage into very distinctive elements. Most of the time, people perceive it as a single unit while they interact with the environment.

Multi- and interdisciplinary work. An integrated approach was possible only because a multidisciplinary research group was formed that could work together to produce and exchange ideas. General coordination was under the charge of a cultural heritage specialist. From the beginning, it was a requirement to find a culturally sensitive natural scientist. Once that was accomplished, the rest of the working team was identified and incorporated into the project. The group was ultimately composed of 17 members, including geologists, biologists, zoologists, sociologists, archaeologists, architects, structural engineers, and communication specialists.

Although the first goal of constructing of a multidisciplinary research group was accomplished, making it work efficiently was the second task required to reach the larger goal of a balanced interdisciplinary study. Even when the decision was made to divide the group, general meetings were still necessary to discuss findings, understand and recognize common trends between the disciplines, and adapt working systems from both fields.

Lack of interagency exchange. In Panama, the management of cultural and natural heritage sites has been traditionally under the responsibility of two different governmental agencies. As a result, the amount of institutional exchange needed for study, management, and protection has been insufficient up until this time.

Another element is the precarious exchange with agencies of urban development and local governments, which are often excluded from the conservation planning programs. A widespread number of isolated and even opposed actions is the daily reality of the sites. The tendency has slightly improved just recently when the urgency to create a common ground for the development of the tourist industry in the country brought together several central government agencies to work on a regional plan.

Exchange and integrated approaches are also discouraged by disparities in the budgets, human resources, and infrastructure of each agency. While tourism and environmental institutions are provided with decent budgets, the cultural affairs agency has always been the Cinderella among governmental organizations.

The actions taken to create a common ground for discussion among the related agencies were promoted by emphasizing the urgent need to identify common trends, and also by reviewing the differences of each field. There was a need to produce fluent exchanges and openness in order to understand the sites as layers of factors that must be planned and worked out with a mutual vocabulary.

Conserving for local people and conservation as a participatory process. These two concepts came out of the working philosophy of the agencies traditionally responsible for cultural and heritage, and had been outside the established practices of conservation programs. Under the viewpoint of protection of natural reserves and cultural sites, the involvement of local communities has been scarce and hardly included on the agendas of conservation agencies. Programs directed to integrate communities in the sustainable development of the park and historic districts are insufficient, as has been the communities' participation in management, yet their pressure on the resources is steadily increasing. Communities perceive conservation as a set of controlling ordinances that are opposed to local necessities, and which are not even close to the improvement of their quality of life.

Another factor to be considered is that the population is a summation of several ethnic backgrounds. Therefore, heritage values are not just one, but several. At least two well-defined ethnic groups inhabit the study area and each one has a slightly different set of heritage values. On the one hand, African descendants' beliefs and awareness of the environment can be described as a low-key impact to nature and an emphasis on non-material heritage. On the other hand, campesinos have a persistent history of engaging in deforestation for the purpose of cattle raising, leading to destruction of the surrounding landscape, while at the same time showing a higher consciousness of the monuments' protection. Therefore, well-defined programs directed at broadening the understanding of conservation and creating alternative sources of income are priorities to change the attitudes of local populations towards heritage protection.

Participation of local governments and communities in decision-making is not an ordinary practice anywhere in Panama. The sturdy centralized government structure does not offer an opportunity to include regional and local viewpoints on administration and management decisions. Most of the time governments are disconnected from local reality. The project opened a small space for discussion and recognition of people's interaction with their heritage through several workshops oriented to exchanging ideas and viewpoints, and to raising awareness of mixed heritage as a relevant part of the region's development opportunities and inherent heritage.

Endnotes

1. This and further information on the San Lorenzo Project can be found on-line at www.sanlorenzo.org.pa/index_in.htm.
2. In Panama, 40% of the protected areas have several types of significant known cultural resources. In addition, another 52% are located within zones of high concentration of archaeological sites.

At the Crossroads of Nature and Culture: Laboratory and Field Studies for Vegetation Management at Historic Sites

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Introduction

Cultural sites in the National Park Service (NPS) and elsewhere are faced with the control and management of vegetation. Because of the site-specificity of vegetation and its potential for damage, it is important to have sound, scientifically based practices for vegetation control and management. Although the Department of the Interior (DOI) has standards for historic structures, there are currently no DOI policies, standards, or guidelines for vegetation control and management on cultural resources. There are, however, draft guidelines in preparation that will fill this gap (Bischoff 2004).

Vegetation, whether it is microscopic or macroscopic, is ubiquitous. No matter if sites are local, state, federal, or international, all are likely facing irreversible vegetation damage to their resources. In carrying out the mission of the NPS to preserve and protect our resources, parks would love to have the "magic bullet" for removing damaging vegetation once and for all. Unfortunately, vegetation control is a cyclic maintenance issue.

There are numerous treatment agents that are effective against various types of damaging vegetation, but it is currently unknown as to which are safe to apply on or near cultural resources. To date, with the exception of the work described herein and a limited study on lime concrete at Fort Laramie National Historic Site, there is only one other research group addressing vegetation issues. These studies at Historic Scotland have examined the effects of chemical treatment agents for vegetation control on sandstone (Wakefield 1993; Young 1995, 1996; Urquhart 1996; Cameron 1998). Thus, more studies are needed to help sites make management decisions on best practices for vegetation control.

It is important to understand how plants populate and grow because of their potential for damage to historic structures. Organisms of interest to the work at the Harpers Ferry Center (HFC) include: bryophytes and pterophytes (ferns and mosses), monocots (grasses, sedges and lilies), dicots (asters, *Utrica* and *Verbena),* lichens, and cyanobacteria.

Bryophytes and pterophytes grow in low-light and high-moisture environments. They tend to grow in regions of accumulated dirt, suggesting that periodic removal of surface dirt can reduce this type of growth. They may pose a particular threat to historic masonry because their fibrous root-like "rhizoids" can invade pores, cracks, and microfissures. This plant type is difficult to remove by pulling without also removing bits of historic fabric. Furthermore, bryophytes and pterophytes propagate by airborne spores, which can number in the thousands per plant.

Monocots usually require high-light conditions and are often adapted to variable moisture regimes, but, similar to the bryophytes and pterophytes, they have fibrous root systems. Monocots can propagate via seeds (hundreds per plant); thus, they can be controlled fairly easily if they are removed or destroyed before they produce seeds.

Dicots present what is arguably the worst threat for damage to the resource because they often survive in variable light and moisture conditions and tend to be ubiquitous. More importantly, they may cause significant damage because of their tendency to have taproots, which can exert pressure on a crack of up to 75 psi (Taiaz 1998). (Compare this with the pressure in a car tire of 28–32 psi.) Anyone who has attempted to remove dandelions is familiar with the difficulty of pulling out the entire taproot, which if not removed will allow the plant to grow back. In addition, some plants in this category, such as the artillery weed (*Pilea* sp.*)* found at Castillo de San Marcos National Monument, propagate by fragmentation. Small bits of plant can break off the mother plant and repopulate when landing on another portion of the resource. In addition to seeds, these plants are often rhizomatous and spread vegetatively, but this also makes them susceptible to systemic herbicides.

Lichens grow in low-nutrient environments. Although some present no danger to historic masonry, others have fibrous root systems with the same problems as posed by other fibrous-root plants. Some lichens excrete organic acids, which may cause chemical erosion of alkaline minerals such as coquina and limestone. Many colorful lichens are used as dyestuffs, and as such may cause staining of the resource.

While not a plant, cyanobacteria (blue-green algae) covers the walls of the fort at Castillo de San Marcos. There is no evidence that this microorganism causes damage to the historic fabric (Ortega-Calvo 1995).

Clearly, many types of vegetation are potentially damaging to cultural resources. Also, there is no single control agent effective against all damaging vegetation. Therefore, it is crucial that parks understand the vegetation types at their site and what risks the vegetation poses for the resource.

Research at Harpers Ferry Center

For the past five years, the Scientific Research and Analytical Support Laboratory at the NPS's Harpers Ferry Center (HFC) has been involved in two complementary scientific studies in collaboration with Castillo de San Marcos. The first is a model study being carried out in the lab and involves examination of the effects of vegetation control agents on historic building materials, specifically coquina stone, a naturally occurring, fragile limestone. The purpose of this study is to assess the damage these treatments may cause to the historic material.

The second is an on-site field study to investigate the effectiveness of various treatments against site-specific vegetation. To a limited degree, some information can be learned about damage to the resource caused by the treatment agent. These studies will help Castillo de San Marcos make appropriate choices for management of its specific vegetation problems. The scientific methodology and lessons learned can also be applied to help national parks and similar sites worldwide control and manage their vegetation problems.

Experimental methodology for in-lab screening studies

Three types of coquina samples were chosen for the study. They included newly quarried coquina, newly quarried coquina with a gray patina of cyanobacteria, and historic coquina. We were fortunate to have access to 300-year-old deteriorated historic coquina stone. During a visit to the fort to plan this project, some severely deteriorated stone was being replaced in an emergency stabilization.

Many factors were considered in making treatment choices for laboratory and field tests. We were concerned not only about the safety of the persons applying the treatment agent, but also for the safety of park visitors. We were likewise concerned with the environmental impact of our treatment choices, since there are many products on the market having deleterious effects on the environment. Other considerations included the potential compatibility of the treatment with the historic fabric, and ease of product application. There were three categories of treatment choices:

- Household materials (e.g., hydrogen peroxide, bleach);
- Commercial herbicides/biocides (e.g., the products Roundup, GreenClean); and
- Architectural materials (e.g., the product Monument Biowash).

Methods for applying chemical treatments to samples include spraying, brushing, or foaming. In most cases spray application was chosen, since this is the method of choice for application of commercial materials.

Treatments were carried out in triplicate for each type of coquina sample. Samples were examined before and after treatment for visible and chemical changes suggestive of damage to the stone. Visual changes were assessed in two ways: (1) samples were examined for dramatic color changes easily observed with the naked eye, and (2) L*a*b* color of all samples was measured before and after treatment using a portable colorimeter instrument. The total color change (ΔE) was determined for every sample treated.

The untrained eye can see color changes of greater than 2 units. The samples treated with bleach turned orange and showed total color changes ranging from 4 to 12 units. The samples treated with Roundup turned darker and showed total color changes ranging from 4 to 6 units. Thus both bleach and Roundup had color changes visible to the naked eye.

Two types of experiments were performed to determine chemical changes. The first was to mix the crushed sample with the treatment agent in a syringe. Acidic treatment agents were expected to evolve carbon dioxide according to the following chemical equation:

$CaCO_3$ (stone) + $2H^+$ (treatment agent) → Ca^{+2} (ions) + CO_2 (carbon dioxide) + H_2O (water)

Since carbon dioxide is a gas, the amount of gas evolved can be measured by the amount of deflection of the syringe plunger.

The second experiment involved encapsulating the sample in a hardening resin and cutting the sample in half using a slow-speed diamond saw. The sample was photographed with a digital camera under a microscope and then the exposed surface of the sample was treated with the chemical agent and rephotographed. Digital images were examined before and after treatment for evidence of microerosion or particle deposition.

Experimental methodology for on-site field studies

Planning and documentation were perhaps the most important processes of the Castillo de San Marcos on-site study. The first step in the planning process is to determine the root cause of the vegetation. In cases where the underlying cause for the vegetation can be addressed, it may be unnecessary to undertake a field study. If, however, it is not possible to control vegetation by other means, a field study is necessary to identify effective chemical treatment(s), which was the case at Castillo de San Marcos.

A treatment plan was then developed which included determination of the treatment types and the location of the controls and test sites. It was important to ensure that the controls were in close proximity to the treatment site for adequate comparison of treatment effectiveness. In addition, the vegetation types present dictated the treatment choices, since not all treatment agents are effective against all types of vegetation. Given the broad range of biodiversity at Castillo de San Marcos, it was deemed best to choose a wide array of treatment agents to identify the best options for long-term vegetation management.

The on-site study required long-term monitoring at set intervals, and so we had to determine the availability of on-site or local support staff for this task. It was critical that the park commit to biweekly or monthly monitoring of vegetation kill and regrowth, so not to invalidate the study with too little information. Once it was determined that all required resources were available, a schedule for carrying out treatments and periodic monitoring was determined. In addition, we trained the support staff who needed to carry out the periodic monitoring to ensure systematic capture of data on vegetation kill and regrowth.

Documentation was critical to the success of the field study. The American Institute for Conservation of Historic & Artistic Works, the group of professionals concerned with conservation of cultural materials, defines "documentation" as "the recording in a permanent format of information derived from conservation [or other] activities." (AIC 2005). Documentation was carried out before treatment, periodically during the monitoring process, and upon completion of the study.

Documentation was performed in a variety of ways, including survey forms, spreadsheets, photographs, and illustrations. After performing full photodocumentation of the vegetation issues, a vegetation survey was carried out. This process included the identification of plant type (e.g., bryophyte, pterophyte, monocot, dicot, lichen) or a particular plant species. The amount of coverage of each plant type was determined, that is, we recorded if there was a single plant, or sparse, moderate, or prolific coverage. Finally, the existence of damage from vegetation or the potential for such damage was assessed.

In the planning process, the numbers and types of treatments to be applied and the test sites and control locations were determined. In order to reduce bias in the study, test locations were randomized. Finally, we chose spray and foaming applications that were consistent with commercial application procedures.

Treatments were monitored in two ways: photodocumentation of vegetation kill and regrowth, and quantitatively using a grid system. The grid system allowed us to estimate the percent kill of vegetation from a treatment and the percent regrowth of vegetation over time at the same location. These data were plotted against time to determine how quickly a treatment took effect and how fast vegetation regrew. Interpretation of these results leads to an understanding of what treatment agents are most effective, and what vegetation can be controlled by what agents.

Outcomes of studies

In-lab screening studies identify damage to the historic material caused by the application of chemical treatment agents. Evidence of damage includes color changes and macro- or microscopic erosion. On-site field studies determine the efficacy of the treatment in controlling vegetation. Neither study alone is sufficient to answer all the questions necessary to make the best management decisions and carry out the best practices for vegetation control and management. This two-pronged approach of in-lab screening studies and on-site field studies leads to the creation of a park-specific vegetation management plan, one where the park will be guided by science to make appropriate management decisions and carry out best practices for cultural resource preservation.

The importance of following this two-pronged approach cannot be emphasized enough. Because each cultural resource is comprised of unique materials with site-specific vegetation, only an in-lab study of the effects of treatments on the unique material will elucidate the potential for damage to the resource by the treatment and only an on-site study will reveal which treatments are effective against the vegetation present at that site.

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Finally, the authors wish to dedicate this paper to the memory of Dean Garrison, former facility manager at the Castillo de San Marcos National Monument. He was the guiding light on this project and recognized the importance of patience when he said, "We want to do the right thing, not just the quick thing." Through Dean's patience and support, this project has continued steadily so that, now, the park he cared so much about will have the guidance it needs to protect and preserve the wonderful 17th-century fort. Dean's patience and support were not in vain.

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The Nature of Battle: Contesting Ideals of Ecology and History at Gettysburg

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A monument can incidentally be a work of art or a public facility; it can even give pleasure. But those are secondary characteristics. A monument can be nothing more than a rough stone.... Its sanctity is not a matter of beauty or of use or of age; it is venerated not as a work of art or as an antique, but as an echo from the remote past suddenly become present and actual.

—J.B. Jackson, *The Necessity of Ruins*[1]

> Soon after the close of the war I met Colonel Harrison at Gettysburg who was General Pickett's adjutant general, and was with him at the battle.... [W]e spent several hours under the shade cast by the copse of trees, when he explained to me what an important feature that copse of trees was at the time of the battle; and how it had been a landmark towards which Longstreet's assault of July 3d, 1863, had been directed.
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> Impressed with its importance, I remarked, "Why, Colonel, as the battle of Gettysburg was the crowning event of this campaign, this copse of trees must haven the high water mark of the rebellion." To which he assented, and from that time on I felt a reverence for those trees.
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> Later in the season while passing them one day I was shocked to find the owner engaged in cutting them down; a dozen or more already lying on the ground, I expostulated with him, but without effect until I suggested to him that if he cut them, then he was only getting for them their value as rails, whereas, if he allowed them to stand to mark the spot he would eventually get ten times as much for them and he spared them....[2]

If there is one thing that I do not need to explain to this group, it is the basic fact that one person can make a difference when it comes to preserving specific areas. One of our roles as participants in preservation is, at times, to alert others to oversight, either related to a lack of knowledge or awareness or, at other times, to suggest another intellectual vantage point with which to view a place. Each of us in this room likely has specific stories about individuals who have made a difference at a specific site; very likely, most of you have made a significant difference through your own efforts. In my research of the preservation efforts at the Gettysburg Battlefield, there are many such individuals; however, John B. Bachelder, the author of this quote, still stands out to me.

As a veteran, painter, printer, and historian, Bachelder provided meaning and definition to early preservation at Gettysburg. With the aesthetic vocabulary of an artist, Bachelder shaped the ethics of early preservation at Gettysburg to create a combination shrine and park. His account continues:

> Subsequently an avenue was laid out which embraced them; but as their historical importance became known, relic hunters commenced to cut their branches for canes; and, at a meeting of the board of directors in 1885 I made a motion that they be enclosed with an iron fence; but, the motion was lost. In 1886 I reported the same motion, which was again defeated; but in 1887 I embodied that motion in a written resolution, which passed unanimously and the Superintendent of Grounds was directed to erect it, which he did.
>
> On the 25th of September 1888 I offered a resolution at a meeting of the Executive Committee, "that a bronze tablet be prepared indicating and setting forth the movements of troops at the copse of trees on Hancock Ave., July 3d, 1863" which passed unanimously, and I was appointed a committee by the chair to do the work: he remarking facetiously that, "there were no funds ... [and] only a small tablet bolted to the fence would be required.[3]

A fence, it seems, could accomplish a great deal in 1891 (Figure 1). But Bachelder and other early preservationists functioned in a simpler time. Today, a fence accomplishes very little in terms of preservation. Nature, it turns out, cares little for the limits of fences.

Figure 1. The copse surrounded by Bachelder's fence, circa 1900. Courtesy of Gettysburg National Military Park Collection.

Although Bachelder's era of preservation possessed complexities, including land acquisition, management of the grounds, etc., there were scarce examples of what anthropologists and other refer to as *"public contest."* A fairly straightforward period of land acquisition and enabling at least nominal tourist access gave way to more than a century of shifting definitions and, at times, contrary efforts. From an era before 1894 when most individuals seemed to be on the same side of the preservation cause at Gettysburg, after Bachelder's death in 1894 we enter into an era of conflicting interests and discourse. And after 1900 of course, a new actor will become intimately involved in the preservation at Gettysburg: that is, the federal government, first in the form of the Department of War and later in that of the National Park Service. Throughout the 20th century, then, the primary role of the federal government consistently grew to be that of the arbiter between diverse interest groups, each with conflicting ideas of preservation.

Changes in these ideas of preservation and the concrete form that they took and continue to take on the landscape are the subject of my research. And I should report at the outset that my research grew out of my concern about some of the ideas put in place on the battlefield by the 1999 general management plan. As part of my larger effort to contextualize the

1999 plan within the history of the battlefield, today I'd like to discuss one portion of the evolution of preservation ideas at Gettysburg: the natural environment. In the interest of brevity, this paper focuses only on the years of Park Service involvement at Gettysburg prior to the 1990s. As Bachelder's quote indicates, though, the earlier era of preservation (1865–1890s) also relied on elements of the natural landscape—particularly for ordering the battle narrative and the visitor's experience. Expectations, though, altered the management of the natural environment significantly during the Park Service years at Gettysburg. The 1999 general management plan, which set out efforts to re-create the natural environment of 1863, marked an important moment in the National Park Service's interest in meeting visitors' expectations.

In summary, my findings are fairly straightforward: although the 1999 general management plan marked a significant international watershed in the use and manipulation of the ecological landscape for historic preservation, at the Gettysburg National Military Park it marks the culmination of a remarkably consistent approach to the natural resources of the site throughout the 20th century. Whether one agrees with this policy or not, the majority of the initiatives implemented in the 1999 plan for the battlefield are entirely consistent with the preservation aspirations that were laid out by federal park administrators at this site throughout the 20th century.

Defining a preservation mandate

Soon after the creation of the National Park Service in 1916, Director Horace Albright set out to place military parks under the Park Service purview.[4] While he argued that such sites had unique historic value, some also possessed important scenic qualities.[5] Congressional discussion of the shift drew criticism that the Park Service would make the military sites little more than "pleasure grounds." The Park Service, it was argued, was not to be trusted with such sacred sites. The War Department, however, was extremely concerned about the expense of keeping up these sites and they were willing to support a transfer. As bills tried and failed over the next decades, the Park Service clarified its stand. In 1929, for instance, a Park Service position paper specifically described Gettysburg's situation in this fashion:

> Gettysburg, a great battle area, is marked with all sorts of questionable monuments. It is literally 'monumented" almost to the cemetery—or graveyard—condition. Our problem in any future development of physical features is serious. We might have to forego for many years making any changes due to the considerable influences that are back of the present situation.[6]

In 1933, President Franklin Delano Roosevelt's committee on government reorganization suggested that such sites be shifted to the Park Service. His executive order of June 10, 1933, made the transfer official. In 1933, the National Park Service took control of the battlefield as well as a number of other historic sites. On paper, this transfer marked a wholesale change in the philosophy of park management. However, there appears to be a disconnect with the application of these policies on the battlefield landscape. In their management plans for the site, however, one finds that the Park Service had a very different ethic in mind for the battlefield from the beginning of its tenure.

In 1934, the Park Service proposed a six-year development plan for the park. Foremost was the effort to restore the conditions of 1863: "The Park should, as far as possible, represent the condition as found in 1863. It should in every possible way be restored to the condition of that time. Formal features and the demands of modern transportation necessitate a certain amount of work foreign to the desired 1863 atmosphere. Every attempt will be made to keep such development to the minimum. A general program of restoration is established as a guide to all work undertaken."[7] This restorative approach was reiterated in a 1936 announcement of the park's first master plan, when Superintendent James R. McConaghie stated:

> Today the structure itself is primary.... The task before the field is to carefully plant so that the numerous monuments will appear to fit and be screened so as not to unduly affect the landscape.
>
> The primary purpose is to preserve an area of great historical value in such a manner as to permit the visitor to visualize conditions of the day. A promoted educational program is definitely needed to replace the personal knowledge of yesterday. Necessary conveniences to provide for the health and comfort of the visitor and safety measures so that he may drive or walk with the least possible danger. To him, this is a memorial park presenting an area of 1863. The word, "Park" and the date, "1863" are two definite guiding factors placed in front of the developer and administrator today. A certain amount of modernity is, of course, necessary. Where this appears, it must not be too obvious. Restoration, preservation, accessibility and usability are the primary objectives of physical work conducted in this park, coupled with these should be educational objective effort so that the field may be understandable....

The management plan was updated, revised, and reorganized each year between 1939 and 1941. The educational value of the battlefield, it was clear, bore a direct connection to the landscape's ability to remain consistent with the appearance of 1863.

During the 1940s, the natural environment also became a more active portion of the preservation process. Initially, this attention came in the form of clarifying the use of portions of the battlefield for controlled agriculture. Most often, this involved leasing fields to farmers who would grow crops that were consistent with 1860s usage. The agricultural "living history" usage also took the form of Peach Orchard restoration, which started in 1941 and included the controlled planting of approximately 270 trees in squares fifteen feet apart. By 1943, a more complicated understanding of ecological change emerged in efforts to manage the landscape. In 1943, the Park Service's regional director, Oliver Taylor, wrote:

> When so regarded, it is apparent that this complex historic object (the battlefield and everything on it) should be preserved or restored and presented to the public

> as nearly as possible in the physical appearance that it had at the time of its wartime use. If it becomes greatly altered or changed by man or by erosion, its importance as historical source material and its value in enabling one to understand the battle become materially lessened.... If a battlefield area is already greatly changed by reforestation or agriculture practices, the long-range development program of the park should aim at the gradual restoration of the war-time scene by whatever steps appear most practicable, taking into consideration the fact that erosion is as destructive of historic scene as man himself. The long-range development program then becomes that of a balanced program to combat as much as possible the destructive forces of man and of nature.[8]

When the Mission 66 initiative followed for the Park Service, the Gettysburg National Military Park—as did each national park—prioritized visitor resources. At Gettysburg, this included resurfacing park roads and constructing several facilities: a new visitor center–cyclorama complex with space for park offices, new field exhibits, pull-outs from auto tour, and a new "High Water Mark" walking tour.[9] When initiatives shifted a few decades later, the battlefield's natural resource management plan returned to the Park Service's interest in returning the view of 1863. The 1981 plan put the goal this way: "to restore, maintain, and perpetuate as closely as possible the historic scene and character that existed on this battlefield in July of 1863. A reasonable understanding of the events which occurred here cannot be achieved by visitors unless the landscape is accurately portrayed."

> Natural systems are not static but are dynamic and constantly changing. To recapture or maintain the July 1863 scene requires continual monitoring and intensive management of these natural systems to prevent the natural succession which in this area would eventually led to a dense, climax, hardwood forest. Such a forest would not represent the historic scene we are charged with preserving and it would be impossible to clearly interpret the battle, the historic scene or the commemorative purpose for which the Park was established.
>
> We use practices such as clear cutting of shrubs and trees; agricultural activities that include plowing, tilling and mowing, continuous livestock grazing on non-tillable lands; use of historic woodlot management; pesticides (biocides), and reforestation. Vegetative screening is used to conceal modern intrusions where necessary, and wildlife is controlled where unreasonable damage occurs to agricultural crops, cultural resources are threatened, or where it may endanger safety or health. Although we manage our natural resources primarily for their historic values, we cannot ignore or fail to mitigate, as much as possible, the effects of our management programs on the ecological welfare of these natural resources....[10]

Park historian William Unrau reports that when officials were confronted with how to maintain the historic landscape once it had been re-created, they "intended to maintain it that way indefinitely through low-cost agriculture permits." Of course, this was not realistic from an ecological or economic perspective.

Figure 2. Forest reduction in progress in fall 2004. Courtesy of the author.

Conclusion: The 1999 plan

After a series of hearings and scientific studies, in 1999 the Park Service put these internal aspirations front and center for the first time. Using landscape planning and the advice of scientists, the Park Service created a general management plan in 1999 that not only stated the utopian desire of restoring the 1863 landscape (as the agency had done throughout the 20th century), but now implemented a resource management plan to do so, including deer harvest, forest reduction (Figure 2), and removal of tourist-oriented structures on portions of the battlefield. The outcome has been a watershed in preservation history that continues to unfold today.

Acknowledgments

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Endnotes

1. J.B. Jackson, *The Necessity for Ruins, and Other Topics* (Amherst: University of Massachusetts Press, 1980), 91.
2. John B. Bachelder, *The Bachelder Papers* (Dayton, Oh.: Morningside, 1995), 1854–1855.
3. Ibid.
4. Gettysburg had been created by private preservation groups. In the 1890s, the lands were deeded to the Department of War, although some of the original preservationists continued to administer the properties.
5. This episode is discussed in Harlan Unrau's *Administrative History: Gettysburg Nation-*

al Military Park and Gettysburg National Cemetery (Washington, D.C. National Park Service, 1991), 140–142.

6. *Transfer of National Military Parks*, hearing transcript before Committee on Military Affairs, House of Representatives, 1929, 2–23.

7. Gettysburg National Military Park, "Superintendent's Report for Year 1935–6," 33–34.

8. Gettysburg National Military Park, "Statement for National Battlefield Parks," memoranda of Oliver Taylor, September 3 and October 6, 1943.

9. Unrau, 253.

10. Gettysburg National Military Park, *Natural Resource Management Plan* (Gettysburg, Pa.: National Park Service, 1981).

Wilderness Advocacy from Aesthetic and Rational Grounds: Epistemology and Ontology as Grounds of Necessity in Wilderness Preservation

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This paper seeks to differentiate *rational* arguments as necessary and universal from *aesthetic* arguments as contingent and particular. Any speaker uses language, and this language depends upon reason for its coherence and meaningfulness. With arguments for and against wilderness preservation justified with appeals to "truth," even the most rugged of anthropocentrists must pay this piper with Reason. After beginning with descriptive aesthetic arguments and moving to the syllogistic rational arguments of theoretical reason, we will culminate in practical arguments that lead into and proceed from wilderness.

Two of three faculties of theoretical reason

We begin with Immanuel Kant and his differentiation between *aesthetic* and *rational* faculties of knowing. This differentiation between the faculties occurs first in Kant's 1781 text, *Critique of Pure Reason*. Kant gives us what he calls a "transcendental aesthetic" at the beginning of this text. As transcendental, these elements are *a priori,* or prior to, experience and, therefore, necessary. They are not subject to the contingencies of finitude because they are always already present. This section begins with what he calls "conditions of sensibility" as the necessary conditions from which experience emerge in the contingencies of finitude and yet transcend any reduction to these empirical phenomena. These two conditions are space and time, and the act of joining them is called "intuition." Nothing can be said about space and time, because intuition is non-discursive. Intuition is merely the immediate relation between the object and the cognition of this object, but it is not yet thought.

Another faculty called "the Understanding" is that which thinks objects, and this thinking of objects results in what Kant calls "concepts." Judgments such as, "In wildness is the salvation of the world," and, "This is a cathedral draped in mosses" are made through concepts, and Kant famously declares that, "Thoughts without content are empty, intuitions without concepts are blind."[1] Intuitions are still the "formless wasteland" of Genesis where God has not yet separated day from night.[2] Only division by the Understanding through concepts can give form and necessity. In the Understanding and its judgments lie a material cause of the division between nature and human, however, because nature must be "not-human" if it is to escape the logical fallacy of the tautology. Everything must be defined in terms of what it is not, or, in the words of Baruch Spinoza, "all determination is negation:"[3] logger versus "environmeddler," corporate fat cat versus displaced choker-setter, and owls versus jobs.

Aesthetic arguments from intuition and the understanding

Intuition and the Understanding provide the cognitive basis for aesthetic arguments, although description as an argument is a misnomer: precisely because they are aesthetic, descriptive, formed by judgments, and lacking syllogisms, they are not arguments if we define arguments as structured syllogistically. This is a fundamentally descriptive enterprise. Descriptive judgments become arguments only when the reader shares an experience of the writer through the mediated intuition present by the text. The moral conscience of the reader is the critical link leading from these intuitions to moral claims such as, "(1) One ought to preserve ancient forests; (2) I can preserve this ancient forest; (3) Therefore, I ought to preserve this ancient forest (1,2)." Premise two is provided by an aesthetic argument, but premise one of this syllogism (and consequently the conclusion) is external to the aesthetic judgment.

We thus see how aesthetic arguments use judgments to make a case for wilderness preservation. The goal of such writing is to communicate intuitional content, i.e., to bring the reader from her armchair in the flat or urban wasteland to heather-covered summits and deserts. Nature writing frequently employs both aesthetic and rational arguments and alternates between the arguments based on the artistic sensibilities of the writer, so pure paradigms of the different types of arguments are uncommon. Nevertheless, William O. Douglas' *My Wilderness* comes closest to the pure paradigm of an aesthetic argument.

Douglas begins this text as follows: "The Arctic has strange stillness that no other wilderness knows. It has loneliness, too—a feeling of isolation and remoteness born of vast spaces, the rolling tundra, and the barren domes of limestone mountains."[4] Only in the introduction and the final sentence of the book does he mix description with prescription: "Audubon's hermit thrush sang over and over again.... It means the Wallowas, and lengthening shadows, and a sanctuary that greedy man must never destroy."[5] The "must" expresses a moral "ought," and this division of "is" from "ought" departs from pure description which necessarily confines itself to description of that which "is." With such sparse moral claims, we are left to speculatively assume that Douglas is writing to stimulate "an aroused public opinion and effective political action to keep the Pacific West from being ruined."[6]

By transmitting the intuitional content of experience with wildness, conservationists have used aesthetic arguments with great success—John Muir in nature writing and Ansel Adams with nature photography, for example. Nevertheless, aesthetic arguments remain trapped in the contingency of the empirical: one *may* or *may not* feel moved by wildness just as one may or may not have a conscience. Aldo Leopold begins *Sand County Almanac* by differentiating between "some who can live without wild things, and some who cannot."[7] While he directs his aesthetic arguments toward the former, he relies upon rational arguments to reach the latter.

The third faculty of knowing: theoretical reason

High-school debate teams and law students exemplify theoretical reason in its purity. It employs syllogisms, and these are structured by a major premise (M), a minor premise (M´), and a conclusion (C). For example, "M: All wilderness preservation is biophilic. M´: The Wilderness Act preserves wilderness. C: Therefore, the Wilderness Act is biophilic." From this conclusion, we can make another syllogism: "M: All that is biophilic realizes my highest objective. M´: The Wilderness Act is biophilic. C: Therefore, the Wilderness Act serves my highest objective."

Universality is the great advantage of the necessity accompanying theoretical reason, because this universality compels an audience to either accept the rationality of the argument or to deny an appeal to the ground of rationality. If rationality is denied as ground to which to appeal, then the audience is locked into what is known as a "performative contradiction:" they do precisely what they say they cannot do when they use reason to construct an argument against reason. This contradiction is fallacious and, therefore, can be rejected.[8]

Chapter one of John Muir's *Steep Trails* presents a friend of Muir's locked in a self-refuting argument through a performative contradiction. His friend's *practical preference* for wild wool invalidated his *theoretical preference* for civilized things. After exposing this contradiction, Muir examines the theological Argument from Design to show that it does not support anthropocentrism. Divine ends may govern the destiny of matter, but human choice destroying wilderness does not imply that these choices are sanctioned by God. Muir rejects the premise conflating providence as a whole with choice as a part, and this exemplifies a rational argument.

Theoretical reason highlights the necessity of wilderness preservation, but it has one major shortcoming: its universals are desiccated of intuitional content. The theoretical necessity of an argument will convince someone that wilderness must be preserved, but I daresay that a sound argument for preservation by itself moves no one to action. Theoretical rationality is formalistic, pedantic, and boring. Aristotle defined practical reason as desire guided by theoretical reason, and desire arises in relation to the intuitional content from the aesthetic argument. Heart and head must be united for action: I must be able to read about the crumbly rock and old cedars of the Olympic Mountains, feel an intuitional connection to this land, read scientific data suggesting preservation, and then formulate the moral imperative that I ought to seek preservation of the Olympics. My intuitional connection to the land sparks my desire—not my correct syllogism.

Arguments from practical reason: intuition, the understanding, theoretical reason, praxis

Reason proceeds from and returns to wilderness, because aesthetic arguments require intuitional content, theoretical reason requires aesthetic arguments, and practical reason requires action that physically lives out the imperatives of theoretical reason. Wilderness activities are thus the best arguments for wilderness preservation, because they necessitate both the aesthetic connection to the land and the reason required to maneuver in it. Praxis motivated by the imperative to save wilderness transforms *reason considered as the activity of knowing* into *rational activity as the highest form of knowing*. Praxis contains within itself the intuitional content of the aesthetic argument, the judgments constitutive of premises, and the syllogisms whose conclusions are—like mysticism in all its forms—non-discursive: as Aristotle pointed out in the *Nicomachean Ethics* long ago, the conclusion of a practical syllogism is an action. This action is one that preserves and protects wildness and wilderness.

Endnotes

1. Immanuel Kant, *Critique of Pure Reason*, trans. Paul Guyer and Allen Wood (Cambridge: Cambridge University Press, 1997), 193–194.
2. Genesis 1:1–5.
3. Letter 50 to Jarig Jelles.
4. William O. Douglas, *My Wilderness* (Sausalito: Comstock Editions, 1960), 11.
5. Ibid., 160.
6. Ibid., introduction.
7. Aldo Leopold, *A Sand County Almanac* (New York: Ballantine Books, 1949), xvii.
8. The most pure form of rational arguments are found in environmental philosophy texts such as Murray Bookchin's *The Philosophy of Social Ecology*, Erazim Kohák's *The Embers and the Stars*, Arne Naess' *Ecology, Community, and Lifestyle*, and the paper I am reading right now. This rational work is important for a rational people, because they formulate, preserve, or attack premises and reason through their own arguments while preserving or attacking the arguments of others. As products of reason, the conclusions are supposed to be universal and necessary. Yet the relatively pure form of theoretical reason is stripped away from descriptions of Yosemite shrouded in fog or Mount Washington being pounded by gale-force winds. An alternative to purely rational and purely aesthetic can be found in arguments alternating between aesthetic and rational forms. John Muir (among others), for example, is a painter of arguments who paints from a full palette—the art of influencing readers to preserve wildness. We may find other cases of artistic mixing in works such as Henry David Thoreau's *Walden*, Aldo Leopold's *A Sand County Almanac*, Edward Abbey's *Desert Solitaire*, and Jean-Jacques Rousseau's *Reveries of the Solitary Walker*.

Wilderness Zoning: Should We Purposely Manage to Different Standards?

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Introduction

One inherent tension in wilderness management involves balancing recreational access and wilderness protection (Hendee and Dawson 2002). Although recreation is a legitimate use of wilderness, managers are also charged with protecting biophysical resources and visitor experiences. Opinions about how to balance access and protection are diverse. Nowhere has the issue of appropriate wilderness recreation use and need for use limitation been more contentious than in Forest Service wilderness in western Oregon and Washington. Stunning wilderness landscapes are located an hour's drive from millions of urbanites living in and around Portland and Seattle. On summer weekends, more than 200 people per day summit Mount Hood in the Mount Hood Wilderness and groups pass each other every three minutes hiking into Snow Lake in the Alpine Lakes Wilderness (Cole et al. 1997).

The difficulty of managing this issue is exemplified by planning for the Mount Hood Wilderness, where monitoring in the 1990s showed that wilderness standards were being violated. Crowding levels were too high, as was recreation impact. A proposal to bring conditions into compliance with standards, by reducing use as much as 90% in some places and at some times, was met with widespread public outcry. A new proposal was developed that applied more lenient standards in portions of the wilderness, eliminating the need to reduce use so profoundly. This proposal was successfully appealed.

Diverse stakeholders and zoning

The position of the Forest Service—"damned if you do and damned if you don't"—reflects the strong opinions of a diverse public. Any decision the Forest Service makes favors the interests of one group to the detriment of another. One way to meet diverse demands is to give something to each group. Zoning provides a means of providing different conditions or management regimes in different places, so everyone's needs and desires are met somewhere. Zoning has been proposed for decades as a means of increasing equity in decisions about recreational carrying capacity (Schreyer 1979).

Zoning of wilderness has been proposed—and in some places implemented—to accommodate the range of conditions that exist in wilderness and to promote diversity. The Limits of Acceptable Change process (Stankey et al. 1985) includes a step in which wilderness is divided into zones. Haas et al. (1987) point out that variable wilderness conditions are inevitable. Some portions of wilderness lie close to the boundary, within easy trail access of multitudes, while much of the same wilderness is virtually unvisited due to remoteness and difficulty of access. Similarly, some wildernesses are far from population centers. Other wildernesses have been designated immediately adjacent to large urban populations.

In the absence of restrictions on access, crowding is highly variable both within and among wilderness areas. How should managers respond to this? Should they attempt to reduce this variability by limiting access in some places? Should they purposely maintain this variability (or even expand it) by zoning wilderness explicitly and managing different places to different standards? Or should they just allow conditions to vary as they will, without trying to explicitly manage conditions or their variability? Opinions in the literature and among wilderness advocates are diverse. Little is known, however, about how wilderness visitors feel about zoning. This paper reports the opinions of visitors to Forest Service wilderness in Oregon and Washington regarding within- and among-wilderness zoning.

Study design

In the summers of 2003 and 2004, questionnaires were distributed to visitors exiting 36 trailheads in 12 wildernesses in Oregon and Washington: Alpine Lakes, Goat Rocks, Mark O. Hatfield, Indian Heaven, Mount Adams, Mount Baker, Mount Hood, Mount Jefferson, Norse Peak, Salmon-Huckleberry, Three Sisters, and William O. Douglas. We studied both day and overnight visitors to the most heavily used trailheads in Oregon and Washington, as well as a sample of more moderately used trailheads spread across the states. We attempted to pair heavy- and moderate-use trailheads within the same wildernesses. Ultimately, cases of unreliable use data and the small number of very heavily used trailheads in the region forced us to deviate from this design. We identify three use levels: (1) very heavy use (>20 groups per day and >1,500 permits per year); heavy use (11–20 groups per day and 550–1,500 permits per year); and moderate use (≤10 groups per day or ≤500 permits per year.

About 12,000 visitors exited from the trailheads on the days when sampling was being conducted; 7,860 (65%) of these visitors were asked to fill out a questionnaire on-site. Seventy-two percent of those asked agreed.

Results

Within-wilderness zoning. To assess support for within-wilderness zoning, respondents were informed that "Forest Service managers must find an appropriate balance between allowing all people to visit the wilderness when they want and providing opportunities for solitude." Then they were asked for their opinion about "which of the following options strikes the best balance for this wilderness

A. Do not restrict use to manage for solitude anywhere, even if use is heavy.
B. Manage for solitude along a few wilderness trails. The number of people allowed to use these few trails will be limited, but the majority of trails will have no use limits and may be heavily used.
C. Manage for solitude on most wilderness trails, by limiting the number of people using these trails. A few trails will have unrestricted use. Use levels will be high on these trails.
D. Manage for solitude everywhere in wilderness, even though this may mean that use will be restricted and people will be turned away."

The vast majority of visitors supported zoning, selecting options that involve managing for variable conditions within the wilderness. Support was highest (44%) for managing *a few trails* for solitude. Another 34% preferred managing *most trails* for solitude. Support for not restricting use anywhere (17%) was higher than support for managing for solitude *everywhere* (5%). One possible explanation for lack of support for managing for solitude everywhere is that many of these trailheads are not very heavily used and we asked about the appropriateness of zoning *in this wilderness.* However, support for these options did not vary significantly with amount of use (Pearson chi-square = 7.55, df = 6, $p = 0.27$). People visiting high- and low-use wilderness were equally likely to support zoning, as well as equally supportive of restricting access to provide solitude.

Although differences between day and overnight users were statistically significant (Pearson chi-square = 9.38, df = 3, $p = 0.03$), differences were not substantial. The primary difference was in support for managing few trails for solitude (preferred by 46% of day users and 41% of overnight users) in relation to support for managing most trails for solitude (preferred by 31% of day users and 39% of overnight users). The proportion of people supporting one of the zoning options did not vary significantly between day and overnight users.

Support for either of the two zoning options (as opposed to the two non-zoning options) did not vary with any other user characteristics we examined. However, the response options can also be viewed as a continuum from less to more willingness to support use restrictions to provide solitude. We asked, "How important to you personally is the way this area is managed?" We found that visitors who thought a lot about wilderness management were more likely to support restrictions (Somers' d = 0.15, $p < 0.001$). Support for restrictions did not increase significantly with self-reported knowledge about the Wilderness Act (Somers' d = 0.04, $p = 0.10$). Support for restrictions decreased significantly with increases in a visitors' experience in this area (Somers' d = –0.06, $p < 0.01$), but was not significantly related with either experience with other wildernesses ("How many other wildernesses have you visited?") or with the frequency of wilderness visits.

We asked people about the experiences they were seeking on this visit (their motivations), as well as the extent to which they experienced what they hoped to. Support for restrictions was highly correlated with motivations. Support increased significantly with increases in every motivation we asked about ("a sense of freedom," "solitude," "to think about who I am," "closeness to nature," "to learn about this place," "wilderness opportunities," "a feeling of remoteness," "surroundings not impacted," "away from crowds," "a sense of challenge," "away from modern world," "to be my own boss," and "to develop personal, spiritual values"). Even those who sought "to be near others who could help if needed" (a distinct minority) were more supportive of restrictions. In contrast, support for restrictions was seldom significantly related to the degree that visitors experienced what they hoped to. That is, those who reported that they were seeking solitude were more supportive of restrictions than those not seeking solitude. But those who reported they found solitude were no more supportive of restrictions than those who did not find it.

Among-wilderness zoning. Visitors' opinions about among-wilderness zoning were explored by asking a question that began by stating that "some wilderness areas are within an hour's drive of large cities like Seattle and Portland, while others are far from such cities."

They were then asked to indicate the extent to which they agree or disagree about ways in which wilderness close to cities should differ from wilderness far from cities. Two items addressed appropriate conditions and four items addressed appropriate management.

Overall, there was modest support for among-wilderness zoning (Table 1). The only item that was not supported by a majority of respondents was the statement that "in wilderness areas close to cities, it is OK to have more wear and tear on the vegetation from recreation use than in remote wilderness." In contrast to lack of support for more lenient biophysical impact standards in urban-proximate wilderness, there was strong support for more lenient crowding-related standards in urban-proximate wilderness. Only 7% of respondents disagreed with the statement that "in wilderness areas that are close to cities, it is OK to see more people than in remote wildernesses."

In wilderness close to cities:	Percent agree[1]	Mean[2]	Median[2]
It's OK to see more people	79	1.5	2
It's OK to have more impact	41	–0.1	0
People should be allowed to visit whenever they want	68	1.1	1
Behavior should be more restricted	59	0.7	1
More acceptable to manipulating the environment to increase durability	54	0.4	1
Use limits more likely necessary	67	0.9	1

[1] Neutral responses (0) are NOT included in the percent that agree.
[2] Values range from +3 (strongly agree) to –3 (strongly disagree).

Table 1. Visitor opinions about managing wilderness areas close to cities to different standards and in different ways from that of remote wilderness areas.

About two-thirds of respondents supported allowing people to visit wilderness whenever they want, in urban-proximate wilderness, "so they can get relief from the city." A similar proportion agreed that use limits are more likely to be needed in urban-proximate wilderness. Interpreted strictly, these results are not logically consistent. This inconsistency likely reflects the personal values conflict many wilderness users feel about wanting access to wilderness, to get away from the city, and recognizing the need for limits. Taken together, most respondents seem to believe that crowding standards should be more lenient in urban-proximate wilderness, resulting in an increased ability to allow people to visit these wildernesses when they want to, but also believe that, even with more lenient standards, use limits are still more likely in these wildernesses. Majorities also support more behavioral restrictions in urban-proximate wilderness, as well as more environmental manipulation (Table 1).

As was the case with support for within-wilderness zoning, support for among-wilderness zoning did not vary substantially with amount of use on the trail where the visitor was contacted. Nor did it vary much between day and overnight visitors. There were a few statistically significant differences. Visitors contacted in more lightly used places were more likely to support the need for more behavioral restriction in urban-proximate wilderness

(Somers' d = 0.82, $p < 0.01$) and more likely to agree that use limits are more likely to be needed in urban-proximate wilderness (Somers' d = 0.11, $p < 0.001$). But differences were small. For example, 73% of respondents at the more lightly used trailheads agreed that use limits were more likely in urban-proximate wilderness, compared with 62% of respondents at the most heavily used trailheads. Day users were significantly more likely than overnight users to agree that in urban-proximate wilderness people should be allowed to visit whenever they want (Pearson chi-square = 7.55, df = 6, $p = 0.27$). Again differences were small, 70% agreement versus 64% agreement.

Visitors who think a lot about and are concerned about how wilderness is managed are less supportive of more lenient biophysical impact standards in urban-proximate wilderness (Somers' d = –0.14, $p < 0.001$) and less supportive of more manipulation in those wildernesses to increase the ability of the environment to withstand recreation use (Somers' d = –0.06, $p = 0.02$). Conversely, they are more supportive of the need to restrict visitor behavior (Somers' d = 0.15, $p < 0.001$) and limit use in urban-proximate wilderness (Somers' d = 0.12, $p < 0.001$).

Visitors who report that they have a high level of familiarity with the legal definition of wilderness are also less supportive of more lenient biophysical impact standards in urban-proximate wilderness (Somers' d = –0.06, $p = 0.03$) and less supportive of more manipulation in those wildernesses to increase the ability of the environment to withstand recreation use (Somers' d = –0.11, $p < 0.001$). They are less likely to agree that in urban-proximate wilderness people should be allowed to visit whenever they want (Somers' d = –0.07, $p = 0.01$)and more likely to agree that use limits are needed in urban-proximate wilderness (Somers' d = 0.08, $p < 0.01$).

Conclusions

Most visitors support the concept of wilderness zoning. Support for within-wilderness zoning is stronger than support for among-wilderness zoning. There is substantial agreement that crowding standards should be more lenient in urban-proximate wilderness, but little support for allowing more biophysical impact in urban-proximate wilderness. Most visitors believe that management of urban-proximate wilderness will have to be more intensive (more use limitation, behavioral restriction, and environmental manipulation).

While some wilderness visitors do not support zoning, it would be incorrect to conclude that these visitors are much more (or less) likely to be knowledgeable about the Wilderness Act or to be more concerned or thoughtful about wilderness management. Nor would it be correct to conclude that they are more experienced, more likely to seek out less crowded places in wilderness, or more likely to be an overnight visitor. Support for restrictions varies more consistently with visitor characteristics. Day users, visitors to very heavily used trailheads, and visitors who frequently return to the same location are somewhat less supportive of restrictions, while visitors who are particularly concerned about management and knowledgeable about the Wilderness Act tend to be more supportive of restriction. However, differences are not substantial.

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Reconciling Tradeoffs in Wilderness Management: A Comparison of Day and Overnight Visitors' Attitudes and Preferences Concerning Management of the Okefenokee Swamp Wilderness

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Decisions about how to manage wilderness involve balancing tradeoffs among the social, resource, and managerial conditions of the wilderness setting (Cole 2000; Lawson and Manning 2001). Efforts to optimize one desirable attribute of the wilderness setting may mean having to compromise one or more of the other important attributes of wilderness. For example, having minimal or no restrictions on travel itineraries may increase visitors' sense of freedom, but this might simultaneously result in more encounters with other users. Conversely, regulating travel itineraries might reduce encounters, but would diminish visitors' sense of freedom and spontaneity (Cole 2000).

Recent research has used stated preference methods (e.g., stated choice and conjoint analysis) to examine visitors' attitudes concerning tradeoffs among social, resource, and related management conditions of the recreation setting (Lawson and Manning 2001, 2002, 2003; Cahill et al., in review). Stated preference study results provide quantitative estimates of the relative importance visitors place on selected attributes of the recreation setting and the extent to which they support alternative management practices designed to optimize tradeoffs related to recreation management.

To date, most applications of stated preference methods to park and wilderness management have implicitly treated all visitors within a study area as a homogeneous group by reporting study results for the sample as a whole. However, previous research suggests that wilderness recreationists evaluate wilderness conditions and management differently depending on a number of factors, including mode of travel (e.g., motorboat versus paddle canoe), length of stay (e.g., day versus overnight trip), and type of group (guided or nonguided) (Hall and Shelby 1996; Manning 1999). The purpose of this study is to extend existing applications of stated preference methods by examining the attitudes and preferences of selected subgroups of visitors to the Okefenokee Swamp Wilderness, Georgia, USA. In particular, this study uses conjoint analysis to examine three pairs of visitor subgroups' attitudes and preferences for wilderness conditions and management: day and overnight visitors; motorized and nonmotorized visitors; and guided and nonguided visitors.

Okefenokee Wilderness

The Okefenokee Wilderness was designated in 1974. At 353,981 acres, it is the third largest wilderness area east of the Mississippi River. It is administered by the U.S. Fish and Wildlife Service as part of the 396,000-acre Okefenokee National Wildlife Refuge. The refuge was established in 1937 to protect the unique environmental qualities of the Okefenokee Swamp ecosystem.

Approximately 120 miles of water trails are maintained within the refuge. Access to the water trails in the Okefenokee Swamp Wilderness is provided from the Suwannee Recreation Area, Stephen C. Foster State Park, and Kingfisher Landing. Nonmotorized use of the water trails is primarily by paddle canoe and kayak. The use of powered watercraft, propelled by motors of ten or less horsepower, is permitted on a portion of the wilderness water trails. Canoe and motorboat rentals as well as guided tours are offered by a cooperating partner at the Suwannee Recreation Area and by state park staff at Stephen C. Foster State Park. Individuals can also use their own canoes, kayaks, and small motorboats.

Overnight camping in the Okefenokee Swamp Wilderness is permitted at seven designated campsites. Most of the campsites within the swamp consist of raised wooden platforms located in the water with little or no land surrounding them. A wilderness permit is required for overnight stays in the swamp; these are available by phone up to two months in advance of the trip, and the limited permits are often taken within minutes of their becoming available each day. Permitees are given an assigned travel route and camp locations, at which they must arrive by sunset and stay only one night. While there is no fee for day use of the Okefenokee Swamp Wilderness water trails, overnight visitors pay a $10 per-person per-night use fee. Motorboats are prohibited on overnight-use water trails, and overnight visitors typically travel by canoe.

Study methods

Conjoint analysis. Conjoint analysis was originally developed to study individuals' preferred consumption levels and relative importance of the multiple attributes of market goods (Green and Srinivasan 1978, 1990; Louviere 1998). For example, marketing studies have used conjoint analysis methods to assess how important various features of automobiles (e.g., color, horsepower, automatic locks, etc.) are to consumers. Conjoint analysis has since been extended to study public attitudes and preferences concerning the provision and management of public goods (Teisl et al. 1996; Dennis 1998). Within conjoint analysis studies of public goods, respondents are presented with a series of alternative management profiles and asked to rank the profiles or rate the desirability or acceptability of each profile on a numerical scale.

In this study, Okefenokee Swamp Wilderness visitors were asked to rate a series of wilderness setting profiles using a scale ranging from 1 ("Unacceptable) to 10 ("Ideal"). The profiles included in this study describe varying conditions or levels of six wilderness setting attributes relevant to the management of the Okefenokee Swamp Wilderness. Analysis of respondents' ratings (i.e., conjoint ratings) provides information concerning visitors' preferred conditions of the wilderness setting attributes and their relative importance to subgroups of visitors. The statistical model derived from respondents' conjoint ratings can also be used to estimate visitor subgroups' relative support for wilderness management alternatives (Teisl et al. 1996). The following sections of this paper describe the design and analysis of the conjoint profiles used in this study.

Design of the wilderness setting profiles. As noted in the previous section of this paper, the wilderness setting profiles used in this study are composed of varying conditions or levels of six wilderness attributes. The attributes and their levels or conditions are presented in Table 1. Selection of the attributes for this study was based on a review of previous research concerning backcountry and wilderness recreation experiences (Manning 1999), and consultation with refuge staff.

A fractional factorial design was used to combine the attributes at varying levels into a total of 80 wilderness setting profiles. The profiles were blocked into eight questionnaire versions, each containing ten unique setting profiles. An example of a representative Okefenokee Swamp Wilderness setting profile is presented in Figure 1.

Survey administration. The conjoint procedure was conducted as part of a larger survey of Okefenokee Swamp Wilderness visitors from October 1999 through May 2000. An

Table 1. Okefenokee Swamp wilderness setting attributes and levels.

Number of other boats seen per day:
Encounter 5 other boats per day
Encounter 15 other boats per day
Encounter 30 other boats per day
Amount of facility development along water routes:
No developments along the water routes for the visitor
A few simple facilities like existing pit toilets and camping/rest platforms
A few simple facilities like pit toilets, boardwalks, observation platforms, and screened-in camping/rest platforms
Cost of boat trip per day:
No user fee to travel the swamp
$10 fee to travel
$20 fee to travel
Percent of wilderness water trail miles open to motorboat use :
Five percent of trail miles open to motorboats
Twenty-five percent of trail miles open to motorboats
Fifty percent of trail miles open to motorboats
One-hundred percent of trail miles open to motorboats
Regulation of travel itineraries for water trails:
Assigned entry and assigned travel route
Assigned entry and freedom to travel where one wants
Freedom to enter where one wants and assigned travel route
Freedom to enter and travel where one wants
Amount of information provided along water trails:
No information, except maps
Only minimal information, like maps and simple directional and distance signs
Much information, like maps and educational materials about Swamp history and ecology

Instructions: Please rate your personal preference for the scenario on a scale of 1 to 10 (where 1 = unacceptable and 10 = ideal).

- You see about 15 boats per day.
- No developments are provided along Swamp routes for visitors.
- You pay $0 per day.
- About 50% of water trail miles are open to motorboats.
- You may enter where you want and travel where you want.
- Only minimal information, like maps and simple directional and distance signs are provided along Swamp routes.

Rating Scale: 1 2 3 4 5 6 7 8 9 10

unacceptable fair ideal

Your Rating:___________

Figure 1. Example of an Okefenokee wilderness setting profile.

on-site contact sheet was used to collect mailing addresses from visitors entering or exiting the wilderness from one of three public access points. Visitors also recorded information about their visit on the contact sheet, including whether they were on a day or overnight trip, using a motorized or nonmotorized boat, and on a guided or nonguided trip. Questionnaires containing the conjoint procedure and other questions were mailed to the addresses of visitors recorded on the on-site contact sheet. Recipients of the mail survey were randomly assigned to complete one of the eight versions of the conjoint questions.

Data analysis. Responses to the conjoint questions included in the visitor survey were analyzed using ordinary least squares regression with the conjoint rating as the dependent variable and the six wilderness setting attributes as the independent variables. Three of the independent variables—number of boats seen per day, percent of water trails open to motorboats, and cost of boat trip per day—were coded as continuous variables and the other independent variables were entered into the regression model using effects coding. To test whether attitudes and preferences for wilderness setting conditions and management differ among subgroups of Okefenokee Swamp Wilderness visitors, separate regression models were estimated for each of the visitor subgroups mentioned earlier in the paper.

Results

A total of 770 visitors agreed on site to participate in the survey and were sent a questionnaire by mail. The response rate to the mail survey was 68.1%, resulting in a total of 524 completed questionnaires. The results of the regression analyses for day and overnight visitors to the Okefenokee Swamp Wilderness are reported in Table 2. Regression models were also estimated to compare visitors traveling in motorized and nonmotorized boats, as well as visitors on guided versus nonguided trips. The scope of this paper is limited to discussing the results of the analysis for the day and overnight visitors.

Variable	Day Coefficient t-statistic		Overnight Coefficient t-statistic	
Number of other boats seen per day	–0.05	****	–0.06	****
	–13.14		–6.23	
Amount of facility development along water routes				
No developments along the water routes for the visitor	–0.35		–0.41	***
	–6.13		–3.17	
Few simple facilities: existing pit toilets, platforms	0.18	****	0.21	*
	3.20		1.63	
Few simple facilities: pit toilets, boardwalks, screened-in platforms	0.17	***	0.20	
	2.83		1.51	
Cost of boat trip per day	–0.03	****	–0.02	**
	–5.31		–2.03	
Percent of water trail miles open to motorboat us	–0.01	****	–0.04	****
	–6.88		–12.84	
Regulation of travel itineraries for water trails				
Assigned entry and assigned travel route	–0.20	***	–0.33	**
	–2.80		–2.00	
Assigned entry, freedom to travel where one wants	0.27	****	0.21	
	3.93		1.37	
Freedom to enter where one wants, assigned travel route	–0.24	***	0.22	
	–2.96		1.19	
Freedom to enter and travel where one wants	0.17	**	–0.11	
	2.34		–0.65	
Amount of information provided along water trails				
No information, except maps	–0.35	****	–0.16	
	–5.75		–1.13	
Maps and simple directional and distance signs	0.00		0.11	
	0.06		0.84	
Maps and educational materials	0.35	****	0.05	
	5.80		0.38	

* p<0.10, ** p<0.05, *** p<0.01, **** p<0.001

Table 2. Regression results for day and overnight subgroups.

The regression coefficients reported in Table 2 provide insight into the effect of the attributes on visitors' ratings of alternative wilderness profiles and the preferred levels of the attributes. For example, the negative coefficients in both regression models on "Number of boats seen per day" suggest that both day and overnight visitors prefer to see fewer boats while visiting the swamp and that as the number of boats seen increases, the ratings of the wilderness setting diminishes. Similarly, the positive coefficients in both regression equations on "A few simple facilities such as existing pit toilets and camping/rest platforms" suggest that the presence of these facilities in the Okefenokee Swamp Wilderness is desirable to both day and overnight visitors.

The t-statistics reported in italics in Table 2 provide insight into the relative importance of the wilderness setting attributes to day and overnight visitors and are suggestive of how they might prefer to balance tradeoffs associated with Okefenokee Swamp Wilderness management. That is, while the coefficients of the regression models indicate the preferred levels of the wilderness attributes, the t-statistics provide managers with a sense of which wilderness attributes visitors would prefer them to emphasize and which to compromise when multiple wilderness attributes come into conflict (e.g., unrestricted travel itineraries versus few encounters with other boats). The values of the t-statistics suggest that the two most important attributes for both day and overnight visitors to the Okefenokee Swamp Wilderness are the percent of water trails open to motorboats and the number of boats seen per day, and that they prefer lower levels of both. The least important attribute for day visitors is the amount of information provided within the swamp. For overnight visitors, the amount of information provided and the amount of regulation of visitors' travel routes in the swamp are the least important attributes.

The regression models reported in Table 2 were used to estimate the relative support of day and overnight visitors for the status quo and two alternative wilderness management strategies. Profiles of the status quo conditions of the Okefenokee Swamp Wilderness for day and overnight visitors are presented in Table 3. The status quo profiles for day and overnight visitors, which are based on existing management practices and use levels of the wilderness, are similar for the two subgroups, but differ with respect to the number of other boats seen, the amount of use fees charged, and management of travel itineraries. An alternative emphasizing freedom from management was evaluated by setting the management of travel itineraries at its least restrictive level (i.e., "free to enter and travel where you want") and the number of boats seen at 30 boats per day, while holding all other attributes at their status quo levels. An alternative emphasizing solitude was evaluated by setting the management of travel itineraries at its most restrictive level (i.e., "assigned entry, assigned travel route") and the number of boats seen at 0 boats per day, while holding all other attributes at their status quo levels. This analysis is based on the assumption that if travel itineraries were regulated more strictly, the number of encounters among visitor groups would decrease.

Day and overnight visitors' average ratings for the status quo and the two management alternatives were estimated by inserting the appropriate attribute codes into the two regression equations presented in Table 2. For example, the following equations illustrate the method used to calculate day and overnight visitors' average ratings for the status quo. The numbers outside of the parentheses are the regression coefficients and the numbers in parentheses are codes for the status quo levels of the wilderness attributes.

$$\text{Rating}_{\text{day}} = 6.25 + 11(-0.05) + 0(-0.03) + 0.18 + 50(-0.01) + 0.27 + 0.35 = 6.00$$
$$\text{Rating}_{\text{overnight}} = 7.46 + 8(-0.06) + 10(-0.02) + 0.21 + 50(-0.04) + 0.22 + 0.11 = 5.32$$

The preferred alternative for overnight visitors is to maintain the status quo, while day visitors would prefer managers to adopt the solitude-oriented alternative (Figure 2). However, the results of the analysis suggest that neither day nor overnight visitors have a strong preference between the status quo and the solitude-oriented alternative. Overnight visitors, however, are substantially more supportive of the status quo than the freedom-oriented alternative. That is, overnight visitors would prefer managers to continue regulating travel itiner-

Day	Overnight
Visitors see about 11 boats per day.*	Visitors see about 8 boats per day.*
Pit toilets, camping/rest platforms are provided along water routes.	Pit toilets, camping/rest platforms are provided along water routes.
Visitors pay $0 per day to travel water trails.	Visitors pay $10 per day to travel water trails.
About 50% of water trails miles are open to visitors for motorboat use.	About 50% of water trails miles are open to visitors for motorboat use.
Visitors are free to enter and travel the swamp without a permit.	Visitors have an assigned travel route required by permit.
Maps are available for visitors.	Maps are available for visitors.

* Number of boats seen per day was obtained by averaging results from a survey question that asked respondents to indicate the number of other boats they encountered that day.

Table 3. Status quo profiles for day and overnight subgroups.

aries to some degree than to have increased freedom from management but see other boats in the swamp more frequently than they currently do.

Discussion and conclusions

The results of this study suggest that while there are subtle differences between day and overnight visitors' attitudes concerning management of the Okefenokee Swamp Wilderness, they generally agree on which attributes of the wilderness included in this study are most important and the conditions they prefer for those attributes. Both day and overnight visitors rank the number of boats seen per day and the percent of water trails open to motorboats as the most important attributes of the Okefenokee Swamp Wilderness included in this study, and they prefer fewer of both.

Furthermore, estimates of day and overnight visitors' relative support for the status quo, a solitude-oriented management alternative, and a freedom-oriented alternative suggest more similarities than differences between the two visitor subgroups. Results of the tradeoff analysis suggest both day and overnight visitors prefer the status quo and solitude-oriented alternative more or less equally, and are less supportive of the freedom-oriented management alternative. The overnight group, however, was substantially less supportive of the freedom-oriented alternative than day visitors.

The findings from this study suggest that coming to consensus between day and overnight visitors on Okefenokee Swamp Wilderness management may not be as challenging as one would expect. The results of the conjoint analysis can assist managers by identi-

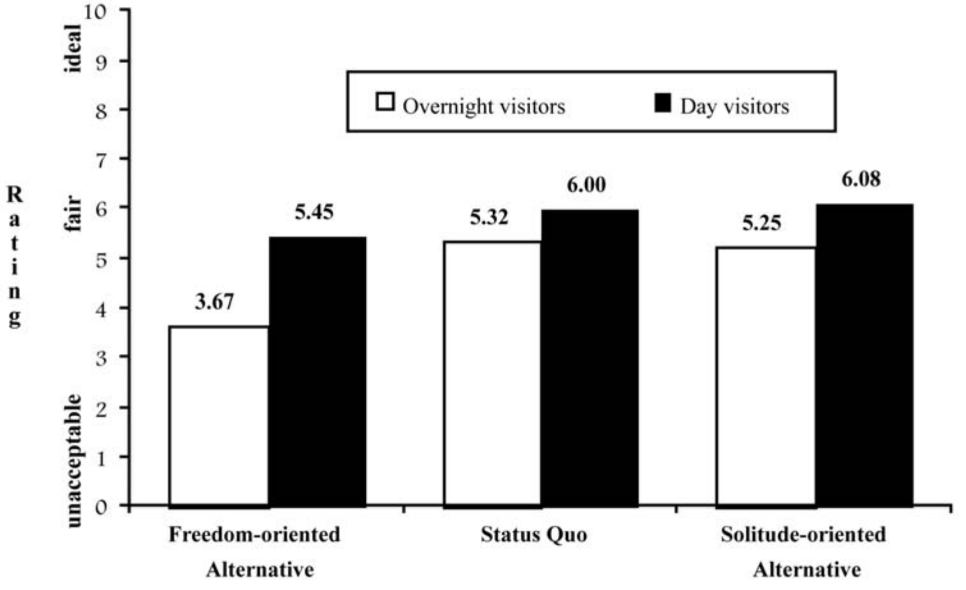

Figure 2. Day and overnight visitor's ratings of three Okefenokee Swamp wilderness management alternatives.

fying common ground between day and overnight visitors and areas where these subgroups differ in their preferences and attitudes for wilderness settings and management alternatives.

While the results of this study suggest that day and overnight visitors have similar attitudes and preferences concerning the attributes of the Okefenokee Swamp Wilderness included in this study, the way the subgroups were defined may be a limitation. In particular, the day and overnight subgroups here are mutually exclusive, but may not be homogeneous subgroups. For example, day visitors may travel through the swamp in a motorized or nonmotorized boat, may be from the local area or have traveled a long distance to get to the swamp, and may be visiting the swamp for the first time or be a repeat visitor. Consequently, differences between day and overnight visitors might be masked by differences within the subgroups as they are defined in this study. Future research should focus on further refining how discrete subgroups are differentiated in studies of visitors' attitudes and preferences concerning outdoor recreation management.

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Our *Nationwide* National Wilderness Preservation System

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Today, the National Wilderness Preservation System includes 166 units east of the Rocky Mountains, comprising some 4,245,000 acres—nearly 9% of all designated wilderness in the 49 states other than Alaska.[1] Those who conceived and enacted the Wilderness Act envisioned a single system of areas held to one definition and stewardship mandate nationwide. They laid down two fundamental ideas:

1. Wilderness areas will be diverse in size and wildness. In Aldo Leopold's words, "in any practical [wilderness] program the unit areas to be preserved must vary greatly in size and in degree of wildness."[2]
2. The defining concept of wilderness was never some ideal of pure, virgin nature. The framers of our national wilderness policy welcomed opportunities to preserve such areas, but their wilderness definition embraces lands with past human impacts. One founder of The Wilderness Society wrote: "a wild area is not necessarily a virgin area, but is one without roads and mechanized means of transportation...."[3]

In 1947, leaders of The Wilderness Society set in motion the campaign that led to the enactment of the Wilderness Act. Howard Zahniser, the society's executive director, drafted the legislation. As first introduced in 1956, the bill named each federal land unit involved. Later, generic language replaced this long list of forest, park, and refuge units, but the original list demonstrates that the sponsors always intended a nationwide wilderness system. The list included the Forest Service-administered Boundary Waters Canoe Area (Minnesota) and Linville Gorge (North Carolina); national wildlife refuges, including Moosehorn (Maine), Okefenokee Swamp (Georgia), and Wichita Mountains (Oklahoma); and national park areas, including Everglades (Florida), Great Smoky Mountains (Tennessee and North Carolina), and Shenandoah (Virginia).[4] All involved were aware that these and other Eastern units involved lands disturbed by past human impacts.

During Senate debate, Senator Thomas Kuchel (R-CA), responded to concern that there would be reason "for fear or trepidation on the part of Senators representing Eastern States that forest areas within their States ... could not ... become a part of the wilderness system. I deny it.... If the distinguished senior Senator from Florida wishes to introduce proposed legislation creating a wilderness out of any of the area owned by the Government of the United States in his own State, let him do so.... That would be precisely what would be required of him if the proposed wilderness legislation were enacted into law...."[5]

In its final form, the law immediately designated four eastern areas, including the Shining Rock Wilderness (North Carolina) that the Forest Service established administratively in May 1964. The entire area showed fading evidence of extensive railroad logging and slash fires that occurred between 1906 and 1926.[6] After visiting the area, Harvey Broome, then president of The Wilderness Society, advised: "The fact that it has been cut-over and burned-over is unfortunate, but areas of this size are limited in number in the east and ... it is desirable to set such aside as there is opportunity.... [T]he need is so great in the east and southeast that it is fortunate that Shining Rock is being considered ... and in fifty or one hundred years it will reach a high degree of restoration."[7]

In including this and the other wilderness areas immediately designated in the act, the floor leader in the House of Representatives noted that his "committee, in effect, was reviewing each of these areas individually," finding that each had been defined with precision and met all of the criteria of the soon-to-be-enacted law—including areas in both the East and West that had a history of earlier human impacts.[8]

The framers of the Wilderness Act designed a practical law applicable to the realities of land use history. Senator Clinton P. Anderson (D-NM), lead sponsor of the Wilderness Act and chairman of the Senate committee, carefully explained the two-sentence definition: "The first sentence is a definition of pure wilderness areas, where "the earth and its community of life are untrammeled by man.... *It states the ideal.* The second sentence defines the meaning or nature of an area of wilderness as used in the proposed act: A substantial area retaining its primeval character, without permanent improvements, which is to be protected and managed so man's works are 'substantially unnoticeable.' *The second of these definitions of the term, giving the meaning used in the act, is somewhat less 'severe' or 'pure' than the first"* [emphasis added].[9]

In 1964, eastern areas qualified as wilderness according to both the Forest Service and Congress. Yet six years later the agency opposed congressional designation of new wilderness areas in West Virginia with similar land use histories of decades-old logging. In 1971, the associate chief pronounced that "areas with wilderness characteristics as defined in the Wilderness Act are virtually all in the West."[10] For its own political reasons, the agency hierarchy adopted a new "purity" interpretation—that no lands with a history of human disturbance, East or West, could qualify as wilderness.[11]

The agency quietly drafted an alternative to the Wilderness Act "to establish a system of wild areas within the land of the national forest system" and peddled it on Capitol Hill. Their bill was described as necessary because Eastern areas "do not meet the strict criteria of the Wilderness Act."[12] Members of Congress who championed the Wilderness Act resolved to turn back this misinterpretation. Representative John Saylor (R-PA), lead sponsor of the Wilderness Act in the House, challenged those "who tell us [the act] is too narrow, too rigid, and too pure in its qualifying standards" to allow any formerly abused lands or lands with present abuse that can be restored with time. "I fought too long and too hard, and too many good people in this House and across this land fought with me, to see the Wilderness Act denied application ... by this kind of obtuse or hostile misinterpretation or misconstruction of the public law and the intent of the Congress of the United States."[13]

Senator Henry Jackson (D-WA) warned his colleagues that "[a] serious and fundamental misinterpretation of the Wilderness Act has recently gained some credence, thus creating a real danger to the objective of securing a truly national wilderness preservation system. It is my hope to correct this false so-called 'purity theory' which threatens the strength and broad application of the Wilderness Act."[14]

Senator Frank Church (D-ID), leader of the Senate debate on the Wilderness Act, observed that "the effect of such an interpretation would be to automatically disqualify almost everything, for few if any lands on this continent—or any other—have escaped man's imprint to some degree."[15] Church pointed out that the Wilderness Act itself "placed three eastern areas into the National Wilderness Preservation System [that] ... had a former history of some past land abuse," explaining: "This was by no means a so-called grandfathering arrangement. It was, and is, a standing and intentional precedent to encourage such areas to be found and designated under the act in other eastern locations."[16]

In launching their purity interpretation, the Forest Service hierarchy was out of step with the other agencies working correctly under the Wilderness Act criteria. Presidents recommended new wilderness areas in national parks and national wildlife refuges in the East and Congress steadily added these areas to the wilderness system—lands with a history of land use impacts, such as refuge wilderness areas including Great Swamp (New Jersey, 1968), Seney (Michigan, 1970), and Wichita Mountains (Oklahoma, 1970).

Wilderness advocates and their congressional allies responded to the Forest Service legislation with a counter bill, the proposed Eastern Wilderness Areas Act. At hearings, Senator Church emphasized the threat the purity misinterpretation posed to the vision of a single nationwide system of wilderness areas, telling the Forest Service: "If we [adopt your interpretation] we will be saying, in effect, that you can't include a comparable area in the West in the wilderness system. That is the precise effect of your approach, because you will have redefined section 2(c) of the Wilderness Act."[17]

In the Eastern Wilderness Areas Act, signed by President Gerald Ford on January 3, 1975, Congress designated 16 new wilderness areas totaling 206,988 acres of national forest lands east of the Rockies.[18] The final legislation adopted some elements of the Forest Service-inspired bill, but did not alter the definition and intent of the Wilderness Act. Congress had flatly repudiated the most serious threat to the vision of a nationwide wilderness system.

Understanding the legislative history of the Wilderness Act and the Eastern Wilderness Areas Act helps reinforce seven important lessons:

1. The National Wilderness Preservation System is just that—*national*. Wilderness areas East and West are subject to the same criteria and stewardship mandate. The Forest Service now administers 121 wilderness areas comprising some 1,950,000 acres east of the Rockies. Widened to all agencies, there are 166 wilderness areas comprising 4,245,000 acres in that region, including most recently the Gaylord Nelson Wilderness in Apostle Islands National Lakeshore (Wisconsin), signed into existence by President George W. Bush in December 2004.

2. Our National Wilderness Preservation System is wildly diverse. The wilderness system, still a work-in-progress, already fulfills Aldo Leopold's vision that in any practical wilderness program, the areas will be diverse in both size and degree of wildness. Of the smaller areas nearer population centers, Leopold, Bob Marshall, and the other founders of The Wilderness Society observed that "[a]lthough one cannot obtain in them the adventure, the dependence on competence [for survival], and the emotional thrill of the extensive wilderness, they are the closest approximation to wilderness conditions available to millions of people."[19]

3. There is no "eastern wilderness act." The law signed on January 3, 1975, has no short title, which would usually be found in section one—in fact, this law has no section one, reflecting a clerical error back when "cut-and-paste" meant just that. Dropped on the cutting room floor was the short title "Eastern Wilderness Areas Act," the title of the Senate-passed bill and the version approved by the House committee. The word "Areas" in this title signals that this was simply one more law designating additional areas within the one-system structure of the Wilderness Act. Had the title been "eastern wilderness act," some might argue that it implied a separate legal regime for wilderness areas in the East.

4. Congress, not the agencies, decides what lands are suitable as wilderness. Federal agencies provide recommendations on proposed wilderness legislation. But Executive Branch recommendations are not definitive; recommendations also come from other interested parties. As exemplified by the Eastern Wilderness Areas Act, Congress acts as a "court of appeals" to which citizens may appeal when they feel an agency's political leadership is misinterpreting the act or taking an unsatisfactory position on the dimensions of a proposed area.

5. Purity: "A misperception exists—let's get rid of it." The purity theory is demonstrably at odds with the congressional intent of the Wilderness Act. Congress has designated many wilderness areas with a history of human impacts, whether over an entire area (as is true of the Gaylord Nelson Wilderness designated in 2004) or in a portion, as is typical in lower-elevation valleys or plateaus in the West where some evidence of earlier human impact can almost invariably be found. Nonetheless, the purity theory is raised periodically by agency personnel, interest groups, or members of Congress who do not know this history or are unsympathetic to new wilderness designations.

I like the advice one Forest Service official offered at an agency workshop in 1983: "Understand that there is one, and only one, National Wilderness Preservation System as established by Congress. The Wilderness System is dynamic and diversified throughout our Nation.... A misperception exists—let's get rid of it."[20]

6. Restoration is an important issue for wilderness managers. Given the fact that no wilderness area is or could be utterly "pure," administrators are presented with challenges concerning possible active steps to restore what some perceive to be more "natural" ecosystem function.

My own view is that, East or West, great hesitation is needed in decisions to actively manipulate a wilderness environment in the name of restoring what we might perceive as more natural ecosystem function. A fundamental underpinning of wilderness philosophy and the Wilderness Act is that in these areas we meet nature on its terms, with humility—including the humble awareness that ecological "certainties" we perceive today may prove wrong with greater knowledge in the future. As Howard Zahniser put it, in wilderness we should be "guardians, not gardeners."[21]

7. Congress has worked to get wilderness closer to urban populations. Congress has made a particular effort to protect wilderness areas near where people live, beginning with the1968 designation the San Gabriel Wilderness adjacent to Pasadena, California. Today the system includes the Sandia Mountain Wilderness and the Pusch Ridge Wilderness, literally on the city limits of Albuquerque and Tucson, respectively. For the same reason, where the opportunities for protecting wilderness areas are so constrained, as in the Eastern half of the country where federal lands are so rare, Congress has shown a consistent strong interest in securing near-the-people wilderness areas.

Conclusion

The rich legislative history documented by the framers and champions of the Wilderness Act is reinforced in the legislative history of more than 120 laws adding new lands to the wilderness system. This history consistently demonstrates that in its broad purpose and fine details, this is a practical law thoughtfully shaped by practical people. As in the Eastern wilderness debate, we have an obligation to sustain their practical vision and not wander into misinterpretations that would hamstring the building of the National Wilderness Preservation System.

In statutory language in the Vermont Wilderness Act of 1984, Congress chose to remind us of its long, consistent application of the fundamental features of the Wilderness Act. It is a concise statement not limited to Vermont or the East—a statement every agency wilderness steward and every wilderness advocate should keep readily at hand:

"The Wilderness Act establishes that an area is qualified and suitable for designation as wilderness which (i) though man's works may have been present in the past, has been or may be so restored by natural influences as to generally appear to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable, and (ii) may, upon designation as wilderness, contain certain preexisting, nonconforming uses, improvements, structures, or installations, and Congress has reaffirmed these established policies in the designation of additional areas since enactment of the Wilderness Act, exercising its sole authority to determine the suitability of such areas for designation as wilderness."[22]

Endnotes

1. In this article, "East" means the half of the continental United States east of the Rockies and embraces a wide variety of forest types, prairie grasslands, wetlands, and swamps. All data from www.wilderness.net, accessed April 8, 2005.
2. Aldo Leopold, *A Sand County Almanac* (New York: Oxford University Press, 1949), 189.
3. Harvey Broome to Peter J. Hanlon, May 18, 1962, blind carbon copy in Howard Zahniser's files, in The Wilderness Society archives, Western History Collection, Denver Public Library. Broome was addressing the suitability of the Shining Rock Wilderness (North Carolina), now a unit of the wilderness system.
4. U.S. Senate, S. 4013 (84th Congress, 2d session, June 7, 1956).
5. Senator Thomas Kuchel, "Establishment of National Wilderness Preservation System," *Congressional Record* (September 5, 1961), 16919, bound edition. Senator Kuchel spoke with particular authority as one of the ten original co-sponsors of the wilderness bill in June 1956, the second-most senior Republican member of the Committee on Interior and Insular Affairs which approved the bill in 1961, and the committee's most senior Republican when it re-approved the bill in 1963.
6. U.S. Forest Service, "Area History" (text on official map), *Shining Rock Wilderness and Middle Prong Wilderness*, Pisgah National Forest, North Carolina, Forest Service Recreational Guide R8-RG 23, revised June 1993.

7. Broome to Hanlon, May 18, 1962.
8. Representative Wayne Aspinall, "National Wilderness Preservation System," *Congressional Record* (July 30, 1964), 16846, bound edition. As the House of Representatives debated the Wilderness Act, Shining Rock was included in a tabulation of the acreage of the wilderness areas to be immediately protected. Chairman Aspinall characterized these areas, which became statutorily designated wilderness in the 1964 act, as having been "administratively designated as having wilderness characteristics." He explained how closely his committee reviewed these new areas before approving them: "Parenthetically, I note for the record that 2 years ago when our Committee on Interior and Insular Affairs was considering wilderness legislation there were only 6,822,400 acres of land [administratively] designated as 'wilderness,' 'wild' and 'canoe' and that the increase of 2,317,321 acres that has taken place since then has been accomplished by the Department of Agriculture after coordination with the Committee on Interior and Insular Affairs."
9. Statement of Senator Clinton P. Anderson, chairman, Senate Committee on Interior and Insular Affairs, *Wilderness Act: Hearings before the Senate Committee on Interior and Insular Affairs on S. 174* (87th Congress, 1st session), February 27–28, 1961, 2.
10. Associate Chief John McGuire, speaking before the Sierra Club's Biennial Wilderness Conference, September 24, 1971, quoted in Dennis M. Roth, *The Wilderness Movement and the National Forests* (College Station, Tex.: Intaglio Press, 1988), 39.
11. This purity interpretation was consciously evolved by agency leaders. See Richard J. Costley, "An Enduring Resource," *American Forests* (June 1972), 8.
12. Senator George Aiken, *Congressional Record* (June 13, 1972), 20570. The bill was S. 3699 (92nd Congress, 2nd session).
13. Representative John Saylor, "Legislation to Save Eastern Wilderness," *Congressional Record* (January 11, 1973), 849.
14. Senator Henry Jackson, *Congressional Record* (January 11, 1973), 754.
15. Senator Frank Church, "The Wilderness Act Applies to the East," *Congressional Record* (January 16, 1973), S737 (daily edition; pagination may differ in the bound edition).
16. Church, "The Wilderness Act Applies to the East," S738.
17. Senate Committee on Interior and Insular Affairs, *Eastern Wilderness Areas: Hearing before the Subcommittee on Public Lands on S. 316* (93rd Congress, 1st session, February 21, 1973), 31.
18. Eastern Wilderness Areas Act, Public Law 91-504; 84 Stat. 1104, October 23, 1970.
19. "The Wilderness Society: Reasons for a Wilderness Society," January, 21, 1935, in The Wilderness Society archives, Western History Collection, Denver Public Library, 2.
20. Charles R. Joy, Recreation Group Leader, Eastern Regional Office, "One National Wilderness Preservation System—Resolving the Perception of Eastern, Western, and Alaskan Wilderness," talk at the University of Idaho Wilderness Workshop, Moscow, Idaho, October 12, 1983, author's files, 6.
21. Howard Zahniser, "Guardians Not Gardeners" (editorial), *The Living Wilderness* (spring–summer 1963), 2.
22. Vermont Wilderness Act of 1984, Public Law 98–322, June 19, 1984, 98 Stat. 253, Section 101(a)(5).

Prioritize Your Exotic Plant Battles: Get Focused

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Introduction

Pimentel et al. (2005) estimate that there are at least 25,000 exotic plants in North America. Most land ownerships have far too many nonnatives to attempt eradication. In fact, as it is in agriculture, on-going suppression is the likely course of management for many exotics. Focusing management activity is essential to be effective, efficient, and actually control those species that pose the greatest threat to park resources. This paper outlines a ranking and prioritization process to aid management focus.

To arrive at a combined list of exotic species to control and areas to protect, an analysis should include the following examinations:

- Identify the nonnatives within your ownership. Focus on those that are recognized as problematic by regional or state authorities.
- Rank invasives by their potential for environmental harm and potential for control.
- Identify resources that need special protection due to their significance or sensitivity. Identify local restrictions that affect the means and timing of treatment.
- Meld the species-specific and geographic inputs, along with operational considerations, into an overall treatment priority system.

Focus on regionally recognized problems

Professional organizations and interest groups such as botanical societies, native plant societies, and exotic species councils are excellent sources of information and thought on the subset of nonnatives deemed to be invasive to the area. Most regions and states have such groups whose published materials can lend ready help in evaluating whether to focus on particular nonnatives. (See the paper by Åkerson and Forder, this volume, for more information.)

Since eliminating all nonnatives is virtually impossible, the most aggressive invasives must be identified for priority treatment. Typically, nonnative species that are highly-to-moderately invasive cannot be tolerated at even low levels due to their ability to quickly expand and dominate native systems.

It is possible that newly emerging invasives will not be included in published lists. In that case, use professional input from other regions and states that have already encountered the plant. Figure 1 illustrates a species that was not, until recently, recognized in published materials of the Commonwealth of Virginia.

Many weeds that are invasive of meadows are not considered invasive in shady forest settings. Maintaining a consolidated list for priority-setting runs the risk of having certain meadow weeds eliminated from consideration. Therefore, if meadows and forests are being managed, it is better to keep separate lists. Recommendations:

Figure 1. Mile-a-minute vine is highly invasive by seed and vegetative spread. Certain newly arrived, highly invasive exotics such as mile-a-minute should be treated regardless of being on published lists.

- Refer to invasive plant lists from an appropriate state or regional exotic pest plant council or native plant society.
- Consider plants that are a high-to-moderate threat within your geographic region of consideration.
- Create separate listings for forest (shaded) and meadow (full-sun) settings.

Create a species-based ranking

The process above winnows down the candidates from all nonnatives to a subset of the most invasive to a given area. The next step is to create a relative ranking amongst the invasives. This should not be seen as merely picking to most "virulent" or fast-spreading. It is also wise to focus on those invasives that are newly introduced or have the least breadth of impact. Starting with those will cost the least time and resources to gain control and eradication.

There are several ranking methods that look at both an invasive's biological threat and its potential for early control success. We have used an early version of Hiebert and Stubbendieck's ranking model (1993) with good success. Other ranking methods include: the NatureServe Invasive Species Assessment Protocol (Morse et al. 2004), which is best used in a regional assessment scope, and several evaluations created by states (including models from Virginia, California, Nevada, and Arizona).

The Hiebert and Stubbendieck model is described in their *Handbook for Ranking Exotic Plants for Management and Control*. It evaluates a given species by its significance of impact (evaluating innate ability to become a pest and current level of impact) and its feasibility of control (evaluating current abundance within the park, ease of typical control, and side effects of control). Figure 2 helps illustrate the relative ranking that develops from such a system. Where three species are approximately coequal in their feasibility of control (kudzu, Johnson grass, and gorse), it is readily apparent that it would be wise to tackle kudzu before the others since it has a significantly greater current and potential impact.

Without other considerations, an initial ranking from the example above would be as in Table 1. Note that two species are considered equal in overall ranking. Where local knowledge can inform the process, the species ranking might be grouped differently. Recommendations:

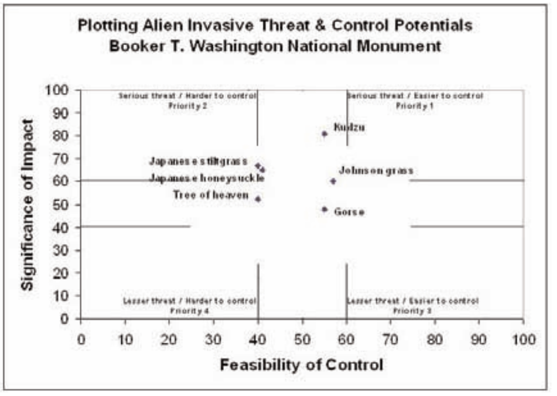

Figure 2. The graphical output of species-specific ranking by the Hiebert and Stubbendieck (1993) method. Note the relative values indicated at the four quadrants of the graph.

Treatment priority	Invasive species
1	Kudzu
2	Johnson grass
3	Gorse
4	Japanese stiltgrass Japanese honeysuckle
5	Tree of heaven

Table 1. The apparent ranking where other considerations do not override the Hiebert and Stubbendieck method.

- Use a species-based ranking system to arrive at a relative ranking that considers environmental risk and best potential for early control success
- Use local knowledge to adjust the initial rankings and groupings.

Consider areas and native species needing protection

If setting treatment priorities were only about ranking nonnative species, one might be left with chasing a particular plant wherever it is found in the park. Although this is a good strategy for extremely invasive exotics such as mile-a-minute vine and others, it is not practical in more complex environmental settings or with moderately invasive plants. Field crews would spend more time locating sites than actually controlling invasives. What is needed is geographical consideration.

Identify the natural and cultural resource areas that have especial need for protection. Preferentially protect areas containing native listed species. Consider monitoring and controlling infestations in sites recently disturbed by natural and human-caused events. Protect water resources. Protect cultural resources such as nationally listed landscapes, historic sites, and archaeological sites. Consider controlling invasives in highly trafficked areas and those with strong prevailing winds. Such areas act as vectoring pathways for population expansion. Vectoring areas may include trailheads, trails, roads, and land adjacent to home sites, as well as mountain gaps and passes, ridge tops, and wide roadways.

On the other hand, it is also necessary to identify areas that by law or policy have certain management restrictions. Wilderness areas, for instance, have restrictions on the kind of equipment that may be used. Without specific approval, power saws and other motorized equipment may not be used. Battlegrounds usually have restrictions on digging and uprooting, since artifacts might be exposed and their *in situ* significance destroyed. In such a case, soil disturbance during treatment would not allowed. Other local restrictions may also apply. In all these cases, planning is needed to either gain special dispensation or invest added time in the control work. Recommendations:

- Consider special native species, habitat, and geography for early treatments: presence of rare, threatened, endangered or state listed species, or its habitat; recent site disturbances where exotic plants are likely to invade; riparian zones, wetlands, and streams; cultural resources at risk; and vectoring areas where invasives can be inadvertently transported by people, wildlife, and winds.
- Incorporate local restrictions that impact the means and timing of treatments: wilderness restrictions, archaeological resource protection restrictions, and historic landscape and plantings restrictions.

Create an operationally sound approach

By this point, a subset of the most invasive plants has been gathered from the dozens of exotics present. The individuals in the subset have been ranked for their relative invasiveness and potential for control. Native species and geographical areas requiring priority treatment have been identified, and restrictive concerns have been noted. The final step in the prioritization process is to meld these considerations into an operationally feasible whole. It is the most tactical of the steps. Operational efficiency must be considered. In the end, program success comes from the rapid accumulation of restoration success, one site after another.

Consider the following criteria during the melding process. They are listed in their order of importance.

- Protect listed native species before considerations of general invasive plant control.
- Control the highly ranked invasives before those of lesser threat and control potential.
- Treat new and small infestations before larger, older ones.
- Consider delaying treatment in areas where policy restrictions are in force.
- When possible, once in an area to treat a given invasive species, treat all invasives in the area.

The considerations above focus on biological and cultural need as well as programmatical efficiency. It cannot be overemphasized that funding agencies must be shown results for the trust and funding they provide. Early on in the life of a program, one must show evidence of a series of rapid successes. It is organizational death to tackle huge sites that cannot speedily be brought under control. Recommendations:

- Create a plan that can accomplish a series of rapid successes.

Figure 3. Often ignored, Japanese stiltgrass takes over after control of other exotic plants.

- Don't treat one highly invasive species but leave moderately invasive species behind to take over (Figure 3).
- Aim for full restoration of native species and ecosystem function.

Get organized in your war against invasive exotics. Create a ranked priority system that helps you remember where you are headed in the midst of battle. Aim for early successes that you can document to prove the value of your program and gain added support. Never underestimate the psychological benefits of successes for building momentum and support.

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An Assessment of White-tailed Deer *(Odocoileus virginianus)* and Feral Hog *(Sus scrofa)* Populations at Big Thicket National Preserve, Texas

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Introduction

Big Thicket National Preserve, composed of roughly 86,000 ha, is the first national preserve established by Congress and was set aside in 1974 primarily to protect its biological diversity as opposed to its scenic or recreational resources (NPS 1996). The preserve's enabling legislation, however, also mandates that recreational hunting be permitted within its boundaries (NPS 1996). Hunting within the preserve (Figure 1) is permitted within the Big Sandy Creek, Beech Creek, Lance Rosier, Beaumont, Jack Gore Baygall, and Neches Bottom units. Hunting activity in the preserve is regulated via a permit system administrated by park staff. Each unit is allotted a specific number of permits according to sustainable game-harvest population estimates determined by the preserve's resource managers. An evaluation of the efficacy of current management guidelines for the hunting program is done every five years. The number of permits given for particular units, and maximum allowable harvest rates for game species, is revised continually upon analysis of short- and long-term harvest rate trend information gathered from hunter survey cards (Chavarria et al 2004). The information gathered from these surveys also serves as a means of projecting population trends of game species and their potential impacts to resources in the national preserve. An updated assessment, conducted in 2004, of the population trends of two large game species in the preserve—the white-tailed deer *(Odocoileus virginianus)* and feral hog *(Sus scrofa)*—was an important component to continuing the sound management of resources in the national preserve.

Methods

Harvest survey cards submitted by individual hunters report the number of animals harvested and the number of trips each hunter made to a particular unit. This information is used to calculate harvest effort—a measure of the number of animals harvested per unit of hunter trips. Harvest effort can be used as an index to population abundance and trends (Caughley and Sinclair 1994). From hunter card survey data, we determined hunter effort (number game harvested/100 trips) by species, unit, and period for the preserve (Chavarria et al. 2004). Due to breaks in the sequence of data for some units and years, we categorized data approximately into five-year periods: 1980–1984, 1985–1989, 1990–1994, 1995–1999, and 2000–2003. Periods will be referred to by the first year of data collected (e.g., 1980 = 1980–1984, etc.). Annual estimates were averaged by period. When hunter

Figure 1. Management units of Big Thicket National Preserve, 2004.

effort is standardized, these indices can be used to compare relative differences in abundances between areas, provided that a few basic assumptions are met (Caughley 1977). One critical assumption in use of this index is that the number of hunters has not changed significantly over the 23-year period of interest. A review of the average number of permits issued and average number of hunters for each unit supports this assumption. Changes in hunter effort between periods, therefore, would track changes in population abundance (Caughley 1977; Caughley and Sinclair 1994).

Results

Hunting program trends. Since 1981, the number of permits issued for all six management units has been fairly consistent. The hunter card survey return rate is high (>59%).

Harvest trends. Harvest rates for white-tailed deer have increased slightly over the past 20 years (Figure 2). Harvest effort for white-tailed deer appears to be relatively stable in recent years, suggesting that the deer population is stable under current harvest rates (Chavarria et al. 2004). Harvest rates have increased dramatically, by nearly three-fold, for feral hogs over the past twenty years (F=20.96, P<0.001) (Figure 3). Increased observations of feral hog numbers in the preserve support the premise that population numbers have increased. Feral hog population numbers have increased generally in all the units where hunting is permitted. Future management of feral hog populations will likely be necessary to reduce impacts of the species on native wildlife and vegetation.

In comparing harvest effort among periods and units, we found differences in effort for white-tailed deer for units (F=10.26, P<0.001) and periods (F=5.16, P=0.005). Harvest effort in the Beech Creek unit was lower than that in the Neches Bottom unit; all others were similar. Harvest effort for white-tailed deer was lower in Period 1980 but similar in all other periods (Figure 2). The population growth rate for white-tailed deer has slightly declined, but remained relatively stable over the past 20 years (Figure 4). The population growth rate for feral hogs has consistently increased (r>0) over the past 20 years (Figure 4).

Management implications

Manage health of vegetative communities. Several rare and federally listed endangered plants are found within the park boundaries, including bog coneflower *(Rudbeckia scabrifolia),* Navasota ladies-tresses *(Spiranthes parksii),* Texas trailing phlox *(Phlox nivalis* var. texensis), and white firewheel *(Gaillardia aestevalis* var. winkleri) (NPS 1996). The preserve must manage for protecting these species and other native vegetation from excessive

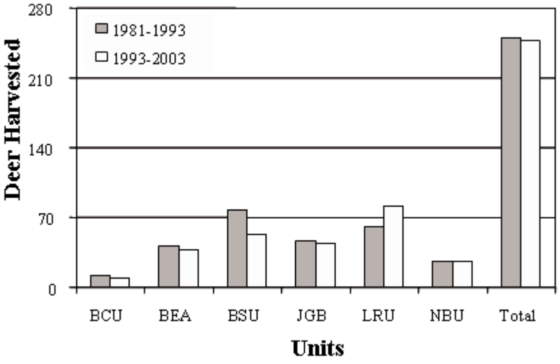

Figure 2. Harvest rates of white-tailed deer in Big Thicket National Preserve, 1981–2003..

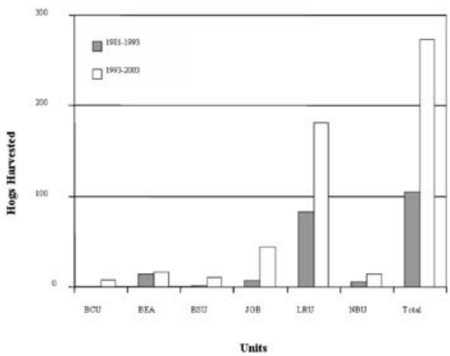

Figure 3. Harvest rates of feral hogs in Big Thicket National Preserve, 1981–2003.

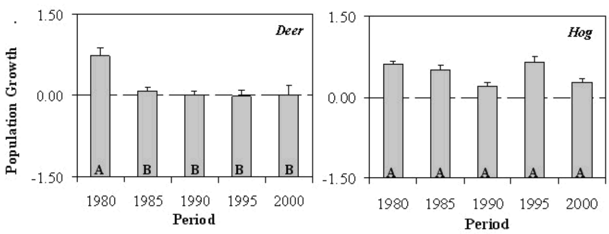

Figure 4. Projected population trends (exponential rate of increase, *r)* for white-tailed deer and feral hogs calculated from 1981–2003 harvest data, Big Thicket National Preserve.

herbivory associated with native or exotic fauna. Current trends of abundance and rates of population growth of feral hogs in the preserve pose an increased threat to the health of native vegetation in the preserve.

Protect native wildlife populations. The preserve is responsible for maintaining healthy and stable populations of its native wildlife. This is particularly important to species directly affected by legalized sport hunting within the preserve, such as rabbits, squirrels, and white-tailed deer. The assessment of harvest rates from the past 20 years indicates that the preserve has adequately managed stable populations of white-tailed deer, but the increase in the number of feral hogs may pose a competitive threat to other wildlife in the preserve that overlap in resource utilization.

Control exotic wildlife, reduce associated impacts. The Texas Animal Damage Control Service notes that if the feral hog is not properly managed, it has the potential of causing extensive damage (Figure 5) to native wildlife, habitat, and agricultural resources (Beach 1993). Miller (1993:12) describes the many forms of damage caused by feral hogs as "rooting and feeding on forest regeneration sites, row crop and pasture lands and food plots or plantings for wildlife; damage to ponds, tanks, springs and water holes; damage to wild ecosystems and threats to biodiversity; competition with other preferred wildlife species, [both] game and non-game; predation on other wildlife and domestic animals; and, disease threats to domestic livestock and humans." Revision of current management practices for controlling feral hogs at Big Thicket National Preserve will be necessary to reduce their associated impacts to native flora and fauna—especially those which are listed as threatened and/or endangered by state or federal authorities.

Figure 5. Wallowing and rooting damage to soils and native vegetation associated with increased feral hog abundances in Big Thicket National Preserve, 2004.

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Controlling Pests, Preserving History, and Using Video as an Integrated Pest Management Information Tool

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This presentation showcases a project funded by the National Park Service Rocky Mountains Cooperative Ecosystem Studies Unit (NPS-RM-CESU). The project, which was carried out by Grant-Kohrs Ranch National Historic Site working in cooperation with Montana State University, resulted in an integrated pest management (IPM) plan for the historic furnishings and collections of the national historic site. Also as part of this project, a smaller, local museum received an introduction to the concept of IPM and specific recommendations during an on-site visit by project members. An additional product was an education video on IPM that was distributed to small museums throughout Montana and Wyoming. Following is a brief description of the project including a discussion of the added values of working with a university on this sort of technical assistance.

Grant-Kohrs Ranch National Historic Site, often referred to as the "nation's ranch," is in Deer Lodge, Montana, midway between Glacier and Yellowstone National Parks. It was established by Congress in 1972 to provide an understanding of the frontier cattle era, preserve the ranch itself, and interpret its nationally significant values for this and future generations. This site's ranching history began when Johnny Grant established the ranch in 1862. Grant traded cattle with westward-bound immigrants. He gave one healthy animal in exchange for two or more trail-worn ones, which he fattened and healed up over winter, and traded one for another couple the next summer. Grant's tenure at the ranch, however, was relatively short-lived. Unhappy with what the Gold Rush was doing to Montana, Grant sold out to Conrad Kohrs after just five years, and returned to his original home in Canada. Kohrs, a German immigrant, arrived during the Gold Rush and owned several butcher shops in the various mining camps of southwest Montana. He bought the ranch in 1867 to supply the beef for his shops. Mining played out, but the East was desperate for cattle after its ability to produce beef was destroyed in the Civil War. The open range, where animals roamed year-around on unfenced public lands at no charge, allowed huge profits to be made. Kohrs became the recognized cattle baron of Montana—grazing over 10 million acres and selling up to 10,000 steers a year at the Chicago Stockyards. Eventually, his grandson and namesake, Conrad Kohrs Warren, took over the home ranch. A significant rancher in his own right, Warren and his wife preserved the family ranch and made it available for purchase by the National Park Service (NPS) in 1972.

Back in the 1970s, Congress was enchanted by the idea of living history, and clearly indicated that this new historic site was to be a working cattle ranch, incorporating living history as the best way to tell the story of ranching. Today, the 1,500-acre ranch hosts around 50 head of cattle. Most ranching chores are done through modern practices with numerous demonstrations on historic haying, branding, blacksmithing, and other ranch activities.

As curator, I am charged with the care of collections made up of 27,000 objects and 75 linear feet of historic archives. They represent the entire time line of the Grant-Kohrs Ranch as well as the many functions of a family and ranch. Objects include textiles from wedding dresses to horse blankets and equipment from wagons to butter churns. The archives date from Kohrs' 1860s butcher shop account books up to the day his grandson died in 1993—over 120 years of ranch and family records. Around 90% of the collection is original to the ranch. With no visitor center or formal exhibit areas, 90% of the collection is in storage. Just three years ago a state-of-the-art storage facility was constructed for its long-term care.

About 10% of the collection is on exhibit. Most items are displayed in an authentic representation of the turn-of-the century family mansion or 1930s bunkhouse. Other exhibits include the tack room and blacksmith shop of the 1930s and a display of horse-drawn wagons and equipment. It is in these permanent exhibits areas in historic structures where perpetual pest problems exist—the reason for this project.

Grant-Kohrs Ranch was using an IPM approach in controlling unwanted guests in the museum. However, the existing plan was drafted in large part by authors with background in collection management and without benefit of expertise in science and entomology. Even after the Grant-Kohrs Ranch staff's best efforts at an IPM approach, cluster flies remained a significant problem, coming into the house by the tens of thousands each fall. These flies breed in the turf outside and, on that first cool day, try to get inside where it is warm. As soon as they are inside, they go toward a source of light to escape. The impact to cultural resources was considerable, particularly fly specks on turn-of-the-century wallpaper. The other persistent problem was dermestid beetles whose larva liked to graze on the 19th-century wool carpets. Damage to carpet took place over the years, mostly before it was under NPS care. However, monitoring showed dermestid larva were continually active and still feasted on the wool fibers.

During this time, I also was learning about the NPS-RM-CESU. One of its goals was to coordinate research, education, and technical assistance projects among member agencies and academic institutions. NPS-RM-CESU was somewhat unique among fellow CESUs in that it provided funding for projects. I also learned that the NPS-RM-CESU was interested in opening up its doors to projects with a cultural resource component.

I also happened to know that the Montana State University–State Extension Office entomologist, Will Lanier, had a background in museum IPM plans. He seemed the perfect individual to look at our stubborn pest problems. After we contacted with Lanier, he proceeded to take the project idea to a whole new level.

First, Lanier asked if there was another small, local museum that could also benefit from an on-site visit when he came to see Grant-Kohrs Ranch—getting more "bang for the buck" for his time and expenses. The Powell County Museum and Arts Foundation, just a mile from the Grant-Kohrs Ranch, fit the bill. It is a small, nonprofit organization with few or no professionally trained museum staff. The organization has several small museum components, the major one being the state's territorial and then state prison, which was in use until the early 1980s. They were contacted and very interested in getting some help with their pest problems, particularly pigeons.

Lanier also thought we could reach a very wide audience if we produced a training video for museums, using Grant-Kohrs Ranch as a real-life case study. Montana has over 200 museums, with the vast majority run by all-volunteer staff or perhaps one paid employee with no museum training. To make this happen, the entomologist offered to use his salary as a match for the grant, freeing up money for video production.

Montana State University had recently created a new one-of-a-kind degree program—a Master of Fine Arts, Science, and Natural History Filmmaking—that seemed a perfect fit for the training video. Working with the Montana State University graduate film school on various projects, the project entomologist knew of a recent graduate who might be interested in the project. Zach Gildersleeve had recently graduated with honors and, with a fellow graduate, formed the Aver Ingenuity film company. Gildersleeve helped us work up a budget that was within the funding limits of the potential NPS-RM-CESU grant.

The grant request emphasized the natural, cultural, and educational components of the project. The high percentage of match from Montana State University also showed a high level of partnership commitment. Coordinators at NPS-RM-CESU reviewed the grant and their recommendations were incorporated before the final submittal.

Grant-Kohrs Ranch received the grant. The project was formalized through a basic NPS-RM-CESU task agreement and scope of work. They included more details than required—responsibilities, budget, time line, products, and formats—to avoid confusion and discrepancies. Material associated with the project—video footage, files, photographs, etc.—were sent to Grant-Kohrs Ranch at the conclusion of the project for park archives. The NPS retained full copyright of the training video. With these agreements in place, the project began.

Use of modern technology saved travel money and helped meet deadlines. Video conferencing was available at the local courthouse and allowed same-time interaction in reviewing outlines and story boards. Microsoft PowerPoint was used as the storyboard format. Versions were traded back and forth through email or, if large, uploaded to the Extensive Service web site.

Since the ranch staff had never been involved in production of a film or video, Gildersleeve guided the process. A fairly detailed script was written and matched to slides in PowerPoint. This script and story board were reviewed many times to produce a somewhat final format. Gildersleeve then produced a "shot list" of images that he would need to video once on site. We reviewed the list and brainstormed where these images could be shot. With the "shot list" in hand, Gildersleeve was able to do all the filming at Grant-Kohrs Ranch in a day. The next step was a Microsoft Word table matching up the actual text with the video image. Gildersleeve was invaluable at this point in condensing previous versions down to a script that was within the budget and scope of the project. Also, if the script made sense to him—someone without an insect or museum background—then it probably would make sense to our target audience. A VCR tape was produced, reviewed, and resulted in the final educational training DVD.

Grant-Kohrs Ranch received very specific recommendations on the revised museum IPM plan—the original goal of the project. Perhaps the most important suggestion was the use of degree-days to determine pest management and control actions. The existing museum IPM plan had extensive schedules for pest management activities, all based in the calendar. However, insects do not seem to pay much attention to the calendar, but they do respond to changes in weather. Now pest management activities are based on pest activity, as predicted by watching degree-days. A web site helps determine the degree-days, based on several weather factors gathered from local weather stations.

A common goal Lanier has when reviewing a museum's pest management plan is finding ways to spend the same amount of resources on pest management but targeting it on the most important activities. At Grant-Kohrs Ranch, monitoring traps consistently caught around the same number and types of pests, religiously recorded in the computer database. Lanier suggested that instead of documenting the same data over and over, the park should use that time and money for an activity that provided better prevention or control. Among the creative time-saving methods that we looked at was taking digital images of pest traps and recording the catches directly into the computer database, cutting out the hard-copy stage.

It was determined the site's dermestid beetle problem was tied closely to the huge number of flies that get into the structures and eventually die, providing a ready and plentiful food source for larva. Controlling flies would largely control the dermestid larva. Monitoring and staff observations showed flies were particularly bad on the south brick wall of the main ranch house. Even after maintenance work on these windows, flies could get through. With resources saved from more efficient monitoring, the park could afford a targeted application of low-toxicity chemicals around the windows and doors on the wall, timed just before a particular degree-day level was reached.

Another low-tech fly control method was incorporated into the IPM plan: the use of light. Flies will go toward a source of light and buzz around until their very limited amount of energy is exhausted and they die. Lanier designed a light mounted on a stand (also available in hardware stores) near but not in a collection area. It sits on top of newspapers where flies fall, making clean-up easy.

As planned, the Powell County Museum and Arts Foundation also was introduced to the concept of IPM. Prior to his visit, Lanier had them make a floor plan. This floor plan was a tool to show the optimum trap locations (besides being handy for future planning projects). An on-site visit, done the same day as the video shoot at Grant-Kohrs Ranch, helped the museum determine a few specific actions to control their pest problems.

At the end of the project, the budget allowed Gildersleeve to produce over 100 copies of the training video. These have been informally distributed around the state to museums and to cultural resource staff in NPS. The Extension Service is working on a formal distribution process to all Montana county extension agents. Finally, an on-line version was produced and now appears on the Montana State University Extension Service web site.

What started as one person's wish to get an entomologist's opinion on Grant-Kohrs Ranch's persistent pest problems ended up meeting a grander goal—having the greatest possible number of people benefit from our modest budget.

As with most projects, there were lessons learned along with some unplanned benefits. It was satisfying to see the network of partnerships that developed. NPS-RM-CESU provided a format for an NPS historic site, a state university, and a young professional to work together to produce an educational product for a very wide audience and meet the specific needs of pest management at Grant-Kohrs Ranch.

The diversity of people and their backgrounds benefited the project. For example, Lanier had worked only with a large, well-funded university museum with resources to implement a sophisticated museum IPM program. However, as a board member of the Museums Association of Montana, I knew that the vast majority of our collecting institutions had no such resources. The final training video reflects an effort to make the process as efficient and low-cost as possible.

The 100 copies of the training video were produced in a DVD format. This proved to be too advanced a technology for most of our audiences. At best, museum staff could take it home if they happened to own a DVD player. The majority of copies should have been in a VCR or CD format for easy viewing in the museums.

Finally, the CESU agreement is very easy to use. Formal contract and bidding process has already taken place. CESU coordinators help locate university programs and staff that fit the project. The university overhead charge is a modest 17.5%, allowing the majority of the funds to go directly to the project. The required task agreement and scope of work are basic and simple to complete. Perhaps the success of this project will encourage other CESU member agencies and universities to take advantage of this service.

Regional Integrated Management of Imported Fire Ants (*Solenopsis* spp.) along the Natchez Trace Parkway

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Introduction

The imported fire ants *(Solenopsis invicta* Buren, *S. richteri* Forel, and their hybrid; hereafter collectively referred to as *fire ants)* are myrmicine species that are native to South America but have been accidentally introduced to the United States, Australia (McCubbin and Weiner 2002), Taiwan, Hong Kong, and mainland China. In the U.S., the black imported fire ant (BIFA), *S. richteri*, was introduced into southern Alabama around 1918, followed by the red imported fire ant (RIFA), *S. invicta*, in the late 1930s (Lofgren 1986). The BIFA is now restricted to northeast Mississippi, northwest Alabama, and south-central Tennessee (Shoemaker et al. 1994). The RIFA occurs throughout the southeast from coastal North Carolina west to central Texas, with additional infestations in New Mexico and California (Figure 1). A zone of hybridization exists through central Mississippi, Alabama, and Georgia.

Fire ants create a number of serious problems for humans and wildlife. Some negative impacts of fire ants were reviewed by Vinson (1997), including adverse affects on human recreation. These stinging ants can occur in densities of more than 600 mounds per hectare (Vogt et al. 2003) and rapidly recruit to food and moisture sources, disrupting outdoor activities. Additionally, fire ant stings can result in anaphylaxis in at least 1% of reported cases (deShazo et al. 1990, 1999; deShazo and Williams 1995). Fire ants can have negative impacts on native ants and other arthropods (Vinson 1994; Jusino-Atresino and Phillips 1994; Wojcik 1994), and overall biodiversity (reviewed by Wojcik et al. 2001). In another study, Morrison (2002) demonstrated that arthropod diversity in one area recovered to pre-invasion levels twelve years after fire ant establishment but fire ants had become the domi-

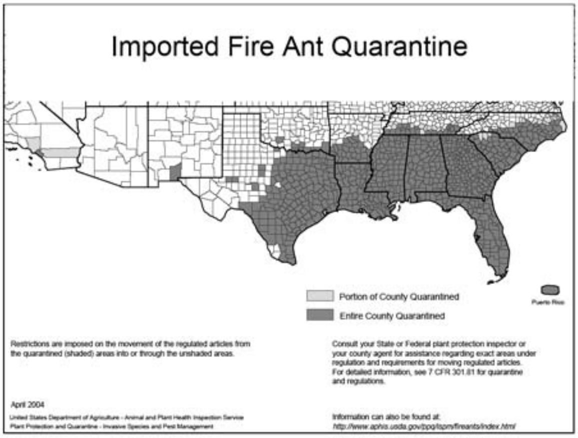

Figure 1. Imported fire ant quarantine areas in the United States.

nant ant species. While fire ant impacts on vertebrate wildlife are difficult to quantify, considerable evidence points to population-level impacts of fire ants on various mammals, birds, and herpetofauna (reviewed by Allen et al. 2004). Fire ants cause direct economic damage by piling soil and debris into areas such as telephone relays, electronic junction boxes, and air conditioning units, and their tunneling activities can even damage paved roads (Banks et al. 1990).

The U.S. Department of Agriculture–Agricultural Research Service (USDA–ARS) is partnering with various state and federal agencies to develop and implement integrated pest management (IPM) strategies for long-term suppression of imported fire ants. The ARS Biological Control of Pests Research Unit (BCPRU) based in Stoneville, Mississippi, is leading a regional integrated management program targeting imported fire ants along the Natchez Trace Parkway. This paper is intended to provide an overview of the rationale for this program, the various components of the program, and the expected outcomes.

Rationale

The Natchez Trace Parkway (NTP) is some 444 miles long and serves to commemorate an ancient trail that at one time connected southern portions of the Mississippi River with salt lick areas in what is now central Tennessee. The park, established in 1938, encompasses nearly 52,000 acres which include the roadway, a right-of-way of variable width, and various byway exhibits, historical sites, and campgrounds. Fire ant mounds have become characteristic features of the NTP viewscape, creating unsightly bare spots (Figure 2) and possibly threatening the health of trees when constructed at their base (Vogt, unpublished data). Mounds also occur in close proximity to the road bed, potentially harming the parkway itself.

For several reasons, the NTP is ideal for a regional integrated management program targeted against fire ants. Stretching from Natchez, Mississippi, to Nashville, Tennessee, the NTP represents an existing north–south transect along which populations of red, hybrid, and black imported fire ants exist (Figure 3). This is important, as apparent and potential differences between red and black fire ant populations may affect the efficacy of control measures (Vogt et al. 2003). Portions of the NTP lie within three separate states (Mississippi, Alabama, and Tennessee), maximizing the potential for collaborative efforts. Numerous habitat types exist along the NTP, each of which may require a different approach to fire ant control. Finally, the NTP offers unique educational opportunities, particularly the potential

Figure 2. A fire ant mound. This mound is approximately 70 cm wide and 30 cm tall.

for educational posters at the various byway exhibits and campgrounds.

Regional integrated management programs offer unique opportunities for research, collaboration, implementation, and technology transfer of meaningful solutions targeted toward specific end-users. Researchers working on related projects in the same area have the opportunity to share data and maximize results. Enhanced collaborative efforts make it possible to pool resources and expertise. Implementation on a regional basis can maximize impact and visibility.

Program Components

Several collaborators are working with the BCPRU on different components of this program. These include Mississippi State University, Department of Entomology and Plant Pathology; USDA–Animal and Plant Health Inspection Service; Alabama A&M University, Department of Plant and Soil Science; Tennessee State University, Otis Floyd Nursery Research Center; and Tennessee Department of Agriculture. The various research projects being pursued along the NTP fall within three broad categories: (1) biological control of imported fire ants, (2) preservation of native ant species, and (3) enhanced monitoring methods for imported fire ants

Biological control of imported fire ants. Several species of phorid flies (Diptera: Phoridae) are parasitoids of ants. Phorids in the genus *Pseudacteon* parasitize *Solenopsis* spp. fire ants, and three species have been approved for release in the U.S. *(P. curvatus* Borgmeier, *P. tricuspis* Borgmeier, and *P. litoralis* Borgmeier). These tiny flies lay a single egg in a fire ant worker. When the larva hatches, it migrates to the head of the ant and eventually consumes the contents, causing the head to fall off; thus the common name "decapitating flies." The flies disrupt fire ant foraging and other activities, and their establishment and spread in the U.S. as classical biological control agents may help tip the ecological balance more in favor

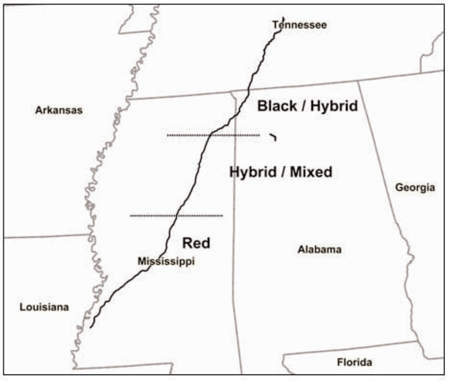

Figure 3. Approximate distribution of red, hybrid, and black imported fire ants along the Natchez Trace Parkway (line from southwest Mississippi to central Tennessee).

of native ants (Porter et al. 1997). Of the three species listed above, *P. curvatus* has been established along the NTP, releases of *P. tricuspis* are ongoing, and releases of *P. litoralis* are in the planning stage. Ongoing research includes periodic sampling of release and control sites in an attempt to determine population-level effects of phorids.

A microsporidian disease of fire ants, *Thelohania solenopsae* Knell, Allen and Hazard (Microsporidia: Thelohaniidae), was first discovered in the U.S. in the late 1990s (Williams et al. 1998). Efforts along the NTP include a survey (nearing completion) of disease incidence, intermediate host determination, and disease augmentation. In another project, fire ant populations are being surveyed for additional pathogens such as bacteria and fungi that might be useful in augmentative releases or for formulation as commercial products.

Preservation of native ant species. Researchers with the Mississippi Entomological Museum are conducting a thorough survey of the ant fauna along the NTP, which will provide baseline data for the regional program; this survey has already resulted in several species being identified as new state records (R. L. Brown, personal communications). Several projects along the NTP are designed to minimize impact of fire ant control measures on population densities of native ant species. Bait application timing and placement could potentially be altered to minimize bait retrieval by native ants. Some native ants that occur along the NTP greatly slow or cease foraging at night (Vogt et al. 2004); however, in one trial, mid-day and late-evening bait applications had similar negative effects on native ants (Vogt et al. 2005). Experiments with different bait timing regimes are ongoing. Additional research involving bait placement is ongoing.

Current bait products are generally effective against fire ants, but are not species-specific and are susceptible to degradation from weather extremes. Methods are being developed for making current and new bait formulations more species-specific and weather resistant. Promising bait formulations that appear to be more attractive to fire ants and less attractive to native ants will be field tested in the near future. In a related project, potential fire ant repellents are being tested and developed; these would be useful for excluding fire ants from sensitive areas such as electrical junction boxes and telephone relays. This work has already resulted in a new, more efficient bioassay to determine repellency of compounds (Chen 2005).

Enhanced monitoring methods for imported fire ants. In an effort to reduce costs associated with sampling fire ants on the ground and enhance the capability to make management decisions on a regional scale, BCPRU researchers are developing remote sensing technologies for quantifying fire ant mounds. Fire ant mounds have several unique characteristics that make them suitable targets for some sensor types, including shape, texture, topography, temperature, and vigorous vegetation growing at their periphery. Multispectral (Vogt 2004) and thermal aerial imagery are being tested and developed as tools to quantify fire ant mounds. Data will be used to study landscape effects on fire ant populations, and establish risk assessment criteria to predict fire ant population densities.

Researchers with Mississippi State University are conducting extensive ground surveys to characterize landscape effects on fire ant populations, specifically in forested and transitional habitats. These data will contribute to our ability to predict problem areas and will have implications for bait and pesticide placement. This aspect of the program will also contribute to our knowledge of interactions between fire ants and native ants in habitat types that are under-represented in the fire ant literature.

Expected outcomes

The regional integrated management program for fire ants along the NTP is expected to produce useful data to further our knowledge of fire ant biology and ecology, and new technologies for managing imported fire ants. New control methodologies will be widely applicable beyond the NTP, while new data on native ant distribution will assist the NTP in cataloguing natural resources, and educational efforts will directly influence park visitors.

Biological control efforts have already expanded the overall distribution of phorid flies in the U.S. and introduction of additional phorid species along the NTP may provide a sustainable reduction in fire ant population densities. Similarly, augmentation of microsporidia that infect fire ant colonies may contribute to long-term decline in population densities. Research on infection rates along the NTP may shed light on differences between red, black, and hybrid imported fire ants.

New bait technologies involving improved products and application methods will be useful for preserving native ant species; this aspect of the program is particularly relevant to our national parks but will be useful throughout the range of fire ants. Finally, more efficient monitoring methods, including remote sensing technologies, will reduce the costs associated with sampling fire ant mounds over large areas, give researchers new tools for evaluating the effects of biological control agents on fire ant populations, and provide the necessary information for making management decisions on a regional scale.

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Riparian System Recovery after Removal of Livestock from Santa Rosa Island, Channel Islands National Park, California

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Introduction

In 1995, the California Central Coast Regional Water Quality Board, through a Cleanup and Abatement order, directed Channel Islands National Park to correct cattle grazing and road-related water quality problems on Santa Rosa Island. The order alleged that the park, by permitting improper road and riparian grazing management practices, was discharging unlawful concentrations of bacteria and sediment into waters of the state in violation of the regional water quality control plan for the Central Coast Basin.

As part of its effort to address the state's concerns, the park required a rapid evaluation of riparian-area conditions on Santa Rosa Island and an assessment of whether modifications to the existing livestock grazing management scheme could be used to meet water quality goals. An interdisciplinary team composed of personnel from the park, the National Park Service (NPS) Water Resources Division (WRD), the U.S. Forest Service, and the Bureau of Land Management (BLM) completed the field portion of that assessment during the week of March 20, 1995. The 1995 team's findings and recommendations for improved grazing management were published in a report titled *Federal Interagency Riparian Assessment and Recommendations for Achieving Water Quality Management Goals—Santa Rosa Island, Channel Islands National Park* (Rosenlieb et al. 1995).

Of the seven stream reaches that were subject to year-round cattle grazing, six were rated as "nonfunctional" and one was rated "functional–at risk." Of the three reference reaches, two were in "proper functioning condition" (PFC) and one was rated "functional–at risk." The authors concluded that Santa Rosa Island's degraded riparian areas had a very good chance of recovering if livestock management changed from year-round continuous grazing in most of the pastures to management that allowed for multi-year, or at least seasonal, rests from grazing. To that end, the report offered several alternative grazing strategies for consideration.

In 1998 the NPS, under a settlement agreement pursuant to a lawsuit regarding ungulate management on Santa Rosa Island, eliminated cattle from the island. Between 1998 and 2000, the NPS reduced the deer population by one-quarter and slightly reduced the elk population. Since these management changes, park employees have observed dramatic improvements in riparian vegetation cover and water quality. In 2004, the park requested technical assistance from WRD to perform a post-grazing reassessment of Santa Rosa Island riparian areas. The idea was to apply the same techniques (PFC assessments and repeat photography) on the same stream reaches that were evaluated in 1995 to document vegetative and geomorphic changes in the six years since cattle were removed. Specifically, we wanted to see if riparian areas that were rated as "nonfunctional" or "functional–at risk" in 1995 had recovered to PFC simply by removing livestock, or if additional management steps are necessary to promote such recovery.

Methods

Based on a review of available methods for evaluating riparian functional condition, the 1995 team chose to apply the BLM's PFC method for the Santa Rosa Island riparian assessments. We decided that the most appropriate way to reassess riparian areas in 2004 was to have a comparable team of subject-matter experts (vegetation ecology, fluvial geomorphology, hydrology, riparian–wetland science) re-apply the same methods at the same sites and compare the results. Updated documentation for the PFC method can be found in *A User Guide to Assessing Proper Functioning Condition and the Supporting Science for Lotic Areas* (BLM 1998).

The PFC technique uses an interdisciplinary team to assess the "functional condition" of riparian systems according to 17 hydrology, vegetation, and stream geomorphology factors. The "proper functioning condition" of a riparian area refers to the stability of the physical system, which in turn is dictated by the interaction of geology, soil, water, and vegetation. A properly functioning riparian area is in dynamic equilibrium with its streamflow forces and channel processes. The channel adjusts in slope and form to handle larger runoff events with limited perturbation of channel characteristics and associated riparian–wetland plant communities. Because of this stability, properly functioning riparian areas can maintain fish and wildlife habitat, water quality enhancement, and other important ecosystem functions even after larger storms. In contrast, nonfunctional systems subjected to the same storms might exhibit excessive erosion and sediment loading, loss of fish habitat, loss of associated wetland habitat, and so on.

Proper functioning condition does *not* refer to the seral stage or potential natural vegetation community of a riparian–wetland system. Rather, the evaluation is based on the concept that in order to manage for desired vegetation communities or habitat characteristics, the basic elements of a geomorphically stable system must first be in place and functioning properly. For example, riparian vegetation recovering from a recent fire may be in an early seral stage, and may even be missing an important component (e.g., woody vegetation was destroyed by the fire), but it may still be in proper functioning condition with respect to basic physical stability and the capacity to recover desired vegetation and habitat attributes over time.

Based on assessments of the 17 hydrologic, vegetative, and geomorphology elements of the riparian area, the interdisciplinary team assigns one of the following three functionality ratings to a site:

Proper functioning condition (PFC). Streams and associated riparian areas are functioning properly when adequate vegetation, landform, or large woody debris is present to:

- Dissipate stream energy associated with high water flows, thereby reducing erosion and improving water quality;
- Filter sediment, capture bedload, and aid floodplain development;
- Improve floodwater retention and groundwater recharge;
- Develop root masses that stabilize streambanks against cutting action;
- Develop diverse ponding and channel characteristics to provide habitat and the water depths, durations, temperature regimes, and substrates necessary for fish production, waterfowl breeding, and other uses; and
- Support greater biodiversity.

Functional–at risk. These riparian areas are in functional condition, but an existing soil, water, vegetation, or related attribute makes them susceptible to degradation. For example, a stream reach may exhibit attributes of a properly functioning riparian system, but it may be poised to suffer severe erosion during a large storm in the future due to likely migration of a headcut or increased runoff associated with recent urbanization in the watershed. When this rating is assigned to a stream reach, then its "trend" toward or away from PFC is assessed.

Nonfunctional. These are riparian areas that clearly are not providing adequate vegetation, landform, or large woody debris to dissipate stream energy associated with high flows, and thus are not reducing erosion, improving water quality, sustaining desirable channel and riparian habitat characteristics, and so on as described in the PFC definition. The absence of certain physical attributes such as a floodplain where one should exist is an indicator of nonfunctioning conditions.

The 2004 team further documented post-grazing riparian recovery by relocating 1995 photo points and taking new photos from the same locations. With the 1995 photos in hand, team members walked the assessment reaches and used visual clues to determine the locations and camera angles necessary to re-shoot the photos.

Results

Table 1 summarizes the results of the PFC analyses for the ten stream reaches surveyed in 1995 (year-round cattle grazing in most watersheds) and again in 2004 (six years after cattle were removed). The table shows that each of the six stream reaches that were rated "nonfunctional" in 1995 recovered to "proper functioning condition" after cattle were removed in 1998. The two Lobo Canyon reaches maintained their 1995 "proper functioning condition" ratings in 2004, although they showed remarkable improvements in the diversity, cover, and structure of native vegetation. Windmill Canyon (#1) and Acapulco Canyon (#7) are the only reaches that did not achieve "proper functioning condition" ratings in 2004. Both remain "functional–at risk." A full description of the 2004 survey findings is in a report published by the National Park Service (Wagner et al. 2004).

Of the stream reaches that recovered from "nonfunctional" to PFC, Arlington Canyon (Reach #5) had the most dramatic geomorphic and vegetative response (see repeat photography in Figure 1). The 1995 grazing-era photo shows a stream that is missing almost all of the components required for a properly functioning riparian system. An oversupply of sedi-

Stream reach (name and ID)	1995 PFC rating	2004 PFC rating
[1]Windmill Canyon (1)	functional–at risk (high)	functional–at risk (high)
[1]Lobo Canyon (2)	proper functioning condition	proper functioning condition
[1]Lobo Canyon (3)	proper functioning condition	proper functioning condition
Arlington Canyon (4)	nonfunctional	proper functioning condition
Arlington Canyon (5)	nonfunctional	proper functioning condition
Arlington Canyon (6)	nonfunctional	proper functioning condition
Acapulco Canyon (7)	functional–at risk	functional–at risk
Quemada Canyon (8)	nonfunctional	proper functioning condition
Old Ranch Canyon (9)	nonfunctional	proper functioning condition
Jolla Vieja Canyon (10)	nonfunctional	proper functioning condition

[1] *reference reach*

Table 1. Comparison of riparian condition assessment results from 1995 (year-round cattle grazing) and 2004 (six years after cattle were removed).

ment from upland and channel sources had exceeded the stream's transport capability, resulting in a mostly braided channel form, high lateral instability, high width-to-depth ratios, and other characteristics that were out of balance with the landscape setting. Riparian–wetland vegetation was absent, exposing banks to excessive erosion in each flood event. By 2004, this stream reach had recovered to a narrower, deeper, meandering channel with a well-developed floodplain and a gradient that is in balance with the landscape setting. Recovery of chaparral and riparian vegetation has apparently reduced excess runoff and erosion to the point where the stream is now in balance with the water and sediment being supplied by the watershed. Point bar development along the new meandering channel is one of the most striking geomorphic changes. For example, the large point bar at the center of the 2004 photo in Figure 1, which rises several feet above the current channel, did not exist in 1995.

Old Ranch Canyon (Reach #9) provides a second example of recovery from a "nonfunctional" condition during year-round grazing (1995) to PFC after removal of cattle and reductions in deer and elk populations (2004). The 1995 photo in Figure 2 shows the poor stream/riparian conditions that existed in 1995 (high width-to-depth ratios, unvegetated and eroding bars and channel banks, low sinuosity). By 2004, about 30% of this reach had developed narrower, meandering channel forms and well-vegetated channel banks and floodplains within the old incised channel. The rest of the reach recovered to a properly functioning system characterized by vegetated swales with nearly 100% cover within the older incised banks in most areas.

Figure 1. Arlington Canyon, 1995 (left) and 2004 (right). Recovery of vegetation, reduction of erosion, and point bar development between 1995 and 2004 resulted in a meandering stream channel in balance with the water and sediment being supplied by the watershed.

Figure 2. Old Ranch Canyon, 1995 (left) and 2004 (right). Cover and height of the native shrub coyote brush *(Baccharis pilularis)* increased considerably between 1995 and 2004.

Discussion and conclusions

The remarkable improvement in Santa Rosa Island's riparian conditions since 1995 demonstrates the ability of these systems to "self-restore" once the major stressor, year-round cattle grazing, was removed. The transitions from "nonfunctional" to PFC riparian systems became possible when vegetation recovery in the watersheds likely led to decreased runoff and sediment delivery to the island's stream systems and when appropriate bank-stabilizing and energy-dissipating vegetation became established in the riparian areas.

The PFC method proved to be a very useful tool for evaluating riparian system recovery on the island. However, we emphasize two points that are critical to a successful evaluation using this method: (1) the team must be carefully assembled to assure proper (and repeatable) application of the method, and (2) the team must understand that even though a riparian system may be in "proper functioning condition" with respect to geomorphic stability, it may not be on a trajectory toward a site's potential natural vegetation community or other desired vegetation condition.

Regarding the first point, the 1995 and 2004 PFC teams included subject-matter experts in all of the core assessment areas (vegetation ecology, fluvial geomorphology, hydrology, riparian–wetland science) who were also experienced in applying the PFC method. Although the PFC method is based on the BLM's well-established *quantitative* riparian assessment techniques (Leonard et al. 1992), team members must be able to draw on their experience with such methods to make rapid *qualitative* evaluations of the 17 checklist elements based on observations of field indicators. We were also careful to include local team members (Channel Islands National Park staff), who helped calibrate both teams' evaluations by clarifying land use history, identifying relic or "reference areas," providing local vegetation expertise, and so on. Three members of the 1995 team were included on the 2004 team, which helped promote consistency in application of the PFC method for the two assessments.

The second point is illustrated by the fact that even though stream reaches in Arlington, Quemada, Old Ranch, and Jolla Vieja Canyons recovered from "nonfunctional" in 1995 to PFC in 2004, the expected woody riparian components of these systems (willows and cottonwoods) have not become re-established. Therefore, in addition to reporting PFC functionality ratings, the team should also identify management actions that may be necessary to put functional systems on a trajectory toward desired future riparian–wetland vegetation conditions.

One reason for the absence of willows and cottonwoods on these reaches may be a lack of seed sources. Unlike many herbaceous wetland plants whose seeds can persist in soils for decades, cottonwood and willow seeds are very short-lived (1–2 weeks) and do not form seedbanks. Their wind-borne seeds are released in late spring, and in order to germinate and become established, they must fall on appropriate riparian substrates (bare, moist, mineral soils) during that short period of viability. The only remaining cottonwood stand on the island, found in Lobo Canyon, has not been observed to produce seed. These trees may be the result of vegetative reproduction from a single plant, either male or female. Many of the willows that remain on the island do produce seed, but they are mostly found in the uppermost reaches of the watersheds. Willow seed densities tend to drop off rapidly with distance from parent plants (Gage and Cooper 2003), so re-establishment may need to progress relatively slowly and incrementally down the canyons.

Herbivory by introduced deer and elk appears to be another important reason for the absence of willows and cottonwoods on most of the island's stream reaches. Though willow seedlings appear fairly often in some riparian areas, park staff report that these seedlings are consistently browsed away by ungulates in their first or second year. So, even if willow seeds do periodically find their way to appropriate riparian germination sites, we believe that deer and elk will continue to quickly and preferentially eat any seedlings that manage to get established.

Presence of willows, cottonwoods, and other woody riparian species may not be absolutely necessary in most of the drainages for channel bank and floodplain stabilization, but they would enhance such stability, help dissipate flood energy, trap sediment, and provide valuable wildlife habitat that would have likely occurred historically in the canyons.

Therefore, further reductions or elimination of introduced deer and elk and establishment of seed-bearing willows and cottonwoods at strategic locations may be necessary to promote a more complete recovery of riparian ecosystem structure and function on Santa Rosa Island.

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Partnerships and Protected Landscapes: New Conservation Strategies that Engage Communities

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Introduction

In North America, as in other regions of the world, conservation strategies are becoming more inclusive, recognizing multiple values, encompassing the interests of local communities and indigenous peoples, and relying on collaborative management approaches that involve diverse stakeholders. Community involvement and inclusive approaches to conservation are central to an emerging new paradigm for protected areas worldwide as summarized in Table 1.

Table 1. Contrasting protected area paradigms (from Phillips 2003).

Topic	As it was: protected areas were …	As it is becoming: protected areas are …
Objectives	• Set aside for conservation • Established mainly for spectacular wildlife and scenic protection • Managed mainly for visitors and tourists • Valued as wilderness • About protection	• Run also with social and economic objectives • Often set up for scientific, economic and cultural reasons • Managed with local people more in mind • Valued for the cultural importance of so-called wilderness • Also about restoration and rehabilitation
Governance	• Run by central government	• Run by many partners
Local people	• Planned and managed against people • Managed without regard to local opinions	• Run with, for, and in some cases by local people • Managed to meet the needs of local people
Wider context	• Developed separately • Managed as "islands"	• Planned as part of national, regional and international systems • Developed as "networks" (strictly protected areas, buffered and linked by green corridors)
Perceptions	• Viewed primarily as a national asset • Viewed only as a national concern	• Viewed also as a community asset • Viewed also as an international concern
Management techniques	• Managed reactively within short timescale • Managed in a technocratic way	• Managed adaptively in long-term perspective • Managed with political considerations
Finance	• Paid for by taxpayer	• Paid for from many sources
Management skills	• Managed by scientists and natural resource experts • Expert led	• Managed by multiskilled individuals • Drawing on local knowledge

This is particularly true for protected landscapes. Protected landscapes are protected areas based on the interactions of people and nature over time. Living examples of cultural heritage, these landscapes are rich in biological diversity and other natural values not in spite of but rather *because of the presence of people.* It follows that their future relies on sustaining people's relationship to the land and its resources. It is this complex mix of cultural and natural values, of tangible and intangible heritage, that makes protection of landscapes so vital, and at the same time so challenging. It requires an approach that is interdisciplinary, inclusive, and that engages people and communities.

This paper introduces the protected landscape approach and explores its application. Drawing from the book *The Protected Landscape Approach: Linking Nature, Culture and Community* (Brown et al. 2005), it provides brief descriptions of examples of protected landscapes from different regions of the world, including experience from North America.

The protected landscape approach

The *protected landscape approach* links conservation of nature and culture, and fosters stewardship by people living in the landscape. While grounded in experience with IUCN's category V protected landscapes/seascapes, this approach is broader than a single protected area category or designation. Rather, it relies on different tools and designations to achieve protection, and on an array of processes and traditional systems to sustain people's relationship to the land.

The protected landscape approach recognizes that the cultural and natural values of landscapes are inextricably linked, and embraces the central role of communities as stewards of these landscapes. It puts them at the heart of management of these protected areas, sharing in the benefits and responsibilities of conservation. It is an inclusive approach, relying on participatory processes and partnerships that link a diverse array of stakeholders in stewardship and sustainability.

Protected landscapes are often part of a mosaic of protection tools, and can help strengthen linkages between more strictly protected areas and the broader landscape. It is important to stress here that an approach that emphasizes lived-in landscapes should in no way be seen to reduce the importance of strictly protected areas. Rather it is a complementary model—one that is particularly appropriate in settings where biodiversity and cultural practices are linked, and where management must accommodate traditional uses, land ownership patterns, and the need to sustain local livelihoods. This is often the case when conservation objectives are to be met over a large area of land (often referred to as "landscape-scale" conservation). Protected landscapes can contribute to the viability of more strictly protected areas (such as national parks and nature reserves) by strengthening linkages within the broader landscape and connections among protected areas.

Central to the protected landscape approach is the idea of *stewardship*. In its broadest sense, stewardship refers to the essential role individuals and communities play in the careful management of our common natural and cultural wealth for now and future generations. More specifically, it can be defined as *efforts to create, nurture and enable responsibility in landowners and resource users to manage and protect land and its natural and cultural heritage* (Brown and Mitchell 1999).

The protected landscape approach engages local communities in stewardship of landscapes by reinforcing individual and community responsibility for resource management. It builds on existing institutional responsibilities; and encourages flexible arrangements for management of resources, including collaborative management agreements and the range of private land stewardship tools.

What are protected landscapes and seascapes?

Landscapes may be protected by a variety of designations and tools, including some that are not formally recognized within national or international protected area systems. Examples of three models are introduced briefly in Table 2.

Experience from diverse regions of the world

A growing body of experience worldwide illustrates how the protected landscape approach can work in very different settings, addressing a variety of conservation objectives and challenges. A few examples are presented briefly here.

Central Europe: sustaining landscapes in the White Carpathian Mountains (Czech Republic and Slovakia) and the Jizera Mountains (Czech Republic)

In the White Carpathian Mountains along the Czech–Slovak border (Figure 1), a category V protected landscape encompasses upland meadows, which have a great diversity of orchid species. The special traditional landscapes of this region largely survived land collectivization during socialism, because other agricultural land was more accessible. However, today they are threatened by abandonment. As people leave aside traditional practices such as haying, the upland meadows are threatened by encroachment of scrubby vegetation, which in turn threatens the region's rich biodiversity of orchids.

One way that the government protected landscape authority and other conservationists are working to slow this trend is to create partnerships with local landowners and help to support continued haying in these upland meadows, which in turn maintains biodiversity. Another partnership among nongovernmental organizations (NGOs), local government, and the protected landscape Authority supports the planting of old varieties of fruit trees. The partnership not only provides trees to the farmers, but has helped create a market for these products through the construction of a traditional fruit-drying facility and a juice plant to produce cider, which is marketed nationwide in the Czech Republic.

This case study and others from Central Europe, such as the Jizera Mountains Protected Landscape in northern Bohemia, Czech Republic, illustrate how engaging communities in stewardship can contribute to rural economic development, community revitalization, and fostering civil society in the post-Communist societies of the region. In the protected landscapes of these two mountainous regions an approach that reinforces local people's relationship to nature, supports their resources and traditions, and encourages sensitive management of the landscape can contribute to economic strengthening of rural areas. In both cases NGOs have played an important role in bringing new vision and innovation to traditionally conservative rural areas (Kundrata and Huskova 2005).

Table 2. Examples of designations and tools to protect landscapes/seascapes.

Category V protected landscapes/seascapes. A primary tool is through formal designation as a protected landscape/seascape, which is category V in the IUCN system of protected area management categories. According to the IUCN *Guidelines for Protected Areas Management Categories,* the definition of a category V protected landscape/seascape is "an area of land, with coast and sea as appropriate, where the interaction of people and nature over time has produced an area of distinct character with significant aesthetic, ecological and/or cultural value, and often with high biological diversity" (IUCN 1994). (For a comprehensive introduction to category V protected areas, and guidance for managing these areas, refer to Phillips 2002). The category V designation explicitly recognizes that safeguarding the integrity of this traditional interaction is vital to the protection and evolution of such areas, making category V protected landscapes both a designation and a p rocess aimed at sustaining people's relationship to the landscape.

World Heritage cultural landscapes. Since 1992 the World Heritage Convention, an international treaty, has recognized and protected cultural landscapes, which are selected based on the outstanding value of the interaction between people and their environment. The operational guidelines for convention define "cultural landscapes" as "illustrative of the evolution of human society and settlement over time, under the influence of the physical constraints and/or opportunities presented by their natural environment and of successive social, economic and cultural forces, both external and internal and as a diversity of manifestations of the interaction between humankind and its natural environment" (UNESCO 1996). Examples include the Rice Terraces of the Philippines Cordilleras; Uluru–Kata Tjuta, Australia; Ferto/Neusiedlersee, Hungary and Austria; and Qadisha Valley, Lebanon (see Lennon 2005; Phillips 2005; Rössler 2005; Villalon 2005).

Community-conserved areas (CCAs). One important way that indigenous and local communities conserve biological diversity in the landscapes they inhabit is through CCAs. These encompass the array of strategies that indigenous and local communities have been using for millennia to protect land and natural and cultural resources important to them. Long ignored by governments, and not included in the accounting of official protected areas, CCAs are now receiving growing attention in the protected areas field. These areas, which are found worldwide, can be defined as "modified and natural ecosystems, whether human-influenced or not, and which contain significant biodiversity values, ecological services, and cultural values, that are voluntarily conserved by communities, through customary laws and institutions" (Barrow and Pathak 2005). Examples include sacred groves, watersheds protected for communal water sources, coastal areas protected for fishing, traditional agricultural systems, and areas reserved for grazing and forage by pastoralist peoples. (For more on CCAs, see Jaireth and Smyth 2003; Barrow and Pathak 2005; Borrini-Feyerabend et al. 2005).

Figure 1. Meadows in the White Carpathian mountains (Czech and Slovak Republics) support rich biodiversity, particularly orchids. To maintain meadow ecosystems in the protected landscape area, NGOs are working with local farmers to continue traditional haying practices and reintroduce sheep grazing. Photo courtesy of Brent Mitchell.

Andean South America: a community-conserved area in Peru

Andean South America is a region rich in landscapes shaped by traditional land uses that have proven sustainable over centuries. Writing about Andean landscapes, Sarmiento et al. (2005) note that culture and nature are interlocked in a closely knit fabric where the resulting mosaics of land uses have provided diversity and stability to the ecology of mountain landscapes. Their case studies from Peru, Ecuador, and Colombia illustrate the role of indigenous communities and *colono* communities in sustaining landscapes. They argue that landscape conservation based on traditional knowledge, practices, and innovation systems is likely to have greater success in conserving the local landscape, while providing for livelihoods, than those that rely solely on conventional conservation approaches (Sarmiento et al. 2005).

An excellent example of this approach is found in the Sacred Valley of the Incas in Pisac, Peru, a landscape that, since Inca times, has been essentially agricultural in character. It is a recognized microcenter of origin for potatoes, with over 2,300 cultivars being grown. At the heart of this cultural landscape, six Quechua villages have come together to manage their communal land jointly and to sustain their traditional ways of farming. They have created *El Parque de la papa* ("the Potato Park") to protect the astonishing genetic diversity of the area (Figure 2). Working with the Quechua Aymara Association for Sustainable Livelihoods, a Cusco-based indigenous NGO (known by the acronym ANDES), the communities are using principles of integrated landscape conservation to manage this community-conserved area. Bordering areas of the park link the agricultural landscape with high-mountain native forests, grasslands, and wetlands that play an important role by hosting a rich variety of endemic

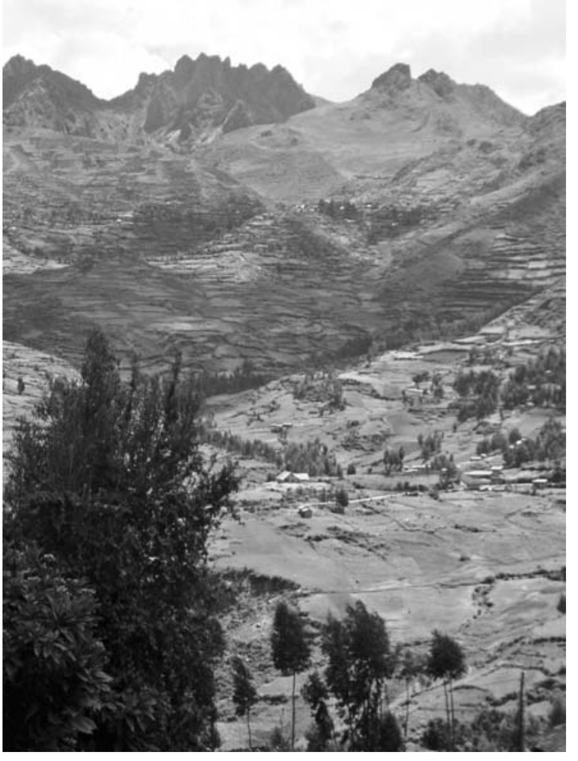

Figure 2. The Sacred Valley of the Incas (Peru), whose agricultural landscape was shaped by pre-Colombian Inca cultures, today is managed by Quechua communities who have created El Parque de la Papa, or Potato Park. The traditional patterns of land use that have created this cultural landscape contribute to biodiversity, support ecological processes, and have proven sustainable over centuries. Photo courtesy of Alejandro Argumedo.

plant and animal species. An important element of the project is to gather traditional knowledge about these practices and secure the intellectual property rights of the indigenous people (Sarmiento et al. 2005).

North American experience

There is growing recognition of the conservation values of lived-in landscapes in the United States and Canada, and a broadening of protected areas systems in both countries to include a greater diversity of sites and an array of management partnerships. Increasingly, the new areas being added under the auspices of the U.S. National Park Service (USNPS) encompass lived-in landscapes, whose management depends on partnerships (Brown et al. 2003). Called "nontraditional units" or "partnership areas," they include long-distance trails (such as the Appalachian National Scenic Trail, which spans 14 states), wild and scenic rivers, and heritage areas and corridors. While these kinds of protected areas are familiar in the Northeastern part of the country, with its longer history of settlement and high proportion of privately owned land, they are now found in every region of the United States. This trend can be seen also in Canada, where similar partnership areas are increasingly being designated (Tuxill et al. 2004).

Following are three examples from the United States and Canada that illustrate the importance of partnerships, community engagement, and participatory governance models.

John H. Chafee Blackstone River Valley National Heritage Corridor (Massachusetts and Rhode Island, United States). The John H. Chafee Blackstone River Valley National Heritage Corridor, listed by IUCN as Category V, was designated by the U.S. Congress in 1986 to preserve and interpret for present and future generations the nationally significant values of the Blackstone Valley (Figure 3). The designation encompasses nearly 400,000 acres located within central Massachusetts and northern Rhode Island along 46 miles of the Blackstone River, and includes 24 cities, towns, villages and almost 1 million people within the valley landscape, whose distinctive character was shaped by the American Industrial

Revolution. The heritage corridor designation has three broad purposes: to enhance and protect cultural landscapes and natural resource values, improve public understanding and heritage appreciation, and stimulate community and economic development.

A Corridor Commission for this heritage area provides a management framework to engage the USNPS, the state governments of Massachusetts and Rhode Island, dozens of local municipalities, businesses, nonprofit historical and environmental organizations, educational institutions, and many private citizens in working together to protect the valley's special identity, develop and implement management programs, and prepare for its future (Creasey 2001). The commission has reached out to other institutions and built cooperative linkages to address management issues within the Blackstone River Heritage Corridor such as river water quality and public access for recreation. These and other projects help to create connections among the many environmental, historical, and economic and community values of the landscape.

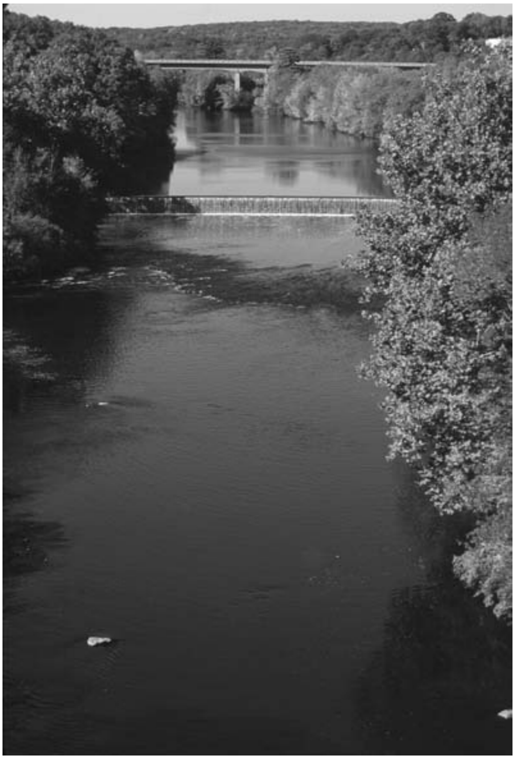

Figure 3. The John H. Chafee Blackstone River Valley National Heritage Corridor (Rhode Island and Massachusetts) is one of 24 national heritage areas in the United States. The valley's distinctive character was shaped by the American Industrial Revolution. Photo courtesy of U.S. National Park Service.

Cuyahoga Valley National Park (Ohio, United States). Cuyahoga Valley National Park preserves the rural landscape along twenty miles of the meandering, northward-flowing Cuyahoga River in northeastern Ohio. Established in 1974, the park today includes a complex network of land ownership and management practices. Of the over 32,000 acres in the park, only 19,000 are in federal ownership, with the remaining acreage owned by other public entities, private and nonprofit institutions, and individual private landowners.

Even though agriculture has been an important part of the of the Cuyahoga River valley's history, preservation of "rural landscape" character and values has only recently been recognized as a priority. To ensure the perpetuation of agricultural land use or traditions, the park has proposed a new rural landscape management program called the Countryside Initiative. Working in partnership with a local NGO with agricultural expertise, the initiative integrates privately supported, economically viable, and environmentally advanced approaches to agricultural practices within a national park setting, and develops markets for locally produced products. Its goal is to sustain the agricultural heritage of the valley in a way that is consistent with best environmental practices and USNPS rural landscape management objectives, and, through this value-added economic strategy, to preserve the remaining agricultural land and buildings (Debo and McMahon 2001).

Sahyoue/Edacho: protected landscapes and First Nations (Northwest Territories, Canada). To the Sahtu Dene people, the two peninsulas of Sahyoue and Edacho on the western shores of Great Bear Lake in Canada's Northwest Territories are sacred sites, used since time immemorial. In this area of 5,587 sq km, the Sahtu Dene continue their traditional land use and lifestyle activities of hunting, trapping, fishing, camping, gathering medicinal plants, and knowing the land. As Susan Buggey writes, the fundamental relationship of the Sahtu Dene with the Sahyoue/Edacho peninsulas is expressed in the continuing cultural meaning, ecological integrity, and biological diversity of the landscape (Mitchell et al. 2005). The association of place and story contained in the narratives sustain Sahtu Dene culture by transmitting language, prescribing behavior, and identifying sacred sites (Buggey 1999). Protection of these sacred sites and the associated story-telling are therefore essential to the continuity of Sahtu Dene culture and livelihood.

The landscape was designated a national historic site in 1996. To afford further protection to Sahyoue/Edacho, the Sahtu Dene community drew upon the powers and processes of the Northwest Territories Protected Areas Strategy (NWT PAS). Sahyoue/Edacho was the first protected area moved forward under the NWT PAS (NWT 1999). Developed collectively by First Nations organizations, governments, industry, and environmental groups, the NWT PAS responds to intensifying threats to territorial lands from mining development and proposed pipelines with a framework for identifying and establishing protected areas.

In a region such as Canada's North, landscape protection needs to be integrated—by means of a participatory process—with community priorities, local planning, economic development, tourism initiatives, and their associated funding sources. Sahyoue/Edacho illustrates how many parties working from the community base may provide a model for cooperative action between native peoples, NGOs, and government in protecting such areas (Mitchell et al. 2005).

Conclusions

The protected landscape approach is a "new face" for conservation. Most fundamentally, the goals for conservation are dramatically expanded from protection of nature and biodiversity to include a broader cultural context and social agenda. For it is within this broader context that a wide diversity of people can find their connection to biological and cultural heritage, and commit to stewardship. These large-scale landscapes are cohesive venues for conservation due to their regional identity, shared history or culture, and shared ecosystem boundaries. These are complex landscapes with multiple values where nature and culture exist alongside human communities, often for many generations. In many cases, the value of the landscape is intimately influenced by the interaction with people over time, and the protection of the landscape requires sustaining these relationships and associated stewardship. It is within these complex and challenging settings that innovative approaches to conservation are being crafted.

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Resource Stewardship and Community Engagement at George Washington Birthplace National Monument

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The National Park Service (NPS) Northeast Region, in partnership with National Capital Region and the Conservation Fund, has developed a process using the gateway community model to address park and community partnerships in the critical area of responding to the pressures of urbanization that frequently affect park resources and visitor experiences. The fund's gateway model presents the Northeast Region with an opportunity to adapt an existing approach in the development of civic engagement strategies that will have demonstrable, long-term benefits to the park and the community it interacts with—now and into the future. This case study describes how the model is being applied to George Washington Birthplace National Monument, a park that is initiating the preparation of a general management plan (GMP), and one of five parks in the National Capital and Northeast Regions that are involved in the pilot program. The term "community partnership" replaces the term "gateway" in the Northeast Region, at the request of the three parks involved in the project.

George Washington Birthplace is in the path of the next generation of growth evolving from the nearby and rapidly exurbanizing Interstate 95 corridor between Washington, D.C., and Richmond, Virginia. The park has a unique opportunity to begin the community dialogue at a time when it can be focused on planning for the benefit of both the community and the park. This case study will introduce the community partnership project at the park as an approach to civic engagement within the planning process for the park's GMP, which is in its early phases. The case study will describe the sequence of project activities, the centerpiece of which is a day-long workshop, and the community profile, a data product that will play a role in establishing the context for planning and for park–community engagement.

The partnership project is one of three civic engagement initiatives designed as outreach to improve interactions with the community during the GMP planning project.

- The *Scholars Roundtable* will bring together historians and resource professionals to present and deliberate current scholarship and resource information on the park. The discussion will inform a revision of park purpose and significance, a building block of the planning process. It affords an opportunity for an invited audience to take part in discussions that will influence the development of the plan.
- In the *Preserving Memory Seminar,* scholars will guide park staff and others in developing a better understanding of a largely untold story, that of slavery on the Washington family plantation, and in meeting the challenges of interpreting this aspect of plantation life.

- The *Community Partnership Workshop* is the third initiative.

Four steps in the Community Partnership Project

1. The centerpiece of the project is a workshop (held on April 12, 2005), when some 55 people—community leaders, local officials, agency representatives, and others who have a special interest in the park, along with park staff—took part in a community partnership workshop facilitated by the Conservation Fund to discuss the park's connections to the larger community, the interests and resources shared by the park and community, and areas for future collaboration. Ed McMahon, a nationally recognized conservation leader, was the principal speaker at the workshop. His previous involvement with Northern Neck activities has sparked local interest for a balanced approach to managed growth and conservation—a key factor to community "buy in."
2. While the workshop focus is on discussion and dialogue with community representatives, there will be presentations intended to build an awareness of shared community and park interests. This presentation will introduce the George Washington Birthplace *community profile,* a digital data product focused on regional land use trends and an assessment of significant natural and cultural resources.
3. The Conservation Fund staff has guided *workshop planning.* The staff suggested at the beginning that the park bring in selected partners to plan the workshop. The partners are representatives of the Northern Neck Planning District Commission, Westmoreland County government (the county the park is located in), and the Northern Neck Tourism Council. Through an initial scoping session and subsequent conference calls, Conservation Fund staff have worked with park and regional NPS and the community partners in developing the agenda, determining workshop objectives, and identifying the list of potential participants. The partners have also co-signed the letter of invitation to the workshop indicating the extent of community interest.
4. The workshop outcomes (referenced in step 1) will almost certainly lay the groundwork for collaborative relationships between the park and the community. It is also expected that some ideas for further activities will emerge (not only between the park and the community but among different interests in the community). While the partnership pilot project for the park ends at this point, the GMP will be moving forward. The pilot project merges into the planning effort with the public involvement program, providing an opportunity to build on workshop outcomes.

Issues of the park and region

George Washington Birthplace is set in Virginia's Northern Neck and Westmoreland County and shares a relationship of enduring historic value. The county's historic atmosphere is sustained by the presence of the birthplaces of Washington, James Monroe and Robert E. Lee; nine other nationally or state recognized sites of historic significance, and a continuing rural, agricultural landscape.

Currently the nearby lands are either farms, forests, or wetlands. These uses are consistent with the historical associations of the park and enhance its commemoration of George Washington. Adjacent inappropriate land and waterfront development could dramatically alter this critical rural historic scene.

From the perspective of park managers, key concerns that extend outside the park boundary are preserving the cultural landscape, protecting water resources, and enhancing the visitor experience. Possible problems include:

- Potential new housing developments and associated infrastructure outside the boundaries places increasing pressure on these fragile resources.
- Development trends in the region may equally threaten viewsheds and related resources in the approach to the park and in the park's surroundings.
- Degradation of views and quiet serenity will diminish the historical environs and the visitor experience.

Other considerations include:

- Water and other natural resources in the park remain relatively pristine. These unspoiled resources are the result of efforts focused on the preservation of the historical setting at this location and limited development bordering the park.
- Popes Creek estuary, encompassed by much of the park, has high research and scientific value due to water quality and habitat.
- Congressional intent upon establishing this national monument was to preserve the site in order to allow visitors to appreciate the natural world and experiences of George Washington's boyhood.

Building resource stewardship through civic engagement

It is clear in a region poised on the brink of change, such as the Northern Neck of Virginia, that the protection and management of significant resource values must be considered in a context broader than the confines of the park boundary. Further, this context should consider the interrelationships of functioning landscapes and the effects of local governance. In accordance with NPS management policies, George Washington Birthplace must be managed to protect and sustain the cultural and natural values intrinsic to the place. In protecting the integrity of "place," however, the park must be managed in a regional context, so that it can positively influence the decisions and subsequent actions occurring beyond its boundaries that would otherwise diminish the value of park resources or the experience of visitors. In its day-to-day management, the park can seek to involve the greater community in building a sense of ownership among citizens and instilling a stewardship ethic throughout the community. In addition to community stewardship, park managers can influence the management of surrounding environmental and cultural resources as well as those decisions that could affect the future of these resources—ideally through a framework for collaborative decision-making.

Gaining a regional perspective can help to inform park staff about activities that could affect park resources or influence management and identify opportunities for joint actions that could benefit both the park and the region. By working collaboratively, citizens, stakeholders, and local leaders can define important resources and shared assets of the region, address actions posing a threat to these values, and work together to realize a shared future by building on available opportunities. The community partnership workshop began this important community dialogue to support future collaborative efforts. It introduced citizens, stakeholders, and local leaders to some of the values and significant resources of the park and the surrounding region through the community profile and related resource assessment. The profile informs the park of the regional perspective, and, for those in the community, how the park relates to the region. It is a tool to illustrate the resources and assets shared by the region and the park, the issues and opportunities facing both, and, ultimately, a framework to guide participants toward shared goals for the region's future.

The community profile is intended to help establish the groundwork for collaborative relationships between the park and the community: it describes the region and its resources, defines indicators of landscape function, and identifies trends and local decisions influencing future change. Describing the regional context in terms of landscape function, resource value, and anticipated future change will enable citizens, stakeholders, and local leaders to gain insights into how resource protection can be balanced with managed growth. Factors affecting future park management can be evaluated against this description of the regional context, and challenges transformed into opportunities for a shared future. This context is comprised of three key components: regional trends described in terms of demographic and economic growth and changing geographies, landscape character illustrated by spatial resource information, and regional guidelines expressed through federal agency and commonwealth of Virginia commitments for the restoration and protection of the Chesapeake Bay.

Compiled primarily by the Conservation Fund, indicators of regional trends include population change between 1970 and 2000, estimated future population growth to 2030, evolving geographies expressed through changes in local farm and forest lands, and delineation of areas anticipated to be most likely to incur future growth. In addition to trends, the Conservation Fund also compiled relevant information derived from the current comprehensive land use plan for Westmoreland County regarding local zoning and subdivision ordinances for lands surrounding the park, including corridor protection (greenbelts) along principal travel routes to the park. A slight decline in forestlands throughout the county is attributed to a combination of residential development and conversion to farmland. The continued loss of farms and farmland is a result of fewer working farms, escalation of farming costs, retirement among farmers, changes in employment away from farming, and increased value of land for development.

Relying primarily on the resource lands assessment completed by staff of the Chesapeake Bay Program, several spatial data layers have been assembled illustrating the resource-rich character of the region. The assessment was conducted for all lands within the 64,000-square-mile Chesapeake Bay watershed (including all of the lands encompassed by the Northern Neck, a five-county peninsula bounded on the north by the Potomac River, on the east by the Chesapeake Bay, and on the south by the Rappahannock River) to delineate priority resource lands and guide a commitment to "preserve from development 20 percent of the land area in the watershed by 2010." Resource data layers include land cover, ecological systems, lands important for water quality and watershed integrity, and prime farmlands.

Additional information delineating priority biological lands and connecting corridors has been developed through the Virginia Conservation Lands Needs Assessment. Beyond the identification of important lands surrounding the park, this resource information could further inform local decision-making by directing future growth toward appropriate lands for residential and commercial development while identifying important lands to protect.

Management of the region's natural resources is further influenced by the *Chesapeake 2000 Agreement*, which provides performance-based commitments leading toward the restoration and protection of the Chesapeake Bay. Both the commonwealth of Virginia and the National Park Service are partners in *Chesapeake 2000*. In addition to land preservation, the agreement establishes specific commitments for sustaining resource-based economic activities such as commercial fishing, farming ,and timber harvesting; the preparation and implementation of locally developed watershed management plans; the use of sound land management practices; and the attainment of water pollution reduction goals (reductions in nitrogen, phosphorus, and sediment). The agreement and its individual commitments provide a regional framework for resource management which, in turn, guides the implementation of local decisions structured to meet the needs of local communities while also addressing important restoration and protection needs of the Chesapeake Bay.

Beyond the interaction between park and region influenced by trends, landscape character, and guidelines, park managers and other NPS staff serve a key leadership role in the protection, management, and interpretation of natural, historical, and cultural resources through involvement in various local initiatives. Park staff, for example, have participated in an evolving effort to establish the Northern Neck Rural Heritage area "to protect, preserve and promote our history and water heritage; and to enhance fishing, farms, forests and villages, with consideration for sustainable economic development and public access." The heritage area initiative could effectively inform managed growth throughout the region and establish a framework for heritage tourism. Service staff have also supported the establishment of the Northern Neck Land Conservancy, a group of concerned citizens organized "to preserve the rural heritage of the Northern Neck by conserving its lands, waters, economics, and culture for future generations." These locally driven initiatives will strengthen capacity for sustaining important resource values and provide the "fabric" necessary to preserve the unique sense of place found only on Virginia's Northern Neck.

Environmental Youth Programming in Chicago: Urban Parks Make Their Impact with Place-Based Education

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Environmentalists generally agree that Chicago is one of the greenest cities in the United States. Imprinted upon the city's corporate seal is the Latin motto *urbs in horto*, meaning "city in a garden." The environmental history of Chicago spans over 150 years of development, from its Indian roots when it was named Che-Cau-Gou to its rise as the leading port town in the West to the creation of the development of a cohesive parks systems based on the designs of Frederick Law Olmsted circa 1890. Today, Mayor Richard M. Daley states: "The city of Chicago leads by example. We are building environmentally friendly buildings, purchasing clean fuel burning vehicles, and exploring new technologies that help conserve resources and save money."[1] The city has a proud tradition of valuing environmental progress. However, in order to continue striving for change, this city must invest time and resources into the education of our young people. We must focus our attention on the future of the environmental movement in Chicago and beyond: all of the attempts to move towards a society of conservation rather than one of waste will be lost unless we can educate the next generation of Chicago citizens about how to keep their city as green as can be.

The primary stewardship responsibilities for open space in the city of Chicago rest in the hands of the Chicago Park District. In managing over 7,300 acres of parkland, 33 beaches, 16 lagoons, 9 harbors, and much more, the district operates with the goal of connecting Chicago's people with the unique eco-treasures that surround them. Inherent in working towards that goal is the need to educate those who enjoy the natural spaces about why those spaces must be preserved. Recognizing this need as essential and the most valuable of investments, the Chicago Park District is taking a leading role in offering opportunities in the fields of science and education to teenagers from neighborhoods across Chicago. In order to present environmental education messages in a way that is relevant to urban youth, the best method is to create a program attended by their peers, taught by their neighbors, and located in their backyards. This is known as "place-based education." This method places emphasis on local action that is supplemented with cultural, historical, and environmental factors that are specific to the community being affected. Park Districts are in a unique position to institute place-based programming because they reach many diverse communities in urban areas.

The Junior Earth Team (JET), for example, is a nature- and service-based program that is present in five different Chicago parks and communities through a fiscal partnership with the energy company ComEd/Exelon. The program educates teens to make responsible environmental choices and empowers them to make change in their world. JET is an innovative project. Its facilities, participants, and staff are working and living in the communities they serve. JET employs place-based techniques by immersing itself in the local culture and natural areas of the city and is tailor-made to serve teens at each of its locations. Chosen to represent a diverse cross-section of Chicago's young audience, JET parks act as settings for youth to make connections with their places. Using local parks as teaching tools, the JET curriculum encourages students to use real-world examples to illustrate broader conservation concepts.

The relevance of place

To achieve a lasting and measurable result, place-based education emphasizes the need for action within one's community. Area culture, history, and geography are infused into a meaningful curriculum; students are taught local particulars of an issue that translate into a deeper understanding of the issue on a broader scale.

Think back to your personal connections with nature as a young person. When did you first realize that nature is an important issue in *your* life? Did it come from a textbook or from images of a far-off land? Or was it the first time you caught a frog, or saw a fish swimming by, or maybe it was when you went for a walk in the park?

An effective connection between teacher and student

Making a real and lasting connection between youth and their impact on their local environment acts as a driving force and even a mission statement for environmental educators. This is undoubtedly true. Too often, however, educators use far-off examples: the decimation of tropical rainforests, imminent extinction of Sumatran tigers, melting of polar ice caps, and desertification. These are meant to illustrate our planet's uncertain future on the large scale. However, these examples remain abstract; local teens have nothing in their life experience that relates. The bridge between the object and subject must be built from scratch, and mortared with empathy. These examples are fine motivating factors behind encouragement of action and responsible behavior among students, but spending one day in the park can have a greater impact than a book full of abstraction.

> "The importance of our stewardship project is that we got the chance to give back to our community. We were able to plant a garden in our park for many people to enjoy."
>
> — Jenny Santiago, Humboldt Park JET, age 16 (2003)

> "I enjoyed the visits to other JET parks because they were nice and they treated us like their own. We worked with JETs all over Chicago and learned about their parks and they learned about ours."
>
> — Daniela Mitchem, Jackson Park JET, age 14, (2003)

Nuts and bolts of a new direction

Conceptual investigation of problematic issues occurring in inaccessible areas almost negates the importance of the issues themselves. The problems seem remote, overwhelming, and unsolvable; educators run the risk of developing eco-phobia amongst their students. Urban teens are at a stage in their lives when they begin to (or have completely) shed the innocence of their childhood and face difficult realities in their families, schools, neighborhoods, and peer groups. It is the responsibility of environmental educators to provide programming through which teens can identify a problem that:

1. Can be visually identified, analyzed, and understood by the students.
2. Encourages active stewardship.
3. Has a solution that is readily implemented and that encourages ownership and pride in the students' local community.[2]

Place-based educators believe that when people learn about the ecological patterns of, cycles in, and human impact upon the place they inhabit, they will be more prepared to take on the role of active steward.[3] Any city has the ability to apply these tenets to its programming and should strive to implement place-based pedagogy.

In Chicago, we have an ideal backdrop of diverse human populations situated near distinct environments including dunes, wetlands, and forests. The Chicago Park District's JET program brings together groups of teens that live in the neighborhoods surrounding these natural areas, provides them with site-specific curricula, and spends time and resources supporting the active stewardship of *their own* environment. Even the teaching staff comes from the community.

Through place-based strategies, JET avoids the pitfalls of standardized testing, worksheets, and performance evaluations (these factors generally are considered when hiring and evaluating youth in programs with paychecks), and replaces them with personal experiences that make the subject matter individually relevant for each student.[4]

Case studies

As the place-based movement builds momentum, educational programs work towards connecting the communities they serve with those people's needs and interests. The community provides the context for learning, student work concentrates on area-specific needs and interests, and local professionals and institutions act as resources and partners throughout the process of teaching and discovery. The following examples show that, in Chicago, a new methodology connecting people with their place is changing the landscape of environmental education. Specific activities of JET are mentioned as well as another initiative from this organization.

JET in River and Jackson Parks. The JET program develops new projects every summer for each of its five locations. The content is site-specific. Individual locations along with each park's unique features determine what the students will do in terms of stewardship and how they will make their impact on the community. Each group is given a theme and free rein to develop it into a six-week project that illustrates how it is represented at the park.

River Park, aptly named for its position along the North Branch of the Chicago River, is the location of a contracted relationship between the Chicago Park District and a canoeing organization that works with the JETs. The teens learned paddling techniques so well that they were able to teach them to their JET colleagues from other areas of the city. They used pond dipping, fishing, botanical studies, and bird watching to create a comprehensive biological map of the park based on their theme "What Swims Through Our City?"

Jackson Park, located on the Southside lakefront of Chicago, teamed up in 2004 with the Illinois Butterfly Monitoring Network to perform a "citizen–scientist" study involving Bobolink Meadow, a small prairie adjacent to the park. The teens spent six weeks studying the butterflies that migrate through the meadow and their findings were added to the statewide database.

Nature Oasis Outdoor Classroom. In addition to the JET program, ComEd/Exelon Corporation also funds the Nature Oasis Outdoor Classroom, another Chicago Park District program. The outdoor classroom works directly with K–12 schools, providing them with opportunities to use their local park as a field trip site for nature exploration. Led by an Exelon Fellow, a Chicago Public Schools teacher on loan to the park district, each visit focuses on education, stewardship, and reflection. Caring for the park next to their school helps foster a sense of pride and ownership of that area with the ultimate goal being that children who spend time experiencing nature grow up to be ecologically conscious adults. The outdoor classroom provides opportunity for self-reflection as well, which helps the students identify what parts of the trip had meaning for them and what environmental concepts they are interesting in pursuing further.

Conclusion

Here in Chicago and, as shown in various case studies, around the country, educators are beginning to make connections between their students and the cultures from which they come. Too often we trot out far-distant problems, study about them in books, write hypothetical solutions that are global in scope and, in the end, come to the conclusion that we can do no more. By empowering youth in their own communities, educators allow their students to succeed more naturally and in ways that are relevant for their own development.

JET students in Chicago parks are tackling real, tangible, and accessible environmental issues. The Chicago Park District emphasizes place-based education that brings the people out of their houses and into their local parks where they can touch, smell, feel, and hear nature. It is a program that connects teens to their community parks and brings stewardship of their city to the forefront.

The pedagogy of place is a growing one and while much of the practice is happening in some small schools, park districts can be equally important in bringing these methodologies to young people across the country. As urban teens grow to value and invest in their parks, often the only natural areas they have ever seen, their attachment to the world around them grows in strength and scope for the rest of their lives.

Endnotes

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Examining the Role of Community Participation in Biological Resource Management: Human Dimensions of Deer Issues in Northeastern National Park Service Units

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Introduction

Wildlife management is becoming increasingly complex for land resource management agencies. White-tailed deer *(Odocoileus virginianus)* have been a major concern in many national parks the northeastern United States for over two decades. Biological studies have been undertaken at a number of parks to determine deer population density, movement, and impacts on park resources (Underwood and Porter 1991; Warren 1991; Frost et al. 1997; Shafer-Nolan 1997; Porter and Underwood 1999).

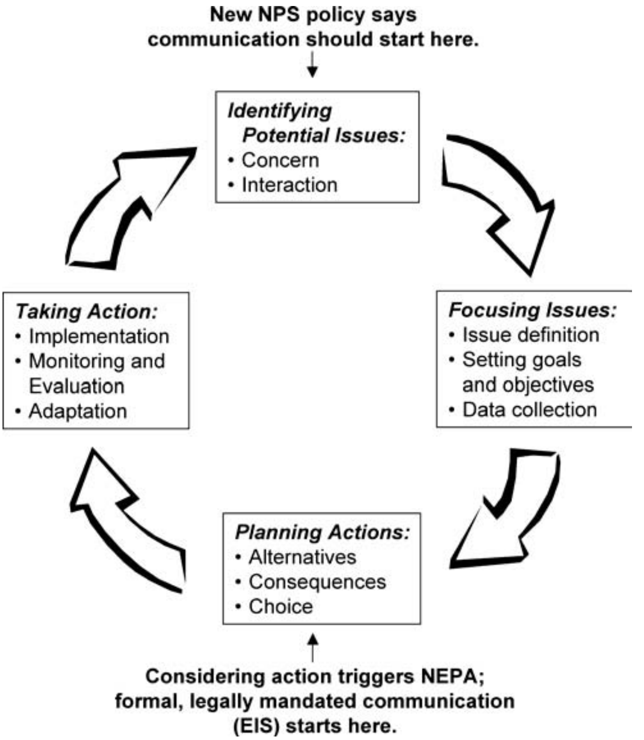
While biological knowledge improves the understanding and predicting of ecosystem responses to management actions, human dimensions insight enhances the understanding and predicting of social responses to management actions. The human dimensions of wildlife management are defined as insights about "how people value wildlife, how they want wildlife to be managed, and how they affect or are affected by wildlife and wildlife management decisions" (Decker et al. 2001:3). Consideration of human dimensions broadens the traditional definition of wildlife management from its focus on manipulation of wildlife and habitat to "the guidance of decision-making processes and implementation of practices to purposefully influence interactions among and between people, wildlife, and habitats to achieve [valued] impacts" (Riley et al. 2002:586).

Because of the relative wealth of biological knowledge about deer and growing resource management concerns that are perceived to involve them in some way, deer issues in northeastern parks were identified as a "model" system for developing human dimensions insight and expertise related to biological resource management in the National Park Service (NPS). This paper describes managers' perceptions of deer issues and their management in northeastern parks and develops an approach for future inquiry to aid management practice and policy interpretation.

Methods

Discussions with NPS science staff resulted in the development of a model representing the evolution of wildlife issues in national parks. According to this model, wildlife issues evolve through four main phases (Figure 1):

Figure 1. Issue evolution model of NPS wildlife management and policy implications (adapted from Hahn 1988). "New policy" includes *Management Policies 2001* (2000), *Director's Order #75A* (2003) and *Director's Order #52A* (2001).



- **Identifying potential issues.** Concerns are voiced and activity from concerned individuals increases; the issues are not yet fully formed in this phase.
- **Focusing issues.** The issues are formally defined,[1] goals and objectives (specific to the issues) are set, and data are collected, laying the groundwork for effective program evaluation.
- **Planning action.** Potential actions to address the issue are identified based on the outcome of data collection. These are evaluated with respect to variables such as cost, efficacy, and social acceptability. Traditional scoping processes related to the National Environmental Policy Act (NEPA, passed in 1969) may be invoked at this phase. Management alternatives are selected.
- **Taking action.** Management alternatives are implemented, evaluated, and adapted as necessary. Activities may be refined as a result of evaluation through monitoring, as an adaptive management strategy.

As a first step in understanding NPS resource managers' perspectives on deer issues throughout the northeastern USA, a brief questionnaire was developed to determine sources and impacts[2] of concern with respect to deer, as well as the level of action parks were taking, with reference to the issue-evolution cycle. Regional NPS science staff identified 52 parks in the Northeast and National Capital Regions that had experienced or had the potential to experience impacts from deer; representatives of these parks were asked to respond to the questionnaire via the internet.

Forty-four rangers, biologists, natural resource managers/specialists, superintendents, and others representing 49 parks responded. Responses reflect professional judgments of the individuals responding. Most respondents (N=32, or 73%) had current deer concerns and were at various stages of taking action related to these concerns. Only two parks were implementing management activities and four parks were planning action, whereas ten were collecting data and were poised for future action planning.

A subset of 22 parks was selected for follow-up site visits. Parks visited represent a range of NPS designations (i.e., national park, national historic site, national recreation area, national battlefield, etc.), sizes, and phases in the issue-evolution cycle. Between May and October 2004, semi-structured informal discussions were conducted with 47 natural resource managers and staff at these parks. These discussions helped to: (1) identify the extent and general nature of deer impacts in parks of the northeastern USA; (2) gain an understanding of how these situations have been approached, especially with respect to the public engagement and knowledge about the human dimensions of deer management; and (3) identify common themes or experiences with respect to successes and problems related to deer issues for further in-depth inquiry.

Results

Discussions with managers revealed three main insights with respect to deer issues: a multi-tiered complex of influences shaping the management environment; differences in perceived impacts of deer on parks, stakeholders, and relationships, and elements necessary for successful natural resource management.

Influences on the management environment

Parks are governed and influenced by political, sociological, ecological, and economic considerations (Decker et al. 2001) acting at multiple scales, ranging from within the park to local, regional, and national levels. An individual park's management environment will thus depend on the specific combination of influences experienced at each scale, resulting in a management environment unique to each park. Managers identified most deer issues as originating at the interface between parks and local communities. Yet with one exception, managers did not identify any NPS staff whose primary role is to address local-level influences on an on-going basis. Instead, NPS staff charged with managing resources within park boundaries also addressed cross-boundary influences if and when primary, intra-park responsibilities were affected. When official public scoping efforts were required, as in the development of an environmental impact statement (EIS), contractors or NPS regional offices were recruited to spearhead these efforts. The one park with permanent staff focused on local-level influences was unique because it houses an institute founded on collaborative leadership and community-based conservation involving cooperation and partnerships.

Extent and nature of deer impacts

The management environment, in turn, appears to affect what managers interpret as negative impacts on the park. The suite of impacts experienced by a park and its stakeholders may interact and develop into broader issues. Impacts of primary concern to managers focused on aspects of the parks' natural resources and cultural landscapes. In contrast, managers believed that most stakeholder concerns related to private property damage, health and safety, or recreational opportunities. Thus, managers described a management environment in which parks and stakeholders were concerned about different impacts, with parks primarily focused on impacts within park boundaries and stakeholders focused on impacts outside park boundaries. Given this perception, it is not surprising that almost every park noted negative impacts on their relationship with neighboring communities and landowners. The few parks that did not note negative impacts to these relationships believed that their neighbors did not expect the park to take a leading role in managing deer populations, either due to the small size of the park and number of staff, the purposes for which the park was established, the history of inaction on the part of the NPS, or the fact that deer impacts had not yet reached a high level of concern for the local community.

Key elements for successful management of deer issues

While deer issues have been a concern and focus of study in northeastern parks for over two decades, very few parks have developed or implemented formal activities related to deer. In our discussions with managers, a number of areas emerged as barriers to taking action on deer issues. Each of these barriers also represents a necessary element in developing an effective program to manage deer and deer issues. The following discussion identifies an example for each element that was perceived to be a barrier, as well as proposed or actual solutions suggested for overcoming these barriers.

Understanding the uniqueness of the management environment. Because negative impact to resources is defined by the overall management environment, managers who described similar levels of deer browse, complaints from neighbors, or deer–vehicle accidents often had very different interpretations as to how soon, or how important it would be, to take action related to deer. Some managers observed that this "uniqueness" made it difficult to learn from other parks' experiences.

Others believed that understanding the unique management environment of the park helped determine appropriate actions and partners to include. One manager stated that the success of management activities related to deer issues depended on the engagement of all divisions of the park, as well as external stakeholders, such as cooperators, concessionaires, volunteers in trail management and backcountry hut management, and state wildlife agencies.

Internal NPS coordination. Many managers indicated that internal communication among park staff often was weak, citing a need for coordination and common goals among the different divisions within a park. Activities of different divisions often were described as being at cross-purposes; for example, salting roads in winter or eliminating weekend trash removal exacerbated wildlife–human conflicts. Other parks actively fostered internal communication. Some natural resource managers and interpreters collaborated in designing messages to further natural resource objectives, and one park even developed a formal partnership between natural resource managers, law enforcement officers, and educators to focus on deer issues.

Coordination with external stakeholders. All parks that were considering a formal deer management plan were concerned about external stakeholders, either because stakeholder complaints were a major impetus behind considering management or because of concerns about stakeholder reactions to management decisions. Most managers believed that the public neither understood park management goals and planning processes nor recognized the difference between city parks, county parks, state parks, and national parks. Many managers remarked that stakeholders often were frustrated at perceived park inaction, even though the park had been involved in the initial, albeit internal, processes of action-planning for a long time (sometimes years). Some parks were attempting to increase public awareness by developing relationships with local universities, journalists, and state wildlife agencies. In addition, one park was involving local community members in gathering deer movement data. One manager noted that it is instrumental to have partners, both external and internal.

Effective planning processes. Discussions of deer management planning focused mainly on understanding and implementing legal and policy requirements, especially related to NEPA. Managers referred to NEPA as a double-edged sword: while it ultimately allows parks to move forward with preferred management activities, the associated planning process was often described as a hurdle that delays action. This perspective is most obviously reflected by the term "NEPA compliance," which is often used as a synonym for "planning." Alternatively, one manager believed that the culture of "compliance" gave planning an unjustly negative connotation. Others suggested that early planning meetings with the public, *before* formal public scoping activities required by NEPA, could not only provide earlier opportunities for public involvement, but could also ensure that both management and public concerns were represented, or at least acknowledged, in the definition of the problem.

Adequate resources. Almost all managers mentioned lack of staff and funding as impediments to managing deer issues. Most managers who mentioned lack of funds spoke in terms of funds to increase staffing, although some also expressed a need for guidance in writing proposals that would be approved for NPS funding and/or technical assistance. Their concern was not that past proposals had been rejected, but rather that they did not receive enough feedback to improve future proposals. Some managers interacted regularly with their natural resource colleagues who provided feedback on experiences with funding projects, what worked, who they liked to interact with, etc. Others noted supervisors as key resources in helping identify funding sources, supporting proposals for additional staff, and facilitating information sharing between NPS employees.

Discussion

Unlike many public issues that have been studied at parks, deer issues are not primarily driven by visitor concerns, but instead involve local communities. The NPS currently has teams focusing on basic biological, geological, and cultural landscape inventories, as well as visitor surveys. However, less work has been done assessing local communities, their attitudes toward park actions, and their effect on management activities. Parks face many transboundary issues that may affect local communities, such as fire management, invasive species management, ecosystem restoration, and disease outbreak management. A technique to better understand how local communities relate to parks and management issues would be applicable in these types of situations as well as to deer issues. While national stakeholder groups may become involved after an issue is defined and action is being planned, local stakeholders often play a crucial role in the initial identification and development of these issues.

Under NEPA, NPS managers are required to include public input only when a park considers or approves an action whose impacts on the human environment are significant enough to warrant an EIS, i.e., when the issue has reached the phase of "Planning Actions" (Figure 1). However, to some managers interviewed, it is clear that stakeholders can have a significant role much earlier in the cycle, and even play a crucial part in defining the overall context in which the issue evolves. The federal government currently is placing greater emphasis on including stakeholders in policy-making from the beginning of, and continuing throughout, the issue-evolution cycle, and recent NPS policies explicitly call for active, on-going public participation in the planning process (National Park Service 2000, 2001, 2003).

Future research will examine the role of communication and public participation in enhancing biological resource management. This approach assumes that understanding not only the beliefs and attitudes of stakeholders, but also the degree of mutual understanding between stakeholders and NPS staff, can be used to design more appropriate, and therefore more successful, communication and education initiatives related to public participation. In turn, tailoring participation strategies throughout all phases of the issue-evolution cycle will ultimately result in more informed, equitable, and sustainable management decisions. These assumptions must be tested; future work will develop a framework and methodology for doing so, with the intention that these products can be applied whenever the NPS faces management issues that originate in local communities.

Endnotes

1. An "issue" is a statement that can be acted upon (Kent and Preister 1999).
2. "Impacts" are the socially determined important effects of events or interactions involving wildlife, humans and wildlife, and wildlife management interventions (Riley et al. 2002).

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Bringing Civic Engagement into Richmond National Battlefield Park: The Story of Lincoln's 1865 Visit

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Paraphrasing and condensing from the Director's Order #75A, let's start with a definition of *civic engagement:* a continuous, dynamic conversation with the public that strengthens public understanding of the full meaning and contemporary relevance of natural and cultural resources. All of our work is connected to real places, real resources, which give ideas substance over and above printed words on a page. Director's Order #6 for *Interpretation and Education* quotes the National Park System Advisory Board's 2001 report, *Rethinking the National Parks for the 21st Century*:

> The study of our nation's history, formal and informal, is an essential part of our civic education. In a democratic society such as ours, it is important to understand the journey of liberty and justice, together with the economic, social, religious, and other forces that barred or opened the ways for our ancestors, and the distances yet to be covered. Visits to historic places, whether managed by the Park Service or by others, allow us to take the measure of our history in immediate ways. Parks should not be just recreational destinations but springboards for personal journeys of intellectual and cultural enrichment. The Park Service must ensure that the American story is told faithfully, completely, and accurately.

The national battlefield park where I work in Richmond, Virginia, has a long and distinguished history of interpreting Civil War events. The Richmond area has a lot to interpret, more than we had tapped traditionally. There were some thirty battles around Richmond, some of them Union victories, some Confederate. Bigger-than-life statues of Confederate generals and their horses, installed in the early twentieth century, dot the city's landscape today. Cemeteries honor both Union and Confederate war dead. Roads and bridges are named for Confederate figures and only for a few Civil Rights figures. Our park headquarters is on the site of one of the largest Civil War hospitals.

So, you can see that our stories are diverse, but located in the former capital of the Confederacy makes telling *all* the stories challenging on occasion. We had had a narrowly limited audience until recently, when we have made more efforts along the lines of civic engagement. Telling some stories gets a negative reaction from some of our traditional audiences.

One very significant episode concerning Richmond and the Civil War had not been much told for over 100 years in Virginia, or anywhere else for that matter, except in a passage buried in a thick book, *The Battle Cry of Freedom*. That is the story of President Abraham Lincoln in Richmond in April 1865. Lincoln's visit produced, in the words of the prominent modern historian, James McPherson, "the most unforgettable scenes of this unforgettable war." We started telling this story as more than a passing image in our film in April 2003 at our main visitor center at Richmond National Battlefield Park. And when we did so, some members of our community took offense. (Some were members of the Sons of Confederate Veterans, some not.) Their reaction sparked a national controversy in the media. I am convinced that the numbers who were incensed across the nation were small, but the story was juicy for the media, which hyped it considerably. When I tried to engage some of the callers in dialogue, it was clear to me that their interest was not in reconciliation over the subject. But, you are captured listeners today, and I will tell you our rationale.

As always, context is important to understanding the significance of a historic event, and I'd like to supply you with that historic context of President Lincoln's visit to Richmond.

Our country has been called a "unique experiment in democracy" and the Civil War has been called the *watershed* event in our nation's history. Our Constitution, framed in the late 18th century here in Philadelphia, was a document only delicately held together at the time. Both before and after ratification by the states, differences of opinion existed. The threat of *disunion* surfaced again and again over taxes, slavery, banking, and representation; the threat of disunion was voiced by both northerners and southerners at various times. For many decades early in the country's history, Virginians were leaders in patching over differences, working for compromise. It's important to remember that Virginia did not want disunion, and most of her voting citizens opposed secession, but neither did they want any states to be coerced to stay in the Union.

Now, let's set the scene just prior to the Civil War. Until late 1860, many Richmonders had looked with calm pride upon the city's past and with confidence toward its future. Prosperity was obvious in the city's growth and in the number of immigrants and northern workers that had come to work in the city. As an urban center and port city, Richmond reflected a more diversified social structure and economy than was common in the rural South. Of the city's 38,000 residents in 1860, about 40% were African-American, and of these some 8% were free black. Among whites, almost one-fourth were foreign-born. Slave labor was used extensively in factories and commerce. Richmond competed well against other cities in its four major enterprises: the iron industry, flour milling, tobacco, and the internal slave trade. Canals, railroads, and stage lines connected the city to the larger world.

In Virginia, even after the 1860 election of Abraham Lincoln, many influential politicians had almost blind hope that peace would prevail. Virginia's Governor John Lechter said on January 7, 1861, "Surely, no people have been blessed as we have been, and it is melancholy to think that all is now about to be sacrificed on the Altar of Passion. If the judgments of men were consulted, if the admonitions of their consciences were respected, the Union would yet be saved from overthrow."

Only after the Confederates fired on Fort Sumter in mid-April 1861, when President Lincoln then called for volunteer troops to suppress the rebellion, did Virginia decide to secede from the Union and ally itself with the nascent Confederate government.

At the close of the Civil War, after four bloody years with many of the battles within earshot of Richmond, this was an occupied city under Union rather than Confederate martial law. Imagine the scene that Lincoln chose to visit—against the advice of many. Burned-out hulks of buildings lined streets; smoke still hung in the air; uncertainty of the final outcome must have caused fear and apprehension of what would be next. Streets and houses were becoming densely crowded with returned Confederate soldiers, returned former residents, and occupying Union troops. While black Richmonders celebrated the end of slavery, the former slaveholders found their wealth in slaves gone.

Much of Richmond's business and industrial section lay in rubble and ashes. No telegraph lines and none of the five railroads were in operation. The Army's Provost Guard, expecting disorder, arrested freed black men and women who gathered on the street and forbade their presence in Capitol Square. Such actions of the Union Army reassured many white Richmonders, while suggesting to black Richmonders that the meaning of freedom remained to be established.

Timing often means everything—and it's true here. Remember President Lincoln's speech from just a month prior to his visit to Richmond. In his concise and powerful second inaugural address on March 4, 1865, the president delivered the now-famous passage: "With malice toward none; with charity for all; with firmness in the right ... let us strive to finish the work we are in; to bind up the nation's wounds ... to do all which may achieve and cherish a just and lasting peace among ourselves, and with all nations."

Lincoln seemed to want only three things. Three simple but monumental things. If there was agreement to end the war, abolish slavery, and restore the national authority, he would consider all other conditions "in a spirit of sincere liberality." "Let 'em up easy," was Lincoln's message to his military staff. He was not interested in trying southerners for treason or confiscating property. So that's the context of Lincoln's April 1865 visit to Richmond.

In the midst of telling the story of Civil War Richmond and its battlefields, it seemed appropriate to us to remind people of the pivotal role of President Abraham Lincoln, and his amazing trip with his son to Richmond, and we have done so with an interpretive exhibit that includes a statue of him with his son, Tad. They came up from City Point, Virginia, on various boats on the James River. The trip was fraught with mishap, some describing it as ignominious as he finally arrived on a rowboat with no fanfare or guards to meet him at Rockett's Landing, whence he walked into the city. Little is recorded of his route or his words that day.

Remember that Lincoln's visit produced, in the words of the prominent modern historian, James McPherson, "the most unforgettable scenes of this unforgettable war." How could we ignore Lincoln in Richmond?

The Civil War framed the presidency of Abraham Lincoln. Within weeks of his election in 1860 as the sixteenth American president, South Carolina seceded from the Union. The primary Confederate army surrendered on April 9, 1865, only days before Lincoln's assassination.

Here we have the head of state of the enemy force visiting Richmond only a day after its evacuation by the Confederate government. The visit was remarkably daring for its timing and circumstances. Weary of war and worried about the country's future, he came on a mission of peace and reconciliation, we know from his second inaugural address.

You need to recall Lincoln's bone-tired physique in 1865 and his bone-strong determination for reuniting the United States. During his long walk into Richmond, Lincoln received a boisterous and prolonged welcome from the large population of African-Americans. In contrast, most white residents greeted the president with stony silence. As we know, only a few days later he was shot dead by an assassin in the other capital, where he had resided as president.

You may be tired of hearing how author William Faulkner reminded us that in the South the past isn't dead, it isn't even past. Maybe because it is still so much alive, we find ourselves on contested ground when we try to engage its various aspects. But try we must, and in the process include more people in the appreciation and discussion of our history.

What Does the Soviet Gulag Have to Do with the National Park Service?

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For the past four years, I have been working with a dynamic and highly significant museum deep in the heart of Russia: the Gulag Museum at Perm-36. You might ask, as I do in the title of my talk today, "What does the Soviet Gulag have to do with the National Park Service?" It's a question I get asked often, and so I want to start with a brief discussion of civic engagement. To expand a little on what Cynthia Macleod said in her introduction to this session, at its core, civic engagement means creating an ongoing dialogue with visitors about the stories we tell. We use historic sites to tell powerful stories about the American past, but we also can and should connect those histories to contemporary issues in American society.

The civic engagement initiative developed out of several impulses, some internal and some external to the NPS. Today I want to touch on one of those external forces: the International Coalition of Historic Site Museums of Conscience. In 1999, the Lower East Side Tenement Museum in New York City, an affiliated site of the NPS, issued an international call to historic site directors committed to not only preserving the past but also actively engaging visitors in issues facing society today. Several site directors responded with enthusiasm, including our own Marie Rust, then the Northeast regional director. The group's charter declares:

> We hold in common the belief that it is the obligation of historic sites to assist the public in drawing connections between the history of our site and its contemporary implications. We view stimulating dialogue on pressing social issues and promoting humanitarian and democratic values as a primary function.

The founding members included: Lower East Side Tenement Museum, New York City; Terezin Memorial, Czech Republic; District Six Museum, South Africa; Slave House Museum, Senegal; Work House Museum, England; Open Memory, Argentina; The Liberation War Museum; the National Park Service, Northeast Region; and the Gulag Museum, Russia.

In 2003, the Gulag Museum's director, Victor Shmyrov, proposed a joint project to collaboratively develop, design, and bring to the U.S. an exhibit on the history of the Soviet forced labor camps and the role of the Gulag Museum to educate Russians about their totalitarian past.

Several National Park Service sites address social injustice in American history and the relevance of this history to contemporary life. Some of these sites welcomed the opportunity to host such an exhibit, and they have been actively engaged in developing this project. These sites include Manzanar National Historic Site, the former Japanese internment camp in central California; Brown v. Board of Education National Historic Site in Topeka, Kansas; Martin Luther King, Jr., National Historic Site in Atlanta; Eleanor Roosevelt National Historic Site in Hyde Park, New York; the Ellis Island Immigration Museum, New York City; and Boston National Historical Park.

What was the Gulag? "Gulag" was the acronym for the Soviet bureaucratic institution, ***Gl**avnoe **U**pravlenie ispravitel'no-trudovykh **Lag**erie* (Main Administration of Corrective Labor Camps). This branch of the secret police oversaw the Soviet forced labor camp and internal exile system. Between the Russian Revolution in 1917 and the fall of the Soviet Union in 1991, some 25 million people were held in the Gulag system. At its height under Stalin in the early 1950s, the system held over 5 million prisoners.

Figure 1. Artist's rendition of the camp in 1946. There were four barracks of 250 prisoners each, a headquarters building, outhouses, a hospital, and a punishment block. Courtesy of the Gulag Museum at Perm-36.

The former Gulag camp, Perm-36, was originally set up as a rather typical camp in the 1940s in the heavily forested region in the Ural Mountains, not far from the western edge of Siberia. It housed 1,000 prisoners in four barracks (Figure 1). Under brutal conditions (Figure 2) , prisoners cut timber and in the spring floated it downstream to help the cities rebuild after the devastation of World War II.

After Stalin's death in 1953, the new Soviet leaders drastically reduced the size of the Gulag, and most labor camps were abandoned. Perm-36 survived because of its remote location. First it housed convicted Soviet authorities. Then, in the early 1970s, it was transformed into one of the most notorious facilities for human rights political prisoners. By the late 1960s, the Soviet Union faced a serious internal threat: dissidents and human rights activists who publicized their activities when possible and created serious image problems internationally. The human rights movement had been growing in the 1960s and it was spurred by opposition to Soviet actions, in particular the suppression of the Prague Spring in Czechoslovakia in 1968. Increasingly the government had to deal with punishing and isolating these political prisoners. In 1972, during a period of renewed political repression in the USSR, Perm-36 was converted into a political prison, and for the next 15 years, the camp, along with two others nearby, held many of the Soviet Union's most prominent dissidents.

After the Soviet Union's collapse, some Russian historians, human rights activists, former Gulag prisoners, and others created civic organizations to help foster remembrance. One of the most prominent, the Memorial Society, erected small monu-

Figure 2. Restored prison cell at the Especially Severe camp barracks. During the prisoner's term, he only saw his cell-mate and his guard, who took him to his work cell and to his exercise yard. Most prisoners spent at least five years in this camp. Several died there as well. Courtesy of the Gulag Museum at Perm-36.

Figure 3. The last remaining original barracks in 2001. The museum has been working to restore the original structures to interpret the entire history of the camp. Courtesy of the Gulag Museum at Perm-36.

ments throughout the country to commemorate victims of totalitarianism. In 1991, Memorial Society activists, who wanted to preserve a forced labor camp to serve as a memorial to the Gulag victims, organized to save Perm-36. By the early 1990s, Perm-36 lay in ruins (Figure 3). KGB officials had destroyed much of the facility after Ukrainian Television crews filmed and broadcast the facility where internationally renowned poet Vasyl Stus had died from neglect in 1985. Thanks to dedicated reconstruction efforts, the museum was able to open in 1996, and today the former camp is the only surviving complex from the Soviet Gulag system (Figure 4).

Through the offering of tours, exhibits, and workshops, the museum is able to fulfill its mission statement: "To promote democratic values and civic consciousness in contemporary Russia through preservation of the last Soviet political camps as a living reminder of repression and as an important historical and cultural monument."

Figure 4. Visitors at Perm-36 Museum. Courtesy of the Gulag Museum at Perm-36.

The stories the museum tells remain highly controversial today. In a 1993 Russian public opinion poll, about 8% who responded believed that Stalin's role had been positive. In 2003, on the 50th anniversary of his death, the positive response had swelled to over 50%. Many forces in Russia today do not like what the Gulag Museum is doing.

The exhibit that the National Park Service and the Gulag Museum are jointly bringing to the United States will present the story of the Gulag in three sections. The first section will explore the Gulag as it developed and grew into a powerful tool of repression under Stalin. The second section will address the rise of the human rights movement within the Soviet Union and focus on the history of Perm-36. The final section will look at the legacy of the Gulag in Russia today (Figure 5).

I want to leave you with one image today, a pair of ordinary objects that will be featured in the exhibit: the toothbrushes of former dissidents Ivan Kovalev and Tatiana Osipova.

In the late 1970s, Ivan was editor of the outlawed *Chronicle of Current Events* which documented human rights abuses within the country. Tatiana, his wife, was active in the

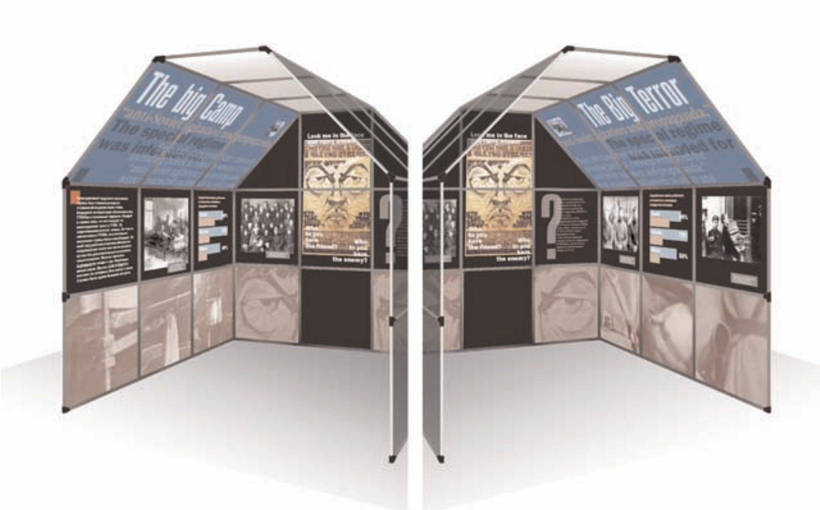

Figure 5. Traveling exhibition module prototype design. The exhibit will feature full-scale prison cell sections, prisoner artwork, artifacts, maps, photographs, Soviet propaganda posters, and official Soviet newsreels on the Gulag. Oleg Trushnikov, exhibit designer. Courtesy of the Gulag Museum at Perm-36.

Helsinki Group, a human rights organization. After she was arrested in 1980, he sent her a toothbrush. Etched in the plastic is a love message. The authorities never saw it. When he was arrested in 1981, she sent him, through her mother, a toothbrush which also contained a love message. Sadly, Ivan never thought to look for a message since it came through Tatiana's mother, but when they were reunited in the late 1980s, he still had the toothbrush. These are treasured objects. And they tell a powerful story of struggle and endurance.

All societies and countries have painful pasts—histories that are difficult to face, stories some would rather ignore or deny. This traveling exhibit presents an opportunity for the NPS to share with American visitors a model of how historic sites can play an important role in the dialogue about a nation's past and its future. No doubt there will be some visitors surprised when visiting Ellis Island or Martin Luther King, Jr., National Historic Site to discover an exhibit on such a seemingly foreign topic. I hope and believe it will spur them also to think about the history of the site they are visiting and its implications for our society today.

Big Egg Marsh Experimental Restoration in Jamaica Bay, New York

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Saltmarsh loss in an urban national park

At Jamaica Bay, in the New York City harbor area, centuries of urbanization destroyed 90% of the wetlands. The remaining 400 ha of saltmarsh islands are disappearing at an accelerating rate. Currently, about 16 to 20 ha of saltmarsh islands are being lost every year, through internal decay and erosion (Gateway National Recreation Area 2001). The grassy interiors of the islands are transforming into mosaics of soft mud and isolated grass tussocks. Investigations are underway to identify the causes of these losses and to find effective ways of restoring saltmarshes (Gateway National Recreation Area 2004).

To address the question of what is an effective and long-lasting method for saltmarsh restoration, Gateway National Recreation Area undertook the Big Egg Marsh experimental restoration. The project area comprises approximately 1 ha of restored saltmarsh and an adjacent 1 ha of control (or reference) marsh in the southern side of Jamaica Bay. This site was selected because the saltmarsh is well along in transforming to a bare mudflat. It also is conveniently located adjacent to Broad Channel village, where there is easy access for interpretive activities and for the public's participation in the Volunteers-in-Parks (VIP) program.

The Big Egg Marsh experimental restoration project is funded by the National Park Service, and is being carried out by Gateway NRA. The project location, Jamaica Bay, is at the southwestern end of Long Island. Jamaica Bay lies within the boroughs of Brooklyn and Queens. Jamaica Bay and its saltmarshes today measure about 6 km north to south, and 13 km east to west. Most of Jamaica Bay's estuarine waters, wetlands, and artificial uplands lie within the Jamaica Bay Wildlife Refuge, now included within the national recreation area.

Gateway was established as the nation's first urban national park over three decades ago (U.S. Congress 1972). The park includes historic forts that defended New York harbor. It also includes natural resources that are important habitats for migratory birds and fishes. Several federal-listed threatened and endangered birds and plants occur within Gateway. The New York portion of the park includes most of Jamaica Bay, large portions of the Rockaway barrier island, and parts of Staten Island. In New Jersey, most of Sandy Hook barrier island is included in the park. Overall, Gateway includes over 10,500 ha of ocean water, saltmarshes, beaches, and adjacent uplands. Most of the fringing freshwater wetlands, however, are lost to urban development.

Planning the experimental restoration

An environmental assessment was prepared to recapitulate the issues, present alternative actions, and review the resources and impacts (Gateway National Recreation Area 2003). The "no action" alternative would allow the gradual transformation of the remnant saltmarsh into bare mudflats. Six "action" alternatives were considered, but four were immediately rejected because they were based on barging in sand from a distant source; such action would have necessitated dredging an access channel, which was prohibitively expensive, time-consuming, and destructive. The remaining two "action" alternatives that were considered further depended on excavating sand from a trench in the adjacent tidal creek. One of these alternatives was to dredge a thin layer off the entire creek bottom, and the other was to dredge a deep narrow trench. The latter, the ecologically preferred alternative, was chosen because it was expected to provide the purest sand for the marsh surface while having the least impacts on the local fauna.

The selected method for applying sand to the experimental restoration site is by means of a small barge with a swing-ladder dredge and a high-pressure spray (Figure 1). The intake end is the swing ladder, which moves side-to-side across a swath 6.7 m wide with a maximum depth of 1.8 m. The intake pipe has a rotating cutting head at its distal end. The slurry that enters is pumped through a 20-cm diameter pipe, and then reduced to a 10-cm diameter nozzle that sits 3 m above the stern. The slurry spray is supposed to deliver to a distance of around 60 m.

This spray technique was chosen because it was expected to be less destructive to the remnant marsh than conventional dredging. The plan was to add layers of sand to elevate the treatment site generally a minimum of 20 cm above the plane of the highest existing remnant

Figure 1. A swing-ladder dredge with high-pressure spray extracted 6,000 cu^3 of sand from a trench in the adjacent creek and sprayed it over the surface of Big Egg Marsh.

tussocks of smooth cordgrass *(Spartina alterniflora)*. Prescribed places within the site were to receive an additional layer of sand up to 23 cm thick, to attain a maximum elevation of 43 cm above the reference plane. The lowest-lying mudflats and drainages (which cut below the reference plane) were, therefore, to receive up to 100 cm of fill. The design was to place most of the sand in an L-shaped ridge, paralleling a bend in the adjacent creek. The total volume of sand needed was estimated at 5,000 to 6,000 cu m. Sand was to be dredged from a trench along the deepest part of the creek bottom, and sprayed throughout the fill site. The dredging and spraying were planned to start in summer 2003, immediately after the environmental compliance was completed.

The finished fill elevation was designed so that most of the marsh would be covered by the daily high tide. The highest parts of the filled site are the same elevation as the lower edge of nearby common reed *(Phragmites australis)*. If the fill were any higher, the treatment marsh would be at risk of invasion by the unwanted alien genotype of common reed.

Ecological Monitoring

Before beginning the restoration, one year of ecological monitoring was done. It was accomplished collaboratively through a cooperative agreement between the National Park Service (NPS) and the Aquatic Resources and Environmental Assessment Center (AREAC) at Brooklyn College, City University of New York. Coordination and carrying out the fieldwork was done by Gateway natural resources staff, assisted by AREAC student interns and by volunteers (local and international). Technical supervision and support were provided through the NPS Cooperative Ecosystem Studies Unit at the University of Rhode Island, and through the NPS Boston Support Office.

Monitoring of the control site and treatment site began in autumn 2002, one year before the sand was applied—thus, we have comparisons of the control and treatment sites both before and after. Monitoring is focused on physical and chemical changes of the marsh surface and creek bottom, changes in plant cover, and changes in animal occurrence. Each site has three surface elevation tables (SETs), more than 100 grid markers (many with elevations), and 30 permanent 1-m^2 vegetation plots. Also, on the treatment site there are sixteen 2-m^2 unplanted plots to monitor regrowth of the original vegetation and colonization by seedlings. There are ten places on each site where the water table is monitored, and where soil particle size and sulfides are monitored. The occurrence of birds, mammals, insects, and spiders are surveyed, as are the macroinvertebrates in the soil and water. Water quality (12 parameters) and fishes are sampled in the adjacent creek. Recovery of the excavated trenches that supplied the sand is being monitored, too. The monitoring in large part follows the guidelines specific to saltmarshes elsewhere (e.g. Niedowski 2000; Raposa et al. 2001; Roman et al. 2001).

A SET is installed at three locations in the treatment site and another three in the control site. Each SET consists of a steel rod driven at least 15 m deep into the marsh; the rod is capped with a movable arm that holds nine sampling pins (Cahoon et al. 2000). Plots of either sand or bentonite are placed nearby. The SETs provide information on subsidence, upward expansion, erosion, and accretion. Before-and-after and control-and-treatment monitoring was accomplished by installing SETs in the treatment site and in the control site, with readings beginning one year before the dredging and continuing indefinitely thereafter.

Doing the experimental restoration

Before dredging and spraying sand on the marsh, a silt fence was installed around the low-lying portions of the perimeter. About 240 hay bales, held in place by more than 1,000 wooden stakes and 2,000 m of sisal twine, provided the primary containment (Figure 2). Where silt runoff became apparent, supplemental containment was provided by installing 100 m of black plastic construction fence for silt control.

The swing-ladder dredge with high-pressure spray was contracted to pump for 200 hours. During this time, over 6,000 cu^3 of sand were placed on the 1-ha treatment site. The spray was effectively delivered to a distance of only 40 m. To gain additional distance, some slurry was streamed farther into the marsh interior by directing the nozzle horizontally across the surface of the fresh fill, causing the slurry to flow further inland. The placement of the fill was guided by white polyvinylchloride (PVC) pipes arranged in a grid pattern. Each pipe contained an elevation target marked with red duct tape and plastic flagging. Dredging was completed by the beginning of October 2003.

Figure 2. Before spraying sand on the Big Egg Marsh restoration site, 240 hay bales were staked across the drainages to contain the runoff of silt and organics.

Planting began on 3 October of that year. Over 20,000 peat pots of smooth cordgrass were planted by the volunteers and by park staff. These plants were grown on contract with the Native Plant Center, which is operated by the New York City Department of Parks & Recreation. Their seed sources were two locations on Staten Island, about 10–30 km from Jamaica Bay, but within the New York City harbor. Volunteers continued the planting for about six weeks, ending in late November 2003.

Simultaneously with the planting, green plastic fence was erected to keep geese from devouring the new plants. Geese regularly dig out smooth cordgrass by the roots during the winter, and graze the fresh green growth throughout the growing season. To prevent this on the restoration site, volunteers and NPS staff installed about 700 m of fence on 260 wooden posts. The fences were arranged in cells of about 20 m diameter, to make it difficult for geese to land or take off within the fences. Additionally, mason's woven string with surveyor's plastic flagging were stretched overhead to further subdivide the cells. Repairs had to be done repeatedly during the winter, due to damage from floating debris (wrack, wood debris, and ice), wind, and waves.

Results

The U.S. Geological Survey is reading the SETs at approximately three-month intervals. On the restoration site their SETs recorded dredge-filled sand 40 to 50 cm thick. In the year since placement of the sand, the ground surface at the SETs fell by several centimeters due to settling and surface erosion. The northwest edge of the filled area was impacted by wind-driven waves, resulting in an erosion belt 60 m long by 3–5 m wide that lost 20–40 cm of elevation. Another place of long-fetch is in the southeast, where eroding waves created another erosion belt 20 m long by 5 m wide that lost at least 20 cm of elevation.

In the first spring after planting, the smooth cordgrass in peat pots, spaced 50 cm apart, showed nearly 100% survival and regrowth. The only significant mortality of potted plants was from erosion along the marsh edge, where pots washed away. Plastic fencing kept the geese out of the planted area during spring and summer 2004, but since then the geese have become an ever-increasing problem. They seem habituated to the fences, and at high tide they swim freely through breaks in the fences to feed. Snow geese *(Chen caerulescens),* brants *(Branta bernicla),* and Canada geese *(Branta canadensis)* graze upon and dig out the smooth cordgrass. The migratory snow geese were present only during February and March, and the brants from October to May. Canada geese, however, were present all year round.

Most of the treatment marsh also experienced germination of smooth cordgrass seeds, which washed naturally onto the sandy surface during the winter. During the last week in March 2004, there seemed to be more than 2,000,000 seedlings on the treatment site. By 20 April, there were still at least 300,000 seedlings on the treatment site; in some places, particularly in wet depressions, seedling density was up to 800 seedlings/m^2. These seedlings filled in the spaces between the potted plants, at an average density of 35 seedlings/m^2 surviving in June 2004 (the range was 1 seedling/m^2 to 230 seedlings/m^2) in the plots that were unplanted. By September, the periphery of the treatment site outside the goose-excluding fence was nearly 100% reworked by the geese, resulting in the loss of most plants (both the potted plants and the seedlings that germinated on site). Inside the fence, however, most plants were surviving, except where in May and June 2004, hundreds of horseshoe crabs *(Limulus polyphemus)* passed under the fences and laid eggs in the sand of the restoration site. In doing so, they dislodged many thousands of tiny seedlings.

One of the expected advantages of thin-layer spray was that the original scattered clumps of smooth cordgrass would rebound and continue growing through the thin layer of sand. In the first year after the treatment, however, we observed that the smooth cordgrass survived only when it received 20 cm or less of sand cover. The thinner the layer, the greater the survival.

The treatment marsh after one full growing season had silt accumulating on the sand. All but the highest places had a cover of algae. The grass was entirely smooth cordgrass (Figure 3). By October 2004, in most of the permanent vegetation plots the stems from seedlings were no longer distinguishable from the stems that arose from rhizomes of the potted plants—their combined density averaged 151 stems/m^2, with a maximum of nearly 600 stems/sq m. The average stem density was nearly double that of the pretreatment plots and the control plots, due to more of the treatment plots having vegetation in them, i.e., there were fewer bare areas after restoration. The restored marsh already was being colonized by fiddler crabs (*Uca* sp.), eastern mud nassa *(Ilyanassa obsoleta),* common periwinkle *(Littorina littorea),* as well as fishes, worms, and insects.

Figure 3. By the end of the first growing season, Big Egg Marsh regained a good carpet of smooth cordgrass *(Spartina alterniflora).* The sandy soil already was accumulating silt, algae, and macroinvertebrates.

Stakeholder participation

The Big Egg Marsh experimental restoration is a collaborative effort that includes NPS permanent staff at Gateway and from the Cooperative Ecosystem Studies Unit at the University of Rhode Island. Other collaborators are AREAC, the Marine Sciences Institute at Rutgers University, Department of Oceanography and Marine Sciences at Dowling College, U.S. Geological Survey, Environmental Protection Agency, Natural Resources Conservation Service, New York State Department of Environmental Conservation, New York City Department of Parks & Recreation, and three contractors.

NPS's Jamaica Bay Institute is located at Floyd Bennett Field, a historic airfield at the west side of Jamaica Bay. The institute's mission is to lead the way toward improved stewardship of the Jamaica Bay ecosystem by creating a bridge between science and decision-making through research and education on the natural and cultural heritages of Jamaica Bay. The institute endeavors to connect people with the environmental consequences of their actions. During the past three years, the Jamaica Bay Institute has disseminated research results through publications and workshops, assisted new researchers, and fostered appreciation and accountability for the Jamaica Bay ecosystem in the urban community. The institute is participating in the experimental restoration of Big Egg Marsh.

In 2002–2003, more than 80 volunteers from local community groups, universities, and government agencies assisted in the pretreatment monitoring, site preparation, and planting (Figure 4). Since then, an additional 60-plus volunteers assisted with the maintenance and monitoring of the site. Overall, the participants in the Big Egg Marsh experimental restoration number over 200 individuals, comprising volunteers, student interns, collaborators from government agencies, contractors, and NPS staff. Many of the volunteers came from local conservation groups such as the EcoWatchers, the American Littoral Society, the Audubon Society, and the Jamaica Bay Task Force. Others came from local businesses, colleges, schools, and community organizations. To all these stakeholders, we owe many thanks.

Conclusions

The Big Egg Marsh experimental restoration is technically successful insofar as the sand is transforming into a silty and organic saltmarsh soil, there is a dense cover of smooth cordgrass, and an appropriate animal community is becoming established on the treatment site. Geese grazing and rooting increased in intensity inside the fenced treatment site after the first

Figure 4. Approximately 80 stakeholders volunteered in 2002–2003 to prepare the Big Egg Marsh restoration site, replant the Smooth Cordgrass, and assist with the monitoring. Since then, additional volunteers and other stakeholders bring the total to 200 participants.

ten months, apparently due to habituation. Consequently the goose-deterring fence will need to be rigorously maintained in place for an additional year, or alternative goose-scaring methods will be needed. Although the results are good to date, it remains to be seen how many decades the restored site will last.

The experimental restoration also was successful in a nontechnical way, by providing the opportunity for about 200 local stakeholders to become involved first-hand in protecting wetlands.

Gateway currently is collaborating with the Army Corps of Engineers to restore at least 12 ha of saltmarsh at Elder's Point, in the north side of Jamaica Bay. The findings from Big Egg Marsh will be useful for designing and monitoring the Elder's Point restoration.

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Five-Year Post-Reconstruction Kingman Marsh Monitoring Project: Vegetation

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Background

A five-year post-reconstruction monitoring project (2000–2004), which was designed to track the development of the freshwater tidal Kingman Marsh in the urbanized Anacostia River estuary (Washington, D.C.) following reconstruction in 2000, was supported by funding from the Baltimore District of the Army Corps of Engineers (CoE), the Department of Health for the District of Columbia government (DHDC) and the U.S. Geological Survey Patuxent Wildlife Research Center (PWRC). The study was conducted by staff from PWRC and the University of Maryland Department of Biological Resources Engineering (Dr. Andy Baldwin and graduate students; Baldwin 2004). The concept of the study was to track the Kingman Marsh evolution and compare it with those of a series of other local wetlands (Figure 1) as references: Kenilworth Marsh (1993), a similarly reconstructed marsh just a half-mile upstream; Dueling Creek Marsh, the last, best remaining tidal marsh in the urban Anacostia area; and the Patuxent River Marsh, a rural freshwater tidal wetland in the adjacent Patuxent watershed. The Fringe Marsh was reconstructed in 2003, but data from it is not included in this paper. Reference wetlands were monitored concurrently with the reconstructed ones. The Anacostia once had over 2,000 acres of wetland, but most were removed by mandatory dredge-and-fill operations during the first half of the 20th century (Syphax and Hammerschlag 1995) . The urge to rebuild once-extant wetlands in the Anacostia was promoted by the National Park Service (NPS) ,which has management responsibility for the reconstructed landscapes. Further background, detail, and methodology may be garnered from PWRC annual reports prepared for CoE and DHDC for the years 2000–2003 inclusive, as well as from the scope of work.

This paper is designed to include important results from the vegetation portion of the study and synthesize results from all five years of the study. The scope of this study has provided an extraordinary opportunity to gain insights into the ramifications of wetland reconstruction, and perhaps most importantly to provide data that have been used to evaluate and guide, as well as document, adaptive management actions following unforeseen or uncontrollable interventions in the marsh restoration processes. Wetland restoration efforts rarely go just as planned because complications often develop. Thus what might have been naively envisioned as a rather straightforward process at Kingman, perhaps similar to the early years at Kenilworth, became convoluted as a result of vegetation depletion from intensive grazing by overabundant resident Canada geese along with concomitant effective lowering of marsh sediments, likely from a combination of erosion, consolidation, and compression forces as

Figure 1. Composite image of a portion of the tidal Anacostia River (September 2003) showing the study wetlands. The site dates indicate when the wetlands were reconstructed. The Patuxent River Marsh is not displayed since it is in an adjacent watershed. Photo courtesy of Kinard Boone, USGS.

well as from extended periods of considerably higher-than-normal water levels. Comparisons with Kenilworth Marsh have been affected by intensive invasion by the non-native form of phragmites *(Phragmites australis)* and purple loosestrife *(Lythrum salicaria)*, which ultimately triggered necessary herbicidal treatments by a special NPS vegetation management team, while comparisons to Patuxent River Wetlands have been distorted by the building of a beaver dam, which flooded a number of transects. As a result this study really is not poised to reflect a successful pattern of restoration success from the Kingman reconstruction, but can document well what has occurred both before and after complications and adopted management actions. Actually, to embellish the original study, which focused principally on vegetation, seed bank, and seed source, the project core has been amplified by the inclusion of a three-year funded benthic study, a three-year bird study, two years of surface elevation table (SET) measurements and hydrologger data, as well as associated information from four years of fenced exclusion plots and observations from fenced plantings by the Anacostia Watershed Society (AWS).

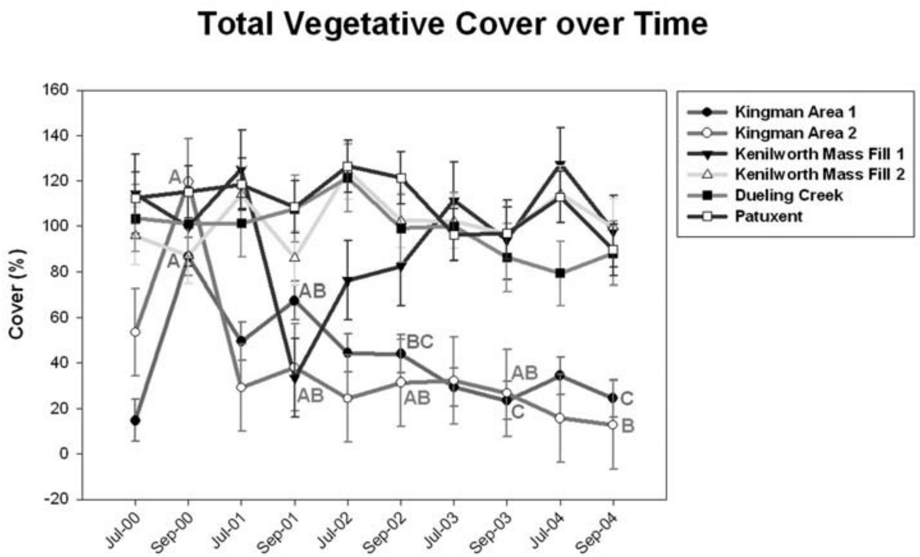
The vegetative community is recognized as a useful surrogate for such marsh functions as wetland habitat, sediment deposition, aesthetics, marsh stability, nutrient cycling, etc. Its establishment also reflects well the status of marsh hydrology, which is the key driver controlling wetland establishment under normal conditions.

Total vegetative cover

We started our scheduled monitoring in July 2000 just after planting was completed. Kingman Area 2 had been planted first, which likely accounts for vegetation cover being closer to 50%, while cover in Kingman Area 1 was less than 20%, much of which consisted of the new plantings. It is a testimony to the rapid establishment of these freshwater tidal marshes that total cover by September 2000 increased to roughly 100% (120% at Kingman Area 2 and 80% at Kingman Area 1), of which the planted species provided about 30% of the cover. Total cover in September 2000 at Kingman was similar to that of the other marshes. Thus, despite some lag in the completion of the plantings, partially due to the need to fence as well as plant, one would have to say the first-year revegetation process was successful in terms of cover, which comprised a solid component from the planted species along with an even stronger contribution by volunteer species. During the following winter of 2000–2001, the fencing was deliberately removed. The miscalculation about the fencing is evident in the 2001 cover data. Cover plummeted at Kingman Area 2 to less than 30% and at Kingman Area 1 to about 60% (Figure 2). The cover at Kingman Area 1 was significantly less (repeated measure analyses coupled with Tukey tests) than the Patuxent and the Kenilworth sites in July. The September 2001declines in cover at Kenilworth followed the first herbicide treatments to remove the invasive non-native species there—primarily the Phragmites and Lythrum. The cover decline continued at a lesser rate in the succeeding years, such that by September 2003 cover at Kingman Area 1 was significantly less than in September 2000 and at Kingman Area 2 cover was significantly less in 2002 than it was in 2000. It was good to see the rapid recovery in terms of cover, particularly at Kenilworth Mass Fill 1. Due to the marsh loss the CoE and DHDC funded a partial replanting in 2002 at Kingman.

Much of the marsh growth at Kenilworth tends to be luxuriant, with cover frequently exceeding 100% and proving almost impenetrable by summer's end. Cover at Dueling remained pretty stable over the five-year period as did that at Patuxent, with but a slight decline by September 2004, likely a result of flooding effects from the beaver dam along several transects. By September 2004 both Kingman Areas 1 and 2 were significantly different between the years from what they were in 2000 (repeated measures analyses), while Kingman Area 1 remained significantly different within the year for 2004 from the Kenilworth sites. The image depicted in Figure 2 is dramatic in portraying a persistent decline at Kingman from 2000 onward unmatched by any of the other sites (except Kenilworth Mass Fill 1,

Figure 2. Total vegetative cover of areas over time. Data points represent least square means +/- SE. Labels are based on Tukey test results (overall $\alpha = 0.05$). Within-areas means sharing the same uppercase letters are not significantly different from year to year. Unlabeled series have no significant differences.



as explained), which, overall, remained consistent, with cover near 100% or more. It is likely that the geese were responsible for the initial decline at Kingman but that in succeeding years eroding and consolidating sediment along with higher water levels in 2002 and 2003 made it difficult for the marsh to recover from grazing effects. Thus total vegetation cover that was near 100% initially has been reduced to close to 25% at Kingman while the reference areas all have been close to 100%.

It is interesting that most portions of Kenilworth Marsh, except for some edge areas, proved resilient to the goose population even though some grazing occurred early in the growing season. It just appears the marsh was able to outgrow the goose grazing pressure and produce enough vegetation so that the geese refrained from penetrating marsh areas.

Species richness

It is impressive how the number of species can be so high immediately following reconstruction. We identified 125 species at Kingman Marsh in 2000. A valuable point (Neff 2002) is that the 18 transects at Kingman picked up 75% of the total species identified there. This provides a rough efficiency of the transect cover. The number of species at Kingman Area 2 on a per-sector basis was higher in July than for any other time or for any of the other wetlands. Kingman Area 1, which was completed (final filling and grading) a couple months after Kingman Area 2, saw an increase in the number of species to a high level by September 2000. Clearly there are an important number of species that volunteer in the newly exposed sediments that would likely get competed down to a more normal level (as depicted by the other wetlands) thereafter. However, at Kingman this phenomenon did not have an opportunity to be expressed because the fence removal and consequent grazing by the geese reduced the species number in Year 2 (2001) at both Kingman areas below those of the other wetlands. By September 2001 the species per sector at Kingman was already significantly lower than the year before (Year 1). Apparently the herbicidal treatment by NPS directed at the Phragmites also affected other species at Kenilworth Mass Fill 1 because its number of species was also significantly reduced. The number of species at the other sites remained stable over the five-year period. By July 2002 the number of species at Kingman Area 2 was significantly lower than for Patuxent at the same time. The significant decline in Year 2 and the continued decline through Year 5 (2004) can be attributed to persistent grazing pressure and low sediment elevations that repress regeneration. Fewer species germinate at the lower elevations and those few that do are readily grazed in the exposed areas. Seed germination suppression due to flooding has been well documented in the literature (Leck 1995, 2003; Neff 2002; Peterson 2004; Smith et al. 2002). By 2004 there were but a few species per sector and these were growing at the higher elevations.

Contribution from planted versus unplanted species

The planting at Kingman in 2000 consisted of seven species: *Pontederia cordata* (200,000), *Peltandra virginica* (154,000), *Schoenoplectus tabernaemontani* (120,000), *Sagittaria latifolia* (120,00), *Juncus effusus* (43,000), *Schoenoplectus pungens* (40,000), and *Nuphar luteum*. This total of roughly 700,000 plants includes about 40,000 that had to be replanted due to initial goose grazing before fencing was installed to protect the new plantings. These species were pared down from the sixteen species planted at Kenilworth based on availability and survival. The expectation was that the plantings (on approximate 2-ft centers) would ensure rapid colonization cover of species that would be important to the ultimate marsh community structure. While it had been documented by Baldwin's project study that there was abundant waterborne seed available to help establish rapid cover, the investment in planting important plant species not in abundance in the seed bank was still considered a worthwhile investment to assure establishment of a vigorous and representative freshwater tidal marsh. A small portion of the marsh was left unplanted. What we determined from monitoring was that altogether the planted species provided about 40% of the cover by September 2000 (the first year) but that this contribution toward absolute cover declined by year two (2001) and remained at about 10% cover thereafter, even though there was partial replanting of *P. virginica* and *S. tabernaemontani* (both geese-unpalatable species) in 2002, some small portions of which happened to be in locations where our transects were located. What does need to be noted is that even though the cover by planted species remained low, they did provide about 50% of the vegetative cover that remained in 2003 and 2004. Almost none of the planted species, except less than 5% cover by *P. virginica* and *J. effusus* in 2004, were found in the unplanted transects during the study. By 2003 Peltandra and Nuphar were the only planted vegetation providing cover. The bottom line is that the situation of extensive goose grazing and minimal area left unplanted precluded the reconstructed Kingman Marsh from being a fair measure of the utility of heavily planting the newly reconstructed Anacostia wetlands.

Contribution by annuals and perennials

Annuals succeed by producing seeds which germinate and yield new plants on site each year. If conditions become less favorable for this process to occur, annuals will decline. For many annuals seed germination and seedling growth is dependent on aerobic respiration, which in turn needs at least modest oxygen levels in the sediment. The longer sediments are inundated, the more likely they will be anaerobic. What this means, then, for explaining the cover produced by annuals is that conditions that lower sediment elevations or raise water levels may lead to decline of annuals or make it more difficult for them to recover from grazing pressure. At Kingman Area 1 there has been a complete loss (significant) of annuals since 2000, when annuals provided as much as 30% cover. Annuals also collapsed at Kingman Area 2, although some of the higher elevations there may provide some refuge. A problem faced by annuals was that as soon as a few slower-responding annuals would sprout in the more open (grazed out) lower elevations, the geese and other herbivores could easily nip them off. Under this scenario there is little or no opportunity for the vegetation to outgrow the goose grazing pressure at Kingman, whereas successful out-competing growth seems to occur at the unfenced, but higher-elevation, Kenilworth Marsh. Kenilworth supports about 10–20% cover by annuals. Dueling Creek Marsh, as an unreconstructed wetland bench in the Anacostia, sustained about 30% annuals throughout the study. The Patuxent wetland, which is less urban and less disturbed, supported about 60% cover by annuals until flooding in 2002 by the newly constructed massive beaver dam caused a significant collapse of annuals there!

Perennials may be better adapted to lower sediment oxygen levels since many can transport oxygen down to the roots via their emergent tissues. Also, perennials that can regrow year-to-year from rhizomes and tubers are not as dependent for survival or spread by seeds. Perennials declined sharply with removal of fencing at Kingman Area 2 in early 2001 and have continued to slowly decline throughout the study to where they provide less than 20% cover in 2004, whereas they were as high as 80% in 2000 (however, this decline is not statistically significant). At Kingman Area 1, which has some higher elevations where some of the transects are located, the perennials declined significantly from 60% cover in 2000 to about 25% cover in 2004. Kenilworth seemed to experience some modest increase after 2002, possibly as a recolonization response following herbicide treatment for Phragmites. Perennial growth at Patuxent also increased after 2002, possibly partially taking advantage of the reduction in competition from the annuals lost to beaver dam flooding. Meanwhile, perennial cover at Dueling Creek, the one site in our study that didn't undergo any traumatic impacts, held steady throughout the study at about 70% cover. Thus, in this study the absolute cover by annuals and perennials seemed to reflect well the conditions under which they were forced to grow.

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Reclamation is a Long-Term Prospect: Lessons Learned at Prince William Forest Park, Virginia

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Introduction

Prince William Forest Park, a unit of the National Park Service (NPS), is located in Triangle, Virginia, approximately 30 miles south of Washington, D.C. The park protects 15,000 acres of Piedmont forest and 70% of the Quantico Creek watershed. It is used primarily for passive recreation, including hiking, biking, and camping. One of the most heavily visited areas in the park is the Cabin Branch Pyrite Mine site. Waysides located at the site tell the story of the large pyrite mine that operated in the late 19th and early 20th centuries.

Pyrite was first discovered in Quantico Creek in 1890, and the Cabin Branch Pyrite Mine began operation in 1889 in the southeastern corner of what is today Prince William Forest Park. Pyrite (iron sulfide) was mined for its sulfur content, which was used in the production of sulfuric acid, gunpowder, and many other products. From 1908 to 1920, more than 200,000 tons of pyrite were excavated from the pyrite lens, which was estimated to be 1,000 feet long and up to 14 feet wide. There were eight shafts, a narrow-gauge railroad, and 70 buildings associated with the mine (Mountjoy 1978). After the mine closed in 1920, the site was abandoned, and aerial photographs taken of the site in 1937 and 1954 show it to be barren with a few small patches of vegetation.

Early studies and reclamation efforts

Prior to reclamation, the site contained approximately seven acres of primarily barren, acidic soils spanning both sides of Quantico Creek, and water quality at the site was very poor due to acid mine drainage and heavy metal contamination. Eight reclamation projects and/or studies were undertaken between 1971 and 1994 at the Cabin Branch Pyrite Mine site. Management efforts during that period were focused around stabilizing the stream bank and leaving the rest of the site barren for environmental studies and experimentation by park visitors, researchers, and youth groups.

The first documented soil samples were taken on site in 1971 by James Patterson, an agronomist working in the NPS National Capital Region's Professional Services Division. The pH was found to be around 2.8, and lime and fertilizer applications were recommended (Patterson 1971). No follow-up work was documented in park files. In 1980, superintendent Robert Harney requested additional assistance from Professional Services staff, stating that "In the last few years, the area has been subject to extensive erosion…. The pyrite ore is highly acidic and is continually exposed by precipitation and erosion."

Twenty-seven research plots were installed at the mine site in the summer of 1980. Nine different reclamation techniques involving varying concentrations of fertilizer, lime, compost, and a combination of lime and compost were evaluated. Grass seed was planted in each plot; the best results were observed in those plots treated only with compost. Soil samples showed pH values ranging from 2.0 to 3.9, and concentrations of soluble salts ranging from 1,800 to 2,560 ppm (Patterson et al. 1984). As part of this three-year study, the researchers also measured the depth of overburden at the site and found depths ranging from 8 inches to more than 36 inches. Overburden is defined as a mixture of pyrite, sulfur compounds, soil, stone, and rock fragment. They noted that the soil had been moved often during the life of the mine and that the spoils had been used as fill for grading (Patterson et al. 1982).

Subsequent efforts included the development of a site rehabilitation plan by park staff; a stream bank stabilization project performed by a group of Eagle Scouts; a Virginia pine transplant study conducted by L.K. Thomas, research scientist in the National Capital Region; and an abandoned mineral lands field inspection and site reconnaissance visit conducted by Bob Higgins, chief of the Mineral Resources Section of the NPS Mining and Minerals Branch, and Phil Cloues, a mining engineer. During the latter site visit, several old mine shafts were identified by their concave appearance on the landscape, and erosion problems along the stream banks were noted. Higgins and Cloues recommended that all shafts be located and drilled to determine how they were capped, that soil and water samples be collected and analyzed for metals and pH, and that warning signs be posted at the site (Higgins 1989).

In the early 1990s, Prince William Forest Park began planning for a full-scale reclamation of the Cabin Branch Pyrite Mine site. This period marked a shift in management focus from stream bank stabilization to total site remediation. The impetus for this shift was a change in Environmental Protection Agency (EPA) regulations, which now included acid drainage from abandoned mines as nonpoint source pollution. Assistance was requested from the NPS Water Resources Division, which funded a project that collected and analyzed groundwater, surface water, stream sediments, and soils. Several metals were found at concentrations that exceeded EPA standards, pH values ranged from 6 to less than 3.5, and the mine site was found to be impacting the local aquatic ecosystem (Resource International Ltd. 1993, 1994).

Site reclamation

The primary non-NPS partner for the reclamation project was the Virginia Department of Mines, Minerals, and Energy (DMME), which helped secure funding and develop reclamation project specifications based on previous work at abandoned pyrite mine sites. National Park Service staff from the Water Resources Division, Geologic Resources Division, National Capital Region Center for Urban Ecology, and Prince William Forest Park worked closely with the DMME to ensure that the project was in line with NPS policies and to review and update specifications. The goals of the project were to eliminate impacts on natural resources, ensure the safety and health of park visitors and staff, and bring the area into compliance with the Clean Water Act.

In 1995 the park began a $152,000 multi-agency reclamation project with funds from the EPA's Non-point Source Program, the NPS Geologic and Water Resources Divisions, the DMME, the Virginia Orphaned Mines Program, the NPS National Capital Region, and the Virginia Department of Conservation and Recreation. The reclamation included sealing eight mine shafts with reinforced cement caps, pulling back all tailings within 20 feet of the stream banks and storing them against a high wall on site, leaving the other tailings piles in place, and treating all tailings with agricultural lime at a rate of 20 tons per acre and covering them with approximately one foot of clean topsoil. Stormwater conveyances were constructed to divert surface water away from the tailings piles, and 3,500 trees and 500 shrubs were planted.

Post-reclamation studies and follow-up efforts

Disturbed lands reclamation is a long-term process that requires numerous studies and efforts both before and after the main reclamation work. There is no quick fix and the Cabin Branch Pyrite Mine is a prime example of this. The reclamation project is considered to be a success and has been highlighted as such by the Environmental Protection Agency (EPA 2002) and the DMME. Post-reclamation, ten studies have been conducted by universities, federal agencies, and park staff; these have evaluated the success of different aspects of the reclamation project. Highlights from several of the studies are provided below.

During the period 1997–1999, a two-year post-reclamation water quality study was conducted by researchers from George Mason University. The data collected showed a decrease in heavy metals in Quantico Creek, an increase in the number of fish species and individual fish in the creek, and an increase in the pH of the creek to a level that is now capable of supporting aquatic life. Benthic macroinvertebrate data showed assemblages that varied from nonimpaired to moderately impaired (Hamblin-Katnik et al. 2000), and data collected at the site as part of Prince William Forest Park's in-house water quality monitoring program show that diversity is improving in this area.

The U.S. Geological Survey (USGS) has performed several studies on site. The first was a one-year (1997) surface water and groundwater study in which quarterly samples were taken and compared with those taken at a control site. The control site was located in an area with a large pyrite belt that had never been mined, thus providing a reference for what would be natural background levels. All samples fell within the field of those taken at the control site (Seal 1997). In 1999, the USGS performed a ground electromagnetic survey that used soil conductivity to map the distribution of sulfides. They found that the highest conductivity zones were associated with the tailings piles and that the creek and stream banks were low-conductivity areas (Wynn 2000). Finally, the park worked with the USGS on a three-year project during the period 1999–2001, which demonstrated that the stormwater conveyance and associated ponds were effectively capturing runoff, and several of the ponds were providing suitable habitat for amphibians (Pollio 2001).

In September 2004, over 100 soil samples were collected by park staff with assistance from Greg Eckert, an NPS restoration ecologist, in response to a trip report written after a 2002 site visit. Eckert noted that "[t]he site is stable today; however, a nonnative species of lespedeza is the primary ground cover. A 'hot spot' also remains on the east side of the creek. This area is devoid of vegetation and water samples taken from the storm water runoff channels show high concentrations of metals.... Virginia pine is colonizing the site from one side, while other tree plantings appear to have had total failure" (Eckert 2002). The purposes of this project were to evaluate the integrity of the lime cap, determine the soil conditions where the site is barren and compare them with the vegetated areas, and provide data to determine what soil amendments may be needed. Preliminary results indicate that soil on the west side of the creek is intact and functioning, and remaining bare areas may be evidence of erosion from surface runoff. These need to be addressed, but will not require major application of lime and soil. Soil sample pH in the samples from the west side ranged close to neutral. The east side of the creek may need additional reclamation efforts, as numerous acidic hotspots were identified in that area. The data are currently being analyzed by Ken Gerow, statistician with the Statistical Consulting Center at the University of Wyoming. Additional studies, including mycorrizhal fungal assessment of abundance, morphotype identification, and innocula increases, are being conducted through the Rutgers University Pinelands Research Station.

Conclusions

Ten years after reclamation, follow-up efforts to treat barren sites and continued monitoring are still required. Conditions at the Cabin Branch Pyrite Mine have improved dramatically, but the site is still far from being fully restored. Prince William Forest Park staff remain in contact with NPS Natural Resources Program Center staff, and with the DMME, and are encouraging additional research on this unique site.

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Snake River Restoration Efforts in Grand Teton National Park

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The Cooperative Conservation Initiative process

In the first year of its funding (2003), the Cooperative Conservation Initiative offered a very short time period in which to develop partnerships and obligate funds. Grand Teton National Park was made aware of the initiative in August. Partnerships had to be formed and funds obligated by 30 September of that year. In spite of the short time frame, Grand Teton managed to obligate $120,000 (with a $120,000 match from local partners), and developed partnerships that continue to this day. Eight projects were funded through the 2003 Cooperative Conservation Initiative.

Habitat restoration/enhancement at Bar BC Spring

Prior to the dedication of Grand Teton National Park, a fish hatchery was constructed on the East Fork of the Upper Bar BC Spring. Dams were constructed to provide rearing ponds. Some of the channel above and below the rearing ponds was widened for some unknown purpose. After the hatchery was abandoned, the dams were left intact and sediment continued to accumulate in the ponds. In 1984, in cooperation with the park, Wyoming Game and Fish Department personnel removed three of the dam structures, excavated sediments, and exposed gravels to a limited extent. This project continued the restoration work begun in 1984. Project tasks included removal of remaining dam structures, removal of accumulated sediments, narrowing the channel to normal width, excavation of natural gravels or placement of commercial washed gravels where natural gravels cannot be reclaimed, and placement of overhead cover (trees) for protection of spawning fish and escape cover for fry.

Two Ocean Lake culvert replacement

Two Ocean Lake has been stocked with 30,000 cutthroat trout annually by the Wyoming Game and Fish Department. A culvert on Two Ocean Creek was identified as a barrier to native fish migration. If this culvert were replaced or modified to allow upstream migration of fish, the need for stocking of Two Ocean Lake would be eliminated, and natural processes could be restored. This project modified the approach to the existing culvert by constructing a series of rock weirs to facilitate fish passage. Wyoming Game and Fish plans to discontinue stocking of Two Ocean Lake, allowing natural migration to maintain cutthroat trout populations.

Water use documentation project

Restoration of habitat for fish and other aquatic organisms depends, in part, on the availability of sufficient water within park water bodies. This project conducted an inventory of irrigation ditches within Grand Teton National Park. The ditches were mapped, flow in the ditches was measured, and an interactive database containing all the adjudicated water rights within the park was constructed. The results of this project will help managers make decisions that comply with applicable laws and regulations pertaining to allocation and use of water, as well as provide the best protection of park resources.

Jackson Lake fisheries evaluation

Jackson Lake was originally stocked with lake trout *(Salvelinus namaycush)* in1937, and is still being stocked today. Little research has been conducted to document the effects that stocking of introduced (exotic) lake trout may be having on the native Snake River cutthroat *(Oncorhynchus clarki* ssp.). The objective of this study was to analyze fisheries data and develop a bioenergetics model to use as a tool for assessing the current status and predicting future trends of the lake trout population in Jackson Lake. Initially, the bioenergetics model will be used to help define data gaps. The bioenergetics model will also provide a framework for future investigations of the status of native fishes within Jackson Lake, including Yellowstone cutthroat trout (*Oncorhynchus clarki bouvieri*). This study is on-going. Preliminary results include:

- Cutthroat, lake, and brown trout stomachs were dissected and frozen under dry ice conditions, and otoliths removed.
- Food items were removed from fish stomachs, weighed, and classified as: zooplankton, aquatic macroinvertebrate, terrestrial macroinvertebrate, and fish.
- No trout were observed in any fish stomachs.

Streambank restoration, Snake River at Moose

The west bank of the Snake River at Moose has retreated as much as five feet over the last six years in response to 1997 flood conditions. Undercutting of the bank is on-going, evidenced by several trees that have recently toppled into the river. In the past, park managers have used unsightly riprap to help reduce bank erosion in this reach of the Snake River. The Natural Resource Conservation Service, in cooperation with the local Conservation District, sponsored a "Riparian Ecology and Restoration" workshop in Moose, May 24–26, 2005. The workshop will consist of a one-and-a-half-day classroom exercise, followed by a one-and-a-half days of field work that will call upon attendees and other volunteers from the community, neighboring agencies, sister parks, etc., to complete the bank stabilization work. This project will utilize state-of-the-art bioengineering techniques to restore riparian vegetation, thereby restoring fish habitat to this area. In addition, this project will serve as a demonstration project for streambank restoration techniques.

Snake River and Yellowstone cutthroat trout subspecies distribution mapping

The goal of this project was to document the geographic distributions of Snake River cutthroat trout and Yellowstone cutthroat trout in the Snake River headwaters of Wyoming. The distribution of Snake River and Yellowstone cutthroat trout in the Snake River basin is unique. This is the only watershed where two subspecies of cutthroat trout are indigenous. Until this project, the range of Yellowstone cutthroat trout within the Snake River basin of Wyoming was unconfirmed. A systematic inventory was conducted to delineate the reaches of streams that support Yellowstone cutthroat trout. Maps are now available that definitively display the present distribution of these subspecies of cutthroat trout in the Snake River headwaters in Wyoming.

Effects of Jackson Lake Dam on hydrology and geomorphology of the Snake River

The outlet of Jackson Lake was dammed in 1906. The original log-crib dam was replaced by a larger structure in 1918 that raised the lake level by 11.9 m (39 ft). The reservoir has since been operated to provide irrigation water to areas in Idaho during the growing season. In 1957 the Palisades Reservoir became the primary storage facility for irrigation agriculture. The release schedule for Jackson Lake Dam changed, with a decrease in the frequency and magnitude of the peak flows. These changes in flow regime have triggered channel and vegetation changes.

Jack Schmidt of Utah State University conducted an analysis of the hydrologic change that has occurred on the Snake River near Moran during the last century, using daily U.S. Geological Survey stream-flow data and synthetic natural stream-flow data representative of unregulated conditions.

The hydrologic regime of the modern Snake River is substantially different from the estimated natural flow regime and from the regulated flow regime that existed prior to 1957. Today's late-spring floods are much lower and late-summer flows much higher than if the dam did not exist. Today's fall and winter flows are approximately what they would be if there were no dam, and they are much higher than prior to 1957, when base flows were very low. Today's flood regime is much lower than those prior to 1957 but occur in a more "natural" season. Analyses were based on three techniques: traditional comparison of mean daily and instantaneous stream flow, continuous wavelet analysis, and analysis using the Indicators of Hydrologic Alteration software.

Fish Screen for large irrigation diversion near south boundary

A large irrigation diversion within Grand Teton National Park is removing a significant cutthroat trout population from the Snake River. While many of these trout are providing a supply of fish to creeks located further down the watershed, many fish are also lost (trapped) when the ditch is shut down in the fall. This project paid for a consultant to survey the diversion and design a system of fish screens to redirect the cutthroats back into the Snake River.

Conclusions

We concluded that Cooperative Conservation Initiative funding was a valuable resource for Grand Teton National Park. Properly written projects could get a lot of "bang for the "buck," and the partnerships formed for these projects are lasting and continuing. Partners included the following:

- **One-Fly,** a local fly fishing organization with ties to the National Fish and Wildlife Foundation, participated in design and on-the-ground project implementation.
- **Trout Unlimited—Wyoming Water Project** worked collaboratively to inventory water uses of water bodies targeted for restoration efforts.

- The local chapter of **Trout Unlimited** partnered with several of project components.
- **Wyoming Game and Fish Department** fisheries biologists were involved in almost all projects to some extent, with mostly in-kind donations for professional expertise. They supervised most restoration work. Thirty years of fisheries data were compiled and analyzed, representing a significant cost share contribution.
- **Teton County Conservation District** staff provided significant in-kind contributions for workshop organization (advertisements in paper, meeting coordination) for the bank stabilization project at Moose. In addition, they will contribute tools and materials needed to complete the project.

Native Plant Restoration at Stones River National Battlefield

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Stones River National Battlefield is located in south-central Tennessee on the outskirts of the city of Murfreesboro. Historically, this park is the location of the first major battle in the Union's effort to divide the Confederacy by mounting an eastward-moving campaign through the South to the Atlantic Ocean. The battle fought here between December 31, 1862, and January 2, 1863, ranged over 4,000 acres, of which 10–12% is preserved within the current Stones River National Battlefield. Many battlefield accounts of the difficult terrain exist, especially of the cedar thickets, cedar brakes, and rock ledges and outcroppings that presented major obstacles to the movement of troops and equipment.

Cedar glades, another component of the battlefield terrain, are also mentioned in battlefield records. Figure 1 is a vintage photograph that is fairly representative of cedar glades in the area circa 1862.

Today, cedar glades at Stones River are typically represented by the scene in Figure 2. The transition from the previous scene to this has occurred primarily through cessation of farming the land.

Figure 1. Cedar glades, circa 1862. Photo courtesy of Stones River National Battlefield natural resources staff.

Other typical battlefield scenes include period artillery pieces such as cannons, boardwalks and signage in key interpretive areas within the park, earthwork embattlements, and monuments.

In addition to its historic importance, Stones River National Battlefield is also ecologically significant. Stones River is one of the top twenty-six calcareous glades in Tennessee and one of the top 40 glades in the Southeast. Calcareous glades of the southeastern United States contribute to the biodiversity of the region through their unique habitat and the species that colonize that habitat. In Tennessee, the Division of Natural Heritage has found that 10% of the Tennessee-listed rare plants are found in limestone glades. A glade is identified as an open area of relatively shallow, often rocky soil surrounded by cedar woods. Some examples of rare taxa that inhabit Stones River glades are *Echinacea tennesseensis*, Tennessee coneflower, and *Talinum calcaricum*, limestone fameflower. Other non-listed endemics include *Erythronium americanum*, trout lily; *Cardamine concatenata,* five-parted toothwort; and *Trillium cuneatum,* toadshade.

In 1995, the natural resources staff at Stones River conducted a vascular plant inventory of the calcareous glades of the battlefield. This inventory established a vegetative baseline for monitoring vegetative changes within the Stones River glades. The data also provided information about the direction of change for major glade indicators with the increase in woody (that is, cedar) cover. Population trends for major glade indicator species have declined with increasing cedar cover.

Figure 2. Typical present-day cedar glade. Photo courtesy of Stones River National Battlefield natural resources staff.

Using these findings, the natural resources staff at Stones River has developed and is implementing an invasive species control plan. Exotic invasives are being controlled primarily through use of labor to cut or dig the offending plants. Native invasives, such as the red cedar, will likely be controlled through cutting and/or controlled burning. However, the degree of complexity associated with the glade indicator species population trend is greater than the complexity of the invasive species control issue.

Thus, Stones River National Battlefield opted to enter into an agreement with the U.S. Department of Agriculture–Natural Resources Conservation Service Plant Materials Center in Alderson, West Virginia, to produce seed and/or seedlings of some 20 species of glade indicator plants in order to preserve and/or improve cedar glade floristic authenticity. Plants are produced by the plant materials center from Stones River-ecotype seeds and used to establish seed production fields within the park. Seed harvested from these fields will then be used to enhance floristic authenticity within the park's calcareous glades. A brief description of this process follows.

The process begins with collection of native plant seed within the park confines from plants such as *Andropogon ternarius,* splitbeard bluestem (Figure 3).

Figure 3. *Andropogon ternarius,* splitbeard bluestem. Photo courtesy Alderson Plant Materials Center.

Once harvested, seed is transported to the plant materials center where it is conditioned and stored in a temperature- and humidity-controlled environment until planting.

Seed conditioning typically utilizes specialized equipment to separate vegetative debris from seed. Conditioning is performed to improve seed handling and/or germination characteristics.

Upon removal from climate-controlled storage, seed is planted in individual cells. After planting, the flats or trays may be placed cold storage for stratification if needed or directly into a greenhouse environment if stratification is not required. Once placed in the greenhouse, seed is subjected to controlled temperature, lighting ,and moisture regimes to ensure optimal germination. Plants remain in greenhouse conditions until an extensive root system has developed. Plants are then returned to Stones River, where they are used to establish permanent seed production fields.

At Stones River, transplanting is accomplished by using a mechanized transplanter that is propelled with a small farm tractor. Hand labor is used to remove the seedling plugs from the greenhouse trays and load them into the transplanter. Field preparation prior to transplanting typically involves use of a contact herbicide to remove existing vegetation and tillage, followed by plowing and disking to prepare the soil to ensure optimum transplant root-to-soil contact.

Figure 4. Typical seed production field at Stones River National Battlefield. Photo courtesy of Stones River National Battlefield natural resources staff.

Figure 4 shows well-established seed production fields that should serve the native plant restoration needs of Stones River Natural Resources staff well into the future. With proper management and care, fields such as these should remain productive indefinitely.

Other species that are being increased for Stones River include *Solidago nemoralis*, gray goldenrod; *Lespedeza violacea,* violet lespedeza; *Forestiera ligustrina,* upland swamp privet; *Symphotrichum drummondii,* Drummond's aster; and *Eragrostis spectabilis,* purple lovegrass. In 2004, the Alderson Plant Materials Center produced approximately 20,000 seedling plugs of 12 Stones River-ecotype native plants. The Stones River native plant restoration project is scheduled to continue for at least three more years.

In summary, the Stones River National Battlefield native plant restoration project promotes sustainability of local plant ecotypes, ensures circa-1862 floristic authenticity within the park, minimizes genetic shift, and improves knowledge of propagation techniques for several native species.

Place Identity, Place Dependence, and Place-Based Affect: Examining Their Relationship to Participation in Educational and Interpretive Programs at Isle Royale National Park

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Introduction

Study of the person–place relationship is becoming increasingly important to public land managers as they strive to incorporate the public into management plan development and implementation. Place attachment is one dimension of the person–place relationship that can provide information regarding visitors and their connection to particular public lands. Place attachment has been described as "the emotional link formed by an individual to a physical site that has been given meaning through interaction" (Milligan 1998:2). It is generally described as having at least two dimensions: place identity and place dependence. Place dependence is conceptualized as the opportunities a setting provides for goal and activity needs (Stokols and Schumaker 1981), and place identity refers to the symbolic meaning a particular place has to an individual (Kyle et al. 2005). In addition to its cognition and behavioral components, Low and Altman (1992) describe place attachment as primarily an affective construct. However, few previous studies measure affect separate from identity. In this study, place-based affect was constructed to measure that affect and operationalized as the positive or negative feeling one has towards a place (Rosenberg 1960).

With respect to place attachment, researchers have found that individuals are more likely to act in protective ways about places to which they are attached (Vaske and Kobrin 2001). Additionally, researchers have also suggested people become attached as they interact with a place (Jorgensen and Stedman 2002; Moore and Graefe 1984). One method of interacting with a place is through participation in educational or interpretive programs at that place.

The purpose of this study was twofold. In the first part of the study, we separated affect from identity and analyzed the three separate constructs of place identity, place dependence, and place-based affect. For the second part of the study, we examined the relationship of each of these constructs to participation in Elderhostel programs, an educationally based program conducted at Isle Royale National Park, and to participation in National Park Service interpretive programs conducted at Isle Royale National Park.

Study location

Established in 1940, Isle Royale National Park also received designation as an international biosphere reserve in 1980. The park is 99% federally designated wilderness and consists of an archipelago of approximately 44 islands located in the northwestern part of Lake Superior approximately 30 miles off the coasts of Minnesota, U.S.A. and Ontario, Canada.

Visitor centers are located on northeast and southwest ends of the 9-mile-wide and 44-mile-long main island. The island is home to an abundance of small animals such as foxes, beavers, loons, and cormorants, a plethora of wildflowers and insects, and a self-contained wolf and moose population. Isle Royale usually has from 15,000 to 18,000 visitors annually and is one of the least visited parks in the national park system. It is accessible only by seaplane or boat.

Methods

In August 2004, visitors returning from Isle Royale were asked to participate in a survey designed to measure the three constructs of place identity, place dependence, and place-based affect as well as participation in both educational and interpretive programs at the Park. On the return boat trip from Isle Royale visitors were provided with a 30-minute questionnaire. The convenience sampling technique resulted in 254 completed questionnaires, of which 248 were usable.

Results

Women (47%) and men (53%) were relatively equally represented in this survey. Sixty-eight percent of them were from the neighboring states of Michigan, Wisconsin, Illinois, and Minnesota, while the remaining 32% were scattered from California to Arizona to Maine to Florida and twenty other states. Respondents reported permanent residences as well as household incomes that varied relatively equally (see Table 1). They were also highly educated (mean education = 16.1 years of school) and predominantly white/Caucasian (96.1%). While visiting Isle Royale, the majority of respondents camped in the backcountry and participated in activities typical of wilderness-type areas, e.g., wildlife viewing, day-hiking, and camping.

The purpose of the first part of the analysis was to determine the factor structure of the items used to measure place identity, place dependence, and place-based affect. Place dependence, place identity, and place-based affect were all measured on bipolar nine-point scales. Place dependence and place identity were measured with Likert-type scales ranging from strongly agree (9) to strongly disagree (1). Place-based affect was also measured on a nine-point scale. However, based on previous research (Vescio et al. 2003), a semantic differential scale with emotion pairs (9 = strong positive emotion and 1 = strong negative emotion) was used to measure this construct (see Table 2).

Exploratory factor analysis with a varimax rotation was conducted on 15 items (four measuring place identity, five measuring place dependency, and 6 measuring place-based affect). As predicted, the 15 items loaded into three factors (see Table 3). Using Cohen's recommendation of factor loadings acceptable if greater than .60, there were two items of concern. First, item IR_PA5 cross-loaded on both the identity and dependence factors. This item, however, was supported by existing theory to test place dependence and was retained as a place dependence factor in the analysis. The other item was IR_PA3, which had a factor loading of .555. However, this item was again retained in further analysis due to the previous theoretical and empirical support for its inclusion as a measure of place identity.

Characteristic	N	Overall % (n=245)
Gender		
Male		53.0
Female		47.0
Current residence		
Small town or rural		30.8
Large town/small city		17.6
Medium-sized city		26.9
Large city		24.7
Where grew up		
Small town or rural		30.8
Large town/small city		17.6
Medium-sized city		26.9
Large city		24.7
Household income		
<$40,000		24.7
$40,000-79,999		30.9
$80,000-119,999		24.6
$120,000 or more		19.8
Race		
White or Caucasian		96.1
Asian		2.2
American Indian, Alaska Native or First Nation		1.3
Black or African American		
		0.4

Table 1. Sociodemographic characteristics of participants.

Reliability analyses were then conducted on the items predicted to load on each factor. Each predicted factor exhibited a Cronbach's alpha of greater than .70, which was determined to be an acceptable level of internal consistency (Nunnally 1978). One item, "The things I do at IRNP, I would enjoy doing just as much at a similar place," which was reverse-coded for analysis, would have increased the reliability of the place dependence factor from .806 to .855 if removed. This is consistent with previous research on place using reverse-coded items (e.g., Williams and Vaske 2003; Stedman 2002; Bricker and Kerstetter 2000). However, these items also allow for the testing of the negative aspect of place dependence rather than only the positive. Due to its contribution to the overall measure and the acceptable alpha of all five items as well as support from previous research, the reverse-coded item was retained.

Based on the factor and reliability analyses, the three place constructs were accepted as three distinct factors. Index scores were created for each of the place constructs by calculating the mean of all items contributing to that construct. Index scores were then examined for differences between those who participated and those who did not participate in educational and interpretive programs at Isle Royale National Park. Two null hypotheses were tested. Hypothesis 1: There will not be a significant difference in place identity, place dependence,

Item Code		Factor 1 Place Identity	Factor 2 Place Dependence	Factor 3 Place-based Affect
IR_PA6	(PI) IRNP reflects type of person I am	.796	.104	.270
IR_PA11	(PI) Visiting IRNP says a lot about me and who I am	.795	.095	.140
IR_PA8	(PI) IRNP means a lot to me	.675	.324	.071
IR_PA3	(PI) I feel that I can really be myself at IRNP	.552	.102	.054
IR_PA5	(PD) IRNP is the best place to do the things I enjoy	.565	.555	.054
IR_PA9	(PD) What I do at IRNP is more important than doing it anywhere else	.377	.803	.014
IR_PA12	(PD) I wouldn't substitute any other area for doing what I do at IRNP	.230	.785	–.004
IR_PA2	(PD) I get more satisfaction visiting IRNP than any other place	.369	.670	.033
IR_PA1	(PD) The things I do at IRNP I would enjoy just as much at a similar place*	–.180	.609	.122
IR_PAFF1	(PBA) Happy/Angry at IRNP	.155	.098	.877
IR_PAFF2	(PBA) Calm/Tense at IRNP	.109	.004	.871
IR_PAFF3	(PBA) Relaxed/Worried at IRNP	.079	.063	.825
IR_PAFF4	(PBA) Self-assured/Insecure at IRNP	.031	.074	.742
IR_PAFF5	(PBA) Energized/Lethargic at IRNP	.241	–.087	.643
IR_PAFF6	(PBA) Content/Irritated at IRNP	.211	.100	.629

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

(PI) = Place identity, (PD) = Place dependence, (PBA) = Place-based affect.

Place identity and place dependence measured on 9-point Likert-type scale with 1=strongly agree and 9=strongly disagree.

Place-based affect measured on 9-point semantic differential with 1=strong positive affect and 9=strong negative affect.

*Item was reverse-coded.

Table 2. Rotated component matrix for place attachment items measured for Isle Royale National Park.

Item	Mean	SD	if item removed	Index
Place Identity				.787
I feel I can really be myself at IRNP.	6.44	1.85	.784	
IRNP reflects the type of person I am.	6.19	1.88	.692	
IRNP means a lot to me.	6.92	1.85	.739	
Visiting IRNP says a lot about me.	5.82	2.12	.710	
Place Dependence				.806
I get more satisfaction visiting IRNP than elsewhere.	5.12	2.14	.736	
IRNP is the best place to do the things I enjoy.*	5.61	1.93	.756	
What I do at IRNP is more important than elsewhere.	4.71	2.23	.693	
The things I do at IRNP, I would enjoy just as much at a similar place.**	3.64	2.32	.855	
I wouldn't substitute any other area for IRNP to do what I like to do.	4.16	2.22	.727	
Place-based Affect				.868
Relaxed/Worried	7.65	1.41	.867	
Happy/Angry	7.73	1.68	.832	
Energized/Lethargic	7.88	1.46	.817	
Calm/Tense	7.68	1.45	.856	
Content/Irritated	7.41	1.75	.865	
Self-assured/Insecure	7.62	1.61	.815	

Place identity and place dependence items were measured on a 9-point Likert-type scale with 9=strongly agree and 1=strongly disagree.

Place-based affect items were measured on a 9-point semantic differential with 9=strong positive affect and 1=strong negative affect.

* This item factor loaded on both place dependence and place identity.

** This item was reverse-coded for analysis.

Table 3. Means and preliminary reliability analysis for place attachment items and indices.

and place-based affect between visitors to Isle Royale National Park who participated in educational programs related to the park and those who did not participate. Hypothesis 2: There will be no significant difference in place identity, place dependence, and place-based affect between visitors to Isle Royale National Park who participated in park interpretive programs and those who did not participate.

Hypothesis 1 was tested by dividing participants into two groups: those who had participated in Elderhostel and those who had not. Then, using t-test statistics, mean scores of each place construct were tested for differences between the two groups. No significant relationships were found (see Table 4).

Hypothesis 2 was tested in two ways. First, Elderhostel respondents were removed from

Construct	Elderhostel Participant	Mean	F-value	p-value
Place Identity				
(IRNP)	No	6.41	.610	.436
	Yes	6.23		
Place Dependence				
(IRNP)	No	4.82	3.32	.070
	Yes	4.28		
Place-based Affect				
(IRNP)	No	7.65	.005	.945
	Yes	7.67		

Table 4. ANOVA of place construct index scores based on participation in Elderhostel program.

the data set, leaving a sub-sample of n=191. This was done because all Elderhostel participants participated in the same number of programs and this hypothesis was intended, in part, to examine the place constructs relative to the number of programs visitors attended. The total number of interpretive programs in which visitors participated during their most recent visit to the park was correlated with each of the place construct index scores. Place identity was found to correlate positively with the number of park interpretive programs visitors attended; however, the relationship was relatively weak at $r = .147$, $p = .046$. The other two constructs did not significantly correlate to interpretive program attendance.

The second part of testing hypothesis 2 was to test for mean differences in place construct index scores between those who had participated in any interpretive programs and those who had not. Place identity was found to be significantly higher among those individuals who had participated in one or more park interpretive programs (See Table 5). However, no significant relationship was found with place dependence and place-based affect.

Discussion

The first portion of the analysis was to measure and describe three theoretically supported dimensions of the person–place relationship. The three-dimensional factor structure was supported over a unidimensional factor structure. This is consistent with previous literature (Kyle et al. 2005; Jorgensen and Stedman 2002). However, further analysis is warranted to test the relationship between place identity, place dependence, and place-based affect. It is not yet clear how place-based affect relates to place identity and place dependence. It may be a dimension of place attachment, as research suggests place identity and place dependence are, or it may be another dimension of the person–place relationship that is different from place attachment.

With respect to participation in educational and interpretive programs, hypothesis 1 was not supported. This may reflect that these Elderhostel programs, while education-based, were also relatively constrained in terms of requiring participants to attend the educational and interpretive programs selected for them. Unlike individuals who visited Isle Royale individually or in informal groups, Elderhostel participants were required to attend the park interpretive programs. Therefore, the information they receive may have been processed differently. At least, it did not appear to affect their attachment to Isle Royale.

	Interpretive program participant	Mean	F-value	p-value
Place Identity (IRNP)	No	6.20	4.02	.046
	Yes	6.65		
Place Dependence (IRNP)	No	4.73	.33	.567
	Yes	4.89		
Place-based Affect (IRNP)	No	7.57	.71	.401
	Yes	7.72		

Bold items are significant at the p = .05 level.

Table 5. ANOVA of place construct index scores based on participation in park interpretive programs.

Also, no relationships were found between place dependence or place-based affect and participation in park interpretive programs. A positive relationship was found, however, between place identity and program participation. In other words, although the park programs did not influence activity-based attachment (i.e., place dependence) or emotion-based connections (i.e., place-based affect), visitors' self-identification with Isle Royale National Park was enhanced by their participation in park interpretive programs. For those who develop and conduct interpretive programs, this could be considered one measure of success. While we did not specifically measure information retention, it seems likely that information from the park programs was retained in some form. If not, it is unlikely there would have been any significant difference in place identity levels.

There are many opportunities for additional research regarding education and the person–place relationship. For example, it would be helpful to understand how people process information while at Isle Royale National Park or a similar recreation destination. While there is extensive literature regarding information processing in educational settings, e.g., schools and universities, future place attachment studies could include similar measures to identify possible relationships. It would also be helpful to conduct similar studies to this one, but in parks that are not so isolated. Perhaps programs in less-isolated parks are more influential on the process of becoming attached to a particular place. Also, further testing of the three place constructs relative to each other as well as to antecedent behavior could further a clearer understanding of the person–place relationship.

In summary, it is important to continue studying the person–place relationship as well as its antecedents and outcomes. As our public lands receive increasing numbers of visitors, it is likely that management actions will receive more critical examination. Understanding the framework within which people operate while visiting public lands—more specifically, how they become attached to those lands—allows land managers to better appreciate and respond to visitors' needs.

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Quality of Life Indicators in Two Small Towns in the Blue Ridge Heritage Area

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This paper describes an ethnographic study of two towns in western North Carolina's Blue Ridge National Heritage Area. My objective was to formulate indicators of quality of life in small mountain towns, and then design a survey based on them that measures the effects that HandMade In America (HandMade) a non-profit based in Asheville, North Carolina, is having on the towns that it works with through its Small Towns Revitalization Program (STRP). HandMade has kept records of quantitative data for the towns (new businesses, jobs created and lost, investments, etc.), but this step toward qualitative measurement is innovative.

I begin with the story of HandMade and its involvement with the establishment of the Blue Ridge National Heritage Area. Next, I describe STRP, as well as the ethnographic work I completed with this program to identify key themes for quality of life. Finally, I discuss my findings and their implications for the Blue Ridge National Heritage Area.

HandMade and the Blue Ridge Heritage Area

HandMade has been involved in the effort to establish the Blue Ridge Heritage Area since the mid-1990s. Founded in 1994 in reaction to a widespread desire in western North Carolina to revitalize and diversify the economy, HandMade is based on the belief that the area needs to supplement industrial development in the region, a sector of the economy that is rapidly declining. HandMade promotes the "silent" crafts industry that already exists. Through a variety of programs to link crafts people together, increase community capacity, and promote both the natural and handmade resources of the area, HandMade hopes to make western North Carolina a national and international destination for crafts. After eight years of work, the organization, along with others, put the proposal for the Blue Ridge National Heritage Area together in 2002, and saw its establishment in November 2003. As this heritage area is new, it is still in the process of moving from paper to reality in western North Carolina. Recently, $45,000 of heritage area money was allocated for HandMade's STRP; nine towns will receive $5,000 each.

Small Towns Revitalization Program

One of HandMade's best-known products is the guidebook to the region's galleries, craft studios, restaurants, and places to stay, entitled *Craft Heritage Trails of Western North Carolina* (1996). This guide, now in its third edition, offers visitors and residents maps and directions for driving tours throughout western North Carolina. When first published, it was hailed as giant step for a region that had not previously linked these resources together for the benefit of both craftspeople and visitors. However, HandMade also received feedback from some towns that were not included, but were within the geographic area that the guidebook covered. They wanted assistance promoting themselves too, even if they did not have craftspeople and galleries. Thus began the STRP.

Based on "mentoring, technical assistance, self-help, and learning from each other and from neighboring communities" (HandMade in America 2002), STRP is modeled after the National Trust for Historic Preservation's Main Street Program (www.mainstreet.org). It is a capacity-building effort in that the town residents themselves decide how they would like to enhance their community, and then participate in the steps required to achieve their goals. Towns have completed projects such as courthouse restoration, creek walk trails, and the establishment of a summer music series. According to David Quinn, director of STRP, the projects are often as much about making residents' lives more pleasant as having noticeable economic effects (personal interview, April 16, 2004). However, the program has shown that as STRP completes projects focused on making residents' lives and communities better, the "economic growth and well-being" of the community improves as well (HandMade in America 2002). Twelve towns are currently in the program.

The staff at HandMade decided that the best use of my anthropological skills would be to measure the qualitative difference that STRP is making in the towns that it collaborates with. Quinn recommended two North Carolina towns to be the focus of this study, as the scope was limited by time constraints. He selected Hayesville (population 300, on the state's border with Georgia) and Crossnore (population 287, near Boone, North Carolina). Both of these towns are very active in STRP, so Quinn thought that their residents would be amenable to being interviewed. Although the towns are similar in size, they have significant differences.

Clay County, where Hayesville is located, has been experiencing a population boom over the past few years sparked by its location in mountains closest to Atlanta, Georgia. Retirees and second homeowners appreciate the scenery without getting too involved in the community. Vacationers take advantage of the nearby Lake Chatuge, mountains, and quaint downtown square. Once a farming town, the economy is shifting. Real estate is big business, as is building contracting; farmers are dividing up land to sell in housing lots for more money than they could get from agricultural use. Businesses are moving from the town square to the highway bypass. Some residents speak of recruiting big industry to the area, but many believe that the county does not have a competitive edge in attracting companies.

The STRP group is called the Clay County Communities Revitalization Association (CCCRA). It has tackled projects of many sizes, including planting flowers around town, putting on festivals on the square, and refurbishing the distinguishing landmark of the county, the Clay County Courthouse. Although members of CCCRA are a mixture of locals and newcomers, many locals see the group as outsiders trying to change things.

In contrast, three hours to the northeast in Avery County, Crossnore has not grown in the last few decades. At a higher altitude than Clay County, Avery County is cooler in temperature and home to much of the state's ski industry. Just off the main road to Boone, Crossnore can easily be passed by without noticing. It has a vibrant local history of education and medicine, owed to Eustace and Mary Martin Sloop, two doctors who came from the central Piedmont of the state to start a school and hospital in the early 1900s. The town was a center of Avery County's business and nightlife in the 1940s and 1950s. Once home to a movie theatre, general store, several restaurants, bowling alley, and hospital, businesses have closed or moved away. They could not compete with Wal-Mart and chain groceries in nearby Newland; more people owned cars and could go to Boone or Asheville for entertainment or services. The hospital was eventually consolidated with others in another part of the county. Today, The Weaving Room and Sales Store, both affiliated with Crossnore School Incorporated, are the only businesses in the center of town, and residents do not have many reasons to come to, or linger in, Crossnore's center. Although recently a restaurant opened on the highway to Boone and is well supported, Crossnore is a quiet residential community, made up of families who have lived here for generations. Gated communities and resorts in the region are encroaching, causing land prices to soar; however, the Christmas tree industry, visible on every hillside, is booming. Crossnore Community Enhancement (CCE) is the STRP program here. Although many residents think of it as a ladies' garden club, this group has not only planted flowers downtown, but also put on a July Fourth celebration, hosted weekly music jams and an annual Christmas bonfire, and created a town park and creek walk.

Methods of ethnography

Through HandMade, I met residents in each town that directly participate in STRP, and asked these groups for a list of people to interview about living in their town and the STRP group's projects. Both groups provided lists that were diverse in age, gender, length of residency, and included "nay-sayers" (those who often oppose the projects that STRP committees work on) as well as supporters. Members of these committees contacted the people on the list to let them know that I would be contacting them. This provided me with an entrée into the community, without which this project would have been difficult. Everyone that I contacted agreed to an interview. I talked with thirty-one people in Hayesville and twenty-three in Crossnore. Interviews lasted from a few minutes to an hour and a half. I asked the same questions of everyone,[1] with follow-up questions determined by their responses. I also spent time observing daily life at the center of each town.

I was to use the ethnographic information that I collected to create a written survey assessing the ways in which STRP is affecting the quality of life of residents in all twelve towns. However, as I sat in numerous living rooms and kitchens talking with men and women, old and young, local and newcomer, it became clear that while there are similarities across the region, each town has its own set of resources and problems that dictates the concerns of its residents. Therefore, after recording and transcribing the interviews, and coding each one according to themes that arose in conversation, I came out with three different lists. One list was of themes shared between the two towns, which I used to create a common survey. The other two lists contained the items specific to either Crossnore or Hayesville, and these led to survey questions particular to each town.[2]

The indicators

How does one describe the things that make life good or bad, or the things that matter? The approach I took was to talk to people, ask concrete questions, and then look at the themes that surfaced across interviews. I came up with 36 themes. Many of the themes are complicated, inter-related, and even contradictory—just like life itself. The fact that these 36 themes were evident in both towns suggests that they might be pertinent to residents of other small towns in the region. However, this is hard to tell without doing some ethnographic research in these other locations. Using the commonalities I found in my work, I grouped themes together to form indicators for quality of life:[3]

- Sense of history/heritage/culture
- Ties to community
- Environment/land
- Change/ "progress"
- Civic engagement/politics/policy
- Insider/outsider dynamics
- Socioeconomy
- Access to conveniences

Each town is dealing with different issues dictated by its location, demographics of residents, history, geography, and socioeconomic structure. Therefore I composed another list of indicators that pertain exclusively to each Hayesville and Crossnore. These are:

- **Hayesville:** Courthouse (emblem of county, future uncertain), conservatism of county commissioners, affordable housing, athletics (everyone follows high school teams), theatre/arts community, health care, library (good resource, communal space), transportation, role of town center, Forest Service land (way of protecting mountains).
- **Crossnore:** Relationship with Crossnore School Inc., Christmas trees (big industry), Highway 221 expansion (threat), Sloop Dam (historic site in disrepair), tax base (too small to leverage change).

What does this mean?

After preliminary analysis of these data, I am left with three main points. First, these small mountain towns find themselves in the midst of change on many levels. If they are to be the keepers of the heritage that they embody, more support is needed from those who value this heritage. Second, the key to the survival of these towns and those similar to them may be found in the intangible "sense of community." Third, the dynamic between insiders and outsiders is a powerful one that will shape the local atmosphere as the region becomes more accessible in a variety of ways.

One of the main reasons that this area of North Carolina was designated a national heritage area is that it, along with other areas of Appalachia, has been relatively isolated and fostered unique cultures, arts, and communities. This is a time of change not only economically, but also socially and culturally. The region is not as inaccessible any more; new highways, television, and the internet bring in the world; jobs are moving to other countries; and differences between generations are noticeable. It is important to understand the elements that contribute to quality of life for the residents of the area; a pervading theme is heritage. Although the area has been designated a national heritage area (giving it value on a national level), average people living there are not generally aware that this heritage area exists, nor does the designation affect their lives. As livelihoods and pastimes change, it is imperative for the region to recognize the heritage it possesses, but recognition alone will not fill the economic gaps left by factories and a changing agriculture base. As national attention turns to the heritage of western North Carolina, the best tactic for residents may be to encourage community-based tourism development. Tourism may be the brightest star on the economic horizon, but it must be undertaken with care.

Sense of community is hard to define, hard to pin down, hard to create. However, one thing the interview data suggests is that a primary contributor to satisfaction is a feeling of belonging. This issue has two levels to it. First, for a variety of reasons, mountain social life developed to focus not on the community as a whole but on "reference" or peer groups (Weller 1965). As residents become more mobile and new people move into the area, these reference groups are fading, but are still a part of mountain culture. It is helpful to recognize this cultural history in looking at these communities and the ways in which various elements work together. Second, both of these communities used to have more community gathering places and events. As community development agencies look at this region and try to help it economically, I suggest they look at ways of creating more person-to-person contact, as well as spaces, places, and opportunities for informal community interaction. HandMade recognizes this link between the social and the economic health of communities, stating in its annual report that as communities grow stronger so do their economies and general well-being (HandMade in America 2002). This is the key to both small-town survival and the preservation and evolution of the heritage of the area.

The insider/outsider dynamic is one to consider when assessing the region's heritage. In the past two decades, the world has opened up in a way that we have never seen it before. People can live where they want to and telecommute, as well as have multiple homes, and isolated areas are more physically accessible to visitors as our automobile and highway technologies become more refined. People from the Northeast and other parts of the country are moving into western North Carolina. They are met with a variety of attitudes, dependent in large part upon the attitude with which they approach these mountains. Heritage is perhaps the one thing that these disparate populations can unite behind, although it may have very different meanings to the two groups. Those who define this heritage wield a lot of power.

Endnotes

1. Questions asked of all respondents were: (1) What do you like about living here? (2) What is difficult about living here? (3) What are your hopes for the future of this town? (4) What are your fears for the future of this town? (5) How are people's lives changing here in the past few years? (6) Why do you think people choose to live here? (7) What is important to residents here? (8) Are you familiar with the STRP? What do you think of it?
2. The survey results have not been analyzed at the time of this writing.
3. I used the method of "pile sorting" to put these themes into eight indicators. Pile sorting involves writing each term on a piece of paper and then grouping like terms together.

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Between Utopia and Total Institution: Structural and Secondary Adjustments in the Andean Identity Market

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Objectives

This paper is on the Sanctuary of Machu Picchu located in the southern Peruvian Andes. The goal of this paper is not to criticize nature conservation efforts there but to call attention to the contradictions people face when those efforts are integrated with privatization policies, sometimes referred to in Peru as "neoliberalism." *What happens when conservation and the need to attract global investments come together?* I explore Erving Goffman's work on "total institutions" (Goffman 1961), particularly the idea of "secondary adjustments" and the institutional loops they create, as helpful in understanding the lived contradictions of people who reside in this protected area.

The tangible lives of an intangible place

When I arrived in Machu Picchu, the pueblo was in the midst of its big festival—the anniversary of the founding of the political district. The anniversary festival is a special event for the people of Machu Picchu. It is perhaps a time when the community reasserts its jurisdictional autonomy over the sanctuary designation. Festival activities are often encounters with the intersecting spaces of district and sanctuary.

As part of the festivities, a dance competition was planned. Raul had spent the last few weeks preparing his dance group for the evening contest. In designing the dance he called "Rito al Dios Sol" ("A Rite to the Sun God"), Raul wanted to create a dance to represent the pueblo of Machu Picchu. Although Raul knew little about dance or choreography, he took it upon himself as the president of one of the barrio associations to organize some of the local children. Raul explained, "The pueblo does not have an identity and creating its own dance would offer something unique to Machu Picchu." "We are the only pueblo in Peru that has no identity," he declared.

That evening, spectators crowded the plaza waiting for the competition to begin. All participants were from the pueblo with the exception of those dancing for the Instituto Nacional de Cultura (INC, the state archaeological conservation agency). Many objected to their participation, claiming that these dancers were outsiders. When it was time for Raul's group to dance, he entered the stage to explain to the audience that this was their new dance created to represent ancient times in Machu Picchu. He stressed to the pueblo that they should accept this dance as theirs because "our pueblo does not have its own dance."

However, the judges decided that the INC had won. Raul and his group began shouting "fraud"; he was furious and insulted the panel of judges made up of officials from the municipality. "Incompetents," he cried. He expressed the feeling that the municipality had betrayed the pueblo and explained, "They don't represent us, but rather the powerful." The felt need by many, such as Raul, to create a Machu Picchu identity, raised the question of what is considered an appropriate identity for the pueblo and why having one had become urgent.

The people of Machu Picchu live in a landscape made to represent a utopia, classified as an intangible zone by the tourism industry, state institutions, and international bodies such as the United Nations Educational, Scientific, and Cultural Organization (UNESCO), which, through its World Heritage Convention secretariat, defines Machu Picchu as a World Heritage site—heritage for all humanity (*patrimonio de humanidad)*. Under UNESCO Legislative Resolution 23349, Peru is required "to identify, protect, conserve, restore and transmit to future generations" its World Heritage sites. Since the creation of the sanctuary in 1981, residents of the district overlapping the sanctuary were granted user rights to land, but prohibited from holding property titles. What happens to those rights when the concept of intangibility is steered to serve larger capital investors in the tourism economy? In one sense, the mammoth growth of the tourist industry in Peru turned Machu Picchu into a commodity that commercializes an image of the past. That image dictates the kinds of identities acceptable within the sanctuary boundaries. In another sense, governing agencies methodically manipulate the law to promote some interests above others and to dispose a population for the purpose of moving poorer people out of the way.

Secondary adjustments

It might stretch the imagination to think of the residents of Machu Picchu as "inmates" living in a "total institution" (Goffman 1961), because the conservation institutions of the state are not designed for the management of people in the same sense as those of a prison or hospital, but rather are those of a heritage zone. Moreover, people are not confined behind physical walls and cut off from the wider society, as are people in a total institution. Also residents are not so brutally "stripped" and "leveled," in Goffman's sense, of status and identity, as they would be in a prison. And of course the residents of the district don't quite live in "batches," where all activities are carried out in the constant presence of others (Goffman 1961:4–28).

Nevertheless, sanctuary life shares similarities with life in a "total institution." For instance, while people are not confined, exit and entry into the sanctuary is highly controlled, and it is difficult for a resident to receive a family member or friend without the guest paying tourist entrance fees. Furthermore, the privatization of the railroad has meant that residents are subject to fare hikes that in effect limit their movement. While residents of Machu Picchu do not live in "batches," their movements are constantly watched by park rangers, and from the perspective of the sanctuary director, the status of community is denied to the rural residents. At least in his eyes, residents are a chaotic mass of people, referred to by terms like *grupos humans* (human groups) rather than as legitimate communities.

However, the semblance of a total institution arises when, beginning in the mid-1990s, governing institutions integrated neoliberal policies into their management of the sanctuary. First, by tying nature to the debt crisis with debt-for-nature exchanges. Second, by offering multimillion-dollar contracts to nongovernmental organizations to conserve specific ideas of nature that stigmatize the activities of the population. Finally, by privatizing services formerly run by the state, such as transportation and major hotels, to the giant tourism company

Orient Express. In effect, the state retains control of a nationally symbolic territory while maximizing capital accumulation needs. It does so by balancing the idea of a public good, a commons normally not associated with the politics of privatization, with an emphasis on private property, creating a contradiction that needs to be resolved, and the resolution is a coercive politics of blame. Corporate and governmental interests come together to impose an intensified institutional order of people management.

Suddenly, residents find themselves "stripped" in the sense of having their possessions taken or restricted for the financial benefit of others, and "leveled" in the sense of having a new commercialized identity imposed on them as a qualification to live in the sanctuary. Equally important, people must still respond to the strict rules and regulations of the sanctuary. What we see is something akin to what Goffman referred to as "secondary adjustment," where people adapt to the institutional order, often through secretive and deceptive practices. These are "practices that do not directly challenge staff but allow inmates to obtain forbidden satisfactions or to obtain permitted ones by forbidden means" (Goffman 1961:54).

An examination of secondary adjustments in the city of Cuzco is useful in seeing that the intensification of conservation enforcement problems in Machu Picchu is the result of privatization policies. Up until 1999, the Plaza de Armas (central plaza) in the city of Cuzco was teeming with small-level merchants selling artisan goods arranged on the pavement, along the portals, and under the balconies that encompass the plaza. Men and women without the resources to rent pavement space ambled around the plaza as they carried their goods, such as clothing, jewelry, or food, to sell. There were shoeshine boys and children who sold postcards or posed in traditional Andean garb with a llama or a lamb, and for a small fee offered tourists a photo opportunity. And of course the plaza area was also filled with tourist establishments, such as tour agencies, artisan shops, restaurants, and bars. At the turn of the millennium all of that changed. The wealthier establishments were left untouched, but the merchants selling their wares on the portal pavements were sent off to a newly built artisan market located about a mile away from the plaza, where most foreigners never go. The rationale was that they were unsightly and that they posed a hazard to tourists by attracting criminal elements. In contradictory fashion, another artisan market was constructed for them near the central market, an area where many tourists are specifically told not to go because it is considered dangerous and unsightly. These markets are also not well advertised and tourists tend to make their purchases in the establishments in or around the plaza. The displaced small merchants thus suffered great economic loss. Hence, just as the Orient Express captures the high-end tourist market in Machu Picchu, plaza space is regulated to capture the dollars of wealthier western tourists by removing competition and the temptation of customers purchasing cheaper goods or memorabilia.

A more dramatic alteration of plaza space in Cuzco can be seen in the new laws that prohibit street sellers of any sort from entering the plaza. Whereas once poorer families could reasonably benefit from the tourist economy by selling goods without having any overhead costs, now they cannot. The plazas are in effect "cleaned up" of poorer people who do not look well educated or cosmopolitan, and are thus viewed as "racially" different.

In contrast to the city of Cuzco, in Machu Picchu the boundaries of the sanctuary not only define the market space, but also a public good, and the commodity sold; a tourist must pay to enter the sanctuary to have a "heritage experience." In Machu Picchu, the changes in sanctuary laws affect the interactions between tourists and residents with profound economic consequence. Here, great effort is made to separate tourists from locals. For example, tourists were once allowed to hike the Inca Trail alone, crafting their own kind of "authentic" experience through interactions with residents. Residents could make some extra money by renting a bed to a hiker. Tourists at that time were far more likely to attempt to engage in dialogue as well as receive local interpretations of Inca monuments. Also, before privatization tourists could take the local train either to the kilometer from where they would start their hike on the Inca Trail, or go directly to the pueblo to visit the citadel. While it was crowded and not the most comfortable ride, many tourists chose the local train not just because of cost, but also to be engaged with the realities of a contemporary Andean population. With a shortage of seats, a tourist might be asked to share a seat with a child to lighten a mother's load. From a resident's perspective these interactions were also opportune moments to establish economically significant godparent relationships with foreigners.

Now the tourists are no longer allowed to use the local train. Tourists are also no longer allowed to hike the Inca Trail alone, but must go through tour agencies that provide a tour guide; Andean life as well as the past is now interpreted through a professional tour guide who echoes official versions of the past. The tour company provides all the food and there is little interaction between locals and tourists. Tour groups have designated campsites that, while often located near homes, offer few opportunities for interaction with residents. The little interaction that does take place between locals and tourists is largely confined to the purchase of a bottle of water or a candy bar as they pack their gear to leave. Residents must pick other moments and places to sell to tourists directly, often tagging behind them as they walk.

Conclusion: the neoliberal double bind

Finally, it should be understood that Goffman's notion of secondary adjustment is not defined as an attempt at subverting social hierarchies. In the setting of a "total institution" secondary adjustments are a mode of adaptation to power, not a confrontation. But more importantly, as the institutional setting becomes more encompassing, adjustments can backfire and be made to serve the interests of those who are in control. Goffman's notion of "looping" describes a double bind scenario where secondary adjustments inmates need to make to survive the rigors of the institutional order can then be used by the staff to further justify the rationale for incarceration.

I apply that reasoning to situations revolving around economic structural adjustment and state conservation efforts. I offer the concept of secondary adjustment here as a way of understanding how people are disciplined to respond to economic conditions designed to favor more powerful interests. I suggest it shows how market space is "cleaned up" to make way for larger investors.

This application of secondary adjustment connects with the way the geographer David Harvey (2003) defines "neoliberalism" as the "the cutting edge of capital accumulation by dispossession." He ties the imperial impulses of global capital to dispossession of land and property as ways of clearing away smaller property holders to make way for larger investments and cheaper labor, identifying state force as the primary means (Harvey 2003:149). Investment opportunities may "lie idle" as property titles, land rights and many other juridical entanglements block them.

In conclusion, the introduction of a neoliberal economy in Machu Picchu has changed the relationship between conservation enforcement and forms of economic adaptation. Now a concerted effort is placed on criminalizing the more fuzzy infractions found in secondary adjustments, converting them into more severe crimes that must be prevented. Locals are now excluded from a market arena. In these cases, secondary adjustments become much more of a gamble at the same time as they become more crucial for survival. Now people risk expulsion from the sanctuary and their district as well as property confiscation.

In addition, as a national symbol, Machu Picchu represents Peru to the rest of the world, and it receives a lot of media attention. In order to retain its value as a commodity, Machu Picchu must retain this image. Both rural and urban residents are forced to find ways to contend with this image. Race and Indian identity are not merely implicated in the above-mentioned dance festival but are also more directly embedded in the history of the area, the development of a tourism economy and the subsequent incursions of state institutions of conservation. For the conservation authorities of the state, and the expectations of the tourism industry, an idealized nature must be populated by nothing short of an idealized Indian. The current population is out of place because it does not fit well with the romanticized notion of an Incan past symbolized by the citadel.

If we view the sanctuary as a place where public goods and user rights collide with privatization efforts, we can see secondary adjustments eliciting harsher government discipline. Initially the expropriation of property was justified by the state in the name of the public good. Now, the uneven standards in nature preservation enforcement mean that, the more stringent the enforcements, the harder it is for residents to survive without making secondary adjustments. The more pervasive secondary adjustments become, the more those governing institutions turn to documenting ecological violations or damages to a public good. This situation leads to increasing justification by governing agencies for the further dispossession of sanctuary residents, and the subsequent turning over of that space to larger capital holders. Machu Picchu is an intangible good. Equally intangible are its institutional walls.

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A Social Landscape Perspective on People and Places in Amenity-Rich Rural Regions

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Introduction

Trends in research and practice in natural resource management identify human behavior and social systems as important dimensions of ecosystem management. Natural components of ecosystems include people and communities, plants and animals, minerals and chemicals, and air and soil. Knowledge of human social and cultural systems is essential for proper understanding of selected changes in biological systems, monitoring biodiversity and habitat fragmentation, development and implementation of resource management strategies, and an appreciation of how non-human biophysical elements of the ecosystem influence human attitudes and behaviors.

Several reasons for moving towards an integrated, socially constructed landscape framework exist. First, the adoption of ecosystem management practices by public land management agencies requires an assemblage of data, variables, and measures at a macro-level scale to understand the relationships between managed land ecosystems, human populations, and human communities. Second, biological scientists and park, forest, and wilderness managers recognize that people and social systems are vital components of the ecological equation and their needs, interests, and behaviors need to be incorporated into management decision-making strategies. Third, measures of the natural landscape mirror measures in demography, human ecology, and community studies (Field et al. 2003) suggesting the use of a landscape ecology framework to integrate social, biological, and ecological science at comparable scales. Our purpose is to reinvigorate inquiry into the interrelationships of social organization, culture, and the biophysical environment in space and time. This paper's goal is to generate discussion about the collection, analysis, and use of concatenated social and natural resource base data to more fully understand the interactions between social and biological systems.

Toward a graphical representation

To anchor our work, we provide a perspective on the complex multilayer relationships between the social and biophysical worlds. Figure 1 summarizes the three main dimensions: the landscape, community, and individual land parcel. Three interdependent axes—the spatial, temporal, and theoretical—are highlighted since they are critical to the character of landscapes, community, and individual land holdings. The first two axes highlight the importance of space and time at each level of analysis, as well as between levels. By depicting these relationships as occurring across landscapes, over the variety of community types, spanning

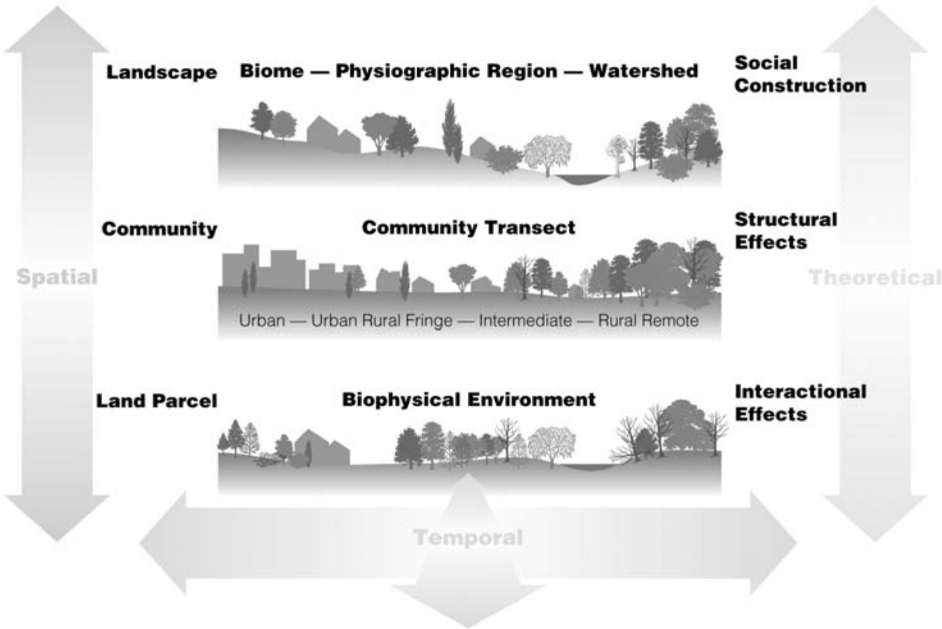

Figure 1. Integrating human behavior, community structure, and ecosystem change across time and space.

the range of land parcels, this multilayer perspective reflects the role played by space and time. It directs attention to the history, context, and size of a geographic area, as well as the extent to which changes occur over time. The third axis reflects that knowledge about these interrelationships is informed by theory. Through the application of theory, the science of landscape perspectives on people and places in amenity-rich rural regions is advanced.

Each level is characterized by a continuum reflecting differences in levels of interaction across the social and biophysical systems, contributing to different configurations of human–natural resource space. How the landscape is studied depends on the research question. It can range from a watershed to a bioregion or the biosphere. At the community level, the figure reflects typical settlement patterns, from rural remote areas to densely settled urban centers. Different patterns emerge within each of these ecosystems as reflected in our perspective of the land parcel.

Protocols for studying the complex multilevel spatial and temporal relationships between landscape, community, and land parcel dimensions are necessary. A transect approach can help frame such work. Through its application a researcher can capture the most human-influenced environment at one extreme and a more remote natural environment where human influences are minimal at the other (the horizontal axis in Figure 1).

We see nestedness (vertical axis) among levels of analysis. Understanding individual land parcels helps inform an understanding of community organization, which in turn is reflected in the landscape. When descriptions of individual land parcels are studied together, a frame of the geographical bounds of community is developed. If descriptions of communities are combined, a socio-biological or -geographical landscape is defined.

Integrating a theoretical perspective

Three complementary frameworks influence our work—social construction (Greider and Garkovich 1994; Bridger 1996), structural effects (Blau 1960), and interactional effects (Wilkinson 1991). Interdependence of social landscapes, community structure, and individual land parcels is this paper's core. The social construction of natural resources, informed by their structural and interactional parameters, facilitates multilevel, temporal, and spatial analyses.

Human ecologists, geographers, and community scholars have explored social behavior, social organization, and institutional structure at a spatial scale for a long time (Galpin 1915; Kolb 1933). This reflects space as an ever-present element in human interaction and interdependence (Hawley 1950). It plays a central role in the basic social relations characteristic of individuals at home, in a cafe, sitting on a park bench, at the beach, in a campground (Burch 1965), or in a public park or forest. Behavior shapes space and space shapes behavior. How humans socially construct space gives it identity.

Socially constructed landscapes

Early scholars focused on spatial analyses of human behavior to understand the organization of rural life. Galpin's work focused on rural trade centers and was premised on his belief that rural communal survival depended upon a towns' relationship with its surrounding countryside. Each village or city center was surrounded by a zone of land, irregular in shape and subject to expansion and contraction with the ebb and flow of community growth (1915:6). Kolb replicated this work and studied patterns of social interaction among rural residents along spatial dimensions. This helped him define rural social networks and identify trends in the growth and decline of socially constructed neighborhoods (Kolb 1933). Regional demographers including Vance (1935) linked agricultural production regions with population and settlement and called them cultural landscapes. He felt that such landscapes informed the configuration of socially constructed land forms (Vance 1935:14).

There has been much more recent work. Altman and Zube (1979) studied public places and pleasuring grounds. Edgerton (1979) focused on the social order of a California beach and noted its changing nature with early morning use by families with children, late afternoons by teenagers and other single adults, and early evening by mature couples. Burch (1965) found that the dynamic nature of changing campers acting out various rituals defined the campground's social order. Lee's urban park study (1972) indicated how people transformed recreational spaces into their own culture and experiences. Clark and Stankey (1979) emphasized the sociocultural background of campers together with local facilities that provided a social definition of place. Cheek et al. (1977) indicated that a mutual influence of the group recreating and the kinds of facilities available that led to social imprints on natural resources. Others described the constructed landscapes of inner cities: gang lands, no-man's lands (Whyte 1955), night as frontier (Melbin 1978), and the differences in social order between neighborhood tavern and cocktail lounge (Gottleib 1957).

Clearly, social meaning of space varies with time and season and individual or group in that space. Fitchen captured the essence of socially constructed landscapes when she wrote that "The land that makes up rural space includes ... one's privately owned land [and the] entire landscape that surrounds people. [It] is a ... space in which people operate ... and ... space has the power to modify activities that take place within it (1991:250–251).

Thus, space can be viewed as the biophysical environment and acts as the backdrop or stage for human activities. The socially constructed landscape is inextricably linked and reciprocally related to the biophysical environment. Greider and Garkovich (1994:1) said that landscapes were "symbolic environments created by the human act of conferring meaning to nature and the environment."

We define socially constructed landscapes as *spatial areas in which the socio-cultural and institutional structure has meaning for and frames the ecological questions being addressed.* The landscape concept implies a diverse collection of social, cultural, and biological features linked across time and space. Moreover, both social and biophysical landscapes are dynamic entities whose meaning changes across varying temporal and spatial scales. Ecological meaning is a product of the distribution of humans and of human behavior in varying biophysical settings. Equivalent human behavior does not have equivalent ecological implications across diverse biophysical settings. Nor do equivalent biophysical settings engender equivalent human behavior within a particular biophysical landscape since a diversity of cultural attributes, attitudes, and values significantly impact natural resources.

Structural effects and social construction

Blau suggested there were two kinds of social facts. The "first was the common values and norms embodied in culture or subculture," and the "second [was] embodied in the networks of social relations in which the processes of social interaction become organized and through which social positions of individuals and subgroups become differentiated" (Blau 1960:178). He also distinguished macro-attributes (community and cultural characteristics of the social structure) from individual behavior and values and indicated that there was a difference between a value's prevalence in a community or group and whether an individual held that value (1960:180).

We have interest in both sets of facts. The first provides an understanding of the context for human action, while the second focuses on the networks of social actors who make communities function. Both are central to address the changes facing rural communities in amenity-rich regions (McGranahan 1999). The structural effects of these shifts have direct consequences for public land management issues and require an ability to analytically distinguish values and behavior held by individuals from common values vested in the community. Each must be measured separately.

We also need a better understanding of the growing disconnect between new landowners and long-term residents in amenity-rich areas. Seasonal and permanent residents own land for different reasons (cf. Field et al. 2005; Krannich et al. 2005).With increased fragmentation and parcelization creating increased opportunities for increased ownerships, the difficulties of properly managing forested lands are exacerbated (Egan and Luloff 2005).

Interactional effects

Interactional theory begins with an assumption that the community is the primary setting for contact between the individual and society. While recognizing that there have been massive changes in social life (e.g., Warren 1978), and that community is not the holistic, integrated unit it once was, the local community remains a critical aspect of people's lives from the interactional perspective, which routinely identifies three components: (1) a shared geographic territory or locale; (2) a local society comprising social institutions, organizations, and associations; and (3) collective actions and mutual identity, usually emerging as a result of actors' participation in associational action. Through the latter interactions people develop a social definition of self and beliefs about how society operates. As indicated by Wilkinson (1991:17): "Community ... is a natural disposition among people who interact ... on matters that comprise a common life."

When people share a common life, a local orientation emerges. This orientation is a necessary, but not sufficient, condition for creating shared, generalized bonds, that "cuts across and links special interest activities within the local territory" (Wilkinson 1991:37). When crosscutting and generalized bonds exist, special-interest demands are minimized. Where collective community interests and actions are well established, collaborative processes and broad-based cooperation in response to threats emerge more readily than in places dominated by special interests and fragmented communal ties.

Testing our conceptual framework

Our research in southwest Utah can be used to illustrate how our social landscape framework can help to enhance understanding of key patterns of change occurring across time and space and across dimensions of social organization. This area is characterized by vast tracts of public lands. Its eastern portions encompass parts of the Colorado Plateau, where high-desert sagebrush tracts are interspersed among towering redrock structures, deep slot canyons, and forested, snow-capped mountains. Extending westward, it encompasses both high-elevation forested lands of the Markagunt Plateau and lower-elevation arid deserts representing a transition to the vast Basin and Range geographic province.

Over time, some portions of this area have experienced limited landscape changes, biophysically or socially. This reflects management practices that preserve large tracts as undeveloped lands utilized primarily for recreation or seasonal grazing. Other portions have exhibited dramatic changes in population size, land use patterns, resource utilization, and social organization. This is particularly evident in portions of Washington County. Fifty years ago this previously remote locale was a sparsely populated desert area with a combined county population of about 10,000. Then, economic activity centered on irrigated agriculture and tourist trade associated with the presence of Zion National Park contributed to unprecedented growth rates and development.

Our transect approach demonstrates the spatial patterning of growth and change at the landscape level. Located less than five hours south of the Salt Lake City metropolitan area, Washington County has become a popular warm-weather destination for golfers, recreationists, and retirees seeking a warmer place to live, year-round or seasonally. This location is also about a two-hour drive northeast of Las Vegas and has become a popular destination for seasonal home owners and recreationists from there. We can also apply the spatial transect approach within our study area to illuminate patterns of human settlement and land development (first the growth centered around St. George but now has extended in all directions, especially northeast along the I-15 corridor toward the Virgin River corridor and Zion

National Park, and west toward a spatially distinct area surrounding Santa Clara and north toward the Pine Valley mountains).

Population growth over the past decades has generated sprawling residential and commercial development in former pristine desert landscapes, irrigated cotton and alfalfa fields, vineyards, and orchards. With the expansion of the spatial footprint of urbanized land uses, formerly remote rural areas have been transformed into the rural–urban fringe, and those once part of the rural–urban fringe now are within a continuously urbanized landscape.

In sum, our model and study site provide evidence that social constructions helped spur patterns of land and resource utilization that do not occur if they are not broadly shared. Structural effects of individual as well as collective values and norms that prioritized economic growth and private property rights also served to foster development and resource utilization patterns here. And actions that emerged from collective interactions based on shared interests and locality-based bonds reflect a dynamic interplay between the social and the biophysical components of the landscape setting.

Conclusion

Contemporary trends transforming rural landscapes surrounding public lands require integrated social and biological information that can be used to foster relevant policy formation by decision-makers. Our framework facilitates this. Mills (1959), Merton (1967), and Sorokin (1965) alerted us to the traps of engaging analytical, fact-finding efforts in the absence of synthesizing, generalizing work. There is a clear need for studies and theories of the middle range if we want to advance work. As noted elsewhere, rural sociologists have attempted to integrate biological systems to better understand human behavior on the land (Field, Luloff, and Krannich 2002). The social organization of rural America has always been a story of the relations of people and natural resource systems.

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Neighborhood Park Uses by Phoenix Residents: An Exploration of Sociodemographic Differences

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Introduction

Neighborhood parks are defined as green spaces located near people's residence. As such, they represent the most accessible and democratic fragments of "nature" in urban settings. In addition to influencing the quality of life, they may play a significant role in shaping the perceptions of nature of urban residents. In spite of this importance, neighborhood parks have received little attention from social scientists. This paper reports the result of an exploratory study that investigated the determinants of park usages in neighborhoods of different types. It argues that people's relationships with neighborhood parks are influenced by four reciprocal dimensions:

1. *Neighborhood experiences.* The influence exerted by residents' social ties and interactions with the physical markers and institutions present in a bounded territory.
2. *Residents' sociodemographic characteristics.* The influence exerted by residents' age, gender, education, income, ethnicity, family composition, occupation, and housing.
3. *Park features.* The role played by the physical and social attributes of neighborhood parks.
4. *Residents' recreational activities and landscape preferences.* The role played by the activities residents engage in in parks.

Study objective

This study was conducted in the city of Phoenix, Arizona. Like many other modern metropolises, Phoenix is a mosaic of contrasting neighborhoods. Within the span of a few city blocks, one can observe significant shifts in populations, as well as in the natural features and infrastructural resources available to residents. This study was designed to better understand the variations of park use within and between neighborhoods socially and physically differentiated. In particular, it strived to identify which factors or variables were the most salient in explaining variations of park use.

Methodology

Data for this study were compiled with a mailed, self-administered survey/questionnaire. The questionnaire posed 37 questions in four categories:

1. *Neighborhood familiarity and attachment.* Residents were polled about the length of time they had resided at their current address, the number of neighbors they knew by first name, the number of neighbors they considered close friends, the number of relatives living nearby, and their level of security in, and attachment to, their neighborhood.
2. *Neighborhood park use.* In addition to marking a list of 10 activities usually engaged in in parks, residents were asked how often they performed these activities, and at which time of the day/week they most often visited their park.
3. *Neighborhood park satisfaction.* Residents were asked to indicate their level of appreciation for the following features: trees and other vegetation, overall appearance, open or grassy areas, cleanliness/maintenance, safety/security, children's play equipment, playing courts and fields, park buildings, social programs and special events, and park location.
4. *Demographics.* Questions were posed about age, gender, education, income, ethnicity, the number of other household members, the age of the other household members, the type of housing, the property ownership, and the current employment status.

Roughly 2,100 households were randomly selected to participate in this study. They were located within one half-mile of six neighborhood parks. These parks were selected to fall into high-, medium-, and low-income neighborhoods (U.S. Census), to be between 4–15 acres in size, and to have relatively homogeneous neighborhoods surrounding them. The questionnaires, letters, and postcards developed for this study were sent in both English and Spanish to three neighborhoods, where 15% of the population did not speak English "at least well" (U.S. Census 2000). In the end, in June 2003, 638 questionnaires were completed.

The questionnaire answers were entered into a SPSS database spreadsheet. A frequency table and a bar chart were produced for each variable. Then, logistic regression models (stepwise procedures) were generated to distinguish which variables of the survey/questionnaire were the most highly correlated with park visits. Four sets of variables, corresponding to the four influential dimensions of park visits described above, were processed.

Results

Overall, 70% of residents who completed the study survey/questionnaire indicated that they had visited their neighborhood park at least once during the last year. Almost half of these residents (47%, n=203) stated that they had gone to their park "a few times per year," and the remaining group declared that they had gone "a couple of times a month" (27%, n=119), or "a couple of times a week" (22%, n=96). Only a small fraction (4%, n=17) used their park on a daily basis.

Variations in park usage appear when residents of different neighborhoods are compared. Generally speaking, residents of affluent neighborhoods are more likely to visit their park than are other residents: 76% (n=217) of those answering the survey had visited their neighborhood park at least once during the last year, compared with 62% (n=128) for the middle socioeconomic category, and 71% (n=102) for the lower socioeconomic category.

Residents of affluent neighborhoods also visit their park on a more regular basis. About 53% (n=115) of them use their neighborhood park "a couple times a week/month," compared with 49% (n=60) for the middle socioeconomic category, and 40% (n=40) for the lower socioeconomic category. Like their parents, children in affluent neighborhoods are also regular users of their park. About 72% (n=65) of them visit it "a couple times a week/month," compared with 61% (n=46) for children of the middle socioeconomic category, and 46% (n=34) for children of the lower socioeconomic category.

The following details which four variables were identified as the most salient predictor of park visits.

Neighborhood experiences

Visiting a park is part of the experience of living in a neighborhood. This study hypothesized that the relationship that residents have developed with their park might be conditioned by their overall neighborhood experience. Results of the logistic regression model (stepwise procedure) showed that three variables measuring people's familiarity and attachment to their neighborhood appeared to be strong predictors: length of time at current address, number of acquaintances, and neighborhood attachment.

Length of time at current address. The longer residents had been at their current address, the less likely they were to have visited their neighborhood park at least once during the last year (p=.000). As detailed later, having household members 12 years of age or younger is one of the strongest predictors of park visits. The longer residents have been at their current address, the less likely it is that they have other household members in this age category.

Number of acquaintances. The more residents know other people in their neighborhood by first name, the more likely they are to visit their neighborhood park (p=.000). This is especially true for residents in the higher socioeconomic category (p=.001). Close to 60% of them know between 4 and 15 persons in the neighborhood by name, compared with 51% for the middle socioeconomic category, and 40% for the lower socioeconomic category.

Neighborhood attachment. The more attached residents are to their neighborhood, the more likely they have visited their park at least once during the last year (p=.001). Residents of higher socioeconomic categories, who are the highest park users, also expressed the highest level of attachment to their neighborhood. Sixty-seven percent (n=189) of them said that they would be "sorry" or "very sorry" to leave their neighborhood, compared with 49% (n=102) for residents in the middle socioeconomic, and 45% (n=65) for residents in the lower socioeconomic category.

Residents' sociodemographic characteristics

Variables that help to delineate the sociodemographic profile of the residents are instrumental in explaining the variations of park visits. Results from the logistic regression model (stepwise procedure) showed that three of them have strong predictive power: the age of the respondent, the age of the other household members, and education.

Age of the respondent. Young adult residents are more likely to visit their park (p=.000) than older residents. Roughly 85% (n=123) of those between 18 and 35 years of age have visited their park at least once in the last year, compared with 71% (n=260) for those between 36 and 65 years of age, and 51% (n=64) for those more than 65 years of age.

Age of the other household members. Young residents between 18 and 35 years of age appear to be more frequent users of neighborhood parks in part due to family composition: 32% (n=86) of them have children under 13 years of age, compared with 21% (n=113) for residents between 36 and 65 years of age, and 5% (n=5) for residents over 65 years of age (p=.000). Residents with young children are the most faithful users of neighborhood parks. This is true for all three socioeconomic categories.

Education. Residents having a higher level of education are also more likely than other residents to visit their park (p=.000). As detailed later, residents with a higher level of education tend to practice "individual-oriented" activities, whereas residents with a lower level of education are inclined towards "group-oriented" activities. Individual activities, such as walking, jogging, and bicycling, are usually performed on a more regular basis than group activities, which require coordinating the participation of several residents.

Park features

The decision to use a park is also affected by the physical and social characteristics of the site. This study polled residents about different features of their park. Results from the logistic regression models showed that three features were strong predictors of park visits: trees and other vegetation, park security, and park location.

Trees and other vegetation. The more residents are satisfied with parks' trees and vegetation, the more likely they will use it on a regular basis (p=.007). This is true for all three socioeconomic categories. Among residents who use their park "a couple of times a week," for example, 86% (n=78) indicated that they were "satisfied" or "very satisfied" with the vegetation, compared with 74% (n=145) of those who use their park "a few times per year."

Park security. The higher the comfort level, the more regularly residents tend to visit their park (p=.001). Among those who are going to the park "a couple of times a week," for example, 74% (n=67) indicated that they were "satisfied" or "very satisfied" with the park security, compared with 70% (n=171) for those who attend their park "a few times per year." The relationship between park security and park visits is the most highly correlated among the lower socioeconomic category (p=.029). Residents of this category who feel secure in their park are much more likely to visit it on a regular basis than residents of other socioeconomic categories.

Park location. Residents who express a higher level of satisfaction toward the placement of their neighborhood park are also more inclined to visit it (p=.000). This is especially true for residents in the higher socioeconomic category (p=.004). Roughly, 100% (n=51) of those who visit it "a couple times a week" are "satisfied" or "very satisfied" with its location.

Activities taking place in parks

Finally, the experience of visiting a park is shaped by the desired recreational activities.. Table 1 shows the most popular activities for which all residents, and residents of each socioeconomic category, regularly use their parks.

Low socioeconomic Category	Middle socioeconomic category	High socioeconomic category	All respondents
Relaxing with family and friends 20% (n=45)	For individual exercise 28% (n=128)	For individual exercise 24% (n=229)	For individual exercise 24% (n=229)
For individual exercise 19% (n=43)	Relaxing with family / friends 17% (n=68)	Relaxing with family / friends 17% (n=157)	Relaxing with family / friends 15% (n=119)
Relaxing by oneself 14% (n=32)	To walk dog 17% (n=75)	To walk dog 13% (n=122)	To walk dog 11% (n=122)

Table 1. The three most popular recreation activities in parks.

The type of activities taking place in parks tend to be slightly different between residents of the different socioeconomic categories. While residents of the lower socioeconomic category use their park primarily for "group-oriented" activities (relaxing with family and friends), those in the middle and higher socioeconomic categories are more inclined toward "individual-oriented" activities (individual exercise). Residents in the lower socioeconomic category tend to recreate accompanied by their closest friends and family members, while those in the higher socioeconomic category, who have more "acquaintances" in the neighborhood, engage in more in individual activities.

Discussion

Results showed significant variations in park attendance when residents living in different neighborhoods were compared. In addition to using a "classical" approach, which would explain these variations by the differentiations in the residents sociodemographic characteristics, this study also considered the influence of other basic variables rarely compared before: neighborhood experience, park features, and residents' recreational activities and landscaping preferences.

With respect to sociodemographic variables, age of the respondents, age of the other household members, and education were the strongest predictors of park visitation. The fact that young residents tend to use their park more regularly than older residents is consistent with numerous studies (Payne et al. 2002). The age of the other household members as the second most influential variable of park visitation is novel, however, as most research studies do not include the age of the other household members among the sociodemographic variables computed. Therefore, they usually conclude that gender or ethnicity are the most influential variables (Hutchison 1987; Loukaitou-Sideris 1995; Oguz 2000; Gobster 2002; Payne et al. 2002). Finally, the role of education as a predictor can only be understood by considering the type of recreational activities residents engage in in parks. People with a higher level of education tend to engage in individual-oriented activities; these residents may use the park more simply because it requires less coordination with others.

In terms of park features, this study showed that residents who are highly satisfied with park vegetation, security, and location are also more regular park visitors. Security is a particularly compelling feature for residents in the lower socioeconomic category. One may also hypothesize that park location matters: parks in upper-income neighborhoods are more likely to be encircled by homogeneous single-family residences, whereas those located in the lower-income neighborhoods are more likely to be surrounded by a mix of residential, commercial, and industrial buildings. Getting to a park in a spatially fragmented neighborhood may be more hazardous. Physical obstacles such as busy intersections, dense traffic, and vacant lots may discourage park visitation.

The experience of visiting a park can be determined by the physical markers and the institutions present nearby. It can also be affected by the relationships that residents have developed with other community members, and by the attachment residents have toward their neighborhood. Results reported in this study showed a strong correlation between park visits and social ties in the community. This finding supports the conclusions of other research studies, which found that the presence of green spaces in residential areas predicted the formation of social contacts (Whyte 1980).

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Preservation and Politics: A National Park in North Cyprus

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Introduction

Since August 1974, the Mediterranean island of Cyprus has been divided along ethnic lines. A coup organized by the military junta then ruling Greece led, five days later, to an invasion by Turkey, citing obligations under the treaties of 1960 that gave the island its independence. Peace talks have been held intermittently since, sometimes aiming for an overall solution to the "Cyprus Problem," sometimes aiming to build confidence between the two sides by making incremental changes to the status quo. But, although a solution within the context of the island's membership of the European Union seems likely, the area that Turkey took control over, the "Turkish Republic of Northern Cyprus" (TRNC), remains unrecognized by the international community.

The political (and geographical) isolation of north Cyprus meant that tourism was slow to develop. Prior to 1974, hotels had sprung up around Famagusta; lured by the promise of sun, sand, and sea (and possibly sex), and by the falling price of air travel, northern Europeans were increasingly prepared to spend their summer vacations on the island. With the division of the island, the industry migrated southwards, to Greek Cypriot-controlled areas, creeping slowly but inexorably along the southern coastline. Concerns have been expressed over the speed of development: Saveriades (2000) has attempted to estimate the social carrying capacity of the Ayia Napa/Protoros region in the south.

The Karpas Peninsula

The Karpas Peninsula, the panhandle at the northeastern end of the island, is a land apart: a peripheral area, distant from the major towns of Cyprus (see Scott 1999). The wild, haunting beauty, the remoteness, the flora and fauna are all features that attract a certain type of visitor. In spring, the lowlands turn first green, as the grass benefits from the winter rains, and then cascade with color as flowers grow to maturity. Lizards sun themselves on rocks. The rare Audouin gull breeds on the rocky islets off the tip of the peninsula. Of supreme importance are the green and loggerhead turtles. Some 30% of the Mediterranean population of the green turtle, and 10% of the loggerheads, choose to nest on north Cyprus' beaches (Phillips 2001; Godley and Broderick 1995).

The rapid departure of much of the Greek Cypriot population produced an interesting side effect: domestic animals were set free by fleeing farmers, leading to a population of feral donkeys (now estimated at some 250), and an unknown number of feral pigs. The villagers who farm the area see the donkeys as a menace that devours their crops. It was once suggested that licenses could be issued to foreign hunters to cull the herd; however, there is little kudos to be gained from boasting that one has shot a donkey, and so the idea was quickly dropped.

The cultural environment of the area is also rich. Strabo, in the third century BC, count-ed one settlement, Aphendrika, as one of the six most important cities on the island. Today, several remains of Byzantine churches survive. Other churches also bear mute testimony to a time when the population was much greater.

The only inhabited building in the last 20 km of the peninsula is the monastery of the Apostle Andrew, formerly a place of pilgrimage for both Greek and Turkish Cypriots; prayers to the apostle were said to be particularly effective in healing the lame. Several times during the 1990s, organized tours of Greek Cypriots were able to visit the monastery on the Apostle's Feast day (30 November).

Today the Karpas is more lightly populated than at any time in recorded history. Most of the Greek Cypriot population left after the de facto partition of the island. Although the Vienna Agreement of 1975 recognizes their right to stay, until recently conditions imposed by the Turkish Cypriot authorities have made life difficult for the dwindling Greek population. In 1960, the population of the area was around 8,000; with the departure of all but some 450 Greek Cypriots, the population today is less than half that. The remoteness of the area discouraged settlement: many of the new Turkish settlers who made their way to Cyprus after 1974 left after only a few years.

To prevent excessive and inappropriate development, there has been support for turning the area into a national park. As the Cyprus problem edges towards a resolution, a novel political aspect comes into play: the declaration of a park could be a way of restricting the right to return of the Karpas' former residents.

The one large village, Rizokarpasso, once home to 3,500 Greek Cypriots, has the feeling of being a semi-ghost town. A new mosque was built in the 1990s on a hill overlooking the church, but many of the houses formerly occupied by Greeks are abandoned. There are few economic opportunities for residents: the main activities are animal husbandry and farming, with a small amount of fishing, quarrying, and bee-keeping.

Tourism

In 1986, the Turkish Cypriot authorities declared tourism to be the engine of growth of the economy, with the aim of attracting northern European visitors seeking sun, sand, sea (and perhaps sex). But Turkish Cypriot tourism development has been slow, hampered by poor communications (all flights to North Cyprus must land in Turkey en route, adding time and expense to the journey), the lack of facilities, and the disturbing presence of 30,000 Turkish soldiers. While the south was drawing over 2 million tourists a year (worth 1.74 billion euros, or 15.5% of the Gross Domestic Product and 13% of employment in 2003) the north, with over half the island's coastline, received only 430,000—of which two-thirds were from Turkey.

Gradually, though, helped by government subsidies, more hotels have been built. Mass tourism was centered on the north coast (where Kyrenia had developed as a small resort in the 1960s), and hotels and villas have extended along the coastline there (Figure 1).

The remoteness of the Karpas Peninsula, has, so far, kept it free from any large-scale development. In the mid-1990s, fewer than 10,000 visitors a year were recorded at the monastery. But as suitable sites for hotels are sought, the pressures on the peninsula are

Figure 1. Major features of Cyprus, with main areas of tourism development.

growing. Julie Scott (1999) found that the district office (then located in Famagusta) was abuzz with talk of tourism "exploding" in the Karpas. The large number of attractive beaches makes the area very attractive to developers. But such development would put considerable pressure on a fragile ecosystem, and destroy much of the beauty of the place.

The negative effects of mass tourism are well-known, but the short-term benefits seem attractive. Living with noisy visitors for a few years reduces the positive feelings locals have to tourists, but prior to their arrival, local communities express strong support (see Akis et al. 1996). Ecotourism would obviously have great potential for the Karpas Peninsula—if properly managed to prevent the degradation of sites there. (For further discussion on options open to the Turkish Cypriots, see Warner 1999.)

North Cyprus has had some success in the development of longer-term tourism. The village of Karmi, in the hills southwest of Kyrenia, has become populated almost exclusively by retired European expatriates. The houses there (abandoned since the Greek Cypriot population was expelled in 1974) are let to foreigners on long leases; initially rents are very low, as it is a condition that the tenant spend money restoring the house. As a means of preserving the houses, and raising revenue for the government, this has been highly successful. Something similar might be appropriate for the Karpas region, if the vexed issue of property ownership could be resolved. However, European Union citizens who have bought ex-Greek Cypriot property in North Cyprus are currently threatened by the possibility of lawsuits brought by the Greek Cypriot owners of the houses and land they have bought.

A small national park and its extension

The tip of the panhandle was placed under Turkish military control in the years after 1974. Visitors needed a permit to go the last 20 km of road. In 1983, when the army left, this area was declared to be a national park. In a sense, this was not a big change: prior to the Turkish invasion, the Forestry Department had been responsible for the area (with the exception of the area immediately around the monastery), and, as with other areas of forest on the island, the Forestry Department's main concern was conservation.

Interestingly, much of the impetus for further preservation came from outsiders, rather than locals. The Turkish residents of Rizokarpasso could see that a mass influx of tourists would probably benefit them (by raising property values and providing employment opportunities); and Turkish Cypriot and Turkish developers helped reinforce this attitude. In addition, the possibility that one day several thousand Greek Cypriots might return to the area made rapid development seem like a good idea to them, so as to make money before their return.

The strongest pro-environment voice in northern Cyprus came from the expatriate community. A retired British army major established the Society for the Protection of Turtles, and was instrumental in getting Glasgow University to organize an annual census of turtle nests in the Karpas (and elsewhere along the north coast). The Society for International Development (SID), headed by another retired British army major, and the National Trust of North Cyprus (headed by another expatriate) were also instrumental in arguing for more sustainability in the development process, Among Turkish Cypriots, some interest in preserving the Karpas area developed. A group known as Yesil Baris (Green Peace, but unaffiliated with the international organization of the same name) became concerned with protecting the feral donkeys.

For the Turkish Cypriot government, the declaration of an extended national park in the Karpas held the prospect of both political threats and opportunities. The issue dominating Cyprus politics—the "Cyprus Question"—means that any policy decision is made in the light of its perceived effect on the relative advantages of the two sides in negotiating a political settlement. For the Turkish Cypriots, anything that increases the chances of recognition of the TRNC (and the end of the perceived economic embargo against the north) is seen as positive; anything that seems to lend support to the Greek Cypriot claim to be the legitimate government of the whole island is a negative.

The 1983 decision brought little reaction from the Greek Cypriot government. There was relief that the Turkish army had withdrawn from the monastery, and continuing concern about the plighted of the "enclaved" (the Greek Cypriots remaining in the Karpas), but by far the biggest issues that year were the breakdown, amid mutual recrimination, of the Denktash/Kyprianou talks for a settlement, and the subsequent diplomatic push to prevent recognition of the Turkish Cypriots' unilateral declaration of independence.

For the Turkish Cypriot government, offending a few villagers in the region was probably not significant, but the potential of revenues foregone from Turkish and Turkish Cypriot hoteliers might be significant, should they run out of suitable alternative locations. In addition, having declared tourism to be the economy's growth sector, taking action that would appear to restrict hotel development appears contradictory.

But declaring a national park would score Brownie points with the world community—a significant consideration for an unrecognized state—and would place the Greek Cypriot government in an awkward situation. In their view, any purported legislation of the TRNC is null and void. On the other hand, to denounce the declaration of a national park as wrong is unlikely to win friends and influence people. Further, some of the plans for the reunification of Cyprus called for "cantonization": returning the Karpas to Greek Cypriot control, and a return of its former inhabitants. This would have passed any advantages of development over to the Greek Cypriot community, whereas declaring a national park would leave the Greek Cypriots with the embarrassing choice of either validating "illegal" legislation (and upsetting those Greek Cypriots who want to return to their homes there), or of violating the park, to international opprobrium.

One factor strengthening the decision to declare a park is that tourism in the Karpas was different from that in the rest of the north. Relatively few Turkish tourists make their way there. The Blue Sea hotel, a basic hostel without mains electricity that opened in 1990, caters almost exclusively for foreigners from Western Europe—only 3% of its guests in 1994–95 were Turks. It was clear that these visitors were looking for a different type of experience from the Turkish tourists frequenting the casinos in the Kyrenia region, and from the sort of Western tourist lounging on the beaches of the south. On the other hand, it would be easy for a developer to argue that, given the low economic value of the region (for calculations, see Warner 1995), mass tourism would be an appropriate development strategy.

The status of the park today

The 1997 TRNC Environment Law paved the way for an extension of the park to include more of the Karpas Peninsula. The next year, the Turkish Cypriot government declared 155 km^2 of the Karpas Peninsula to be the TRNC's first and only national park. This, in theory, provides protection of the Karpas area by limiting development and taking notice of the environmental impacts of any increased activity. In practice, though, it may make little difference. It is noteworthy that the 2001 "Secret Action Plan" for North Cyprus (prepared in Turkey) invests the Forestry Ministry with the creation of the National Park—this over two years after it had been established (*Sabah* Internet edition, 3 January 2001).

The danger is that declaring an area to be protected may not be enough: similar protections have not protected the Akamas peninsula, despite active campaigns from environmental groups there.

And yet there are some grounds for optimism. Ayse Dönmezer, then Turkish Cypriot Minister of Tourism, stressed the need for conservation. "Nature is our biggest resource," she said, speaking in April 2004, adding, "Our responsibility is to future generations. People don't want to see concrete; they want to see nature. In Spain and south Cyprus they have made money, but at the expense of the environment. We don't want to do this." And yet she went on to argue for more investment in tourism in the north, to match the levels of investment and tourist arrivals seen in the south. The ambiguities of the status of the Karpas could be partially by design: if the "Cyprus Problem" is resolved, then it would be relatively easy for the authorities to acquiesce in granting special privileges to friends who wish to build hotels on the Golden Sands beach. The failure to develop a comprehensive management plan for the Karpas makes it all the easier to remove whatever theoretical protections the area has. The temptation to allow use to exceed the carrying capacity of the area is very great. Only constant vigilance by environmental groups will be able to maintain this wonderful landscape for future generations.

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How Will Climatic Change Affect Air Quality in Parks and Wilderness?

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Introduction

As global temperatures and populations increase and demands on natural resources intensify through the 21st century, management options will become more constrained and more trade-offs will have to be evaluated. For example, in the USA land managers use prescribed fire for restoring and maintaining ecosystems (Allen et al. 2002). In landscapes in which fire severity was low prior to active suppression but fuel loadings are now higher than they were historically, prescribed fire can also reduce the risk of catastrophic wildfire that would threaten key resources or human communities. Land managers in protected areas (national parks and wilderness) have adopted a policy of "wildland fire use," whereby they allow naturally ignited fires to burn unless they threaten one or more values—typically fire risk to structures or ambient air quality—held to be of higher priority.

Fire effects on air quality can be both local and regional. On actual burns and in watersheds immediately downwind of prescribed fires, smoke exposure causes respiratory problems even in healthy people, but is especially problematic for those with asthma or other chronic respiratory problems. Particularly hazardous are the particulate emissions smaller than 2.5 μ in diameter ($PM_{2.5}$), which can be breathed more deeply and cross protective membranes in the lungs (Kreyling et al. 2004).

These same particulates and other elements of the smoke plume can contribute significantly to visibility impairment hundreds of kilometers downwind from emissions sources (Malm 1999). In the western United States, regional haze from fires and other sources reduces visibility in most of the protected areas at some time during a typical year.

To maintain air quality in Class I areas into the future we need to understand not only present-day emissions from fires, but also how they may change over time in response to climatic changes, land use, and management strategies. Fire regimes will likely evolve in response to temperature increases and vegetation changes associated with them (McKenzie et al. 2004). Specifically, annual area burned by wildfire is expected to increase across the western United States and Canada (Flannigan et al. 1998; McKenzie et al. 2004). Fires in many ecosystems are already becoming more severe than they were historically because of increasingly severe fire weather, unnatural fuel buildup from fire suppression, or both (Agee 1997; Allen et al. 2002). Increases in area burned and fire severity increase biomass consumption and smoke emissions, and consequently atmospheric dispersion of particulates and aerosols that produce regional haze.

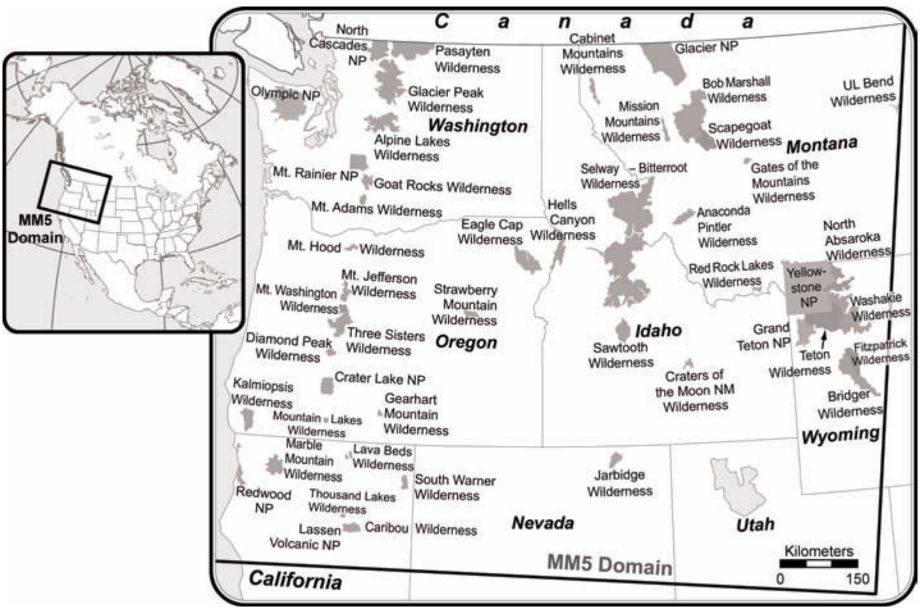
In this paper we describe the integration of four simulation models, an array of GIS raster layers, and a set of algorithms for fire danger calculations (National Fire Danger Rating System, or NFDRS; Cohen and Deeming 1985) into a modeling framework for simulating regional-scale smoke dispersion. We focus on a representative fire season (2003) in the Pacific Northwest, USA, and track the simulated dispersion and concentration of $PM_{2.5}$ over the course of the season. We compare summary statistics for simulations to real data for the same time period, and briefly discuss implications for management of parks and wilderness into the future.

Study area

Our study area is the Pacific Northwest 12-km domain used in real-time forecasts from the MM5 mesoscale meteorological model (Grell et al. 1994; Mass et al. 2003) as shown in Figure 1. In this region, steep gradients in elevation, precipitation, and temperature exist across multiple scales. The diversity of climatic conditions, topography, and elevations supports a variety of ecosystem types, including coastal temperate rainforest, subalpine parkland and alpine meadows, drier mixed-coniferous forests, and semi-arid shrublands and grasslands.

Fire regimes within the Pacific Northwest include large, stand-replacing fires (Agee and Smith 1984); mixed-severity, medium-frequency fires (Morrison and Swanson 1990); and

Figure 1. Class I wilderness areas in the MM5 12-km modeling domain for the Pacific Northwest. Inset shows the full extent of the domain, which includes parts of southwestern Canada and the northeastern Pacific Ocean.



low-severity, high-frequency fires (Agee 1993). Lightning is the main source of wildfire ignitions in our study area (Rorig and Ferguson 1999), and climatic variability, both within and among fire seasons, is the dominant control on fire occurrence and fire extent within the region (Hessl et al. 2004; Gedalof et al. 2005).

Methods

The framework of the integrated modeling system is shown in Figure 2. Multiple dependencies exist among elements. For example, climate affects fire severity directly through fire weather, but also indirectly through its effects on vegetation and associated abundance and distribution of fuels. Within the conceptual framework, we delineated three modules: (1) a fire scenario builder (FSB) that simulates fire starts and fire sizes as a function of fire meteorology and historical fire frequency, (2) a consumption and emissions module that calculates particulate and aerosol emissions from biomass consumed in the fires, and (3) a smoke dispersion module that simulates the smoke plume and atmospheric dispersion of emissions from each fire. For this study we simulated only lightning-caused wildfires.

Fire scenario builder. The FSB uses climatic information (historical observations or future climate simulations) to determine a scenario of fire starts, sizes, and locations that can be then used by the consumption module. The FSB is designed to accept three input layers: meteorology, vegetation/fire regime, and management, but for this exercise we omitted any management options. We used the "natural background" of annual area burned associated with potential natural vegetation in the region, and used simulated daily meteorological output to downscale annual area burned to individual fires and increase or decrease it proportionally based on fire weather.

From the MM5 model, we extracted all necessary meteorology variables needed for the modeling system, including surface temperature, relative humidity, and rainfall. As a proxy for atmospheric instability, and therefore the probability of lightning, we calculated the maximum CAPE (convection-available potential energy) statistic for each day at each 12-km grid cell. Lightning was simulated when max(CAPE) > 1000, creating 4–5 episodes of sufficient lightning potential during the fire season, similar to what is observed.

The potential for lightning to trigger a fire was estimated using the NFDRS (Cohen and Deeming 1985), which provides a set of algorithms for estimating fire danger. We used the equations in Cohen and Deeming (1985) to calculate daily equilibrium moisture content (EMC) from MM5 output in the size classes of surface fuels (0.6–8.0 cm diameter) most important for fire spread. A fire was "ignited" on the ignition day for a cell

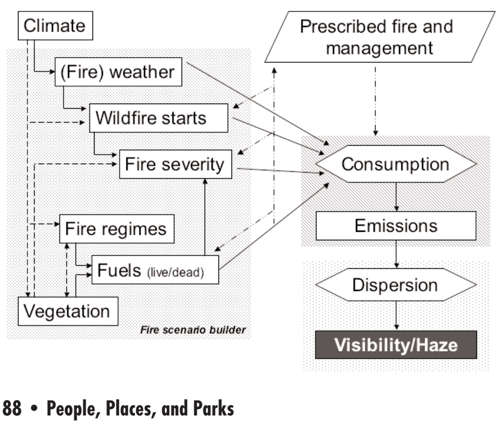


Figure 2. Integrated modeling framework for simulating regional haze from wildland fire. Interactions with solid arrows are activated in the current paper. Dotted arrows indicate interactions that are turned off or for which default values are assumed. See text for explanation.

if the weighted average fuel moisture percentage in the 0.6–8.0 cm size class was below 25%, considered a default threshold for fire danger modeling (Cohen and Deeming 1985).

Fire sizes were simulated in the following way. The fuel moisture damping coefficient from NFDRS (Cohen and Deeming 1985) was calculated with an extinction level of 25%. Using the "expected" area burned for each cell as a mean, the damping coefficient defined the quantile of a negative exponential distribution with that mean. The cell's "fire size" was adjusted to the associated quantile. Fires produced in this way ranged from the miniscule up to 2,800 ha, with the majority being under 40 ha. Fires under 40 ha were then eliminated. Because real fires under this size are not tracked, they are excluded from emissions inventories and thus should be absent from our simulated inventories.

Potential fire duration was a linear function of the adjusted fire size. Total area burned was then assigned to "ignition days" and days following, if any, proportionally to the weighted-average fuel moisture values for each day. A fire "went out" if fuel moisture reached 25%, but area burned was not truncated; rather, it was renormalized to occur in the consecutive days after ignition whose fuel moisture was below 25%.

Consumption and emissions module. The consumption and emissions modules are currently nested in the BlueSky Smoke Modeling framework (http://www.fs.fed.us/bluesky/; O'Neill et al. 2003). Fuel loadings in the Pacific Northwest domain were obtained from a 1-km GIS layer developed by the U.S. Forest Service (Hardy et al. 1998). Within BlueSky, area burned for each day and fuel loadings for each cell were passed to the Emissions Production Model (EPM; Sandberg and Peterson 1984), which calculates hourly consumption, heat release, and smoke emissions ($PM_{2.5}$ and PM_{10}, CO_2, CO, VOC, NMHC) from fires based on an exponential mixture model of flaming and smoldering stages of combustion.

Dispersion module. The emission estimates from EPM, along with meteorology from MM5, are processed for the CALPUFF Gaussian dispersion model (Scire et al. 2000). CALPUFF is a puff dispersion model that simulates point, volume, or area sources, assuming that plume dispersion occurs in a Gaussian pattern. CALPUFF also estimates plume rise and accounts for density differences between the plume and the ambient air. A pre-processing program, EPM2BAEM, converts the emissions from EPM into an area emission source suitable for input into CALPUFF. It calculates flame height (Cetegen et al. 1982) using the heat-release estimates from EPM and vertical velocity of the smoke plume, assuming conservation of buoyancy flux proportional to heat-release rate.

Data output. We ran the simulations through a 61-day period in the summer of 2003, producing $PM_{2.5}$ concentrations across the MM5 Pacific Northwest domain. In this paper we focus on $PM_{2.5}$ concentrations in selected Class I Wilderness Areas within the domain (Figure 1). We recorded the maximum of 24-hour running means of $PM_{2.5}$ over all 12-km cells included in the Class I area. We then calculated an extinction coefficient to represent the worst-case reduction in visibility from pristine conditions associated with the 24-hour concentrations of $PM_{2.5}$ from fire only (Engling et al. 2004).

Engling et al. (2004) found, in a study of aerosols in Yosemite National Park, that $PM_{2.5}$ from fire was 80% organic carbon (OC). Assuming that this finding is applicable to fire across the western U.S.; assuming that the ratio of OC to elemental carbon (EC) from fire is 9:1; and neglecting sulfate, nitrate, and fine soil, the extinction coefficient from fire only is:

$$\beta ext = 4[OC] + 10[EC] = (4)(0.8)[PM_{2.5}] + (10)(0.8)[PM_{2.5}]/9$$

where [ ] indicates concentration ($\mu g\ m^{-3}$), OC is organic carbon, EC is elemental carbon, and βext is in units of Mm^{-1} (USEPA 1999).

We used the WinHaze Visual Air Quality Modeler (Air Resource Specialists 2004) to visualize the visibility reduction from modeled $PM_{2.5}$ concentrations. This allowed us to compare simulated reductions in visibility to a library of photographs of Class I areas (IMPROVE 2004), thereby qualitatively estimating the percentage of regional haze attributable to smoke dispersion from fire by comparing WinHaze output for days with the highest extinction coefficients to library photos of days with the worst visibility. One can also quantitatively compare results to the highest extinction coefficients reported for a particular Class I area on the IMPROVE network (http://vista.cira.colostate.edu/improve/).

Results

Area burned tracked the number of fires started for most days, reflecting the contribution of fuel moisture calculations, and particularly the extinction threshold of 25% in woody fuels, to both variables. One exception occurred on 16 July (day 197), when 48 fires started but only about 4,000 ha burned, reflecting extensive simulated atmospheric instability but without, on average, dry woody fuels. In late August, total fire activity was greatly reduced, reflecting widespread precipitation across much of the domain.

Using these simulated fires, consumption and dispersion were calculated to yield smoke concentrations throughout the domain. From 24-hour mean concentrations of $PM_{2.5}$, light extinction coefficients (βext) were computed at each Class I area in the domain. Figure 3 shows βext for selected Class I areas in northern Idaho and western Montana. The maximum βext is 144 Mm^{-1} in the Selway-Bitterroot Wilderness Area in late August (Figure 3).

The cause of this August spike is due to much of the fire activity in late August being concentrated upwind of the Selway-Bitterroot. Based on comparison with data from the IMPROVE visibility monitoring program, the maximum simulated value (144 Mm^{-1}

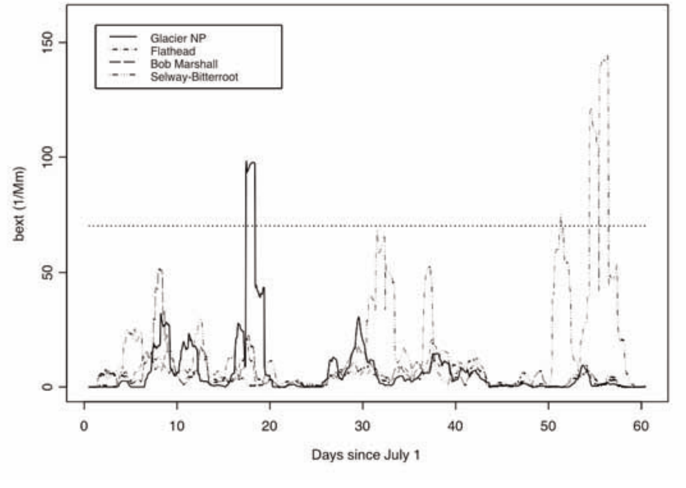


Figure 3. Twenty-four-hour running means of maximum extinction coefficients predicted for four Class I areas in Idaho and Montana (see Figure 1 for locations). Predictions for the Selway-Bitterroot are for the northern half only (see text). The horizontal line at 70 Mm^{-1} represents “significant degradation” according to national air quality standards.

in the Selway-Bitterroot) exceeds the 20 worst days average of any western national parks, but is below the maximum observed values for many western national parks.

Discussion

We simulated the contribution of wildfire to fine particulates ($PM_{2.5}$) that cause visibility reduction (regional haze) in Class I areas of the Pacific Northwest, USA, under historical (natural background) fire regimes, but using current fuel conditions.

The modeling system produced light extinction coefficient values at Class I areas within the range observed historically at western U.S. national parks. The simulated days of maximum reduction in visibility, in late August in the Selway-Bitterroot Wilderness Area and in early July in Glacier National Park, are analogous to observed visibility impairment from wildland fire. We expect that wildfires upwind of Class I areas will consistently reduce visibility—if not to record levels of degradation, then at least to levels associated with worst-case days by regulators and with unacceptable loss of scenic vistas to the public.

How will wildfire affect visibility in the future? Both empirical models (McKenzie et al. 2004) and process-based models (Lenihan et al. 1998) suggest that wildfire area will increase in the western USA with a warming climate. We can therefore expect the contribution of fire to regional haze and reduced visibility to increase. Our modeling system provides a framework for translating estimates of area burned into pollutant concentrations in Class I areas, provided that appropriate meteorological time series are available.

Given the anticipated complexity of future management and policy decisions, integrated multidisciplinary models are needed to guide management alternatives in the face of dynamic ecosystems and a warming climate. For example, adding prescribed fire scenarios or other means of fuel reduction will allow us to estimate the potential value that fuel treatments on multiple-use lands might have for maintaining pristine air quality in protected areas. Clearly there will be trade-offs between air quality and ecosystem restoration, and precise quantitative estimates of the effects of treatments will help land managers across the West to make informed choices.

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Climate Change Adaptation for Park Managers

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Why adapt?

Protected areas will be impacted by climate change as much as other lands and waters in their natural regions. However, fewer mitigation and adaptation options exist for natural areas than for those that can be routinely manipulated. Park custodians must therefore adapt management practices to help maintain biodiversity and natural processes, to assist nature through its inevitable transitions, and to participate in communications and house-in-order programs. Adaptation is encouraged for several reasons:

- Climate change impacts cannot be prevented.
- Benefits will accrue from removing or halting maladaptive policies, practices, and stresses that increase vulnerability.
- Visitor activities and related infrastructure and marketing investments are tied to the timing and duration of climatic cycles and phases.
- Effective government is abetted by leadership by example. This means, for example, early achievement of greenhouse gas emission reductions from high-profile institutions such as parks.

How to adapt ... maybe

The protected area/climate change literature provides strong reasons for having parks and reserves, why there should be more of them, why they should be accorded enhanced protection, and how they might be selected. For example, the recommendations of Hannah et al. (2002) and (Hansen et al. 2003) include:

- Locate parks with climate change in mind;
- Avoid fragmentation—provide connectivity and maintain buffer zones;
- Represent vegetation types and diverse gene pools across environmental gradients;
- Determine the necessity to transplant species and control rapidly increasing species;
- Involve local communities for management of biodiversity;
- Strengthen research capacity, e.g., to model biodiversity under changing climates; and
- Conduct long-term monitoring to seek causality between climate change and biodiversity responses.

However, these and other reports provide little guidance to managers of existing protected areas, a gap this paper attempts to fill.

What to do

Core principles. I propose the following core principles for a climate change strategy for protected areas.

- **House in order and public communications.** A park agency can foster mitigation by putting its own emissions house in order, and can use its outreach and presentation activities to demonstrate leadership. Visitors are generally ready to soak up information and listen to sound arguments by credible proponents. Indirect contributions through interpretation, education, and outreach can far exceed in-house emission reductions, but credibility depends on such reductions.
- **Risk management.** Environments have a degree of resilience and in some cases can accommodate climate change by species migration or *in situ* adaptation. However, there are many other stresses impinging on ecological integrity, so I recommend a risk management approach whereby tractable stresses are reduced or eliminated. This can only happen through collaboration with stakeholders.
- **Focus on mandate, complement with partnerships.** Protected areas increasingly emphasize ecological and commemorative integrity in their mandates, outweighing tourism development, infrastructure, and regional economic development. Leave unto others the leadership of activities that are their responsibility. However, to the extent that internal capacity allows and that one's prime mandate is favored, cooperate in such activities. Education, emission reduction, and national science programs are good examples.
- **Porous landscapes.** Park agencies should promote the importance of regional ecosystems characterized by connectivity and porosity for wildlife movement. "Porosity" means not just defining wildlife corridors (connectivity), but removing impediments to movement across all lands. Examples include maintaining hedge rows and wood lots in agricultural areas, eliminating the cosmetic use of pesticides in urban areas, fostering dark sky preserves, and installing wildlife crossing alert lights on major highways, as in a Newfoundland pilot project.

Targets

Action plans need time-bound and measurable targets against which to assess progress, and to redefine schedules and activities as appropriate. I propose three time frames and related goals.

- Short-term: appropriate climate change information is available to ecosystem and asset managers.
- Mid-term: climate change is factored into all aspects of ecosystem and asset management, and reflected in park management plans.
- Long-term: parks are nested within landscapes that are porous for the movement of native species and free of other significant threats to ecological integrity.

Alarming actions

Many actions can be conceived to fulfill these principles and goals, examples of which follow. They can be grouped under categories that form the acronym ALARM:

- **A**wareness;
- **L**eading by example;
- **A**ctive management;
- **R**esearch; and
- **M**onitoring.

Awareness

Staff awareness. Full engagement in any action depends on staff having an appropriate level of understanding of climate change impacts and adaptation. Actions include disseminating summary documents, newsletters and technical reports, giving seminar and workshop presentations, and including climate change overviews in basic training components.

Stakeholder awareness. Successful adaptation depends in part on the management of surrounding natural areas. Urge your ecosystem partners to adapt in concert. Ideas include extending awareness activities, promoting ecological porosity between and around protected areas, and mitigating local and regional threats to ecological integrity.

General public awareness. The public should be made aware of the impacts of climate change upon species, ecosystems, and features, and what adaptations may be required. Interpretation programs should help visitors become aware of what they can do at home and at work, by direct actions and by spreading the word to their friends and family. Post a climate change summary on your Internet site. Work with education authorities and nongovernmental groups to deliver climate change information to children and adults alike.

Leading by example

Reduce greenhouse gas emissions. Park agencies can use their favorable public profile to promote minimizing building energy consumption through design and operational practices, reducing fleet size, switching to more energy-efficient vehicles, fuel switching, and taking advantage of emerging technologies.

Promote personal action plans for staff. Employees and volunteers can play a role through their personal actions at home and in their neighborhoods. Employers can provide transit passes rather than subsidizing parking. They can provide incentives for car pooling, cycle commuting, and telecommuting, and promote energy use reductions in homes and lifestyle choices.

Address climate change adaptation in park management plans. Given the enduring nature of parks and the long-term implications of climate change, adaptation should be addressed in management plans. For example, modify park purposes to protect processes and biodiversity rather than specific biomes and species. Review boundaries to seek opportunities for changes that optimize the protection and maintenance of ecological integrity. Endorse research and monitoring of indicators of climate change impacts. Take future climates and vegetation successions into account in ecosystem restoration projects such as fire restoration and land reclamation.

Report on natural and management adaptations to climate change. Whether reactive or adaptive, an integral part of management is the monitoring of progress towards a goal, assessing results, and modifying future actions accordingly. Documenting these processes is essential to full debate and support. A regular report series is the best guarantee of systematic publishing, dissemination, and readership. Annual corporate reports and periodic state-of-the-park reports are often appropriate. Select indicators of climate change impacts for your park and its natural region, develop protocols, and implement monitoring, and collaborate with regional partners to report impacts to the public and policy makers.

Active ecosystem management

Adapt natural region representation strategy. As a basis for park establishment, natural region representation assures a distribution of parks across landscapes and ecotones, itself one of the best ways to protect biodiversity. It also deflects demands for land protection when there is already a park representing a specific region. Natural regions are typically based on physiography and vegetation. While physiography remains largely constant in anything less then geological time, vegetation has changed significantly in living memory. Climate change will accelerate this process to the extent that natural successions will evolve within decades. Therefore retain map entities of natural regions, but revise their descriptions to reflect the dynamics of present and future climate.

Eliminate or mitigate nonclimate *in situ* threats. The growing body of research on interactions between climate and nonclimate stresses suggests that responses are synergistic. To maintain or rebuild ecosystem resilience one must reduce the number and/or magnitude of insults faced by an ecosystem. Fortunately, many stressors are more locally and regionally controllable than climate change. In a freshwater system this may require limiting the concentration of toxic substances in effluent. In a forest ecosystem it may mean preventing fragmentation by access roads. These tasks are approachable on a local level through conservation partnerships.

Use adaptive management. The uncertainty about the exact nature of climate change impacts and responses requires a responsive, flexible approach to ecosystem management. Adaptive management allows one to proceed with only limited or uncertain knowledge. An intervention is conducted as if it were a scientific experiment, with measurable, time-bound targets set in advance, careful measurement of results as thing happen, and approaches adjusted as new information becomes available. Use adaptive management in impact abatements such as species protection or retardation of invasive pioneers.

Use climate change research results. It is not enough to have good primary science. There must be secondary products that digest and customize this knowledge for interdisciplinary professionals. Commission reports that translate the science to regional and park-specific data sets. Parks Canada has done this through the work of Scott (2003), which resulted in spreadsheets of annual, seasonal, and monthly temperature and precipitation data for several scenarios at three periods of the 21st century, accompanied by narrative projections of potential physical and biotic changes.

Park managers also need the tools to use climate change information in their decision-making processes. Climate change guidelines for environmental assessment are now available in Canada, covering projects that either have the potential to emit greenhouse gases, or projects that will be affected by climate change.

Adjust park boundaries as needed for climate change adaptation. Changes in climate will lead to changes in habitats and species survival. Some plant species would have to migrate hundreds of kilometers to follow climate. Others might find a new home a short distance away. For the latter it may be possible to adjust park boundaries to capture the anticipated movement of habitats and species. Park boundaries could be realigned to accommodate transition zones where large changes of climate, habitat, and species distribution are expected.

Research

Understand the impact of past and future climate change. Decision-makers and park visitors alike benefit from a knowledge of Holocene landscape changes. This helps to understand the changeable nature of climate and nature's ability to adapt autonomously, even in historical times. Research the impacts of climate change on natural processes and visitor activities before committing to ecosystem restorations or visitor infrastructure development. Rate each park for its sensitivity to a $3xCO_2$ atmosphere.

Identify values at risk of being significantly affected by climate change. Identification of valued ecosystem components (VECs) provides a means to set management goals without bogging down in the minutiae of all species, all minerals, and so forth. Identify a limited suite of VECs that are sensitive to climate change, such as species at the margins of their climatic range, species with limited or excessive abilities to migrate, and temperature-sensitive features such as permafrost and ombrotrophic wetlands. Identify barriers to migration such as fragmented habitats and restricted vertical migration paths.

Monitoring

Data gathering and reporting actions. Each park should have long-term climate and climate change indicator data. These data should be reported at the park level and regional or national levels.

Promote parks as long-term integrated monitoring sites. Integrated monitoring can reveal unexpected linkages between ecosystem components and the drivers of environmental change. Each stress does not need its own unique set of indicators. Often, several stresses can be tracked from a limited but well-selected ensemble of indicators. Integrated monitoring also fosters partnerships in which many agencies share costs while reaping benefits greater than the sum of their inputs.

What not to do

Do not move parks to anticipated biomes. The presence of a well-distributed system of protected areas is one of society's best adaptations to climate change. Species will have their best chance of finding new homes in a well-managed, well-distributed, well-connected, and properly sized network. While some parks might benefit from local boundary adjustments to protect ecosystems and habitats at risk from climate change, the notion of dynamic parks must be rejected. This would open the door to other reasons to move a park, e.g., to extract minerals or fiber. Secondly, few natural areas remain for new park establishment within regions that already have park representation. Rather, the present parks are often all that remain as natural havens. Thirdly, park establishment is a lengthy process with no guarantee of success.

Do not use parks to buffer or mitigate other impacts. Parks are not an insurance policy to cover poor management of natural hazards and natural resource supply. The restoration, protection, and maintenance of natural systems precludes their manipulation to counter an anthropogenic threat. Ecosystem services may come about with the maintenance and restoration of ecological integrity, but parks should not be manipulated deliberately for flood protection, water supply, or carbon sequestration, for example. This could open the door to the commercialization of natural resources in parks.

Do not change natural regions to fit future biomes. The natural region representation approach to national park establishment has served Canada well since its adoption by the Federal Cabinet in 1976. The constancy of the number of regions and their boundaries has ever since been a cornerstone of the national park system plan. It helps to deflect lobbying to add a park just to satisfy vested local interests. If the precedent were to be set that the natural regions policy could be changed, then there could be no end to further pragmatic modifications of regions and parks.

All climate scenarios are based on assumptions about future emissions, the physics and chemistry of the atmosphere, and geographical simplifications to allow global models to operate on today's supercomputers. Vegetation response is likewise modeled on plant succession assumptions. While these represent today's best science, the placement of boundaries remains notional and subject to change as models improve and as the world develops real emission inventories rather than scenarios. To change natural region boundaries on this basis would open up a never-ending process, and create an unrealistic setting for park feasibility studies and establishment negotiations.

Conclusions

A good network of protected areas free of other stresses is already one of society's and nature's best available adaptations to climate change. Park agencies can also influence visitors and the general public, but this in turn requires well-researched and -monitored climate change impact indicators as the basis for adaptive ecosystem management, accountability, and reporting systems. House-in-order programs complement the messages that governments should send to their people. Research on the synergy between climate change and other processes can provide the knowledge to guide the mitigation of local and regional stresses, thereby restoring natural resilience of ecosystems and wild species.

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Native Plant Gathering Along the Village Chain Routes of Yosemite Genealogical Family Use Districts

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Native plants and family use district routes

Long before visible native land use practices in the Sierra Nevada were replaced by the cultivation methods of the Spanish and other Euro-Americans, native agroecology manicured the landscape. Manipulations by the indigenous population increased native plant yield, and propagated economic species for survival and trade (Baumhoff 1963; Anderson 1988). Southern Sierra Miwuk native plant data regarding the gathering of plants for material, medicinal, and dietary uses were viewed through this study to relate traditional plant use to the ancient and historic villages. Southern Sierra Miwuk village names were given by family members and used in a confidential native plant guide for tribal monitors. The guide is being developed in response to the need to monitor the plant resources during consultations with governmental agencies.

In precontact times, agroecological botanical life forms were managed by an indigenous methodology according to plant use category and ecosystem. Cultivation and harvesting methods varied according to the resource and harvesting calendar (Baumhoff 1963; Anderson 1988). Ceremonial roundhouse placement was related to the native plant life in and around villages. Plants with cultural religious uses are known to exist in ancient village sites, and are gathered at those sites by the current family members. Ceremonial roundhouse sites have been located within the traditional cultural property of the Yosemite families through nomenclature comparisons.

Knowledge of plant distribution is currently being mapped because it is known that some historic villages were named after the resources in those areas (Gaskell 2002). In addition to establishing associations between the villages and resources, the healing practices of a region may be extrapolated from the plant inventory after all the data are mapped. The permaculture within a village site varied greatly according to the climate and type of cultural contact (Merriam 1903). Various ethnographers documented domesticated plants, such as tomatoes, growing in the roundhouse villages around the turn of the century, interspersed within patches of local plants (Merriam 1906). Traditional plants that are California native plants are listed in the confidential tribal botanical name guide along with their uses within the territorial and tribal cultivation areas.

Watershed and traditional travelways

Within Yosemite Valley, the roundhouse villages existed between watersheds and at the base of particular deer migration trails. This region has been divided into the eight zones present on the Yosemite Valley floor management tracts or districts (Powers 1877). There is a linguistic relationship to the natural resources in these separate regions or zones and it is related to naming practices in the family use districts and to the territorial names within the Ahwahneechee land management system where physical habitation evidence occurs (Barrett 1893–1977; Merriam 1898, 1900–1920; Powers 1877). Each watershed between the listed geographic points is connected to a family tract. Present-day families have been compiling ethnobotanical information for watersheds based on their cultural knowledge of resource use and management that has been passed down through the families. Within the archaeological record, the food production areas within the family tracts are classified by archaeologists as physical features and by the families according to the trail content of a district village chain.

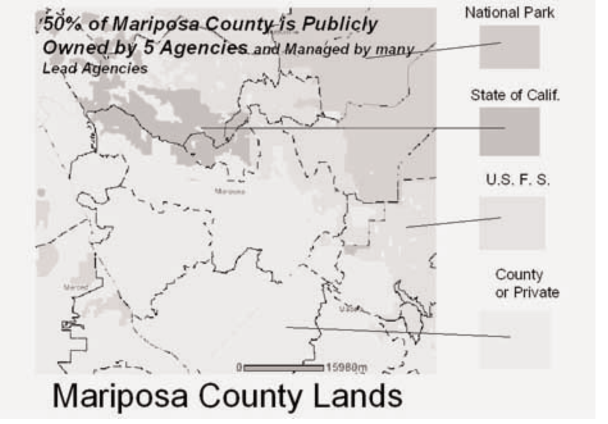
The Class I villages were the center of activity for four or more smaller Class II villages supporting the Class I village. An example of the naming practices can be found in a listing at the end of a narrative by J. H. Taylor, "Yosemite Indians and Other Sketches," published in San Francisco (Jonck & Seeger), where she writes in 1936 of witnessing the villages on El Capitan Meadows in Yosemite Valley named *Haengah, Awokoie, Helejah, Yuachah*, and *Hephepooma* (Figure 1; Merriam 1917). Of these five villages, Chief Lemee implicates the designation of the village named *Awokoie* as the Class I village because it was the village of the Headman Old Lancisco Wilson (Broadbent 1956). Merriam classified the villages of the Southern Sierra Miwuk into two categories: large important ceremonial centers and lesser villages surrounding it. Whitney's explanation in the U.S. Geological Survey guidebook of California in 1871, titled "A Description of the Yosemite Valley and Adjacent Regions of the Sierra Nevada, and the Big Trees of California," was verified by Merriam, who observed that a captain's village name dominated the names of the villages of lesser significance (Merriam 1902, 1955).

Figure 1. An example of changes to the ecology of traditional family lands can be found in the meadow under El Capitan (photo by John Muir, 1867, University of the Pacific John Muir collection, Stockton, California, and the Sierra Club).

Agency methodology to identify family use routes

As part of the cultural landscape studies housed in the tribal council office of the Southern Sierra Miwuk Nation, there are many environmental assessment studies, and environmental impact reports written by seven or more agencies studying regions of historic villages. Boundaries were drawn along linguistic, watershed, county, and reservation delineations. Agency policies regarding the management of cultural resources and biological elements differ between organizations. Since the tribal concept of gathering includes cultivation and harvesting at all trophic levels in balance, isolation of one element could produce discord. The *spirit of the law* that defines intent when dealing with the federal government is found in 36 CFR 2.1, which designates the superintendent as the final interpreter of the *intent* of plant use.

Figure 2. The 50% of the land open to public plant gathering by local descendants of Yosemite.



Because government agencies manage 50% of Mariposa County, it is an excellent region for studying agency treatment of gathering resources (Figure 2). Elevation models and travelways as they relate to the migration patterns defined by resource gathering may reveal village systems. An overview is needed in order to understand the decision-making about and policy standards for the use of traditional native California plants of these regions. These policy standards include: (1) the policies of these agencies; (2) the geography of a travelway; (3) the genealogy and cultural landscape of the regional land; (4) the settlement pattern and village structure example; (5) health, botanical, or nutritional legislation affecting the use of resources; (6) current issues surrounding the policy at specific locations (such as endangered plants; Figure 3); and (7) the policy and philosophy of disclosure of information surrounding cultural properties and plant gathering and use practices concerning them.

Scientific methodology to identify family use routes

Issues surrounding the indigenous knowledge of local communities were tapped by government forestry agencies for national fire management legislation signed in 2003. Recent policies regarding the harvest, preparation and sale of herbal products will have implications affecting Native American traditional family practitioners. Heritage seeds, soil seed banks, and the health of plant populations at project sites have raised questions regarding sustainability. A tribal center for scientific study of plant biology and propagation is planned in the design of Wahhogah in Yosemite. This could influence educational directives for ecological restoration. *Wah-ho-gah* is the name of the village area recorded by Merriam in 1917, and *Wa-ha-ka* is the name of the village area recorded by Powers in 1877. Wahhogah has been through environmental review and designed as a facility for use by the tribe as a cultural center of activity. Plant *use* questions, where the

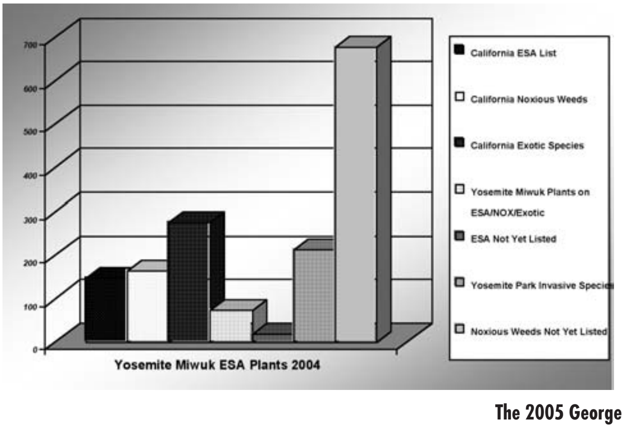


Figure 3. Comparison of Yosemite Miwuk native economic plants to ESA, CalEPPC exotic, noxious, and not yet listed lists.

stressed plant populations need to undergo rehabilitation, could be part of the scope of the cultural center.

Lineal descendants of the Class I villagers relate that the historic locations of these villages was usually determined by the juxtaposition of water and plant resources. Village naming procedures within the culture also suggest this. Historically, agencies interested in weeds or native California plants were intent on classifying them as either invasive, exotic, or worthy of listing as threatened or endangered. Now, with the resurgence of interest in the chemical components and uses of plants thought to be wild, even the gathering of these plants by native peoples on public lands has been highly scrutinized. The Southern Sierra Miwuk Nation has created a method for reconstructing, through evidence found in oral history, archaeological records, and geographical identifying characteristics, a strategy for identification of California native plant populations along a family use district, emanating from the center of a village settlement region.

This knowledge was a part of the plant and wildlife resource knowledge revealed in the "Petition to the Senators and Representatives of the Congress of the United States In the Behalf of the Remnants of the former Tribes of the Yosemite Indians Praying for Aid and Assistance," written about in the 1891 report of the acting superintendent of the park. The village and potato field became a hayfield. How this process impacted the Inner Valley (highground) family use districts and the territorial family districts is learned by examining the ethnographic data identifying village headmen. A comparison between the oral interviews of pioneer settlers and the Native American oral tradition shows how the resource management styles collided and put the entire ecosystem into chaos in El Capitan Meadow. Gathering in another family's resource area was cause for discord, and the Native Americans were more willing to approach the settlers for their land by petitioning the government than to encroach upon the land rights of adjoining families. Cultivation and gathering practices specific to the Yosemite Valley were performed by the families of sister villages inhabited concurrently in the valley and outer territories (Gaskell 2002).

Today, the outer territorial villages are population density centers for the Native American population, and the family burial and ceremonial areas are not far from them. Family members maintain areas of many varieties of nutritional, medicinal, and basketry plants on land near their homes. Soil seed banks in the ancient and historic villages should provide biological data. Surveys of the current plant and wildlife populations of historic family use tracts can contribute to the knowledge necessary to plan for future resource management.

Sovereign tribal cultural resource management office role

Institutional mission statements are useful in determining the philosophical goals of cultural resource management businesses. The goals of a cultural resource management professional are determined by the policy of the agency that employs her or him. Family use tract managers continue to frequent old village sites to collect and gather materials for daily use. Due to the holistic nature of the Southern Sierra Miwuk belief system, it is sometimes difficult to separate the indigenous knowledge system (IKS) regarding sacred sites and medicinal plants from village health. In order to identify the plant varieties used, since they are naturally occurring, this study needed to investigate villages where the resources were located.

Pharmaceutical business philosophy follows paths similar to tribal philosophy while trying to identify new treatments. Comparison of plant use in herbal products, alternative medicine, and homeopathic medicine against tribal healing methods reveal similar uses for regional species of the family use tracts.

The spiritual aspect of the practice of healing transcends the chemicals found in the native plants. This raises the question of what part of the plant knowledge is culturally sensitive? The whole process is culturally sensitive—the soil growing the plant, the water feeding the plant, and the practice of preparation, the use, and the healing. The use of a plant crosses over issues of cultural sensitivity and religion. IKS locations constitute gathering areas where there is a high probability of the existence of undisclosed villages of past family members. Ethnobotany is defined as the study of the utility, diversity, and chemical characteristics of plants found in their environment of indigenous people, while ethnopharmacology is defined as the "observation, identification, description, and experimental investigation of the ingredients and the effects of indigenous drugs" (Yano 1993). This traditional ethnopharmacological knowledge provides researchers with the first-hand, ages-old experience and experimentation of medicinal plant resources by indigenous peoples.

Ecological restoration and herbal medicine

Mental inventories of village locations and plant resources are covered under the category of intellectual property rights of culture. A biological inventory is an effective tool for ecosystem management, but there are disclosure rulings regarding cultural knowledge inventory. Demands for native plants has placed pressure on the public land agencies governing areas protected for public use, and they are confronted with gathering entities from different cultures (Figure 3). Conservation of the California native plants and Native American plant gathering activities in the Sierra Nevada foothills relates to four areas of influence on the environment: (1) agricultural and conservation easements, (2) vegetation management and public roads maintenance, (3) wildlife corridors, hedgerows and integrated pest management (IPM); and (4) Native American gathering for cultural uses.

Each agency has its own cultural resources policies and means of liaison. Wildcrafting versus cultural gathering is one of the key issues of intent (Anderson 1988; McCutcheon 1996; Hurlburt 1999). In preparation for various ecological restoration projects in the future, tribal members are recording the plant habitats and populations in the regions where each individual cultivates and manages plants in Mariposa County and other areas where they gather resources. Wildcrafting philosophy and Native American plant management are closely related, but with different intents.

Southern Sierra Miwuk native plant data regarding the gathering of plants for material, medicinal, and dietary uses were viewed through this study to relate traditional plant use to the ancient and historic villages along the family use district chains (Figures 4 and 5). The distribution of various plant resources are currently being mapped by Yosemite Valley Miwuk family members. Traditional plants that are native California plants are listed in the botanical name guide along with their uses and the relationships between the tribe and the gathering territory of those species. The Class I villages were the center of activity for four or more smaller Class II villages supporting the Class I village. Village naming procedures with-

Figure 4. Percentage of references to each plant named in the 1,183 species in sample. The sample contains species confirmed through oral interview, ethnographic and geographic documents, and from other biological listings.

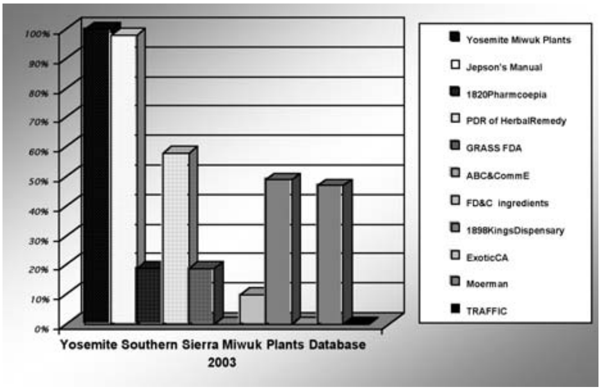
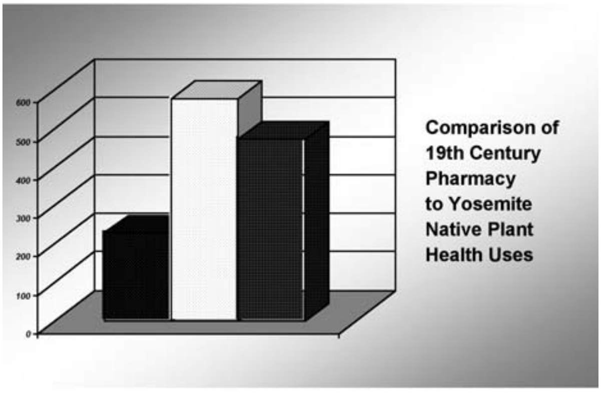


Figure 5. A comparison between the earliest American pharmacopeias and the Southern Sierra Miwuk biological inventory use list.



in the culture also suggest this. Mental inventories of village locations and plant resources are covered under the category of intellectual property rights of culture as are the practices of Native American gathering for cultural uses. Southern Sierra Miwuk native plant data relates traditional plant use to the ancient and historic villages. The sensitivity of this discussion condenses intent, philosophy, and high spiritual and monetary cost where two cultures interpret *preservation* with opposing meanings as preservation through use or preservation through nonuse.

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Anthropological Perspectives of Transboundary Park Impact: People of the Great Limpopo Transfrontier Park, Southern Africa

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This paper explores the politics behind the creation of a trinational park and the people it affects in the creation process. Rather than look solely at the various and very important environmental impacts a park such as this creates, this paper focuses mainly on trinational park creation, the reasons for doing so, and its effects on the local, rural, poor, and indigenous populations living within and around park boundaries. Historically, the majority of native populations within and around parks have been disenfranchised, disempowered, dislocated, and relocated to lands on the edge of park boundaries or entirely outside of parkland to areas that are less-appealing and have less-productive soils. As in the United States, this takes place in countries around the world, if not more so. Such is the case in Africa. But like the United States, parks in other countries are transforming, and in the process they are trying to incorporate native peoples back into the conservation, sustainable development, and management of parks.

In this particular examination three very important processes happening simultaneously at one park in Southern Africa are described. First, the paper explores the creation of a trinational, triboundary park through the removal of fences to create vast, open, and undefined wilderness habitat for wildlife and tourism. Second, it examines the how and why the park was created and the problems associated with taking on such an endeavor. And third, the effects all this has on that "other" population, the humans, and what they are doing about it. As a park ranger in a past life, I find the evolution of single parks to multicountry managed parks extremely exciting and fascinating, especially for the positive benefits it provides for wildlife. But from an anthropological perspective, which is the one taken here, local people, their habitat, and their empowerment is important and should be incorporated into park conservation, development, and management. The research for this paper was not collected in Africa, although I would like to go there in the future. This paper and the presentation based on it that was given at the GWS 2005 conference is hopefully a precursor to that goal.

National parks such as the ones first created in the United States have been emulated and copied throughout the world (Reid 2001). But national parks are evolving from singular political state boundaries into multistate managed parklands. The growing trend of combining neighboring countries' national parks with surrounding communal, reserve, and state park land signifies an exceptional development: the creation of transboundary reserves. The idea of international transboundary protected areas was first introduced in the 1920s and 1930s, but has only come to fruition within the last few decades (Wright 2001). The first attempt at creating a transfrontier protected area took place in 1924 when Czechoslovakia and Poland tried to solve a boundary dispute at the end of World War I, an effort which ultimately failed (UNESCO 2002). The first successful transboundary park to be established was in 1931, linking Glacier National Park in the United States to Canada's Waterton Lakes

National Park (Wright 2001). Referred to also as "transfrontier parks," "binational parks," "trinational parks," and "super parks," these connecting, unfenced parks preserve and nurture whole bioregions rather than just ecosystems. The World Bank estimates that 10% of the world's total protected area network is composed of transfrontier complexes, including 400 protected areas within 98 countries (MacKinnon 2000). Following the World Conservation Union's (IUCN's) 1988 report and guidelines, at least 70 protected areas that straddle national boundaries in 65 countries have been identified as probable transfrontier conservation areas (TFCAs) (PPF 2003b). In 1996, after the fall of the Berlin Wall and the Communist bloc, changing geopolitical climates have allowed for acceleration of transboundary initiatives, producing more than 100 pairs of transboundary parks in more than 65 countries (UNESCO 2002).

The park that is examined here is the Great Limpopo Transfrontier Park that connects Mozambique, South Africa, and Zimbabwe (Figure 1). I chose this park because as an anthropologist my particular specialization is in Southern Africa and because, once created, the Great Limpopo will be the largest park in Africa and the largest transborder park in the world. Furthermore, fences are being removed along the borders of the three countries to increase and connect wildlife preserves to allow animals (including rare, threatened, and "exotic" animals) to be able to roam freely over their naturally large territories without constraint. Attention is generally given to the large game animals, better known as the "big five" (lion, leopard, elephant, rhino, buffalo), because of their historical significance as hunting trophies (Carruthers 1995). The dropping of fences increases the health of individual animals and herds by increasing genetic diversity within populations (that may have not had access to one another) and a general increase in habitat, food resources, and shelter (UNESCO 2002). Besides obvious conservation preservation, the park intends to serve as one of the major, if not the major, revenue producers in the area. Since environmental tourism is on the rise around the world, Zimbabwe, Mozambique, and South Africa plan to profit on the phenomenon. Tourism will affect not only the park but all areas and businesses around it, including but not limited to hotels, restaurants, souvenir shops, safari operations and sightseeing tours in general, and legal hunting excavations (which still exist and provide a lot of money). This quote sums up the idea well:

Figure 1. Greater Limpopo Transfrontier Conservation Area.

> It is intended that the core GKG Transfrontier Park [referring to the three main areas to be incorporated into the park; see below] will be connected to a hinterland of private, resettlement and communal lands, creating the wider GKG TFCA. This will allow the spread of benefits to reach a much wider community than would otherwise be the case. It would also allow the whole lowveld wildlife/tourism community to piggy-back onto the momentum stimulated by the creation of the TFCA (which is one of the most important motivations for creation of the TFCA) (Wild-Net Africa 2001:3–4).

One of the most important reasons for the creation of the park is to attain political peace between the three countries through unification. One name for the park—"Peace park"—is particularly relevant. Creating the Great Limpopo Park is an opportunity to find ways to join the efforts of environmental conservation and preservation with community development between three countries that historically were very troubled and until recently have had significant upheaval and turmoil (which continue in Zimbabwe) and civil war. It's a symbolic joining between countries in Southern Africa to create one of the largest parks in the world promoting conservation, stability, and peace. But one of the main challenges to do this, since people live in and around the parkland, is how to integrate these local communities into conservation practices while understanding, facilitating, and promoting their needs.

The super park's composition contains national parks, reserves, sanctuaries, communal land, and private land designated within the three countries of South Africa, Zimbabwe and Mozambique (Duffy 1997; Wolmer 2003). Specifically, the largest and main areas of incorporation are Mozambique's Gaza Province (also called Coutada 16), South Africa's Kruger National Park, and Zimbabwe's Gonarezhou National Park. Banhine Park and Zinave Park in Mozambique are other parks marked for inclusion. Communal lands such as the Sengwe area in Zimbabwe to the Makuleke region in South Africa are included. Reserves such as the Manjinji Pan Sanctuary and the Malpati Safari Area in Zimbabwe will be annexed (GLTP 2003a; WildNet Africa 2001). Other areas around these lands are being incorporated into the transnational park while new areas are constantly being evaluated and considered for their inclusion (Duffy 1997). Idealized future plans for the park eventually have its boundaries reach across the entire country of Mozambique (GLTP 2003a).

Originally the three main parks within Mozambique, South Africa, and Zimbabwe produced the name GKG Transfrontier Park (Gaza–Kruger–Gonarezhou). Sometimes the name GKG TFCA (transfrontier conservation area) is used, as in the quote above. The unbiased and neutral name of the Great Limpopo Transfrontier Park was later adopted so as not to favor one country over another (Clark 2001; PPF 2003a). "Limpopo" comes from the name of one of the major rivers that runs through the center of the park from west to east between the borders of Zimbabwe and South Africa, through Mozambique where it empties into the Indian Ocean. The total surface area of the transfrontier park is approximately 35,000 sq km. Planned annexation of other wildlife areas surrounding the super park would bring the surface area to a grand total of 99,800 sq km (GLTP 2003a).

Other major rivers that flow through the greater Limpopo Park are the Save, Olifants, and Komati (PPF 2003a; Wild Net Africa 2001). The Great Limpopo Transfrontier Park consists mainly of four landscape types—a lowland plain, granite plateau, mountain range, and river valleys—and is in general very dry. The park is essentially a flat savanna broken by the Lebombo mountain range that runs north to south with minimal rainfall even during the summer's rainy season and mild temperatures year round. Vegetation types range from montane woodland and shrubveld, mixed bushveld, sandveld, to riverine woodland (GLTP 2003a). "Only a few areas within the Great Limpopo Transfrontier Park have been intensively surveyed for biodiversity attributes" (GLTP 2003a:3–4). Nonsurveyed TFCA areas in Zimbabwe should see increasing wildlife abundance as fences between borders drop.

One hundred and forty seven species exist within the TFCA, including a significant population of large mammals such as lions, spotted hyenas, elephants, Burchell's zebra, hippos, giraffes, warthogs, buffaloes, kudu, waterbuck, blue wildebeest, and impala. Several types of birds, reptiles, fish, amphibians, and plants are abundant. The super park also holds several endangered animals such as the rhino (both black and white), wild dog, Juliana's golden mole, eptesicus bat, roan antelope, sable, and the tsessebe (GLTP 2003b). More than 6,000 wild animals and 1,000 elephants will be relocated to the Limpopo Park from Kruger National Park at the completion of the TFCA. Already dozens of elephants from Kruger have been placed within Mozambique (PPF 2001).

There are many different human communities within and around the park. They are mainly composed of groups of Bantu origin: Africans speaking languages descended from the same linguistic phylum of the people who displaced the original San hunter-gatherers 800 years ago (Azevedo 1991; PPF 2003b). Many of these people live a life based on animal, totemic and ancestor spirit religions, such as the Shona in the north of the park to the Makuleke in the south. Currently, dislocation of local, poor, and native peoples proves to be a continuing consequence for the creation of the park, even though native voices were originally promised to be heard and incorporated into park management. This has not been the case. In fact, over 6,000 people are currently being relocated to lands outside of park boundaries (Refugee Research Programme 2002; Seria 2002).

Initiatives behind conservation efforts around parks and within communal land programs sound good on paper but in reality these efforts have negative outcomes and consequences for local people. Intentions of the conservation effort are admirable. Nevertheless, the failure to address human needs within this framework is serious. Additionally, the policy creators who put conservation efforts in place often fail to understand the local population's viewpoint. Parks such as these take ecological considerations into account first, leaving human populations as an afterthought most of the time.

Another problematic point in the creation of parks intended for worthy conservation issues is that these parks are in many cases created according to a racist, Western, white viewpoint. The importance of "nature" forces deprivation of resources by the local population. Conflict between the countries over money allocation is also a major problem. This is a major cause for concern since South Africa is arguing for most of the funds produced by the transfrontier park since it is based off of the flagship Kruger National Park (Mail and Guardian 2003). Additionally, border crossing is still a problem that needs to be worked out, including whether to issue passports and visas. Because of issues like these the park is currently not up and running. One of the main problems comes from Zimbabwe, with its recent political upheaval and its distrust in joining the transborder park initiative. Additionally, land mines found in Zimbabwe's part of the park have prevented that country from joining the TFCA so far (Maravanyika 2003). Wildlife poaching is still a major problem, while disagreement over the disbursement of hunting licenses has management taking conflicting sides. Of all the TFCA park management issues, the proper training of wildlife managers (the equivalent of park rangers in the U.S.) has come to be the most serious problem facing park enforcement, regulation, and operation (AllAfrica 2003). To make the park possible, logistical problems and money allocation must be figured out. Zimbabwe must settle its dispute in joining the park and clear its landmines since it is the major factor stopping the progress of park creation. If it cannot, it may be left out of the initiative, for now. Various problems beyond training for wildlife managers for proper park implementation exist, too many to discuss here. Exploring just the implementation of such a grand park or the various reasons why Zimbabwe has not joined the TFCA as of yet are papers in themselves.

To resolve many of these conflicts requires patience, finesse, and examples to draw from if available. The design and implementation of projects that help surrounding park communities use the land efficiently to promote environmental conservation, while including cultural and economic viability in the equation, are needed. Such an example comes from one of the native communities within the park, the Makuleke. The Makuleke own a lodge within park boundaries. The Makuleke own and profit from all concessions in the park since they own the land. But the land is still guaranteed conservation status and is protected and operated under full park status. This joint venture between the Makuleke community and SANP (South African National Parks, which currently runs Kruger National Park where the Makuleke's land exists) is considered a contractual park (Carruthers 1995; Reid 2001; Poonan 2002). The argument made here is that if the Makuleke example is followed, local communities, not just wildlife and visitors, can benefit from the park. Local communities and visitors may interact with and prosper from one another. Community involvement is achieved, visitors' cultural knowledge is expanded, wildlife is protected, and the land's current conservation status stays part of the park system. It will be interesting to see how the Makuleke's contractual park with SANP will change to integrate into new transfrontier park once established. Hopefully the process will be a smooth one with few conflicts, with the result ultimately to the benefit of the Makuleke. If the Makuleke transition is positive, other peoples within the Great Limpopo transfrontier area may want to follow their example. If the Great Limpopo Transfrontier Park allows local land policy such as this to advance, rural, poor, and indigenous people within and around parks have a chance for increased empowerment. Once this is achieved, parks and their people around the world can follow the Great Limpopo Transfrontier Park example.

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Protected Areas, Indigenous Peoples, and the Western Idea of Nature

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In 1930, about four decades after the Oglala Lakota (Sioux) were forced to dramatically decrease the size of the reservation provided for them in the 1868 Fort Laramie Treaty and one year after the Congressional authorization of the Badlands National Monument, Lakota spiritual leader Black Elk observed that the United States government had "made little islands for us and other little islands for the four-leggeds," (Neihardt 1959:9), and that these "islands" would become increasingly separated as time passed. History has proven Black Elk correct, not only in terms of actual acres allocated to wilderness and the "four-leggeds," but in the way in which the National Park Service and other government agencies continue to foster an estrangement between indigenous activities and designated wild places.

It may come as a surprise to some that some 70 years before the removal of Indians from the Badlands National Monument, many Americans perceived wilderness to be incomplete and unnatural without native peoples. Indians were seen as part of the natural world. For example, in 1833, George Catlin, the famous early 19th-century painter of Indians from the Plains and Rocky Mountains, proposed that the government preserve large expanses of land in their "pristine beauty and wildness ... where the world could see for ages to come, the native Indian in his classic attire, galloping his horse ... amid the fleeting herds of elks and buffaloes." Catlin called his vision a "nation's Park, containing man and beast, in all the wild and freshness of their nature's beauty" (*New York Daily Commercial Advertiser,* 1833, quoted in Spence 1999:10)

Perhaps even more surprising is the little-known fact that several American proponents of environmental preservation, including Washington Irving, John James Audubon, and Henry David Thoreau, shared Catlin's sentiments. "In Wildness is the preservation of the World"—Thoreau's famous statement, made shortly before his death in 1862, was voiced not only to save vast acreages of "wildness," but Indians in their native "wild" habitat, thereby preserving, in Thoreau's view, the keepers of true wisdom and wildness. This more complete wilderness was what Thoreau thought civilized Americans needed. (Note that Thoreau said "wildness," not the popular misquote, "wilderness.")

The importance of wildness as an antidote to the abstracting and alienating tendencies of urban civilization remains a dearly held value by many modern environmentalists. Deep ecologist Jack Turner, who environmental poet Gary Snyder has likened to Thoreau, wrote in *The Abstract Wild* (1996:26): "In our effort to go beyond anthropogenic defenses of nature, to emphasize its intrinsic value and right to exist independently of us, we forget the reciprocity between the wild in nature and the wild in us, between knowledge of the wild and knowledge of the self that was central to all primitive [sic] cultures ... 'wild' names the quality of a relationship, one in which we are not in control." With respect to "wilderness," Turner writes: "what counts as wilderness is not determined by the absence of people, but by the relationship between people and place."

Native peoples recognize a similar relationship with nature—a relationship "in which we are not in control." As desert ecologist Gary Nabhan points out in *Cultures of Habitat* (1997:162), the O'odham (Pima) word for wilderness, *doajkam,* is "etymologically tied to terms for health, wholeness, and liveliness." This is not so different from the etymology of the English word for nature, which comes from the Latin *nasci,* meaning "to be born," that is, with a life force of its own guiding its own unfolding or becoming. The O'odham, like most indigenous peoples, also feel a sense of responsibility for the maintenance of creation—a responsibility that they exercised through their ceremonial participation in the yearly "re-creation" of the world as *supplicants* to natural forces over which they have no control. In other words: *One prays for rain because one has no direct control over rain.*

I have participated in such a care-giving experience. In 1994, I helped organize an inter-tribal effort in southwestern Oregon to bring back, after an absence of 150 years or more, an experience we call the Salmon Homecoming and Thanksgiving Ceremony. Although salmon are wild, they are, like all plants, animals, and natural forces, related to humans. Their flesh sustains us, but their spirits live on. They see how we treat them. If we treat them well, they will continue to come back. Ceremonies like the Salmon Homecoming honor their sacrifice. Ceremonies make the world whole again—all of the world, whether it be "wild," "feral" or "cultivated." The differences are not as important in daily living as the similarities. We don't "control" the annual migrations of anadramous fish such as salmon. But this doesn't absolve us of our care-giving responsibilities, which for Pacific Northwest tribes included cleaning spawning beds, burning to lower evapotranspiration and retain sufficient water quantity, opening sand-blocked river mouths for fish passage, and regulating fishing areas, gear, and practices.

While tribes differ considerably with respect to their specific practices in their own unique habitats, it is safe to say that for indigenous peoples globally, *culture overlaps with wild nature.* People inhabited wild nature but also manipulated wild plants and animals through a variety of means, including intentional fire, cultivation, selective harvesting, out-planting, pruning, and more. All of this—the distinctly wild, the feral, and the "cultivated" (whether by fire, digging stick, or field hoe) comprised in its totality what we could, following the lead of Western ecologists, call "ecological integrity."

As wildlife biologist and political scientist Charles Kay argues, Indians were keystone players in ecosystem dynamics in North America. They were top carnivores, until their removal to reservations. Kay has shown the negative effects of this ecological loss through field studies in Yellowstone and Jasper National Parks. Ungulates, such as elk, when protected for viewing by tourists in national parks (much like Indians were allowed to stay in national parks, such as Glacier and Yosemite, as long as their presence promoted tourism), have increased to a point vastly exceeding the carrying capacity of their ranges. As a result, they destroy native grasses and ecologically critical riparian browse, such as aspen and willow, and promote invasion by unpalatable exotic range plants.

Indians did not have to manipulate the entire or even a major part of their environment to affect an ecosystem's structure, composition, or function. For example, which patch of land an Indian tribe decided to burn that year, that is the *selectivity* of prescription fire, was perhaps more important than its frequency, extent, seasonality, or intensity. The incredible length of time that native peoples have been interacting with their environment in particular places has unquestionably led to intimate co-evolution and co-adaptation with plants and animals, affecting their genetic makeup. For example, selective harvesting of wild foods and periodic burning of wild plants favored plants that were productive and easy to harvest; of the right shape, size, and taste; fire adapted; and had medicinal or ceremonial uses. Moreover, there are numerous examples of culturally important plant populations that actually decreased in numbers when Indian management ceased. These include tobacco species; "Indian potatoes" such as *Triteleia, Camas,* and *Calochortus;* cordage species such as *Apocynum* and *Asclepias;* and medicinals, such as *Angelica* and *Lomatium.*

The development of the scientific rationale for Indian removal took form gradually and in line with a nascent National Park Service (NPS) policy that perceived Indians as inimical to wilderness preservation. The real issue, of course, was the desire for absolute control of all NPS holdings. Partly assimilated Indians in white man's clothes did not seem to fit the romantic image of the historical Indian as a pure and undefiled child of nature. Park managers wanted a "pure" wilderness. Besides, Indian removal would further the popular new policy of assimilation. Hunting and intentional burning, both considered "unnatural," had already been banned (although enforcement was, and in Glacier National Park still is, problematic). Biologists, such as Joseph Grinnell of the University of California, George Wright of the NPS, and other scientists lent credibility to this new wilderness policy. *As the historical Indian disappeared, so would the memory of their integral role in the ecology of their homeland disappear.*

In *Playing God in Yellowstone,* Alton Chase (1986) exposed the kinds of convoluted reasoning that supported the National Park Service hands-off management policy—a policy that increasingly became a sham following the creation of the National Park Service in 1916, and which gained real momentum with the development of the concept of "natural self-regulation." Natural self-regulation theory, which served as the putative scientific underpinning for the policy, held that animal deaths due to starvation on an over-browsed and degraded winter range would be automatically compensated for by more births. This way of managing led to surreptitious reversals in policy when it was convenient, including the killing of overabundant elk and endangered grizzly bears alike. Field studies by wildlife biologists, such as the Craigheads's studies of grizzly bear populations in Yellowstone during the 1970s (Craighead et al. 1995), definitively refuted that claim, although the National Park Service suppressed the reports.

Over time, natural self-regulation became a convenient excuse for the failed management policies described above. The science that had given credibility to the idea of wilderness without Indians was scuttled by park managers to promote tourism. The tragedy for science was the untimely death of George Wright in an automobile accident; tourism now would dominate NPS policy. Tourists at Yellowstone were to be given what they wanted in spite of the ecological costs, and what tourists wanted was both artificially managed elk herds and a "pure" wilderness experience. So while elk were being fed artificially in winter, Yellowstone management was creating the illusion of wilderness through its pseudo-scientific policy of natural self-regulation. The National Park Service's "let-burn" policy—even when fuel loads were completely outside the range of natural variability and natural fire cycles (which included Indian burning) had been repeatedly missed—is another example of pseudo-science being used to justify an impossible and contradictory attempt to create the illusion of wilderness. Fiercely held beliefs about the place of humans in nature also inspire political agendas, the success or failure of which hold ominous consequences for both our wild lands and the native peoples who call them home. These consequences may indeed manifest themselves in the future direction of ecological restoration and in the fate of the cultural survival of 600 million indigenous persons globally.

Thomas Vale, a geographer from the University of Wisconsin–Madison and editor of a recently published book, *Fire, Native Peoples, and the Natural Landscape* (2002, Island Press; see review in *Environmental Review* 20(1): 69–70), is representative of a growing number of natural scientists who discount the positive role of Indians in North American ecosystems. Their political agenda is the preservation of wilderness, not indigenous cultures. These academics invoke climate as the basic natural explanation for changes in landscape vegetation structure and composition over time. They argue that, while Indians may have burned around permanent village sites, (for example, in Yosemite Valley), the vast backcountry (wilderness) was left wild. This argument, however, ignores the seasonal rounds Indians made into the backcountry where culturally important plants and wildlife habitat were regularly burned to enhance productivity. Selective use of fire created and maintained what amounted to refugia for plants and animals adapted to fire and sunny, open habitat. These scattered patches, some thousands of acres in size (especially those for the rejuvenation of wildlife habitat), may not have occurred everywhere, but where they did occur they contributed to the stability, function, and integrity of the landscape. One must also remember that it is not the size of a burn so much as where a place was burned. For example, riparian areas, which comprise about 5% of the total land area in western North America, are used by up to 80% of wildlife at some point in their lives. Burning or not burning, then, can make a significant difference in terms of wildlife habitat.

It is instructive to remember Yellowstone's natural self-regulation policy. Climate was invoked to explain why elk winter range was being degraded, why aspen was not regenerating, and why fuel loads were mounting in the forest! Apparently, in the desire to find a *natural* explanation for failed management policies, management forgot the obvious: human use and local climate interact in ways that synergistically amplify both.

Indigenous cultural survival depends on healthy land. Degraded ancestral lands require restoration. The climate argument, like the natural self-regulation argument, does not address either the cultural survival of indigenous people or the ecological survival of protected areas. Indeed, healthy lands depend on the survival of indigenous peoples and their positive role as keystone players in our planet's diverse ecosystems. So, it may come as no surprise that the World Conservation Union (IUCN) reports that at least 80% of the world's biological "hot spots" are the homelands of indigenous peoples.

The survival of these "hot spots" and their complementary indigenous peoples may well depend on how we define nature. If we view nature as functioning best without human caregivers, then not only will American Indians continue to be locked out of their ancestral lands, but the freedom of religion guaranteed by the First Amendment of the Constitution will be denied them. Native Americans have never won a single legal case for sacred site protection based on First Amendment rights because Indian sacred sites occur in *natural* places and are not built by human labor, like non-Indian churches or mosques.

Let me put this into a familiar perspective. Would we refuse a healing treatment because the doctor was interfering with a natural process? A medical doctor, like ecological restorationists, works with natural processes, intervening no more than necessary to nudge nature just enough to change its natural trajectory from a human-caused downward spiral to one that is potentially positive. This is our role in nature, as indigenous cultures remind us, and the reason we have the privilege of living on Earth.

Western ecological science has sequestered itself in either the obtuse language of mathematics in its description of nature or has resorted to mysterious concepts, such as natural self-regulation, at time and space scales that are mostly irrelevant to the scale at which humans operate. All this is occurring at the very time when the earth and its inhabitants are most in need of healing. Native cultures, although badly fragmented by the impacts of industrial societies, still hold onto significant ecological wisdom based on long ecological experience in particular places. To ignore that millennia-long local experience and knowledge is to risk doing poor science. The Precautionary Principle should be involved when we, in our extremely short tenure in this continent, think we know enough to claim that indigenous peoples did not, and do not, matter ecologically.

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Evaluating Effectiveness in Parks: Does Indigenous Co-management Make a Difference?

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Introduction to the proposed research

Given the importance of parks to global biodiversity conservation, it is prudent to ensure they achieve their objectives as effectively as possible. The endeavor to pursue protected areas only makes sense if there is a good chance of success in maintaining and protecting ecological and cultural features in perpetuity (Hockings 2003). Unfortunately, the establishment of a park does not guarantee that the environmental or cultural features within it will be protected (Hawthorn et al. 2000). Hence, the effectiveness of parks and their sustainability over the long term is in question. Many critics have claimed that parks cannot continue to protect the biological resources within their borders and there is a widespread sense that these areas are simply not working (Bruner et al. 2001). Although parks may be operating under many handicaps, including serious threats to biological diversity and poor relations with local communities, "instead of abandoning the hundreds of parks that are currently foundering, ways of strengthening them must be found" (Terborgh and van Schaik 2002:5). Consequently, an emphasis on determining the effectiveness of parks management has been gaining purchase (Dudley et al. 1999).

At the same time, many indigenous communities worldwide continue to be negatively affected by the establishment of parks, and this has led to an increased emphasis on the involvement of indigenous people by park agencies and international organizations over the past decade. Several recommendations arising from the World Conservation Union's (IUCN's) Fifth World Parks Congress (held in 2003) call for a strengthened role for local and indigenous people in park collaborative management or co-management (World Commission on Protected Areas 2003). Co-management defines "an arrangement where responsibility for resource management is shared between the government and user groups (Sen and Nielsen 1996:406). In spite of this, there is still significant controversy over the appropriate role for indigenous people in park management. Some argue that local human needs are co-opting the integrity of parks (Terborgh 2004), while others see human issues as inalienable from discussions on parks (Brosius 2004). Co-management continues to be pursued despite evidence that these types of initiatives are either functional or dysfunctional, and despite a dearth of data on best management practices (Morgan et al. 1997; Budke 1999; Nadasdy 2003). Hence, "empirical data are needed to understand whether community-based conservation is effective and under what conditions, so that appropriate policies for protected areas management and biodiversity conservation can be implemented" (Mugisha and Jacobson 2004:233).

Given this, the purpose of the proposed research is to determine how the level of indigenous co-management of a park correlates with its ecological and sociocultural effectiveness.

Following Ervin (2003) but including an explicit focus on the need to mitigate impacts on local people, a park will be considered *effective* if it maintains biodiversity, abates threats, achieves park management objectives, and contributes to local livelihoods. Using several case study parks in three or four countries, this analysis will be accomplished by evaluating how effectively each park achieves a subset of its ecological and sociocultural objectives. The effectiveness of at least two parks will be compared for each case study country: one park heavily co-managed by government and local indigenous groups, and one characterized by minimal co-management with indigenous groups. The remainder of this paper briefly reviews the salient literature on evaluation and co-management, and presents a rationale for evaluating the ecological and sociocultural effectiveness of parks under varying levels of indigenous co-management.

Evaluation and indigenous co-management

Evaluation in parks and protected areas. "Evaluation is the process of establishing value judgments based on evidence about a program or product" (Smith and Glass 1987:30). It implies the systematic gathering and analysis of evidence about a program, project, or policy in order to determine the worth of that which is in question. Some of the most important reasons to conduct an evaluation are to provide accountability, focus and guide program planning, and determine whether or not a program is accomplishing its goals and objectives. There are two general levels of scaling common to evaluations: nominal and ordinal. Nominal scaling relies on distinct, mutually exclusive, and exhaustive data (Bailey 1994). There is no rank ordering in a nominal scale; no "greater than" or "less than" is implied (Bingham and Felbinger 2002). This means that each case must fit into a category, but only into one category, such as gender, marital status, and age.

Ordinal scales are used more commonly than nominal scales given the greater depth of information they produce. Ordinal scales also consist of mutually exclusive and exhaustive categories; however, unlike nominal scales where the data are essentially "equal," the data in an ordinal scale are ranked in a way that suggests "better" or "worse," or "more" or "less" of a variable (Bailey 1994; Bingham and Felbinger 2002). One of the most common types of ordinal scales is the Likert Scale developed by Likert in 1932, which increases the variation in the possible scores by coding from "strongly agree" to "strongly disagree" (Bailey 1994), instead of a simple dichotomous response option of "agree/disagree."

Although the evaluation of parks is in its infancy (Hockings 1998), it is critical to the success of these areas as it encourages adaptive and responsive management, reviews results of actions taken, assesses whether these actions produced desired results, improves guidance, and increases accountability (Dudley et al. 1999; Hawthorn et al. 2002). The scale proposed in this interdisciplinary evaluation of the ecological and sociocultural effectiveness is given in Table 1. This scale was developed by De Faria in 1993 and it utilizes a 0–4 ordinal scoring system in which a set of conditions is constructed for each indicator with the optimal condition or outcome having the highest value (Arias and Valery 1999). This five-point scale has been adapted from an International Organization for Standardization (ISO) standard percentage scale (Cifuentes et al. 2000).

Table 1. WWF/CATIE rating scale for determining protected area's management effectiveness. Source: Arias and Valery 1999.

Rating	% of Optimum	Description
0	<35	Unsatisfactory
1	36–50	Minimally satisfactory
2	51–75	Moderately Satisfactory
3	76–90	Satisfactory
4	91–100	Very Satisfactory

Indigenous people and park co-management. Many indigenous communities worldwide continue to be negatively affected by the establishment of parks. The explicit involvement of indigenous people and the incorporation of their knowledge has often not been a priority in parks management, and hence national parks have had severe, adverse impacts on local traditions and beliefs, including "obsolescence of cultural values, social disintegration, unsustainable harvesting, and severe conflicts over resource use" (Nepal and Weber 1995:12). These impacts and the ensuing conflicts have led to calls for increased local participation in parks, and co-management was first defined in regard to protected areas by Brechin et al. (1991:25) as "the substantial sharing of protected-area management responsibilities and authority among government officials and local people."

In all but the most strictly community-controlled protected areas, the role of indigenous people in decision-making has not been equitable, and the relationship of park agencies with local communities has generally been paternalistic and unidirectional (Stankey 1989). A critique emerging from the conservation field is that participation is still seen as a means to achieve externally desirable conservation goals. This means that, although the need for participation is recognized, there may be clear limits to the form and degree of participation that conservation managers tolerate in protected area management. Under the rubric of "local participation," an external agency decides what should be done, and the local community participates in its implementation; thus for genuine participation to occur, there needs to be some form of decentralization which results in the delegation of authority and power over decision-making being given to the local community (Little 1994). For more participatory co-management to occur, a shift is required from the less-meaningful versions of participation to increased levels of local participation and equity in decision-making. Table 2 depicts a hierarchy of co-management in which the lower levels of the hierarchy are characterized by varying degrees of tokenism for the involvement of citizens, whereas the higher levels demonstrate a significant redistribution of power to allow real accountability and responsibility on behalf of the citizens.

The importance of indigenous people, their role in decision-making, and the applicability of their traditional knowledge has been recognized as crucial to the sustainability of protected areas (Mitchell and Buggey 2000). In Canada, there has been an increased awareness that local indigenous people should play an equal role in the design and implementation of management plans for protected areas to overcome these conflicts (Morgan et al. 1997). A variety of co-management arrangements have been pursued around the world. South Africa's Kruger National Park, Australia's Kakadu and Uluru-Kata Tjuta National Parks, Colombia's Alto Fragua-Indiwasi National Park, Bolivia's Kaa-ya Iya National Park, and Canada's Kluane and Gwaii Haanas National Parks are all examples of co-managed park models.

5	**Community Control**	Delegated decision-making to users; users hold clear majority of seats on committees with delegated power; user groups inform government of decisions.
4	**Advisory**	Planning and decision-making responsibilities are shared through joint committees; joint action on common objectives; users advise government of decisions to be taken and government endorses these decisions.
3	**Co-operation**	Government and users cooperate together in decision-making; local concerns enter management plans and local knowledge is used.
2	**Consultation**	Community input is heard but not necessarily heeded; mechanisms exist for government to consult with users but all decisions made by government; generally a one-way flow of information.
1	**Informing**	Community is informed about decisions already made; minimal exchange of information between government and users; essentially non-participative.

Table 2. A hierarchy of co-management. Adapted from Arnstein 1969, Berkes 1994, Sen and Nielsen 1996.

Research rationale

The research proposed in this paper strives to determine how the level of indigenous co-management of a park correlates with its ecological and sociocultural effectiveness by comparing parks under varying levels of indigenous co-management. There are three main reasons why this research is timely and relevant to national parks management. First, regardless of in which country or region case study parks are located, management plan objectives generally share the following meta-objectives: protection of native flora and fauna; monitoring and maintenance of native species at risk; restoration and maintenance of historical fire cycles; eradication and monitoring of identified exotic flora and fauna. The evaluation scale will be used to gauge each case study park's progress on at least one objective in each of the above categories, with a goal of evaluating approximately fifteen objectives in total for each case study park. "Evaluating management plans in light of the objectives they set forth is a critical component in determining the effectiveness for a protected area" (Tompa and Lajeunesse 2002:459). This format provides a more direct measure of achievement than those that only target inputs or processes of management, as it measures the real impact of management action (Dudley et al. 1999; Jones 2000; Hockings 1998). Once the effectiveness with which objectives are achieved is determined, it is then possible to determine what factors contribute to, or detract from, effectiveness. These factors could include well-trained enforcement personnel, reliable and consistent funding and budgets, or the initial location and design of the park.

Second, Saterson et al. (2004:598) note that few evaluations to date have been "comprehensive enough to assess effects on biological resources, on ecosystem function, and on social welfare and equity." Likewise, in his review of twenty-seven assessment methodologies, Hockings (2003) found that, of the methodologies focused on outcomes, none employed both monitoring (i.e., ecological) and perception (i.e., qualitative) data. The evaluation scale in this research (Table 1) has been deemed appropriate for an interdisciplinary evaluation of the ecological and sociocultural effectiveness of parks as it combines both a percentage scale and a descriptor scale, the former being appropriate for ecological monitoring data and the latter for perception/interview data.

Finally, the co-management of parks around the world is becoming increasingly common and there is every reason to believe that the push for indigenous co-management will continue to increase as protected areas cannot survive in isolation from the landscape beyond their boundaries. There will continue to be a need to involve neighbors of parks and protected areas in broader landscape conservation programs, as co-management allows park managers to manage lands beyond artificial boundaries. As such, with an explicit focus on the contribution that co-management initiatives can make to park's effectiveness, this evaluation will help to determine if such arrangements are functional. By identifying successes and failures, the subsequent adaptation of management regimes according to the lessons learned can further strengthen park co-management endeavors.

Conclusion

Many protected areas worldwide have been ineffective at conserving biodiversity, while others have been unsuccessful at mitigating the impacts of parks on local indigenous communities. The indigenous co-management of parks and protected areas is expected to increase, hence productive and effective working relationships between governments, parks personnel, and local people are needed to ensure threats to parks are minimized and local livelihood needs are being met.

Evaluating the outcomes of park management plans is the only way to make an explicit link between actions and resulting outcomes. Once it is determined whether or not outcomes are being achieved, it will be possible to work backwards to determine what are the factors contributing to, or detracting from, effectiveness. By following the evaluation scale in this paper, it will also be possible to determine what role collaborative management with indigenous groups plays in the ecological effectiveness of parks.

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Sierra Nevada de Santa Marta: Understanding the Basis for Natural Resource Management

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Few have understood the value of the philosophical store of knowledge that indigenous people hold for humanity through their understanding of nature. This discussion will look at efforts invested in understanding the basis for indigenous natural resource management, which indicate that attitudes commonly held about indigenous knowledge are beginning to change.

Nature and culture: the Sierra Nevada de Santa Marta case

Colombia presents perhaps the best opportunity and the greatest challenge for the conservation of biological and cultural diversity in our hemisphere. This South American country is recognized as the nation with the greatest biological wealth per square mile and the largest number of languages. Amidst this wealth lies a national treasure: Sierra Nevada de Santa Marta.

Sierra Nevada de Santa Marta, a UNESCO biosphere reserve, is an isolated mountain set apart from the Andes mountain chain that runs through Colombia. Reaching an altitude of 18,942 feet above sea level, and lying just 26 miles from the Caribbean coast, Sierra Nevada is the world's highest coastal peak. Sierra Nevada encompasses about 4.2 million acres and serves as the source of 36 main rivers. The Sierra comprises two natural national parks (Sierra Nevada de Santa Marta and Tairona) and three large indigenous reservations and five small ones. Due to its altitudinal variation as well as its location at 11 degrees latitude north, the Sierra Nevada contains samples of all of the climatic zones that can be found in the tropical Americas.

Sierra Nevada de Santa Marta is one of the most distinctive, diverse, and threatened areas in South America. Tapirs, red brocket deer, and howler monkeys are among the 120 species of mammals roaming the Sierra Nevada, along with elusive cats such as the jaguar, puma, and little spotted cat. The park also harbors 46 species of amphibians and reptiles; those that live above 9,900 feet are found nowhere else on the planet, having evolved in complete isolation. An amazing 628 bird species have been recorded only in the area of Sierra Nevada de Santa Marta National Park.

During the last fifty years, the Sierra Nevada has suffered from degradation and deforestation. This poses a threat to the approximately 1.5 million people who rely on its watersheds for survival, the species of this ecosystem, and the future of its traditional indigenous cultures. At present, only 18% of the ecoregional forest remains and two of the 35 rivers have completely run out of water.

As a result of its geographic and historical characteristics, the Sierra Nevada is shared today by a diverse set of ethnic and cultural groups, each with its own interests and values. The Sierra's population includes 32,000 members of the indigenous cultures of the Kogi, Ijka, Wiwa, and Kankuamo groups, descendants of the Tayronas that still keep their ancient traditions. There are also approximately 150,000 peasants, and 1.5 million city dwellers in the lowlands. Of these, the only stable populations are the indigenous groups, and although each group has its own language they share a similar system of beliefs. Since pre-Hispanic times, the indigenous peoples of the Sierra Nevada have possessed a worldview, social organizations, and living patterns revolving around the management and conservation of this unique environment. The Sierra Nevada is a sacred mountain—"the heart of the world" (Figure 1). For the tribal communities living here, the forests are vital, providing wildlife habitat and serving as sanctuaries for worship and religious ceremonies. The resources in the forests also provide shelter, fuel, and clothing, household utensils, medicines, food and materials for their artistic expression.

As of their first moment of contact with the Western world, the indigenous communities have witnessed the incessant pillage and destruction of their territories, their sacred sites, burial grounds, and customs of their ancestors. The four tribes that managed to survive are undergoing various degrees of acculturation due to outside actors. Today few have understood the value of the philosophical store of knowledge that the indigenous people hold for humanity through their understanding of nature. The fact that some effort is now being invested in understanding the basis for indigenous natural resource management indicates that the negative attitudes commonly held about indigenous knowledge during the colonial era have begun to change.

The Law of the Mother

At present, the native peoples are practitioners of the "Law of the Mother." This is a complex code of rules that regulates human behavior in harmony with the plant and animal cycles, astral movements, climatic phenomena, and transhumance in the sacred geography of the massif. The indigenous peoples are the best guardians of the knowledge of their ancestors. The strict observance of this complex code of knowledge by indigenous society has enabled the native population to survive and remain self-sufficient over the course of several centuries.

However, this unique example of harmony between humans and

Figure 1. A hand-drawn interpretation of the cosmovision (worldview) of the indigenous people of the Sierra Nevada de Santa Marta.

their environment is beginning to fade due to outside intervention and the loss of fertile lands now in hands of drug-traffickers, rich banana and oil palm growers organized for international trade, and the guerrillas and paramilitary.

The indigenous groups live in a complex ranked society in which lineage plays a major role. The true power of decision in personal and community affairs is concentrated in the hands of the native priesthood *(Mama)*. They possess a profound knowledge of their environment, such as astronomy, meteorology, and ecology, and use this knowledge to plan their agronomic calendar and distribution of lands and crops. They believe that between humans and nature there is an equilibrium, one which might easily be disturbed by irresponsible human actions. This equilibrium not only refers to the subsistence-related activities such as water management, forest conservation, and tending crops, but also to the spiritual and moral balance of the individual and to agricultural rituals. These ritual dances and ceremonies play a prominent role in the indigenous peoples' religion and agricultural practices, which are submitted to many ritual rules timed according to astronomically determined seasons. In other words, the ritual calendar corresponds to the agricultural cycle.

It is believed that all native food plants have their "fathers" and "mothers" and crop fertility has to be ensured by offerings to these spiritual beings. Soil types, such as clays, humus, etc., are ritually named, as are such categories as rains, winds, and lagoons, along with the cardinal points with which they are associated. These offerings are real evidence of indigenous knowledge, as is the ritual payment for the use of a particular species of tree to build a bridge. This payment consists of feeding sacred food to saplings of the same species dispersed in the forest, thereby favoring their survival.

The only link between productive sectors is through the native peoples' use of the water, which makes forest conservation imperative and which, in turn, requires a social accord that includes the validation of indigenous knowledge by our society, as they are controlling the conservation of basic resources that ensure the region's well-being. As such, the water, a product whose value extends beyond the forests, is a basis for dialogue between the various groups in conflict. Without social agreement between indigenous people and inhabitants of the urban and farming areas on the surrounding lowlands, conservation of the forests and sources of water for the future development of the region will not be possible.

Conclusion

Intrinsic to the definition of culture— and, in many places, cherished as gods or demigods— mountainous cultural landscapes have evolved in ways that produce a symbiotic relation between nature and culture. This region provides an example of how local and indigenous Colombian communities can be engaged in sustainable development and protection of mountain landscapes, while at the same time revealing the complexity of interactions between culture and nature in this region, and the importance of traditional indigenous practices in landscape management.

Conservation Units, Tourism, and Environmental Impacts in the Bragantina Region, São Paulo, Brazil

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Conservation units, tourism, and environmental impacts

In the last decades, diverse environmental problems have attracted attention, research, and study from scientists, politicians, and even from the general population. Solutions have been proposed, and actions and programs implemented worldwide, all aimed toward mitigating or resolving the impacts on the environment. Among these studies, we can highlight those that led to the formulation and diffusion of the sustainability concept, which comprises biological, socioeconomical, ethical, and philosophical aspects (CMMAD 1988; Redclift and Woodgate 2000).

Initiatives that make possible the sustainable uses of natural resources are thus of extreme relevance. These programs are particularly vital in regions exposed to rapid deterioration or in areas with resources that are valuable, not only for economic uses, but for the survival of other species.

Currently, there is a global concern about the quality, quantity, and availability of natural resources and their conservation. This concern has led to the formulation of numerous public policies. Among these policies, we can point out the creation of conservation units (Brasil 2000).

In Brazil, conservation units were created with the intent not only to minimize the environmental impact of disordered occupation of areas with unique natural and cultural characteristics, but to raise public awareness of the importance of preservation and conservation (Secretaria de Meio Ambiente 2000).

Among the several types of conservation units created in Brazil, we can highlight the environmental protection area (EPA). According to the Brazilian system of conservation units, an "EPA is usually a large area, with some degree of human occupation and presenting abiotic, biotic, esthetic or cultural attributes, which are particularly important for the quality of life and the welfare of the human population. The basic objective of an EPA is to protect the biologic diversity, to discipline the human occupation process and to assure the sustainable use of resources" (Brasil 2001:17).

So, in an environmental protection area, there exists both legal control of and restrictions on the development of potentially degrading economic activities. However, the continuation of productive activities may result in land use conflicts if the several social actors involved do not cooperate in achieving novel economic practices (Wells and Brandon 1992; Hoeffel and Viana 1996).

Among the potentially sustainable economic activities proposed for conservation units are those related to tourism. According to Honey (1999; 2002) and Fennell (2001), tourism in conservation units may help develop environmental awareness, provide direct financial benefits to conservation projects and the local communities, and promote regional culture. However, tourism may also result in deep environmental impacts and has often been the mechanism by which preserved natural strongholds are being transformed into merchandise.

According to Rodrigues (1996), the appropriation of nature for tourism and subjugating it to "market" service would hinder social and environmental sustainability. Environmental and sociocultural degradation resulting from tourism is not different from that caused by agricultural and industrial activities. The model is always the same: the unsustainable use of resources until they are depleted and then relocation to other areas, which are in turn exploited. Similar ideas are pointed out by Krippendorf (2000), Honey (1999), and Fennell (2001) when analyzing the environmental impacts of tourism.

Ferreira et al. (2001), when analyzing social conflicts in protected areas in Brazil, pinpoint, among several other issues, the socioenvironmental impacts caused by some tourism-related activities, land speculation, and agrarian conflicts, as well as changes in work patterns and work relationships, and in local culture.

Other authors (Honey 1999, 2002; Fennel 2001) believe in the sustainability of tourism despite its potential for environmental degradation, as long as some basic principles are observed, such as knowledge of and respect for the environment, the active participation of local populations in the planning as well as the implementation of tourism activities, and the dissemination of conservation practices through environmental education programs.

Environmental protection areas, hydrologic resources, and sustainability

In the state of São Paulo, Brazil, the need to preserve regionally important hydrologic resources determined the creation of the environmental protection areas of Piracicaba and Juqueri-Mirim Rivers Basins (EPA Piracicaba) and the Cantareira System (EPA Cantareira), among other conservation units (Secretaria de Meio Ambiente 2000).

These conservation units occupy a large part of the municipal areas within the Bragantina Region, located north of the metropolis of São Paulo. The Cantareira System supplies water to an extensive area of the metropolitan regions of São Paulo (60%) and Campinas (85%), the largest urban and industrial centers of the country, which are in constant conflict for water use. The Cantareira System includes four reservoirs—Jaguary/Jacareí, Cachoeira, Atibainha, and Juqueri—constructed in the 1970s. They divert two-thirds of the region's hydrological resources with the objective of consolidating the industrialization processes of the metropolitan region of São Paulo.

The Bragantina Region represents a singular example of environmental problems. It contains headsprings and water-capture zones of regional importance and, despite its proximity to the metropolitan region of São Paulo, it still preserves significant remnants of the Atlantic Forest. Other relevant aspects are the presence of an historical–architectural patrimony inherited from the colonial period of Brazil and from the "Coffee Cycle" (second half of the 19th century), as well as attributes of a traditional rustic culture still extant among the regional populations.

These characteristics, allied to its natural beauty, have made the region a target for several real estate ventures, consolidating and increasing the land occupation process and disordered tourist use. Furthermore, ease of access to this region, through important regional highways, is provoking industrial and urban expansion and tourism development, thus increasing socioenvironmental and regional cultural impacts. This reality has required the elaboration and implementation of studies, projects, and action plans to enable sustainable management of natural resources (Vargas 1997; Hogan et al. 1997; Secretaria de Meio Ambiente 1998).

Among these actions we emphasize a sustainable development program based on *Agenda 21 (Schedule 21)* carried out by the Environmental Department of the State of São Paulo, named *Entre Serras e Águas* ("Among Sierras and Water"), meant to minimize social and environmental impacts and point out economic practices appropriate to the conservation of regional natural resources (Secretaria de Meio Ambiente 1998). Nevertheless, the program did not achieve its intended objectives, due to the absence of effective participation of the regional population and because of a lack of defined policies that resulted in the lack of enforcement of the environmental protection areas.

At the same time, we notice that there are many differing approaches for the development of Bragantina Region. Most municipal governments do not recognize the importance of environmental issues and predominantly adopt a developmental approach that considers the industrialization process as the way out of regional economic problems.

Since the municipal governments do not evaluate this ensemble of problems from a systemic viewpoint, they are not able to correctly evaluate the multitude of impacts resultant from this approach. For some municipal governments, regional environmental characteristics are an economic barrier preventing the implementation of several productive activities and requiring special care to minimize several impacts.

Over the last few years, the increasing restrictions and monitoring of the activities affecting natural resources have become significant in areas regarded as strategic, such as the Piracicaba River Basin and the Cantareira System. Nevertheless, these environmental regulations were not accompanied by local environmental educational programs, thus generating several conflicts.

When restricting economic activities, the environmental control system does not provide the rural population with environmentally sound feasible alternatives. This divergence of objectives gives no options to local communities; they persist in their traditional activities or in activities resulting in increased profits but causing significant environmental impacts, such as reforestation with eucalyptus, or the sale of their properties to real estate companies, with the consequent subdivision of land into small parcels (Secretaria de Meio Ambiente 1998).

It is therefore necessary to intervene with environmental planning proposals incorporating the concept of hydrographic basins, a historical evaluation of the regional ensemble of problems, environmental education programs, and a knowledge of the diverse conceptions of land use. These proposals would allow for concrete changes in the way natural resources can be used as well as in the elaboration of environmentally sound models.

The present situation demands the implementation of sustainable activities, including promoting tourism and education, utilizing the environmental/cultural patrimony of the region, as well as informing and educating local communities about the fragility and characteristics of the Bragantina Region, thus aiding in the recuperation and maintenance of the environmental quality, and of its past and its history.

Environmental education and participatory management in the Bragantina Region

The creation of conservation units has historically resulted in several conflicts between the need for preservation and conservation of natural resources and the economic activities usually practiced by the local population. Another aspect to be considered is that, although one of the guidelines of the Brazilian system of conservation units is the guarantee of an effective participation of a local populace in the creation, implementation, and management of the conservation units, this involvement does not always take place.

This is an extremely relevant fact in an environmental protection area where, as Cabral and Souza (2002) point out, the social aspect is a predominant issue, due to the fact that, within an EPA, the owner—whether public or private—is granted the economic use of the property, together with the responsibility for the maintenance of the quality of the environment.

In this regard, we present several studies in progress that aim to characterize the social and environmental reality of the Piracicaba and Cantareira Environmental Protection Areas and the current situation of the Cantareira System and its hydrologic resources, as well as propose appropriate measures of intervention.

Vargas (1997), Hogan and Carmo (2001), and Fadini and Carvalho (2004), in their essays about the sustainability of regional hydrologic resources, emphasize the need for an integrated management involving government and users and present participatory planning proposals, which deal with the land occupation processes and the urbanization of the Piracicaba and Cantareira Environmental Protection Areas.

The environmental history of the Bragantina Region has contributed to the development of environmental education practices with university students, students from rural schools, tourists, and local community members that use examples of regional impacts as pedagogical material for reflection about environmental issues. These practices make it possible to propose solutions to detected problems, suggest environmentally sound economic alternatives that involve local communities, and rescue the cultural and natural characteristics of the region (Lima et al. 2003).

Participatory environmental education programs aimed at the regional populations made possible the training of environmental agents and the diffusion of a conservationist conscience. The data obtained from these programs indicate that environmental education may perform an important role in the implementation of environmental protection areas

(Hoeffel et al. 2004a).

According to Vasconcellos (2002), environmental education is included in the objectives of all management categories of Brazilian conservation units. This requirement implies that protected natural areas shall be planned and managed in a way that involves the local population, and stimulates behavioral changes. The author also emphasizes the need to transform the current relationship between human beings and nature by creating a "new culture."

Studies developed by Hoeffel et al. (2004b; 2004c) and Fadini and Carvalho (2004) on the environmental perception of the various social actors in the Piracicaba and Cantareira Environmental Protection Areas, involving themes such as regional environmental impacts and participatory management, have been offering technical and scientific support to planning and environmental education works.

These studies show that there is a limited perception of the environment among members of several social groups. The environment and environmental education are both perceived as something separate from the daily lives of the interviewees and addressed only peripherally or partially. Interviewees in general do not perceive environmental degradation as a regional problem, and only when specifically asked do they discuss disparate environmental issues.

Once more, the local populace's lack of involvement and knowledge of the environmental characteristics of the region becomes evident. There is no regional participatory mechanism or plan that could suggest preventive measures via individual contributions that local communities could make towards solutions to socioenvironmental problems. This lack of knowledge and participation in the management of the Piracicaba and Cantareira Environmental Protection Areas is reflected in the lack of conservation of natural resources, generating serious socioenvironmental problems.

This scenario reinforces the approach of Cabral and Souza (2002), which emphasizes the need for a comprehensive regional debate about the objectives, characteristics, and specifics of conservation units, promoting major participation not only from the public sector, but from the local population as well, in the management of socioenvironmental and political conflicts towards the effective implementation of a environmental protection area. This involvement will take place only through the creation of environmental education projects directed toward all community members, and by stimulating equal participation in the decision-making process by providing a comprehensive knowledge of cultural and natural aspects of regional issues.

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Making Your Visitors Count: Collecting and Archiving Visitation Data in U.S. Protected Areas

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Introduction

Overuse and underuse of park resources are two common issues for protected areas in the United States and abroad. While overuse can lead to environmental and social effects, underuse of some protected areas may put their importance in question and affect their ability to justify funding and expenditures. Addressing these and many other management issues effectively requires basic information such as visitation data.

Currently, the authors are conducting a pilot project compiling protected area visitation data in the U.S. as part of the global effort led by the Tourism Task Force of IUCN World Commission on Protected Areas (WCPA) to incorporate visitation data into the United Nations List of Parks and Protected Areas and associated World Database on Protected Areas (WDPA). This effort to add visitation data has recently gained support from the WCPA steering committee (WCPA 2004).

The U.N. List of Parks and Protected Areas is collected by the World Conservation Monitoring Center, an agency of the U.N. Environment Program. The list is regularly compiled under the authority of the U.N. based on resolutions adopted by its Economic and Social Council. From 1962 to 1990, ten editions of the U.N. List were printed. The 1993, 1997, 2003 and 2005 lists are available on the Internet. The overall goal of the U.N. List is to keep an up-to-date list of all protected areas in the world. However, the U.N. List does not include data on visitor use or tourism levels.

The variability in availability and quality of visitation data being archived by U.S. protected areas at federal, state, and local levels may reflect the confidence of any visitation data worldwide. Identifying appropriate data management and reporting practices can help managers communicate needs and use protected areas more effectively. The following discussion is limited to terrestrial protected areas only.

Objectives

The goals of this project are to collect visitation data for protected areas located in the United States, and through that process to develop guidelines and protocols for collecting and reporting visitation data of protected areas worldwide. The purpose of this paper is to report progress on the U.S. visitation data pilot project. The process of data collection has created an environment to discuss issues and challenges emerging across multiple management offices. Finally, we wish to supply some general recommendations for future research and the development of an international protocol for adding visitation to the U.N. List and WDPA.

Methods

The United States protected area dataset was extracted from the 2004 WDPA. This working dataset contains 4,262 IUCN protected area records in the United States. Protected areas encompass a variety of locations ranging from national parks and forests to state parks or wildlife refuges (Table 1). The wide-ranging management objectives of each individual protected area make systematic visitation data collection challenging because the data are conceived through many different land use perspectives.

Table 1. Example of existing entries in the World Database of Protected Areas (selected categories).

AREA NAME	ISO3	LAT	LON	IUCN CAT	SITE CODE	AREA HA
New River Gorge NR	USA	37.737	-80.907	V	2512	25,101
New River Gorge NR	USA	37.990	-80.976	V	2512	25,101
Newport SP	USA	45.240	-86.992	V	22375	0
Nez Perce NHP	USA	46.434	-116.829	V	22658	1,212
Nez Perce NHP	USA	46.110	-115.363	VI	100934	900,060
Nez Perce NHP	USA	46.202	-116.023	V	22658	1,212

NR = National River; SP = State Park; NHP = National Historical Park

Our strategy was to identify management offices with many listings on the WDPA and prioritize by which may be the easiest offices to identify and contact for information. Data collection efforts began in 2004. Management offices were asked to supply one complete year of visitation data for all of the sites they manage. The individual name was then cross-referenced with the larger protected areas, listed by name type of protected area (or designate) and latitude and longitude coordinates. Once positively identified, the data were entered into the working U.S. database as four new data columns (Table 2).

Results

Table 3 summarizes the current progress of this U.S. pilot project. Visitation data from protected area units managed by National Park Service and U.S. Forest Service are mostly complete, while contacts are being made to gather information from several other federal as well as state offices.

Data from the National Park Service (NPS 2005) reflect an agency-wide consideration for visitation data. One NPS representative unified information to its most simple unit in order to supply the information needed for the WDPA.

Individual state park data varies greatly in availability and quantity. Of collected data, 8% of state park agencies cannot supply any visitation data for parks. There are several parks

VISITATION	UNITMEAS	YEAR	SOURCE
201,410	Visitor-Days	CY2003	Butch Street, Management Analyst NPS
201,410	Visitor-Days	CY2003	Butch Street, Management Analyst NPS
142,333	Visits	CY2003	Bonnie Gruber, WI Bureau of Parks and Recreation
21,271	Visitor-Days	CY2003	Butch Street, Management Analyst NPS
500,000	Visits	CY2000	http://www.fs.fed.us/recreation/programs/nvum/reports/year1/R1_Beaverhead_final.htm#_Toc524421321 retrieved: January 11, 2005
21,271	Visitor-Days	CY2003	Butch Street, Management Analyst NPS

Table 2. Example of new data columns on visitation added to the existing WDPA entries.

MANAGEMENT OFFICE	IDENTIFIED	RECEIVED	ENTERED
National Park Service	100%	100%	100%
Individual state park management agencies	96% 8% Unable to Supply Data	74%	16%
U.S. Forest Service	99%	99%	3%
Bureau of Land Management	Need initial contact		
U.S. Fish and Wildlife Service	Need initial contact		
Other agencies (Army Corps of Engineers, TVA)	Need initial contact		

Table 3. Current progress of U.S. data gathering for WDPA.

with detailed and methodical methods of data collection and report data that contain too much detail for parsimonious interpretation and entry. Similarly, there are parks that do not have any visitation data to report.

The U.S. Forest Service (USFS 2005a) reports data on-line. The U.S. Forest Service reports include in-depth information and confidence intervals (USFS 2005b). These reports are fairly easy to navigate, but include separate counts for national forest and wilderness visits.

Challenges

State/province identification. Protected areas, specifically at the state level, are not identified in the U.N. database by their state. In the case of identifying state parks in the database, the process would prove smoother if the database listed provinces or state references for countries with these types of subdivisions. Collecting full state park records including all available data and sorting through to find a small percentage of state data used in the U.N.

List makes the case for including state identifiers.

Additionally, the collection process for state parks yielded many lists of parks and many parks have the same or similar names. Popular park names were listed for several states where the U.N. List may list only one state park with a popular name. In this case the latitude and longitude coordinates in the U.N. List (a geo-referenced database) helped to identify the proper state park to report. The coordinates allow for proper identification, but at a great time cost. Future additions of visitor data would benefit greatly with the time-saving addition of regional identifiers such as the state or province where the protected areas are located.

Site codes. The U.N. List includes site codes as a measure to indicate an individual polygon for protected areas (Table 1). Polygons with the same site code are considered the same location and all polygons with the same identifiers and site codes receive the same reported visitation. Problems may occur is if visitation counts are aggregated by site code and visitation numbers become inflated when the data are transferred and reported in other venues. A measure to prevent this problem from happening is needed.

Site codes also present a challenge because currently the key to what those codes indicate is unknown. In this case the site codes indicate different protected areas with the same or localized coordinates. The managing agency reports that they only manage one area by that name or identifier yet that location is identified in the U.N. List as several sites. This creates the concern for further misspecification in reporting visitation.

Reporting issues. Some protected area management agencies are unaware that their sites are included in the U.N. List and WDPA. This lack of awareness and sometimes lack of understanding of the significance of U.S. protected areas in a world context may decrease the motivation for organization of systematic reporting. Further, individual agencies are not prepared to share information in a standardized manner. Where there is willingness and interest the goal of effective and efficient data reporting is underachieved.

The visitation statistics shared by managing agencies have different levels of variability, yet the variation in validity and reliability across agencies is unidentified. Each individual that enters a park is not doing the same things or having the same experiences as every other. Hornback and Eagles (1999) discuss many factors, such as persons-per-vehicle (PPV), length-of-stay (LOS), and exit–re-entry, that can greatly change the dynamics of a visitation count and the results achieved through different count methods. The variation in validity and reliability must be known to gauge the value of each visitation estimate. Hornback and Eagles (1999) also provide unified definitions for park visitation and tourism statistics that, if adopted, could help provide global standards.

Recommendations

The international effort to add visitation data to the U.N. List requires a protocol for the collection and reporting of visitation data that fall within a reasonable framework of reliability and validity. Currently visitation counts are largely based on agency-level standards and therefore there are problems of generalizability when discussing one protected area in relation to another at the national and international level. Hornback and Eagles (1999) worked to provide a framework for international standards for visitation data. Further work is needed to integrate visitation data following these or similar standards into the U.N. List and management of that database.

The integration of a protocol and effective reporting of visitation data worldwide is a task that lies upon the shoulders of protected area managers and professionals interested and involved in this effort. This can be achieved through increased communication, understanding, and collaboration between local agency managers and WCPA. This is evident in managers of protected areas being unaware of the international designation and little understanding of the purpose and focus of WCPA and IUCN.

Research and development of organization and management systems of WDPA visitation and other related databases will make data more accessible. For example, managers can reference or use the visitation data system to change information as the protected area goes through structural or management strategy changes. This allows any individual accessing protected area information to have the most up-to-date information available. Currently, much of the database information is accessible on-line through the World Database of Protected Areas website (WCPA 2005). A master plan for integration and currency of individual national visitation datasets and WDPA is needed.

Discussion and conclusion

The inclusion of visitation data in the WDPA can help illustrate that protected areas are not merely masses of open land, but that they are actively used and appreciated. Reporting visitation in this venue helps portray the dynamic and powerful impact that protected areas have. Many protected areas in the United States are visited by people from across the nation and the world. The visitation counts alone do not directly portray the unique benefits that protected areas provide, but the popularity coupled with visitor study reports creates a picture of how protected areas affect their visitors.

The WDPA is a list sharing the vital facts and statistics. As the WCPA steering committee has recognized visitation statistics to be a piece of each protected area's record in the U.N. List (WCPA 2004), this U.S. pilot project is one small step towards international visitation reporting in the WDPA. The challenges presented in this project will be addressed to create viable protocols to be utilized when visitation is collected worldwide.

Visitation statistics available for protected areas internationally can assist in identification of issues and characteristics of tourism and protected areas. Once identified international consideration of shared issues can help to develop effective and efficient guidelines and strategies to manage visitation while protecting these unique and valuable resources.

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Denali Air Taxis: Unique Relationships with the Park and Visitors

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Introduction and background

Denali National Park and Preserve is located in south-central interior Alaska and includes over 2.4 million hectares (6 million acres). Approximately one-third of the area is designated wilderness. Development inside the park is limited to visitor facilities, maintenance and administrative support facilities, and an employee-housing complex near the entrance area of the park at mile 237 of the George Parks Highway. The Parks Highway connects Anchorage and Fairbanks, Alaska's two largest cities. The gateway communities of Healy and Cantwell are located near the park entrance, while Talkeetna and Trapper Creek are to the south of the park along the Parks Highway corridor.

The primary access into the interior of Denali is by bus, since private vehicles are restricted on the park road beyond the Savage River at mile 15. Air taxi services based primarily in Talkeetna provide access to the park additions and preserve areas outside the designated wilderness (see Figure 1). Air taxi services transport visitors for a variety of backcountry recreational uses, including mountaineering, hunting, fishing, boating (kayaking and rafting) hiking, and camping. Mountaineering constitutes the majority of the air taxi trips for the services operating within the park and preserve. Mountaineers are landed on glaciers on the south side of the Alaska Range to begin their expeditions.

The most common destination for air taxis is the base camp for climbing access to Mount McKinley. The base camp is located just outside the wilderness boundary on the Kahiltna glacier. Air taxis also provide access to climbing areas by landing on other glaciers in the Alaska Range outside the designated wilderness, including the more remote southwest preserve. Air taxi

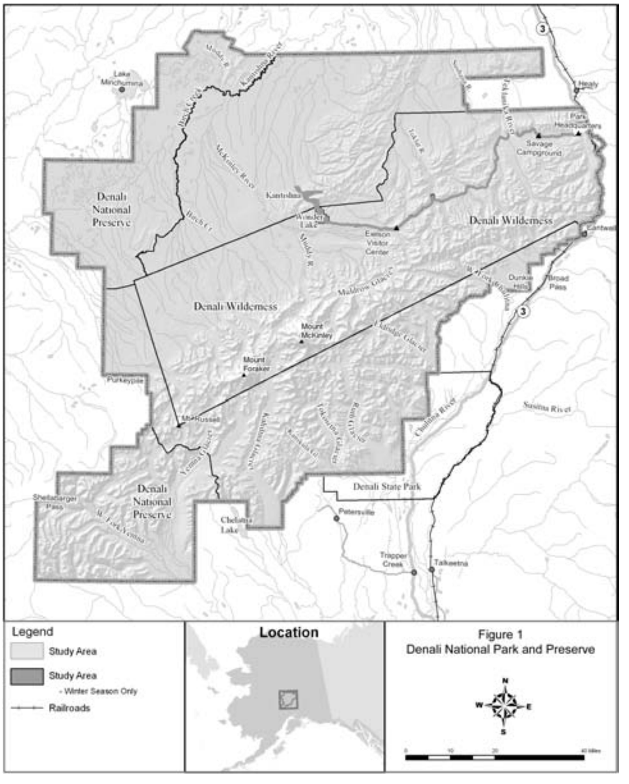

Figure 1. Denali National Park and Preserve.

landings on the north side of the park, while allowed in some areas, are infrequent (Tranel 2000; NPS 2005).

Scenic air tours are offered by the Talkeetna-based companies that provide air taxi services and by both fixed-wing (Figure 2) and helicopter operators based near the park entrance on the north side. An air taxi is a commercial flight in which visitors and/or their equipment are taken to a location and left or picked up. A scenic tour (flightseeing) is a flight in which passengers remain with their aircraft for the entire trip, although authorized concessioners may offer their passengers the opportunity to land briefly on the glacier as part of the tour. There are six businesses with concession contracts authorized to land on glaciers in the southern park additions and 14 holders of incidental business permits (IBPs) to land elsewhere in the park. No commercial landings are permitted in the backcountry of the Old Park.

Figure 2. A fixed-wing airplane above the park. Photo courtesy of the author.

The same companies that provide air taxi services make scenic tour landings, and they land in the same areas as air taxi flights. However, scenic tour flights concentrate their landings in just a few locations, with the Ruth Glacier as the primary landing area.

Air taxi flights and air scenic tours vary in duration. Because of the nature of the service provided, air taxi flights vary in length depending upon the drop-off or pick-up location, air traffic, and weather. The length of time between drop-off and pick-up also varies depending upon the recreational activity and volume of business being handled by the service. For mountaineers, the duration is typically between 15 and 25 days, while a scenic tour flight generally lasts between one and two hours depending on whether or not it includes a glacier landing, which usually lasts between 15 and 30 minutes (Figure 3; NPS 2005).

Challenges for National Park Service management of air taxi operations

The challenges for National Park Service management of air taxi operations in Denali National Park and Preserve are in three primary areas.

These activities pre-date the establishment of Denali National Park and Preserve. Air taxi operations and scenic air tours have been occurring for a long time in Denali and were well established when the original Mount McKinley National Park was expanded to become Denali National Park and Preserve in 1980. Scenic air tours were offered as early as the 1920s, before the 90-mile road into the interior of what was then Mount McKinley National Park was complete. Once the West Buttress route for climbing Mount McKinley was established in the early 1950s, flying by small airplane to the base camp at the 7,000-foot level on the Kahiltna Glacier became the predominant method of access for climbers. Scenic

Figure 3. An air tour party on one of the park's glaciers. Photo courtesy of the author.

air tours and mountaineering and glacier travel in nearby areas, such as the Ruth Amphitheater, expanded from this transportation service to the Kahiltna base camp.

ANILCA, the Alaska National Interest Lands Conservation Act of 1980, significantly expanded the original Mount McKinley National Park and renamed it as Denali National Park and Preserve. The south additions to the national park included all of the Kahiltna and Ruth Glaciers, where air taxi and scenic air tour services were already well established. Companies operating in these areas now were subject to National Park Service commercial operations regulations and policies. In 1996, the National Park Service began to require concessions permits for glacier landings, which were becoming the most rapidly growing segment of all air taxi and scenic air tour services.

Air tour and air taxi operators were accustomed to being very independent in their operations and some had difficulty with new National Park Service regulations. At the same time, the National Park Service came to increasingly understand and respect the needs of the operators, recognizing the challenging conditions in which they operate and the essential service of transportation to wilderness that they provide. In addition to air taxi services and scenic air tours, these commercial operators provide invaluable assistance to the National Park Service with search and rescue and with visitor use management, such as ensuring compliance with permitting requirements.

Current and future challenges generally come from differences in the planning horizon for aircraft operators and the National Park Service. Air taxi and air tour operators plan for the next several operating seasons, while the National Park Service looks 15–20 years into the future in general management planning documents such as the new backcountry management plan that is currently in progress (NPS 2005).

Potential for conflicts among different park users. There are inherent differences between the expectations of visitors who take a scenic air tour when compared with those who are using air travel primarily as a means of access to climbing, mountaineering, or glacier travel. During public scoping for the new backcountry management plan for Denali, the National Park Service received numerous comments from climbers and climbing organizations that noted concern about aircraft noise during the time they are on the ground—often up to three weeks—in Denali (NPS 2005). Air taxi and scenic air tour operators have stated that these complaints may not be valid if an airplane is being used for access. However, the

National Park Service has continued planning based on the premise that using airplanes for access does not render invalid the desires of backcountry users to enjoy wilderness values such as solitude and the opportunity to experience the natural soundscape.

Differing views over the definition of resource values and impacts to those values. ANILCA noted resource values for conservation system units—including Denali National Park and Preserve—such as "benefit, use, education, and inspiration of present and future generations." Preserving "wilderness resource values and related recreational opportunities" was also mentioned. Specific purposes for Denali also included providing "continued opportunities, including reasonable access, for mountain climbing, mountaineering, and other wilderness recreational activities" (Public Law 96-487, 94 Stat. 2371, 1980).

Proponents of expanding airplane access to, and scenic tours within, Denali National Park and Preserve have argued that this means of access has minimal impact and is self-limiting because of changing natural conditions such as weather and the constantly shifting surfaces of the glaciers on which they land. National Park Service planning, particularly the new backcountry management plan for Denali, has been based on the premise that a broad range of resource values, including soundscape and opportunities for solitude, need to be protected to guarantee a full range of visitor opportunities well into the future (NPS 2005). These values were important to park visitors early in the history of the former Mount McKinley National Park; for example, opportunities to enjoy the natural soundscape were mentioned as early as the 1920s (Brown 1993). In recent general management plan revisions such as the backcountry management plan, the National Park Service has defined the resource values that contribute to the "wilderness recreational activities" specifically mentioned by ANILCA, consistent with language found in the 1964 Wilderness Act (Public Law, 88-577, 78 Stat. 890, 1964). The agency has also assumed that Denali National Park and Preserve, because of its international significance and public expectations, should be held to a high standard of care (Tranel 2000; NPS 2005). The agency places a high priority on minimizing resource impacts and protecting a full range of visitor opportunities. Public comment on the draft backcountry management plan in 2003 widely supported this concept (NPS 2005).

Meeting the challenges

In dealing with these challenges, the National Park Service has learned valuable lessons, which are outlined in the four categories below.

The importance of more effectively listening to park users. Concessions management and park planning in Denali over the past decade have improved considerably by incorporating a wide variety of methods to exchange information with park users, including the commercial services providers. Staff at Denali have found informal meetings to be among the most effective opportunities for genuinely listening to the concerns and the new ideas of air taxi and air tour operators. Most of these companies are very interested in having a significant role in planning for the future, since potential limits on levels and types of visitor use could directly affect their businesses.

The importance of clarifying park purposes and values. A critical step in resolving controversy in parks and protected areas is clarifying the purposes and values for which the area was established (Tranel and Hall 2003). The National Park Service has been effective in doing this with the recent closure of the former Mount McKinley National Park to all snowmobile use, and in the new backcountry management plan.

Alternatives to regulation, such as incentives, have proven more effective when working with commercial operators. The experience at Denali National Park and Preserve is that commercial operators have a very strong preference for making their own decisions as to types of aircraft being used, methods of operations, and visitor experiences that they offer. Recent concessions management decisions and planning documents related to commercial services reflect this. For example, the new backcountry management plan for Denali includes voluntary measures for dealing with the impacts of aircraft overflights, especially noise. A working group representing a broad range of interests will be established, with the effect of setting a high standard for aircraft operations in Denali.

The new National Park Service regulations for commercial activities emphasize protecting park resources as one of the most important criteria for selecting a commercial operator for any given activity. This will help considerably as Denali implements its new backcountry management plan.

The National Park Service and commercial operators in Denali share many common values, and this provides a solid basis on which to work in partnership for the future. Air taxi and air tour companies operating in Denali generally advertise a wilderness experience and a once-in-a-lifetime opportunity to see a scenic and fascinating landscape. These goals are consistent with the goals of the National Park Service that come directly from the park's enabling legislation, such as "wilderness recreation." This is evidenced through the following excerpts from interviews with air taxi and air tour operators conducted in the spring of 2004 in Denali.

How do visitors to the Denali backcountry by air describe a visit?

> *It's kind of like flying into a whole other world.... I've had people describe it as going into orbit around another planet.*
>
> *... you land and get out and actually the engine stops and you hear the silence and the occasional avalanche rumbling in the background....*

What makes Denali unique?

> *... being in an environment that's totally, totally alien to them.*
>
> *... the scenery is awesome and it's something that they've never seen before and have never experienced.*
>
> *... the flight is unique in the world.*
>
> *I think McKinley and the Alaska Range is something set apart from everything else. Period. There's no comparison, comparing that, the Alaska Range, to other mountain ranges.*

Is it wilderness?

> *... it's wilderness that's really unlike any other wilderness that most people have been*

exposed to.

I would call it more of a wilderness experience because they're in an area ... where there's very little support from the outside world.

There's nothing there. It's all pretty much wilderness.

And it's just what you happen to have in the airplane is what you have until you can take off again.

How do the customers react to what they see?

A lot of people get there and they just go, now I see why people come here. So they see why it's a park and they see why these types of areas are special.

I've had them just be in tears, you know, thinking, well, that it was the most awesome thing they've ever done in their life.

It's the ultimate experience of our vacation, is a very normal reaction.

These and other statements from air taxi and air tour operators are remarkably consistent with the goals of the new backcountry management plan for Denali National Park and Preserve and with the National Park Service mission to care for "special places saved by the American People so that all may experience our heritage" (National Park Service 1997).

Conclusion

While the National Park Service faces several challenges in managing commercial air taxi and air tour providers in Denali National Park and Preserve, the agency has learned a great deal over the past decade to be able to work in partnership with these companies. Developing an effective working relationship with air taxi and air tour operators has been essential, and this has been possible by building on the shared values of the companies and the National Park Service for providing outstanding visitor experiences.

Denali National Park and Preserve will have considerable challenges in implementing the new backcountry management plan and setting limits on the numbers and types of visitor uses to protect internationally significant resources and high-quality visitor experiences. However, there is a high likelihood for success if the park can build upon past achievements and the effective working relationships with commercial services providers. For air taxi and air tour companies in particular, it will continue to be important for the National Park Service to clarify and promote the full range of park values in Denali and to rely upon built-in incentives rather than strict regulations.

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Implementing the National Cave and Karst Research Institute Vision

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Introduction

The National Cave and Karst Research Act of 1998 (S.231), passed by the 105th Congress, directed the National Park Service (NPS) to establish the National Cave and Karst Research Institute (NCKRI) in Carlsbad, New Mexico (NCKRI 1998). The institute's legislative purposes are to:

- Further the science of speleology;
- Centralize and standardize speleological information;
- Foster interdisciplinary cooperation in cave and karst research programs;
- Promote public education;
- Promote national and international cooperation in protecting the environment for the benefit of cave and karst landforms; and
- Promote and develop environmentally sound and sustainable resource management practices.

Additional mandates within the legislation include that the "Secretary [of the Interior} may spend only such amount of Federal funds to carry out this Act as is matched by an equal amount of funds from non-Federal sources" and that "the Institute shall be jointly administered by the National Park Service and a public or private agency, organization, or institution…." The legislation also cites a study by the NPS that stated: "The National Park Service would have ultimate responsibility for the Institute, and would retain indirect control over its activities and programs. The academic entity would plan, coordinate, and administer the Institute and its programs" (NPS 1994). (The study suggested that the co-administrative partner would be an academic institution.)

The NPS Geologic Resources Division hired an interim director in 2000 to define the scope of operation, design an organizational structure, form partnerships, find funding sources and a physical facility, and define research needs. The state of New Mexico began providing nonfederal operational funding for the project in 2000, and Congress appropriated NPS funds that had been championed by the New Mexico delegation and city of Carlsbad to match their state's contribution. Both appropriation lines have continued to date. By the end of 2002, an NPS-hired director and two full-time New Mexico Institute of Mining and Technology (New Mexico Tech, or NMT) scientists were working in New Mexico and developing NCKRI projects. State and federal funding of about $2 million each was appropriated in 2003 for the construction of the institute's headquarters building in Carlsbad.

An excellent overview of NCKRI's history is provided by the National Cave and Karst Research Institute 2003 annual report, on-line at www2.nature.nps.gov/nckri/annual.htm.

Primary partners

While the institute currently (April 2005) remains a unit within the NPS's Geologic Resources Division, substantial progress has occurred towards forging partnerships. A cooperative agreement between the NPS and NMT identifies the latter as the primary academic partner that will co-administer NCKRI. The partners anticipate transferring day-to-day management of NCKRI to NMT within the next year. The city of Carlsbad (in part through a cooperative agreement with the NPS) is leading the institute's headquarters construction effort. A memorandum of understanding binds the three partners as well.

Community scoping

New Mexico Institute of Mining and Technology convened a two-day workshop in October 2003 to scope the community's vision for NCKRI. Twenty-three representatives attended from a cross-section of the cave/karst community, six federal agencies, two state agencies, five nonprofit organizations, and six academic programs, as did institute staff. The participants shared perspectives and considered the institute's long-term vision, potential activities, organizational structure, and operating plans. A professional facilitator provided a summary of the discussion (NCKRI 2003).

Several themes emerged from the workshop that participants suggested would provide a needed service while neither duplicating nor undermining the work of established organizations. The group identified gaps and opportunities for the institute, including:

- National assessment, status, and trends of caves and karst;
- Research catalogue of national needs and issues;
- Large-scale perspectives (international, national, regional, watershed);
- Role as catalyst for bringing together cave and karst researchers from other disciplines, tier 1 universities, private cave owners, resource managers, and international researchers;
- Role as clearinghouse for information on cave management, international cave and karst literature and research, volunteer issues and opportunities, and protocols, best practices, and lessons learned;
- Visitor education and public awareness;
- Collections (archiving, preservation, data, physical collections); and
- Field laboratory for resource management practices.

Participants also suggested a variety of goal areas, although these suggestions were not ranked nor necessarily received majority support. Those potential goals were divided into the institute's four major mission realms and include the following.

- **Research:** Avoid competition for research dollars; do "big" science with a large consortium (interdisciplinary, regional, national, cutting-edge); serve as a clearinghouse for basic research; focus research on applied research and problem-solving; provide grant programs and/or access to grants; publish an annual report of the institute's activities; publish a national report on status and trends of caves and karst; and publish a national research catalogue (priority problems in need of researchers).

- **Education:** Provide grants for curriculum development and lesson plan development using best teaching practices; support and partner with other education programs; provide national curriculum templates for K-12 and college; investigate and provide access to alternative delivery models (computer, Public Broadcasting System, on-line learning, distance learning); develop interpretive materials and provide training venues for interpreters; and serve as a focal point for state-level testing advocacy efforts.
- **Data and information management:** provide access to and translation of international data and information; provide both a physical and virtual library; serve as a clearinghouse (web portal) for distributed databases; provide support for standards as well as the standards for collections; develop and communicate standards (quality assurance/quality control) for web, digital, and other publishing; develop a referral directory of experts in cave and karst from multiple organizations; develop a source list or directory of taxonomist specialists; and be a centralized location for data on projects in progress.
- **Resource management:** develop best management practices for cave and karst management; set and communicate priorities for resource management; provide training, education, and information-sharing venues for cave and karst management; serve as liaison between federal agencies, nongovernmental organizations, academia, and private owners; be a recognized resource for policy developers and decision-makers; develop interpretive materials and provide training venues for interpreters; develop a digest of current studies and publications on resource management; and take a systems view of management.

Plans for the near future

The city of Carlsbad anticipates beginning the building of a 24,000-square-foot headquarters for the institute in summer 2005, with completion expected in winter 2007. The plans call for a public museum and interpretive area, several laboratories, classrooms, a specialized library, computer center, gift shop, conference room, offices, and appropriate support facilities (NCKRI 2004). Completion of many of these amenities will depend on further fund-raising efforts by the institute's partners. The city hopes that the building site's location adjacent to the mid-town Lake Carlsbad Recreation Area will draw Carlsbad Caverns National Park visitors into the city for more extended visits.

The NPS Geologic Resources Division plans to convene a meeting in early May 2005 with representatives from major NPS cave and karst parks to fully inform them about current institute developments, the impending transfer of day-to-day operations to NMT, and to exchange ideas about how the NPS will continue active engagement with NCKRI. Later the same month, NMT will invite select representatives from the broad cave and karst research, management, conservation, and education communities to their campus in Socorro, New Mexico, to discuss developing an organization and business plan with a charter or by-laws.

Following these meetings, NPS and NMT expect to transition the institute's management to a formal, jointly administrated structure with the NPS retaining "indirect control" and "ultimate responsibility," NMT managing operations, and a council of partner representatives providing vision and planning.

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The World Above, the World Below: The Three-Dimensional, Interdisciplinary Nature of Cave and Karst Stewardship

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Introduction

Karst, the landscape formed by the dissolution of rocks (instead of mechanical weathering), presents unique challenges to land usage and stewardship. Landmark characteristics include the absence of surface streams (or presence of sinking streams), rapid infiltration of water, caves, sinkholes, natural bridges, poor soil development, sharp pinnacles, and rugged terrain. These characteristics can make life unusually demanding. More than any other terrestrial terrain, the surface and subsurface are intimately linked, and responsible management requires a firm grasp of its three-dimensional interdependence.

The chemistry of most karstic rocks (carbonates and sulfates) and their commonly close association with microbial processes have caused many scientists working in the rapidly growing field of geomicrobiology to focus on karst terrains (Northup and Lavoie 2001). The presence of caves has long been recognized as important habitat for rare, and commonly threatened, macrofauna, including bats, salamanders, fish, and many invertebrates (Culver et al. 2000). The importance and sensitive nature of karst aquifers, both to the surface and subsurface ecology of a region (Graening and Brown 2003) and domestic water supplies (Boyer and Pasquarell 1999), adds to the need for a multi-disciplinary approach to karst management.

The three-dimensional nature of karst

The very nature of most subsurface karst features depends on their relationship to the surface. Meteoric water infiltrating from the surface forms most caves and other secondary porosity. Altering the surface runoff patterns or soil profile affects the continuing process of speleogenesis (cave formation). Conversely, the karst aquifers that formed by these processes, and which underlie 40% of the United States, are more readily contaminated than other types of aquifers (Assad and Jordan 1994). Water percolates more slowly through clastic sedimentary rocks or the minute fractures or grussified joints in crystalline rocks than it does in the pipe-like conduits of karst. A slower infiltration rate allows some natural filtration as well as chemical and biological degradation of contaminants. Contaminants entering a karst aquifer generally remain unmitigated (Vaute et al. 1997). Depending on flow conditions at the time of contamination, they will quickly re-emerge at surface springs or may remain stored underground until a major storm flushes them through the system. The surface and subsurface hydrology of a karst region must be managed as an intimately interconnected network.

Sustained storage of contaminants in the epikarst and cave stream sediments adds to the complexity of karst hydrology issues. (Epikarst is "the upper weathered zone of enhanced porosity generally at the soil/bedrock contact and functions to store and direct percolation water towards vertical drains or springs in the karst"; Jones 2004: 3.) A hot topic in the field of hydrology focuses on developing a better understanding of how both dissolved and non-aqueous phase liquids that enter karst vadose zones may be stored and moved laterally over a period of years (Loop and White 2001; Mahler et al. 2004). Thus, while the bulk of an oil or pesticide spill entering the epikarst may pulse through the system within a few days, a low-level presence and discharge of related contaminants may affect both the cave stream and surface spring water quality for years.

Changing land use patterns commonly lead to altered drainage patterns and increased runoff. In karst regions, the changes commonly bring more sediments into the subsurface conduits (Mahler et al. 2004). Those sediments can plug up the natural underground storm sewers (i.e., caves) and cause backflooding onto the surface. A compelling example of surface changes causing dramatic changes in the subsurface that result in devastating changes on the surface may be viewed near Yosonicaje, Sierra Mixteca Alta, Oaxaca, Mexico. Widespread deforestation of hillsides adjacent to a large, fertile doline (sinkhole with a broad, flat bottom) caused extensive soil erosion. With nowhere else to go, the sediments flowed into and filled the caves that historically provided good drainage to the doline. Now, the doline contains a lake many months each year, and it is no longer suitable for agriculture. Local farmers must plant their corn on the steep, adjacent hillsides and use the flat-bottom doline for grazing, when it is not flooded (Figure 1).

Figure 1. Sediments eroded from the deforested hillside in the background plugged the caves in the flat-bottomed doline of the foreground, causing it to flood much of the year. Local people have had to abandon growing crops in the doline and now strive to minimize future problems by maintaining the sediment dams and reforesting the hillside. Photograph courtesy of L.D. Hose.

Subsidence is another common concern in karst calling for a three-dimensional approach to management. Sinkhole development on the surface results from the collapse of a cave, generally caused by changes in the underground environment (Beck and Herring 2001). A lowering water table, petroleum reserve withdrawal (Figure 2), and accelerated speleogenesis due to altered surface drainage patterns are the most common causes. This sequence provides an example of surface changes affecting subterranean processes that, in turn, result in surface alteration. Subsidence, whether catastrophic or gradual, can cause significant economic and safety risks.

Figure 2. Recent subsidence due to petroleum withdrawal in Dragger Draw, southeast New Mexico. Photograph courtesy of L.A. Land.

Most "cave" organisms depend on the surface for their energy and, commonly, part of their life cycle. Many organisms, such as bats and crickets, feed on the surface and use caves for resting and as nurseries (Jones et al. 2003). These organisms depend on healthy maintenance of both habitats. If either their surface or subsurface environment is negatively impacted, the ecology of both environments may be altered. In the case of highly mobile cave-dwelling species, such as bats, alteration of the surface up to several kilometers away may negatively affect them. Deforestation near a cave entrance or between caves and water bodies may cause adverse effects to bat populations by increasing their susceptibility to predation, removing protection from wind and frequent resting places for fledgling fliers, and forcing fledgling and nursing bats to fly further from the roost cave. Similarly, aqueous cave organisms may be hurt by changes on the surface great distances upstream. Deforestation up-drainage may lead to increase sediment influx, harming stream organisms that depend on relatively clear water conditions. Deforestation of the Alaskan Tongass Forest has directly affected the fishing waters, affecting both commercial (most notably salmon) and noncommercial fisheries (Bryant et al. 1998).

Alteration of the cave habitat, resulting in a decline in the cave-dwelling population, can cause significant impacts on the surface ecology. Many vertebrate species that use caves or karst features move freely between the surface and subsurface, and are functional members of both ecosystems. Disruptions in either of these systems will affect the other, and it is more appropriate to consider the surface and the subsurface as different compartments of a single ecosystem. For some vertebrate species, caves provide resources critical to their survival (Strong 2005). Some endangered species of bats depend on a limited number of caves as hibernation sites. Destruction of their cave habitat by direct (quarrying) or indirect (sedimentation resulting from deforestation plugging an entrance) means may drive a species from an area and, possibly, lead to an overall population decline. Even seemingly benign disruption of a subterranean habitat (e.g., tour groups disrupting hibernating or maternal colonies) can lead to similar results (Johnson et al. 1998; Ferreira and Horta 2001).

Many of the concerns associated with karst regions are also associated with non-karstic cave regions. Subterranean conduit flows through lava tubes comprise important aquifers in the Pacific Northwest and Hawaii. Numerous ancient lava flows and associated lava tubes lie in close proximity to housing developments in Hawaii. Contaminants from surface runoff move through the lava tubes and threaten ecosystems, water supplies, and cultural artifacts (Halliday 2003). Destruction and alteration of caves in nonsoluble rocks (e.g., lava tubes and "talus" caves) raise the same concerns as karstic caves.

The interdisciplinary nature of karst

Many management issues involving caves and karst focus on concerns for keeping the ecology of the region as little disturbed as possible (Bowles and Arsuffi 1993). Water quality and quantity affect the living organisms of the region. Changes in subterranean atmospheric or hydrologic conditions alter weathering and precipitation (i.e., geologic) processes underground. Inappropriate use or maintenance of underground septic systems or leaky oil well casings can lead to altered ecosystem dynamics, causing some species to diminish or even disappear while others flourish.

Traditionally, the field of ecology has recognized and studied the impact of physical parameters on living organisms. Until recently, little attention was generally given to the impact of biology (with the glaring exception of human beings) on the physical environment, particularly the lithosphere (rocks). However, the exploding field of geomicrobiology has recognized that life plays a major role in weathering processes on both the surface and subsurface. The interaction is arguably strongest in carbonate and sulfate rocks, the same rocks that most readily form karst (Sasowsky and Palmer 1994). Compelling evidence of life contributing to the formation of its cave habitat in a subterranean version of Gaia has been documented in several sulfide-rich caves around the world, most notably Cueva de Villa Luz in southern Mexico (Hose et al. 2000). While chemoautotrophic organisms in this cave utilize the carbonate anions in the bedrock and the peculiar water and atmospheric chemistry contained in the cave, they also produce the sulfuric acid that dissolves the walls, facilitates massive conversion of limestone to gypsum, and aggressively enlarges the cave (Figure 3).

Some vertebrates, particularly fish and salamanders, are obligate cave-dwellers that generally rely on organic food resources transported into the caves from the surface. Flowing water transporting organic debris is an example of an interaction between biology and hydrology in karst regions. Vertebrates and invertebrates that move between surface and subsurface environments provide another mechanism for energy transfer. When they defecate in the caves, they provide a resource for a variety of invertebrates and microorganisms. Even subsurface karst voids with no obvious surface opening are likely influenced by water input from the surface. Although some subterranean ecosystems are based on chemoautotrophic bacteria (Hose et al. 2000; Boston et al. 2001), even the most extreme examples utilize an energy component derived from surface sources (e.g., free oxygen, nutrients, etc.).

The disciplines of paleontology and archaeology have strong connections with caves throughout the world. Many karst areas and caves have valuable and irreplaceable paleontological and paleoecological resources (Schubert et al. 2003). The relatively constant temperature and humidity of the cave environment provide conditions conducive to the preservation of bones, some soft tissues of animals, and dung deposits that can be analyzed to provide knowledge of past biological communities in the vicinity of a cave. The same conditions also preserve archaeological or more recent cultural material. Many caves have preserved material tracing the evolutionary and cultural history of humans. The Paleolithic cave paintings of Europe are well-known examples, but U.S. caves also contain valuable prehistoric material. Russell Cave National Monument in Alabama and Grand Canyon National Park preserve extensive records of prehistoric times (Emslie et al. 1987; Schubert 2003).

Figure 3. This pendulous, microbial community of chemoautotrophic bacteria is called a "snottite" (Hose et al. 2000). It produces strong sulfuric acid, which dissolves the bedrock and enlarges its subterranean home, Cueva de Villa Luz. Photograph courtesy of L.D. Hose.

In contrast to the excellent preservation environment that caves generally provide for paleontological and archaeological remains, there are many documented instances of microbial attack on human artifacts, including cave paintings (Schabereiter-Gurtner et al. 2002). These effects are being studied by several groups in an attempt to develop means of amelioration of such damage to irreplaceable cultural and paleontological materials. Clearly these are instances where the native bacterial flora of the cave, which themselves are features worthy of protection, are also threatening archaeological resources worthy of protection.

Because of the physical proximity of different resources, special care must be taken when conducting scientific research in caves. Archaeological excavations could obviously damage paleontological resources without proper attention, but disruption of cave sediments could also adversely affect the biological community. Although it might not always be possible, it would be desirable to have specialists from many disciplines participating in a project to ensure that the maximum amount of information be gained with a minimum of disturbance to the resources.

Applied research specifically targeting cave management practices is lacking (Seiser 2003). Consideration and evaluation of the cave visitors' experiences is an understudied but critically important aspect of any cave and karst stewardship program with an ecosystem management approach. Such evaluations should not only include knowledge gained and retained, as well as the experiential aspect of a visit , but also how the visitors perceive the resource and management activities from a visual context (e.g., barriers, signage, trails).

Education is viewed as a critical component in cave and karst stewardship programs. Public education and engagement of citizens has been shown to be absolutely essential to protection of karst aquifers regardless of the relative efficacy of technological solutions to pollution problems (Ekmeki and Gunay 1997). Education programs targeting local community members and landowners, as well as tourists who visit these regions, regardless of cave-related activities, are needed. Inclusion of visitors helps promote cave resource protection beyond the borders of cave regions. In addition, there is a growing need for karst and cave stewardship programs targeting federal and state land managers. These programs need to address the environmental components of karst and caves, as well as the human dimensions, including but not limited to tourism, recreational, and environmental protection legislation (Seiser 2003).

Conclusion

Management of visitation to wild and show caves often focuses on in-cave activities. However, surface activities and structures need to be evaluated regarding appropriateness for protection of the subsurface environment and entire ecosystem. Parking lots and buildings can affect surface runoff. Potential contamination from restroom facility leakage must be a concern in terms of the ecosystem, visitor experience, and groundwater resources associated with the cave. Consideration should also be given to the need to provide easy access to wild caves (e.g., a road versus a trail). Trailhead parking lots may be located in a more appropriate location distant from the cave. While cave visitation can serve as an educational/interpretive activity focused on the cave environment and ecosystem protection, visitation needs must be weighed against potential surface and subsurface impacts.

It is imperative that land stewards in karst regions approach their tasks with a persistent three-dimensional, interdisciplinary outlook. Responsible management of karst, as with marine, lacustrine, and fluvial environments, requires a firm grasp on both its three-dimensional and interdisciplinary cross-linkages. In addition to protecting caves and karst areas from adverse human actions on the environment, managers must also protect these resources from poorly conceived projects that focus on a single aspect of cave and karst sciences.

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Evaluation of Cave and Karst Programs

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Introduction

This project began when I was contacted by Louise Hose, director of the new National Cave and Karst Research Institute (NCKRI). NCKRI is still in the very early stages of development, but she was looking ahead to establish procedures for evaluating the success of programs and of NCKRI itself, and to conduct a streamlined version of a review.

Why should we be concerned with evaluation? Assessment allows us to know if we have achieved our goals and objectives. We can determine if we are putting enough resources into critical areas for more effective use of scarce resources. Evaluation also gives us important information for supervisors, and for accrediting and granting agencies.

There are many different ways to evaluate programs. I will focus on four types: (1) satisfaction surveys; (2) gap analysis, also known as importance-performance surveys; (3) focus groups; and (4) external reviews.

Evaluation falls under the regulations of the U.S. Department of Health and Human Services concerning the use of human subjects. Nearly all evaluations you are likely to conduct will fall under the category of exempt research, particularly if subject anonymity is maintained, but researchers are not allowed to determine if their own projects are exempt or not. All federal and academic institutions have internal review boards that evaluate all proposals involving the use of human subjects. Be sure your evaluation, no matter how simple, has approval before you begin.

Satisfaction surveys

Satisfaction surveys are the simplest type of evaluation. Usually they are used to determine the effectiveness of a discrete program or event. Examples include such things as evaluations of a course and its instructor, of a service where they change your oil, or of your satisfaction at a conference. A specific contemporary example, drawn from the realm of business, is the advertising campaign used by the Geico insurance company, in which they proudly claim that 97% of their customers are satisfied that their claims service is fast and fair.

Most satisfaction surveys use a five-point Likert scale, where the respondent is given a simple statement to evaluate. The most difficult choice to state is the middle one. The researchers want it to be truly in the middle and not just a "not applicable." Sometimes an additional category is added for "not applicable," so that the scale becomes 5 = strongly agree, 4 = agree, 3 = undecided, 2 = disagree, 1 = strongly disagree, (NA = not applicable). In the Geico example, the claim of 97% customer satisfaction is probably derived from the number of respondents in the top two categories.

The five-point scale can be used to gather specific information. For example:

Select the number of nights you go camping per year:
5 = more than 20
4 = 15 to 19
3 = 10 to 14
2 = 5 to 9
1 = 0 to 4

Or, for simple choices: 1 = yes, 2 = no.

Gap analysis

A gap analysis evaluates the gap or the space between where we are and where we want to be. This style of survey is often described as an importance-performance evaluation. You may be familiar with the U.S. Geological Survey gap analysis program that is often used in state comprehensive wildlife management programs (see http://biology.usgs.gov/cbi/ or www.gap/uidaho.edu). The focus of this program is to keep common species common. The program attempts to identify common species and plant communities and to determine if they are adequately represented in existing protected areas at the local, regional, state, or national level. The gap analysis helps to identify priority areas for conservation.

A gap analysis is usually added to a satisfaction survey. One of the most important aspects of a gap analysis is that it can be used to make important decisions about effective use of resources. In the Geico example, one question would be: "Geico is fast to process my claim." The next question would be: "Fast processing of claims is important to me." Each question has five-point Likert response choices. You can determine the gap between importance and satisfaction by simple subtraction. The data can also be plotted as shown in Figure 1. The actual quadrant boundaries can be shifted as desired. In this example the boundaries are simply set in the middle of both scales. Note that the points (circles) fall into one of four areas. The area marked Well Done indicates projects of increasing importance that are being done well. Low Priority Items are not being done well, but no one cares. Items falling into the Less Attention area are being done well, but are not particularly important. The Needs Attention quadrant is the most important one. These items are very important to your clients, but they are not satisfied with the job you are doing. Often resources can be shifted from Less Attention or Low Priority items.

Survey design

For a good review of survey design, see Schuett et al. 2000. Stay focused on what you want to know. Let your overall goal or question guide you in writing the questions. You want to keep the survey brief—generally no more than 15–20 questions. Keep your questions neutral, short, and direct, with no more than one item per question. For example, Geico would have to ask a question about the speed with which claims are processed, and a different question about the fairness of claims. To ask if claims service is both fast and fair in one question will not get you the information you want. Make sure your categories of responses make sense, especially the middle one. As a bad example, I recently got a survey that asked me how often I did something, with the choices being "yes" or "no." The actual survey should have

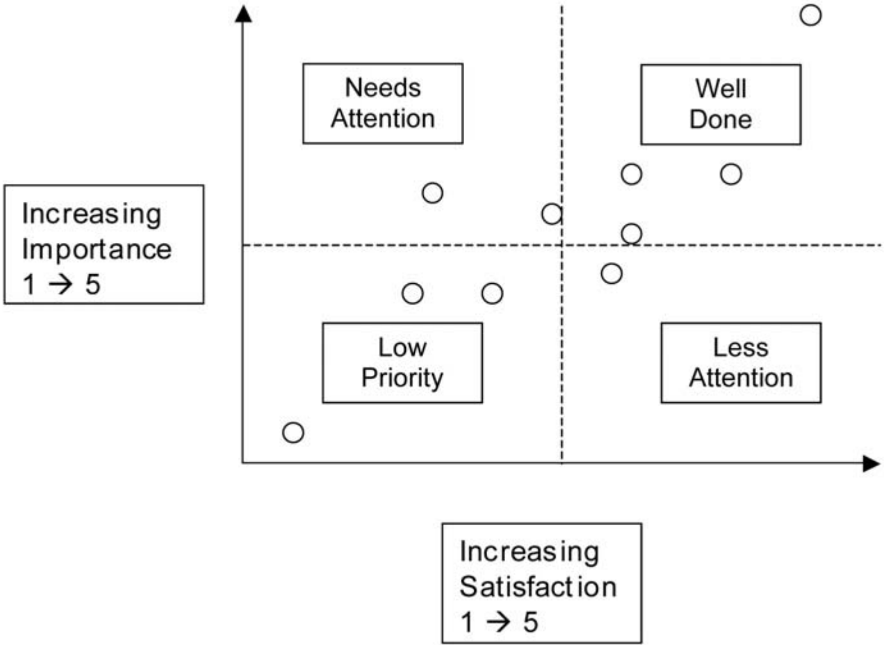

Figure 1. The gap between importance and satisfaction, and the amount of attention each item needs.

a title. Appearance is important, so you want to leave space and not cram questions together. Include clear instructions for taking the survey and how, when, and where to return the completed survey. A self-addressed, stamped envelope is best for a written survey. As an option you can include a brief (no more than one page) cover letter that explains to the client why you are asking for their opinion, the purpose of the survey, and why it is important. If appropriate, ensure the client of confidentiality. Be sure the survey is approved by Department of Health and Human Services, as explained above.

If possible, pilot-test the survey using a focus group. I recently received a survey that asked me to rank a service using a scale of 1 to 5, but they neglected to tell me if 1 or 5 was good. Use the focus group to find out if the client understands the instructions and the purposes of the survey. How much time does it actually take to complete the survey? Are there any questions the client does not understand? Do people understand how, when, and where to return the survey? Can you actually code the data you get for entry and analysis? Should you include space for open-ended comments?

Administering the survey

One very important issue when using surveys is the response rate. While there are no set standards, you want the best possible rate of return. You can increase your response rate by sending mailed or e-mail reminders. You can also increase your response rate by conducting the survey over the telephone. However, an important consideration in doing any survey is cost. If you use e-mail you will end up with faster responses and longer open-ended responses, but you will also have a lower response rate (Seguin et al. 2004).

Focus groups

One use of a focus group in pilot-testing surveys was discussed above, but focus groups can also be a useful means of conducting a survey (Krueger and Casey 2000). The greatest benefit of focus groups is that they are interactive. The clients will tell you what they want, and you have the flexibility of following up on an interesting discussion thread. Focus groups require a lot of planning and a clear objective. Whom will you invite and how? Where will the meeting be held? Who will facilitate the discussion? How will you record the discussion? How will you translate the results from the focus group into action? Focus groups may require expert help to plan and conduct.

External review process

External reviews are widely used in academia to bring in experts who can look at your program or department and help you determine effectiveness, suggest changes, and help set goals. The process I recommended for the National Cave and Karst Research Institute involved a review process in four phases: the preparatory phase, the development of the self-study, the site visit, and a response and wrap-up session, using a five- to seven-year cycle. The goals of the external program review process are to:

- Provide a comprehensive assessment of the current status of NCKRI using a "Progress, Plans, Problems" approach in the development of a self-study;
- Examine stakeholders' and potential stakeholders' attitudes and opinions on issues related to NCKRI;
- Identify strengths and weaknesses; and
- Develop recommendations to allow NCKRI to build on existing strengths, maximize opportunities for growth, and solve current problems.

The guiding principles for program review are:

- Make a candid assessment of strengths and weaknesses that can lead to program improvement;
- Provide a framework for excellence within NCKRI mission and goals;
- Facilitate short- and long-term strategic planning;
- Account for use of resources and level of support among constituencies; and
- Be broadly participatory.

Phase I: Preparatory. The responsible individual notifies NCKRI that he or she is due for an external review. The self-study team is appointed, and external reviewers are selected.

Phase II: Self-study. The self-study report is an interpretive document that uses data as much as possible to assess current program status and future directions. Data should be analyzed and discussed in relation to NCKRI mission and goals. Although the report is compiled and written by the self-study committee, the director of NCKRI is responsible for the content, accuracy, and completeness of the work. I recommend a "Progress, Plans, Problems" approach which assesses progress since the last review, discusses plans for the next three to five years, and candidly describes known problems. It is important that the self-study be clear and objective. The tone needs to be positive and avoid whining. The report should also be realistic. Yes, we could all achieve more if we had twice as much staff and money, but we need to be realistic in our expectations.

Phase III: Site visit and report. The actual review includes a site visit by the external reviewers. In the case of the National Cave and Karst Research Institute, I visited the offices in Carlsbad, met with city officials, traveled to the New Mexico Institute of Mining and Technology (New Mexico Tech) in Socorro, and interviewed many individuals by telephone. The final report should include information and recommendations from structured and open-ended questions. A firm deadline for completion of the report should be established.

Phase IV: Response. Once the final report is received it needs to be reviewed by all of the principal partners. Each needs the opportunity to respond to the report and offer additional information. The self-study team should meet to discuss the report.

Selected findings and recommendations

Following are some of the findings and recommendations I made, but this is not a comprehensive list. In summer 2004 NCKRI was still in the very early stages of formation. The next review will be much more useful, and will use three reviewers rather than just one person.

NCKRI's mission statement reads: "The National Cave and Karst Research Institute facilitates speleological research, enhances public education, and promotes environmentally sound cave and karst management." As you can see from the mission statement, NCKRI has clear objectives. Yet upon further review of documents relating to NCKRI and the self-study, I found three objectives in the mission statement, six goals, five core values, and six services that NCKRI promises to offer. There is considerable overlap, but it is important to stay focused on a manageable number of issues. If you say you will do something, then achieving your goals needs to be assessed, so keep them to a manageable number, typically no more than five.

Several recommendations dealt with the relationship of NCKRI to the National Park Service, which has indirect oversight of its activities, and NCKRI's relationships with the other principal partners, New Mexico Tech and the city of Carlsbad. Construction of the new institute facility in Carlsbad is obviously a top priority.

NCKRI needs to try to change the congressionally mandated limits on fundraising, which state that the institute must match federal funds 1:1 from nonfederal sources. Since most of NCKRI's activities in research and education are in areas where the largest single funding source is the federal government, this restriction places an excessive burden on fundraising.

NCKRI also needs to make progress on strengthening ties to its academic partner, New Mexico Tech, which can provide assistance with grant writing, fundraising, and personnel. One problem that was identified going into the review was negative relations with several individuals dating from the time of the transition from an interim director to a full-time director. All of the individuals contacted agreed to work with NCKRI on projects of significance.

An area of concern of increasing importance is web presence. While the National Cave and Karst Research Institute has a good web presence, the cave and karst program at New Mexico Tech does not. The program also did not have a formal curriculum after two years.

I also made a series of minor recommendations. Currently, NCKRI hosts an excellent and popular speaker series at Carlsbad. I recommended taking the speaker series on the road. NCKRI would publicize available speakers to appropriate educational and professional agencies, and might even defray some of the costs. NCKRI should develop a small grants program to organizations and to individuals working in areas of importance to cave and karst, although there may be some technical issues that could limit awarding grants. Lastly, I recommended expanding developing partnerships by making it possible for individuals to formally associate with NCKRI through a program of associate memberships.

The types of program reviews presented here can be used to evaluate a wide range of activities and organizations, from individual programs on up to entire institutions. Evaluation allows you to assess the success of programs in meeting your goals.

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Stewardship of a Hidden Landscape

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Introduction

Karst landscapes occur in soluble rock types such as carbonates (limestone), evaporites (gypsum), and silicates (sandstone). Sinkholes, disappearing streams, and subterranean drainage, which can include caves, characterize these landscapes. It should be noted that not all caves are found in karst; lava tubes are examples of nonkarstic caves.

At the present time, there are eight national parks and monuments that were created because of the presence of a specific cave: Carlsbad Caverns National Park, Jewel Cave National Monument, Lehman Caves National Monument (now a part of Great Basin National Park), Mammoth Cave National Park, Oregon Caves National Monument, Russell Cave National Monument, Timpanogos Cave National Monument, and Wind Cave National Park. However, within the National Park system, 120 of the 388 units have caves and/or karst features. Over 3,900 caves have been located on 81 sites, and, an additional, 39 sites contain karst features (NPS 2005). With approximately 30% of the units of the national park system having caves and/or karst, these natural resources become a significant stewardship concern.

Barriers to cave and karst stewardship

The stewardship of caves is in many ways a matter of managing a hidden landscape. Often, karst surface features or caves are obscured by vegetation or are just not obvious. As an example, in desert environments sinking streams are typically ephemeral, existing only for short periods after storm events. In addition, management perceptions of the site can obscure the need for cave and/or karst stewardship. NPS units not established because of the presence of caves have management agendas focused on protecting those aspects for which they were established. Other barriers to stewardship exist on organizational, personal, and scientific levels (Wright 2004).

Accessibility is often a barrier to cave stewardship programs. Unlike surface environments, caves lack scenic overviews. Management cannot make use of flyovers or drive-bys for information-gathering purposes and study of the cavescapes. In many cases, those directly responsible for managing caves lack the skills or desire to visit the caves.

Caves have long been viewed primarily as recreational resources, resulting in a significant organizational=based barrier to ecosystem-based stewardship. Recreational components of caving include sport caving (private groups) and adventure caving (tour groups). This aspect of management can often overshadow other uses and needs. Managing for ecosystem and habitat protection, as well as for a variety of scientific studies, can easily be overlooked. Exploration and mapping activities should be considered as scientific endeavors and managed within guidelines and standards designed for such endeavors.

The lack of scientific information is a significant barrier to developing high-quality cave and karst stewardship programs. Although cave and karst-based research is increasing, extensive research activities are limited. In part, this is due to lack of funding and support from the academic and scientific communities (Wright 2004). Scientific input is becoming increasingly important in the development of management plans and policies that can hold up under legal challenges and public opinion (Mills et al. 2001).

Wright (2004) notes that organizational barriers also include the limited availability of funds, current workloads, lack of trained personnel, and agency practices. With the current lack of federal funding for natural resources protection and conservation efforts, it becomes critical that managers look beyond current agency constraints in developing effective cave and karst stewardship programs.

Cave and karst stewardship considerations

As noted earlier, cave and karst stewardship extends far beyond recreational concerns. Management of these resources needs to be approached from an ecosystem level. It requires a multidisciplinary approach, having physical, biological, and social considerations. Physical and biological considerations must address biophysical relationships. Social sciences need to address prehistoric, historical, current, and future use. An understanding of the natural and social systems that may be affected by management decisions, as well as of the associated risks to resources, is crucial in understanding the rest of the scientific data collected (Mills et al. 2001; Shaw et al. 2000).

Cave and karst stewardship must include a multidimensional perspective, considering both surface and subsurface aspects. There exist both direct and indirect associations between these two regions, as well as independent concerns. Stewardship should always be considered from a multiple-use point of view: science, education, interpretation, recreation, and resource extraction.

Cave and karst stewardship activities are being conducted on a variety of levels and offer many opportunities to develop partnerships. Relevant federal agencies include the National Park Service, National Cave and Karst Research Institute, Bureau of Land Management, U.S. Forest Service, U.S. Fish and Wildlife Service, U.S. Geological Survey, and Environmental Protection Agency. Examples of state agencies include the state of Virginia's Cave Board as well as numerous state park programs. Nongovernmental organizations include the National Speleological Society (NSS), Cave Research Foundation (CRF), Karst Waters Institute (KWI), American Cave Conservation Association (ACCA), Bat Conservation International (BCI), and The Nature Conservancy. Regional cave conservancies are on the increase.

Academic programs have presented courses, as well as supported research on cave and karst related subjects. Although the primary focus has been in the earth and life sciences, some work has been done in the social science areas, most notably anthropology (Seiser 2003). Western Kentucky University has two cave and karst programs: the Center for Cave and Karst Studies and the Hoffman Environmental Research Institute. The New Mexico Institute of Mining and Technology (New Mexico Tech) is in the process of developing a cave and karst studies program.

In addition to the research conducted by the scientific community, and work conducted by professional consultants, a significant portion of cave and karst stewardship activities is being conducted by volunteer specialists. These activities extend far beyond the recreational considerations and include restoration, research, exploration and mapping, and specific cave management agreements. Efforts of these volunteer specialists exceed the combined efforts of all other special-interest groups (Werker 1999). The biannual National Cave and Karst Management Symposium is an important stewardship-based conference developed and run by volunteer caving organizations. These conferences receive sponsorship by various federal agencies, an indication of the significance of the presentations.

These professional and volunteer specialists contribute time, energy, and often their own resources to cave and karst stewardship activities for a variety of reasons. Some are interested in research, both pure and applied with the associated management implications. Some are interested from a monetary perspective, typically resource extraction (oil and gas, forestry) and patents (bioprospecting). Others contribute out of curiosity and because they care about the cave and karst environments. Understanding these motivations can lead to tapping volunteer expertise, thereby assisting in overcoming stewardship barriers created by lack of funding and/or trained personnel within an organization.

Conclusion

Cave and karst stewardship efforts will lead to enhanced scientific understanding and management of these resources, improved interpretation and education, as well as better informed land use decisions relating to surface and subsurface activities and multi-use potential.

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Vertebrate Species Use of Cave Resources in the Carlsbad Caverns Region of the Chihuahuan Desert

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Caves are widely known to provide habitat for a variety of vertebrate species that spend all or significant portions of their life cycles inside the totally dark areas of the caves. It is less well known that caves, and particularly cave entrance areas, can provide an important resource for a wide variety of species. Especially in arid regions, caves may provide temporary relief from extreme temperature or low-humidity conditions. In addition, they may provide hiding places to escape predators, den sites, nest substrates, or hunting locations for predators. Many caves are located in extensive deposits of limestone and gypsum in the Chihuahuan Desert. These caves provide more moderate conditions of temperature and humidity that may be a critical resource for many species.

The Chihuahuan Desert covers a large area of southern New Mexico, western Texas, and the extreme southeastern corner of Arizona. This desert includes an even larger area of Mexico, extending far south in the central plateau. This research is limited to a portion of the Chihuahuan Desert in southeastern New Mexico, in the vicinity of Carlsbad Caverns National Park.

Methods

Data in this analysis were compiled from a variety of sources. The primary sources of information were in the unpublished records in the files of Carlsbad Caverns National Park and the Carlsbad Field Office of the Bureau of Land Management (BLM). Several Internet sites have extensive information on vertebrate species and their habitat usage and requirements. Other standard literature sources were also searched for relevant information.

Direct observations were made in both limestone and gypsum caves of this region. A variety of evidence can be used to indicate the presence of vertebrates in caves. Direct observations are a positive indication of the presence of a species in a cave. Mammal or bird nests also confirm a species' use of a cave. Feathers and recent egg shells confirm that these nests have been used recently. Tracks and scat provide evidence of a species in a cave. Skeletal evidence confirms that an animal was in a cave, but disarticulated skeletal material suggests that it may have been brought into a cave by a predator. Other skeletal material at the bottom of a drop suggests that a species was alive when it entered the cave, but it died as a result of the fall.

Results

The literature and files searches and personal observations provided 657 reports of at least 78 species of vertebrates in the caves of the Chihuahuan Desert in the vicinity of Carlsbad, New Mexico. Vertebrate species have been reported from 149 caves of this region. This number includes 81 caves within Carlsbad Caverns National Park, 67 caves on land controlled by the Bureau of Land Management, and one cave on state of New Mexico land. A large number of observations were not specific but merely reported unidentified members of various groups of species. In addition to the confirmed observations for this region, literature reports were found documenting cave use by 26 other vertebrate species in the Chihuahuan Desert, 17 of which are present in the Carlsbad vicinity.

One way of analyzing the data was to determine the distribution of each species, or the number of caves in which each species is present. The horizontal axis of Figure 1 represents the number of vertebrate species that are found in the number of caves shown on the vertical axis. The largest numbers of species are reported from only one or two caves, and 63 of the species are reported from five or fewer caves. Two species have been reported in 30 different caves, but only 10 species have been reported from ten or more caves.

These data can also be used to describe the vertebrate diversity within caves (Figure 2). Most of these caves have records of relatively few vertebrates, with 97 caves having reports of only one or two species. Only nine caves have reports of ten or more species of vertebrates, and seven of these caves are within Carlsbad Caverns National Park. The cave in which the greatest number of reported species is Carlsbad Cavern, with 30 species.

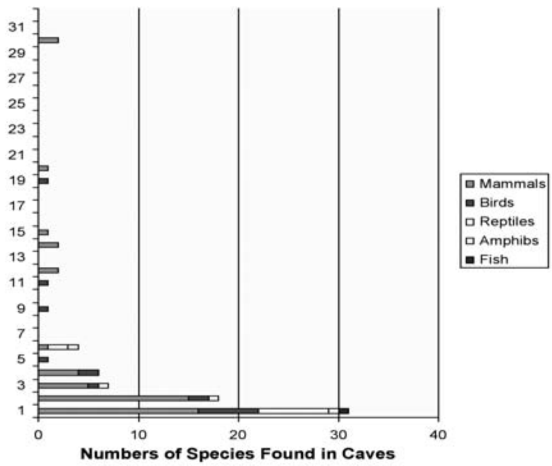


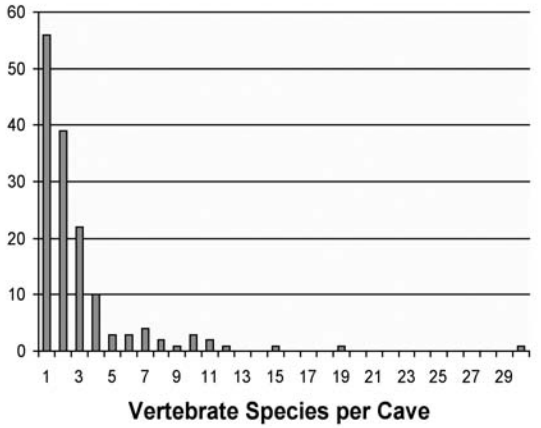
Figure 1. Distribution of vertebrate species found in caves of the Chihuahuan Desert near Carlsbad, New Mexico.

Mammals

Another way to look at these data is by breaking them down taxonomically. At least 49 species of mammals have been reported from 124 different caves in the Chihuahuan Desert near Carlsbad, New Mexico. The total number of species is ambiguous because of unspecified reports of *Myotis* spp., *Peromyscus* spp., *Neotoma* spp., and others. While these reports are likely to be the same species that have been reported in other caves, the possibility exists that they could represent additional species. The mammals reported from these caves represent six orders and 18 families. The orders represented by the most species are bats, carnivores, and rodents.

Most mammals have been reported from relatively few caves, with 33 species reported from three or fewer caves. Nine species have been reported from ten or more caves. The native species most commonly reported are the porcupine, ringtail, mountain lion, wood rat species, mule deer, and Townsend's big-eared bat. Prior to the creation of Carlsbad Caverns

Figure 2. Diversity of vertebrate species in caves in the Chihuahuan Desert near Carlsbad, New Mexico.



National Park, domestic goats were commonly grazed in this region, and their scat and bones are present in numerous caves, and the exotic Barbary sheep has been recorded in several caves.

Birds

Fewer bird than mammal species are reported to be using the caves of this part of the Chihuahuan Desert, with 15 species in 53 caves. These bird species represent seven orders and 12 families of birds. Three orders and eight families are represented by a single species. The orders Strigiformes and Passeriformes account for nine of the reported bird species. The order Falconiformes is based on a single, old record of a ferruginous hawk nesting in the entrance of Carlsbad Cavern (Bailey 1928).

The cave swallow is the most commonly reported bird species in these caves, with 48 records from 19 different caves, all but one of which are located within Carlsbad Caverns National Park. This species is also the most likely bird to go into caves to the limit of the twilight zone. Most other birds are likely to remain in better lighted areas closer to entrances. The great horned owl is also commonly reported, with 13 confirmed records in 11 different caves, and many unidentified owl records could be this species.

The relative lack of records for bird species could be the result of the inability of most cavers to identify birds to the species level or simply the failure to record common species. For example, the rock wren could easily be overlooked, but it is likely to be present at some time in almost every cave entrance of this vicinity.

Reptiles, amphibians, and fish

Reptiles are frequently encountered in the entrances of caves in this part of the Chihuahuan Desert. Eleven species of reptiles in two orders and five families have been documented in at least 35 caves. As with other classes of vertebrates, these numbers are uncertain because of numerous reports of unidentified snakes and lizards.

Rattlesnakes are the most commonly encountered reptile in these caves, with 15 confirmed records of three species in 14 different caves. An additional 16 reports of rattlesnakes in 13 caves did not identify the species. So far, western diamondback rattlesnakes have been reported only from BLM caves, and black-tailed rattlesnakes have been reported only from caves in Carlsbad Caverns National Park, although future surveys are likely to expand the known distribution of both of these species. Mottled rock rattlesnakes have been reported from caves in both areas. Reports of lizards in caves are surprisingly scarce, given their relative abundance in arid regions and their inclination to use crevices in rocks. There are only three confirmed records of lizard species, plus one unidentified lizard.

Relatively few amphibians have been reported from caves of this region, probably a consequence of the arid surface conditions. The two confirmed species, representing two orders and two families, have been recorded in nine caves. Most reports of amphibians are from stream conduit caves in the BLM gypsum karst areas east of the Guadalupe Mountains. No amphibians have been reported from caves in Carlsbad Caverns National Park. The most commonly reported amphibian is the tiger salamander, primarily from the gypsum caves. No cave-adapted amphibians are known from this region.

Only one fish, representing one family and one order, was reported in these caves, in a gypsum stream conduit where it was likely washed in from the surface. This fish was identified as a plains killifish, which is native to the Pecos River drainage.

Discussion

Vertebrate species are using these caves for a variety of reasons. Bats and birds use the caves as daytime roosts, nighttime roosts, and migratory roost sites. Many species of mammals and birds will use caves as nest or den sites. Wood rat nests have been reported in many caves (Mosch et al. 1991; Novack 2004; Allison 2004), but the species building the nests cannot be identified without visual confirmation. Bailey (1928) reported that mountain lions were using caves as den sites, and lions have been encountered in caves in this region (Parent 1998; Allison and Roemer 1998). Piles of small mammal bones may indicate the presence of carnivore den sites. Porcupine den sites have been noted in numerous caves (Fleming and Hummel 1977b; Hummel 1977), and live porcupines have been encountered (Pate 1992; Fleming 1977).

Several bird species are known to use caves in this vicinity for nest sites, with confirmed nesting for eight species: turkey vulture, ferruginous hawk, great horned owl, white-throated swift, Say's phoebe, cave swallow, rock wren, and canyon wren (Bailey 1928; Belski 1989; Fleming and Hummel 1977a; Lindsley 1967; Pate et al. 1995; Spangle and Thompson 1959). The cave swallow is the most common nesting bird in these caves, with nesting confirmed in at least 15 caves. Bats use several caves in this region as maternity colonies, the best known of which is Carlsbad Cavern.

Caves serve as hibernacula for a variety of species. As noted above, bats have been observed hibernating in several caves. The poorwill is the only bird known to hibernate, and it could use caves in this region as hibernation sites. It has been reported hibernating (not in a cave) at Carlsbad Caverns National Park (S. West, pers. comm.), and it has been observed in a crevice in a pit entrance to a cave in the park (P. Seiser, pers. comm.). It is likely that some reptiles and amphibians use caves as hibernacula, but there are no documented observations in the caves of the Carlsbad vicinity.

Caves in this arid region are likely to provide water sources for a variety of animals. Mule deer and bighorn sheep have been reported to get water from pools in caves in Slaughter Canyon (Bailey 1928; Welbourn 1978). It seems almost certain that other species are using these water sources, but if it has been observed, it was not reported.

Some species are apparently using caves as foraging sites. Bailey (1928) reported that white-footed mice were common throughout Carlsbad Cavern and were feeding on crickets and food dropped by tourists. Ringtails are likewise found in deep areas of Carlsbad Cavern (Bailey 1928; D. Pate, pers. comm.), and it seems likely that they are feeding on mice. This evidence of ringtail scat and a pile of swallow feathers suggests that the ringtail is preying on the cave swallows. Bailey (1928) also suggested that mountain lions were using a cave with a large entrance as a hunting site. A paralyzed mouse seen in the entrance of a cave on Carlsbad Caverns National Park had probably been bitten by a rattlesnake that was seen nearby (Reames and Barber 2003).

It seems likely that animals are using the caves to find relief from extreme conditions of high temperature and low humidity, and favorable microclimates within caves are likely to be deliberately selected by many species. However, there have been no direct physiological studies to confirm this hypothesis.

Numerous species of mammals have been identified through the presence of tracks or scat, indicating use of the cave. Birds and reptiles may also leave evidence of this type in caves. These observations could fall into the category of incidental use, and evidence of this sort cannot be interpreted to explain why the animal was in the cave.

Another category of use could be called unintentional use. Animal remains found at the bottom of entrance pits probably did not intend to enter a cave, and once in, they were unable to get out. In many cases, these animals would be killed by the fall. However, some species, particularly snakes and lizards, appear to survive relatively long drops. Skeletal material found in some caves suggests that these animals (or parts thereof) may have carried into the caves as prey items of carnivores. The location of jackrabbit and cottontail bones in small alcoves in a cave and the presence of ringtail tracks in these areas suggest that ringtails could have carried these animals into the cave. Deer legs found in a cave with a large entrance were probably brought into the cave by a large predator (Carrington 1999), and mountain lions are known to use this cave (Roemer 2000).

Conclusions and recommendations

The results of this study clearly demonstrate that caves of the Chihuahuan Desert are being used regularly by a wide variety of vertebrates. This level of usage and the documented types of usage by these species demonstrate that the caves provide a habitat feature that is important for many species. In an arid environment with extremes of high temperatures and low relative humidity, these caves could be critical to the survival of many vertebrates. Although none of the species observed in these caves are listed as threatened or endangered, their continued presence in the Chihuahuan Desert may depend on these cave resources.

With so many species depending on the caves of this region, it is imperative that management agencies, primarily the National Park Service and the Bureau of Land Management, maintain policies that provide protection for these species and their habitat requirements. Most caves in Carlsbad Caverns National Park are administratively closed, although three caves are open for commercial tours (including tours in undeveloped areas) and eight others are open for recreational caving. As noted above, Carlsbad Cavern has a high diversity of species in spite of the heavy annual visitation. The Bureau of Land Management maintains a permit system for several of its caves, and there are some seasonal restrictions on visitation because of bats. However, many BLM caves are open for recreational caving with no restrictions.

Based on the evidence of vertebrate use in these caves, potential impacts on these wildlife species and their habitat requirements must be considered in any action affecting these caves. In addition, when these agencies are giving permits for recreational caving or for scientific research, they should provide the permittees with information about wildlife species using the caves and any precautions they should take to minimize impacts to these species.

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Hurricanes Winds, Tropical Storm Winds, and Tree Fragmentation

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Introduction

The purpose of this study was to collect information about the effects of high winds on different types of Floridian trees. The study was initiated in the summer of 2004 when four hurricanes made landfall in Florida. The objective was to derive information about damage to trees in severe winds that may be applied to planning for areas of human activity, with regard to landscape elements that may be more hazardous than others. Data and analyses here include part of the information from areas affected by hurricanes Charley, Frances, and Jeanne, with data from areas affected by hurricane Ivan not yet considered. This information is a report with limited analysis; estimates and conclusions discussed here are preliminary.

The hurricanes that affected Florida in 2004 were mid-season Atlantic hurricanes that affected nearly all parts of the state. The four hurricanes to make landfall in Florida during 2004 were (much of this information from Tuckwood et al. 2004):

- *Charley,* 13 August, estimated maximum winds: 145 mph (category four hurricane; see Table 1) at landfall. The storm made landfall at Captiva Island on the Gulf coast and moved north–northeast across the state.
- *Frances,* 5 September, estimated maximum winds: 105 mph (category two hurricane) at landfall. This storm made landfall at Hutchinson Island, moved slowly west–northwest across the peninsula, and produced much rain inland.
- *Ivan,* 16 September, estimated maximum winds: 130 mph (category three hurricane) at landfall. The center of the storm made landfall west of the Florida–Alabama border, and produced hurricane-force winds east into the Florida panhandle.
- *Jeanne,* 26 September, estimated maximum winds: 120 mph (category three hurricane) at landfall. This system made landfall at Hutchinson Island and entered the Gulf of Mexico north of Tampa Bay.

Changes associated with hurricanes

Major types of damage usually associated with hurricanes are changes caused by extreme winds. Winds cause much damage to biological communities by breaking or uprooting trees, but these changes are temporary as plants and their communities regrow and can recover from these disturbances in years or decades. Long-lasting disturbance may be caused by severe weather when floods are part of storms. Flooding may occur with extreme rainfall in inland areas and by extreme tides along the coast. In Florida, the land surface is mostly low with little topographic relief, so that serious flooding by rain and associated substrate movement by high-energy moving water is seldom significant. Coastal shorelines of Florida, however, are low with sandy substrates and are subject to change with

Wind speed (mph)	Storm strength
39–73	tropical storm
74–95	category one hurricane
96–110	category two hurricane
111–130	category three hurricane
131–155	category four hurricane
>155	category five hurricane

Table 1. The Saffir-Simpson Hurricane Scale. This scale identifies storm intensities with wind speed categories and descriptions of damage common for each category; damage descriptions are not included here. Tropical Storm designation includes lower strength storms (NOAA 2005).

extreme tides. Changes that involve movement of substrates and associated biological communities are more long-lasting and may affect the region's biological communities for very long periods.

- Hurricane Andrew (1992), category five hurricane, southern Florida. *Winds:* Extreme. *Rain flooding:* minor. This storm moved quickly across the southern part of the state and did not produce much rain. *Tidal flooding:* moderate. Tidal flooding occurred in low-lying areas, but significant changes in shorelines were not common (Loope et al. 1994). *Changes to trees:* high mortality of slash pines. Many of these trees succumbed to secondary infestations by insects or pathogens after hurricane-induced stress; many of these trees remained alive for 12–18 months after the hurricane. Most trees within or near to the eye of the storm were damaged.
- Hurricane Mitch (1998), category five hurricane, Central America. Winds: extreme offshore, but minor inland; this hurricane degraded to a tropical storm soon after moving over mainland Honduras. *Rain flooding:* Extreme. Rainfall of nearly 0.5 m in 24 hours was recorded (NOAA 2005). *Tidal flooding:* minor. *Changes to trees:* Wind damage to trees was in coastal areas; mangrove forests on the Bay Islands and northern shore of Honduras had high tree mortalities. Inland trees were commonly uprooted by flooding and associated substrate movement.
- Hurricane Charley (2004), category four hurricane, Gulf coast and central Florida. *Winds:* severe. *Rain flooding:* minor. This storm moved through the area quickly and produced hard rains, but little standing water resulted. *Tidal flooding:* minor. This storm made landfall on a falling tide so that tidal surges were minimized. *Changes to trees:* Much damage to trees occurred, mostly in areas with category two or greater winds.
- Hurricane Frances (2004), category two hurricane, and Hurricane Jeanne, category three hurricane, east coast and central Florida. Descriptions of these two storms are treated together, as the effects of each separately were not readily apparent after the second storm. *Winds:* moderate. For both storms, winds on the Atlantic shoreline were very strong, but attenuated fairly quickly as the storms moved on shore. *Rain flooding:* moderate. Large amounts of rain fell and accumulated inland during both storms, but little

movement of substrate occurred. *Tidal flooding:* moderate. Some dune overwash and landward migration of dunes occurred; some mangrove communities received up to 50 cm of sand deposition. Hurricane Frances made landfall at about high tide, so that onshore winds (north of the eye) coincided with the rising tide as the storm approached. Hurricane Jeanne made landfall near low tide, so that onshore winds coincided with a falling tide. *Changes to trees:* The most severe damage to trees occurred within 1 km of the coast, but broken trees are common farther inland. Some coastal communities were inundated with substrate (above), so these tree communities will likely change. Perhaps the most consistent perturbation to trees was wind-pruning of leaves by long periods of strong winds in successive storms.

- Hurricane Ivan (2004), category three hurricane, Florida panhandle and adjacent areas. *Winds*: severe. *Rain flooding:* moderate. *Tidal flooding:* severe. This storm made landfall shortly after a weak high tide. Tidal amplitudes were low; tides were mixed with weak activity, and may have had little effect on storm surges. *Changes to trees:* Broken trees were common on barrier islands and within 1 km of the mainland shoreline. On barrier islands, substrate movement produced sand inundation in much of the leeward area dominated by trees. This change in substrate and topography will likely change these forest communities.

Methods

Surveys were done along highways in areas within 100 miles of landfall for hurricanes Charley, Frances, and Jeanne. Survey areas were located at 1-mile intervals. At each location the tree species were noted, and either the type of alteration by high winds (broken branches, broken trunks, uprooted trees, or no apparent damage) was noted, or the size of broken branches, broken trunks, or dbh (diameter at breast height) of uprooted trees was estimated. Estimates of sustained wind speeds were obtained from the National Oceanic and Atmospheric Administration (NOAA) and wind field contours for hurricanes were mapped with ArcView 3.2 contouring software to estimate winds at each survey location. These values were used as an independent variable to compare reactions of trees to winds.

Results

Surveys for hurricanes Charley, Frances, and Jeanne are considered here. On the southern Gulf coast, near the site of landfall of hurricane Charley, 448 sites were surveyed. On the Atlantic coast near the landfall sites of hurricanes Frances and Jeanne, 349 sites were surveyed. Records for 12,118 trees were compiled to compare types of damage, and 439 sites were recorded at which tree structure sizes were estimated.

Slash pine trees. Slash pine *(Pinus elliottii)* trees were the most commonly encountered trees in the surveys. They were selected as an indicator of tree reactions in high winds. Some slash pines lost branches in winds as low as 40 mph, and the proportion of these trees losing branches increased steadily until nearly 100% had branch loss at winds over 110 mph. In tropical storm winds (<74 mph) a few slash pine trees had snapped trunks or were uprooted, but this type of damage was not common until winds were well into the category one hurricane force range (74–95 mph). Proportions of trunk breakage increased to about 40% at

120-mph winds, and proportions of uprooted trees increased to about 10% at 120-mph winds.

Branches broken out of slash pine trees had a mean diameter of about 2 inches regardless of wind speed, suggesting that branches commonly break at about this size then do not break further, as most of the wind-resisting leaf surface area is lost. Tree trunks of about 8 inches dbh occasionally snapped in category one hurricane force winds. This mean diameter at which breakage occurred increased with wind speed to about 10.5 inches dbh at 105 mph and was reduced to about 8 inches dbh at 120 mph. Similarly, occasional uprooting occurred with trees of about 12–14 inches dbh during tropical storm winds with mean trunk size increasing to about 18.5 inches in 100 mph winds, and becoming reduced to about 12 inches at 120 mph winds. In these situations it appears that larger trees are snapped or uprooted by stronger winds, but smaller trees are limber and bend with winds up to about 100 mph. In winds greater than about 100 mph, smaller trees also snap or become uprooted, so that mean dbh estimates decrease with higher winds.

Native and exotic trees. A major consideration was comparing reactions of native trees in high winds with those of nonnative trees in similar situations. Casuarina *(Casuarina equisetifolia)* tree, an invasive tree native to Australia, was a common tree on Sanibel Island. The northwestern part of the island is close to the eye-wall track of hurricane Charley, and many Casuarina trees here were damaged by this storm. These trees are salt tolerant and common in coastal communities; they are gregarious and commonly form nearly monocultural stands on disturbed coasts (Ferriter et al. 2004). Casuarinas are generally much taller than native coastal hardwoods, and provide greater surface area in winds. Their root systems are commonly shallow and they uproot quickly in high winds, especially on shorelines where they may be solitary or in small colonies. In areas farther inland that are occupied by dense Casuarina populations, the trees appear more likely to have experienced snapped trunks, with fewer uprooted individuals. At the five sites surveyed on western Sanibel Island, 58.6% of Casuarina trees snapped or uprooted.

Casuarina and native Virginia live oak. These trees are both large hardwoods that often occupy mesic, sandy soils. In areas that sustained tropical storm winds, live oak trees had damage to branches in about half of the trees observed; this branch damage increased to over 90% of trees in areas that had winds of category two hurricane force or greater. Live oaks occasionally snapped or became uprooted in nearly all wind situations, increasing to about 10% with snapped trunks and about 7% uprooted in areas with category two hurricane winds.

Casuarina trees had similar branch loss, but were about twice as likely to have trunks snapped or to have been uprooted, especially in tropical storm winds. Mean diameters of Casuarina branches lost increased from about two inches in tropical storm winds to about five inches in category two hurricane winds. The dbh measurements of trees snapped or uprooted were both about 8 inches in areas with category one hurricane winds (none was recorded in areas with stronger winds). In areas with tropical storm winds, the dbh measurements of trunks snapped were 8–10 inches and those of trees uprooted were 10–14 inches, indicating that these trees may be likely to be snapped or uprooted in relatively low winds.

Branch loss of exotic trees and native trees. Mean diameters of branches lost from four coastal hardwood tree species were compared with those of branches lost from three exotic hardwood tree species. These trees were selected from at least 18 locations, where each species was measured. Mean diameters of broken branches on native trees were lowest in areas that experienced category one hurricane winds and highest in areas that had tropical storm force winds; simple linear regression produced a negative slope when mean branch size was compared against wind speed. Mean diameters of broken branches on exotic trees were lowest in areas that experienced category one hurricane winds and highest in areas that had category two hurricane winds; simple linear regression produced a positive slope when mean branch size was compared against wind speed. This suggests that native coastal hardwoods may be more likely to lose branches in lower-energy winds than exotic trees (Ferriter et al. 2004; Bodle 2004). This supports the hypothesis that Caribbean trees tend to possess brittle branches that are more often lost quickly. This reduces the tree's crown surface area to decrease the likelihood that the entire tree may be uprooted or snapped near its base. Presumably this enhances these trees' opportunities for survival after severe storms.

Natives and exotics: gross tree alteration. Native Floridian trees showed slightly greater branch loss than exotic trees in areas with tropical storm winds; this early branch loss may contribute to survival of these trees, as just discussed. Overall, exotic trees experienced more damage than natives. Nearly all trees were significantly altered by winds of category three hurricane force or greater. Palm trees generally survived well, but native palm trees were less likely to be compromised. See Table 2 for general comparisons of tree alteration.

Table 2. Damage to native and exotic trees in Hurricanes Charley, Frances, and Jeanne (2004): Percents of all trees, preliminary data. 'Category two+' storm percents contain the few estimates from areas with winds greater than category two-force winds. Changes to palm trees ('Palms') are estimated for tropical storm force winds and hurricanes, including all hurricane-strength categories.

	Tropical storm	Category one	Category two+
All species studied, except palms			
Branches broken			
Natives	51.1	73.8	95.3
Exotics	48.7	81.4	97.6
Trunks snapped			
Natives	3.6	7.4	20.3
Exotics	9.8	11.8	26.2
Uprooted			
Natives	3.1	2.2	5.6
Exotics	6.7	5.3	9.5
No apparent damage			
Natives	48.9	26.2	4.7
Exotics	51.3	18.6	2.4

	Tropical storm	All hurricane-force winds
Palms only		
Trunks snapped		
Natives	0.0	0.0
Exotics	0.0	0.9
Uprooted		
Natives	2.2	3.4
Exotics	7.4	9.5
No apparent damage		
Natives	97.8	96.6
Exotics	92.6	92.4

Preliminary conclusions

An analysis of some data collected after four Floridian hurricanes in 2004 allows for some preliminary conclusions. Some of these conclusions are: (1) winds of category two hurricane force or greater cause damage to almost all trees; (2) exotic trees are more likely than native trees to have broken trunks or become uprooted;

(3) native coastal hardwoods are more likely than exotic trees to lose branches in storms; and (4) palm trees, especially natives, are more likely than dicotyledonous trees or conifers to survive storms.

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New River Gorge Natural Resource Assessment: Methodology and Critique

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Introduction

In 2003, I was given a contract to complete a natural resource assessment for New River Gorge National River with funding obtained by the National Park Service (NPS) Northeast Region from the natural resources and planning offices of the NPS Washington office. My natural resource assessment would meet the goals of the Natural Resource Challenge in assisting the park with the general management plan (GMP) process, which began in 2004. My specific tasks were to gather, synthesize, summarize, and present relevant, useable, understandable, and transferable information about natural resources of the park. In particular, I evaluated the current condition and status of the intrinsically significant natural resources found at the park, identified threats to the resources, recognized information gaps in current data that prevented the park from adequately addressing these issues, and suggested management, including research, recommendations. In addition, I described the current natural resource condition at the park in a historic context in order to elucidate how past land use influenced the landscape that we experience in the park today. The ultimate purpose of the natural resources assessment was to ensure that existing natural resource information and issues are incorporated into the planning process.

Methods

In order to conduct the assessment of natural resources at the park, all relevant reports and publications were identified by using NatureBIB, searching park libraries, meeting with resource managers, and directly contacting researchers who have conducted projects pertinent to natural resources in the park. In addition, I conducted a literature search for articles based on natural resources research conducted in and around the park. For the literature search, I used electronic databases; reference proceedings of conferences, meetings, and workshops; United States Department of Agriculture (USDA) and NPS technical bulletins; journal articles; and websites. Electronic databases included Agricola, Biological Abstracts, and Biological and Agricultural Index. After an initial review of the literature and information, general areas of particular relevance to the park were identified. These areas—biotic resources (plants and animals), forest and other habitat community resources (habitat types, community processes), and hydrologic/geologic resources (water, soil, rock)—then became the focus topics for three workshops held in West Virginia in May 2003. These workshops were attended by invited resource managers, academic and governmental researchers, and research technicians. The purposes of the workshops were to identify all past and on-going natural resource studies, acknowledge gaps in knowledge about the resources, and suggest desired future conditions and management prescriptions for natural resources (Table 1). In addition, the participants gave their collective opinion on what were the intrinsically signifi-

9:00–9:15 a.m.: Introductions

9:15–10:00 a.m.: Background on GMP, NPS policy, the park's founding legislation, and implications to setting desired future conditions (DFCs) and suggested management recommendations and related actions to implement these recommendations. Review preliminary important natural resource list provided by participants. (This list was generated from suggestions that I solicited from participants approximately three weeks prior to the workshop). Also, explain and review maps of GIS data layers provided by the park's natural resource managers that indicate location and relationships of certain biotic resources in park.

10:00–11:00 a.m.: Update important natural resource list and/or add knowledge gaps; add significance rankings (local, regional, national, global) to identified important natural resources.

11:00–noon: Discussion of list and prioritize (prioritize top 5–10).

Noon–12:30 p.m.: Lunch (this can be working).

12:30–1:30 p.m.: For each important natural resource, formulate DFCs (small groups for each prioritized resource).

1:30–2:00 p.m.: Report back on DFCs to large group.

2:00–2:30 p.m.: Discuss and fine-tune DFCs.

2:30–3:30 p.m.: Develop preliminary management prescriptions for each resource/process or identify knowledge gaps (small groups).

3:30–4:00 p.m.: Report back to entire group of participants.

4:00–4:30 p.m.: Identify future needs for GMP process; resources to focus on; future assignments.

Adjourn by 5:00 p.m.

Table 1. Time line and agenda for natural resource workshops to assist in natural resource assessment for New River Gorge National River, May 2003.

cant natural resources found in the park. The attendees at these workshops became the source of a cadre of knowledgeable natural resource professionals who could provide technical review of the natural resource assessment report and aid in the GMP process.

After the workshops were conducted, I performed a thorough review of all identified and collected reports and publications. The information contained in the reports and publications was consolidated, synthesized, and summarized in a manner that portrayed the historical and existing park ecosystems and identified the intrinsically significant natural resources of the park. For each resource category identified, current status and significance, threats to the resource, gaps in knowledge, and suggested management recommendations were described and formulated. In all, I scanned, read, or referenced over 30,000 pages of documents in preparing the natural resource assessment report.

A relevant natural resource area that was not a focus of a workshop was air resources. There has been very little research conducted on air resources in the park. Therefore, the consulting firm Air Resource Specialists was contracted with in order to analyze data from air monitoring sites located near the park as surrogates to assess air quality and visibility and related impacts on park resources.

During the consolidation and synthesis of reports, publications, and data, the large blocks of deciduous forest found in and around the park were identified as having global significance. In order to identify the regions of the park that contained forests with a diversity of habitat elements and minimal fragmentation, I subcontracted with a researcher from the West Virginia Natural Heritage Program to perform a GIS analysis. This researcher was assisted by GIS staff at the park who provided road and utility right-of-way data layers.

In order to provide an organized database containing the majority of the reports and documents cited in the natural resource assessment report, a Synthesis (information management system) database was created by the Synthesis Regional Support Center at James Madison University in Harrisonburg, Virginia. Synthesis is an information management system for efficiently locating, organizing, integrating, and disseminating data (including GIS data) and information. The park Synthesis database contains 81 full-text-searchable documents cited in the natural resource assessment. The documents included in the database were those that I felt were especially informative (e.g., data rich), comprehensive (e.g., Water Resources Management Report), recent (published after 1990), or that were unwieldy in their hardcopy form (e.g., Marshall University vertebrate reports; Pauley et al. 1997). Two compact disks were provided by the Synthesis Regional Support Center. The first CD contains the executable files to run Synthesis and the second contains the park-specific data files. These CDs were copied and disseminated with the final natural resource assessment report.

Once the final draft natural resource assessment report was completed, it was distributed to NPS professionals and a dozen technical reviewers for peer review. The comments of all reviewers were considered and were incorporated into the final report, as appropriate.

Results

A 226-page draft of a final natural resource assessment report was prepared and disseminated to NPS and external technical reviewers 13 months after the project was initiated. Reviews of the report took another 15 weeks to complete. After considering editorial suggestions, I revised and edited the report. I then sent the report out to selected peer reviewers for a second round of review. A final report (129 pages) was printed and disseminated to interested parties in March 2005. A PDF version of the report is available at http://www.nps.gov/nero/science/.

Aside from the important natural resource categories, I prepared a section in the report that describes the historic land use and its potential effects on the current status and conditions of natural resources in the park. This section was divided into three areas: presettlement natural resource conditions and effects of Native Americans, effects of European settlement and industrialization, and effects of resource protection and modern land uses.

The natural resource assessment report summarized the natural resources of the park into the following categories: animal resources; plant resources; geologic, geomorphologic, and soil resources; hydrologic resources; and air resources. For each natural resource element or issue (e.g., oak forests, mammals, fish, geomorphology, etc.) the following categories were delineated with sections subheaded as follows:

- *Current status and significance,* describing the resource's status in and significance to the park, including information about species of special concern;
- *Threats and condition,* describing important existing and/or potential threats and the resource's current condition;
- *Gaps in knowledge,* describing information gaps in current data that are preventing the park from adequately addressing threats to the resources; and
- *Suggested management recommendations*, a bulleted list. This list may not be as extensive as the ones developed at the workshops and detailed in the appendices. These management recommendations are the ones that I think are most pertinent and effective at this time.

I also included a section in the report that identified park-wide perceived or potential threats to multiple natural resources at the park. These threats included oil and gas operations, mountaintop and other mining, New River Parkway construction, and recreation.

Several tables listed the rare, threatened, or endangered species or communities found in the park. In addition, maps depicted current park boundaries and major towns, historic towns and mining operations, and large blocks of continuous forest that contain a minimum of fragmenting features such as roads, utility rights-of-way, and other development. These maps of forest blocks were the result of the subcontracted GIS analysis and delineate areas where park managers may want to encourage natural succession and minimize development. The appendices included in the assessment report contained all the suggested desired future conditions and management recommendations formulated by the natural resource professionals who attended the focused workshops.

Discussion

My overall objective in preparing the natural resource assessment report was to provide comprehensive coverage of natural resource issues specific to the park while maintaining scientific rigor in the presentation of findings. New River Gorge National River has been the subject of numerous natural resource studies and data collection efforts. NPS Inventory and Monitoring (I&M) Program efforts are well underway in this park and my natural resource assessment made use of outputs such as progress reports that summarize data gathered through the program. The assessment process from its inception to completion of the draft final report took approximately 800 hours of my time. This project consumed significantly more time than I expected. If a comprehensive natural resource assessment for a major natural resource park is to be completed in 12 to 15 months, a full-time project leader may need to be hired. In addition, the reiterative review process was very time consuming (it took approximately 13 months). However, by having a template to follow, this review and editorial process may be significantly shortened.

A heavier reliance on carefully selected subcontractors to complete assessments for individual resource elements and issues could, potentially, relieve some of the burden of summarizing, consolidating, and synthesizing natural resource information from the project coordinator. Nonetheless, I suggest using subcontractors with caution. As previously discussed, due to my lack of expertise in the areas of air resources and GIS, I opted to hire subcontractors to perform analyses in these areas. Overall, I was pleased with the timeliness and thoroughness in which subcontractors completed their work. However, once the draft final natural resource assessment report was sent out for peer review, problems with using subcontractors became apparent. Namely, the sections in the report that were prepared by subcontractors were some of the most heavily critiqued portions of the report. I believe this occurred for three reasons. First, because subcontracted work was written by someone other than me, their work did not necessarily flow well with the rest of the report. I tried to improve the flow during my editorial process but inconsistencies and disjunctions in wording and descriptions were apparent to the reviewers. The problems associated with integrating work from a variety of writers, I feel, will be inherent in any report that relies heavily on subcontracted work. Second, because I was not familiar with the current or available research for the resource issues that I subcontracted out, I relied entirely on the expertise of the individual subcontractor and could not provide a critical technical review of their work. Having a subcontractor send out their work for peer-review and revision prior to incorporating it into the assessment report may alleviate some of these issues, although it may increase the length of time it takes for the subcontractor to complete his or her work and could be more costly. Third, subcontractors may not really understand the objectives of the assessment project. I believe having a model format for the assessment report will be an important step in clarifying these objectives.

In preparation of the assessment report, I was careful to avoid using language that could be construed as decision-making from the public's perspective. For instance, management recommendations and desired future conditions developed in consultation with resource managers and researchers were labeled as "suggested" management recommendations and desired future conditions. By using this wording, this assessment is simply another input—in addition to public review—in assisting park managers when deciding which recommendations and desired future conditions to adopt. Additionally, I attempted to make the assessment report less technical than a scoping report or a management plan. Again, I wanted to make sure that the report was useful to the planning process. Detailed citations and the Synthesis database, however, provide access to the detailed, technical information if needed.

The assessment process itself was very helpful in identifying and clarifying the intrinsically significant resources of the park. For example, prior to the assessment, the significant natural resources of the park were listed informally by park managers as follows:

- The geologic history is the most nationally significant feature of the New River, and the size and topographic relief of the gorge is an outstanding scenic resource.
- The New River Gorge has the most diverse assemblage of plant species of any river gorge in the Southern Appalachians.

Despite the preparation of these statements, when resource managers at the park were asked what about the geology is significant, they were unable to provide much clarification or elucidation. Some managers said the geology is significant because the New River is the second oldest river in the world. Likewise, with the plant diversity statement, resource managers were unable to provide a citation that documents it. The assessment process that I conducted for the park was able to clarify and justify these statements with scientific research and documentation.

Aside from helping park managers to support or clarify their significance statements, other intrinsically significant natural resources were identified through the assessment processes. For example, the expanse of contiguous eastern deciduous forest in the portion of West Virginia in which the park lies is the largest remaining relatively unfragmented tract of mid-latitude deciduous forest in the world (Riitters et al. 2002). In addition, neotropical bird migrant and amphibian diversity is globally significant, as is the presence of a globally rare ecological community—the Appalachian Flat Rock community (Vanderhorst 2001; Rosenberg et al. 2000; Southern Appalachian Biodiversity Institute 2004). The abundance of eastern woodrats in the park may be regionally or nationally significant as well (Wood 2001). The biological communities found on cliffs and in abandoned mine portals, which are relatively poorly understood, may also be regionally or nationally significant (McMillan et al. 2003; Nekola and Smith 1999).

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A Project to Synthesize and Interpret Existing Natural Resource Information and Studies to Better Inform Park Planning in Three Northeast Region Units of the National Park System

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Introduction and purpose

The National Park Service (NPS) needs planning information that is relevant, understandable, usable, and transferable for general management planning (GMP) and park resource planning efforts and products. Statements supporting that need are found in two significant places.

The original Natural Resource Challenge budget strategy called for a new planning framework:

> In the past, planning has often proceeded without adequate information on resources, resulting in siting facilities in a manner not sensitive to resource impacts. A new planning framework needs to be developed that ensures that available *resource information is synthesized and interpreted for planning* purposes, with information gaps and their significance analyzed.

The project also responds to the National Parks Omnibus Management Act, P.L. 105-391 and NPS Management Policies 2001, section 2.3.1.5:

> Decisions documented in GMPs and other planning products ... will be based on current scientific and scholarly understanding of park ecosystems and cultural context.... The collection and analysis of information about park resources will be a continuous process that will help ensure that decisions are consistent with park purposes.

This project is centered at three complex Northeast Region (NER) parks, Shenandoah National Park, Fire Island National Seashore, and New River Gorge National River. Each of these three parks is anticipating the start of the GMP process. The project goal is to make critical natural resource information available in a format that informs the process in an understandable and useful fashion. New River Gorge has now initiated its GMP, Fire Island is scheduled for 2006 pending funding, and Shenandoah will be scheduled at a later date. Each park's GMP, five-year strategic plan, and annual action plan will benefit by more fully incorporating existing natural resource data into the planning process. Facility siting and planning will respond better to natural resource-driven constraints.

This project is intended to serve as a pilot for similar efforts throughout the NPS. Adequate and usable information is vital if the NPS is to base its management decisions on a "current scientific and scholarly understanding of park ecosystems."

Shenandoah, Fire Island, and New River Gorge have been the subjects of numerous natural resource studies and data collection efforts. The NPS Inventory and Monitoring (I&M) program is well underway in these parks and this project presents itself as logical use of I&M program outputs. All have highly visible resource issues that will become a focus of their GMP efforts (e.g., air quality at Shenandoah, shoreline erosion at Fire Island, landscape scale forest management at New River Gorge). Unfortunately, the information is often focused on individual resource types and has not been synthesized to provide a collective description of park natural resource characteristics and issues. Park staff turnover has reduced institutional knowledge of the scale and content of past studies and data collection efforts. Past research is a matter of historical record and copies of most documents are often scattered. Information requirements are often overlooked or unknown early in the planning process because of a lack of knowledge. In many cases potentially usable data have not been systematically identified and mapped using geographic information systems (GIS). Without GIS the information is not readily available for use in general management or facilities planning.

This project compliments ongoing NER efforts to assure that cultural resource information is synthesized and interpreted for planning.

Project objectives

For each of the three parks (Shenandoah, Fire Island, New River Gorge) the project objectives are to:

- Identify and review existing natural resource studies and data sets using NRBIB and other appropriate sources;
- Analyze, consolidate, and synthesize this information in a manner that portrays the historical and existing park ecosystem(s) and identifies the natural resource characteristics and conditions in the context of each park's purpose and mission;
- Identify issues and opportunities that should be addressed during the GMP process;
- Identify critical gaps in the knowledge base that must be addressed prior to initiating the planning process;
- Identify and map (using GIS) usable natural resource data to better inform the GMP process;
- Present the results of this work to park planners and managers in a way that is understandable and usable in the park planning and management process;
- Identify a cadre of knowledgeable natural resource professionals who would continue in an advisory role during each park's planning process;
- Identify a cadre of knowledgeable natural resource professionals and park planners who may assist similar projects at other units of the NPS;
- Evaluate the methodology undertaken to complete the project, identify any potential improvements, and assess the applicability of the project for use in other units of the NPS; and,
- Prepare a paper outlining the results of this project and its potential for servicewide application.

Project methodology

NER's two senior scientists (John Karish and Mary Foley), in cooperation with park managers and natural resources staff, have selected knowledgeable natural resource investigators from a variety of disciplines to compile, analyze, and synthesize existing natural resource-related studies and data for each of the three parks. Each team will have a team leader. The teams will be drawn from the Cooperative Ecosystem Study Units (CESUs) that were established to provide research, education, and technical assistance to the NPS and other federal land managers. . While the team members may vary in number and duration during the course of project, the overall effort is estimated at one full-time-equivalent position (FTE) per park. It is estimated that the process of compilation and synthesis will occupy a six-month period for each park.

The preponderance of the data will be park specific. NPS I&M Level I data, basic hydrology, geology and topography, park-based research, and information concerning broader ecological context of the park will be compiled and synthesized. NPS I&M Level 1 data sets include but are not limited to vegetation and wetlands, reptiles, amphibians, mammals, birds, threatened and endangered plants and animals, and air and water quality. Available threatened and endangered plant and animal habitat data will also be utilized.

In consultation with park and NER central office planning staff, park resources staff, and the project teams, the field technical support centers for GIS at the University of Rhode Island and North Carolina State University GIS staff will provide assistance. They have assisted the team in identifying natural resource information that can be transferred to maps useful in the planning process and for other relevant park purposes. GIS staffs have also consulted with other federal, state, and local agencies to determine if their available GIS data layers contain information (e.g., state-endangered or -threatened animal species, point and nonpoint sources of pollution, etc.) that inform the GMP process. Identified data layers were transferred to maps by GIS utilizing the services provided by the two field technical support centers. The workload associated with the consultation is estimated at 0.25 FTE per park for the duration of the project.

Park and NER planning and National Environmental Policy Act (NEPA) staff briefed the resource assessment teams on the GMP process (Director's Order #2) at the commencement of the project. This allowed assessment team members to become familiar with the intent and structure of plans and the types, combinations, and levels of information that would be most valuable in undertaking the respective GMPs. Park and NER planning and NEPA staff have met with the team at mid-course to assist in evaluating the usefulness of the data identified to date, and to provide guidance on how they may be best articulated for planning purposes. At the conclusion of the project there will be a seminar to conduct a project evaluation and assessment of transferability.

Project budget

The budget includes two NPS funds sources and in-kind contributions: natural resource NRPP funds and GMP park planning funds. The funds from the two sources were provided to pay for investigators, GIS costs, and project overhead. They were divided more or less equally over the three parks. Shenandoah, Fire Island, New River Gorge, and NER planning and natural resource staff have provided in-kind staff contributions and miscellaneous expenses. Terry Moore, NER chief of park planning and special studies, has provided the coordination for the overall project. Total funds received for each of fiscal year 2002 and FY2003 was $66,000 from NRPP and $66,000 from the GMP 409 account. The total amount of project funds provided was $264,000.

Project evaluation and assessment of transferability

The discussion today initiates the evaluation of this project. The project proposal stated that NER would present this project at a symposium. For that purpose we had this very conference in mind when the project started. The symposium would involve the NER participants, team members, and interested NPS personnel from the Washington Office and other regions to describe the methodology, discuss the products, and share the joint evaluation noted above.

Upon completion of the reporting phase, NER and park resource, planning, and GIS staff will meet with the teams to jointly evaluate the project's success, changes that should be made in the methodology, and any additional factors that should be considered in similar undertakings.

The Ecological Effects of Lock and Dam No. 6 in Mammoth Cave National Park

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Introduction

As a conservation agency, the overriding mission of the National Park Service is to manage park resources such that they will remain unimpaired for future generations. Given the tremendous growth in the U.S. population, the highest rates of material and energy consumption per individual in the world, and the increasing demands for recreation in the national park system, this is a challenging mission. In our efforts to carry out this mission, it is important to bear in mind that people are part of ecosystems, and the health of our economy is absolutely linked to ecosystem health.

Mammoth Cave National Park is the core of an international biosphere reserve, which is simply recognition by the United Nations Education, Scientific, and Cultural Organization (UNESCO) as a special place in the world. One of the primary functions of the park and biosphere reserve is the conservation of native plants and animals, including the habitats where they live. The park consists of 52,830 acres and is somewhat like an island refuge in a sea of intensively used land. Vegetation communities in the park have exceptional diversity with over 1,100 species of flowering plants including 82 species of trees. As well, 203 species of birds, 43 of mammals, 29 of amphibians, and 38 of reptiles have been reported in the park.

The park is part of a regional karst landscape, which is characterized by subterranean drainage, springs, and caves. At 367 miles charted to date, Mammoth Cave is the longest known cave system in the world. Park cave ecosystems, both aquatic and terrestrial, possess one of the most diverse faunal assemblages in the world, with over 130 regularly occurring species. The Green River runs east to west through the park, and is joined by the Nolin River from the north near the park's western border. These rivers support a highly diverse fish (82 species) and invertebrate fauna (250 species), of which over 50 species are freshwater mussels.

Protection of cave streams and surface rivers has consistently been a high priority for the park. Six million dollars were contributed toward creation of a regional sewage treatment facility, removal of an 1,100-foot-long creosote-treated boardwalk in River Styx by National Speleological Society volunteers is nearly complete, runoff and spill retention/filtration structures along Interstate 65 have been negotiated with the Kentucky Transportation Cabinet, and agricultural best management practices have been supported through the Natural Resources Conservation Service.

History and current status of Lock and Dam No. 6

Located at the west edge of Mammoth Cave National Park, Lock and Dam No. 6 was built in 1904–1905 to allow navigation of barges carrying natural asphalt from mines near Nolin River. Normal flow in 16 miles of Green River and 7 miles of the Nolin River in the park has been retarded by the dam since then. Highway transport and the demise of the natural asphalt business resulted in the facility being decommissioned in 1951. In both 1951 and 1980 the Secretary of the Interior directed efforts to effect removal of the dam, and in 1989 repairs were undertaken to stem infiltration of water beneath the dam, which was partially successful. The Kentucky Natural Resources and Environmental Protection Cabinet, Division of Water, has designated Green River and its subterranean tributaries as an Outstanding Resource Water, and the Green River has also been declared a Kentucky Wild River. Together with the Kentucky State Nature Preserves Commission, the cabinet recommends removal of the dam. Likewise, organizations such as the Cave Research Foundation, National Speleological Society, National Parks and Conservation Association, and the Sierra Club have strongly endorsed restoration of free flow.

Recent investigations including Lock and Dam No. 6

Funded in 1995, the U.S. Army Corps of Engineers (USACE) conducted a disposition study for derelict locks and dams on Green and Barren Rivers in order to make recommendations on deauthorization or disposal of the properties (USACE 2001). The following points have been extracted from the report:

- Trash and old campfires on the site indicate public safety issues such as "drinking, partying, and firearms" at the site by people trespassing despite posted signs (p. 9).
- There is a safety concern for boaters; in 1998 a family nearly went over the dam (p. 20).
- Of the five sites examined, Lock and Dam No. 6 was "by far in the worst condition" due to active undermining of the lock chamber with sinkholes evident nearby (p. 20). The estimated cost of stabilizing Lock and Dam No. 6 is $758,900 (p. 24).
- Removing the dam would nearly eliminate public safety concerns and the possible failure of the lock abutment, which could cause siltation at the Edmonson County Water District intake nearby (p. 21).
- Ferries on Green River in the park can continue operations by extending ramps at Houchins Ferry, and by annually dredging a channel at Green River Ferry (pp. 22–23).
- Removal of the dam would restore the cave aquatic and Green River ecosystems by returning free-flowing conditions, and also enhance recreational opportunities (p. 23).
- The *Miss Green River* excursion boat could operate on the Lock and Dam No. 5 pool at Brownsville (p. 23).

As part of the USACE disposition study, the U.S. Fish and Wildlife Service completed a coordination act report (Widlak1999). Major points from this report are listed below:

- Under free-flowing conditions, the Green and Barren Rivers supported approximately 151 species of fishes, but with the dam-related shift to slower, warmer water conditions, fish populations shifted, which increased "rough" species such as carp, gar, and shad (p. 6).
- The Kentucky cave shrimp is found only in the Mammoth Cave vicinity, and impoundment of Green River is implicated as a causative factor in the reduced populations of this

rare and endangered species (p. 8).

- Dam construction has reduced quantity and quality of freshwater mussel habitat (p. 7). Green River may be the only place where the orange-footed pearly, ring pink, and purple catspaw mussels are still reproducing (p. 9).
- Restoration of free flow would allow recolonization by fish such as darters that help disperse larval mussels, and ultimately enhance mussel populations (p. 11).

More recently, the USACE prepared an environmental assessment, which resulted in a recommendation for removal of the dam and restoration of free flow (USACE 2004). In this environmental assessment, USACE described several dam-related impacts and beneficial effects of removing the dam, which are summarized below:

- The dam has changed the river from a cool, free-flowing state to a slow-flowing and warmer condition with loss of riffle and shoal habitat types. Many native species declined in the pool created, and the altered habitat also caused an increase in rough fish (p. 25).
- Of the 71 species of freshwater mussels found in Green River, more than a third are considered rare, threatened, or endangered at the state or federal level, and the most significant factor is habitat loss caused by dams (p. 25). None of the six federally endangered mussels known from the park have been found in the pool behind Lock and Dam No. 6 (p. 27).
- Populations of the federally endangered Kentucky cave shrimp, which is found only in the Mammoth Cave area, have been affected by the impoundment of Green River behind Lock and Dam No. 6. Roaring River in Mammoth Cave is designated by the U.S. Fish and Wildlife Service as critical habitat for this imperiled endemic shrimp species, and normal flow in this cave stream is affected by the impoundment (p. 26).
- Removal of the dam would benefit the aquatic community overall: fish species that serve as hosts for larval mussels (glochidia) would recolonize restored habitat and enhance mussel reproduction, which is the key to de-listing for any endangered species (p. 52).
- Restoration of free flow would reduce sedimentation in Mammoth Cave's underground rivers, and this would restore habitat for the endangered Kentucky cave shrimp (p. 52).
- Removal of the dam would increase aeration of water in former pooled areas and therefore result in higher dissolved oxygen levels; stream water quality should improve when the stream reaches equilibrium after restoration of free flow (p. 47).
- For people using the river, restoration of free flow would not preclude operation of the ferries within the park (p. 42); canoe rental revenue could increase by $30,000 to $70,000, not counting all the other purchases made by canoeists (p. 41); and fishing for smallmouth bass would likely improve (p. 52).

Ecological effects

According to Cicerello and Hannan (1991), "The park freshwater fish fauna is perhaps the most diverse in the National Park System." Free-flowing conditions, which create riffle, run, and pool habitats, are what existed prior to impoundment, and are extremely important for conservation of fishes. For example, darters and madtoms require the highly oxygenated conditions found in flowing streams (Cicerello and Hannan 1991:35). Loss of this habitat has put many species at risk; the crystal darter *(Crystallaria asprella)* was last collected in the park in 1929, but is now considered extirpated. Other species in decline with similar habitat requirements include the spotted darter *(Etheostoma maculatum),* Tippecanoe darter *(Etheostoma tippecanoe),* stargazing minnow *(Phenacobius uranops),* orangefin darter *(Etheostoma bellum),* which is endemic to Green River, and the mountain madtom *(Noturus eleutherus)* (Cicerello and Hannan 1991).

With documentation on 51 species of freshwater mussels, the Green River within Mammoth Cave National Park has one of the most diverse assemblages of these shellfish in North America (Cicerello and Hannan 1990:1). Both this diversity of mussels and their unfortunate decline are impressive. Just within park boundaries, 6 of the 51 species are listed as endangered by the U.S. Fish and Wildlife Service. One of these, known as the ringpink *(Obovaria retusa),* has declined to the point that it is now known only from Mammoth Cave National Park vicinity. The precarious position of mussels on the verge of extinction has compelled Mammoth Cave National Park and Tennessee Tech University to initiate a mussel restoration project, which will begin in 2005. The offspring produced through this project will be stocked into the Green River in an attempt to restore fragmented and dwindling populations of endangered mussel species (Surgenor 2005). Many more mussels are considered imperiled in the state of Kentucky (see Table 1).

Table 1. Mussels listed as endangered or as species of special concern by the U.S. Fish and Wildlife Service, plus additional species in decline identified by the Kentucky State Nature Preserves Commission. Species extirpated from Kentucky are marked with an asterisk.

Endangered mussels (U.S. Fish and Wildlife Service)
Cyprogenia stegaria (fanshell)
Epioblasma torulosa rangiana (northern riffleshell)
Obovaria retusa (ringpink or golfstick)
Pleurobema clava (clubshell)
Pleurobema plenum (rough pigtoe)
Hemistena lata (cracking pearlymussel)*
Endangered mussels (Kentucky State Nature Preserves Commission)
Cumberlandia monodonta (spectaclecase)
Lampsilis ovata (pocketbook)
Pleurobema pyramidatum (rubrum) (pyramid pigtoe)
Threatened mussels (Kentucky State Nature Preserves Commission)
Quadrula cylindrical cylindrical (rabbitsfoot)
Villosa ortmanni (Kentucky creekshell)
Special concern mussels (Kentucky State Nature Preserves Commission)
Epioblasma triquetra (snuffbox)
Plethobasus cyphyus (sheepnose)

It is well established that most mussel species require shoal or riffle habitat. Cicerello and Hannan (1990) found an overwhelming difference in diversity and abundance of mussels in the free-flowing and impounded sections of Green River within the park. Layzer (2002) found no (zero) mussels in deep pool habitats, but documented 26 species totaling 1,471 individuals from shoal habitats in the park. One reason for such stark differences is that shoals or riffles function as a unit or community. Fish such as darters that live in riffles serve a key role in the life cycle of mussels. After a female mussel's eggs are fertilized, they grow to a small larval stage called "glochidia" before being released. The glochidia must attach to the gills of certain host fish for a variable period of time (4 to 30 weeks or more) before they leave their host fish. The host fish both feed and disperse these tiny mussels, so without the host fish they cannot reproduce. Many of the host fish for mussels have not been identified, and this is an important reason to restore habitat for fish that live in riffles, even if they are not yet listed as endangered (Surgenor 2005).

In addition to mussels, many other species of invertebrates live in the gravels and sands of swift-water shoals. There are approximately 200 invertebrate species exclusive of the mussels known from Green River within Mammoth Cave National Park (Schuster et al. 1996), and these populations are also severely affected by the Lock and Dam No. 6 impoundment. Species richness, diversity, distributions, and proportions of functional feeding groups were affected by the change from fast to slow flow. One major secondary driver for these changes is the high degree of siltation in the slack-water reaches of the impounded zone. Bioassessment of Green River via many indices and metrics all had similar results. Water quality progressively declines from "good" to "fair" or "poor" in the free-flowing, transition, and impounded zone respectively according to the Ohio Invertebrate Community Index, which combines the results of many other indices (Schuster et al. 1996).

Biologically, the Mammoth Cave system is renowned for the diversity of species adapted to the rigors of life underground (Culver et al. 1999). Of the 130 regularly occurring species, the Kentucky cave shrimp is particularly special since it is found only in the Mammoth Cave area. It is also in danger of extinction and therefore was listed as endangered in 1983 (U.S. Fish and Wildlife Service 1988). Poulson (1992) determined that the loss of free-flow conditions has resulted in siltation of shrimp habitat, which has buried the sand and gravel substrates where shrimp feed, and also hinders downstream transport of organic matter. Long-term monitoring of Kentucky cave shrimp populations began in 1993 as part of an effort to develop an index of biological integrity for the aquatic cave ecosystem (Pearson and Jones 1998).

Conclusion

There are many reasons to remove the dam and preserve the lock at Brownsville. The U.S. Fish and Wildlife Service has concluded that habitat for seven endangered aquatic species will be restored. As well, conditions for many species in decline can be improved, and future listings prevented. The U.S. Army Corps of Engineers has agreed that such restoration is the best option for the needs of both wildlife and people, and that removal of the dam is the best way to save the lock from being undermined and destabilized.

Both ferries on Green River in the park will continue operations if the dam is removed, and an engineered channel will allow operation during periods of low water. With restoration of free flow, the ability of river biota to clean water will be enhanced, and therefore water quality at the intake for the city of Brownsville will improve. Smallmouth bass fishing will improve, and populations of rough fish, such as carp and gar, will decrease. Recreational opportunities, particularly canoeing, will increase, with significant economic benefits for Edmonson County. With the dam removed and the lock stabilized, a county park could be developed. Here, the history of navigation on Green and Nolin rivers could be shared with the visiting public via interpretive signs and the *Miss Green River* tour boat.

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Visual Assessment of Stream Bank Conditions at Prince William Forest Park

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Introduction

Prince William Forest Park, a unit of the National Park Service, preserves approximately 15,000 acres of Northern Piedmont forest near Triangle, Virginia. The park lies within two physiographic provinces, the Coastal Plain and the Piedmont, and straddles northern and southern climate zones. The park possesses a unique diversity of habitat, flora, and fauna, and protects approximately 70% of the Quantico Creek watershed. As part of the park's enabling legislation, ensuring the potability of the Quantico Creek has been a primary objective of the park.

Since 1995, Prince William Forest Park resource management staff have monitored water quality of the Quantico Creek watershed. This program has three components; water chemistry, fecal coliform quantification, and the Izaak Walton League of America's "Save Our Streams" (SOS) benthic macroinvertebrate monitoring. While the program provides biological and chemical data on Quantico Creek, it lacked sufficient information regarding the physical attributes of the stream channel. Stream morphology is a key parameter needed to properly document the health and condition of a watershed, so an all-encompassing, non-selective evaluation of the watershed's physical condition was needed. For this reason, a visual assessment program was created and implemented in 2004.

History

The land and water that are now part of Prince William Forest Park have weathered a fair amount of abuse. Before the park's creation in 1936, it had an established history of farming, logging, mining, and hunting. It is estimated that by 1815, 40% of the lands were being actively farmed, mainly with tobacco. After degrading and eroding the soil, tobacco gave way to subsistence farming which continued until 1942. Additionally, by 1800, logging had claimed most of the land once over. Two mineral mines existed within the park's boundary, a gold mine and a pyrite mine. While the Greenwood Gold Mine had little impact on the lands and waterways, runoff from the Cabin Branch Pyrite Mine affected the local aquatic ecosystem and acidic mine spoils prevented vegetation growth on site. Lastly, trapping was so prevalent that beaver, whose dams created slow-moving pools, were extirpated from the area, by the early 1800s. Nearly 200 years of these conditions altered the stream channel.

During the economic disparity of the 1930s, the federal government reclaimed and improved the impoverished lands to provide for recreation. Through well-thought-out conservation, the Chopawamsic Recreation Demonstration Area (RDA) was created in 1936, and served as the model for all other RDAs that followed. With a legislative name change and an agreement with the Quantico Marine Corps Base in 1948, Prince William Forest Park had the responsibility of ensuring the potability of the Quantico Creek. Over time, almost all lands within the park have reforested. Today, nearly all of the reaches within the watershed possess a riparian buffer and slow-moving pools from beavers, which were reintroduced in 1958. However, rapid growth and development are threatening Quantico Creek. The additional impervious surfaces and increased stormwater runoff are down cutting stream channels, and creating lateral expansion and channelization.

Water quality monitoring

The goals of the park's water quality monitoring program are threefold: to determine the presence of organics and heavy metals, to protect visitor health and safety in recreational waters, and to determine the streams' ability to support life. Water chemistry analysis is conducted annually at 12 sites to test for pollutants such as phosphates, sulfates, and lead. Fecal coliform testing is conducted on an alternating weekly/biweekly basis at 5 and 12 sites, respectively. Bacterial levels are quantified through colony counts of filtered and incubated samples. During the summer of 2005, the park will transition from testing for fecal coliform to testing for *Enterococcus coli*. The SOS program is conducted yearly in three rotations of 32 sites, and monitors populations of benthic macroinvertebrates while evaluating basic site conditions. Even though the monitoring program has shown that the Quantico Creek watershed is relatively unimpacted and it has been used as a reference stream by the Environmental Protection Agency (EPA) and the Urban Biodiversity Information Project, more documentation of the streams was necessary. Using methods outlined in the U.S. Department of Agriculture–Natural Resources Conservation Service's (NRCS's) stream visual assessment protocol (SVAP; NRCS 1998), the resource management staff at Prince William Forest Park set out to capture the morphology and current physical condition of the second-order streams in the Quantico Creek watershed.

Methodology

The visual assessment program began in 2004, and collected baseline morphology information and data. Using the NRCS SVAP as the foundation of the programs, Prince William Forest Park resource management staff incorporated two additional tasks: georeferenced photo points and cross-channel profiles. This multifaceted project not only maximized efficiency in the field, but substantially increased the amount of data generated.

The first task conducted at every site was the collection of georeferenced photo points at 50-m increments along each second-order stream. This task was performed by taking a series of five photographs and collecting global positioning system (GPS) data from the middle of the stream channel. The five photographs were taken in the following order: downstream, perpendicular to the river right, upstream, perpendicular to the river left, and canopy. The GPS data were collected using a Trimble TSCe data logger and a Trimble ProXR base system. The following parameters were used to collect the GPS data: at least 30 readings generated and a position dilution or precision (PDOP) value no higher than 8.0.

At 100-m increments, a cross-channel stream profile was performed, except in those areas where water depth exceeded 1 m. The width of the base flow, the width of the active channel, and the depth of the stream were recorded. A transect was set up by stretching a field tape across the width of the active channel, beginning with the higher of the two banks.

The tape was leveled using a hanging level, and the distance, between the leveled tape and the stream bank or bed, was measured at 0.5-m increments. The procedure was repeated until the peak of the opposite bank was reached.

The final task, conducted at 100-m increments with no exception, was the collection of data required by the SVAP. There are ten basic aspects to be assessed and five optional ones. For this project, the ten basic assessments were used, along with two of the optional parameters. Data collected addressed channel condition, hydrological alteration, riparian zone, bank stability, water appearance, nutrient enrichment, barriers to fish movement, instream fish cover, pools, invertebrate habitat, canopy cover, and riffle embeddedness. All data were input into a data dictionary for the Trimble TSCe data logger.

The repeatable methods used were carefully documented to allow for future comparisons. The georeferenced photo points produce an accurate, visual representation of stream conditions, and precisely geopositioned locations. The cross-channel profile provides a current, baseline physical morphology of the stream channel, and the SVAP grades the current condition of the stream channel. While field data collection is complete, no statistical analysis has been performed.

Results and discussion

For the second-order streams of the Quantico Creek watershed, 529 sites were established at 50-m increments. A total of 529 georeferenced photo points were established, and 224 cross-channel profiles and 246 assessments using the SVAP were created. The photo points produced a total of 2,645 photographs, which are currently being processed; this involves reducing the size of the photo, labeling them, checking their quality, and examining the order of each picture taken. Once this is completed, the photos will be grouped together and imported into Microsoft PowerPoint. The photos will also be tied their respective GPS data and imported into an ESRI geographical information system (GIS) product. The cross-channel profiles, which are currently being processed, will be used to determine which reaches are laterally expanded or deeply incised. The data from each of the profiles are being converted into a graphical display that will allow for a better visualization of the morphology. SVAP data show that nearly 100% of the land use in the park is forest, and that that dominant substrate of the streams is nearly equally split between sand, gravel, or boulder. The assessments also show that within the Quantico Creek watershed, there are 11 sites in "excellent" condition, 86 in "good" condition, 130 in "fair" condition, and 19 in "poor" condition.

A brief analysis of the collected information yielded various trends that were more or less applicable to all sites within the specific condition class. Among "poor" condition sites, the base flow is usually very shallow, and the stream channel is very narrow. These sites are commonly found upstream from recent blown-out dams or downstream from newly built dams. Deep pools are absent, canopy cover is under 50%, a drop structure can be found within three miles of the site, and water appearance is considerably cloudy. Among "fair" condition sites, the base flow is still somewhat shallow, but the active channel is much wider than "poor" condition sites. The substrate is usually boulder, and there is a good amount of healthy debris in the stream. More fish cover is available and water appearance is less cloudy.

However, these sites still lack deep pools and stable banks.

Among "good" condition sites, the physical characteristics continue to improve. The active channel is usually wide with an average base flow. The substrate is almost always cobble (large gravel, small boulder) and again there is healthy debris present. Banks are now stable, and water appearance is less cloudy. However, these sites continue to have barriers to fish movement, and riffles are well embedded into the stream bed. Lastly, among "excellent" condition sites, an average base flow is found within a wide stream channel. These sites often have an equal mix of substrates, usually sand and cobble. The sites grade very high in almost every category assessed. However, the lack of deep pools and/or the presence of barriers to fish movement still exist.

By examining the ratings by stream, differences between the second-order streams can be determined. All of the "poor" condition sites are found on Quantico Creek, with nearly all of the sites lying within the headwaters region. However, approximately three-fourths of the remaining sites are rated in "good" condition. Nearly all of the "excellent" condition sites are found along the South Fork of Quantico Creek. However, approximately three-fifths of the remaining sites are rated as being in "fair" condition, and two-fifths in "good" condition. Without statistical analyses, which will be performed at a later date, one can not make a clear distinction as to which stream is in better physical condition.

Conclusion

The visual assessment of stream channel conditions project at Prince William Forest Park has been a success. The initial field work captured needed data and currently provides baseline knowledge of the stream conditions. However, more field work is needed. During the summer of 2005, this program will be used to access first-order streams and tributaries within the park. With the conclusion of the project, Prince William Forest Park will have succeeded in creating a well-rounded water quality monitoring program that encompasses the biological, chemical, and physical parameters of the Quantico Creek watershed.

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Environmental Contaminant Exposure Data and Monitoring Prorities for Wild Terrestrial Vertebrates at National Parks in Coastal and Estuarine Habitat

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Introduction

The Biomonitoring of Environmental Status and Trends (BEST) Project of the U.S. Geological Survey (USGS) assesses the exposure and effects of environmental contaminants on select species and habitats in the United States. One of the many BEST Project activities entails the development of decision-support tools to assist in the identification of chemical threats to species and lands under the stewardship of the Department of the Interior. Although there are many ecotoxicological monitoring programs that focus on aquatic species and habitats, there are currently no large-scale efforts that are focused on terrestrial vertebrates in the United States. Nonetheless, organochlorine contaminants, metals, and new pollutants continue to pose hazards to terrestrial vertebrates at many spatial scales (ranging from small hazardous-waste-site point sources to entire watersheds). To evaluate and prioritize pollutant hazards for terrestrial vertebrates, a "Contaminant Exposure and Effects—Terrestrial Vertebrates" (CEE-TV) database (www.pwrc.usgs.gov/contaminants-online) was developed (Rattner et al. 2000). The CEE-TV database has been used to conduct simple searches for exposure and biological effects information for a given species or location, identification of temporal contaminant exposure trends, information gap analyses for national wildlife refuge and national park units, and ranking of terrestrial vertebrate ecotoxicological information needs based on data density and water quality problems (Cohen et al. 2003). Herein we provide scientists and natural resource managers with some findings that may aid in the prioritization of terrestrial vertebrate contaminant biomonitoring in the national park units in coastal and estuarine habitats of the United States.

Methods

Retrospective contaminant exposure and effects data for wild terrestrial vertebrates living in U.S. estuarine and coastal habitat were compiled using scientific literature search tools (e.g., BIOSIS, Wildlife Review), various federal and state governmental databases (e.g., U.S. Environmental Protection Agency Ecological Incident Information System, USGS National Wildlife Health Center Mortality Database, data managed by the New York Department of Environmental Conservation), and through communication with approximately 500 scientists in government agencies, conservation organizations, and academic institutions. Source documents were reviewed, and unless obvious errors in data quality were apparent, information was entered into the CEE-TV database. All data were referenced with geographic collection coordinates. If samples were collected across an entire county or a state, the coordinates of the county seat or state capital were assigned to the record. Data were compiled in Microsoft Access 2000 version 9.0 with information fields describing taxonomy, collection date, study location, geographic coordinates, sample matrix, contaminant concentration, biomarker or bioindicator response, and source of information (for details, see the above-mentioned website and Rattner et al. 2000, 2005).

The CEE-TV database was sorted for phylogenetic, temporal, spatial, contaminant exposure, and response patterns or endpoints using query search features of Access. Maps of sample collection locations were created using ArcGIS 8.2. Spatial information gap analyses were conducted by overlaying locations of CEE-TV records on boundary maps of national park units. To avoid potential bias of records with coordinates assigned to a county seat or state capital, only records with known collection coordinates were used in this analysis. Data gaps were defined as recent if there were no records with data collected from 1990 to 2003. To account for possible imprecision and uncertainty of sampling coordinates, and for animal movement, maps with 1-km buffers and 10-km buffers were created around each national park property boundary.

The Index of Watershed Indicators (IWI; U.S. Environmental Protection Agency 1997, 2000) classifies watershed water quality from "better" to "more serious," and watershed vulnerability (i.e., potential for discharges and other stressors to affect water quality) from "low" to "high." The IWI rankings were joined by hydrologic unit codes to the watershed map to identify watersheds of concern (i.e., IWI classifications of more serious water quality problems and/or high vulnerability to pollution). In order to identify the information data gaps that are of greatest concern, buffered national park units were overlaid on the IWI. Each national park unit that intersected with watersheds of concern was placed into a separate map for further information gap analysis.

Results and discussion

The CEE-TV database contains 17,150 records derived from over 1,850 source documents. There are 483 unique terrestrial vertebrate species in the database, with 78.6% of the records on birds, 18.5% on mammals, 3.8% on reptiles, and <0.7% on amphibians. Sample collection dates range from 1884 to 2003, with 90% of the data records derived from investigations since 1970. The relative amount of information for various species in the database reflects a variety of factors including their abundance and distribution in estuarine and coastal habitat, management status (threatened or endangered), use in monitoring programs, ease of collection, and sensitivity to various contaminants. Clearly, only limited data are available on free-ranging amphibians and reptiles (Sparling et al. 2000). The database records

Park unit name	State	Inventorying & Monitoring network	Park unit area including 10-km buffer (km²)
I&M national park units lacking data			
Atlantic Coast			
Canaveral NS	FL	Southeast Coast	1485.6
Cape Hatteras NS	NC	Southeast Coast	3021.4
Castillo de San Marcos NMON	FL	Southeast Coast	339.4
Fort Caroline NMEM	FL	Southeast Coast	358.5
Fort Matanzas NMON	FL	Southeast Coast	373.0
Fredericksburg & Spotsylvania NMP	VA	Mid-Atlantic	1081.3
George Washington Birthplace NMON	VA	Northeast Coastal & Barrier	390.5
Manassas NBP	VA	National Capital Region	284.5
Minute Man NHP	MA	Northeast Temperate	437.9
Moores Creek NB	NC	Southeast Coast	301.7
Saugus Iron Works NHS	MA	NortheastTemperate	325.2
Thomas Stone NHS	MD	Northeast Coastal & Barrier	363.9
Timucuan Ecol and Hist Preserve	FL	Southeast Coast	1488.3
Weir Farm NHS	CT	Northeast Temperate	337.4
Pacific Coast			
Fort Vancouver NHS	OR	National Coast & Cascades	252.3
John Muir NHS	CA	San Francisco Bay Area	290
San Juan Island NHP	WA	National Coast & Cascades	551.1
Gulf Coast			
Big Thicket NPRES	TX	Gulf Coast	957.8
Biscayne NP	FL	South Florida/Caribbean	990.7
Dry Tortugas NP	FL	South Florida/Caribbean	1165
Great Lakes			
Cuyahoga Valley NRA	OH	Heartland	977.9
Grand Portage NMON	MN	Great Lakes	597.5
Pictured Rocks NL	MI	Great Lakes	1914.8
Sleeping Bear Dunes NL	MI	Great Lakes	2524.3
I&M national park units in watersheds with "more serious water quality problems" and "high vulnerability to pollution" lacking data			
Minute Man NHP	MA	Northeast Temperate	437.9
Saugus Iron Works NHS	MA	NortheastTemperate	325.2
John Muir NHS	CA	San Francisco Bay Area	290

Table 1. Inventory and Monitoring national park units in coastal and estuarine drainages of the continental U.S. lacking recent (1990–2003) CEE-TV data.

contain contaminant exposure and concentration information on 209 elements and compounds, including halogenated organics, cholinesterase-inhibiting pesticides, economic poisons, metals and trace elements, and petroleum hydrocarbons, with <10% of the records containing biomarker or bioindicator effects (e.g., eggshell thinning, biochemical responses, histopathology).

Of the 464 coastal watersheds in the United States, CEE-TV data records were found for 270. To identify spatial data gaps, 11,360 database records with specific sampling locations were combined with the boundaries of national park units. Attempts were made to verify the findings by contacting staff at each management unit. Of 126 national park units, data were available for terrestrial vertebrates at or within 10 km of 80 (63.5%) units, and recent data (1990–2003) were available at 66 (52.4%) units. When these data gaps were overlaid on watersheds exhibiting serious water quality problems and/or high vulnerability to pollution, 59 national park units in the continental United States were found to lack recent data and may deserve priority for further hazard assessment and potentially terrestrial vertebrate contaminant monitoring. There were no data in the CEE-TV database for 24 of the 66 national parks in the Inventory and Monitoring Program. (See Table 1, opposite.)

On-going activities and conclusions

Currently, we are evaluating terrestrial vertebrate contaminant data for Inventory and Monitoring parks in the national park units in the National Capital and Mid-Atlantic networks. In order to identify significant contaminant issues, 10-km buffer maps around each of the units are being overlaid on locations of CEE-TV data, and the locations of Toxic Release Inventory sites, 303(d) Impaired Waters, Superfund National Priority List sites, fish consumption advisories, and solid waste and wastewater treatment facilities. In addition, interviews are being conducted with staff of these park units to identify potential pollution issues. These and other data may be used to prioritize the need for additional ecotoxicological data in an effort to focus monitoring, management, and potential remediation activities.

Despite widespread concerns about environmental contamination, during the past decade only about one-half of the coastal national park units appear to have terrestrial vertebrate ecotoxicological data. Based upon known environmental contaminant hazards, it is recommended that regionalized monitoring programs or efforts focused on lands managed by the Department of the Interior should be undertaken to prevent serious natural resource problems.

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Assessing the Potential Plant Community Impacts of *Not* Having Grazing in a Small Prairie Park

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Introduction

For thousands of years grazing and fire were part of the ecosystems that compose the North American Great Plains. European settlement drastically changed these ecosystems by replacing large migratory herds of bison—occasional grazers—with more continuous cattle grazing, and by suppressing fires. National parks within the Great Plains seek to maintain and restore these processes, not only to provide visitors the experience of the Great Plains as they used to be, but also to preserve the biological diversity that they promote. Prescribed burning programs have returned one of these vital processes to most prairie parks, but grazing by large herbivores is more difficult to implement, particularly in small parks. Currently, Scotts Bluff National Monument contains significant areas of native prairie but does not have any large grazers such as the bison that helped form and maintain the mixed-grass prairie ecosystem.

Just as fire suppression has affected many native ecosystems, this lack of grazing may also have significant effects on the prairie. Besides the obvious effect of grazing on the stature of vegetation, grazers affect plant community composition through their preferences for some species over others. For example, shorter grasses often increase in the presence of grazing because of reduction in competition from the taller grasses that grazers select (Bragg and Steuter 1996). In addition, large herbivores often increase grassland plant diversity by introducing heterogeneity at a variety of scales. Also, there is some evidence that uniformly heavy spring grazing may be a useful management tool for controlling invasive annual brome grasses *(Bromus japonicus* and *B. tectorum)* (Daubenmire 1940; Whisenant and Uresk 1990; Young and Allen 1997), which are a major management concern at Scotts Bluff.

On the other hand, high-intensity grazing over long periods may significantly reduce plant diversity (Fuhlendorf and Smeins 1997) and increase the diversity and abundance of undesirable, invasive species (DiTomaso 2000). Also, ungrazed areas such as Scotts Bluff may provide some heterogeneity to the regional landscape, which is largely managed for commercial ranching, and may even serve as reservoirs for plant species that are negatively affected by grazing.

To summarize, there is concern that the lack of grazing at Scotts Bluff is having negative impacts on the prairie ecosystem. Consequently, it has been suggested that a grazing program should be considered for Scotts Bluff and other small prairie parks like it. Before a decision regarding such a radical change in management can be made however, information on the potential effects of the decision is needed. This document reports on the results of a pilot project designed to begin addressing this information need.

Although grazing of any kind can affect many different components of an ecosystem, from the plant and animal communities to nutrient cycling, soil compaction, and water infiltration, this study focused on the richness and composition of the plant community within the dominant vegetation type at Scotts Bluff. By comparing these between the ungrazed national monument and an adjacent private cattle ranch, some preliminary conclusions about the impacts of currently *not* having grazing and potential impacts of restoring grazing into Scotts Bluff can be drawn.

Methods

Scotts Bluff National Monument lies in the Nebraska Panhandle near the town of Gering. The 3,003-acre park was established in 1919 to preserve and protect two large bluffs, the historical and cultural legacy attached to these bluffs, and the trails that passed between them. Public grazing was allowed on the property until the monument's establishment, after which a three-year grazing permit was given to a local citizen. No other use by domestic livestock has occurred since then except for a war-time permit for a portion of the monument's property during the period 1943–1945 (Harris 1962). Wild large herbivores in the monument are relatively rare. Grazing pressure on the grasslands has therefore been low for at least 58 years.

The area sampled for this project is in the South Bluff management unit of the monument. Approximately 65 ha in size, the only recorded fire in this unit was a prescribed fire in March 1998. The vegetation in this area is dominated by *Hesperostipa comata–Bouteloua gracilis–Carex filifolia* mixed-grass prairie. The private ranch used for comparison in this study belongs to the Keller family. It lies on the southwest border of the monument adjacent to the South Bluff unit. The area sampled is approximately 65 ha in size; it has not burned and is similar to the adjacent area in the monument in soils, topography and vegetation. The area is currently grazed by cattle, with stocking rate and timing of stocking varying from year to year depending on climate and market conditions, a practice typical of operations in the region.

Vegetation sampling was done on June 22–23, 2004, as part of the regular schedule of the National Park Service's Heartland Inventory and Monitoring Network and Prairie Cluster prototype monitoring program (HTLN). Seven permanent sites within the South Bluff management unit monitored by this program were used for the samples within the monument; seven additional, but temporary, sites were established in the adjacent Keller ranch in early June 2004. Because the HTLN sites that were appropriate for this study all fall in the *Hesperostipa comata–Bouteloua gracilis–Carex filifolia* mixed-grass prairie vegetation association, sampling sites at the Keller ranch were also confined to this vegetation association. Sites at the Keller ranch were located randomly within this vegetation type and established in June 2004.

Sampling followed the protocol described in DeBacker et al. (2004). To summarize, frequencies of individual species were calculated for each site from their occurrences in plots of various sizes located systematically throughout a 20x50-m sampling site. In addition, basal cover of individual species and ground cover of bare ground, litter, and rock were measured using the modified step-point method (Owensby 1973). Finally, a complete species list was compiled for the 1,000-m^2 area encompassed by the sampling site. Table 1 summarizes this design, showing the number of each size of plot sampled at each site.

Table 1. Number of points and plots of each size at each sampling site.

Point or plot size (m^2)	Number at each site
point	200
0.01	42
0.1	42
1	10
10	10
1000	1

For all data analyses, *Bromus japonicus* and *B. tectorum* were treated as one (*Bromus* spp.) as were *Pascopyrum smithii* and *Elymus trachycaulus* (*P. smithii–E. trachycaulus*) because of difficulties in distinguishing between the two species in each group in the field. T-tests were used to compare response variables between the monument and Keller ranch properties.

Results

Based on some measures, the grazed and ungrazed properties were not very different. Bare soil cover, total plant basal cover, and basal cover of four of the five species for which basal cover comparisons were possible did not differ significantly between the South Bluff unit and the Keller ranch (Table 2). Frequencies of seven of the eight species for which analyses could be done were not significantly different (Table 3). Finally, total and non-native species richness in the 1-m^2 and 10-m^2 plots were also similar (Table 4).

There were significant differences in other measures, however, particularly those involving more than just the most common species. The one species that did show significant differences in abundance was *Bouteloua gracilis*. It was more abundant in the grazed property than in the ungrazed property. *Vulpia octoflora* also showed a tendency to be more abundant at the ranch than at the monument (Table 3). Litter cover was significantly higher in the South Bluff unit than at the Keller ranch (Table 2), and native and exotic species richness were both significantly higher in the ungrazed unit than in the grazed ranch in the 1,000-m^2 plots (Table 4). Finally, similarity in plot species composition between sites within a property was significantly lower in the South Bluff unit than at the ranch ($P = 0.04$).

Table 2. Soil and plant basal cover in the grazed Keller ranch and ungrazed South Bluff unit of Scotts Bluff National Monument. Values shown are cover means and standard errors (in parentheses), expressed as percent. The final column shows the *P* value for testing for differences in the variable between the two properties.

Variable	Keller ranch	South Bluff unit	P
Bare soil	41.6 (5.5)	30.7 (3.0)	0.11
Total plant	9.3 (1.7)	6.1 (1.5)	0.12
Litter	47.1 (6.2)	62.9 (2.9)	0.04
Bouteloua gracilis	2.9 (1.1)	0.0 (0.0)	0.04
Bromus spp.	0.4 (0.1)	0.7 (0.3)	0.31
Carex filifolia	5.1 (1.1)	3.4 (1.0)	0.27
Hesperostipa comata	0.6 (0.1)	1.4 (0.5)	0.14
P. smithii–E. trachycaulus	0.2 (0.1)	0.5 (0.2)	0.26

Species	Plot size (m^2)	Keller ranch	South Bluff unit	P
Bouteloua gracilis	1	81.4 (7.7)	8.6 (4.0)	<0.0001
Bromus spp.	1	42.9 (13.4)	57.1 (16.0)	0.51
Carex filifolia	0.01	62.2 (7.5)	59.2 (6.7)	0.77
Hesperostipa comata	0.1	19.0 (6.6)	26.5 (6.2)	0.53
P. smithii–E. trachycaulus	0.1	49.0 (6.5)	50.0 (13.0)	0.95
Sphaeralcea coccinea	1	20.0 (6.2)	32.9 (6.8)	0.19
Vulpia octoflora	1	41.4 (8.6)	18.6 (7.4)	0.07

Table 3. Frequency of seven species in the grazed Keller ranch and ungrazed South Bluff unit of Scotts Bluff National Monument. The second column shows the plot size used for calculating frequency, which was determined by the plot size yielding an overall frequency of that species (in both properties) closest to 50%. Frequency values shown are means and standard errors (in parentheses), expressed as percent. The final column shows the *P* value for testing for differences in the species' frequency between the two properties.

Variable	Keller	South Bluff unit	P
Total species richness			
1-m^2 plots	4.4 (0.2)	4.0 (0.2)	0.17
10-m^2 plots	6.1 (0.3)	6.5 (0.3)	0.39
1,000-m^2 plots	15.1 (1.0)	26.1 (3.2)	0.01
Non-native species richness			
1-m^2 plots	0.4 (0.1)	0.6 (0.2)	0.43
10-m^2 plots	0.6 (0.1)	0.9 (0.2)	0.21
1,000-m^2 plots	1.4 (0.2)	3.4 (0.5)	0.008

Table 4. Total and non-native plant species richness in three plot sizes in the grazed Keller ranch and ungrazed South Bluff unit of Scotts Bluff National Monument. Values are means and standard errors (in parentheses).

Discussion

Ideally, a study to investigate the potential effects of introducing grazing into Scotts Bluff would have used replicated experimental treatments to investigate the effects of various grazing regimes on a variety of plant communities over a time covering a wide range of climatic conditions. In contrast, this pilot study used observational methods to compare the plant community composition of a single vegetation association between two properties in a single growing season in the midst of an extreme drought. (Precipitation over the year preceding this study was in the bottom tenth percentile of all previously recorded years; National Climate Data Center 2004a). Consequently, no definitive conclusions can be drawn from this work alone. Thus, this discussion focuses on interpreting the results of the pilot study for the purpose of determining what other research and evaluation are necessary to decide if *not* having grazing is detrimental to the park's ecosystem and whether to consider re-introducing large ungulates.

Results from this work. The results of this study showed almost no difference in the abundance of the most common species between the grazed and ungrazed properties. This is not surprising for two reasons. First, sampling was limited to a vegetation association characterized by four of these species. Second, previous work in northern mixed-grass prairie has shown that climate, especially precipitation, is the primary driver of grassland vegetation composition, with grazing regime having a secondary effect within the climate context (reviewed in Biondini et al. 1998), or no effect at all depending on the grazing intensity (Biondini et al. 1998; Heitschmidt et al. 1999). Thus, given that this study took place at a time when climate effects would be expected to be extremely strong, it is notable that any differences between the two properties existed. The one species that did differ in abundance between the properties was *Bouteloua gracilis*, a short-statured, native grass. This species and the native annual grass *Vulpia octoflora*, which tended to be more frequent in the grazed property, have been shown in previous work to increase in community importance when vegetation is grazed (Smith 1940; Herbel and Anderson 1959). It is also noteworthy that the abundance (measured as frequency) of the major invasive species of concern—annual brome grasses—did not differ between properties, although the small sample size in this pilot study limits the statistical power for detecting differences.

Although it is tempting to surmise that the long history of grazing on the private property has eliminated grazing-sensitive species, the lack of control in this study for other factors makes this only one of many possible explanations. Since the major invasive species at this site, *Bromus* spp., were not considerably more abundant in the grazed property, competition from invasive species is probably not the explanation. An interaction between drought and grazing may be partly responsible, in that the combination of drought and grazing has been shown to reduce the species richness of forbs (which comprise the majority of species richness in grasslands) in similar grasslands (Hild et al. 2001). Thus, the combination of drought and grazing may have had adverse impacts on species richness in the Keller property. Greater heterogeneity among sample sites at the monument may also have played a role, as indicated by the greater difference in species composition between sites within this property than within the ranch. This greater heterogeneity may result from greater heterogeneity in underlying factors that affect plant species diversity and composition, such as soils and topography. Although these last two factors were somewhat controlled for in this study, detailed information was not collected, so some variability may have existed.

Whatever the underlying cause of the greater plant species richness in the ungrazed South Bluff unit compared with the ranch property, it is probably the most important result to come out of this study. Overall, 29 of 57 species at the monument were unique to monument samples; three of these were non-native. In contrast, only five of the 33 species encountered in the Keller ranch sample sites were unique to that property; one of these was non-native. Although those species unique to the monument are not overwhelmingly grazing-sensitive, this greater diversity of species in the monument samples suggests that the monument may be a refuge for grazing-sensitive species. Clearly much more extensive investigation is necessary to understand this result. However, it is likely that the grazing regime practiced on the Keller property has had some negative impact on species richness of the plant community.

Putting these results in a greater context. This pilot study was exactly that—a pilot study done to provide some preliminary data for a more thorough discussion of a complicated topic. Two important points need to be made when using the results of this study. First, there are many types of grazing regimes and this study compared the vegetation in only two. A grazing regime is defined not only by the number of animals per acre, but also by when the grazing occurs, whether the animals have free range of a large area or are confined to small areas, and which animals are used. All of these factors influence "grazing effects." Indeed, given the right combination of these factors, the plant species diversity within the monument could probably be increased beyond what it is now. Second, this study looked only at differences in vegetation composition between the grazed and ungrazed properties. One of the most striking and obvious effects of grazing on vegetation is of course the difference in structure. This is important not only for how it looks to people, but also for how it affects other species. Also, as noted in the introduction, grazing can significantly affect other ecosystem properties, from nutrient cycling to streambank structure.

In addition to the above caveats, one must acknowledge that decisions about such a significant change in natural resource management practice are not made based solely on natural resources. Other issues must be addressed. These include logistical issues (e.g., water availability, fencing, personnel for handling animals and/or contracts), issues involving both logistics and natural resources (e.g., grazing regime, location of grazing, interactions with the prescribed fire program), policy issues (e.g., Could domestic livestock be used or are native species the only option? Is grazing consistent with the establishing legislation for the park? How does a park choose between the need to contribute to the conservation of regional biological diversity with a need to conserve natural conditions and processes?), and visitor issues (e.g., safety, acceptance of different species, impact on the visitor experience). This pilot study was designed to address a small part of one of these issues—the potential impacts on plant community composition.

Keeping this greater context in mind, the results from this pilot study do not point to any adverse effects of *not* having grazing in this small prairie park. If viewed in a different way, however, the results also do not suggest that restoring the natural process of grazing to the monument would have large negative impacts either. If it were restored, a carefully designed and executed monitoring program would be essential to ensure that the management practice is having its desired results.

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Nature-GIS: Unification of Nature Protection in Europe—Building a Unified Information System

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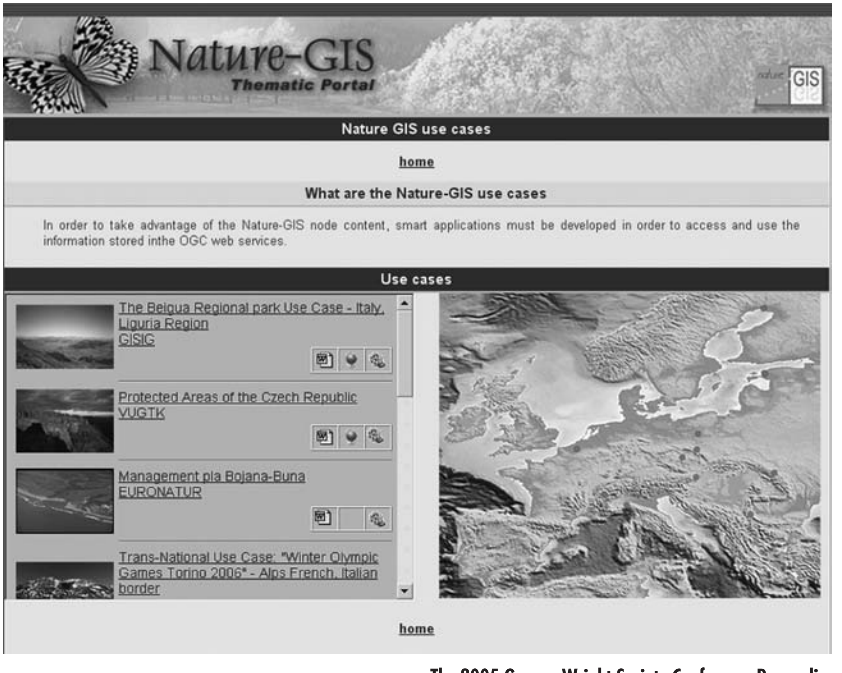
Introduction

All EU (European Union) members have similar legislation on nature protection. Nevertheless there are differences in attitudes toward different types and levels of protected areas. What has been missing is a unified data model for maintenance of information on protected areas. Nature-GIS is a pan-European project whose aim is to create a thematic network of nature-protection organizations and promote the use of geographic information systems (GIS) in nature protection. An information portal for European protected areas is being created on the Internet to inform the public (Figure 1). The Czech Republic is one of the "national nodes" taking part in this pilot project (Figure 2). This paper will stress some difficulties arising from the national differences and will describe the data structure of the system.

Structure of Nature-GIS

Nature protection has a strong geographical content, implying that experts from the GIS disciplines will be working alongside end users having different cultural or technical backgrounds. The potential of GIS technology is often not properly exploited; a key goal of

Figure 1. Nature-GIS portal (www.naturegis.net) linking together case studies in different countries.



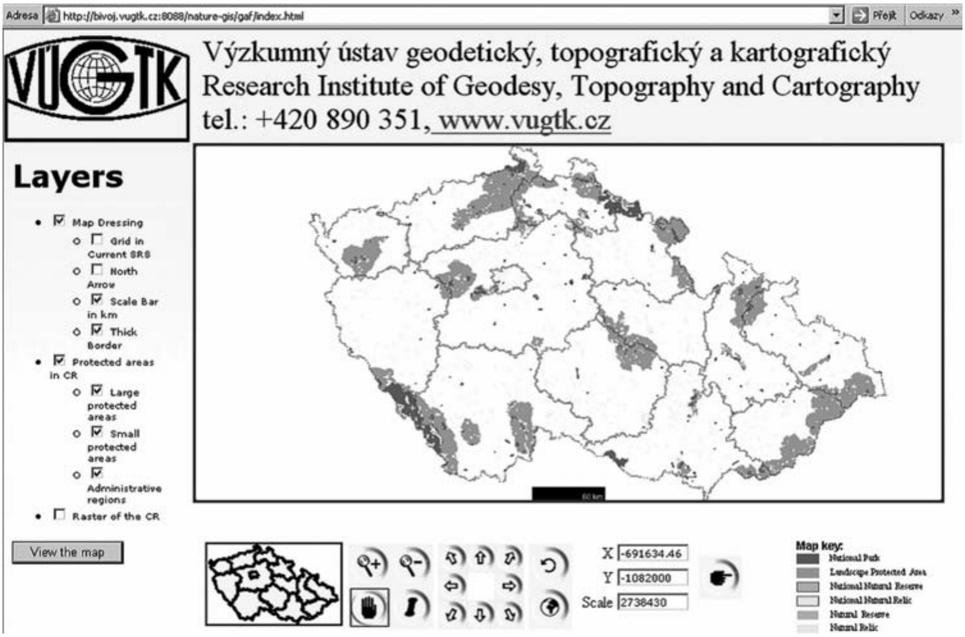


Figure 2. National Node for the Czech Republic: services for publishing maps of protected areas in the republic.

Nature-GIS is to bridge this gap by bringing together the different categories of specialists working in this field.

Nature-GIS creates a pan-European network linking all the different organizations and stakeholders who have an interest in GI (geographic information) and GIS in relation to protected areas. Nature-GIS is intended to make a contribution to the EU's Sixth Environmental Action Plan, and will form a focal point for the exchange of information and the identification of specific GI/GIS requirements across a range of EU policies and initiatives, such as INSPIRE (INfrastructure for SPatial InfoRmation in Europe).

Some action items include:

- Produce technical guidelines on geo-data access and exchange through standardization of data infrastructures for protected areas;
- Define and realize web access to information on European protected areas; and
- Disseminate the results to the GIS and nature preservation communities.

Final expected outcomes of the network:

- Use of the guidelines to implement GIS in protected areas.
- Demonstration of how web access to information is applicable in the field (thematic portal).
- Raising of European awareness of a supranational approach in GI management in the field and a push for more concerted and integrated actions.

- Establishment of a pan-European "Nature-GIS Group" that will continue after the project's end.

Tasks of VÚGTK, the Czech Research Institute of Geodesy, Topography and Cartography, include:

- Project coordination at national level: comments on the deliverables and acquisition of comments from other stakeholders in the Czech Republic;
- Communication with project coordinators;
- Preparation of the National Node: creation of pilot version of the portal for nature protection in the Czech Republic as a way to access data on the Internet;
- Provision of information to partners from the domain of nature protection; and
- Cooperation with the creation of the database structure.

Partners of Nature-GIS are shown in Table 1 and Figure 3.

Problems being solved

The categorization of protected areas is different in each country and the national terminology differs as well—there are even identical terms that mean something different. Therefore, unified categories were prepared. Another problem relates to national bound-

Figure 3. Countries participating in Nature-GIS. B = Belgium, BG = Bulgaria, CY = Cyprus, CZ = Czech Republic, D = Germany, E = Spain, EE = Estonia, F = France, H = Hungary, I = Italy, P = Portugal, PL = Poland, S = Sweden, SK = Slovakia, UK = United Kingdom.

Table 1. Partners of the Nature-GIS project.

Institutional partners
GISIG — Italy
JRC — Joint Research Centre
EU University of Aberdeen — United Kingdom
IONIC Software SA — Belgium
University of Evora — Portugal
Cemagref — France
Regione Piemonte — Italy
Tarnium Sarl — France
University Joseph Fourier — France
Euronatur — Germany
University of Girona — Spain
Lulea University of Technology — Sweden
Ursit Ltd — Bulgaria
University of Cyprus
VÚGTK — Czech Republic
Estonian Environment Information Centre
University of West Hungary
Jagiellonian University — Poland
University of Zilina — Slovakia
nature protection companies, SW companies across Europe
Czech national partners
Czech Office for Survey, Mapping and Cadastre (CUZK)
Ministry of Environment of the Czech Republic (MZP CR)
Agency for Nature Conservation and Landscape Protection of the Czech Republic (AOPK CR)
State foundation of environment of the Czech Republic
Nature Conservation Authority (SOP), especially GIS Laboratory
Czech National Parks

aries: the extent of national parks differs from country to country and national boundaries make for unnatural boundaries in terms of protection.

Another problem has to do with national mapping systems. Each country has a history of having its own co-ordinate system and projection method. When one puts such different maps together, the boundaries are not continual. Therefore, the use of unified mapping method is needed. Likewise, each country has a different structure for its protected areas database. To address these issues, there is a proposal for recommended data structure. It is composed of seven data themes/feature types:

1. Base Map Themes: reference layers that provide a foundation for other layers and that are frequently needed by a large number of users.
2. Governmental/Service and Administrative Districts/Areas: Layers that represent boundaries of governmental jurisdictions (at different levels), areas designated for administration by agencies/organizations, and political districts associated with elections.
3. Utility and Infrastructure: Layers that deal with human-made facilities, including utilities, transport, buildings.
4. Emergency Planning and Management: Layers that are necessary for hazard management and emergency planning and response.
5. Natural Resources and Physical Landscape: Layers that delineate and characterize land, air, water, and biological features and areas. Includes habitats, species, and areas designated for protection.
6. Property-Related Data representing land ownership and rights, etc.

7. Tourism/Leisure/Socioeconomic Data themes dealing with tourism and leisure facilities.

All these categories contain features with attributes that are recommended to be maintained, and the rationale for such maintenance is explained as part of the metadata.

To demonstrate the possibilities for informing the public, stakeholders, and others, the Nature-GIS portal has been created. It will include links to the National Nodes, which will contain information on protected areas in each country. Then a user can easily find whatever information is available on nature protection in a particular locality. The objective is to cover the whole of Europe. A discussion forum on the website also is planned.

Website links

- http://www.naturegis.net (Nature-GIS portal)
- http://www.gisig.it/nature-gis (webpages for the project)
- http://bivoj.vugtk.cz:8088/nature-gis/gaf/index.html (National Node for the Czech Republic)

Atmospheric Deposition Effects on Water Quality in High-Elevation Lakes of the Teton Range, Wyoming, U.S.A.

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This report focuses on the effects of atmospheric deposition on the water chemistry of high-alpine lakes in Grand Teton National Park, Wyoming. Atmospheric deposition is the primary cause of acidification in lakes and streams in the United States. Mountainous watersheds have an especially low buffering capacity for nitrogenous acidifying compounds that are common in atmospheric deposition because of their limited soil development and vegetation, short growing season, and large areas of exposed bedrock. These watersheds are also susceptible to the release of atmospheric pollutants during spring snowmelt—pollutants that accumulate in the snowpack during the winter. This inherent sensitivity to acidification, coupled with increased deposition of atmospheric pollutants due to population growth and industrialization, means that acidification of high-elevation lakes and streams is a concern for resource managers, particularly in relatively unaffected wilderness areas.

Increased urbanization of the Western United States has caused a dramatic increase in atmospheric deposition of anthropogenically produced compounds in recent years. Long-term monitoring of high-elevation lakes and streams in Rocky Mountain National Park, Colorado, has indicated increased levels of atmospheric deposition and increased sensitivity to acidification in park waters (Mast et al. 1990; Baron 1992; Campbell et al. 1995; Baron and Campbell 1997; Peterson and Sullivan 1998; Campbell et al. 2000; Sueker et al. 2000; Williams and Tonnessen 2000; Cosby and Sullivan 2001). Monitoring of alpine and subalpine lakes in Grand Teton has also indicated greater sensitivity to atmospheric deposition in recent years, although the situation is not as serious as it is at the Colorado site (Williams and Tonnessen 1997; Peterson and Sullivan 1998). Unlike Rocky Mountain, currently there is no long-term monitoring effort in place for either atmospheric deposition or water quality of high-elevation lakes at Grand Teton. The nearest National Atmospheric Deposition (NADP) monitoring station is at Tower Junction in Yellowstone National Park. The only water quality data for Grand Teton high-elevation lakes are from the 1985 Western Lake Survey (Landers et al. 1986), the 1999 resample of this survey (Clow et al. 2002), and from synoptic sampling conducted by Gulley and Parker (1986) and Williams and Tonnessen (1997). Monitoring of water quality in the high-elevation lakes in Grand Teton is essential to elucidate long-term trends and determine the range of interannual and seasonal variability in sensitivity to acidification from atmospheric deposition. Therefore, the objectives of this study were: (1) to determine the status and trends in water quality of 12 high-elevation lakes in Grand Teton with respect to atmospheric deposition impacts, and (2) to use the relationships between water chemistry and watershed physical characteristics to predict which lakes in Grand Teton are most sensitive to acidification.

Methods

Monitoring of all potentially impacted water bodies in Grand Teton was impractical, so it was necessary to focus monitoring efforts on only the most sensitive sites. Basin physical characteristics such as topography, geology, and vegetation were used as selection criteria and as parameters in the development of a predictive model of lake sensitivity to acidification. The model will provide a planning tool that can be used to focus future monitoring efforts in Grand Teton high-elevation lakes.

Twelve lakes were sampled during the summer of 2002. Nine of the lakes are located within the national park on the east side of the Teton divide, with the remainder on the west side in the Targhee National Forest. Sampling parameters included acid neutralizing capacity (ANC), pH, conductivity, major anions and cations, dissolved organic carbon (DOC), total and particulate nitrogen, and total and particulate phosphorous. The effects of deposition on the study areas were quantified with NADP deposition data and snowpack surveys.

Modeling efforts for the 2002 study in Grand Teton were centered primarily on multiple linear regression analysis and SPSS discriminant analysis. Basin physical characteristics were determined using digital coverages of topography, geology, and habitat and cover type. Stepwise multiple linear regression and discriminant analysis were used to identify which variables make a significant contribution to lake sensitivity. The model was calibrated with the data collected in the summer of 2002 at Grand Teton. Mean concentrations of late-season samples were entered into the model. Water chemistry data collected by Clow et al. in 1999, Williams and Tonnessen in 1996, and by Landers et al. in 1985 were used for model testing and validation.

Results

The sampled lakes had a wide range of ANC concentrations—from 37.9 µeq L^{-1} to 1488.3 µeq L^{-1}, with a median of 256.5 µeq L^{-1}. Major ion concentrations and conductivity were also highly variable in the sampled lakes. Nitrate concentrations ranged from 0.1 µeq L^{-1} to 20.1 µeq L^{-1}, with a median of 7.9 µeq L^{-1}. The highest NO_3^- concentrations occurred in lakes with the lowest ANC values, with the exception of lakes underlain by limestone. Delta Lake, which is fed by Teton Glacier, had the highest NO_3^- concentration (20.1 µeq L^{-1}). Positive correlations between ANC, conductivity, Ca^{2+}, Mg^{2+}, and Na^+—indicative of carbonate mineral weathering —were relatively strong ($p \leq 0.01$). Both NO_3^- and Ca/Na ratios were negatively correlated to DOC concentrations.

Six of the lakes were sampled on more than one occasion as a means of detecting temporal trends and solute fluxes. Concentrations of ANC were variable, with just over half of the lakes exhibiting a decrease in ANC while the other half increased. On average, Ca^{2+} and Mg^{2+} concentrations decreased, and Na^+ concentrations increased. Nitrate concentrations decreased seasonally.

There were no consistent trends in ANC concentrations among the 12 lakes for which there are data from both 1996 and 2002. Seven of the lakes showed an increase in ANC since 1996, whereas the remainder exhibited decreased ANC concentrations.

Trapper Lake is the only lake that was surveyed for more than two years. ANC in Trapper Lake has decreased by 50% since 1985 (Figure 1), and most major cations have also decreased since 1985, particularly Ca^{2+}, which has decreased by 48%. Unlike cation trends, anion trends in Trapper Lake were variable. Since 1985, NO_3^- concentrations have increased and SO_4^{2-} concentrations have decreased.

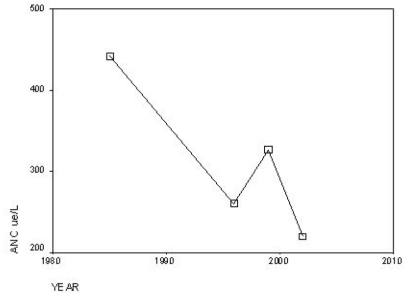

Figure 1. Acid neutralizing capacity (ANC) trends in Trapper Lake between 1985 and 2002. Based on data from Landers et al. 1985, Williams and Tonnessen 1997, Clow et al. 1999, and the 2002 survey.

Topographic characteristics in the Teton Range are characteristic of glacial environments. Most of the study basins were located in glacial cirques and tarns that had high percentages of steep slopes dominated by granitic rock and young debris and very little vegetation. This is also reflected in the correlations among basin characteristics, with the strongest and most numerous correlations occurring in the granite, limestone, and young debris categories.

Multiple linear regression was used to predict solute concentrations and as a method of constructing interactions among solutes and basin characteristics. The regression models were developed using data collected in 1996 by Williams and Tonnessen at Grand Teton. A total of 17 lakes were sampled.

The complexity of interactions between modeled parameters is illustrated in the coefficients that resulted from the stepwise multiple linear regression. Although correlations were strong for many of the variables, the relationships were not always linear, and transformations were necessary in order to adequately fit the data. Granite and limestone served as the best predictors for solute concentrations, with young debris and steep slopes playing significant roles for most solutes—especially major base cations and pH.

Generally, the regression models for major cations showed good agreement between observed and predicted values (Figure 2b–f). The strongest model in this group was the Mg^{2+} regression model. Limestone, granite, forest, and subalpine meadow were the best predictors for Mg^{2+} and accounted for 97% of the variance in concentrations. The weakest model was the Na^+ regression model (adjusted R^2 = 0.636), which relied on limestone and median elevation as predictors. Limestone by itself would not be the best chemical predictor for basins in the Grand Teton study area because only four had limestone deposits. In this study, granite was present in every limestone basin except Rimrock Lake, which had a high percentage of metamorphic rock.

The regression model for ANC (Figure 2a) served as an excellent predictor for buffering capacity. Once again, limestone and granite were the predictors for the ANC model and explained 86.5% of the variance.

Discriminant analysis was used to identify the features responsible for splitting the data into categories of sensitivity. Categories reflected the common assumption that sensitive lakes have concentrations of ANC <100 μeq L^{-1}. Therefore, groups were coded based on their relative susceptibility to acidification: chronic (ANC < 50 μeq L^{-1}), episodic (ANC < 100 μeq L^{-1}), or not susceptible (ANC >100 μeqL⁾. The same data that were employed in the regression analysis were used in this categorical analysis, and granite, limestone, and young debris were the variables.

The variable that best defined group membership was granite (Figure 3). After analysis of the regression equations discussed in the previous section, it is not surprising that granite was the best variable to maximize the differences between ANC categories. On average, lakes with ANC concentrations < 50 μeq L^{-1} were in basins that had total granite compositions ranging from 60% to 80%, lakes with concentrations of 50–100 μeq L^{-1} had granite deposits comprising 20% to 50% of the basin, and lakes with concentrations >100 μeq L^{-1} had less than 20% granite in the basin (Figure 3).

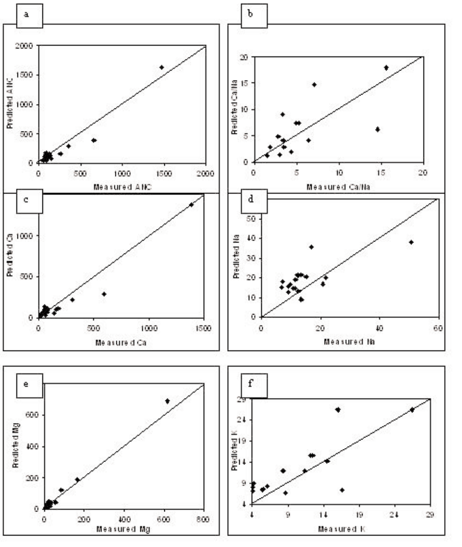

Figure 2. Relations between measured and predicted mean lake concentrations of (a) ANC, (b) Ca/NA ratios, (c) Ca^{2+}, (d) Na^{+}, (e) Mg^{2+}, and (f) K^{+} for Williams and Tonnessen (1997).

The data from the Tower Junction NADP station indicate an overall increase in the potential for acidification of Grand Teton waters by nitrogen-based compounds in atmospheric deposition. However, since Grand Teton does not have its own NADP station, such an inference remains tentative.

Decreased NO_3^- and SO_4^{2-} concentrations were observed in snow samples collected at Garnet Canyon and Rendezvous Mountain between 2001 and 2002. The fact that these values are lower than the 1993–2000 averages may be due to interannual differences in precipitation which may mask trends for wet deposition in snow.

Discussion

The ability of a landscape to neutralize acidity is reflected in the chemistry of its waterbodies (Stumm and Schnoor 1985). Chemical weathering, especially in abraded areas, can largely account for lake chemistry (Stauffer 1990) and is the major acid neutralizing process in most mountain ecosystems. Weathering results in the neutralization of H^+ and the production of soluble base cations, aluminum, and silica (H_4SiO_4). Weathering also buffers surface waters (Johnson 1984) and supplies nutrient cations to the soil (Likens et al. 1977). Chemical weathering rates are temperature and moisture dependent, so climate is a primary control. In the cool, dry climate typical of high-elevation watersheds in semi-arid western North America, weathering rates are relatively low. Consequently, ion concentrations in lakes and streams are very low, and vulnerability to acidification is high. However, differences in basin geologic, topographic, and vegetation characteristics can result in variability among high-elevation watersheds in their relative sensitivity to acidification (Clow and Sueker 2000; Turk and Campbell 1987). For example, acid-reactive sinks in the form of sedimentary materials increase the reactivity of alpine systems (Johnson 1984). The results of the present study indicate that two factors—the bedrock geology and the amount of young debris—are important controls on lake water chemistry and sensitivity to acidification. In addition, the presence of a glacier within the watershed appears to affect lake water chemistry by providing an additional source of solutes or by adding complexity to the flow path of catchment water.

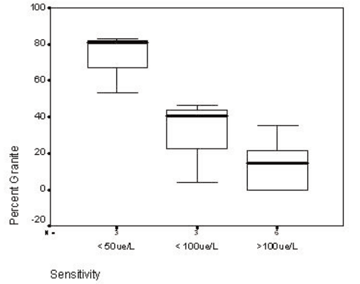

Figure 3. Boxplot of percent granite in study basins relative to acidification susceptibility.

Carbonate rock dissolution is responsible for the bulk of the alkalinity in North American waters, with the remainder originating from calcium and magnesium silicates and alumino-silicates (Johnson 1984). Limestone is present in parts of the Grand Teton National Park study area, and lakes with limestone bedrock appear to have sufficient buffering capacity as a result of carbonate weathering. The three basins with limestone bedrock, Snowdrift Lake, Sunset Lake, and Alaska Basin Lake, had ANC values of 676.2, 1488.3, and 110.3 μeq L^{-1}, respectively, for a mean of 758.3 μeq L^{-1}. In contrast, lakes without limestone bedrock had ANC values ranging from 42.5 to 219.6 μeq L^{-1}, with a mean of 89.3 μeq L^{-1}.

The increased weathering associated with the presence of rock debris can either help or hinder a water body's buffering capacity, depending on the bedrock characteristics. For example, in a 1985 study of Grand Teton lakes, Gulley and Parker (1986) noted that the only significant difference in solute chemistry among survey lakes was the elevated Mg^{2+} in Schoolroom Lake. Schoolroom Lake is located below Schoolroom Glacier, which is situated on limestone bedrock that apparently contributed to the buffering capacity of Schoolroom Lake. However, NO_3^- concentrations in talus contributed to NO_3^- in stream water in the Green Lakes Valley of the Colorado Front Range (Williams et al. 1997). Talus slopes contain areas of sand, clay, and organic material that sometimes support patches of tundra-like vegetation, which may affect the N cycle. Williams et al. hypothesized that the increased surface area of talus, and the increased residence time of water flowing through talus fields, results in increased NO_3^- concentrations in surface waters.

Glacier dissolution in Grand Teton study basins may be responsible for seasonal increases in NO_3^- concentrations in glacier-fed lakes (Figure 4), which in turn decreases the ANC. Delta Lake—a glacier-fed lake—had a mean Ca^{2+} concentration of 50.9 μeqL^{-1}, but NO_3^- and SO_4^{2-} concentrations were high (20.1 μeq L^{-1} and 12.3 μeq L^{-1}, respectively), resulting in an ANC value of 42.5 μeq L^{-1}. In contrast, Alaska Basin Lake had a mean Ca^{2+} concentration of 68.5 μeq L^{-1}, a mean NO_3^- concentration of 0.4 μeq L^{-1}, and a mean SO_4^{2-} concentration of 13.7 μeq L^{-1}. The ANC value for this lake was 110.3 μeq L^{-1}.

Research on subglacial hydrological systems is limited. Current studies have shown that chemical processes in glacial environments are not inhibited by limited soils and vegetation and low temperatures as was originally thought, but are enhanced by the increased physical weathering in glacial areas (Brown 2002).

Conclusion and recommendations

The results of the present study suggest that both mechanisms—the acid neutralizing effect of limestone bedrock, and high nitrate from talus fields—affect the basin water chemistry at sites in Grand Teton. However, watersheds without limestone but with a large amount of young debris have some of the lowest ANC values. In addition, the results indicate that, in watersheds without limestone, high NO_3^- increases the sensitivity to acidification, and glacier dissolution in Grand Teton study basins may be responsible for seasonal increases in NO_3^- concentrations in glacier-fed lakes, which in turn decreases the ANC.

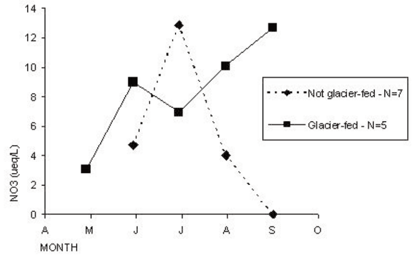

Figure 4. Relations between glacier-fed lakes and seasonal mean NO_3^- concentrations.

It is recommended that the National Park Service conduct additional monitoring of target lakes in Grand Teton—especially Delta Lake, Surprise Lake, Amphitheater Lake, Lake Solitude, and Mica Lake—all of which should be sampled annually. In conjunction with seasonal monitoring of selected lakes, an investigation into the mechanism of nitrate deposition into glacier-fed lakes (namely, Delta Lake) is suggested. It is also recommended that a NADP monitoring station be installed at Grand Teton to better monitor the effects of atmospheric deposition within the park.

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Maintaining the Biological Integrity, Diversity, and Environmental Health of the National Wildlife Refuge System

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Section 4(a) of the National Wildlife Refuge System Improvement Act of 1997 states that, in administering the National Wildlife Refuge System, the secretary of the interior shall "ensure that the biological integrity, diversity, and environmental health of the System are maintained for the benefit of present and future generations of Americans." This clause, hereinafter called the "biological integrity and environmental health clause," provides one of the philosophical cornerstones of refuge system management. A policy to implement the clause was published in the *Federal Register* (U.S. Fish and Wildlife Service 2001). The policy constitutes Part 601, Section 3 of the Fish and Wildlife Service Manual and is hereinafter called "601 FW 3."

In 601 FW 3, biological diversity is defined as "the variety of life, including the variety of living organisms, the genetic differences among them, and the communities in which they occur." Biological integrity refers to "biotic composition, structure, and functioning at genetic, organism, and community levels consistent with historic conditions, including the natural biological processes that shape genomes, organisms, and communities." Environmental health means "abiotic composition, structure, and functioning of the environment consistent with historic conditions, including the natural abiotic processes that shape the environment." For the purposes of this article, the phrase "ecological integrity" will be used to represent the summation and integration of biological integrity, diversity, and environmental health.

In the process of implementing 601 FW 3, refuge managers are required to:

1. Ascertain the purposes of the refuge.
2. Ascertain historic conditions for the refuge. Historic conditions are defined as "composition, structure, and functioning of ecosystems resulting from natural processes that we believe, based on sound professional judgment, were present prior to substantial human related changes to the landscape."
3. Assess current conditions and compare them with historic conditions to determine the degree to which ecological integrity has been compromised.
4. Determine the refuge's importance to local, regional, national, and international ecological integrity, and identify refuge-specific roles and responsibilities within that context.
5. Consider the relationships among biological diversity, biological integrity, and environmental health, and integrate the application of these concepts.
6. Consider the purposes of the refuge and employ management techniques in pursuit of ecological integrity, phasing out techniques that compromise ecological integrity.

Scope of the biological integrity and environmental health clause

The biological integrity and environmental health clause applies to the entire refuge system, but the extent to which it applies to individual refuges varies with each one's purposes, which are provided in the legal instruments used to establish them (such as acts of Congress and executive orders). Where the purposes of a refuge may conflict with ecological integrity—for example, when they include domestic livestock grazing or other activities that are inconsistent with historic, natural conditions—refuge management adheres to the guidelines provided by 601 FW 3 to the maximum extent practicable.

Maintaining or restoring biological integrity, biological diversity, and environmental health

Refuge managers consider the relationships among biological diversity, biological integrity, and environmental health, and integrate these concepts in management decisions, as described in the next section. Nevertheless, it is essential to understand what is required to maintain each of the three components in order to integrate the maintenance of each.

Biological diversity. Refuge managers strive to maintain populations that are numerically viable and sufficiently functional to maintain genetic diversity. They minimize fragmentation and loss of connectivity within and between blocks of habitats. They maintain or restore corridors to facilitate movement of terrestrial wildlife and provide for the breeding, migrating, and wintering needs of migratory species.

Refuge managers develop estimates of species richness and, if possible, relative abundance as measures of biological diversity. They also manage for biological diversity at other taxonomic levels, including class, order, family, genus, subspecies, and distinct populations. At the community level, refuge managers monitor biological diversity using indicators of plant community composition, typically based on the National Vegetation Classification System.

Biological integrity. Refuge managers maintain or restore biological integrity by maintaining, restoring, or mimicking the natural environmental and evolutionary processes that shape ecosystem composition (including species) over time. These processes include plant community succession, the evolution of species, and disturbance regimes such as fire and flooding. Refuge managers mimic natural processes—for example, by using water control structures to simulate natural hydrological functioning—to contribute to the restoration of biological integrity.

Maintaining or restoring biological integrity is not the same as maximizing biological diversity. Managing the refuge system for the conservation of biological integrity may entail managing for a single species or community at some refuges and for combinations of species or communities at other refuges.

Environmental health. Corresponding to the genetic level of biological integrity, refuge managers maintain or restore environmental health by preventing contamination that interferes with reproductive physiology and mutation rates. Such contamination includes carcinogens and other toxic substances that are released within or outside of refuges.

At the population and community levels, refuge managers consider the habitat components of food, water, cover, and space. Food and water may become contaminated with chemicals that are not naturally present. Security or thermal cover may be modified by activities such as logging and mining or by structures such as fences and water tanks. Security is also compromised by unnatural noise and light pollution. Space may be displaced by unnatural physical structures, including buildings, reservoirs, infrastructure, and fences. Refuge managers construct new facilities and maintain existing facilities only when necessary to accomplish the purposes of a refuge or to contribute to overall ecological integrity. Facility construction and maintenance is designed to minimize impacts on environmental health.

At the ecosystem level, the major physical components and structures include topography, geological formations, soils, hydrology, and airsheds. Physical functions include soil formation, water cycles, nutrient cycles, and temperature regulation. Environmental health is diminished when the natural condition of these physical components, structures, and functions are modified by unnatural processes associated especially with industrial activities or industrialized agricultural and extractive activities. Refuge managers avoid the unnatural modification of the physical components of natural habitats and ecosystems and strive to restore natural physical components.

Integrating biological diversity, biological integrity, and environmental health

Considered independently, biological integrity, biological diversity, and environmental health can be conflicting goals. The integration of these properties produces ecological integrity (Pimentel et al. 2000). Refuge managers manage for ecological integrity in an integrated and holistic manner by maintaining, restoring, and mimicking historic, natural conditions. Refuge managers thus reduce the divergence between current and historic conditions.

Refuge managers do not always attempt to maximize ecological integrity at a particular refuge, because they are also concerned with ecological integrity at the ecosystem, national, and international levels. With regional and national guidance, they focus on natural communities, species, and ecological processes that are rare, declining, or unique. For example, they may contribute most to the ecological integrity of the refuge system by managing a particular refuge for a single vegetative community such as a nationally significant saltmarsh, desert, or coniferous forest, or by managing for a single species or group of species.

Unless sound professional judgment indicates that a species was present in the area of a refuge under historic conditions, managers do not introduce or maintain the presence of that species for the purpose of biological diversity. They may make exceptions where areas are essential for the conservation of a threatened or endangered species and suitable habitats are not available elsewhere. Cases may also arise where biological diversity has become unnaturally high. For example, small-scale agriculture in the midst of undeveloped lands may result in unnaturally high levels of biological diversity due to increased edge effect.

In fragmented landscapes, physical structures may be necessary to maintain biological integrity; for example, water control structures to maintain and restore natural hydrological cycles. While these structures compromise environmental health because they are unnatural physical alterations, they are essential to maintaining the biological integrity of the refuge and are usually considered appropriate.

Determining the historic conditions of a refuge

Management for biological integrity and environmental health requires a frame of reference. For refuge management purposes, the frame of reference is "historic conditions," or those "resulting from natural processes" and "present prior to substantial human related changes to the landscape" (601 FW 3). Although humans played a significant role in shaping American flora and fauna throughout the Holocene epoch, "substantial" human-related changes are generally interpreted to have begun with the early stages of the American industrial revolution, circa 1800.

Refuge managers must also determine how much prior to substantial human-related changes should be considered in the frame of reference for historic, natural conditions. The draft version of 601 FW 3 circulated for public review cited the advent of the Medieval Warm Period (circa 800 AD) as the beginning of an ecologically and evolutionarily relevant frame of reference for natural conditions (U.S. Fish and Wildlife Service 2000). The precise starting point is not as important as avoiding the use of a "snapshot in time," such as conditions as they occurred precisely in 1799, for example. The full range of an area's natural plant community succession should be considered as indicated below. However, it is also important to avoid the use of irrelevantly ancient time periods (such as the Pleistocene epoch or earlier).

In some areas the industrial revolution did not commence until much later than 1800, especially in Alaska. In these areas, refuge managers may extend the frame of reference for historic, natural conditions beyond 1800 based on historical information and sound professional judgment.

Information on conditions prior to substantial human-related changes may be historical, archaeological, or paleoecological (including fossils, packrat middens, pollen cores, and tree ring data). Refuge managers obtain information on these conditions from their own investigations and from their partners in academia, conservation organizations, and other government agencies.

Consideration of successional stages in determining historic conditions

Refuge managers ensure that their management activities result in the establishment of a community that fits within the natural successional series. For example, if they determine that an area in question was aspen parkland in 1750, they may manage for aspen parkland or any other community that fits within the natural successional series, with a focus on natural communities and ecological processes that are rare, declining, or unique for the sake of conserving biodiversity. They may choose to maintain nonclimax communities pursuant to refuge purposes. They favor techniques such as fire that mimic or result in natural processes to maintain these nonclimax communities. However, where not precluded by refuge goals and objectives, they allow or, if necessary, encourage natural successional processes.

If there is evidence that certain successional stages were naturally precluded, refuge managers generally do not attempt to manage for those stages. For example, if a volcanic eruption in the 12th century impounded water that flooded a forest, creating a lake in the process, refuge managers would not drain the lake to reproduce the forest. Reproducing conditions that naturally ceased to exist compromises ecological integrity.

However, some relatively natural disturbance events warrant restoration efforts, especially more recent events that may have been exacerbated by unnatural conditions. For example, if an intense forest fire resulted in the sterilization of soils on a refuge, and forested habitats were required for fulfilling refuge purposes, it would be appropriate to fertilize and otherwise restore conditions conducive to forested habitats, especially if the fire's intensity resulted from an unnaturally modified fire regime. This example illustrates the need for a holistic perspective and sound professional judgment in implementing the biological integrity and environmental health clause.

Managing populations to maintain and restore ecological integrity

Population management strategies on the refuge system are designed to support accomplishing refuge purposes and system objectives while maintaining or restoring ecological integrity. When consistent with refuge purposes, refuge goals and objectives for population management are formulated to maintain natural densities, social structures, and dynamics.

On some refuges, including many of those having the purpose of migratory bird conservation, managers establish objectives to maintain densities higher than those that would naturally occur because of the loss of surrounding habitats. By maintaining higher densities at the refuge level, refuge managers more closely approximate natural levels at larger scales. Refuge managers also consider population parameters such as sex ratios and age class distributions, objectives for which may be set within the range of values occurring under historic, natural conditions.

Refuge managers support the reintroduction of native species that have been extirpated. They do not introduce species outside their historic range or introduce species that were naturally extirpated, unless such introduction is essential for the survival of a species and is prescribed in an endangered species recovery plan. They detect and control populations of invasive species.

Habitat management

Refuge managers manage habitats to meet refuge objectives using strategies that promote ecological integrity by maintaining or mimicking natural ecosystem functions. For example, prescribed burning to maintain natural fire regimes or water level management to mimic natural hydrological cycles is often necessary to maintain natural plant and animal communities in fragmented landscapes. Farming, haying, logging, and livestock grazing are appropriate habitat management practices only when they are prescribed in plans to meet wildlife or habitat management objectives, and only when more natural methods such as prescribed fire or grazing by native herbivores are not feasible.

Refuge managers do not authorize land uses or management practices that result in the maintenance of nonnative plant communities unless they determine that there is no other feasible alternative for accomplishing refuge objectives. Where farming is practiced, refuge managers develop integrated pest management strategies that consider the effects on ecological integrity. Where farming is practiced but not prescribed in plans to support accomplishing refuge purposes, refuge managers may cease farming and strive to restore natural habitats.

Maintaining and restoring ecological integrity at the system level

Refuge managers maintain and restore ecological integrity on individual refuges and contribute to the maintenance and restoration of ecological integrity at broader landscape scales. Refuge, regional, and national personnel evaluate how individual refuges contribute to accomplishing national, regional, flyway, and ecosystem goals.

For example, on the Alaska Maritime National Wildlife Refuge, biological integrity includes a high density of nesting Aleutian Canada geese. The wintering grounds in California, however, have been usurped to a large extent by agriculture and other developments. Only if refuges on the wintering grounds, including the Sacramento and San Luis National Wildlife Refuge Complexes, are managed intensively can a goose population conducive to historic conditions on the Alaska Maritime Refuge be supported. Intensive management includes mechanized crop production, which compromises biological integrity and environmental health. With national and regional input, refuge managers therefore compromise some of the ecological integrity of the southern refuges to pursue the ecological integrity of the Alaskan refuge and of the system as a whole.

Ecological integrity in the context of climate change

With the global climate changing as a function of industrial production, maintaining or restoring historic, natural conditions will become more difficult. Global warming and sea-level rise pose particularly salient challenges to the ecological integrity of the refuge system, especially in coastal areas where many refuge properties will be submerged or transformed into different habitats in the current century. Maintenance or restoration of historic, natural conditions will not be possible in such scenarios. However, ecological integrity will remain relevant to managers. Regardless of how far conditions may differ from the baseline of ecological integrity, management prospects may always be viewed in terms of their propensity to drive an area closer to or further from historic, natural conditions and to mimic natural processes.

Summary

The biological integrity and environmental health clause of the Refuge Improvement Act provides one of the philosophical cornerstones for refuge system management. With a focus on historic, natural conditions, management will generally be less intrusive and will be designed to mimic natural processes. Ecological integrity may never be entirely restored, but the U.S. Fish and Wildlife Service and its managers will strive to maintain existing levels of ecological integrity and will achieve a degree of success in restoring what has been lost. The result will be a refuge system that more accurately represents the wildlife heritage of the nation.

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The Importance of Soundscapes in National Park Management

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All profound things and emotions of things are preceded and attended by Silence.
— *Herman Melville*

Introduction

Soundscapes have emerged in recent years as a key issue in national park management. Soundscape management objectives are addressed in current National Park Service (NPS) policy, and a program specifically designed to help implement policy was created in 2000. This paper defines the "soundscape" concept and its importance in national park management. It also introduces the Park Service Natural Sounds Program and its functions in acoustics, planning, and impact assessment.

The soundscape concept

What is a "soundscape?" The term "soundscape" is coined in Park Service policy. It is the audio equivalent of a "landscape," "viewshed," or "watershed," terms that are in fairly common usage by land management agencies. The soundscape could alternatively be called the "sound environment" comprising all the sound conditions within an area. As defined in Park Service policy, "the natural soundscape is the aggregate of all the natural sounds that occur in parks, together with the physical capacity for transmitting them."

Natural soundscapes exist in the absence of human-caused sound. This is often what is meant by "natural quiet," recognizing that nature is often not quiet. The term "natural quiet" is commonly used, as shown by references to it in various laws. However, because nature is often not quiet, the Park Service has adopted the soundscape terminology.

The soundscape concept extends beyond "natural." Other important soundscape characteristics for national parks may be identified. For example, some human-caused sounds may be important to the understanding, appreciation, interpretation, or use of culturally or historically important sites. The natural soundscape, or the absence of noise, could be an important component of such sites at times. So, an additional construct is that of the *"appropriate soundscape."* A soundscape, whether it is natural or has a large component of human-generated sounds, may be viewed as appropriate to the *purposes and values* for which a park was established.

Why it is important to protect national park soundscapes

There are three fundamental reasons why it the Park Service recognizes and protects soundscapes: (1) laws; (2) the importance of sound to the natural environment, to cultural values, and to people; and, (3) the apparently diminishing part natural soundscapes are playing in American life and experience.

The Organic Act and other laws

Under the Park Service Organic Act, a premier part of the agency's mission is to preserve or restore the natural resources of the parks. We are to protect and conserve scenery, wildlife, water, air quality, geologic features, etc., as part of the natural setting. We protect them first for their intrinsic value, and then so they can be enjoyed by people. It is revealing for us to ask, "Why would we preserve all components of the natural setting except for sound?" In trying to answer the question it is difficult to imagine either the natural environment, or the human experience one might have there, without it!

We conclude that natural sounds are intrinsic elements of the environment, associated with the parks and their purposes. They are inherent components of "the scenery and the natural and historic objects and the wildlife therein" protected by the NPS Organic Act. We further conclude that other sounds may be appropriate to parks whose purposes are less associated with natural phenomena, and that these soundscapes also are to be protected. Soundscapes are resources.

Other laws have been promulgated, at least in part, by concern for the impacts of noise on people and the environment. Here is a selection.

- Wilderness Act (1964 P.L. 88-577)
- Noise Control Act of 1972, as amended (P.L. 92-574)
- Grand Canyon National Park Enlargement Act (1975 P.L. 93-620 §8)
- National Parks Overflight Act (1987 P.L. 100-91)
- National Parks Air Tour Management Act (2000 P.L. 106-181)

The soundscape concept exists in law, or as an assertive response to law. For example, the Grand Canyon National Park Enlargement Act of 1975 recognizes "natural quiet as a value or resource in its own right, to be protected from significant adverse impact." The National Parks Overflight Act of 1987 requires the Park Service to report on the nature and scope of overflight problems in parks, as well as on the injurious effects of overflights, including noise, on natural, historic, and cultural resources, impairment of visitor enjoyment, and impacts of noise on safety of park users. The Park Service's response to this act, *Report to Congress on Effects of Overflights* (1995), affirms that "natural quiet" is a park resource whose preservation is within Park Service mandates.

Demonstrating the importance of soundscapes

The importance of sound in preserving ecosystems and the natural environment. Natural soundscapes are vital to the natural functioning of park fauna. The precise relationships between species and their habitats, and how they are influenced by various sound characteristics, have not been studied comprehensively. We do know, in general, that the sound environment is important for some species in these ways:

- Intra-species communication and behavior;
- Territory establishment, finding desirable habitat;
- Courtship and mating;

- Nurturing and protecting young;
- Predation and predator avoidance; and
- Effective use of habitat.

The importance of sound in the natural environment should be self-evident. A natural environment in a park should *look, feel, smell,* and *sound* natural. This is the comprehensive view of a natural environment having intrinsic worth, held in trust for the American people. As presented earlier, the preservation of the natural environment as an inherent value is a basic tenet in the agency mission.

The importance of sound for cultural or historic values. Some sounds, natural or not, accompany the use, interpretation, appreciation, or enjoyment of cultural or historic settings in a park. Such sounds or the emphasis on a "quiet, contemplative, reverent" environment can be part of the cultural or historic value established for a park in legislation. The use of traditional cultural properties or religious sites, or their protection, may demand an environment free from sound other than that which is part of the site's character. Sites that celebrate or commemorate historic events may use certain sounds to enhance the understanding or appreciation of those events. Parks that are established to maintain a living history or traditional cultural practices similarly depend on appropriate soundscape characteristics for these purposes.

The sound environment and the opportunity for people to enjoy parks. The public, in general, supports and is concerned about preserving national parks and what they represent. Visitors, though they may not always be aware of noise, nevertheless have expectations about being able to appreciate and enjoy park resources. People should be able to hear and attend to interpretive programs. Historic, cultural, scenic, geologic, and biological resources in parks all have a soundscape context that is important to the opportunity for their enjoyment. It should be evident that noise which discourages the presence of wildlife also prevents visitors from viewing and enjoying them. Visitors come to parks to enjoy the sights and sounds of a natural environment and to learn about and appreciate cultural and historic treasures, and in some instances to retreat from the noise of everyday life.

The natural sound environment is a diminishing resource

Increasingly, even those parks that appear—visually—as they did in historical context do not sound like they once did. A number of sources of sound potentially affect parks by detracting from the purposes for which they were established. The ambient sources of sound include:

- Overflights of all kinds;
- Adjacent land uses, growth, and development;
- Through traffic;
- Park operations and maintenance;
- Other motorized uses, including all-terrain vehicles, snowmobiles, and personal watercraft;
- Numbers of visitors (there was a 226% increase in national park system visitation

between 1972 and 2000: from 190 million to 429 million visits per year); and
- Cumulative sources.

The impacts of these sources can derive from a variety of sound characteristics, beginning with sound frequency (tone), amplitude (sound pressure or "loudness"), and source proximity. Along with the physical characteristics of sound, impact is further defined by the duration, time of day or season, and temporal frequency (continual, random, frequent, or infrequent) of the sound events. The significance of the impact is defined by the types and locations of resources, values, or visitor opportunities that are affected. How sound is transmitted from the source to the receptor through a medium is also a major factor in determining impact. Is the sound generated from above, and transmitted through the atmosphere to create a "soundprint" on the ground, or is it generated on the ground, to travel across the landscape? Many parks have marine habitats where sources of sound can generate effects both below and above the water surface.

Given the nature of sound impacts as described, there is a clear potential for conflict between many sources of sound and the purposes and values for which a park was established. This includes the opportunity for visitors to enjoy the park precisely for those purposes and values. Most visitors have expectations about their park experience. Many times, expectations are defined in contrast to what people routinely experience day-to-day. In terms of sound, many people expect to hear only natural sounds in a natural environment or a wilderness area—not the continual drone of traffic miles away. They expect to hear the quiet, harmonious tradecraft of an Amish farm community, not the sound of race cars at a nearby track. They expect to hear and enjoy a ranger talk along a quiet nature trail, but instead get a ranger straining to be audible above the sound of a hovering helicopter.

The National Park Service Natural Sounds Program

The Natural Sounds Program began in 2000. Its establishment responded in part to the passage of the National Parks Air Tour Management Act of 2000. The issue of overflight noise from air tours above national parks, and the potential for impacts on park resources and visitors, is directly addressed by this act. Overflight impacts and noise had been a simmering issue owing to the experience with air tours at Grand Canyon National Park, and the question of how overflights affect parks throughout the system. Both are the subjects of earlier legislation. The issue of noise arose directly in dealing with the impacts of winter motorized use in Yellowstone and Grand Teton National Parks, and similarly with the use of personal watercraft in a number of other park units. The need for a specific program about acoustics and soundscape management was evident.

The Natural Sounds Program's work plan for 2005 is briefly described below. For Park Service employees, more information about the program is available at http://www1.nrintra.nps.gov/naturalsounds/. A similar site is available on the worldwide web at http://www.nature.nps.gov/naturalsounds/.

The Natural Sounds Program mission

"The Natural Sounds Program works to protect, maintain or restore natural soundscape resources in parks in a condition unimpaired by inappropriate or excessive noise sources. We fulfill this mission by working in partnership with parks and others to increase scientific and public understanding of the value and character of natural soundscapes and to eliminate or minimize noise intrusions."

Organization

The program offices are located in Fort Collins, Colorado, as a detached Washington Office unit of the National Park Service Division of Natural Resources Stewardship and Science. Organizationally, it is within the Air Resources Division headquartered in Denver, Colorado. The present staff includes people with expertise in planning and National Environmental Policy Act, acoustic data collection and analysis, and military liaison.

Current program priorities

As reflected in the introductory paragraph, current program priorities are heavily weighted to overflight issues. Soundscape policy goes well beyond that issue to express general objectives for soundscape management and related planning. The program staff is therefore engaged in a number of activities to help implement the policy. In order of priority, these activities are briefly presented below.

Air tour management planning. The National Parks Air Tour Management Act requires the development of a plan for each park with air tours. These plans are to prevent significant adverse impacts to park resources and visitors from air tour operations. The act requires the Federal Aviation Administration (FAA) to be the lead agency for developing environmental documents, and the National Park Service to be a cooperating agency. The directors of both agencies are to sign each plan. The Natural Sounds Program represents the estimated 120 park units, coordinates between parks and FAA, and is part of the national team for implementing the act.

Soundscape management planning. Soundscape management policy provides direction for planning: "Using appropriate management planning, [NPS] will identify what levels of human-caused sound can be accepted within the management purposes of parks." Objectives for soundscape planning can be paraphrased as: NPS will preserve natural soundscapes, restore degraded soundscapes to their natural condition, and protect natural soundscapes from degradation due to noise, as far as possible. The program has developed a number of practical guides to assist parks with soundscape management planning, and a number of such plans are underway. Guides are to be published on the program website.

Guidance to the field on acoustic data collection, and methods development. The program has devised a number of practical guides to soundscape management and acoustic data collection. These are to be published on the program website.

Acoustic data collection. The program maintains a number of equipment sets for the collection of acoustic data. Some sets have been loaned to the FAA for collecting data at air tour parks. Program acousticians are actively engaged in collecting data in strategically meaningful park locations.

Responding to park requests for assistance on noise issues and impact assessment. The annual call for technical assistance draws requests from park units that wish to have acoustic data collected to deal with a variety of noise issues. Issues include airport developments, ambient noise, air tours, military overflights, and adjacent land use. Program staff has responded with assistance in soundscape planning and acoustic data collection methods. A number of workshops have been conducted at park units for this purpose.

Providing liaison with military on overflight issues. The program staff maintains contacts in the military community, and uses those contacts when parks have problems with military overflights. A sourcebook for parks in the Pacific West Region was developed in 2002, in cooperation with the U.S. Air Force.

> Silence is something more than just a pause; it is that enchanted place where space is cleared and time is stayed and the horizon itself expands.
>
> — *"The Eloquent Sounds of Silence" (Preamble to the Report to Congress on Effects of Overflights on the National Park System)*

The Science of Sound: Acoustics and Soundscape Measurement

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Introduction

Soundscapes have emerged in recent years as a key issue in national park management. In 2000, the National Park Service created the Natural Sounds Program specifically to help implement soundscape policy. This paper explains the basics of sound, sound pressure, frequency, and other units of measure. It shows how these acoustics measures might be applied in soundscape management.

What is sound?

Sound is a pressure variation in air or other media that is within the hearing range of a given species. It is a physical phenomenon having two dimensions: amplitude and frequency.

Amplitude is the magnitude of sound pressure. It is measured in Pascals (the metric equivalent of pounds per square inch). The range of pressures that a human can detect is greater than 1,000,000:1. Because of this very large range, a logarithmic scale is used. A decibel is the logarithm of the ratio of the measured pressure to a reference pressure. When decibel values are given, they are usually expressed as dBA, which means that the scale (A-weighted) has been adjusted to human hearing by setting the threshold for human hearing at zero decibels.

Frequency is the number of pressure variations per second, called Hertz (Hz). The frequency of a sound causes the tone of a sound: most aircraft are low frequencies, and most bird calls are high frequencies. A person with normal hearing can hear sounds between 20 and 20,000 Hz. The frequency range on a piano is 27.5 to 4186 Hz.

The following graphs illustrate how amplitude and frequency relate. The graphs, from recorded audio data, show the amplitude of sound as it varies across the frequency spectrum. The spectrum is divided into one-third-octave bands across the horizontal axis. The magnitude of each bar shown is the amplitude in decibels. These illustrations, and several others, are from animated slides used in the presentation to George Wright Society along with a simultaneous recording and visual display. As the recording played, each bar rose and fell independently with changes in decibel level. The left-hand graph in Figure 1 shows birds alone, and the right-hand graph shows birds and helicopters recorded at the same decibel level. The latter demonstrated to the audience that both sounds were readily distinguishable.

A sound amplitude comparison from national parks

The following comparison (Table 1) helps people relate decibel levels to what they hear. Clearly, the tone or frequency of the various sounds is different, enforcing the idea that the decibel measure doesn't fully explain sound or sound impacts.

It is fairly well accepted in the acoustic science community that a 3-decibel (dBA) dif-

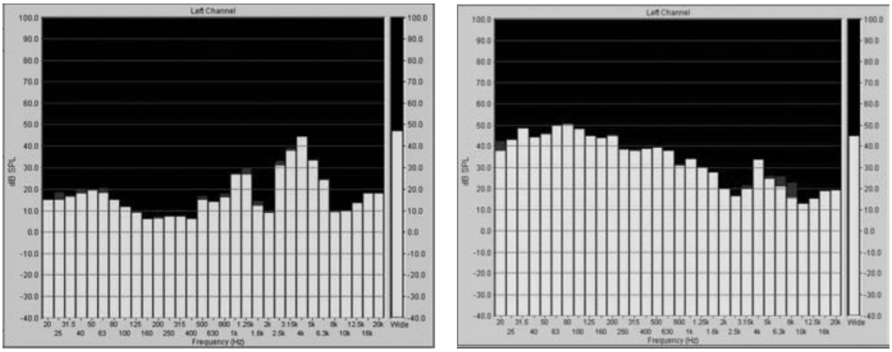


Figure 1. The relationship between amplitude and frequency. Left: birds alone, 46 dBA. Right: birds, 46 dBA, and helicopter, 46 dBA.

Sound	Sound pressure (Pa)	dBA
Threshold of human hearing	0.00002	0
Haleakala: volcano crater	0.000064	10
Canyonlands: leaves rustling	0.0002	20
Zion: crickets (at 5 m)	0.002	40
Whitman Missions: conversational speech (at 5 m)	0.02	60
Yellowstone: snowcoach (at 30 m)	0.2	80
Arches: thunder	2	100
Yukon–Charley: military jet (100 m above ground)	20	120

Table 1. Comparative decibel levels of sounds at different U.S. national park system units.

ference in sound level is perceptible to the human ear, while a 10-decibel change is a doubling of sound.

Adding sound sources together

Since decibel values are logarithmic, they are not added arithmetically. Two sources that emit sounds at 40 dB each do not produce a total sound level of 80 dB. The following example (Figure 2) shows the additive nature of sound source decibel levels.

Human hearing versus that of other species

The following graphs show the threshold of human hearing, along with those of selected birds and mammals. Different animals hear differently. This is not a biological treatise, but it should be noted that how animals hear is the product of how we have evolved in our habitats in order to feed, procreate, and survive. As an editorial note, most sound impact analyses published by federal agencies use decibels on the A-weighted scale—which is how humans hear. If it were necessary to determine sound impacts on other species, use of that scale may be appropriate for some species but not for others.

Acoustic data collected by the Natural Sounds Program

Acousticians with the Natural Sounds Program have developed protocols for data collection. Both amplitude and frequency data can be obtained and calibrated by the use of the following collection protocol (in brief):

Figure 2. The additive nature of sound source decibel levels.	Number of sound sources	2	2	2	4
	dB of each sound:	40.0	40.0	40.0	40.0
		40.0	46.0	50.0	40.0
					40.0
					40.0
	Cumulative dB:	43.0	47.0	50.4	46.0

- 1-second sound energy level for each of 33 one-third-octave bands (12.5 to 20,000 Hz).
- 1-second wind speed and wind direction
- Digital recording, periodic sample (usually 10 seconds every 2 or 4 minutes).
- Digital recording, events that exceed thresholds (usually 20-second recording of events that exceed 50 dB for 10 seconds)

Examples of acoustic data collected at Arches and Zion National Parks

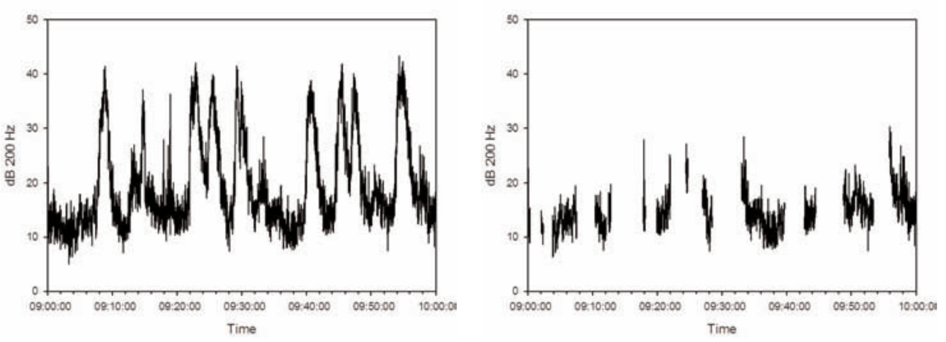
The following graphs (Figure 3) depict sonograms from data collected at Arches National Park. The sonograms capture time series data of sound events, in decibels.

From these data, several metrics may be used to characterize the soundscape as shown below. In Arches National Park on 9 October 2003, from 0900 to 1000, at the frequency of 200 Hertz, the sound level in decibels is illustrated for two conditions. These metrics display the ambient soundscape with aircraft and with aircraft sound sources removed (Table 2).

Using these data, an analysis of "noise-free interval" is produced. This analysis shows the continuous period of time during which only natural sounds are audible. In this case, aircraft were audible 53% of the hour. Most were high commercial jets measured at a maximum of 45.7 dBA during the period. However, for purposes of illustrating the overall impact, the distribution of those intervals is very revealing. For the noise-free periods of the hour, totaling about 26 minutes, the longest continuous noise-free interval was 6 minutes, 40 seconds. The average noise-free interval during the hour was just over 2 minutes (Table 3).

At Zion National Park, on the Chinle Trail, sound sources were monitored over the period of 21 August 2001 to 9 September 2001. The following graph (Figure 4) depicts, by hour of the day, the average percentage of the day in which human-related sounds were audible, distinguishing between aircraft as a source and all other sources together.

Figure 3. Sonograms for Arches National Park, 9 October 2003, 9:00–10:00 am. Left: with aircraft. Right: without aircraft.



Metric	With aircraft	Without aircraft
Total sound energy (dB)	36.8	28.5
Average level	19.6	14.7
Median level	16.7	14.2
Lowest level	5.0	6.4
Highest level	43.3	30.2

Table 2. Arches National Park, 9 October 2003, 9:00–10:00 am: the sound level in decibels under two conditions.

	Noise-free interval	Aircraft noise
Total time	0:26:32	0:33:11
Periods	12	11
Mean	0:02:13	0:03:01
Minimum	0:00:15	0:00:23
Maximum	0:06:40	0:08:15

Table 3. Arches National Park, 9 October 2003, 9:00–10:00 am: noise-free intervals.

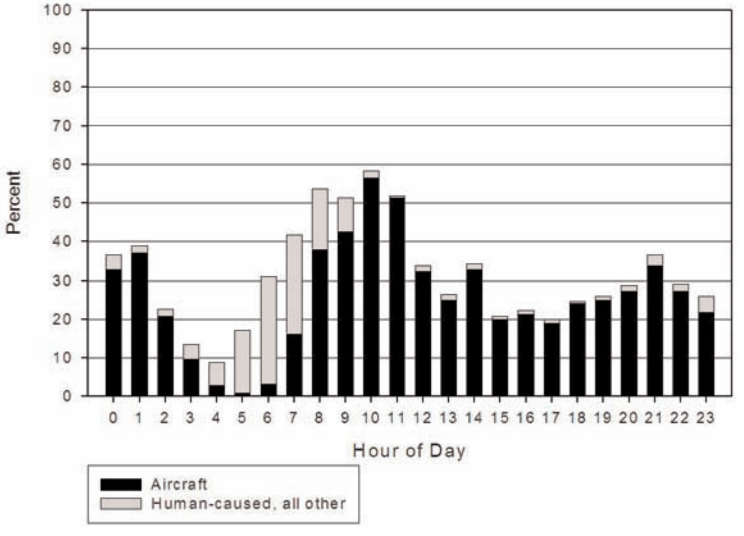


Figure 4. Average percent time audible, 21 August–9 September 2001, Chinle Trail, Zion National Park (based on 5-minute/5-second sampling scheme for entire period).

As sources were identified, their duration was timed. This is a process referred to as "audibility logging." When data are collected by automated means, the sampler periodically performs this task so that the record identifies the sources of sound being monitored in the soundscape. Without this, or without a recording to go with the data, the soundscape is characterized only by changes in decibel levels and not by what caused those changes. There would be little to distinguish between the sound of thunder and a military jet, for example. At Zion, using the referenced data set, the following "human-related" sound sources were catalogued, and the percentage of time they were heard is given. This is a further breakdown from Figure 4. Note that these are not additive percentages, because more than one source may be audible at the same time.

- Jet aircraft (55.2%)
- Propeller aircraft (24.6%)
- Helicopter (0.6%)
- Vehicle (3.6%)
- People talking (5.9%)
- Unknown motor noise (10.1%)

Soundscape management

The preceding information shows what sound is, and how it may be measured and analyzed. Soundscape management in the National Park Service uses these measures and tools for the purpose of implementing policy in order to manage the soundscape in relation to park purposes. The following concepts are important to understanding acoustics in national park soundscapes. They relate closely to the metrics that are to be used in defining standards for soundscape management.

Audibility is a measure of the biological properties of sound. It is the ability of animals with normal hearing, including humans, to hear a given sound. Of course, this is a function of the decibel level of a particular sound source through the frequency spectrum. If two dissimilar sounds (for example, a bird and an airplane) are emitted at the same time and the same decibel level, but at different frequencies, both will be heard equally well as separate tones. This frequency separation accounts for the fact that airplane sound is clearly audible even if continuous bird sounds are 8–10 decibels higher. However, if two dissimilar sounds operate at different decibel levels but at the same frequency, the louder of the two will "mask" or cover up the other.

The *natural ambient sound level* is defined as the sound condition produced by including all sounds of nature and excluding all human-related sounds. This is a convention that is important in acoustic analyses where natural or wilderness park settings are particularly of concern. The most appropriate metric for describing the natural ambient sound level is the median value in a data set that measures natural sounds alone over a period of time. The natural ambient is considered an analysis baseline, with which existing or proposed sound sources might be compared. Many park soundscapes are not naturally "quiet." Some are the "quietest" places in the United States. Usually, the higher the natural ambient sound level — for example, in the vicinity of a waterfall—the smaller the differential between the natural level and other sources of sound that may be present. Conversely, the lower the natural ambient the greater is the audibility of other sounds.

In contrast to the natural ambient is the *existing ambient sound level.* This is the composite of all sounds occurring in a given environment; it includes all natural and human-related sounds. Some agencies consider this level to be a baseline for analysis. The logic for this is not persuasive, since it could be said that this condition is always changing, and becoming higher over time.

Soundscape management indicators and standards

Standards are necessary by which to gauge whether or not management objectives are being met. They are also necessary to gauge the potential effects of a proposed action, or of

Table 4. General soundscape indicators and standards by management zone type.

Management zone	Indicator[1]	Standard
Administration and infrastructure	Percent Time Above Natural Ambient[3]	50% to 100%[2]
	Percent Time Audible[4]	50% to 100%
	Maximum Allowable Single Event dBA[5,6]	60 dBA
Frontcountry visitor use areas	Percent Time Above Natural Ambient[3]	50% to 100%[2]
	Percent Time Audible[4]	50% to 100%
	Maximum Allowable Single Event dBA[5,6]	60 dBA
Motorized travel corridors	Percent Time Above Natural Ambient[3]	50% to 100%[2]
	Percent Time Audible[4]	50% to 100%
	Maximum Allowable Single Event dBA [5,6]	60 dBA
Nonmotorized travel corridors, small backcountry and transition areas	Percent Time Above Natural Ambient[3]	20% to 40%
	Percent Time Audible[4]	10% to 35%
	Maximum Allowable Single Event dBA[5,6]	40–45 dBA
Large nonwilderness backcountry areas, RNAs (research natural areas)	Percent Time Above Natural Ambient[3]	10% to 30%
	Percent Time Audible[4]	10% to 25%
	Maximum Allowable Single Event dBA[5,6]	40-45 dBA
Designated and recommended wilderness	Percent Time Above Natural Ambient[3]	10 to 20%
	Percent Time Audible[4]	5 to 15%
	Maximum Allowable Single Event dBA[5,6]	40–45 dBA
Unique or highly sensitive areas[8]	All Indicators	Spatial/Temporal Soundscape Objectives[7]

[1] These three management standards, Time Above Natural Ambient, Percent Time Audible, and Maximum dBA, shall be achieved in 90% or more of the specific management area. Maximum sound levels are as measured at 50 ft from the source.
[2] It is understood that in some areas in some parks, non-natural sounds may be audible 100% of the time, and this may be appropriate to meet park purposes.
[3] "Time Above Ambient" means time sound levels of non-natural sounds exceed sound levels of natural sounds.
[4] "Audible" means able to be heard by a person of normal hearing.
[5] NPS has noise regulations for snowmobiles (72 dBA at 50 ft), boats (82 dBA at 82 ft), and other audio devices (60 dBA at 50 ft; as described in 36 CFR, 48 Federal Register 30275, June 30, 1983; as amended at 61 FR 46556, September 4, 1996). Natural ambient sound levels in backcountry areas of many national parks, absent mechanical or electrical sounds, are commonly between 20 dBA to 30 dBA, and often less than 20 dBA. An increase of 10 dBA is perceived as a doubling of sound level; hence, a sound level of 40 dBA would be 2 to 4 times greater than natural ambient sound levels common in national parks. Therefore a sound level of 40 dBA for mechanical/electrical sounds is suggested as a reasonable maximum allowable level in large areas managed for primitive, natural, or wilderness qualities, and where non-natural sounds are rare.
[6] Sound levels decrease as distance increases (approximately 6 dBA less as distance doubles, but dependent on several factors such as frequency content, vegetation, ground surface, temperature, humidity, and others). In general, a sound level of 78 dBA at 6 ft would be 60 dBA at 50 ft, 54 dBA at 100 ft, 30 dBA at 1,600 ft, and 18 dBA at 6,400 ft.
[7] Soundscapes in sound-sensitive areas should be managed spatially or temporally as appropriate. For example, a cultural area might be sound-sensitive year-round, or only during certain ceremonies. An example of a sound-sensitive wildlife area might be the nesting area of an endangered species during the nesting season.
[8] Unique or highly sensitive areas: This category includes areas or sites such as critical habitat, nesting sites and birthing sites for threatened and endangered species, cultural/religious/historic sites, or special designations. Often, these sites or areas are small inclusions in other management zones, even those that are zoned to frontcountry developed uses that might be inconsistent with the desired soundscape for the unique area. Special zones can be created for these, or they can be represented as a sub-zone inclusion.

the accretion of activities, on a resource. Soundscape management objectives are derived from laws, policies, and existing management plans. Indicators are selected as appropriate means by which existing or potential impacts can be measured. Standards reflect specific levels at which objectives are not met. A process for developing indicators and standards may be patterned upon the NPS visitor experience and resource protection (VERP) framework.

Generalized indicators and standards for the range of management zones found across the national park system are provided in Table 4 (previous page). Some standards are shown as a range of values. While parks are unique, it is recognized that there should be some consistency in objectives and standards for any particular type of management zone regardless of where in the system it exists—wilderness, for example. The range allows for a broad consistency while permitting flexibility for the unique circumstances that may apply within or near a park. The selected indicators and values in the Table 4 represent the current best professional judgment from the NPS Natural Sounds Program.

Acknowledgment
The graphics in this paper were provided by Skip Ambrose, acoustician.

Ecosystem Management Concepts: Connecting the Dots among the Sciences as Viewed from an Integrated Science Perspective

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Introduction

This paper summarizes a three-part topical session, "Ecosystem Management Concepts: Connecting the Dots between the Physical and Biological Sciences," which emphasized the ecosystem concept for resource management, reinforced an integrated science approach to ecosystem management, and promoted the geological science contribution to ecosystems and multidisciplinary teams. Additionally, the concept of *geodiversity,* coined from its familiar predecessor, *biodiversity,* was introduced. The sessions provided case studies of units of the national park system or examples of ecosystems issues that could apply to national parks (Figure 1). This was done to illustrate the benefits of an integrated science approach so that these methods can be incorporated into future natural resource management programs.

Figure 1. Careful monitoring of Alaskan glaciers provides critical information about the global warming dilemma. National Park Service geologist Ron Karpilo setting up to document Muldrow Glacier in Denali National Park, summer of 2004.

In addition to the twelve companion presentations that made up these sessions, nine park vignettes were provided as examples where physical sciences in general and geoscience in particular have significant consequences for ecosystem function. In some instances the examples were used to point out the significance of geology. In other instances they pointed out where geoscience was ignored in ecosystem management, an oversight that often had negative results. Other examples illustrated success stories of how the integrated science approach produced excellent results when all the disciplines were considered valuable on the multi-disciplinary team. Abstracts for the other talks can be found in the conference program and abstracts book, available at the George Wright Society website (www.georgewright.org).

Integrated science approach

Higgins' talk was titled "Integrated Science: The Importance of Understanding Other Scientific Perspectives," and was intended to set the stage for the other presentations that followed. How we manage our lands, and specifically our public lands, depends upon how we view ecosystems. John Muir once observed that when we try to pick out anything by itself, we find it hitched to everything else in the universe. Understanding how these interdependent ecological systems work provides the basis from which we attempt to manage them. If we are going to successfully implement an integrated approach, then we need to have an appreciation of the natural sciences and the social sciences, which comprise the ecosystems. It is our ability to appreciate different perspectives that will be critical to the success of multidisciplinary teams created to work through solutions to land management issues.

Lawmakers, park managers, and scientists agree that science is needed to manage parks, as evidenced by passage of the National Parks Omnibus Management Act of 1998. To address resource issues, research in the basic scientific fields is critical, but just as importantly the National Park Service needs scientists of different disciplines and perspectives (i.e., integrated science teams) to arrive at comprehensive solutions. Changes to implement these approaches are occurring, but a number of factors hinder the rate of progress in taking the ecosystem approach. Resource specialists are most comfortable operating within their area of experience and academic training, and often that expertise is limited to biology. Many parks are not accessing specialized expertise, such as that offered by geoscientists, biogeoscientists, and geoecologists. The time, effort, and cost of bringing together multidisciplinary teams have also been a deterrent. What is helping us progress? We have a broadening definition of ecology that has begun to include the abiotic, such as ocean temperature, soil chemistry, and even the texture of cliff faces. Our view of ecology is changing.

In the late 1960s, our first view of Earth from space gave us a striking image of the interdependent nature of our planet's ecosystems. Since then, there has been an increasing public expectation, nationally and internationally, that scientists would eventually gain an understanding of our global ecology and thereby improve our ability to preserve the environment in which we live. There are further expectations that national parks protect the best examples of pristine conditions and therefore may provide a baseline for ecosystem comparisons. By gathering long-term data on ecological indicators of change in our national parks, we hope to gain a better understanding of the physical components of ecosystems and provide information that will contribute to the preservation of healthy ecosystems (Higgins and Wood 2001).

The original concept of ecology and the ecosystem was a biological one. It focused on the interaction of species, such as predator–prey relationships, declining populations and causes for extinction, etc. In short, ecology was a biological concept. Landscapes began to creep into the picture primarily as the basis for habitat. Geology was thought of as the backdrop on which the complex and varied interactions were played out. It involved processes that take millions of years and was therefore not often considered in the design and implementation of land management programs. This is a basic misconception that has plagued our understanding of the role of geology in ecosystem management, and is a factor even to this day. In reality, the opposite is true: geologic processes can occur rapidly, in the same timeframe as biological processes, and are easily observed over the period of a human lifespan. Geology is a dynamic part of the physical science component of the ecosystem, which is as important as the biological and human components.

Geology and the other physical sciences, along with information from social and biological sciences, contribute important information to our understanding of ecosystem function. The triangular diagram (Figure 2) conceptually illustrates this ecosystem model.

Understanding ecosystems requires not only knowledge of the component parts and their interactions, but of their natural cycles and variability as well. In the last few decades, we have come to realize that change in an ecosystem is natural and desirable. Steady-state conditions over time are not generally found in nature. This concept is important for our understanding of the interaction of human influences and natural processes. We perceive that the human component of change in the ecosystem is expanding disproportionately and often at the expense of abiotic and other biotic components. But, measuring stress at the interface between humans and the environment requires scientific tools that can resolve naturally occurring change from human-induced change (Higgins and Wood 2001).

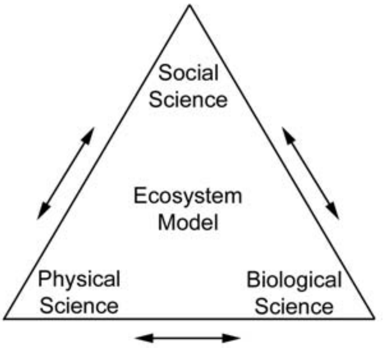


Figure 2. Illustration of how contributions of the different sciences contribute to understanding the ecosystem.

Many people develop a comfort zone in the vicinity of one of the points of the triangle model. However, we often find the solutions to our resource management issues in the area closer to the center of the triangle. This indicates the issues tend to be multifaceted, often having biologic, physical, and social aspects.

Making the point for the forgotten science

In addition to addressing the misconception of physical features as scenic backdrops to the plants and animals, there is another major concern: overcoming an entrenched bias toward one aspect of ecosystems, the biocentric approach. The intrinsic value of geology and the possible roles it plays in ecosystems are just barely being realized, despite the fact that geologic processes and features are often primary reasons for establishing many parks. Geology has often been inadequately addressed in park planning, facility design and placement, visitor safety, resource management, and visitor education. The consequence has sometimes been that park facilities are built in geohazardous areas, park visitors are exposed to geologic hazards, management decisions are detrimental to resources, and educational displays are incomplete (Shaver and Wood 2001).

Although outnumbered by more than ten-to-one by Park Service biologists, the agency's geoscientists are becoming part of an integrated approach to science-based resource management in parks (Figure 3; Shaver and Wood 2001). The hope is that, as park managers gain access to geoscientists, they gain an appreciation of the value and relevance of geology for preserving and understanding park resources.

In order to measure success, there are several things to watch over the next decade. The first is the degree to which geologic monitoring is incorporated into ecological (vital signs) monitoring programs. One of the key concepts of monitoring is to ensure that we design park programs that cover all aspects of the ecosystem so we increase our chances of detecting the first trigger of change. If geological processes are not being sufficiently monitored, we increase the possibility of missing the first element of change in a particular ecosystem. The absence of geologic monitoring data also has the potential of giving us an inaccurate picture of the ecosystem. Budgetary constraints force us to pick and choose what monitoring we can afford, and this simply magnifies the need to use multidisciplinary approaches in carefully weighing which vital signs we should choose.

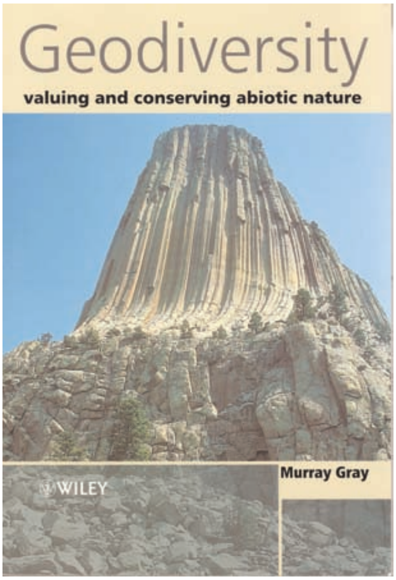
Figure 3. Characteristics of the rock, as well as coastal processes, biological communities, and human activities, all play a part in designing projects for effective resource management. Photograph taken by National Park Service geologist Rebecca Beavers at Cabrillo National Monument.

The second parameter for success is to improve on the availability of geologic information in our planning documents. Geologic information is needed to clearly frame some of the important issues of park planning. The Park Service is also embarking on an ambitious objective to create stewardship (natural resource) plans over the next five years for every park in the system. In order to have a comprehensive natural resource management plan, it is critical that geologic information be incorporated.

New concepts from the geologic community

A movement within the geologic community is giving rise to a new way of thinking about geology: it is the concept of geodiversity. The concept of geodiversity, a term coined from its familiar predecessor, biodiversity, comes alive in Murray Gray's new book, *Geodiversity: Valuing and Conserving Abiotic Nature* (Figure 4). The book uses arguments parallel to those used to support the importance of biodiversity to build a strong case for valuing geodiversity. There are three significant concepts and parallels. One is the need to identify the geologic resources, such as features and processes, that are analogous to biotic species inventories. Another is embracing an understanding and definition of geologic values that is parallel to the values we have placed on maintaining diversity of biota. The third is realizing that the protection of geologic features and processes is equivalent in importance to preventing species extinction and disruption of migrations (Gray 2004).

Figure 4. In his 2004 book *Geodiversity: Valuing and Conserving Abiotic Nature,* Murray Gray makes the point that preservation of important geoheritage sites is just as critical as preservation of biological habitat and communities.



Although there are a number of national, state, and local programs focused on creating inventories of geologic features, they do not use the same criteria and are not compatible with one another. The National Natural Landmarks program is the best documented effort designed to identify and document nationally and regionally significant landmarks. Examples of geologic heritage sites include Grants Lava Flow, John Day Fossil Beds, Malaspina Glacier, and Eureka Sand Dunes. Parks are now required to produce a paleontological inventory, which could provide another type of data. We have created many other pseudo-inventories by simply identifying significant sites, such as citing geologic type sections in scientific literature; setting aside parks that focus on geologic icons (Devils Tower, Yellowstone, Grand Canyon), setting aside areas that have scientific significance (Hagerman Fossil Beds, Wind Cave, Hawaii Volcanoes), and writing curricula and trail guides to natural curiosities (Bubble Rock in Acadia, cross-bedded sandstones in Zion, and karst in Everglades).

Because of the durable nature of rocks and their seemingly endless supply on the landscape, it may be surprising to learn that many geologic features are as rare as endangered species. Fossils created millions of years ago, dazzling cave features, or rare minerals can never be replaced when destroyed by the hands of vandals and collectors. Like the strategies to protect against biological extinction, parks must work to make the public aware that a similar permanent loss can happen to our rare geologic features and fossils. For the most part, geologic resources are irreplaceable and, in some cases, even minor disturbance can result in the loss of significant scientific information. We owe a debt of gratitude to Murray Gray and the geologic community for creating a heightened awareness that geology, like biology, has a rich diversity worth identifying, valuing, and protecting.

Advances in geotechnology are adding to park's traditional field observation and investigation methods. The technological tools now available are more precise and have wider application to support our integrated science approach. Such tools range from the macro- to the micro-scale. Remote sensing has been available for decades; however, the continuing improvements in resolution and different wavelength scanning capabilities are enhancing our ability to examine both geologic features and biota in greater detail. By using geologic themes with biotic layers, GIS capabilities are expanding our ability to spot geospatial relationships. Most recently developed, terrestrial three-dimensional laser scanning makes it possible to capture critical landscape data on plants, geology, and impacts from social activities at one time. It is also looking very promising to use this technology as a monitoring tool, when used at repeated intervals. The ability to apply such technologies in a multidisciplinary approach may lead to the availability of better information to guide management decision-making.

The geologic community itself is becoming more integrated in the disciplines that it encompasses. New broad-based curricula are being developed, and academic degrees are now based on integrated science courses whose names reflect this integration: biogeoscience, geoecology, and geoarchaeology. Additionally, the traditional ecology degrees are beginning to require a heavy dose of physical sciences and social sciences. Even professional organizations in geology now recognize the importance of crosscutting work and offer opportunities for recognition of multidisciplinary endeavors by scientists. All of this could benefit parks by providing a community of scientists who could provide support to our integrated science approach.

Conclusion

While there may be some consternation in the geologic community, there is reason to be guardedly optimistic that we are making progress in the right direction. Paradigm shift often occurs as an evolving process, rather than an abrupt change. The Park Service is slowly moving away from a stovepipe approach to science, where options are developed by a single specialist or a group of like-minded specialists. We are undergoing a slow, but steady, change to an integrated science workforce.

The National Park Service has made a strong commitment to science-based management and has taken several steps toward gathering and using natural resource information to gain a better understanding of park resources. The triangle ecosystem model is a means to illustrate how information from the many scientific disciplines within the physical, biological, and social sciences can be integrated into a holistic ecosystem management approach. The concept of biodiversity and the emerging concept of geodiversity provide perspectives on the interplay between physical settings and biological communities. Examples of integrated science information being applied to park management issues make the point that the integrated science approach can work. We must be ever-vigilant of our need to examine scientific information from many disciplines in order to guide our management decisions and realize our goals for ecosystem management.

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Neoclassical Economics and the "Cult" of Economic Efficiency: Understanding the Ghosts of the Past

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Introduction

As part of this panel on ecological economics, I have been asked to critique neoclassical economics, the persuasion to which most economists ascribe. To do this, one must be familiar with economic efficiency, the cornerstone of neoclassical economics. Indeed, economic efficiency provides the foundation for the work of neoclassical economists and for much of our policy making. For example, cost/benefit analysis, which is a tool many of you use, is a derivative of the principle of economic efficiency and is believed to be the automatic outcome of markets that are functioning perfectly.

Adam Smith's world and legacy

The roots of the preoccupation with economic efficiency and the idea of perfectly functioning markets go back to the work of Adam Smith. During the 16th, 17th, and 18th centuries the long history of feudalism was coming to an end in Europe and a different type of economic system was emerging. Smith was trying to make sense of this changing world. In 1776 he published his seminal work, *The Wealth of Nations,* where he articulated for the first time a systematic treatment of the market economy and highlighted the benefits therein.

Smith was a great proponent of natural law. He saw human nature as complex and characterized by many different "impulses," some of them contradictory. The market economy seemed to him to build on and balance out innate inclinations that included "self love, sympathy, a desire to be free, a sense of propriety, a habit of labor, and the propensity to truck barter and exchange one thing for another" (Roll 1974:146) Smith presumed that social harmony grew out of individual self-interest under the organization of the market economy. He stated: "It is not from the benevolence of the butcher, the brewer, or the baker, that we expect our dinner, but from their regard to their own self interest. We address ourselves not to their humanity but to their self-love, and never talk to them of our own necessities but of their advantages." We are all acquainted with the metaphor of the invisible hand. Producers follow their own self-interest; that is, to make money and are led "by an invisible hand" to provide people with what they want (Smith 1776 [1969]:18).

Smith highlighted the fact that we all have a natural proclivity to truck barter and exchange, which encourages a division of labor, thereby making us more productive. The limit of the division of labor is thereby dictated by the extent of the market.[1] Finally, Smith recognized the importance of competition to assure that the freedom of individuals to trade was not corrupted by economic power. Again, the market economy, by building on and balancing our natural proclivities, was considered by Smith to be the natural order of society.

Neoclassical economics and the meaning of economic efficiency

Over the course of the 19th century, Adam Smith's idea that the market economy was the natural order of society eventually ossified into a system of thought we refer to as "neoclassical economics." Neoclassical economists worked out a highly mathematical, mechanistic framework for modeling the market economy that gave new meaning to the notion of the natural order. The market economy was thought to behave like the laws of Newtonian physics, mechanistic and deducible from first principles. In this model, individual decision-making is the entry point and focus of analysis. Individuals are thought to be self-interested maximizers of utility and profits. The complexity of human nature acknowledged by Smith was reduced to the crass utilitarianism and individualism of Jeremy Bentham as espoused in his book *An Introduction to the Principles of Morals and Legislation* (1780 [1969]). Provided there is no coercion or "market power" and provided that individuals have all relevant information, the "invisible hand" of the market is thought to automatically assure that individuals get what they want in the amounts they want at the lowest possible price, all without central planning and big government. This is specifically what is meant by "economic efficiency." Thus the market channels individualism and self-interest into what is considered an optimal allocation of resources. The model of the economy, known in principles of microeconomics courses as "perfect competition," is the systematic presentation of this framework.

In the neoclassical model of perfect competition or perfectly functioning markets there is no concentration of economic power and no advertising. Information is perfect and so is foresight, and markets are accessible to all who want entry. Individuals maximize their utility and firms maximize profit under these arrangements and all costs and benefits of production and consumption are reflected in market prices.

But the reality is markets never function perfectly. Over time, the concentration and centralization of market power have become facts of economic life and the nature and size of the economy has changed dramatically. We've moved beyond pin factories, Adam Smith's quintessential example of modern production. Moreover, markets have been plagued by the presence of externalities, common-property resources, and other sorts of "market failure." Indeed, many costs and benefits of production and consumption are simply not registered in the market. Furthermore many environmental services and amenities, such as healthy ecosystems and the presence of wilderness, have no market values attached and are simply not considered in market decision-making. Ascribing market value to environmental amenities that cannot be priced is contrived and always inadequate.[2] Nonetheless, after several centuries of the reality of imperfectly functioning markets we are still using the model of perfect competition as the norm or standard by which we judge how well real markets are functioning.

The problem of misplaced emphasis

It is true that over time neoclassical economics developed models of *im*perfect competition and "market failure" to accommodate economic reality. The recognition of different sorts of market failure, such as common-property resources and the existence of externalities, and the presence of imperfect competition, such as monopolies and oligopolies, became the framework for thinking about the real world. The idea was/is to try to determine how these real-world situations deviate from the "norm"; that is, the norm of perfect competition—which rarely occurs and therefore is not the norm. In this framework. policy-making attempts to militate against the concentration of economic power, internalize externalities, specify property rights, and ascribe prices to amenities that have no prices. In short, these are the strategies used to deal with the "aberrant" markets so that they can be made to function more perfectly and assure the outcome of economic efficiency. This misplaced emphasis places the real world of markets in the shadow of perfect markets, subsumed under the heading "market failure." Efficiency, which is never the outcome of real markets, somehow becomes the *sine qua non* of market outcomes. Things are turned upside down. In part, this is how we are led out of the world of reality and into the world of ideology where beliefs become fixed in an almost irrational way.

But perhaps as problematic as the misplaced emphasis is the fact that we are given the impression that if only we can correct for market failure, things will be "hunky dory." This simply is not the truth. Efficiency doesn't guarantee sustainability or equity. As an example, wilderness can disappear completely from this earth. Fisheries can be depleted. Biodiversity can be lost. Ecosystems can be simplified and degraded. We can have an economy that produces mink coats while people can't access health care. That is not to say that sustainability and equity can't be added on as separate goals; indeed they must be added on if they are to be acknowledged as necessary outcomes of our present economic system.

The problem with making biophysical reality and history irrelevant

Another significant problem with the preoccupation with economic efficiency is that it offers us a framework for envisioning the economy that is removed from biophysical reality and de-emphasizes history. The importance of biophysical reality and qualitative and cumulative effects of the economy over time are sacrificed for the emphasis on rational decision-making of individuals given the constraints they face (reflected in prices) at a point in time. Neoclassical economics tells us that at a point in time there aren't enough resources to produce everything that everyone wants. Thus "the" economic problem becomes one of constrained maximization; that is, getting the most satisfaction out of the resources we have. Individuals maximize utility given the prices they face and their budget constraints and firms maximize profits given the prices of resources. Prices presumably reflect short-run scarcity and all costs and benefits of production and consumption. Efficient markets will assure that existing resources are allocated to resulting maximum satisfaction, therefore guaranteeing that we do the best with what we have.

For a moment let's see where this emphasis takes us. It is assumed that if firms are presented with the scarcity of a particular resource, the price of that resource will increase. In response to the price increase, firms will simply try to find another resource that they can use as a substitute, much as consumers will substitute among products they consume as prices change. Firms have the imperative to find substitutes on the basis of price changes because of the reward of profit or the fear of being put out of business. Moreover, in the longer run, as some resources become scarce, technological change, also induced by price changes, is assumed to be forthcoming to overcome any particular resource constraint. This is a world where all resource scarcity is relative and registered in prices and no scarcity is ever absolute, an economic world disconnected from biophysical reality. The belief is that price changes elicit substitution and technological change, which overcome short-run and long-run problems of scarcity. With faith in technology and the fungibility of resources, there is no concern with the overall scale of economic activity, nor is there concern with absolute scarcity. The primary concern is assuring that market prices register what they should so we get efficient outcomes.

But what do history and biophysical reality actually tell us? They tell us that the rate of change and growth of the economy are unprecedented and both this *rate of change* and its *cumulative effect* are important considerations. They tell us that environmental and ecological sensibilities and understanding are often eclipsed by short-run economic imperatives, and that more often than not we are unable to anticipate in a timely fashion the problems that technology and the scale of economic activity present us. Market prices will never sufficiently capture all that is necessary for a full consideration of the relationship of the economy to the natural world.

Conclusion

Jack Turner's rant on "Economic Nature" in his book *The Abstract Wild* (Turner 1996:51–68) provides an interesting perspective on economics. According to Turner, we must be mindful of the ways that economists colonize the world with their language. Surely we should not allow the world to be colonized by the language of "economic efficiency." It is not magic, it's not natural law, and it can't reflect all of the reality society needs to consider. It cannot assure economic justice or sustainability in the sense that we leave future generations with the same possibilities for fulfillment that we have enjoyed. We should be cautious about using a framework that claims to account for so much and yet accounts for so little. Without proper attention to the dynamic historical reality of the interface between the economy and the natural world, an emphasis that the framework of economic efficiency can't provide us, we will be left trying to deal with global climate change as if it were an externality and wilderness preservation as simply a matter of appropriate valuing in the framework of cost/benefit analyses. It is imperative to think outside the box of economic efficiency. We must account for many things that cannot be encapsulated in the language of efficiency, including the irrationality of unbridled economic growth.

Endnotes

1. The economist, Karl Polanyi, made the following comment about Smith on this point: "In retrospect it can be said that no misreading of the past ever proved more prophetic of the future" (Polanyi 1944 [1957]:43).
2. For an excellent critique of attempts to do so see Ackerman and Heinzerling 2004.

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Using Interns for Research and Resource Management at Mesa Verde National Park: A Success Story

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Program overview

In partnership with Fort Lewis College in Durango, Colorado, Partners in Parks is managing the intern program in nearby Mesa Verde National Park. Starting as a small project with a few students, it has grown to ten students, from two schools, supporting several of the park's programs. The interns receive academic credit and a stipend for their work. Their assignments range from historical research, assessing archaeological sites and features, website and brochure design, and cataloguing artifacts, to surveying specific plants and animals, and designing computer programs for data management.

In 2001, Partners in Parks approached Fort Lewis College and Mesa Verde about establishing an internship program. Under the leadership of the college, four interns were placed in the park in 2002, and paid with park funds. In 2003, Partners in Parks obtained funding from the Colorado State Historical Society, along with matching funds from the Fort Lewis College Foundation and the Mesa Verde Museum Association, which allowed participation to increase to nine interns. In 2004, funding from the same sources as 2003, plus additional funds from the park and elsewhere, supported ten interns. The 2005 program will receive funds from the three partners and will support eight to ten interns.

We have an effective recruitment mechanism. The college establishes academic prerequisites for the intern candidates. Park staff hold an internship fair to attract student interest. Faculty screen the candidates for park staff to make the final selection.

Internship projects contribute to park programs. They are not just procedural exercises. Park staff have been enthusiastic and successful student mentors. College faculty and park staff evaluate the quality of the work done. Partners in Parks provides oversight to the ongoing partnership and manages the funds from all the sources that support this program. The three partners are strongly committed to the success of this program.

The partners

Partners in Parks creates educational opportunities in national parks for students and volunteers. We recruit highly skilled individuals to conduct research and preservation projects in these special places. In addition to our internship program with Mesa Verde, Partners in Parks has sponsored a successful internship program with national parks since 1997, primarily at significant battlefield sites. Our interns are both graduate and undergraduate students who receive stipends and academic credit for their work. Several students have used their projects as the basis of their thesis or dissertation. Other current projects include a habitat restoration project at Glen Canyon National Recreation Area (Arizona). We have awarded a fellowship to a master's degree student, who will conduct research on controlling two exotic species and restoring the native habitat. Zion Partners, a volunteer group working at Zion National Park (Utah), manages the park's native plant propagation program and provides educational programs to local elementary schools.

Fort Lewis College is a four-year, state-assisted undergraduate institution that offers baccalaureate degree programs in the arts and sciences and in the professional areas of education and business. Fort Lewis College is an outstanding partner, for it is dedicated to undergraduate education that links knowledge with practice for all its students, and particularly for those whose ethnic heritage is linked with the Southwest. One of the academic deans, John Ninneman, directs the college's part of the internship program. He has encouraged the participation of several professors and helped standardize the academic requirements of the internships. He writes:

> The close relationship between Fort Lewis College, Mesa Verde, and Partners in Parks is a natural one in which everybody wins. Not only are real-world experiences made available to students in a variety of disciplines, but the Park gains skilled and eager learners, and perhaps even future Park professionals. Partners in Parks has been the catalyst in helping this successful relationship to work as well as it has.

Mesa Verde National Park is one of the most outstanding and culturally significant sites in the country, with archaeological sites that are some of the most notable and best preserved in the United States. Created in 1906, it was the first national park designated for its cultural resources; all previously designated national parks primarily celebrated natural features. It was also the first area in the United States to be named a World Heritage site. The chief of research and resource management manages the park's part of the internship program. She has been able to involve a number of the park's divisions in the program.

The process

The 2005 internship partnership among Fort Lewis College, Mesa Verde National Park, and Partners in Parks began with a planning meeting in November 2004. Guidelines for the internship program were developed, the roles and responsibilities of each of the three partners were defined, a schedule of activities for the internships was set, and potential funding sources for 2005 and beyond were discussed.

Park and college staff held an internship fair at Fort Lewis College for prospective interns in early February. Forty students attended; 18 returned a questionnaire, indicating their interest in an internship. Eight students have been chosen for projects to begin in May 2005. Partners in Parks will draft the internship agreement, which the three partners and the interns sign. For each project it specifies the work to be done, and who the mentor and supervisor will be.

Each intern has a park staff mentor, who prepares the student to do the assigned work. For some projects, park staff and interns work together as a team. For other projects, the interns do their work, checking in with the park mentor on a regular basis. The interns also receive oversight by their faculty advisors, who receive park staff recommendations and assign a course grade. Faculty members may assign additional reading and/or reports to support the work done in the park.

Eight interns will work this summer in positions funded by the State Historical Fund, Mesa Verde National Park, and Fort Lewis College Foundation. The students will begin their internships on May 9, 2005, with an orientation meeting. Their next requirement is to attend the park's two week interpretive training course at the end of May. An interim meeting will be held at the park in mid-June, at which each intern will present his/her internship project and accomplishments to date to the other interns and park staff. The interns will finish their projects in July and submit their work products and final reports to their park mentors and faculty advisors.

During the past several years, projects have been created in areas such as archaeological preservation and stabilization, architectural history, natural resource monitoring, and visitor education. Many of the projects include database management, computer mapping, and/or website development. Some archaeology project assignments require completion of the college's Archeology Field School prior to the internship.

Interns work for 400 hours. Partners in Parks provides stipends of $8.50 per hour and pays some travel or housing expenses, in order to offer students of lesser means the opportunity to participate.

This intern program also focuses on American Indian students, as Fort Lewis College is required by federal statute to admit these students "free of charge for tuition." To lend prestige to the program, the college created a named internship, the Robert and Florence Lister Internship, which recognizes an outstanding student who has demonstrated a strong interest in historic preservation. Two students have already received this honor. A third Lister Intern will be named in April.

Partners in Parks is the fiscal agent for the program. Park funds are moved to Partners in Parks' account through task orders that are written each year and are attached to Partners in Parks' cooperative agreement with the National Park Service. Partners in Parks has raised over $100,000 to support this program.

The outcome

College students need practical experience in their area of interest, prior to making a career choice. They should learn from a practicing professional what their life work would be like. Such an experience usually energizes the students and focuses their interest, or occasionally causes them to change their major program. Either outcome is exceptionally valuable. The park offers a vast opportunity for discovery, contemplation, and study. Students are given an opportunity to advance their skills in a protected area of national significance, while helping the park fulfill unmet needs through professionally mentored internships.

The public benefit from this project is both direct and indirect. Students interested in natural resource management, archaeology, historic preservation, and related areas as careers are given the exceptional opportunity to advance their skills and study professional methods and techniques for college credit. The results of their work are added to the park's database, thus contributing to the knowledge and understanding of the site. Their work aids the park's visitor education program, as well, by preparing more information on the park's sites, which can then be imparted to the millions of visitors hosted by the park each year.

Here are a few examples of what our interns have accomplished. They have:

- Developed an internship program brochure and news release, centennial brochure, and illustrations for a "Got Ticket?" brochure;
- Completed historical research on a Civilian Conservation Corps (CCC) camp as the basis for a National Register of Historic Places nomination;
- Detailed documentation of painted surfaces, digitizing the information;
- Developed a GIS project that assesses relationship of precipitation and temperature changes to deterioration of plaster;
- Performed a structural assessment of Oak House and archival research of old photographs and stabilization records;
- Made the park's archaeological research and preservation website more functional and attractive;
- Assisted the condition assessment backcountry field crew in documenting and monitoring more than 600 alcove sites;
- Assisted natural resource management staff in air quality monitoring; bird, bat, fish, and ponderosa pine stand surveys; and nonnative plant control;
- Upgraded storage of collections, worked on cataloguing, and updated database file records;
- Georeferenced historic maps; and
- Developed a program for a hand-held computer to collect data on invasive plants.

> The internship summer was a highlight for me in my educational experience. The privilege was the intern's to be working with outstanding mentors and having exposure to real world employment opportunities after graduation from college. It is my hope that this program will continue so other students may have the opportunities afforded to me from my internship.
>
> — *William Tsosie,* Lister Intern

These projects and others like them are highly professional and very much a part of the park's necessary and on-going work to protect and preserve its resources. Our combined efforts have enabled Mesa Verde staff to learn more about the significance of the park's cultural and natural features and to expand the park's database without adding staff or contractors.

The future

There are several things we intend to do to improve and expand our intern program at Mesa Verde. We will expand the number of subject areas of the projects so more students are eligible to participate. We will include students from other colleges in our program at this park. We will establish internships at other parks in which students from Fort Lewis College and elsewhere might participate. We will continue to emphasize diversity among students who participate in our program. To accomplish this, we will need to increase the amount of funds we raise as well as the number of sources that support us.

Our goal is to use the partnership model we have created with Fort Lewis College and Mesa Verde National Park to establish an on-going relationship between national parks and other colleges and universities. Starting with parks and academic institutions in Colorado and then surrounding states, we will continue to offer interested students a remarkable opportunity to advance their skills in protected areas of significance. With a network of college–park partnerships, parks will be able to recruit from any college or university in the region. Colleges will be able to expose their students to a great variety of professional opportunities.

Organizational Learning in Wildland Fire

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Introduction

The Wildland Fire Lessons Learned Center is a knowledge resource center that serves the entire wildland fire community. The interagency wildland fire community includes the federal land management agencies, the states, and local/rural wildland fire departments in the United States. The center's objectives are to improve safe work performance, improve organizational learning, share knowledge, and promote organizational change.

Background

The Lessons Learned Center got its start in 2002 because of three primary reasons. First, the interagency wildland fire community is a diverse community since it involves hundreds of wildland fire organizations at field and management levels. Second, the Tri-Data study that was completed after the 1994 South Canyon Fire fatalities recommended that the wildland fire community create a program where lessons learned could be shared widely with wildland fire professionals. Lastly, a recommendation from the re-engineering plan for the National Advanced Fire and Resource Institute (NAFRI) recommended incorporating lessons learned and best practices into the fire training curriculum.

Organizational learning

For the wildland fire community to successfully and safely perform its missions, it needs to be a learning organization. A learning organization is skilled in creating, acquiring, interpreting, transferring, and retaining knowledge, and purposefully modifying its behavior to reflect new knowledge and insights (Garvin 2000). The Lessons Learned Center is assisting the wildland fire community in becoming more of a learning organization by performing six critical tasks. These tasks are:

- Collect intelligence about the environment;
- Learn from the best practices of other organizations;
- Learn from its own experiences and past history;
- Experiment with new approaches;
- Encourage systematic problem-solving; and
- Transfer knowledge throughout the organization.

To assist in organizational learning, the Lessons Learned Center is organized around three Focus Areas: collection and analysis, knowledge retention, and knowledge transfer.

Collection and analysis

After-action reviews (AARs) and information collection teams (ICTs) are the primary tools used to collect pertinent wildland fire information. Case studies and surveys are also important collection tools.

After-action reviews. AARs are an inexpensive, simple, systematic process that has the power to change an entire work culture. The AAR is the cornerstone of organizational learning. The four questions asked in this learning after doing tool are: (1) What did we set out to do? (2) What actually happened? (3) Why was there a difference? (4) What are we going to do next time?

AARs begin the knowledge transfer process. Most of the AAR results are used to enhance or sustain the performance of a unit or team. "Gems and nuggets" will surface from the AAR that will be valuable to others, but only *if* they can have access to the knowledge. This is where the AAR rollup tool comes into play. This tool collects the gems and nuggets from your AAR by asking:

- Can you describe one or more of your successes *that others can learn from?*
- What was one of the challenges you faced and how did you overcome it?
- How can training be improved?
- What are your recommendations for any unresolved issues?

AARs and AAR rollups are collected and analyzed by the Lessons Learned Center for wildfire, prescribed burns, wildland fire-use events, fuels projects, and all risk events. The lessons learned and best practices are then shared with the wildland fire community through newsletter publications and the Lessons Learned Center website.

Information collection teams. ICTs are another key tool for collecting wildland fire information. A collection plan is developed before a team is formed, which comprises subject-matter experts and a member of the center staff. ICTs collect tactics, techniques, procedures, and processes at an event for 5–12 days. An initial impressions report is then developed and shared with the wildland fire community. The purpose of an ICT is to collect lessons and practices. The team does not investigate or review. Collection team efforts in 2004 included:

- States—southern fire chiefs and Northeast fire supervisors
- Alaska wildland fires
- Wildland fire-use event in Pacific Northwest
- Hurricane response in Georgia, Alabama, and Florida

Knowledge retention

Communities of practice are key components to how the wildland fire community learns. A community of practice is an *informal* group of people with similar work-related activities and interests. Members can belong to many agencies or reporting structures. Community members regularly transfer and retain knowledge.

In the interest of serving the various wildland fire communities of practice, the Lessons Learned Center developed an on-line community center at www.myfirecommunity.net. Launched in the summer of 2004, the focus is on learning and sharing knowledge because sometimes life's lessons are too easily lost. This on-line community center is here to assist wildland fire communities of practice to identify one another, share learning opportunities, discuss issues and concerns, and exchange knowledge.

The MyFireCommunity website contains four features:

- *Community directory.* This is a "yellow pages" of people who work in wildland fire. People can learn about other members' current projects and interests, and add themselves so others can learn what they are up to.
- *Learning opportunities.* This feature includes a calendar of seminars, conferences, and other events related to one's wildland fire community of practice. Also available are on-line training presentations to view or download.
- *Discussion center.* People can pose questions and get answers by reading or joining in a discussion. All discussions are moderated for content.
- *Knowledge exchange.* People can add a lesson they have learned, share a useful tool or process, publish AAR "gems and nuggets" that others can learn from, or browse submissions from others.

Knowledge transfer

The primary way to share wildland fire knowledge is through the network of professional wildland firefighters working in communities of practice. Workshops such as "Achieving the Learning Organization: Facilitating After Action Reviews and Managing the Unexpected: High Reliability Organizing" have laid the groundwork for the importance of organizational learning. Video products of these workshops are available through the Lessons Learned Center. Other knowledge transfer mechanisms are:

Websites. The www.wildfirelessons.net website contains wildland fire knowledge arranged in a format where users can get to what they are interested in. The website also has significant interaction with safety, training, and leadership development sites for both wildland fire and non-fire incidents. As described above, the www.myfirecommunity.net website is the wildland fire on-line community center.

***Scratchline* newsletter**. The center publishes a quarterly newsletter as new tactics, techniques, procedures, and processes are identified and lessons learned or best practices received from the field. *Scratchline's* main purpose is to inform and educate the reader in a fast and simple format. Articles come from the entire wildland fire community, as lessons are learned everywhere.

The Learning Curve. The center publishes a short lessons learned summary from AAR rollups received and reviewed. It is published periodically for immediate use in the field.

Summary

It is all about organizational learning. As a knowledge resource center, the Wildland Fire Lessons Learned Center is striving to help the wildland fire community be a fully developed and dynamic learning organization. The center acquires, interprets, transfers, and retains wildland fire knowledge. Behavior modification must then occur because we must act on what we know. As the community becomes more involved and embraces these concepts, positive organizational change will take place.

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Realizing Efficiencies through Simultaneous Implementation of Vegetation Research

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Introduction

Prince William Forest Park comprises 15,000 acres of Piedmont forest and protects a majority of the Quantico Creek watershed in Triangle, Virginia. The third-largest national park in Virginia, Prince William Forest Park lies along the border of two physiographic zones: the Piedmont and the Coastal Plain. The park also lies within the transition zone between northern and southern climates. This confluence of environmental factors creates a wide diversity of vegetative communities and habitats that support a unique combination of life. Vegetative species include mixed oak forest, mesic hardwood forest, butternut, bigtooth aspen, swamp white oak, cottonwood, box elder, sycamore, and American beech. Unique habitats include oligotrophic saturated forests (seepage swamps), vernal pools, and habitat for a federally listed threatened orchid.

Before the establishment of the park in 1936, considerable portions of the Quantico Creek watershed were used for logging, subsistence farming, and mineral mining. Land use, combined with the undulating terrain and sandy soils, led to severe erosion problems, including the eventual disappearance of the Quantico Bay due to heavy sediment loads. Once the park was established, the long process of restoration was begun on open farmlands and mined areas.

During the 70-year history of Prince William Forest Park, resource managers have learned a great deal about the types of flora and fauna that exist in the park. However, the last five years have seen the most intensive research on the vegetative composition of the park. Research has included intensive monitoring of exotic plant species, a comprehensive floristic survey, the implementation of a vegetation monitoring program, a vegetation mapping project, and surveys and documentation of a federally listed threatened plant species, *Isotria medeoloides*.

Exotic plant survey

In the fall of 2000, an exotic plant management team (EPMT) was established in the National Capital Region (NCR) of the National Park Service (NPS). The EPMT was one of five rapid-response teams placed throughout the country to give individual parks assistance in surveying and eradicating invasive plant species. In the spring of 2001, park resource managers met with EPMT staff to delineate and prioritize areas to be surveyed in the park. These areas included road corridors, stream corridors, fields, old home sites, utility lines, cemeteries, and backcountry areas. Using a Trimble global positioning system (GPS) unit and field data sheets, the EPMT collected information on the scope of exotic plants within the park's boundary. The team entered this information into the Alien Plant Control and Monitoring (APCAM) database, which has been shared with park resource managers, along with numerous spatial datasets of invasive plant locations.

To date, the EPMT has surveyed over 200 acres within the park, and discovered 45 species of exotic plants (APCAM). Chinese wisteria *(Wisteria sinensis),* princess tree *(Paulownia tomentosa),* Japanese stiltgrass *(Microstegium vimineum),* Japanese barberry *(Berberis thumbergii),* multiflora rose *(Rosa multiflora),* mile-a-minute (*Polygonum perfollatum*), Japanese knotweed *(Polygonum cuspidatum),* and oriental bittersweet *(Celastrus orbiculatus)* are some of the main threats to native vegetation included in this list. Since the completion of the initial survey, the EPMT has focused treatment on highly invasive infestations of Chinese wisteria and Japanese knotweed.

Floristic survey

In 2002, Ted Bradley, associate professor of biology at George Mason University (GMU), and a former graduate student, John Dodge, began a comprehensive survey of vascular plants in Prince William Forest Park. The goals of the project were to accurately estimate the number of vascular plants within the park, to 90%, and to verify that accuracy through an intense plant survey. Bradley's initial 90% estimate was developed by a heuristic method that combined the findings of two vascular plant surveys from similar habitats; one in western Virginia, and the other from the Delaware Water Gap. Prior to the actual field survey, the researchers 90% estimate was 652 species, which implied that the field survey would yield around 724 species. More importantly to resource managers, the survey provided a complete list of vascular plants within the park.

The survey was organized into three main phases. First, by using U.S. Geological Survey (USGS) topographic maps, digital ortho quarter quads (DOQQs), and other spatial data sets, Bradley and Dodge delineated different habitat types within the park boundary. The second phase involved frequent field surveys and plant collection trips. The third phase was a repetition of the field survey trips to similar areas, but during different periods. This was done in order to ensure the identification of plants that emerged, fruited, or flowered during different seasons. Field vouchers were collected for plant species that were unidentifiable in the field, and later identified in a laboratory.

The final report for the floristic survey will be finished by the end of April 2005, but preliminary analysis indicates that 749 species have been identified. This number is only twenty-five more than what was estimated by Bradley.

Isotria medeoloides. Commonly known as the small whorled pogonia, *Isotria medeoloides*, a federally listed threatened plant, was discovered in Virginia in 1983. The first formal study of the park's *Isotria* colonies was conducted in 1988 by Donna Ware, an associate professor of biology at the College of William and Mary (Ware 1989). Currently, seven colonies of the plant are known to be within Prince William Forest Park. These colonies are important because only 47 colonies of *Isotria* have been found in Virginia, and few are on protected lands.

The U.S. Fish and Wildlife Service recovery plan for *Isotria* aims to protect 61 colonies within the normal habitat range of the plant. Of these colonies, 75% must be self-sustaining populations. A self-sustaining population for this plant is defined as a colony of at least 20 emergent stems, of which, 25% must flower over a 10-year period (USFWS 1992). Two colonies that lie within the park may meet the recovery plan's criteria.

In the summer of 2003, Ware revisited the park to survey five research blocks for old and new colonies of *Isotria*. *Isotria* generally grows in upland mixed hardwood forests with trees of at least 40 years of age (Ware 1991), and is often found in an open shrub layer or near a canopy break (Ware 1987). The five research blocks surveyed contained similar characteristics as described above. These areas were meticulously searched by creating a search grid with two to five surveyors walking 2 m apart. Unfortunately, no new *Isotria* colonies were discovered in the 2003 survey.

Vegetation monitoring

Starting in 2003, Biological Science Technician Patrick Donovan re-established fifty 20x20-m vegetation monitoring plots in Prince William Forest Park. The plots had previously been established in 1991; however the program was terminated due to funding constraints. The plots are being used to establish baseline vegetation information, help detect changes, and assist in other research capacities. Along with the fifty vegetation plots, 12 vegetation enclosures were constructed adjacent to randomly selected vegetation plots in order to research the effects of deer browsing on park vegetation.

Protocols for the vegetation monitoring were developed over the winter of 2003–2004, and plot sampling began in the spring of 2004. Data collected at the plots include a conditional assessment of all trees in the plot over 5 cm dbh (diameter at breast height), a randomly placed 2x2-m subplot for the herbaceous layer and seedling classification, and a line transect, bisecting the plot, for shrub layer information. The initial plot sampling will be completed by October 2005 and the park will continue to collect data at five-year intervals (Donovan 2004).

Vegetation mapping program

In 2003, the NPS entered into a cooperative agreement with NatureServe to produce a vegetation classification dataset for the 13 park units in the NCR. The information from the classified vegetation map will assist the regional inventory and monitoring network to establish Vital Signs protocols, help identify threats to vegetation, give insight on the status of vegetation communities within the parks, and assist park managers during planning. In order to have uniformity for the region, the classification process will evaluate all parks within the region as if they were one park.

The classification process can be broken down into three steps: field classification, photo interpretation, and accuracy assessment. For the field classification phase, ecologists Gary Fleming and Kristin Taverna, from the Virginia Division of Natural Heritage, conducted plot sampling using a standardized vegetation sampling protocol at 35 locations throughout Prince William Forest Park. The field plot locations were selected so that all habitat types within the park would be represented. The photo interpretation phase combined the plot sampling data along with color infrared imagery of the park, obtained from flights in the spring of 2004, to delineate vegetation classes to the finest level according to the U.S. National Vegetation Classification, the plant association. An accuracy assessment will be performed after the final product is produced in 2006.

Synthesis

Simultaneously researching multiple aspects of vegetation management has helped resource managers at Prince William Forest Park achieve synthesis. Each of the five vegetation projects conducted at the park over the last four years has given managers valuable information on each individual vegetation assessment. The information has allowed managers to take a more holistic approach in protecting the resource. Also, information from each vegetation assessment improved the results of other assessments. This synthesis was achieved through three broad concepts: relationship-building, coordination, and data-sharing.

Part of the success of these projects and the realization of synthesis was due to the relationships of the researchers. Bradley, Ware, and Fleming had worked on numerous projects prior to their most recent projects in the park. Most notably, they were co-authors of the third edition of the *Atlas of the Virginia Flora* (Harville et. al. 1992). In addition, they worked together to classify Virginia natural communities. There were other important relationships connecting the different vegetation assessments. Donovan, the biological science technician in charge of the vegetation monitoring plots, is currently student of Bradley's at GMU.

Resource management at Prince William Forest Park encouraged coordination and data sharing between projects whenever possible. Some examples of the types of cooperation that occurred include:

- Bradley, Ware, and Fleming met at a private residence, at the beginning of their prospective projects, and reviewed maps of the park in order to delineate areas of interest for their projects.
- Donovan accumulated vegetation identification knowledge and field plot construction skills from assisting researchers in the floristic survey, Isotria survey, and vegetation mapping plot sampling surveys.
- Dodge assisted Donovan in the development of vegetation plot sampling protocols for the vegetation monitoring program.
- The EPMT confirmed the existence of exotic plants for the floristic survey, and identified habitats of interest for field ecologists in the vegetation mapping program.
- The initial species list for the floristic survey was supplied to Bradley by Fleming from the vegetation mapping program.
- Researchers for the floristic survey and vegetation mapping project identified exotic plant sites undiscovered by the exotic plant management team.

At times, researchers from differing projects were converging in the field, sharing information about the location of habitats or plants that may have been important to the other researcher. This would not have happened if there had not been an atmosphere of cooperation between the researchers.

Recommendations and conclusions

From the spring of 2001 until 2005, resource managers at Prince William Forest Park implemented five vegetation assessments, a floristic survey, rare plant survey, exotic plant survey, vegetation mapping project, and a vegetation monitoring program. By performing these projects simultaneously, the resulting knowledge gained was greater than if the projects had been done at separate times. The information shared between assessments enhanced the findings of each individual project, thus supporting synthesis. Park resource managers believe that this synthesis occurred because related research efforts were coordinated, relationships between researchers were encouraged, and researchers and park staff were able to work on multiple vegetation projects.

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Disease as a Factor in the Adaptive Management of Park Aquatic Resources

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Disease concerns in fishery management

Emerging diseases along with a suite of known and persistent diseases can present management challenges for native species management and restoration, can influence biodiversity, or may cause losses of recreational fishing opportunities. Disease is "any impairment that interferes with or modifies the performance of normal functions, including responses to environmental factors such as toxicants and climate, nutrition, infectious agents; inherent or congenital defects, or any combination of these factors" (Wobester 1981). An understanding of the prevalence and role of disease in wild populations of fish and other aquatic organisms should be important criteria in fishery management. Likewise, it has been well documented that diseases can affect survival, reproduction and performance of host fishes. However, as pointed out by Hedrick (1998), the implications of disease are most often overlooked in fishery management. It is not until disease becomes epizootic and dead or dying fish become evident that managers begin to pay attention to the implications of disease in wild fish management. These concerns are particularly relevant when disease is complicated by environmental contaminants, degraded ecosystems, or the result of the introduction of some exotic pathogen.

Disease as a factor in wild fish populations is poorly understood or ignored for a variety of reasons. Certainly, one of the most common reasons is the difficulty of describing the etiology of disease and attributing any cause-and-effect relationships. This is largely due to the complexities of the host–pathogen–environment relationship and the spatial and temporal frameworks within which this association exists. Disease causality in wild populations can be influenced by multiple factors such as changes in population density, loss of habitat, nutritional status, and other biotic or environmental factors that result in stress and changes in immune functions. Some of the more common host-level effects of disease include poor growth or condition, increased susceptibility to predation, altered behavior, altered food conversion, reduced reproductive fitness, and poor survival (Hedrick 1998). These effects can occur singularly or in combination, affecting various life stages, and have cumulative and problematic consequences for wild fish populations (Nehring and Walker 1996).

The effects of disease at the population level are of the greatest concern for fishery managers. In general, diseases that have long incubation periods and where hosts are infected but not infectious have less impact on population growth, while diseases that affect reproductive functions are most likely to suppress population growth (Anderson and May 1979). The spread of disease at the population level is usually directly proportional to the density of susceptible and infectious hosts. Rapid increases in the prevalence of infection in a host population can result in epizootic disease and mass mortality. However, the more common circumstance is for enzootic disease with a low prevalence of infection or pathogenicity. In these later cases, the prevalence of a pathogen alone provides little information of the impact of the disease on the population. Successful management depends on the ability of fishery managers to clearly understand the relationships of disease, fecundity, and survival of infected and uninfected hosts within the population (McCallum and Dobson 1995). Such data can be obtained through carefully designed mark-recapture studies in which infected and uninfected hosts could be determined by serological techniques.

Some diseases in national parks

There have been very few direct investigations of fish diseases in national parks. However, fishes and other aquatic organisms in parks are just as likely to harbor pathogens and parasites as fishes found outside of the parks and at times, these pathogens can result in disease. This is particularly true in parks where present or past fish stockings have occurred, or parks in which exotic aquatic organisms have been introduced. Some examples of diseases affecting fishes in parks are included in Table 1. Some of these diseases are persistent and have been documented in fish for quite some time, while others are just emerging as new problems for resource managers. Whirling disease has been present in North American trout populations since its introduction from Europe in the 1950s. However, it was not until the 1990s that significant declines in wild rainbow trout were noted in the Intermountain West. These declines were eventually attributed to whirling disease. Damselfish neurofibromatosis (DNF) is an emerging disease of fish in national park units in South Florida and the Caribbean. It is a transmissible cancer that is caused by a retrovirus that is known to affect bicolor damselfish (Campbell et al. 2001). It tends to affect larger damselfish more than smaller ones. The effects of the disease on damselfish populations on South Florida reefs are unknown.

In addition to fishes, pathogens are responsible for several other diseases affecting aquatic resources in parks. Examples include amphibian ranaviruses which are suspected of causing population declines of several amphibian species in the northeast and Rocky Mountains and several coral diseases affecting reefs in South Florida, the Virgin Islands, and in the Pacific.

Fish diseases with zoonotic potential

In addition to causing disease in fish there are a few pathogens that are known to be zoonotic, that is, to cause disease in humans. The Centers for Disease Control and Prevention have identified several common fish pathogens that can cause disease in humans. These include *Mycobacterium marinum*, *Streptococcus iniae*, *Aeromonas hydrophila*, *Photobacterium damsela piscida*, and *Edwardsiella tarda.* For instance, the handling of fish infected with *Mycobacterium marinum* by anglers may cause localized skin lesions that can be very difficult to treat. Immuno-compromised individuals, infants, and children can be especially at risk of infection. In 2001, the Maryland State Public Health Laboratory reported 34 positive cases of mycobacteriosis, or fish-handler's disease, in people having handled striped bass in Chesapeake Bay (Blankenship 2002). Likewise, the careless handling of fish infected with *Streptococcus iniae* could result in invasive bacteremic illness. Symptoms of this illness

Disease	Pathogen	Parks affected	Characteristics
whirling disease	*Myxobolus cerebralis*	Yellowstone	Chronic, debilitating parasitic disease known to occur in at least 21 states. Generally considered a disease of cultured trout, but now threatening several "blue ribbon" trout streams in Colorado and Montana (Potera 1997). May represent a threat to native cutthroat trout restoration.
damselfish neurofibromatosis	DNFX retrovirus	Biscayne, Virgin Islands	A transmissible cancer that affects bicolor damselfish on South Florida and Caribbean reefs (Schmale and Kemerer 1996).
striped bass mycobacteriosis	*Mycobacterium* spp.	Lower Delaware	A subacute to chronic wasting disease known to affect 167 species of freshwater and saltwater fishes and occurring in all coastal waters of the U.S. *Mycobacterium marinum* is considered the primary causative agent although several other species may be involved (Rhodes et al. 2001).
bacterial kidney disease (BKD)	*Renibacterium salmoninarium*	Shenandoah	Bacterial kidney disease (BKD) is a serious systemic infection that causes high mortality in populations of wild and cultured salmonids. The disease can be transmitted both horizontally (from fish to fish) and vertically (from parent to offspring; Bullock and Herman 1988). It is also known to be transmitted between wild and stocked fish (Elliot et al. 1997).
Asian fish tapeworm	*Bothriocephalus acheilognathi*	Glen Canyon, Grand Canyon	A serious exotic and parasitic cestode that affects many native cyprinids and some catfish species in the Colorado River basin. Probably introduced along with exotic carp.

Table 1. Some common fish diseases in the national park system.

include cellulitis, infective endarcarditis, meningitis, and/or systemic arthritis. While the risk of contracting infection or disease from fish pathogens is generally low, an awareness of the potential risks should be an important consideration for park managers.

The role of adaptive management

The application of new knowledge of fish disease processes, fish disease defense mechanisms, and ecology is important to the development of fishery management strategies in parks. This is especially true where either epizootic disease or chronic disease influence fish at the population level. In such instances, successful resource management will depend on the ability of park managers to properly diagnosis disease, to predict population- and ecosystem-level risks, and to take appropriate actions for containment and control of the disease. To accomplish park fishery management goals, managers should employ adaptive management techniques that incorporate aquatic animal health concerns whenever disease is implicated as a factor. Adaptive management is a process from which scientific knowledge is generated on an issue or resource and this knowledge is subsequently translated into management strategies that change, or adapt, to new information and changing resource conditions (Wilhere 2002).

Table 2 provides a summary of seven components required to address the adaptive management of fish in parks. The high degree of uncertainty and the general lack of ability to control the system make adaptive management a challenge. To employ active adaptive management in such situations requires the coordination and cooperation of all the responsible authorities and the full integration of aquatic animal health specialists or veterinarians in strategic planning and monitoring. Addressing disease issues in wild populations also requires consultations with the policy makers who regulate the fishery and those that utilize the resource, namely anglers and other park users. When zoonotic risks exist this process should involve not only aquatic animal health specialists but also those responsible for public health decisions. All these actions are predicated on an understanding of the etiology of the infectious disease and having effective communication networks in place for sharing information, making decisions, and getting scientifically valid information to park managers and visitors.

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Component	Primary focus areas
Monitoring	Diagnose disease and determine patterns, trends, and geographic distributions
Reporting	Develop real-time awareness, data summaries, and analysis
Field response	Initiate and evaluate disease management and control activities
Disease etiology	Provide science support for describing host–pathogen–environment relationships and for finding the weak links
Technology development	Provide science support for the development of new tools and methodologies for disease detection, diagnosis, and control including the development of nonlethal sampling techniques
Interagency coordination	Communicate and coordinate to maximize the benefits of jurisdiction/agency involvement and shared responsibilities
Education and outreach	Enhance resource manager, societal, and park visitor awareness, addressing disease issues and park user/public health concerns

Table 2. Components of adaptive management required to address fish disease.

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Is Coral Recruitment Limited by Sedimentation at War in the Pacific National Historical Park?

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Introduction

Coral reefs are important economic, cultural, and ecological resources. However, on Guam poor land management, anthropogenic fire regimes, and soil chemistry contribute to soil erosion and subsequent sedimentation of nearshore reefs. Following even modest rain events, sediment plumes are visible at river inputs along Guam's entire coast. Although significant interspecific differences exist (Rogers 1990; McClanahan and Obura 1997), heavy sedimentation rates (greater or equal to 95% coverage of substrate) have been shown to inhibit coral settlement completely, while more moderate rates (between 50–90%) severely inhibit settlement (Hodgson 1990). Sediments can kill adult coral colonies by burial, decreasing light penetration, disrupting polyp gas exchange, and inhibiting nutrient acquisition (Rogers 1990; Richmond 1993). Some adult species can be effectively smothered at relatively low sedimentation rates, while others are able to secrete mucous to remove these sediments and are thus more tolerant of elevated sediment inputs (Rogers 1990; Richmond 1993). Even if sedimentation is not visibly affecting adult coral colonies, sedimentation rates may be high enough to inhibit all or some juvenile recruitment (Gilmour 1999; Fabricus and Wolanski 2000).

Elevated sedimentation can cover potential recruitment habitat, intensifying competition for space on the benthos. Additionally, increased sediment loads seem to disrupt the attachment and metamorphosis process (Hodgson 1990; Gilmour 1999), a critical process for planulae to successfully recruit to the benthos. Since juvenile corals are more susceptible to environmental disturbances, they may be a good indicator of reef health. Reefs that appear "healthy" may not be receiving sufficient recruits to replace adults, and over time the coral community will deteriorate. This phenomenon has been observed already on some Guam reefs (Richmond 1993; Richmond 1994; Wolanski et al. 2003), raising concern among resource managers about the future, long-term health, and stability of marine resources on Guam.

Soil erosion on Guam is occurring at significant levels (National Resource Conservation Service 1996; Wolanski et al. 2003; Minton et al., this volume) and may be acting as a barrier to coral recruitment, particularly at some locations along the reef at War in the Pacific National Historical Park. Understanding the relationship between sediment load and recruitment is vital to mitigating disturbance and understanding one of the mechanisms that regulate benthic populations and mediate species coexistence on the reef (Underwood and Fairweather 1989).

The objectives of this study were to: (1) assess spatial and temporal patterns of coral recruitment at War in the Pacific National Historical Park; (2) examine the relationship between the sediment deposition and coral recruitment rates; and (3) provide baseline data on coral recruit taxonomy. With this information, natural resource managers would be able to identify areas experiencing sedimentation-related recruitment limitation and better develop best management practices for erosion mitigation in the adjacent watershed.

Study design

A pilot study was conducted from March through August 2004 to assess the feasibility of settling corals onto experimental plates and to determine the level of taxonomic resolution for recruit identification. Information from this study was also used to aid in site selection for the project. Data and logistical insight derived from two three-month deployments of recruitment plates indicated that working at a single depth, using paired sites would diminish possible confounding variables (i.e., coral cover, species richness, wave action, temperature, and salinity). Additionally, data from a year-long sedimentation baseline study (Minton et al., this volume) provided sufficient data to allow us to select paired sites approximately 150 m apart that experienced elevated and moderately elevated sediment loads. The close proximity of these paired sites reduced the likelihood of confounding variables affecting the project's results. All selected sites were at 20 m depth on the fore reef slope.

Methods

At each of the eight study sites, three recruitment plate units (Figure 1) were attached directly to the benthos using "all thread" posts. Each unit consisted of four plates arranged in two stacks of two plates separated by a 10-mm gap using rubber washers. The plates were drilled through the center and held together using stainless steel bolts, washers, and wing nuts. Stacks were braced using three Plexiglas strips, which could be attached to the posts and secured with a short section of tubing and a hose clamp. To ensure uniform orientation and elevation with respect to the benthos, a small spacer was placed underneath the plate unit and held the plates approximately 5 cm off the bottom.

Plates were immersed in running seawater in a covered bucket for at least two weeks prior to deployment to cultivate algal and microbial communities, which are thought to be requisite for coral recruitment (Heyward and Negri 1999). Plates were deployed for three-month periods, collected and transported to a wet lab. All plates were handled by the edges and transported so that their settlement surfaces were not damaged. At the wet lab, high-resolution digital photographs (5 megapixel) were taken while organisms were immersed and fresh to record community composition for possible future analysis. Plates were then disassembled, labeled, and bleached. Algal material was carefully removed while searching for recruits under a dissecting microscope. All recruits were identified to the lowest possible taxonomic level, generally family. High-resolution digital photographs of each recruit were obtained using a dissecting scope and a MaxView Plus adapter set.

Temperature data loggers (Onset HoboTemp) were deployed at each site. Two CTD units (Star-Oddi DST CTD data logger) were rotated among sites every three weeks to obtain salinity, tidal, and temperature data. Daily weather and rainfall data were obtained from the National Weather Service at Tiyan, Guam.

Figure 1. Recruitment sampling apparatus, "plate unit." Photo by Ian Lundgren.

Results

At present, only one of four replicates has been retrieved and analyzed, so these data are preliminary in nature. Additional replicates are being conducted with an expected project completion date in the fall of 2005. We have included data from the pilot study to facilitate analysis; however, interpretation of these results must be done with care because of differences in the study design between the pilot study and replicate 1 of this study.

To date, a total of 30 plate units have been deployed, collected, and examined (120 individual plates and 240 plate surfaces). Only four coral recruits were observed during the pilot study, with an additional three recruits observed in replicate 1 of this study. All of the observed recruits were in the family Pocilloporidae. These recruits occurred at sites with both moderate and heavy sediment loads (Table 1), ranging from as low as 5.15 g to 298.84 g. With these limited data, no relationship between gross sediment loads and recruitment is evident (binomial regression; Z=1.54, p=0.123).

Using data from both the pilot study and from replicate 1 of this study, pocilloporid recruits trend toward settling on the upper surfaces of the top plate (Table 2), but this result was not significant (c^2 Goodness of Fit; X^2=5.15; df=3, p=0.161). Data is limited, however, but if this trend continues over the course of this project, we expect to find a settlement preference among coral recruits for this upper surface.

Discussion

Considerable research on the effect of sediment on corals reefs has been conducted over the past twenty-five years. Much of this literature suggests that corals are negatively affected by increased sediment loads, but efforts to determine a specific threshold level at which sediments become lethal to corals (e.g., Pastorak and Bilyard 1985; Rogers 1990) have not been overly successful (Hopley et al. 1990). Healthy coral reefs can be found in regions of elevat-

Site	Study	Total Sediment (g)	Sediment/day (g/day)	# of Recruits
D60	Pilot	5.15	0.05	2
N60	Pilot	91.76	1.02	1
D60	Pilot	18.00	0.20	1
D60	Rep. 1	9.24	0.10	1
K60	Rep. 1	5.48	0.07	1
O60	Rep. 1	298.84	3.05	1

Table 1. Recruitment under varying sediment stress.

Plate Surface		# of Recruits
Top Plate	Upper	4
	Lower	2
Bottom Plate	Upper	1
	Lower	0

Table 2. Recruit orientation.

ed sediment, suggesting that some species are able to locally adapt to chronic sediment inputs (Ayling and Ayling 1998). This appears to be particular apparent in the Indo-Pacific region, where coral reefs can routinely persist in regions with sediment loads greater than any published threshold (Hopley et al. 1990). Whether these adaptations extend to early life history stages is unclear. Reefs currently surviving in areas of high sediments may be experiencing recruitment failure or sub-lethal stress that may impair their ability to survive a future, acute impact (Wolanski et al. 2003).

Only seven recruits have been observed on 120 plates in this study. By comparison, Neudecker (1981) observed 112 recruits on 282 plates when researching coral recruitment on Guam, using similar methods. While elevated sediment levels may account for this low observed recruitment rate, an alternative explanation is that two weeks of plate conditioning prior to deployment was not sufficiently long enough to ensure that appropriate requisite algal and microbial communities were present. Alternatively, overall recruitment levels may have decreased over the past two decades in response to increased disturbance.

Our results show no significant relationship between coral recruitment and sedimentation. Coral recruits were found across a range of gross sediments loads, from 5.15 g to as high as 298.85 g. Explanations for this are not readily available at these early stages of this work, but it is possible that high sedimentation events are infrequent, and that the sediment flushing time is adequate so that sediments are not inhibiting coral recruitment, or are inhibiting recruitment for only short isolated periods of time. Alternatively, reefs on Guam routinely receive high sediment loads (Randall and Birkeland 1978; Wolanski et al. 2003; Minton et al., this volume), and species may be adapted to these ambient conditions. However, Te (1992) showed that high sediment levels could induce polyp bail-out in a pocilloporid species on Guam, suggesting that recruits of some Guam species may not be able to tolerate elevated sediments. A final alternative is that sediment levels observed in this project were sufficiently high as to have a uniform negative effect across all sites. We hope additional replicates will yield answers to this question.

The orientation of recruits observed during both the pilot study and replicate 1 of this study are showing a trend toward settling on the upper surfaces of plates. Most studies to date show that vertical edges and the undersurfaces of plates are favored by coral recruits, but in studies conducted over a range of depths recruits often shift their settlement to the upper surfaces of plates at increasing depth (Birkeland et al. 1982; Rogers et al.1984; Harrison and Wallace 1990; Carlon 2001). Depth-related changes in recruit orientation are most likely associated with light intensity, which can vary with suspended sediment loads. Recruits require a minimum threshold of light intensity, which might not be met on the more-obscured orientations at increased depths. Decreases in light may also reduce competition with algae for space.

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Spatial and Temporal Patterns in Sediment Collection Rates on Coral Reefs at War in the Pacific National Historical Park, Territory of Guam

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Introduction

On Guam, sedimentation resulting from poor land management is the single greatest anthropogenic impact on coastal reefs (Birkeland et al. 2000). Over the last 25 years, increases in population and changes in land practices have led to significant increases in terrestrial runoff (National Resource Conservation Service 1996), and associated declines in coral abundance, cover, and recruitment (Richmond 1994, 1995; Wolanski et al. 2003a).

Sediments can bury adult and juvenile corals (Richmond 1994; Rogers 1990), impair reproduction (Richmond 1993, 1995), and locally reduce recruitment rates (Hodgson 1990; Gilmour 1999) and juvenile survival (Richmond 1995). While sediment impacts may not always be lethal, coral reef decline may be subtly linked to sediment runoff from adjacent watersheds when sub-lethal affects impair the coral's ability to recover from acute shock, such as tropical cyclones or crown-of-thorn starfish outbreaks (Wolanski et al. 2003b).

War in the Pacific National Historical Park manages 180 ha of coral reef in the Asan Watershed. The coastal edge of the watershed is well developed, containing a small village with a population of approximately 2,000 people (U.S. Census Bureau 2001). Inland, the watershed is protected by its inclusion within the national park, but is still impacted by frequent wildland fires, off-road vehicles, and development along its boundary, all of which contribute to increased soil erosion (National Park Service, unpublished data). Sediment plumes within War in the Pacific are a frequent sight following even modest rains.

Site-specific information on sedimentation rates is needed by park resource managers to assess the magnitude and characteristics of this potentially serious impact to War in the Pacific's principal marine natural resource. This project examined spatial and temporal patterns of sediment collection rates on the park reefs to gather this critical information needed to better target the park's coral reef management activities.

Methods

Sediment collectors, consisting of three polyvinyl chloride (PVC) tubes 5 cm in diameter by 13 cm long, were installed 50 cm off the bottom at 25 sites along the fore reef of the Asan Beach Unit of War in the Pacific (Figure 1). Trap dimensions were based on recommendations of Gardner (1980) and English et al. (1997) to avoid over- and under-sampling. At each study site, two collectors were installed, one each at depths of 10 and 20 m. Sites were spaced approximately 150 m apart. After three weeks, collectors were capped, collected by scuba divers and returned to the laboratory for further processing. New collectors were installed simultaneously. Seventeen temporal replicates were run between 15 September 2003 and 18 November 2004.

Sediments from two of the three tubes were filtered, dried for 24 hours at 100°C in a muffle furnace (Thermolyne F62700), and weighed. Approximately 1 g of sediment was sub-sampled and burned in porcelain crucibles at 550°C and 1000°C for 1 hour each to determine the percentage of organic and non-$CaCO_3$ material in the samples. Non-$CaCO_3$ material in marine sediments can be used as a measure of terrestrial inputs on coral reefs where marine sediments are almost exclusively composed of $CaCO_3$. Upland soils in the Asan Watershed are primarily basaltic in origin, but with some limestone (Young 1988), so the percentage of non-$CaCO_3$ material in our samples underestimates the contribution of terrestrial material to the sediments on park reefs. Sediments from the third tube were processed as part of another project and will not be discussed here.

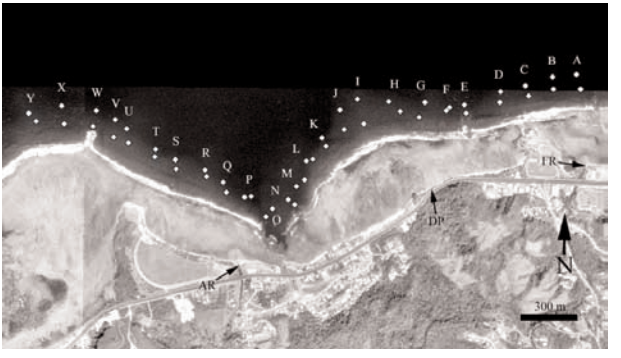

Figure 1. Sediment study sites along the fore reef of Asan Bay. AR = Asan River, DP = Drainage Pipe, FR = Fonte River.

Daily sediment collection rates in g/cm^2/day were calculated by dividing gross sediment weights by the surface area of the tube opening and the total number of days left *in situ.* Daily rainfall data were obtained from the National Weather Service at Tiyan, Guam. Distances from the nearest point source were measured for each sediment collector in ArcGIS using a straight line extending from the center of the river mouth or drainage pipe to the location of each sediment collector.

Data were analyzed using a reduced general linear model with terms for time (replicate), location, and depth. Missing samples in some replicates precluded a full model analysis, and the interaction terms could not be included and were assumed to be non-significant. Pearson correlation coefficients were used to examine spatial relationships within the data. The Minitab statistical package was used for all analyses.

Results

Sediment collection rates (Figure 2) showed a significant spatial pattern (ANOVA; $F=10.78$; $df=24,606$; $p<0.001$). Sediments downstream of the Asan River (sites L–O) and near Adelup Point (sites A–D) all have elevated sediment collection rates. The 20-m collec-

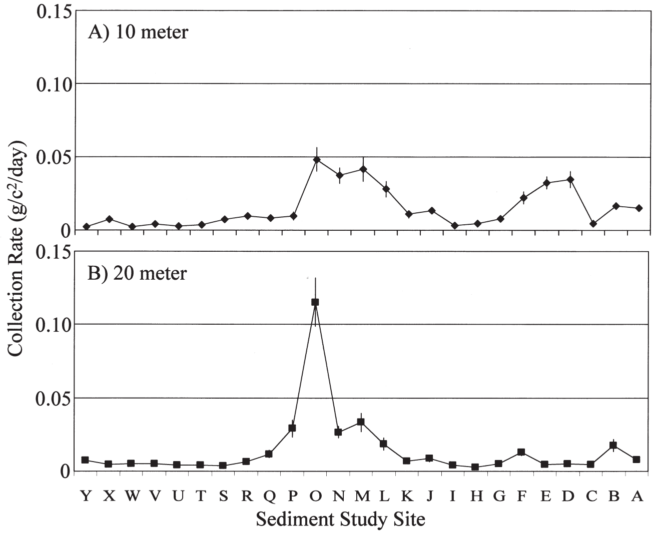

Figure 2. Mean (error bars = ±1 standard error) sediment collection rates (g/cm^2/day) at (a) 10-m-deep and (b) 20-m-deep sediment study sites in Asan Bay. Site reference letters correspond with site locations in Figure 1.

tors at site O had the highest average collection rate, 2.302 ± 2.389 g/cm^2/day. The lowest sediment collections rates were observed upstream of Asan River (sites S–Y). The 20-m collectors at Site W had the lowest average collection rate, 0.045 ± 0.031 g/cm^2/day. No significant difference in collection rate was found between the 10- and 20-m traps (ANOVA; F=2.32; df=1,606; p=0.128).

Sites with high sediment loads were adjacent to sediment point sources. The Asan River drains just west of the Asan Cut, an intermittent storm drainage pipe empties into park waters inshore of site F, and the Fonte River enters just east of Adelup Point, inshore from site A (Figure 1). Sediment collection rates declined significantly with distance downstream from a sediment point source (Pearson Correlation; r=–0.304, p<0.001)

Sediment collection rates varied significantly with time (ANOVA; F=16.38; df=16,606; p<0.001). Guam has pronounced wet (July–December) and dry (January–June) seasons, and the average daily rainfall for the replicates collected during the 2004 dry season (0.400 ± 0.043 cm/day) was approximately one-third of that for replicates collected during the 2003 (1.145 ± 0.115 cm/day) and 2004 (1.520 ± 0.405 cm/day) wet seasons. Sediment collection rates during the 2004 dry season (Figure 3) were approximately half of those observed during the 2003 and 2004 wet season: 0.175 ± 0.036 g/cm^2/day compared with 0.364 ± 0.051 and 0.380 ± 0.037 g/cm^2/day, respectively (ANOVA; F=8.92; df=2,620; p<0.001).

Mean percent non-$CaCO_3$ material in the sediment samples varied from 53.4% to 65.9%, but showed no spatial relationship to sediment point sources (Pearson Correlation; r=–0.053; p=0.716).

Discussion

Sedimentation rates on Guam are believed to have increased over the last 25 years as a result of population growth and poor land management practices (National Resource Con-

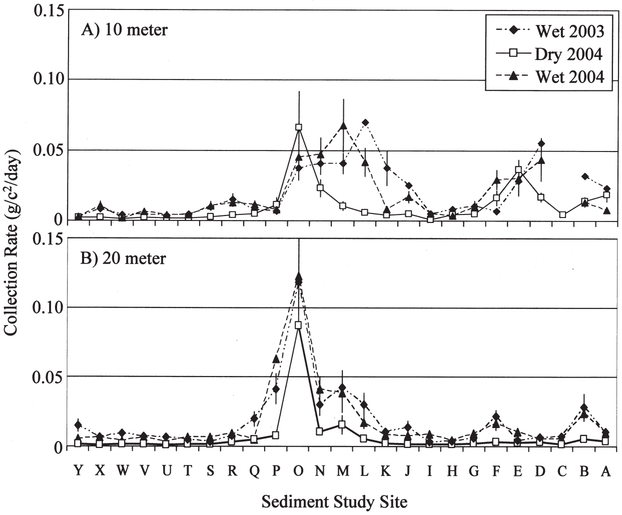

Figure 3. Mean (error bars = ±1 standard error) sediment collection rates ($g/cm^2/day$) by season at (a) 10-m-deep and (b) 20-m-deep sediment study sites in Asan Bay. Site reference letters correspond with site locations in Figure 1.

servation Service 1996). In the Asan watershed, inadequate enforcement of environmental regulations, poor erosion control associated with development, and wildland arson all contribute to increased soil erosion and subsequent sedimentation on the park's coral reefs.

The sediment collection rates measured in this study are among the highest reported in the literature. Numerous studies conducted on the Great Barrier Reef using comparable methods (Mapstone et al. 1989; Hopley et al. 1990) found sediment collection rates 1–3 orders of magnitude lower than the peak rates observed at War in the Pacific. Rates reported from the Caribbean tend to be even lower than those reported for the Great Barrier Reef (Hopley et al. 1990; Rogers 1990).

Sediment collection rates were correlated with distance downstream from the nearest point source. Point source, as opposed to non-point source runoff, appears to be the primary avenue for sediment transport from the Asan watershed onto the adjacent reef. While no significant difference in sediment collection rate was found between 10- and 20-m collectors, plume effects were more evident in shallow water, suggesting influxing sediments were moving parallel to the reef crest and not being transported offshore. After some rain events, we observed sediment plumes 2–3 m thick floating on the ocean surface and moving parallel to the reef crest. Similar plumes have been documented at Fouha Bay on southern Guam (Wolanski et al. 2003a).

On Guam, the peak coral spawning and larval settlement occurs during the wet season (Richmond and Hunter 1990), when sediments are at their highest. Early life history stages and processes (e.g., larval survival and settlement) may be adversely affected by even low sediment concentrations (Hodgson 1990, Gilmour 1999).

After reviewing numerous sedimentation studies, Rogers (1990) concluded that sediment collection rates over 0.01 $g/cm^2/day$ were sufficient to cause negative impacts on corals. Pastorak and Bilyard (1985) predicted, based on sedimentation data collected in Guam by

Randall and Birkeland (1978), severe to catastrophic impacts on coral reefs at chronic sedimentation rates >0.05 g/cm^2/day. However, healthy coral reefs have been observed in nearshore areas where sediment inputs are common, suggesting that these reefs may be adapted to intense sediment regimes (Ayling and Ayling 1998). Coral communities may also be able to adapt to chronic, elevated sediment conditions, allowing them survive in areas receiving consistent but elevated sediment inputs (e.g., river mouths). Most studies have examined sediment stress on adult corals, but other life history stages can be adversely affected by significantly lower sediment inputs than adult corals (Hodgson 1990; Gilmour 1999). Considerable discussion regarding the validity (and value) of these thresholds has been going on for many years, and with the present data, establishing a single threshold limit is probably impossible. Regardless, sediment collection rates observed in this study are orders of magnitude greater than all published thresholds, raising concern for the future health of the park's coral reefs.

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Kemp's Ridley Sea Turtle Nesting Increasing in Texas

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Introduction

The critically endangered Kemp's ridley sea turtle *(Lepidochelys kempii)* has been the subject of intensive, long-term population restoration efforts. Most Kemp's ridley nesting occurs in the vicinity of Rancho Nuevo, Tamaulipas, Mexico (Márquez et al. 1982). In 1947, an estimated 40,000 adult females nested at Rancho Nuevo on one day (Hildebrand 1963). The Mexican government initiated protection efforts at the Rancho Nuevo nesting beach in 1966 (Márquez 1970), but the nesting population had been depleted and continued to plummet. By 1977, it was feared that the Kemp's ridley would become extinct within a few years unless immediate further steps were taken (Carr 1977).

A binational, multi-agency experimental project was initiated in 1978 to aid in the recovery of Kemp's ridley turtles by increasing nesting and re-establishing a nesting colony of this native species (Werler 1951; Hildebrand 1963; Carr 1967) at Padre Island National Seashore, located on North Padre Island, Texas, USA (Shaver 1989, 1990; Shaver and Miller 1999). It was thought that this nesting colony could provide a safeguard for the species, so that if a political or environmental catastrophe occurred in Rancho Nuevo, there would be an area in the USA where this species could nest and be protected.

Based on the strong nest site fidelity of adult females, Carr (1967) and others suggested that marine turtles might "imprint" to, and nest on, their natal beach. Attempts were made to experimentally imprint Kemp's ridley turtles to Padre Island National Seashore in hopes that they would later return to nest. During the period 1978–1988, 22,507 eggs were collected at Rancho Nuevo for experimental imprinting to Padre Island National Seashore by exposure of the eggs to the local sand and exposure of the resulting hatchlings to the local sand and surf. Experimentally imprinted turtles were transferred to the National Marine Fisheries Service Laboratory in Galveston, Texas, for rearing in captivity ("headstarting") in an attempt to increase their likelihood of survival after release and to enable tagging for future recognition (Fontaine et al. 1985; Fontaine and Shaver, in press). During the period 1979–1989, 13,211 headstarted yearling turtles from this project were released, most into the Gulf of Mexico off South Texas (Caillouet et al. 1995; Shaver, in press). An additional 300 headstarted turtles from this project were released after 2–16 years in captivity. Additionally, 10,198 headstarted yearling turtles that had been obtained as hatchlings from Rancho Nuevo in 1978, 1979, 1980, 1983, and 1989–2000 were released (most off Texas), with the objective that they would return to Mexico to reproduce (Caillouet et al. 1995; Shaver, in press; Higgins, pers. comm.).

The purpose of this paper is to describe detection efforts for Kemp's ridley nests on the Texas coast, records of nesting by turtles from the experimental imprinting and headstarting projects, and nesting trends in Texas.

Methods

Kemp's ridley nesting was detected through opportunistic reports from the public and directed searches. Efforts to detect and protect nesting Kemp's ridley turtles and their eggs on North Padre Island, and to determine results of the experimental imprinting and head-starting projects, began in 1986 (Shaver 1990). During the period 1986–2004, patrols were conducted along the entire 128 km Gulf of Mexico shoreline of North Padre Island, including 104 km within Padre Island National Seashore and 24 km north of the national seashore's north boundary. Patrols were conducted during daylight hours from about April through July. During patrols, the shoreline was searched for emergent turtles or their tracks. Mostly four-wheel drive trucks were used for patrols during the period 1986–1992 and mostly all-terrain vehicles during 1993–2004. Patrol effort increased over time (Shaver, in press). During1986–1994, the entire North Padre Island target patrol area was covered from 2–5 days each week. During 1995–1997, the entire area was covered 7 days each week. During 1998–2004, the entire area was repeatedly traversed each day. This repeated coverage increased the likelihood of observing nesting females and locating their eggs.

During 1986–1998, North Padre Island was the only area on the Texas coast specifically patrolled to detect nesting sea turtles. However, repeated daily patrols were also conducted on South Padre Island beginning in 2000 and on Boca Chica Beach beginning in 1999.

Educational programs alerting beach visitors to report nesting Kemp's ridleys were implemented at Padre Island National Seashore in the mid-1980s and later expanded Texas coast-wide (Shaver 1990; Shaver and Miller 1999), to encourage the public to report sightings.

Whenever possible, Kemp's ridleys that nested in Texas were examined for the various tags used to mark turtles released from experimental imprinting and headstarting. Unfortunately, only some of the nesters were examined, since many re-entered the water before biologists arrived. Nesting turtles that were observed by biologists were marked with metal and passive integrated transponder tags.

The origins of Kemp's ridleys nesting on the Texas coast were categorized as "headstart that was experimentally imprinted to Padre Island National Seashore," "headstart that had been obtained from Mexico as a hatchling," "wild stock," or "unknown." Turtles were deemed to be headstarted if they possessed a living, coded wire, passive integrated transponder, and/or metal tag linking them to headstarting. Age of headstarted turtles was calculated based on year-class identified by the tag and nesting date.

Attempts were made to locate nests at all locations where nesting Kemp's ridleys or their tracks were found and reported in Texas. Kemp's ridley nests were classified as confirmed when biologists observed or examined photographs of either the eggs or emerging hatchlings to document reproduction, and either the nesting turtle or hatchlings to identity species.

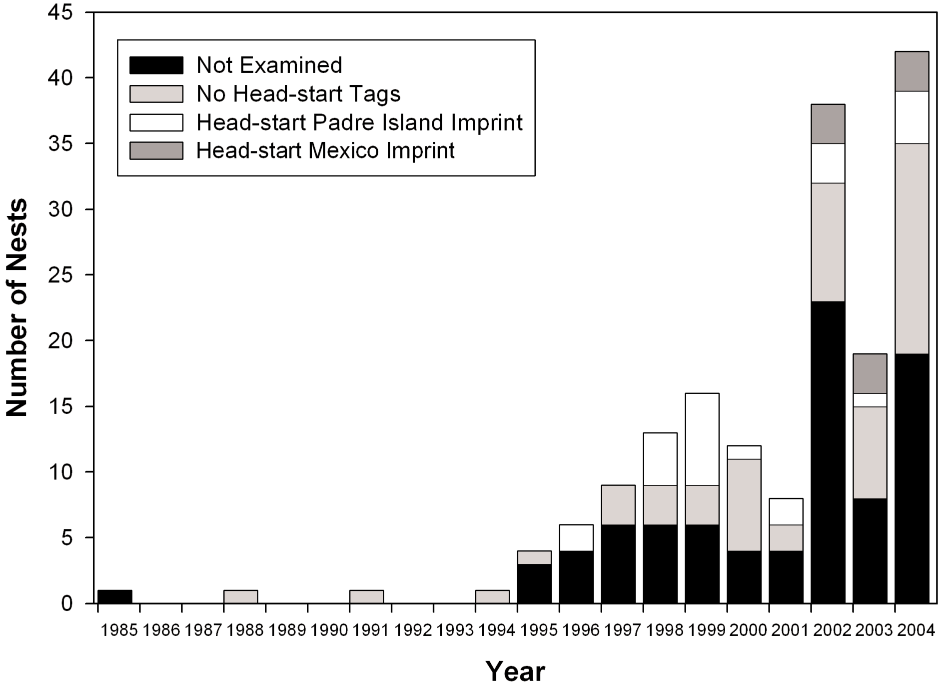
Kemp's ridley nests found in Texas since 1978 were protected to enhance recruitment and thereby aid the program to re-establish a nesting colony. Of the 174 clutches located on the Texas coast during the period 1979–2004, five incubated *in situ* (at the nest site) on North Padre and Mustang Islands, 22 were transferred to corrals (screen enclosures) on South Padre Island and Boca Chica Beach, and 147 were packed into Styrofoam boxes and transported to an incubation facility at Padre Island National Seashore. Most hatchlings were released on the beach at the incubation sites without marking or retrieval in the surf, but hatchlings from one clutch were released on the beach at Padre Island National Seashore, recaptured after release, and transported to the National Marine Fisheries Service Laboratory for headstarting.

Results and discussion

Confirmed nests in the USA. Most Kemp's ridley nests confirmed in the USA were found in South Texas during recent years. A Kemp's ridley nest found at Padre Island National Seashore in 1948 was the first confirmed for this species in the USA (Werler 1951). During the period 1948–2004, 180 Kemp's ridley nests were documented on the Texas coast (Shaver and Caillouet 1998; Shaver, in press). Other possible nests were reported, but could not be fully documented. Additional nests likely went unnoticed, particularly on stretches of beach that were difficult to travel and sparsely visited or patrolled.

One hundred seventy-one of the 180 nests were found between 1985 and 2004, with an overall increase beginning in 1995 (Shaver 1995, 1996a, 1997, in press; Shaver and Caillouet 1998; Shaver and Miller 1999; see Figure 1). The increase in the number of detected nests during that time may have reflected increased nesting, improved detection efforts, increased awareness and reporting by the public, or a combination of all of these factors.

Figure 1. Number of confirmed Kemp's ridley nests found on the Texas coast, 1985–2004.



One hundred seventy of the 180 nests were found in south Texas and the remaining 10 on the upper Texas coast. During the period 1948–2004, more confirmed Kemp's ridley nests were located at Padre Island National Seashore than at any other location in the USA (Shaver 1992; Shaver, in press; Shaver and Caillouet 1998).

During the period 1989–2004, only 20 Kemp's ridley nests were documented at locations in the USA outside of Texas (Shaver, in press). Bowen et al. (1994) suggested that these nesting turtles could have been from the Texas imprinting project, since there were no previous confirmed records of Kemp's ridleys nesting in these other regions, but there is no evidence from tag returns to support this hypothesis.

Nesting by project turtles. Experimentally imprinted and headstarted Kemp's ridley turtles were documented nesting on the Texas coast and near Rancho Nuevo, but a variety of factors possibly limited records and assessment of project results. Of the 171 Kemp's ridley nests found in Texas since 1985 (when headstarted turtles could have been mature and able to nest), nesting turtles were examined for tags at 89 of the nests (Figure 1; Shaver and Caillouet 1998; Shaver, in press). At 56 of those 89, the turtles did not possess any tags linking them to headstarting. However, 24 of the nests were conclusively linked to headstarted turtles experimentally imprinted to Padre Island National Seashore (Shaver 1996a, 1996b, 1997; Shaver, in press; Shaver and Caillouet 1998). Thirteen different turtles laid these 24 clutches. They represented five year-classes (1983, 1984, 1986, 1987, 1988) and ranged from 10 to 18 years of age when first detected nesting. The 24 nests were found in South Texas at Padre Island National Seashore (n=15), North Padre Island north of Padre Island National Seashore (n=4), and Mustang Island (n=5).

Eight headstarted individuals that had been obtained from Rancho Nuevo as hatchlings were documented laying nine clutches in Texas during 2002–2004 (Figure 1). The individuals were from four year-classes (1989, 1991, 1992, 1993) and were 10–15 years of age when first detected nesting. The nine nests were found statewide, including on Padre Island National Seashore (n=5), Galveston Island (n=3), and Bolivar Peninsula (n=1).

More headstarted turtles might have been detected nesting in Texas had the turtles from the earliest year-classes received living and coded wire tags. Some of the examined turtles that lacked project tags could have been members of the earliest year-classes, released without living and coded wire tags (Shaver 1998a). Also, more headstarted turtles might have been detected nesting had patrol efforts been more comprehensive on North Padre Island (Shaver and Fletcher 1992) and elsewhere in South Texas. Additional patrol effort would have increased opportunities to check the unexamined nesters for tags and perhaps locate other nestings that went undetected. Nesting observations were also likely limited by mortality of these turtles in the marine environment. Virtually all of the turtles imprinted to Padre Island National Seashore were released before mandatory usage of turtle excluder devices, designed to reduce mortality of sea turtles due to incidental capture in shrimp trawls.

The number of observations of headstarted turtles nesting in Texas also may have been limited by these turtles nesting elsewhere. However, only two Kemp's ridley turtles that nested in Mexico or elsewhere in the USA from 1985 through 2004 were conclusively found to possess tags that connected them to headstarting. One experimentally imprinted to Padre Island National Seashore from the 1987 year-class was observed nesting at Rancho Nuevo in 1998 (R. Márquez, pers. comm.). One turtle obtained from Mexico as a hatchling in 1989 nested twice in Mexico during 1999 (J. Peña, pers. comm.).

Origins of Kemp's ridleys nesting in Texas. Based on tag returns through 2004, Kemp's ridleys currently nesting in South Texas are a mixture of headstarted turtles experimentally imprinted to Padre Island National Seashore, headstarted turtles that were obtained from Rancho Nuevo as hatchlings, and turtles from the wild stock, with varying degrees of nest site fidelity and some wild individuals nesting both in Mexico and South Texas. In contrast, Kemp's ridleys nesting on the upper Texas coast are headstarted individuals that were obtained from Rancho Nuevo as hatchlings. However, more years of data collection are needed to investigate if these trends continue.

Mortality of adult Kemp's ridley turtles in South Texas waters may have reduced nesting on South Texas beaches. Sea turtles found stranded (washed ashore, alive or dead) on USA shores have been documented by the Sea Turtle Stranding and Salvage Network since 1980 (Shaver 1998b; Shaver, in press). During every year from 1986 to 2003, more adult Kemp's ridleys were found stranded in Texas (most dead) than in any other state in the USA (Shaver, in press), even though adult Kemp's ridleys forage in, and migrate through, nearshore waters of several other USA states (U.S. Fish and Wildlife Service and National Marine Fisheries Service 1992; Turtle Expert Working Group 1998; Shaver, in press). Most found on South Texas Gulf beaches were located during times when Gulf waters were open to shrimp trawling (Shaver, in press). Texas Parks and Wildlife Department regulations, passed in August 2000 to help sustain the shrimping industry in Texas, established a new annual closure of Gulf waters to shrimp trawling off South Texas beaches out to 8 km from shore, from 1 December through mid-May each year, preceding the existing annual Texas Closure, which extends out to 200 nautical miles from mid-May until mid-July each year. This new regulation went into effect on 1 December 2000. It may help protect adult Kemp's ridley turtles in South Texas (Lewison et al. 2003), and may have contributed to the increase in nesting documented in 2002 and 2004 (Figure 1).

The Kemp's ridley population has recently shown promising signs of increase (Burchfield 2003). As the Kemp's ridley population continues to increase and more turtles from the experimental imprinting and headstarting projects, as well as their offspring, reach maturity, it is likely that increasing numbers of Kemp's ridleys will nest in Texas. However, more years of data collection for stranded adult and nesting Kemp's ridley turtles and Kemp's ridley nests in Texas, as well as protection efforts for various life stages, are needed to evaluate the experimental project and Texas Parks and Wildlife Department regulations, and help continue the increase in Kemp's ridley nesting in Texas.

Summary and conclusions

From the late 1940s through the mid-1990s, about one Kemp's ridley nest was documented on the Texas coast every three years, but the number of nests found has increased during the last decade. During the last 50 years, more Kemp's ridley nests have been recorded at Padre Island National Seashore than at any other location in the USA. Kemp's ridleys that nest in Texas today are a mixture of headstarted turtles and others from the wild stock. As the Kemp's ridley population continues to increase and more turtles from the experimental imprinting and headstarting projects, and their offspring, reach maturity, it is likely that increasing numbers of Kemp's ridleys will nest in Texas. Protection efforts on the nesting beach and in the marine environment should be continued to help ensure future nesting increases in Texas.

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Basing Management Decisions on Science: How Does It Really Work?

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The National Parks Omnibus Management Act of 1998 directed the National Park Service to integrate study results into management decisions. How are parks and other protected areas accomplishing this? This session was developed to be a round-table discussion of how scientists, resource managers, and superintendents interact to ensure that the best scientific information is used in decisions affecting park management.

An issue we faced at Saguaro National Park in Arizona was how to protect a sensitive riparian area—a rare source of permanent water. It was in an area that had been virtually closed to all public use for 40 years, but was likely to experience more use from a new trail route and new homes being built on the park's boundary near the site. Using the model of a "pulse" study developed at Olympic and Sequoia/Kings Canyon National Parks, in Washington and California respectively, we developed a plan to have scientists and managers meet together at the site to conduct investigations and have discussions about the site's most sensitive resources. For five days in May 2003, a group of scientists (a hydrologist, aquatic entomologist, botanist, bat biologist, herpetologist, ornithologist), along with a recreation specialist, archaeologist, and historian, camped on-site and collected data on all the resources of the site. For two of those days, they were joined by about two dozen park management staff and specialists from other agencies and universities. Presentations and facilitated discussions identified the issues of greatest concern, possible management actions, additional research needed, and recommended monitoring strategies. Final products include a volume of scientific reports as well as an illustrated brochure for park staff, organizations funding the project, and the public. A key element in this successful transmission of information seemed to be the personal experience and interactions that resulted from having everyone on site together, gathering data, and discussing issues, threats, and solutions.

Issues at other park sites were discussed during this day-capper session. These included: how endangered freshwater mussels at Big South Fork National River and Recreation Area, in Tennessee and Kentucky, might be affected by upstream horse crossings; reintroduction of bears at Big South Fork; concerns of ranchers about the reintroduction of swift fox at Badlands National Park in South Dakota; unofficial guidelines for mowing roadsides at Badlands to minimize the spread of exotic plant seeds; adaptive management of water flow regimes from Glen Canyon Dam to benefit beaches and endangered species in Grand Canyon National Park in Arizona; how to determine the allowable number of cruise ships in Glacier Bay National Park, Alaska; and issues related to limiting vehicle numbers on the major road at Denali National Park, Alaska.

Through these discussions, the group identified several barriers and some possible solutions to transferring scientific knowledge to managers. The following paragraphs provide a brief summary.

Scientific information frequently is not understood by management staff. Resource managers need to be sensitive to the technical level of information being provided and find ways to translate between scientists and nonscientific park staff. Interpreters can frequently help in this arena, since they are trained to convert scientific information into presentations for the general public. One park is using a geologist in the U.S. Geological Survey's Geologist-in-the-Park Program to "translate" all the geology publications about the park. There was a suggestion that scientists work with park resource staff to develop "white papers" on certain issues to summarize scientific information for management. It was also noted that large projects funded through Natural Resource Preservation Program currently require that a certain percentage of the grant be used for an interpretive component. Finally, Jeri Hall, natural resource stewardship training manager at Albright Training Center in Arizona, is developing a new course in response to a needs assessment which indicated that superintendents feel unprepared to use science in complex decision-making. The course will be for groups of scientists, resource managers, and superintendents.

Another barrier is that some activities (such as routine operations and some maintenance procedures) are not being disclosed. Some participants felt that increased emphasis on compliance with the National Environmental Policy Act is driving us to be more up front about the use of science in decision-making. The newly implemented Planning, Environment and Public Comment (PEPC) system will increase this disclosure as parks begin to track all their compliance activities on a system that is available on the Internet.

The lack of access to scientific information and the need to improve record-keeping of scientific projects and of decision-making is a huge issue related to the use of science. This can be a barrier when information is not known or readily available. Developing systems for archiving information and indexing it for accessibility is crucial. Parks that can build an institutional memory of what has been tried previously are often more successful at incorporating scientific information into decision-making. The lack of documentation can also be a legal shortfall to implementing management actions. Most legal challenges to park decisions are based on procedures rather than on the validity of the science being used to support a decision. This makes good record-keeping even more essential.

Finally, there are issues of flexibility and costs. Monitoring the results of management actions takes money, but it is essential to know if the action taken is leading toward the intended result. Indicators and standards must be selected so that monitoring for them can be done economically in the course of regular business. And agencies need to build flexibility into their management systems, such as by using adaptive management. Such systems allow agency staff to review management objectives related to a specific issue, review indicators and standards being monitored, and make adjustments wherever needed so that objectives can be met.

In summary, there are a variety of barriers to integrating study results into management decisions, and there are many strategies for overcoming those barriers. Resource managers, superintendents, and scientists should be vigilant to ensure that communications remain open and that the best information is available and used in decision-making.

Overcoming Barriers to the Use of Science in National Parks (Session Summary)

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Introduction

Following passage of the 1998 National Parks Omnibus Management Act (also known as the Thomas Bill), the National Park Service (NPS) secured funding through the Natural Resource Challenge (NRC) to promote scientifically sound management of parks, increase the scientific community's involvement in providing needed information, and facilitate education to engage the public as partners in resource preservation. Two NRC programs, the park-based Research Learning Centers (RLCs) and the university-based Cooperative Ecosystem Studies Units (CESUs), aim to meet the science needs of parks through facilitating research by external scientists that directly addresses management-identified needs. These programs can only be successful if relevant research results are effectively transferred to park resource specialists and then on to decision-makers so that scientific knowledge can be considered when planning and managing for park management goals. Despite a mandate to use the highest-quality science and information for management, a variety of practical challenges remain. This paper summarizes observations made by NPS participants at a 2005 George Wright Society (GWS) Conference day-capper session to overcome challenges to the use of science for park management (Figures 1–2).

Communication

For scientific research to inform management, results must be effectively delivered to the resource specialists who make management recommendations, to the managers who make decisions, and to members of the public who provide input to or are affected by management decisions. According to communication studies, effective communication refers to the development of a common understanding, such as an understanding about the meaning and potential utility of specific research results. However, communication research elucidates that people frequently report leaving the same encounter with different perceptions of that encounter. Thus, it is not surprising that a research scientist or a resource specialist presents research results in what she or he perceives to be clear terms, and then the intended recipient of that information returns to his or her daily tasks with a modified perspective of what the speaker intended to communicate, with continued uncertainty, and/or a lack of interest that leads to passive rejection of innovations.

Participants at the 2005 GWS day-capper session cited a lack of understanding and/or interest in the results of scientific research as a primary barrier to its use. Particular attention was given to the link between public understanding of scientific information and public support for decisions and actions informed by science. Session participants noted that an important component of receptivity to scientific information is trust in the scientist and/or the agency's science communicator. Consequently, resource staff must sometimes spend extra

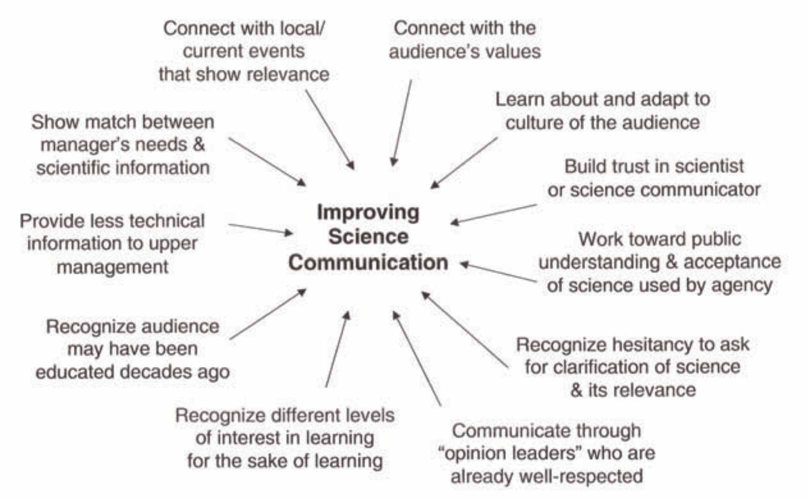

Figure 1. Suggestions for reducing barriers when communicating scientific information to resource management specialists, park managers, or the public.

Figure 2. Current and past institutional efforts to improve both the availability and use of scientific information to meet park management goals.

time documenting information beyond what they see as necessary so they can build trust in management recommendations or decisions. Berger (1997) discusses the need to predict the beliefs and actions of message recipients in order to produce effective messages. He suggests some message uncertainty can be reduced in advance by acquiring information about the social context in which messages are likely to be received. This was consistent with observations raised during the session that it is important to communicate relevance by connecting with people's values, and that external circumstances can increase the perceived relevance of, and thus receptivity to, scientific information. For example, people who actually see glaciers melting in Alaska may be more receptive to the scientific support for climate change than those in warmer states who have never seen melting glaciers. A second example focused on the role of the 2000 fire season in increasing receptivity to scientific information related to ecosystem restoration. Session participants also noted that people might be more receptive to scientific information when they are looking for it, such as at conferences or workshops.

Additionally, participants discussed potential communication barriers between non-NPS scientists or park resource specialists and park managers. In general, people are more likely to pay attention to messages about scientific products if they perceive the messages to be relevant to their goals or needs (Rogers 1995). Participants underscored the importance of targeting different types of information to different management levels. For instance, as one communicates higher up the chain, the science communicator must resist the temptation to focus on the technical information and instead focus more on the interpretation and the applied aspects. Participants reminded scientists that when they are communicating about research results, it is important to first gain an understanding of the culture of the audience, and then adapt to that culture before attempting to communicate. Communicators must start by addressing the audience's need (e.g., to inform current management dilemmas or avoid litigation on a particular topic) and then share pertinent scientific information. They mentioned that scientific information that is understood and accepted can give managers more confidence in defending their decisions.

Individual barriers

Even with clear communication, decisions to adopt scientific findings can be influenced by an individual's beliefs and values about science; their comfort with risk and uncertainty; organizational values related to science, innovativeness, and learning; and the institutional capacity to apply science.

Participants reminded science communicators that some individuals are embarrassed to ask the necessary questions to understand research results and how they can be applied to management. For instance, many managers received the last of their formal education two or three decades ago, and so may not have the context for applying current information. Additionally, scientists, resource specialists, and managers often have different personality types with regard to both learning and communicating. Participants noted that individuals with different personality types are drawn toward different types of positions and are motivated by different types of rewards. Scientists may be more focused on learning but less on communication, whereas managers may be more extroverted but less interested in information for the sake of learning. Thus, differences in education and training backgrounds are confounded by the fact that some people are motivated by learning, whereas others are sometimes intimidated by it. The diffusion of innovations theory (Rogers 1995; Wright 2004) offers an in-depth explanation of different types of personalities regarding comfort with the uncertainty of adopting new ideas as well as the value of finding "opinion leaders" who are well respected by peers and can effectively communicate new ideas. According to participants, it is imperative that some individuals are positioned to bridge the gap between those who either have different personalities or were trained differently.

Institutional barriers

Participants also discussed the changing organizational culture within the NPS and how that has influenced both the communication and use of science. Sellars (1997) provides an historical explanation of traditional NPS culture, which was described during the session as top-down and militaristic, with most power residing with the superintendent and the ranger division. Participants cited several efforts that have contributed to a changing organizational culture that they see as slowly becoming more collaborative, team-oriented, and scientifically informed. These include the Natural Resource Trainee Program of the 1980s, the separation in many parks of the resource management and visitor protection divisions, and the various new programs that have been developed through the Natural Resource Challenge. According to participants, these efforts have increased the number of innovators and scientifically trained people in the Park Service.

Also encouraging has been the level of participation and interest at recent GWS conferences to enhance communication about the contributions of science to resource stewardship. With nearly 800 participants and over 100 concurrent sessions, there were hundreds, if not thousands, of formal and informal discussions at this year's conference about how to incorporate current scientific knowledge on topics such as fire, climate, wildlife, invasive plants, recreation, and wilderness into management. In addition to such issue-centered discussions, at other sessions RLC staff members shared information about how they are identifying park-based information needs, facilitating research to meet these needs, and working to transfer research results to agency resource specialists, interpreters, and directly to the public. The CESUs described how they are successfully linking federal and academic scientists with parks that have identified science needs, the Inventory and Monitoring Network staff discussed how to ensure that monitoring data are applied to management questions and incorporated into park planning, and the Horace M. Albright Training Center described an upcoming innovative training project to bring upper-level managers, staff specialists, and scientists together to address the challenges of incorporating science and politics into complex management decisions.

Conclusion

Although nearly every resource specialist, manager, and research scientist can describe practical barriers to applying scientific information, this session left me feeling optimistic that NPS resource managers and GWS conference participants are working hard to overcome those barriers. The Aldo Leopold Wilderness Research Institute's Research Application Program (RAP) is beginning a systematic research effort designed to understand influences on the use of science by managers in the NPS, the Bureau of Land Management, and the U.S. Forest Service. The project will be informed by the social science literature on communication, organizational learning and behavior, decision-making, and social psychology, as well as discussions such as the one described here which are critical for understanding the context in which NPS managers strive to apply scientific information. Through this project, the RAP hopes to (1) improve understanding of the factors that influence when agency decision-makers and staff specialists decide to adopt and use scientific products, (2) identify barriers to the effective communication and application of science, and (3) provide suggestions for increasing the effectiveness and efficiency of science delivery efforts. More effective science delivery will lead to faster integration of relevant science by managers, and it will increase agency credibility by improving the chances that managers as well as the public have access to and understand the best available science.

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The Marriage of Science and Management: Eternal Bliss or Misery?

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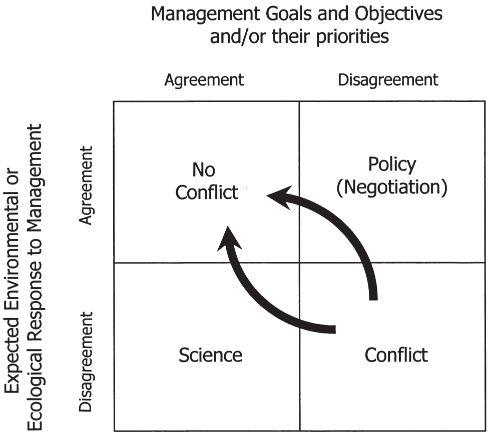
For many reasons, the analogy of a marriage is well suited to understanding the integration of science and management. Like a marriage, it is all too often that science and management are under the same roof, but fail to interact effectively. Like any marriage, strengthening communication can lead to mutual benefits for both parties. Scientists need to better understand the problems facing managers, and managers need to better understand how and when science can help them achieve their objectives. And, like any marriage, the partners need to invest time and effort to make the relationship work. The marriage of science and management is a partnership, and a lack of communication, interest, devotion, and/or effort will undoubtedly lead to failure.

Are they well suited? One of the first considerations before entering into any partnership is whether or not the partners, in this case science and management, are well suited for each other. Lee (1993) proposed that management can be thought of as a vessel by which we influence natural systems, and that navigation of this vessel can and should be influenced by sociological and economical forces. However, there should also be a mechanism to better learn how to reach our destination using past experiences and knowledge. Lee (1993) describes "navigational aids" for helping us along the journey. Policy, as a guide to management, can help determine our final destination. Science, meanwhile, can help determine the route by which we reach our destination. The success of these processes depends, in part, on where conflict lies. If there is disagreement about the final destination (e.g., the management goals or priorities of management goals), then the best route is likely through negotiation and compromise (Figure 1). Although science can certainly influence our priorities, conflicts regarding the goals may not be the best foundation upon which to develop a partnership between science and management. In such situations, science frequently serves as a displacement behavior that stalls the decision process instead of providing solutions. If, however, the conflict is centered on uncertainty about an expected outcome of management, science offer a valuable solution, and a partnership between science and management can be quite productive.

Embracing uncertainty

In any partnership, unexpected events and outcomes will arise, and an expectation that science will eliminate uncertainly is unrealistic. Rather, planning for unexpected events may aid in "weathering the storm." In planning for uncertainty, we strive to reduce it (through learning) and benefit from it (by taking advantage of the learning opportunities afforded by unexpected events) (Holling 1978). While we certainly can learn from situations without *a priori* planning, preparing for uncertainty through well-designed science will allow for more

Figure 1. Conceptual diagram showing the likely path of conflict resolution depending on whether the conflict centers on the management goals or uncertainly about the response to management (adapted from Lee 1993).



efficient learning than would retrospective assessments (Gould and Lewontin 1979; Nichols 1999).

Tools that help us embrace uncertainty include model building, sampling design, and adaptive management. These tools are not mutually exclusive and I have extracted here just a few salient points from each.

Model building helps to identify and clarify uncertainties (Walters 1986). For example, it is well known that fire, forest insects, and disease have a major impact on whitebark pine communities. However, a simple conceptual model constructed for the Greater Yellowstone Ecosystem illustrated that, in addition, the interaction between these influences and changing climate is an area of great uncertainty.

Adaptive management embraces uncertainty as an inevitable attribute of management and uses management as a tool for reducing uncertainty (Walters 1986; Williams et al. 2002). However, some detractors have suggested that adaptive management implies implementing management and, if it does not produce the desired results, we merely try something else. This perception is substantially different from the concept advanced by Holling (1978) and Walters (1986) and diminishes the usefulness of this approach. Adaptive management considers management actions and policy in a context analogous to experimental treatments and embraces uncertainty by attempting to define a set of possible outcomes (hypothesized predictions) that are consistent with management experience. The relative evidence for the alternatives is then considered in a well-designed monitoring framework, just as one would expect from any research design. Thus, sound sampling designs from the outset can make the difference between effective learning and sloppy management.

Adaptive management contributes to the marriage of science and management because it forces the two disciplines to incorporate parts of the other. When adaptive management is correctly implemented, management continues to focus on objectives, but learning (through sound science) becomes an additional, explicit objective. Likewise, management objectives become a source of scientific inquiry, with the explicit purpose of using past knowledge to improve future management decisions. So, in essence, management takes on a part of science (i.e., learning), and science takes on a part of management (i.e., management objectives).

Setting objectives

There is virtually universal consensus among scientists that setting realistic, clear, specific, and measurable objectives is a critical—but often underdeveloped—first step for monitoring ecosystems (e.g., Spellerberg 1991; Elzinga et al. 1998; Olsen 1999). Given this consensus, I will focus here on attributes of objectives that are less common but play an important role in the ability to integrate science and management.

Management versus monitoring objectives. For the purpose of integrating science and management, it is important to distinguish between management and monitoring (or sampling) objectives. Management objectives should reflect the desired *condition, state,* or *dynamics* of the system. In contrast, monitoring objectives should reflect the *measurement* of the desired condition, state, or dynamics.

Management-oriented science is most efficiently accomplished when clearly defined management objectives exist and are accompanied by clearly defined monitoring objectives. Management objectives, expressed in terms of a desired future condition, provide a reference upon which the success of management actions or policies can be assessed. Monitoring objectives provide the measurement used to make that assessment.

State versus action objectives (ends versus means). Failing and Gregory (2003) identified confusion of the ends with the means as one of the most common mistakes in establishing biodiversity indicators. It is common for agencies and organizations to express objectives in terms of the means to achieve an end, rather than as the end itself. While this approach may be well suited for directing the actions of an organization, it does little for enabling better management decisions through science.

As a hypothetical example of the distinction, imagine having the responsibility of conducting a wildlife burn on 900 hectares of land. First, let's consider the scenario with an action objective such as: *Conduct a prescription burn on 900 hectares in shrub habitat for the purpose of reducing shrub density to improve wildlife habitat.*

In addition, consider that we will conduct our burn in three parts of 300 hectares each. As per standard protocols, a burn prescription will specify the ranges of temperature, wind, fuel moisture, etc. Suppose we complete our three burns and all three were within prescription and successfully reduced shrub cover. However, the burns were accomplished under slightly different conditions (e.g., hotter versus cooler conditions). The question is: which, if any, of these three burns was most successful? If the criterion of success is based merely on the action of conducting a burn within prescription, then all three were equally successful.

Let us reconsider this same example using an objective expressed as the desired state (condition) such as: *Using prescription fire, reduce the shrub cover on 900 hectares of shrub habitat from its current state of 56% cover to a desired state of 25% cover*.

Now let's consider the results in relation to this alternative objective. Based on our monitoring, we have determined that the three burns resulted in an overall shrub cover of 39, 11, and 24%, for burns one, two, and three, respectively. Based on this result, burn number two was clearly the most successful.

The scale and hierarchy of goals and objectives

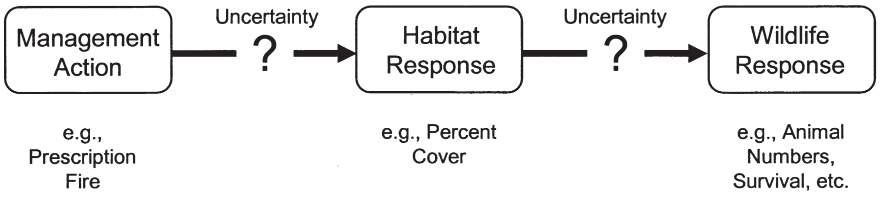
Our management and monitoring objectives are derived from, or are part of, a multi-tiered framework of NPS goals and objectives stated in the planning documents of each unit (National Park Service 2003). Considering how specific objectives fit within higher-order goals and how objectives themselves can reflect different scales is an important component of planning a partnership between science and management. Consider the example above where prescription fire is being used to improve wildlife habitat. The specific objective is to reduce shrub cover. Thus, in terms of designing a monitoring (science) program, one level of uncertainty is the effectiveness of the management action (prescription fire) on achieving the management objective (25% shrub cover). Yet, there is another level of uncertainty that has been, and is often, overlooked. If the purpose of this prescription fire was to improve wildlife habitat, then it seems that we would also want to know whether or not the targeted wildlife responded favorably to the reduced shrub cover. By not making these relationships explicit, these two different types of uncertainty are confounded. These two components also provide very different information for making decisions. The latter (i.e., wildlife response) is probably the most influential for setting the management objectives in the first place; whereas the former is most likely to influence how management is able to achieve that objective. Here again, a simple conceptual model (Figure 2) can help to identify these sources of uncertainty, and explicit expression of the hierarchy of goals and objectives will help in understanding how the specific objectives in a given context fit with the broader strategy of an organization. Biggs and Rogers (2003) provide an excellent example of such a hierarchy from Kruger National Park.

Management actions and options

In reference to adaptive management, Lee (1993) claimed that it embodies a simple imperative: management "policies are experiments; learn from them." The key element here for the integration of science and management is that management actions are considered analogous to treatments in an experimental context. All too often, research proposals are submitted with claims of being essential to management when the direct link is little more than a statement in a proposal indicating how "critical" the work is to management. While it may not be feasible in most circumstances to treat management actions in a fully experimental context (i.e., with randomized allocation of treatments), we can certainly improve the process of explicitly incorporating management actions into our study designs from the outset.

Thresholds. An additional consideration is whether our science program (e.g., monitoring) is proactive or reactive. For example, we can use science as part of the process to determine whether a management action is warranted by incorporating thresholds into our program. Thresholds can be used to express a condition under which management action is warranted or triggered or, alternatively, they can be used more simply to illuminate points of

Figure 2. A conceptual model for the uncertainties of the direct response of habitat to management and the indirect response of wildlife to the altered habitat.



assessment. Biggs and Rogers (2003) provide another excellent example of what they call "thresholds of potential concern." In the Greater Yellowstone Ecosystem, whitebark pine is considered a "keystone" species with roles ranging from a food source for grizzly bears to having an effect on snow accumulation. In recent decades whitebark pine stands have been decimated in areas of the Cascades and northern Rocky Mountains due to the introduction of an exotic fungus—white pine blister rust—as well as mountain pine beetles. Our specific monitoring objectives are intended to determine if white pine blister rust is increasing within the Greater Yellowstone Ecosystem, and whether or not the resulting mortality of whitebark pine is sufficient to warrant consideration of management intervention (e.g., active restoration)? Thus, we will proactively track the status and trends of blister rust infection. In this context, thresholds can be used to assess whether or not active management is warranted (Figure 3). If a decision is reached to implement active management in all or portions of the network, then reactive management can be initiated to compare alternative management actions toward achieving the management goals for this species.

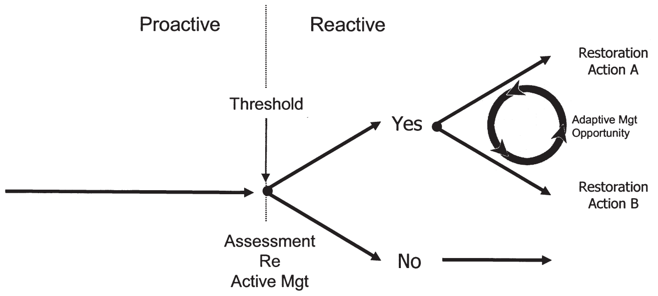


Figure 3. A conceptual model for monitoring whitebark pine health (e.g., infection level of blister rust and survival) in the Greater Yellowstone including a proactive component where a threshold is identified to assess whether or not active management is warranted and a reactive component in should a decision be made to initiate active management.

Incorporating learning into management decisions

The greatest science in the world will do us little good if it does not find its way into the management decision process. Our goal should be providing the right type of information, in the right form, to the right people, at the right time. Much of the discussion thus far has focused on the right type of information. Finding the right form is a different matter altogether. It is naïve to assume that the form in which information is distributed to the scientific community (e.g., technical reports and peer-reviewed journal articles) will be equally useful to managers. Scientific articles and reports may serve to establish the credibility of the information, but not the utility of the information. Effective transfer of information will not likely occur without consideration of the audience and the needs of that audience. It is a rare case that today's managers would have the time or the inclination to wade through myriad detailed statistics, models, and methods needed by the scientific community to establish the validity of the science. Rather, the manager is more likely to need a synthesis of that information that is concise, understandable, and applicable to the management context. An effective synthesis will likely only come from communication between scientists and managers.

Determining the right people and the right time is also a different matter. Providing a manager important new information about the effects of fire on an ecosystem three months after the fire management plan was due is not an effective way to incorporate learning into decisions. In contrast, knowing something about when decisions are made can be a great asset if information delivery is planned from the outset to coincide with when decisions are made. Clearly, communication between scientists and managers will shed some light on this issue, but I also believe another form of conceptual model can help to clarify this information. I believe that it can be helpful to map the decision space (Figure 4). Such a model can include processes or plans for which decisions are expected. It can also include relevant information about who the key players are for a given decision. Unfortunately, it will not likely include all of the decisions for which information would be useful, and so will not replace the need for communication.

Lastly is the process by which information is incorporated into the decision process itself. There are a wide variety of approaches ranging from formal mathematical procedures for deriving an optimal policy using discrete stochastic dynamic optimization (e.g., Kendall 2001) to scientists and managers simply sitting down at the table to discuss the implications of the science to management. What approach works best in a given situation will vary widely, and my argument here is not for one approach over another; however, I do argue that no matter which approach seems suitable for a particular context, it should be explicit and planned. Assuming that information will effectively find its way into the decision process on its own is kind of like assuming that the family vacation you planned on your own without input from your partner will go smoothly.

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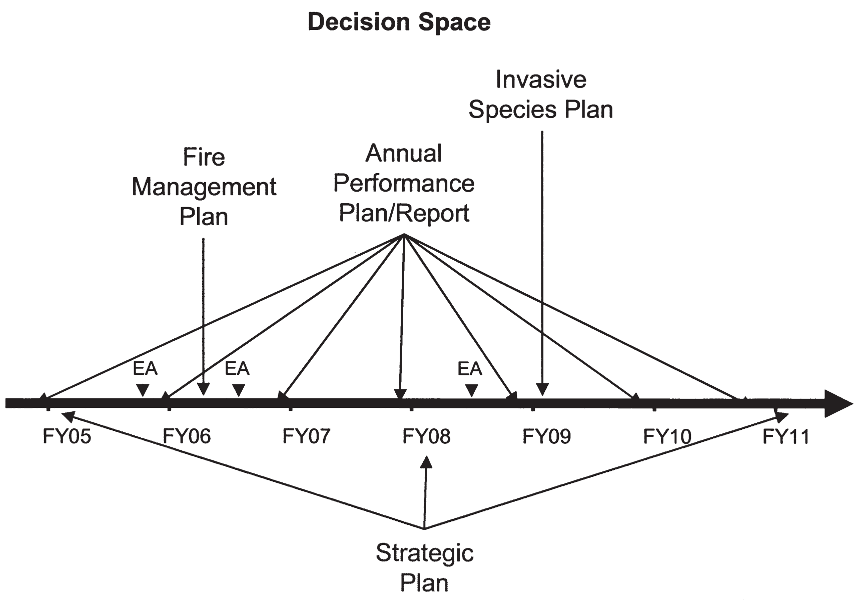
Figure 4. A conceptual model of the decision timing (e.g., plans likely to require decisions) for a national park.



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A Century of Innovation in NPS Museums

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National parks are said to be America's best idea.[1] For the last one hundred years, park museums have contributed not only to the development of that national park idea, but also to the shaping of museums in the U.S. and abroad. To commemorate the centennial of National Park Service (NPS) museums, we have assembled papers under the title "National Park Service Museums: Innovative Legacy, Innovative Future." The papers present some of the creative ideas from early days of national park museums, recent innovations and strategies, and visions for the future. They also reflect on how these innovations have contributed not only to parks, but also to museums and related professions in general.[2] This introductory paper provides a brief history of NPS museums and sets the stage for the following papers.

The earliest museums in parks were not established by an act of Congress or a central authority, but grew organically from their context in place. Initially, they were rudimentary—a 1904 arboretum in Yosemite, a table of artifacts in the ruins at Casa Grande by 1905, and even a museum in a tent at Sequoia (Figure 1). This strong association with place is a characteristic that continues to distinguish park museums and collections. Stephen T. Mather, the first director, recognized the power of collections that are preserved and presented in their original context when, in 1920, he called for "early establishment of adequate museums in every one of our parks." The world's largest museum system has grown from these early beginnings. More than 350 park units preserve objects, specimens, and archival items to tell the stories of the places where many of the most exciting events of American history, cultural experiences, and natural phenomena have taken place.

Although the first rudimentary NPS museums were often the inspiration of a single park employee, park museums did not sprout in a vacuum. Partnerships were integral to the early establishment of full-fledged museums in national parks. Universities and outside museums conducted research that created some of the earliest botanical, zoological, and archaeological collections from parks. Historical associations often helped to develop exhibits and furnish historic structures. As early as 1914, before the establishment of the National Park Service, the Museum of Vertebrate Zoology at the University of California–Berkeley began a study of mammals, birds, reptiles, and amphibians of the Yosemite region.

Figure 1. Museum tent, Sequoia National Park, 1924. The Nature Guide Service established in 1919 shared this tent with the museum in 1924. The park had a nascent museum collection by 1917. Photo Lindley Eddy (concessioner), courtesy of Sequoia and Kings Canyon National Park.

At the request of Director Mather, the secretary of the Smithsonian Institution led an early effort to promote the idea that national parks themselves are “museums of Nature.” Museum exhibits were part of the campaign to build public support for the national park idea. In 1917, Director Mather arranged a special exhibit of park landscapes by painters such as Albert Bierstadt, Thomas Moran, and J. H. Twachtman at the Smithsonian Institution. Many of these paintings are now in park collections.

In partnership with the American Association of Museums (AAM) and with funding from the Laura Spelman Rockefeller Memorial, NPS developed model park museums in Yosemite, Grand Canyon, and Yellowstone National Parks in the 1920s. Museums in these parks are characteristic of developments in parks established as natural areas.

By 1915, Yosemite had established a museum in its crowded headquarters building with exhibits of mounted birds, mammals, pressed plants, and watercolor sketches. In 1922, the park opened a museum in the former studio of the artist Chris Jorgensen with rooms devoted to thematic exhibits. By 1926, the park had opened a model museum in collaboration with the AAM (Figure 2). It featured exhibits on natural history, ethnology, and park history. In 1926 and 1929, Yosemite opened branch museums at Glacier Point and in the Sierra Club Lodge at Tuolumne Meadows. Established in 1920, the Yosemite Museum Association became the first of many cooperating associations to assist park-based museum operations throughout the national park system.

Figure 2. Interior, Yosemite Museum, ca. 1926. NPS and the American Association of Museums collaborated to establish model museums in parks. Yosemite National Park opened its model museum in 1926. Photo courtesy of National Park Service Historic Photograph Collection, Harpers Ferry Center.

By 1922, Yellowstone had opened a museum in the Bachelor Officers’ Quarters at park headquarters in Mammoth Hot Springs. Exhibits illustrated botany, geology, paleontology, and zoology. In partnership with AAM, the park opened model branch museums at Old Faithful, Madison Junction, and Norris Geyser Basin in 1928–1930. In 1931, the Fishing Bridge Museum opened, although it featured more graphics than specimens in its exhibits.

Grand Canyon opened the Yavapai Point Museum as a model museum that included an observation station. Again, with support from AAM and the Laura Spelman Rockefeller Memorial, John C. Merriam, the president of the Carnegie Institution, developed the museum. He created a museum where the canyon was the exhibit and the museum housed viewing instruments, labels, and guided interpretation. The model was so successful that a generation later it was deemed a classic example of interpretive planning in parks. In 1930, Crater Lake, following this model, received one of the first congressional appropriations to build a new museum and observation station, the Sinnott Memorial.

Archaeological parks also developed innovative approaches to preserving and exhibiting artifacts. In 1918, Mesa Verde converted a log cabin ranger station into a museum exhibiting prehistoric artifacts from the park's cliff dwellings and large panoramic photographs donated by the Denver and Rio Grande Railroad. By 1925, the park built and opened the first section of a new museum with donated funds. In the 1930s, funding from the Public Works Administration supported an extension to the Mesa Verde museum, and constructed numerous other museums throughout the national park system. In the 1930s and 1940s, Civilian Conservation Corps archaeological projects at Ocmulgee, Yorktown, and Jamestown amassed large collections. In 1938, Colonial National Historical Park erected a museum at Jamestown that included an archaeological laboratory, collections storage, two small exhibit rooms to orient visitors to the site, and windows allowing the public to view the storage room and activities in the laboratory. The "visible" storage and laboratory exhibit must have been one of the earliest such examples in the country.

In 1916, when the National Park Service was created, the system of fourteen national parks, twenty-one national monuments, and the Hot Springs Reservation included only four areas set aside primarily for their historical significance (excluding archaeological parks). These parks were Gran Quivira, Tumacacori, El Morro, and Sitka. Only one historical area had a museum before 1930: Gran Quivira began developing a museum collection in 1925 and by 1929 had opened a modest operation.

In 1933, an executive order transferred to NPS monuments and parks under the jurisdiction of the War Department, including battlefields such as Gettysburg, Vicksburg, Fredericksburg and Spotsylvania, Kennesaw Mountain, Petersburg, and Shiloh; national monuments under the U.S. Forest Service; as well as parks and monuments in the National Capital Region. In 1935, Congress passed the Historic Sites Act, directing NPS to "restore, reconstruct, rehabilitate, preserve, and maintain historic or prehistoric sites, buildings, objects, and properties of national historical or archaeological significance and ... establish and maintain museums in connection therewith." The number of historic sites in the system, and associated collections, increased rapidly. Today, more than two-thirds of the sites in the national park system were established primarily for their prehistoric and historic resources.

As park museums developed, individually and collectively, they found new ways to solve problems and accomplish their missions. These innovations have become a legacy to the national and international museum community. In 1934, NPS adopted a standard museum development plan, which led to the incorporation of museum functions and facilities into a park's total plan and operations. These plans guided the New Deal public works programs that built many park museums and exhibits in the 1930s through the early 1940s, including Chickamauga and Chattanooga, Guilford Courthouse, Shiloh, Vicksburg, Morristown, Aztec Ruins, Devils Tower, Scotts Bluff, and Tumacacori. A 1939 survey revealed that over the previous four years park museum operations had grown from 36 to 114 and the aggregate exhibit area exceeded that of the Smithsonian Institution's National Museum in Washington. Similarly, in 1956, in response to a rapidly growing number of park visitors, NPS launched a ten-year program, dubbed Mission 66, to build museums. The new museums were called "visitor centers" to emphasize the multiple visitor services offered (Figure 3).

Apart from planning and development of museum facilities and exhibits, there was a

Figure 3. Visitor Center, Fort Union National Monument, 1959. From 1956 to 1966, the Mission 66 Program funded the planning and development of approximately 100 new park museums. The program was designed to avert a crisis caused by a rapid increase in numbers of visitors and a lack of facilities and services. Planners promoted the "visitor center" to include not only a museum exhibit, but also other visitor services, such as an information desk, self-service orientation, maps, and an auditorium with audiovisual presentations. Photo by Jack E. Boucher, NPS, courtesy of National Park Service Historic Photograph Collection, Harpers Ferry Center (FOUN 126).

need to standardize and coordinate other aspects of museum operations. Detailed collections management guidance was issued in *Field Manual for Museums* (1941), *Museum Records Handbook* (1957), *National Park Service Museum Handbook* (1950s and 1960s), *Manual for Museums* (1976), and again the *Museum Handbook* (1984–present). To address the need for detailed technical guidance on caring for collections, NPS initiated the *Conserv O Gram* series in 1975. NPS distributed these technical leaflets free of charge in the United States and worldwide and sold them for a brief period through the Government Printing Office. *Conserve O Gram* and *Museum Handbook* are now accessible on the Web at www.cr.nps.gov/museum/publications/index.htm.

When NPS developed the Automated National Catalog System (ANCS) for park museums, many small-to-mid-size non-NPS museums adopted it as well. Today, ANCS+ is commercially available to other museums as the "National Park Service" version of Re:discovery Software. With the advent of the internet, websites featuring park collections developed in the 1990s and NPS established a "Web Catalog" in 2002 where parks can make their collections records and images widely accessible at www.museum.nps.gov. *Exhibit Conservation Guideline,* a CD-ROM, with over 1,500 copies distributed, is an idea that took hold quickly in the 1990s and remains popular. The "visitor center" concept, pioneered by NPS in the 1950s, is now widespread in parks at local, state, and national levels. NPS has exported ideas abroad, including interpretive planning concepts, the park brochure grid format, and the integration of exhibits and interpretive media in a visitor center. The parks, and park museum collections, have been a testing ground for museum management and interpretive ideas and strategies for one hundred years (Figure 4).

The papers presented under "National Park Service Museums: Innovative Legacy, Innovative Future" cover a wide array of museum functions and innovations over the last century. Kathleen Byrne's paper, "Documentation Equals Access," demonstrates that both parks and the museum profession have benefited from the procedures, guidelines, and automated systems that NPS has developed. The *NPS Museum Handbook* has been adapted for use by other museums, cited by the AAM in its reference services, and used in museology programs. An in-house automated cataloguing system evolved into a customized off-the-shelf system used by parks as well as many other museums. The recently introduced "Web Catalog" allows a new level of public access.

In "Notable Conservation Solutions," Brigid Sullivan Lopez reviews the development of the conservation profession and early NPS involvement. From the treatment of Sitka National Historical Park's totem poles in 1918, to the 353-foot cyclorama at Gettysburg National Military Park in 1959, and the Shaw Memorial from Saint-Gaudens National Historic Site in 1997, NPS conservators have preserved unique objects in challenging environments. NPS has created procedural manuals and technical guidance for parks that have been used by a much wider audience. The parks have been a test bed for preservation ideas and strategies.

Figure 4. Community-curated exhibit, Manzanar National Historic Site, 2004. Individuals from the Japanese-American community helped to determine the content of exhibits at Manzanar, telling the story of life in this World War II relocation center in the Owens Valley of eastern California. Community participation in exhibit development reinforces the NPS Civic Engagement initiative, forming meaningful partnerships with the very people most invested in the parks. Photo credit: Jim Simmons. Photo courtesy of Krister Olmon, Inc.

Sarah Allaback's paper, "Rustic Trailside Museums and Modern Visitor Centers: America's Most Popular Museums," chronicles the history of a museum building type that originated with NPS. In 1926, the Yosemite Museum, in the rustic architectural style, became a prototype for park museums. The "visitor center" concept, pioneered by NPS in the 1950s is now widespread in parks at local, state, and national levels.

In "An Interpretive Media Perspective," Neil Mackay discusses the many design and development innovations that originated with NPS museum exhibits and publications. NPS has exported ideas abroad, including interpretive planning concepts, the park brochure grid format, and the integration of exhibits and interpretive media in a visitor center. NPS waysides, interpretive trails, and historic furnished interiors, with high standards for historical integrity, have been models. Innovative cartography and web technology are new approaches that enrich the viewing of museum objects in their original contexts—the idea that makes park museums different.

Dwight Pitcaithley, in "National Parks and the Interpretive Message Since 1990," presents a commentary on recent changes in interpreting history. He highlights the interpretation of contentious or controversial subjects such as slavery and the coming of the American Civil War with thoughts on how these issues can be approached methodically and intellectually, and examines the connections between museum interpretive content and its role in the broader education program in this country.

Virginia Salazar-Halfmoon offers a commentary, entitled "Changing Ideas and Perceptions," focusing on the process of change and how new ideas are introduced and take hold in NPS. Using the Native American community and park museums as an example, she offers illustrations of how NPS has changed to respond to the diverse ideas, worldviews, and expectations of its employees and the public.

Together, these papers highlight and document the creativity of staff and the resulting innovations that are not only a National Park Service legacy to the museum profession, but also harbingers of future innovations. The challenges of acquiring, documenting, preserving, interpreting, and providing access to 109 million items throughout the national park system have called for big-scale solutions to local problems. New developments in National Park Service museums, the world's largest system of museums, have often had a ripple effect in the greater museum world.

Endnotes

1. Attributed to Viscount James Bryce, author of *The American Commonwealth* (1888) and British Ambassador to the United States (1907–1913).

2. For additional information about NPS museums and the centennial see www.cr.nps.gov/museum. In addition to her own firsthand experience and records of the NPS Museum Management Program, the author credits the following source for information on the NPS museum program: Ralph H. Lewis, *Museum Curatorship in the National Park Service 1904–1982* (Washington: National Park Service, Curatorial Services Division, 1993). It is available online at www.cr.nps.gov/history/online_books/curatorship/ index.htm.

Rustic Trailside Museums and Modern Visitor Centers: America's Most Popular Museums

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This paper focuses on two types of museums designed by the National Park Service: the trailside museum of the 1920s and the visitor center of the 1950s. The visitor center is arguably the country's most popular museum type, providing public information and education throughout the country in places as different as highway rest areas, private attractions, public universities, and the nation's most celebrated natural wonders. As I will show, the rustic trailside museum was a prototype for the visitor center, in terms of establishing the interactive educational role of park museums that we experience today.

The first museum documented in a national park was a 1904 arboretum at Yosemite, and over the next two decades the staffs at several parks—Yosemite, Yellowstone, and Mount Rainier—were slowly building collections of artifacts and natural specimens that they housed wherever room was available. By the early 1920s, the Yosemite museum had been moved to a former artist's studio, and park naturalist Ansel Hall was working to find funding for a new building. In 1924, the American Association of Museums (AAM) secured grants through the Laura Spelman Rockefeller Memorial to fund a museum at Yosemite. Designed by Herbert Maier, a young California architect, the museum closely resembled the park administration building, which was in a style that would come to be known as "Park Service Rustic."[1]

The Park Service Rustic style is characterized by the use of native materials, the desire for architectural simplicity reminiscent of pioneer craftsmen, and an implied association with the landscape. The Yosemite Museum featured a ground floor that appeared to be of rugged granite boulders, but was actually fire-resistant concrete, and the second story was covered with darkly stained shingles. Although the building was designed to employ contemporary construction methods, the style suggests a connection with the past and with the natural surroundings (Figure 1).

The Yosemite Museum met with the approval of the American Association of Museums, which received additional funding from the Rockefeller Memorial to expand the program of park museum construction. A year after the completion of his Yosemite Museum, Maier became an agent of the AAM and, working out of Washington, D.C., designed two additional model museums: an observation station at Yavapai Point in Grand Canyon National Park and a trailside museum at Bear Mountain in the Palisades Interstate Park. For the Yavapai Point structure, Maier imitated the rustic style of architect Mary Jane Colter, who had already sited her Lookout Studio and Hermit's Rest on the south rim of the canyon. From the new museum, visitors could view the canyon through telescopes and learn about what they were seeing in interpretive exhibits.

At Bear Mountain, Maier took the idea of interacting with the landscape even further by creating the first "trailside" museum. Visitors followed a trail up the hill from the boathouse that led right through the building. Actually building a museum on a path, and incorporating it into the park experience, was a key innovation that influenced the work of future Park Service architects, planners, and museum professionals. The idea of diminishing the barrier between the park and the museum—of considering the park itself as the museum—set Maier's work apart from that of his contemporaries.[2] Over the next 40 years, the National Park Service would continue to develop an original type of museum that featured glass observation windows as well as glass cases.

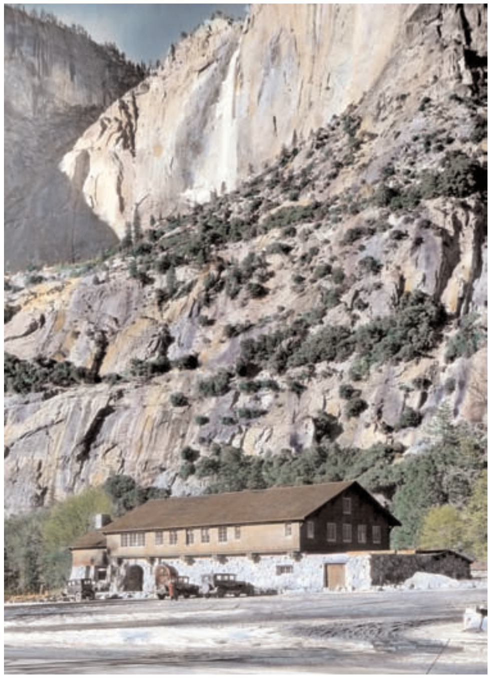


Figure 1. Newly constructed Yosemite museum building with Yosemite Falls in the background, 1925. Photo courtesy of Yosemite National Park (YOSE 50110).

With ongoing funding from the AAM, Maier used what he had learned at Bear Mountain to design four rustic trailside museums strategically situated along the Grand Loop road system of America's largest and most popular national park: Yellowstone. From the beginning of the project, Yellowstone National Park was understood as a decentralized landscape with an assortment of interesting sights that demanded interpretation—an ideal situation for a series of trailside museums. The first museum, located at Old Faithful, was open by 1928, and three additional museums were constructed over the next three years.

The Madison Junction Museum appears to be sited on natural stone. The dark wood shingles, prominent use of rough logs, and alpine motif under the eaves are characteristic of Maier's rustic buildings. The Norris Museum is a seemingly natural frame for the geyser basin, which suddenly comes into view as one enters the hallway. Patterns of rock and wood continue outside the buildings, as terraces invite visitors to treat the outdoors like additional museum space. Fishing Bridge features massive boulder foundations, in which the stones seem to be heaped in natural piles; the log posts were carefully selected for their grains and knots. As a group, Maier's buildings were the first to use architecture to direct visitors toward the park landscape. The museums not only offered typical interpretive exhibits, but also a physical space that directly related to the park itself.

One important component in Yellowstone's scenic loop, the nature shrine, was a compact version of the new trailside museum. Obsidian Cliffs nature shrine, created in 1931, stands at the edge of a parking lot in front of a two-mile-long mountain of volcanic glass. Like the museums, the shrine is constructed of local materials—in this case the very glass under examination in the featured interpretive exhibit. By providing the scenic Grand Loop with an itinerary of geological and biological education, Maier's museum system helped establish the educational role of national and state parks. The new museum type improved the views of specific natural landscapes by adding layers of scientific and aesthetic interpretation for the public to appreciate.

The Depression and World War II took a huge toll on the nation's parks; as late as 1949, Park Service Director Newton Drury called the parks "victims of war." Although visitation increased dramatically after the war, the Park Service was still relying on rustic facilities like those I've mentioned. During the early 1950s, the Park Service began to confront its problems with in-house designs for public use buildings, the prototype for the modern visitor center. The public use building took the unprecedented step of grouping museum services together with administrative functions. Early public use buildings at Grand Canyon and Everglades national parks, conceived before Mission 66, were retrospectively called "visitor centers."

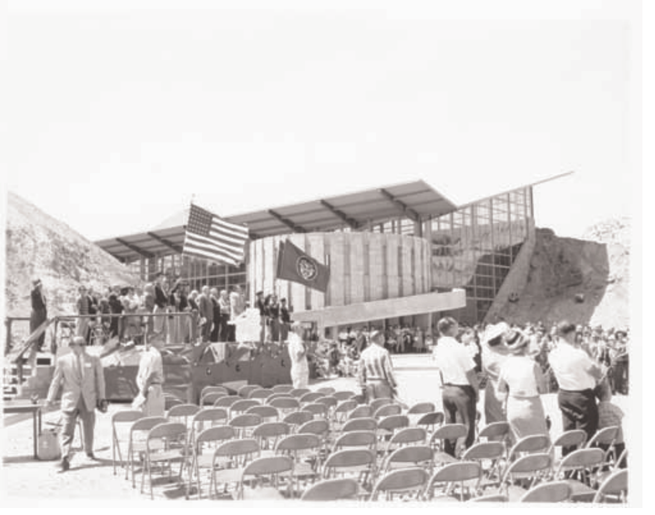
In 1955, Conrad Wirth, director of the National Park Service, introduced a bold new program to rebuild the nation's parks. He called it Mission 66, and received a ten-year budget from Congress to make it work. The architectural cornerstone of Mission 66 was a new building type: the visitor center, a building designed as the center of public services and usually the center of each park's developed area. From their conception, visitor centers were designed to represent innovation: they were modern buildings with state-of-the-art services. The new building type attracted the public with a variety of services, and sprinkled interpretive exhibits throughout frequently traveled areas—particularly the lobby—as well as within areas designated "museum." It was possible to spend time in a visitor center learning about a park without ever consciously entering a museum.[3]

The visitor center at Zion National Park, opened in 1960, is a typical example. The path from the parking lot leads to a broad front terrace from which visitors enter the hexagon-shaped lobby oriented toward scenic views. A central skylight illuminates the room. An information desk stands to the left of the skylight between the entrances to the exhibit space and auditorium. Visitors were encouraged to walk out to the exterior viewing terrace to the Towers of the Virgin, a rock formation behind the building. A certain progression through the building was suggested, and visitors interacted with different types of museum exhibits in the lobby and outdoors, as well as within the room designated for that purpose.

Although most visitor centers were relatively modest buildings with programs similar to others I've described, a small number were spectacular. Dinosaur National Monument's Quarry Visitor Center is a national historic landmark (NHL) in the dry, rocky terrain of northeast Utah, over 200 miles from any major city. Here, the National Park Service demonstrated the power of their building type by transforming a barren pile of fossil bones into a modern wonder.

When Quarry Visitor Center was designed in 1956, the building was hailed as a precedent for things to come (Figure 2). Park Service Director Conrad Wirth acknowledged that his "bold move" would result in a "world-renowned" building and "attract thousands of people." The San Francisco architectural firm Anshen and Allen was commissioned to design the visitor center. A concrete ramp takes the visitor up to the second-story viewing deck for an up-close view of dinosaur remains emerging from the living rock. When the visitor center first opened, visitors could watch paleontologists chip away at the rock matrix to

Figure 2. Dedication ceremony at Quarry Visitor Center, Dinosaur National Monument, 1958. Photo courtesy of National Park Service Historic Photograph Collection, Harpers Ferry Center (HPC-000141).



reveal the gigantic fossilized bones. The lower part of the rock face is viewed from the first floor, where visitors could also see the scientists working in the laboratory. The "museum" portion of the building is a steel-frame structure with an asymmetrical butterfly roof; the ends of the "shed" protecting the bones are glass panels providing natural light. Visitor services are contained within a concrete cylindrical tower adjacent the viewing area. But Quarry Visitor Center used modern technology to do what no other architectural style could: protect the precious dinosaur remains while illuminating them with natural light.

A brief look at two additional NHL visitor centers illustrates how visitor centers were designed to enhance site interpretation.

The Wright Brothers National Memorial visitor center in Kill Devil Hills, North Carolina, was designed in the late 1950s by the Philadelphia architects Mitchell/Giurgula. The building sits on a platform and visitors enter from a terrace with a textured concrete motif. Along with a regular museum area, the visitor center features an assembly room with window walls overlooking the "first flight area." It is sited so that all major points of interest can be seen from this room.

The headquarters at Beaver Meadows, Rocky Mountain National Park, was designed by Taliesin Associated Architects, the successor firm to Frank Lloyd Wright, in the early 1960s. The building is sited to sit low in the landscape; employees enter a two-story administration building, but the visitor center is only one story from the public entrance. The walls are actually made of 101concrete panels in 64 sizes with stones laid into the cast concrete and a structural steel truss system. A viewing balcony encircles the building and one section frames Long's Peak, the highest mountain in the park.

Despite dramatically different architectural styles, the rustic trailside museum and the modern visitor center share many characteristics that set them apart from other museums. In most cases, aspects of the park are part of the building, whether a river boulder or a stunning view. Often, the buildings are sited at an important park location—near the geyser no one wants to miss or overlooking the battlefield that is the reason for the building. In partnership with the American Association of Museums, the Park Service developed two new building types that forever altered the way we view some of our most treasured natural landscapes and most valued historic sites.

Endnotes

1. The early history of Park Service museums is summarized in the first two chapters of Ralph H. Lewis, *Museum Curatorship in the National Park Service 1904–1982* (Washington:, D.C.: National Park Service, Curatorial Services Division, 1993).
2. For a more detailed description and assessment of Maier's work in the context of his day, see Ethan Carr, *Wilderness by Design: Landscape Architecture and the National Park Service* (Lincoln: University of Nebraska Press, 1998), 143–145.
3. For a history of Mission 66 visitor centers, including five case studies, see Sarah Allaback, *Mission 66 Visitor Centers, The History of a Building Type* (Washington, D.C.: National Park Service, 2000).

National Park Service Museum Collections: Documentation Equals Access

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The National Park Service (NPS) may well have one of the largest museum collections in the world. With 109 million items at over 350 sites, the size and diversity of the collections have required innovative approaches to the documentation of collections. Documentation is sometimes called "museum record-keeping"—the work that encompasses accessioning and cataloguing collections, maintaining loan records, completing inventories, and any activity that involves written or computerized information about the items in a collection. Although documentation is generally considered the boring part of museum work, it's actually the foundation of a collection. You've got to know what you have and where it is before you can plan for conservation work and exhibits and interpretation.

Knowing what the NPS has and where it is has always been a challenge for three reasons: the size and diversity of the collections, their geographic locations, and a frequently changing, collateral-duty staff. Ever since 1920, when Yosemite National Park began keeping systematic museum records, museum documentation has been evolving to meet these challenges.

There's no doubt that the number and types of collections are a challenge. There are natural and cultural resource collections in several disciplines. For example, cultural collections include the Philip Syng silver inkstand used in the signing of the Declaration of Independence at Independence National Historical Park and the child's doll that was in the room at the surrender of the Confederacy at Appomattox Court House National Historical Park (see also Figure 1). There are a growing number of archival collections, including landscape design documents from Frederick Law Olmsted National Historic Site and field project records for archaeological investigations at Sitka National Historical Park. Ethnographic and archaeological collections include Mono Latke Paiute baskets at Yosemite National Park and bullets from Gettysburg National Military Park. Natural collections include a new species of dinosaur at Dinosaur National Monument and a rare tree snail collection at Everglades National Park (see also Figure 2). Take a look at some of the web exhibits featuring NPS museum collections at www.cr.nps.gov/museum to see even more examples.

Keep in mind that without museum records, very little would be known about these diverse collections. The challenge comes in documenting so many different types of items. It requires a broad range of expertise from discipline specialists, such as biologists, historians, and archaeologists.

Another challenge to documentation directly relates to the site-specific nature of the collections. It's the most important feature of NPS museum collections. By being preserved in place, the collections can create a sense of place. That makes the information about them even more important. What may look very ordinary may have a great story to tell. Someone once said that most museums have the right stuff in the wrong place, but the National Park Service has the right stuff in the right place.

Having the collections on site is great, but documenting those collections under one system is a geographic challenge. The NPS is spread out all over the country, and sites are often in remote areas. Computers have helped tremendously, but getting staff in one place for training is difficult and expensive. Communication between sites, regions, and the Washington office is essential for everyone to be working on one system.

Figure 1. Chief Red Cloud's Shirt, Oglala Sioux, possibly made by Cheyenne, pre-1902, Agate Fossil Beds National Monument (AGFO 439). Photo courtesy of Harpers Ferry Center, NPS.

Staffing is still the biggest challenge. Unfortunately, the NPS doesn't have trained curators at every site. Collateral-duty staff may know what to do, but they have little time to work on collection documentation. Others have little knowledge or training in museum records.

NPS staff also move from park to park. As people move, their positions may remain vacant, and the history of the collection may leave along with them.

Given the challenges of size, diversity, geography, and staffing, the NPS has had to come up with some innovative ideas for keeping everyone on the same page. Almost from the beginning, the NPS realized that there had to be some type of servicewide guidelines for museum records. As Ralph Lewis states in *Museum Curatorship in the National Park Service 1904–1982*, "The permanent linking of objects and supporting data necessitates systematic museum records." Documentation guidelines have evolved over the years, but basically it's been a progression from paper to computer media.

Figure 2. Miami blue butterfly *(Cyclargus thomasi bethunebakeri)*, Everglades National Park (EVER 6501). Photo courtesy of Nancy Russell, Everglades National Park.

The original guidelines took the form of a handbook. The first *Museum Handbook* was in one volume and published in 1967. Its predecessor was the *Field Manual for Museums*, published in 1941. The *Manual for Museums*, published in 1976, was used by many non-NPS museums. In the 1980s, the notebook format came back into use, and the *Museum Handbook* split into three volumes. Volume I provides guidelines on preservation and protection. Volume II provides guidelines on museum records, and Volume III provides information on access and use of collections. The handbooks have been used in many museology programs and are cited by the American Association of Museums (AAM) in its reference services. The handbooks are constantly being updated, have been rewritten in a plain-language format, and are available on the web at www.cr.nps.gov/museum.

In 1977, the NPS started to collect all the catalogue records in a central repository called the National Catalog. The park typed a catalogue record with a carbon copy, kept the carbon copy at the park, and sent the original to Harpers Ferry, West Virginia, where the National Catalog is located in a converted bomb shelter. The idea was to have an alternative storage location in case of loss at the park and to eventually aggregate all the data.

In 1985, park museums began using the Automated National Catalog System (ANCS) for cataloguing collections. It was an in-house program that was offered at very low cost ($25) to other museums. Many museums both here and abroad ordered the system and the manual.

ANCS has evolved into ANCS+, which is a customized commercial software system. Some curators call it one-stop shopping because parks can do almost all of their museum record keeping using the program. All of the required reports and forms are in the program. Other museums that are considering what to put in their own systems frequently contact the NPS to get examples from ANCS+.

A lot of park curator input went into customizing the commercial product. This participation resulted in two things: a huge NPS system because the collections are so diverse, and some really good ideas from field personnel. The company, which is Re:discovery Software, Inc., has adopted these ideas for its non-NPS version of the software. The company sells the NPS-customized version of the program outside the NPS. Some state and local museums are using it. ANCS+ is now on the General Services Administration pricing schedule, which has recently been opened to state, local, regional, and tribal governments.

One of the things that happened with the use of ANCS+ was that parks could now easily search their collection documentation. Information about NPS museum collections suddenly became much more accessible. The dream was to aggregate all the data into one large database, and that database now exists in both Washington, D.C., and Harpers Ferry. For example, the NPS can now quickly answer questions such as, "Does the NPS own a piano made by Clementi that belonged to Alexander Hamilton?" or "Which parks have bat specimens?"

A future goal is for all parks to have catalogue data available on the web for researchers and the general public to search. There is currently a web catalogue that allows parks to purchase services for mounting NPS catalogue records on the web. Users can browse records or do a word search or search specific fields. They can look at brief records or more detailed records or choose to browse only those records with images.

The NPS is also doing museum exhibits on the web that include multiple images of objects or specimens along with exhibit text and actual catalogue data. These exhibits are making some of the more remote collections accessible to other museums and the public, including objects that are in storage.

So what does the future hold for documentation and access? The NPS still has over 55 million items to catalogue—and more being acquired all the time. And museum staff still need to scrub a lot of old data, like lots of museums do. On the bright side, the NPS has now converted all of the catalogue data from over 270,000 old paper records that were created before computerization. Some of these records date back to the 1930s and 1940s. These records have been virtually inaccessible to anyone but park staff.

Of course, NPS museums will have to continue to migrate data as computer technologies change. As they do so, field staff will come up with additional utilities and reports that will be of use to the larger museum community. Parks suggest improvements to the system almost every month.

The NPS museum program will continue to make museum collection data more accessible. There are plans to place archival collections on line. The Teaching with Museum Collections initiative will soon be available on the web. The next version of ANCS+ will be compatible with NPSpecies, the database used by the agency's inventory and monitoring program.

NPS museums celebrated their centennial year in 2004. The progress has been tremendous, but there's plenty to do in the next hundred years. Hopefully, the NPS museum program will continue to come up with innovative ideas for getting it done with increased efficiency and professionalism. Who says documentation is boring?

An Interpretive Media Perspective

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At a conference at Grand Canyon regarding the state of museum work in the National Park Service, attendees hear of "the need for complete museum records, more adequate housing for exhibits and collections, still better exhibits, and more studies of their effectiveness." The date is 1940, as recounted in *Museum Curatorship in the National Park Service 1904–1982* by Ralph Lewis (1993:106). The same concerns are still present today, but so is the desire to address them creatively.

There is, indeed, a legacy of museum innovation in the National Park Service (NPS), as documented in Lewis's work, in *Interpretation in the National Park Service* by Barry Mackintosh (1986), and, most recently, in *Interpretive Centers: The History, Design and Development of Nature and Visitor Centers* by Michael Gross and Ron Zimmerman (2002). While these works document how the planning, design, and fabrication of museum exhibits has progressed in the NPS over the past hundred years, many challenges remain for the numerous exhibitions spread out across the country. In the pursuit of innovative solutions to these challenges, exhibit developers continue to collaborate, make connections with park resources, explore new tools and processes, and reach wider audiences.

Collaborating for innovation

The history of NPS museums is one of ongoing and evolving collaboration among museum professionals (Figure 1). The first park museums were created at the beginning of the 20th century by ranger-naturalists and park partners responding to the growing demand for nature exhibits by the visiting public. Early on, the NPS partnered with the American Association of Museums (AAM), which established a Committee on Museums in the Parks in 1924.

In the 1930s, funds became available for NPS museums from New Deal programs such as the Civilian Conservation Corps and the Works Progress Administration. Dozens of park museums were created by exhibit workers from the Eastern and Western Museum Laboratories. The very term "museum lab" implies that innovation was expected. The media approach at that time is described in the pioneering 1941 book *Field Manual for Museums*: "…the park as a whole may be regarded as an exhibit and the museum as an

Figure 1. NPS Western Museum Laboratory, Berkeley, California, 1937. Photo by Nix [not further identified]. Photo courtesy of National Park Service Historic Photograph Collection, Harpers Ferry Center.

explanatory label" (Burns 1941:2). As Barry Macintosh notes, this vision often led to a "narrative approach in exhibit design" (1986:48).

Then came Mission 66. Between 1956 and 1966 the NPS built over 100 new visitor centers to meet the growing need to provide services for an increasing number of visitors to the national parks. As the centerpiece of the park interpretive program, the Mission 66 visitor center employed expanded and refined exhibit techniques, including dioramas, relief models, and audiovisual programs (Gross and Zimmerman 2002:32–33).

Ralph Lewis describes a key moment in media collaboration in 1955. The National Park Service conducted an experiment in teamwork by having the exhibit designer travel to a park—Grand Canyon—to work with the curator from the beginning of the project. The experiment was deemed a success, not just in being more efficient, but in increasing the quality of the exhibits (1993:143). This set in motion an important media collaboration trend that continues today: the desire to involve more participants, and to do so earlier in the development process.

Figure 2. Model of Harpers Ferry Center, Harpers Ferry, West Virginia, 1967. Photo by M. Woodbridge Williams. Photo courtesy of National Park Service Historic Photograph Collection, Harpers Ferry Center.

By the end of the Mission 66 period in the mid-1960s, audiovisual programs and publications were assuming more of the narrative story, and exhibitions became less linear and more concerned with giving visitors impressions and park meanings (Mackintosh 1986:48). In 1970, this led to another innovative concept: housing the various interpretive media developers under one roof by creating the Interpretive Design Center at the Harpers Ferry Center in Harpers Ferry, West Virginia (Figure 2). Creators of park brochures, indoor and outdoor exhibits, historic furnishings, slide shows, audio programs, movies—all would work out of the same office to achieve something greater than if they pursued their work separately. The center also established guidelines and standards, such as conservation protocols for developing preservation-responsible exhibits.

Today, Harpers Ferry Center employs a mix of about 180 interpretive planners, designers, filmmakers, curators, cartographers, conservators, project managers, writers, planners, and associated administrative staff and managers. The intent is to work on interdisciplinary teams, from the beginning of a project to its completion. Harpers Ferry Center seeks innovative ways to increase the interpretive media capacity of the NPS by collaborating with field-based media staff.

Knowing what to be innovative about

So, the National Park Service has collaborative media teams ready to be innovative—but innovative about what? It is useful to go back to our roots. Herman Bumpus, director of the American Museum of Natural History, and head of AAM's early park efforts, stated that "[t]he real museum is outside the walls of the building, and the purpose of the museum work is to render the out of doors intelligible" (Gross and Zimmerman 2002:28). In the National Park Service, it is our relationship with the landscape and resources that drives our mission to both protect and interpret. Therefore, some of our most important interpretive media innovations concern providing visitors with a sense of place.

Flat maps, dioramas, murals, relief models—all have been used in NPS exhibits to help visitors make connections with the resources, plan their visits, and better understand their parks.

We continue to employ relief models in visitor centers, but often in new ways or using new technologies. At Harpers Ferry National Historical Park, an important goal of the exhibits is to give visitors a sense of how the use and look of the land has changed dramatically over time. A monochromatic relief model shows the hilly terrain of Harpers Ferry, bounded by the Potomac and Shenandoah Rivers. Touching different locations on the model activates video clips that present historical snapshots and brief descriptions. Today, a relief model might even be located outdoors, such as a touchable model at the new transportation center at Zion National Park, under a shade structure accompanied by other interpretive panels and touchable models of park fauna.

Two-dimensional maps are increasingly emulating the three-dimensional world. Traditional maps and panoramic paintings were done by hand. Today, at the center's cartographic office, innovative digital elevation models, or DEMs, are creating new techniques for visualizing terrain (Figure 3). With base data in place, these three-dimensional models can be manipulated to tell more stories about the land. Artwork can depict how terrain changes over time. For example, a volcano in what is now southern Oregon transforms into the site of Crater Lake. Visitors can now even get a sense of the underground, such as in visualizations of the complex cave system at Mammoth Cave. This pioneering work in three-dimensional terrain mapping is influencing all NPS media: publications, indoor and outdoor exhibits, and audiovisual programs.

Using processes that lead to innovation

Museum exhibit designs for the National Park Service are developed in three design phases: a beginning, middle, and an end, respectively called the "schematic," "concept," and "final design" phases. It is the first, or schematic, design phase that sets the degree of innovation possible, because the macro-design solutions proposed at the start of the process set the course for the rest of the project.

In the past, this was a fairly straightforward approach. The planning and design team worked with park staff, subject-matter experts, and stakeholders to understand the park mes-

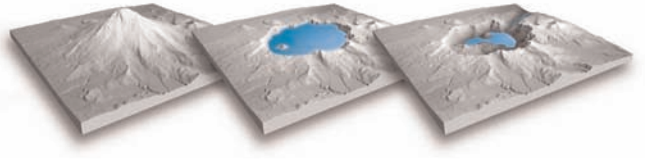

Figure 3. Digital elevation model showing landscape evolution at Crater Lake National Park. Photo by Tom Patterson, NPS. Photo courtesy of Harpers Ferry Center.

sages to be communicated and generated a preliminary, or schematic, design. Once reviewed and approved by the park, the schematic plan progressed into a more refined concept design, and then into a final design package that could be bid to fabrication firms and produced.

But in the early 1990s, the National Park Service initiated a design process protocol called “value analysis.” In doing so, it borrowed lessons learned from World War II. With critical material shortages during the war, innovative substitutions were required, which, it turned out, often led to better and less expensive products. General Electric took note of this effect, and in the late 1940s began to develop methodologies for the systematic analysis of function and cost. This was termed “value analysis,” or sometimes referred to as “value engineering” (National Park Service 1991:3–4). Critical to value analysis is the use of multidisciplinary teams to identify functions of a product, establish a worth for those functions, and provide alternative ways to accomplish the necessary function at the lowest cost through the use of creative techniques.

So what does this have to do with innovation? The key lies in formalizing the generation of alternative design solutions early in the creative process. Without value analysis this might or might not be done as part of a design submittal, and, if done, rarely documented. It takes the ideas generated in sketchbooks and models and organizes them into a set of genuine alternatives. These are then evaluated by a multidisciplinary team and new ideas are generated. The National Park Service, as client, is inviting itself into the decision-making process of the designer, insisting that it be part of the trade-offs of benefits and costs.

To illustrate this concept, consider the Selma to Montgomery National Historic Trail project, a unit of the National Park Service that commemorates the 1965 Voting Rights March along Highway 80 in Alabama from Selma to Montgomery. A new interpretive center, being constructed along the trail in Lowndes County, will provide orientation to the trail and the site, interpretive exhibits, and a movie. Three exhibition design alternatives were generated during the first, or schematic, phase of work. Each alternative had a fundamentally different approach to telling the story (Figure 4).

A multidisciplinary mix of park staff, stakeholders, and media creators evaluated each alternative. Which techniques worked best to tell the story? What designs seemed best integrated to the architecture? In essence, a value analysis work session becomes a medium for the interdisciplinary exhibition team to have a dialogue that leads to innovation. Author Michael Schrage explores how prototypes serve as a medium of communication for designer and client teams in his book *Serious Play* (2000).

After this facilitated value-analysis exercise, the study team selected alternative A, with some changes and with some elements of alternatives B and C included. Then, during the subsequent concept phase, the team conducted another value-analysis exercise that looked more closely at the costs of the proposed exhibition.

In addition to stakeholder involvement, the team worked with an outside evaluator to conduct front-end and formative evaluation with potential audiences. Thus, the stakeholder and the audience were part of the decision-making process early on.

Projects that stick with their first and only design solution tend to get into trouble, and tend not to be as innovative as they might be. As the saying goes, “You can’t pick the best solution if it is never put on the table.”

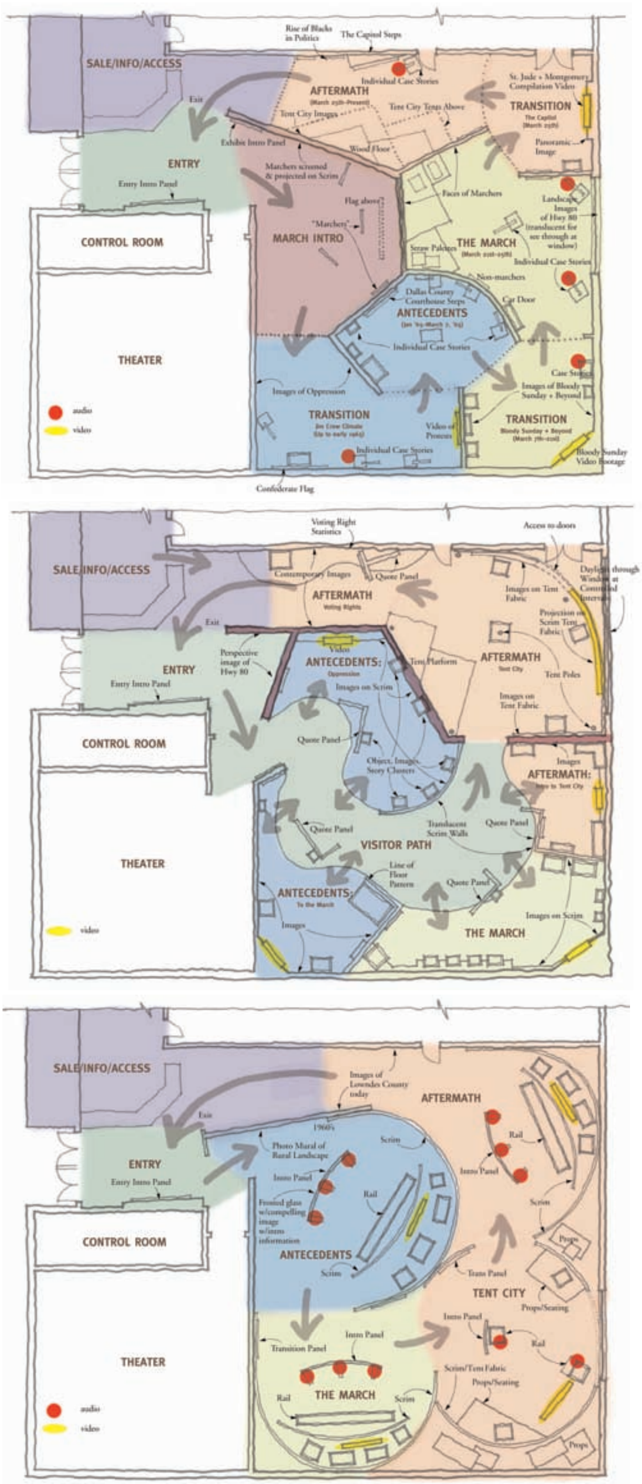

Figure 4. Exhibit design alternatives A (top), B (middle), and C (bottom), Tent City Visitor Center, Selma to Montgomery National Historical Park. Photo by Amaze Design, Inc. Photos courtesy of Harpers Ferry Center.

Creating tools to carry out innovations

Beyond having collaborative teams, focusing on appropriate messages, and using creative work processes, what tools are needed to ensure that innovative exhibition solutions can be realized?

The real breakthrough here has been going from the typewriter and word processing programs to the use of database programs. In the early 1990s, the National Park Service began developing the Museum Exhibit Planner database application to track the myriad elements that go into an exhibition. Harpers Ferry Center exhibit planner David Guiney and the exhibit staff designed the program.

The numbering system is the language, and its grammar is simple. Exhibit elements are "L" for labels, "G" for graphics, "A" for artifacts (any object, actually), and so forth. The identification number "L-01-001" denotes a label in exhibit 1, and is the first element in that exhibit.

An artifact work screen prompts curators and planners for information, as does the graphic work screen. There are similar work screens for the other exhibit elements. When put together in a comprehensive report form, all team members can get a holistic understanding of the exhibition. The description of each exhibit area begins with a purpose statement, in order to reference review comments and become the framework for evaluation. Other reports, such as the artifact schedule and the graphic schedule, are then used during the fabrication phase to ensure that production-ready packages are complete and lead to accurate fabrication bids.

So the database is both a process and a product. It is a process because it helps diverse team members share and review evolving information on a project (and see where they still need to provide information). And it is a product because it allows the team to generate reports for fabrication.

In my work as an exhibit planner, this database application is the single most important tool for carrying out innovative visions on projects. Like value analysis, it combines being efficient with being creative. And it seems to be working for others too. Many of our partners and contractors use this program for non-NPS projects.

Innovating for new venues

The National Park Service is challenging itself to pursue new venues for interpretation. Historically we have always looked for innovative ways to tell our stories. In addition to the visitor center and museum approach at our parks, today we are exploring how to expand the educational opportunities for our visitors. The definition of "education" varies within the NPS, but is increasingly going beyond kindergarten through grade 12 to include lifelong learning, with a pedagogical approach that is learner-centered.

Within the NPS there are a variety of education centers: facilities that are an engaging hybrid of the informal learning environments of the classic visitor centers and the formal nature of classrooms. There are environmental education centers, research learning centers, and a range of other education centers. For the last decade, the Tsongas Industrial History Center in Massachusetts has been a pioneer among the NPS education centers.

More recently, a unit of Gateway National Recreation Area, the National Parks of New York Harbor Education Center at Fort Wadsworth on Staten Island, is developing a 20,000-square-foot space to include a series of educational workshop areas. each dedicated to telling a particular story. For example, a space entitled "Coastal Defense," accompanied by a program called "Sentinels of Our Shores," has been developed for fourth graders. The center is currently evaluating the benefits of involving exhibit planners, designers, and producers in the process of creating these spaces and their learning elements.

The workshop spaces strive to reflect how people learn, creating places for social interaction and a variety of facilitated activities including experimentation. Interactive exhibits are taken to another level and become "teaching aids" for active learning. Educators developed prototypes and tested them with students and teachers. The inclusion of exhibit techniques adds value to these prototypes.

For the past hundred years, the creators of National Park Service museums have sought to collaborate, help visitors make connections with the resources, utilize creative exhibit development tools and processes, and, ultimately, reach wider audiences. This legacy of innovation continues to provide invaluable lessons and to inspire us as we begin the next hundred years of museum work.

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Notable Conservation Solutions

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In 1916, Congress mandated the National Park Service (NPS) to conserve historic objects as well as wildlife, scenery, and the natural environment, and one of the earliest NPS conservation efforts took place in the territory of Alaska.

Sitka National Monument was established in 1910 and brought under National Park Service jurisdiction in 1916. The chief cultural resource is a remarkable collection of nineteenth-century totem poles gathered from coastal Tlingit and Haida villages by the territorial governor for display in the 1904 Louisiana Purchase Exposition in St. Louis and the 1905 Lewis and Clark Exposition in Portland. The aim was to promote Alaska. Eventually, the poles were returned and installed along the Old Russian walk in a peninsula near the town of Sitka, where they remain today at Sitka National Historical Park.

The poles had been repaired at least twice during their journey to the mainland expositions, and NPS's first annual report to the secretary of the interior in 1917 specifically mentioned their poor condition. Fearing total loss of this resource, the NPS teamed with the Civilian Conservation Corps (CCC) to preserve the poles by hiring skilled native carvers and unemployed young native men to repair poles and replicate those considered beyond repair using traditional technology. By using this approach, not only were the poles preserved, but the traditional cultural technology was passed on to a younger generation.

By 1991, continued deterioration of the poles was again a major concern, and the NPS Harpers Ferry Center Division of Conservation began a new conservation campaign with a team of subject-matter specialists, conservators, biologists, and the local native and non-native community to reach consensus on a treatment approach. The question of the propriety of repairing the poles versus allowing them to naturally deteriorate, as is culturally accepted, was discussed in depth, and by consensus it was decided to preserve examples of earlier carvings to inform the public and contemporary carvers of the cultural tradition. Following the same spirit of the CCC work in the 1930s, the new conservation campaign had a strong cultural training component. Led by Al Levitan, a wooden objects conservator at Harpers Ferry Center, preservation of the poles took place over several summers, and Sitka became a clearinghouse for totem pole preservation issues. In 1998, the Division of Conservation, in partnership with Wrangell–St. Elias National Park and Preserve and Sitka, received a grant from the NPS Cultural Resource Training Initiative to bring together carvers, curators, conservators, and tribal administrators to provide a framework for understanding both cultural and technological aspects of carved pole preservation.

Preservation of the *Ki'i* figures at the *Heiau* at Pu' uhonua o Honaunau National Historical Park on the Kona coast of Hawai'i Island was similar in approach. The deteriorated *Ki'i* figures were faithfully replicated by native carvers using traditional technology and placed in protective storage, and the newly carved copies were installed in the original locations with appropriate cultural ceremony. And so, the original carvings were preserved along with the cultural traditions and skills.

Like Sitka, the Franciscan mission of Tumacacori in southern Arizona was named a national monument (in 1908) and brought into the National Park Service in 1916. But unlike Sitka, Tumacacori Mission became a test kitchen for "modern" preservation methods that began to be developed as the professional field of scientific conservation grew from what had been essentially a body of skilled craftsman techniques and practices.

The movement for professional conservation sought to set standards of practice based on scientific method and observation rather than empirical trial and error. In 1929, the Fogg Art Museum at Harvard University set up the first Department of Conservation and Technical Research, and staffed the department with a chemist, x-ray specialist, and an art historian as necessary components of modern conservation knowledge.

In 1949, Fogg Art Museum Conservation Director John Gettens visited Tumacacori and consolidated the friable interior plaster with polyvinyl acetate resin, marking one of the first uses of this resin in a wide-scale architectural application. Over time, the Gettens treatment failed as plaster continued to detach, but for the next 25 years attention was focused on preservation problems of the adobe structure by the former Ruins Stabilization Unit that moved from Globe, Arizona, to Tucson with the Arizona Archeological Center in the 1970s. After years of failed attempts to preserve the interior plaster by various agencies, a NPS Denver Service Center historical architect, Tony Crosby, sought the international community's experience and knowledge of conservation of painting on plaster and enlisted the aid of mural paintings conservators from the International Centre for the Study of the Preservation and Restoration of Cultural Property (ICCROM) in Rome to conserve the remaining original decorative scheme in Tumacacori's domed interior. In 1982, an eight-week project was undertaken under the direction of Italian conservators, and conservators, historical architects, curators, and maintenance personnel from throughout the NPS were invited to participate and learn the approach and procedures (Figure 1).

Figure 1. The author working in the dome of Tumacacori National Monument, 1984. Photo by Mary Sherry, NPS, courtesy of the author.

The Tumacacori project was the first time ICCROM worked in the United States, and through this valuable contact Italian conservators returned to work on the missions of San Antonio in Texas and San Xavier del Bac in Arizona. Consistent with the approach at Sitka in teaching local and native community members techniques of preserving cultural resources, members of the local native community worked alongside professional conservators, sharing their cultural approach and traditional technology with the team to the enrichment and success of the project. This project developed into the Vanishing Treasures Conservation Program,spearheaded by David Yubeta.

In terms of traditional museum collections, the NPS was aware of advances in the newly developing field of conservation, and the 1935 Museum Preparation Memorandum #1 of the NPS Western Museum Laboratory in Berkeley actually refers to work by the British conservation pioneer Harold J. Plenderleith, arguably the founder of modern conservation. However, there were few, if any, people in the United States, let alone the NPS, with sufficient training in modern conservation techniques. Volunteers and civic groups including the Works Progress Administration (WPA) and the CCC were often employed to perform basic preservation procedures, and NPS exhibit preparers and archaeologists in specialized centers often performed remedial treatments.

In 1950, the NPS Museum Branch in Washington, D.C., hired the agency's first professionally trained paintings conservator, Elizabeth H. (Betty) Jones from the Fogg Art Museum. Paper conservator Anne Clapp was hired in 1956 and, in 1957, she set up a satellite lab at Independence National Historical Park. Paintings and paper were covered, but there was a need to treat increasingly complex materials in park collections.

In the 1970s, the Harpers Ferry Center's Division of Museum Services provided servicewide conservation services. The old Shipley School was renovated to contain specialized conservation laboratories for ethnographic and historic objects, furniture, archaeological material, metals, and textiles, as well as paper and paintings. Allied with the exhibits program of the Harpers Ferry Center, objects from parks throughout the country were sent to Harpers Ferry for treatment. Conservators also traveled to sites like circuit riders to undertake on-site treatments and oversee a variety of preservation activities. Training for park staff expanded to offer "Curatorial Methods Phase II," hands-on instruction in very basic conservation techniques for park collections that curators could undertake, as appropriate.

Regional centers offering conservation services to parks developed in the mid-1970s. The regional archaeology centers took off in the late 1960s and 1970s primarily in response to the National Historic Preservation Act of 1966. The Midwest Archeological Center developed from the original River Basin Survey collections in Lincoln, Nebraska, and is now associated with the University of Nebraska. The Southeast Archeological Center developed from the old Ocmulgee National Monument collections and is now associated with the Florida State University in Tallahassee. Both have a history of undertaking conservation of collections, and do so now on a limited basis. The present Western Archeological and Conservation Center grew from the original Southwestern National Monuments group organized under Frank Pinkley in 1923. The center is now associated with the University of Arizona and offers professional conservation services to parks in its service area. The former Northeast Cultural Resources Center grew from the old North Atlantic Historic Preservation Center that was developed in the 1970s. With the realignment of programs in the Northeast Region, the Collections Conservation Branch in Lowell, Massachusetts, is now part of the Northeast Museum Services Center, with the function of providing conservation services to parks in the Northeast Region.

Conservation providers in the NPS continue to cooperate with other institutions to ensure the best conservation outcome possible for our cultural resources. The Robert Gould Shaw memorial monument on the Boston Common is well known, but NPS has responsibility for the final version of the Shaw, a gilded plaster formerly installed at Saint Gaudens National Historic Site in Cornish, New Hampshire. Damage and deterioration by years of exposure in a semiprotected shelter outside, combined with the Saint-Gaudens trustees' desire to mold and cast the plaster in bronze for continued outdoor exhibit, led to an ambitious conservation project to ensure the safety of the original art. Throughout the process of disassembling the original sculpture, preparing it for mold-making, pulling the molds, reassembling the sculpture, repairing the structure, and treating the surface, the NPS worked with expert sculpture conservators and mold-makers (Figures 2 and 3). The completed original Shaw memorial (in gilded plaster) is now exhibited in the National Gallery in Washington, D.C., on a renewable ten-year loan.

Figure 2. View of hidden soldiers' heads during disassembly of the Shaw Memorial at Saint-Gaudens National Historic Site by conservator Clifford Craine of Daedalus, Inc., 1996. Photo by Carol Warner, NPS, courtesy of Collections Conservation Branch, Northeast Museum Services Center.

Another large-scale project currently in progress is the conservation of the Gettysburg Cyclorama painting in preparation for installation in a new visitor center. The cyclorama has a long history, much of it not happy in terms of its preservation. It was restored and exhibited in various venues, and received its first major professional conservation treatment in 1960–61 by paintings conservator Walter Nitkiewicz. Past treatments created present problems, which are now being addressed by a team led by well-known paintings conservator Perry Huston in a multiyear project.

The NPS is once again collaborating with Harvard, this time at the U.S.S. *Arizona* Memorial in Pearl Harbor. With financial backing from Harvard, Ralph Mitchell, the world's leading expert on biofilms and director of the Laboratory of Applied Microbiology, is researching how microorganisms adhere to and grow on surfaces to form biofilms, which, like plaque on teeth, can chew through metal. The combination of saltwater, oil, microbes, and time is a formidable force for deterioration. About 500,000 gallons of oil remain in the ship and Mitchell and his team of microbiologists and marine biologists seek to determine if the interaction between organisms and fuel oil is accelerating corrosion, and if it is possible to predict the amount of time left until the hull ruptures.

In recognition of the continuing need to further advance the preservation of our cultural patrimony, Congress established the National Center for Preservation Technology and Training in Natchitoches, Louisiana, in 1992. Through training and a broad grants program, the center provides an interdisciplinary approach founded in historic architecture, archaeology, cultural landscape, and traditional museum collections conservation in developing technologies for preservation of all cultural resources.

Figure 3. Installation of the conserved Shaw Memorial in the National Gallery of Art, 1997. Photo by Carol Warner, NPS, courtesy of Collections Conservation Branch, Northeast Museum Services Center.

Recognizing that dollars for remedial conservation treatment are declining and the body of knowledge about environmental causes of deterioration is growing, the current focus of instruction to parks is preventive care. Continuing the teaching mission of the old Museum Services Division, the Museum Management Program broadcasts information to parks and the museum community at large by way of the *Conserv O Gram* series, which is also available on the web. The *Exhibit Conservation Guidelines*, prepared by Toby Raphael and other Harpers Ferry Center conservators and produced in a CD format, is a major accomplishment and used by museums internationally. The influence of NPS conservation approaches is visible in the Institute of Museum and Library Services Conservation Assessment Program, among other national programs. Because of the size and diversity of park collections both large and small, NPS often sets precedents for conservation approaches and practices in the larger museum conservation community.

Changing Ideas and Perceptions

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The National Park Service is aware that its relevance and appeal must relate to all people. Monuments that have recently been established do not always commemorate positive aspects of history but are beginning to provide a total picture representative of all cultures and periods in history that make up the United States. Cultural perspectives are adding to the richness of interpretative presentations of newly established parks and parks that were previously established to preserve and interpret the scenic beauty. This change has occurred through active participation of communities whose heritage is being interpreted and preserved by the National Park Service.

Another means of change in the National Park Service occurs through specific laws such as Public Law 101-601, the Native American Graves Protection and Repatriation Act (NAGPRA), which was enacted November 16, 1990. For each federal agency and federally funded museum to be in compliance with the law, NAGPRA required completion dates of activities. One requirement of the law was an item-by-item inventory of human remains and associated funerary objects, which was due November 16, 1995. The inventory list was to be developed by each agency and museum in consultation with lineal descendants and appropriate culturally affiliated Indian tribe officials and traditional religious leaders. Although some National Park Service sites had previously consulted with tribes, the efforts were often dependent on the interest of the park manager and usually occurred infrequently, not in an effort to maintain dialogue.

You may wonder why the law is specific to Native Americans. It is because of a unique legal relationship that exists between the United States and Indian tribal governments, set forth in the Commerce Clause of the Constitution of the United States and carried out through treaties, statutes, executive orders, and court decisions. In some treaties, our nation has guaranteed the right of Indian tribes to self-government. The National Park Service continues to work with Indian tribes on a government-to-government basis to implement NAGPRA and to carry out other responsibilities.

Through tribal consultations, NAGPRA opened the door to begin building relationships of trust and communication between tribes and the National Park Service. Tribes now have a better understanding of responsibilities the National Park Service has to the country as a whole; and, through participating in consultation meetings, the National Park Service has gained new insight into the resources it manages and the cultural concerns of a tribe for its ancestral heritage.

Following are examples of changes that have occurred in parks active in tribal consultation within one region of the National Park Service, supplemented by selected examples from other regions.

The Intermountain Region is composed of eight states: Arizona, New Mexico, Texas, Colorado, Oklahoma, Utah, Montana, and Wyoming, and borders the countries of Mexico to the south and Canada to the north. Eighty-six parks are located within this region. These parks contain approximately one-quarter of the total museum collections holdings of the National Park Service. Approximately 83 Indian nations are potentially culturally affiliated with parks in the Intermountain Region, and it is appropriate for parks to consult with these tribes. In the following examples of the results of tribal consultation from parks and monuments in the Intermountain Region, images are not included because photography of the objects subject to consultation typically is inappropriate.

Aztec Ruin National Monument's tribal consultation efforts have led to the repatriation of all human remains and associated funerary objects and reburial on park lands in a site that was scheduled to be backfilled. Through this process an exhibit that once displayed numerous associated funerary objects was emptied. Aztec staff saw this as an opportunity to inform park visitors about NAGPRA and placed text within the empty exhibit case to describe the law and explain the concerns voiced by the tribes about displaying burial objects. This led to a positive educational experience about NAGPRA for park visitors and provided an opportunity for in-depth discussion with interpretation staff and more respect for the site they were about to visit. In addition, through continued consultation, the park contracted with a tribal member from the consultation group to produce a trail guide that interprets the site from a tribal perspective.

Bandelier National Monument has an active tribal consultation committee. The park meets regularly with the consultation committee to discuss all aspects of park management. Some examples of cultural sensitivity resulting from the consultation include the removal of "loaded" terms from exhibit text and interpretive information, such as "ruins" or "abandoned." It was explained that these words bring to mind something without value or discarded, yet these ancestral places are still mentioned in tribal prayers, oral tradition, and songs. These culturally significant places are now referred to as "ancestral sites." There are other examples of change in terminology resulting from tribal consultation. In addition, an understanding exists between the park management and one of the culturally affiliated tribes that its religious leader will "maintain" a hunting shrine on park lands that is being affected by New Age worshipers and other backcountry visitors leaving inappropriate offerings at the shrine. The shrine is still in active use by tribal members and they can best judge which objects are appropriate for the site.

Carlsbad Caverns National Park and Guadalupe Mountains National Park set national precedents in two ways with one NAGPRA case: the first repatriation of human remains to a tribal consortium. Because of the antiquity of the human remains, it would have been impossible to clearly identify the specific cultural group. In addition, this was the first repatriation of human remains determined to be culturally unidentifiable due to their antiquity. The tribal consultation committee composed of representatives from ten Indian nations submitted a repatriation request to the park for the human remains in an effort to show respect and to honor their ancestors. The parks were in agreement with the tribes because analysis on the human remains had previously been conducted and the parks felt that they had retrieved all scientific data that could be beneficial to the government and the American public from this research. The NAGPRA Review Committee heard the case and, given the findings, the Review Committee recommended to the secretary of the interior that the human remains be repatriated to the consortium of tribes. The park superintendents have agreed to reburial on National Park Service land.

Chaco Culture National Historical Park is a site known worldwide for the architectural mastery and the concentration of ancestral sites. Objects excavated at this site have been the source of numerous exhibits and research efforts. Exhibits developed for the visitor center were installed without tribal consultation in the early 1980s. In 1990, a water leak in the pipes above the exhibit area damaged an exhibit that held painted wooden objects. The painted wooden objects were part of a religious altar used by ancestral people. Prior to reinstalling the wooden objects on exhibit, the park consulted with the tribes who shared information about their original use and asked that the painted wooden objects be permanently removed from exhibit and that viewing of the objects be limited. Chaco honored the request of the tribes, removed the painted objects from exhibit, and provides limited access only through consultation with the tribes.

El Morro National Monument was set aside to preserve the inscriptions of early Spanish conquistadors and Spanish settlers and early U.S. military soldiers who utilized a pool at the base of the cliff. This source of water was important to all people in the area and was originally used by ancestral people and their descendants as well as the newcomers. Efforts at preserving the cliff face with its historic inscriptions have revealed that the inscriptions are often placed over petroglyphs. The park is including tribes in discussing treatment proposals to preserve the rock surface since preservation efforts will also affect the underlying petroglyphs.

El Malpais National Monument is the first monument in New Mexico with enabling legislation that recognizes the past use of portions of the monument by Indian people for traditional cultural and religious purposes. The legislation states that the park will develop plans in coordination with the Pueblo of Acoma to assure access to the land for traditional, cultural, and religious use and provide for privacy during such activities. Legislation also advises the park to seek recommendations from the Pueblo for protecting traditional cultural and religious sites in the nationally significant Grants Lava Flow.

The Gila Cliff Dwellings, contained in the national monument of the same name, were built by the people who archaeologists have named the "Mimbres culture." Mimbres ceramics are known worldwide and are highly sought after, leading to extensive pot hunting and looting of Mimbres sites throughout southern New Mexico. The National Park Service and the U.S. Forest Service, which jointly administer the monument, are exploring ways to accomplish repatriation of human remains and associated funerary objects and reburial on federal lands. This effort between agencies is unique because they are cooperating to provide the best security of the reburial site in consultation with culturally affiliated tribes.

Pecos National Historical Park worked with the Peabody Museum of Archaeology in Andover, Massachusetts, to consult with the culturally affiliated tribe of Jemez Pueblo to repatriate and rebury over 1,000 human remains and funerary objects. The excavations occurred at Pecos Pueblo long before it was in the national park system. The Pueblo of Jemez and other tribes participated in consultation meetings with the Peabody for many years before the human remains and funerary objects could be repatriated. Pecos staff served as facilitators of the efforts and made the necessary arrangements to enable reburial on park lands. It is the largest repatriation and reburial effort to date.

Petroglyph National Monument continues close tribal consultation with culturally affiliated tribes to determine which of the petroglyphs, inscribed on the volcanic cliffs in the park, are appropriate for use in interpretive programs and publications. This relationship is closely linked with an effort to prevent additional urban sprawl of nearby Albuquerque that would occur by way of a proposal to develop a road through the middle of the park, thus destroying not only the context for the petroglyphs but also leading to the destruction of many petroglyphs in the process.

Salinas Pueblo Missions National Monument has successfully repatriated and reburied all human remains and associated funerary objects formerly held in its collections. The park has made great efforts to consult with the tribes, and they frequently refer to Salinas as the example of the way in which tribal consultation should occur. Consultation has led to an awareness of the differences of each sovereign nation of tribes, and to mutual respect and a genuine effort to understand one another and work together on all matters that affect the park. The park, along with the consultation committee, is working on a memorandum of understanding for inadvertent discovery of human remains. This agreement will result in minimal disturbance to the human remains and prevent ground-disturbing projects from having to stop for consultation with tribes, as directed by NAGPRA.

White Sands National Monument is known as a natural site; however, there are numerous cultural sites throughout the park. In one instance, after consulting with culturally affiliated tribes White Sands decided to provide limited application of reburial with no significant alteration to the site. The burial site is being affected by sheet erosion of the soil, causing the exposure of numerous human remains. Through review of the location it was determined that removal of a road and additional extensive groundwork would have to occur to redirect water runoff from nearby hills. The tribes feel that the runoff is part of a natural process which includes the human remains. This specific location is in an area that has very controlled access, which aides in preventing vandalism to the site and looting, as the site continues to erode. In doing minimal intervention the park is keeping its preservation mandate but also considering the cultural concerns voiced by the culturally affiliated tribes.

Beyond the Southwest, other parks in the Intermountain Region have active consultation programs. For example, Yellowstone National Park is known primarily for its natural, scenic wonders; it also includes many important cultural sites for a variety of tribes. The park attempts to keep the tribal consultation committee informed of issues before they hear them reported in the news. Resolution of issues does not always follow the preferred recommendation of the tribe, such as the park's decision to reduce the numbers of buffalo due to pressures from neighboring communities. Nevertheless, Yellowstone consulted with the tribes in preparation for the move of collections to its newly constructed curatorial facility. The tribes wanted the park to ensure that the human remains and associated funerary objects were provided appropriate cultural sensitivity during the move and relocation in the new facility. The tribes requested a place where ceremonies can be carried out for some of the sacred objects in collections. The new facility has a fume hood installed in the collection receiving room that will double as a place where the tribes can hold ceremonies with the objects when the use of smoke is required.

Additional examples of changes resulting from tribal consultation come from park areas in other regions of the National Park Service.

A project that Olympic National Park staff is excited about is the identification of the makers of baskets in the park's collection. Learning the names of the weavers gives relatives of the makers a connection to the park's collections, and they come to study the techniques their relatives used in making the baskets. The park also hears the oral tradition about where basket materials were traditionally gathered and the uses of the various styles of baskets.

Sitka National Historical Park in Alaska is a park that incorporates consultation with every aspect of park management. Many of the objects that make up the exhibits at the park visitor center, such as the carved house posts, painted house screens, Chilkat robes, and clan crest hats are on loan to the park from individual clan leaders who wish their property to remain in Sitka, in protective care.

Sitka's incoming loan agreements recognize clan jurisdiction over these objects. The park consults with the traditional owners on the care and interpretation of these collections on an ongoing basis. The park has agreed to store objects that have been repatriated from other museums to the Tlingit traditional owners. These objects are used in ceremonies at appropriate times during the year and then returned to the park. Sitka Tlingit clan leaders danced in a recent rededication ceremony of the visitor center. This consultation process and relationship has truly benefited both the National Park Service and the Tlingit people.

These are but a few examples that illustrate various changes that have occurred through the consultation process. Mutual benefit for National Park Service interpretation, exhibit development, and collection management and respect for tribal sensitivity has occurred. This awareness has made National Park Service sites more welcoming to tribes and to the continuation of cultural traditions, and has added new depth to park visitors' understanding of different cultures.

National Parks and the Interpretive Message Since 1990

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In a 1994 article titled "Sites of Shame," published in *National Parks*, Robin Winks suggested that

> Education is best done with examples. These examples must include that which we regret, that which is to be avoided, as well as that for which we strive. No effective system of education can be based on unqualified praise, for all education instructs people of the difference between moral and wanton acts and how to distinguish between the desirable and the undesirable. If this premise is correct, we cannot omit the negative lessons of history.[1]

Winks might have been describing a fundamental change that was then transforming the National Park Service (NPS) into an organization fundamentally different from the agency it had been a decade earlier. The decade of the 1990s brought considerable change to the NPS—change that came from within and change that came from outside the organization.

Congress played a major role in moving the NPS to a different place. In 1991, Congress passed legislation changing the name of Custer Battlefield National Monument to Little Bighorn Battlefield National Monument. The legislation further directed the secretary of the interior to erect a monument to the Indians who fell there in order to "provide visitors with an improved understanding of the events leading up to and the consequences of the fateful battle."[2] Through this act, Congress directed the National Park Service to move the management of this park from a shrine to George Armstrong Custer to an educational site where the visiting public could understand the battle from the perspective of the Sioux and Cheyenne as well as that of the 7th Cavalry.

Congress followed the Little Bighorn legislation with a string of acts that designated new kinds of historical parks, parks that require that we understand the past, not simply celebrate it. They require us to think about the past, not merely feel good about the past. These new parks included Manzanar National Historic Site, Brown v. Board of Education National Historic Site, Cane River Creole National Historical Park, Nicodemus National Historic Site, Lower East Side Tenement National Historic Site, Washita Battlefield National Historic Site, Oklahoma City National Memorial, Little Rock Central High School National Historic Site, Tuskegee Airmen National Historic Site, and the Selma to Montgomery National Historic Trail. These parks require more of the Park Service—they require us to dig a little deeper for these stories get to the heart of American democracy.

At the same time, perceptions within the National Park Service were changing. The agency began to clarify and expand its interpretation of the educational mission established by Congress in the Historic Sites Act of 1935, but recognized by Stephen Mather and Horace Albright from the beginning. It restructured its interpretive training program to place equal emphasis on the message as on the medium. The agency began to support openly and aggressively the telling of untold stories, stories that had not traditionally been part of the dominant narrative told at parks. These stories represented different or under-represented voices, different views, different interpretations of a single event. The National Park Service gradually came to the realization that the telling of stories that conflicted with each other was OK; that the goal was not in the story, but in the connection the visitor made to the place. Different visitors respond to different stories. The National Park Service could and should tell the stories of its parks through a range of voices and perspectives. The Northeast Region produced *The Road Ahead,* which required each park to develop interpretive presentations that were not part of the traditional and expected story.

The new direction taken by the Park Service's Civil War battlefield managers represents this new direction. Not feeling content to simply talk about who shot whom and where, the battlefield superintendents decided in 1998 that their parks would start presenting the causes of the Civil War and its consequences, in addition to the recounting of the details of the battles. At Civil War battlefield parks throughout the system one finds new exhibits and publications that explain the causes of the war, placing the war in the social, political, and economic context of mid-nineteenth-century America. The blueprint for this new direction is *Holding the High Ground: Principles and Strategies for Managing and Interpreting Civil War Battlefield Landscapes* (1998) which sets the policy direction for explaining the Civil War in a broader context. The philosophical and historical direction is found in *Rally on the High Ground: The National Park Service Symposium on the Civil War* (2001). This national conference, held in historic Ford's Theatre in May 2000, featured presentations by seven Civil War scholars, including the Pulitzer Prize winner James McPherson, David Blight, Ira Berlin, Drew Gilpin Faust, Eric Foner, James Horton, and Edward Linenthal. Although this new direction has been opposed by those who wish the Civil War to be remembered strictly as military history, the opposition, though quite vocal, has been more concerned with what they fear the NPS will do rather than what it is, in reality, doing. Those exhibits that have already been produced have been greeted with little or no criticism.

In 1990, Congress directed (see Public Law 101-628) the National Park Service to revise its thematic framework for history, which dated, with minor revisions, from the 1930s. The act specifically directed the Park Service to work with "major scholarly and professional organizations" to effect the revision. It was also specific in stating that "the Secretary shall ensure that the full diversity of American history and prehistory are [sic] represented." The new framework, which the Park Service produced in 1994, recognized and embraced the revolution in historical scholarship characterized by the New Social History/New American History, which has altered our perspective of ourselves since the 1970s.

During the decade of the 1990s, the National Park Service established closer and more active working relationships with professional and related organizations. The Canon Scholarship Program designed by the NPS chief scientist, Mike Soukup, is an excellent example of the linking of NPS research needs with those of the academy. The natural resource program has also developed a new network of Cooperative Educational Study Units (CESUs) with major universities throughout the country. At the same time, the National Park Service developed cooperative agreements with the Organization of American Historians, Western History Association, and National Council on Public History. These arrangements allow the

NPS to work in a collaborative fashion with the leading scholars in American history. And finally, the NPS is developing a professional relationship with the Federation of State Humanities Councils.

This rising professionalism or maturation or evolution of the NPS is also reflected in several recent reports on and by the NPS.

National Parks for the 21st Century: The Vail Agenda (1992), a product of the Park Service's 75th Anniversary Symposium, argued that the NPS should be a model "that can teach valuable lessons to a world increasingly concerned with environmental degradation, threats to wilderness values, and rapid cultural and historical change." National Park Service employees, it continued, should have greater opportunities to educate themselves about the issues they confront so they can be better educators; the NPS should interpret controversial or contentious events and sites and do so from multiple perspectives; finally, it suggested, the NPS should "bring scientific expertise and scholarship into management decision making as early as possible."[3]

The *National Park Service Strategic Plan* (1997) likewise reflected changing sensibilities about who the National Park Service is and what its role in a changing America ought to be. The plan acknowledges the Park Service's role as a public educator and the national park system as "the nation's greatest university without walls." It should, the plan argues, help visitors "understand the complexity of the land and its history" and provide all interpretation through the establishment of larger natural and cultural contexts. This changed attitude within the Park Service "also means increased outreach and interaction with educational institutions at all levels, broadening the intellectual enrichment of all."[4]

That same year, 1997, the National Park Service convened an educational summit in Santa Fe, New Mexico, to explore its role as an educational organization. The result was *Findings and Recommendations: Education Initiative Symposium* (1997), which outlined an NPS strategy for the future. The report stressed the importance of presenting different perspectives throughout its interpretive programs and of using a variety of technologies to reach those who may never visit a national park. It also recognized that to be good teachers, NPS employees must also be good students. The NPS should "create an environment that encourages employees to pursue advanced studies to remain current in their field."[5]

The National Park System Advisory Board's recent report *Rethinking the National Parks for the 21st Century* (2001) clearly indicates that the world has turned and that the National Park Service functions in a social and political environment far removed from that in which it was created (in 1916) or even in which it celebrated the bicentennial of the nation's birth in 1976. The Park Service's protection of biodiversity is simply a concept Stephen Mather never had to confront. And Horace Albright's vision for historic interpretation during the 1930s never embraced the idea that this country's story "is often noble, but sometimes shameful and sad." With cultural diversity becoming increasingly apparent, the Park Service has and must continue to change, and this report endorses and encourages that change. The challenge is critical, the report states. "Our nation's history is our civic glue. Without it, our national character is diminished."[6]

Finally, in 2002, the National Park Service produced *The National Park Service and Civic Engagement,* a report of a workshop on civic engagement held in New York City in

December 2001. Taking its direction from the Advisory Board's report, "participants argued for broadening historical context, for giving expression to diverse American voices, and for strengthening the public's understanding of the contemporary relevance of heritage resources." A second civic engagement workshop was held in Atlanta in December 2002, with more being contemplated in other regions.

Without question, the most telling example of how the National Park Service has evolved over the past ten or so years is its reception of Richard Sellars' critique of its natural resource management program. *Preserving Nature in the National Parks: A History* (1997) assesses the Park Service's management of natural resources since the creation of the agency in 1916.[7] It is detailed and thorough, and documents the traditional preference of the agency for preserving pretty scenery over viable biotic systems. In earlier years, the Park Service would have either absorbed the book without modifying its management practices or fought to suppress its publication. Instead, Director Robert Stanton established a working group to assess the problem and provide recommendations on how to fix them. The result was the Natural Resource Challenge that is currently pumping millions of dollars into a reinvigorated park management system.

Civic dialogue is important in every age from George Washington to George Bush. It is important today, and the National Park Service and other managers of historic places and public programs have important roles to play. Public space should serve as public forums for the discussion of the past's unfinished business; common ground for the exploration of what Barbara Kingsolver calls "the spaces between," those cultural divides that separate us—northerners from southerners, east from west, urban from rural, men from women. The issues that are ripe for public discussion are often controversial, and they are controversial precisely because they are important to our national psyche, and quite often they have deep roots in the past. Understanding the depth of those roots allows us to discuss our common problems with a much better chance of crafting a better future for all Americans.

Indeed, understanding the past so we can create a better, more equitable future, is what the study of history is all about. The National History Standards developed through the National Endowment for the Humanities (1996) got to the heart of the matter:

> *Knowledge of history is the precondition of political intelligence.* Without history, a society shares no common memory of where it has been, what its core values are, or what decisions of the past account for present circumstances. Without history, we cannot undertake any sensible inquiry into the political, social, or moral issues in society. And without historical knowledge and inquiry, we cannot achieve the informed, discriminating citizenship essential to effective participation in the democratic processes of governance and the fulfillment for all our citizens of the nation's democratic ideals.[8]

The National Park Service occupies a unique position in the United States. It manages many of the most significant historic places in the country; places that possess stories about the development of this democracy, stories that tell us who we have been and how we got to this place and time, stories that define us as a people, as a community, as a society. These stories about our past are useful to a society interested in where it is going. Indeed, they are essential. As the historian Michael Wallace tells us, "Understanding the way in which the present has emerged from the past maximizes our capacity for effective action in the present—whoever we are. The truth doesn't make us free—but it is an indispensable precondition for freedom."[9]

Endnotes

1. Robin Winks, "Sites of Shame: Disgraceful Episodes from Our Past Should be Included in the Park System to Present a Complete Picture of Our History," *National Parks* (March–April 1994), 22–23.

2. Public Law 102-201, December 10, 1991.

3. National Park Service, *National Parks for the 21st Century: The Vail Agenda* (Washington, D.C.: NPS, 1992).

4. National Park Service, *National Park Service Strategic Plan* (Washington, D.C.: NPS, 1997).

5. National Park Service, *Findings and Recommendations: Education Initiative Symposium* (Washington, D.C.: NPS, 1997).

6. National Park System Advisory Board, *Rethinking the National Parks for the 21st Century* (Washington, D.C.: National Geographic Society, 2001).

7. Richard West Sellars, *Preserving Nature in the National Parks: A History* (New Haven, Conn.: Yale University Press, 1997).

8. Gary B. Nash and Charlotte Crabtree, *National Standards for History* (Los Angeles: National Center for History in the Schools, 1996), 41.

9. Michael Wallace, "The Politics of Public History," in *Past Meets Present: Essays about Historic Interpretation and Public Audiences*, edited by Jo Blatti (Washington, D.C.: Smithsonian Institution Press, 1987), 38.

Renewal of the U.S. Man and the Biosphere Program

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The steering group for the U.S. Man and the Biosphere (MAB) Program met on March 16, 2005, in conjunction with the George Wright Society's biennial meeting in Philadelphia, Pennsylvania. The purposes of the meeting were to review progress to date and plan next steps in transforming U.S. MAB into a fully functioning program. Several factors contributed to the success of the meeting. Among them were representation from many of the agencies that have participated in U.S. MAB, some continuity among participants at this meeting and those who had attened a May 2004 visioning meeting, the leadership of the new interim chairperson of the U.S. National Committee for MAB, and the participation of special guests from the UNESCO [U.N. Educational, Scientific, and Cultural Organization] MAB office and the Canadian Biosphere Reserves Association.

The meeting was an opportunity to brief all members of the steering group on activities conducted since the May 2004 U.S. MAB visioning meeting. Following recommendations from the visioning meeting, a focus of U.S. MAB activity has been the development of communication tools: a website and a brochure. The draft website developed by Dan Neary, U.S. Department of Agriculture–Forest Service, was presented for review and will be made public after reviewers' suggestions are incorporated. Developing the brochure is "on hold" until the U.S. National Committee meets. Revitalizing the U.S. National Committee also was a key directive stemming from the 2004 visioning workshop, and the U.S. MAB coordinator, Deb Hayes, U.S. Department of Agriculture– Forest Service, has been communicating with current members about a meeting date and agenda. Consultations have occurred with the U.S. National Commission for UNESCO about reestablishing the committee and procedural requirements should the committee elect to include nongovernmental members.

Pete Roussopoulos (U.S. Department of Agriculture–Forest Service), the new interim director for U.S. MAB, endorsed the ongoing review of the biosphere reserves and the drafting of criteria for U.S. biosphere reserves as positive steps in moving U.S. MAB forward. He identified the reestablishment of an active national committee and a communications strategy as essential next steps on the path.

Natarajan Ishwaran, director of the Division of Ecology and Earth Sciences and the secretary for MAB at UNESCO, offered encouragement to the U.S. in defining its connection to the MAB program. Presentations outlined UNESCO organization and priorities made clear the relationship of MAB to UNESCO focal areas. The information is beneficial in planning and seeking funding for U.S. proposals.

Other opportunities to strengthen the program discussed by participants include tapping an urban constituency interested in MAB and developing partnerships with related nongovernmental organizations and large-scale research activities such as the National Science Foundation's National Ecological Observatory Network and Long-term Ecological Research Network. The recent ageement between the U.S. National Aeronautics and Space

Administration and UNESCO may also benefit the U.S. MAB program. The consistency of objectives of the MAB program—especially biosphere reserve programs that emphasize community direction—and the U.S. administration's focus on cooperative conservation (Executive Order No. 13352) helps affirm the direction of the U.S. MAB program. Better tailoring the biosphere reserve program to U.S. conditions is the objective of developing U.S.-specific biosphere reserve criteria, and V.C. (Tom) Gilbert of the U.S. Biosphere Reserves Association discussed this effort. And lastly, Glen Jamieson of the Canadian Biosphere Reserves Association discussed its efforts to foster communication across biosphere reserves and in communities hosting biosphere reserves. The Canadian Biosphere Reserves Association, the U.S. Biosphere Reserves Association, and Mexican counterparts have been discussing the benefits of North American cooperation and will continue discussions at subsequent meetings.

The Continental Divide Research Learning Center: The First Four Years

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Background

The Continental Divide Research Learning Center (CDRLC) was one of the first five RLCs funded. It was established to serve Rocky Mountain National Park, although subsequent RLCs were established to serve multiple parks. Efforts to serve other Colorado parks are ongoing, but will not be discussed in this paper. The first staff member arrived in June 2000. At the same time Rocky Mountain National Park received funding for CDRLC, it also received funding for a science officer position and some base funding to direct toward research addressing high-priority management issues. When the science officer position, the first position filled, was advertised, the duties included being the research staff member and director for the CDRLC, as well as the responsibility to issue research permits, oversee all research activities in the park, and function as the superintendent's science advisor. This allowed CDRLC to hire up to a total of three staff members (one from the additional funding and two from the RLC funding). Hiring three staff members produced a number of benefits (discussed below) to the oversight of research activities: by providing additional logistical support for research activities in the park, enhancing the ability to communicate the science occurring in the park, and ensuring that the findings of that research are rapidly integrated into park management.

There are a number of assumptions inherent in the discussion of the mission and activities of CDRLC staff. They include the following. The National Parks Omnibus Management Act of 1998 (the Thomas Act) told the National Park Service (NPS) to use good science in making its management decisions. The Natural Resource Challenge, including RLCs, was the NPS response to the Thomas Act. In funding the Natural Resource Challenge, Congress intended that NPS use the funding to include science in decision-making. NPS staff (including CDRLC staff) have a binding agreement with Congress to use the funding for the purposes for which it was provided.

Managing research

Because of the limits on staff time and the expectations of the taxpayers who fund our work, every action we take must be directed to our core mission. Every activity performed by CDRLC staff must answer one or more of the following questions: What research project does this contribute to? What research project results are communicated? What management decision does this affect? If the work does not address one or more of these questions, we simply do not have the resources to address it.

CDRLC staff issue and oversee all research permits for the park. This is a significant time commitment, given the park issues between 60 and 80 permits a year, the fifth largest research program in NPS. There are several advantages to having CDRLC staff issue research permits. It keeps us current on what activities are occurring, thus helping us identify what to communicate about research. It eliminates duplication of effort because there are no additional permit staff members. It alerts us to research projects that need support and builds bridges to all park divisions because issuing permits involves negotiating a wide variety of activities with and obtaining support from other divisions. It helps us assure research results are used in the park's management decisions, because they are intimately familiar with the research. Finally, it helps us connect researchers with each other to improve project quality, help each other, eliminate duplication of research efforts, build on each other's work, and share samples when possible.

The research activities represented by the research permits require a substantial amount of logistical support. These permits represent about 400 people involved in research activities. CDRLC staff provide a variety of types of support, including housing, campsites, equipment loans, assistance in obtaining research permits, compliance (archaeological and National Environmental Policy Act), recruiting volunteers to assist with research projects, and a wide variety of other types of logistical support. The concept of "bunks for researchers," the logistical directive for the RLC program, has evolved into a wide variety of logistical support activities. Volunteer hours for research activities alone exceeded 6,500 in fiscal year (FY) 2004, the equivalent of three additional full-time employees—a substantial managerial workload for CDRLC staff.

CDRLC staff have a substantial time involvement in funding research. For every park dollar invested in research in FY2004 (about $185,000), partners provided approximately $1.22 in matches. In addition to park base funding, we were able to obtain $480,000 in Fee Demonstration funding to direct to research activities over a three-year period. We have also used the NPS-wide combined call, U.S. Geological Survey funding calls, and other funding sources to acquire an additional $100,000 to $400,000 per year to direct toward research activities. This translates to a substantial number of cooperative and interagency agreements to be overseen by CDRLC staff as well. The success of this effort has led to a workload in excess of the ability of staff to manage ,and will result in shifting emphasis away from acquiring funding toward more oversight in the future.

Communicating research

Once the research has been accomplished, CDRLC staff are actively involved in communicating the results to a variety of audiences. The target audience for communications activities is primarily an adult one, because adults are involved in management decisions, and including science in management decision-making is the core mission assigned by Congress. While this does not preclude serving younger audiences, the limits of staff time available force us to be focused on the highest priorities in our mission. Also, when CDRLC was created, Rocky Mountain National Park already had an active environmental education program addressing younger audiences. Thus, we focus our communication activities on park staff involved in management decisions; other participants in management decisions, including town, county, and state officials, as well as community opinion leaders; other researchers, in order to inform and improve their research; park staff and others involved in disseminating information; and members of the general public. Communications activities focused on specific research related to park management issues involve a science conference every two years, two public science days a year, special workshops for park staff targeted to specific questions they must address, press contacts, presentations to public officials, videos to explain specific research activities for use by local television stations, Internet-based articles and summaries of research projects, and a wide variety of other types of presentations less easy to categorize. Demand for special-emphasis science presentations is increasing, and we are looking for ways to improve efficiency while providing the level and quality of information demanded by a wide variety of audiences.

Incorporating science into park management

All of this effort to encourage and communicate science reaches its fruition if high-quality science is accomplished—and it then informs park management decisions. CDRLC staff and the scientists with whom we partner have been very successful at incorporating scientific results into park management. A few brief examples include the decision to limit the use of magnesium chloride to de-ice roads in the park because of its effect on germination of native plants, the decision to limit the use of prescribed fire in shrub–steppe communities in the park because the combination of current levels of herbivory and use of prescribed fire would prevent recovery of these communities (this decision was made within three hours of the presentation of results by the researcher), the decision to close certain backcountry campsites to avoid negative impacts on state-threatened boreal toads, and the decision by park managers and the town of Estes Park to work toward a more integrated transportation plan based on a study of the projected effects of climate change on park visitation. These are only a few of the many examples that could be cited.

A more detailed example will demonstrate how CDRLC works to support research and assures that research results are integrated into management decisions. In 1967, chronic wasting disease (CWD), an invariably fatal brain-wasting disease, was first recognized in penned deer in Colorado. In 1981, an elk *(Cervus elaphus canadensis)* in Rocky Mountain National Park was diagnosed with CWD. For many years, CWD was known to exist in the wild with mule deer *(Odocoileus hemionus)* as the major affected species, but the implications of the disease were slow to be realized. During the 1990s, the spread of CWD caused growing concern. In 2000, researchers from Colorado State University and the Colorado Division of Wildlife requested a research permit from Rocky Mountain National Park to conduct funded research on mule deer movements and spread of CWD, as well as on a new diagnosis strategy involving the use of tonsillar biopsies. In my CDRLC research role, I reviewed the study design and suggested that while the overall statistical design was sound, the data generated for the work within the park would not provide us with statistically valid movement information for the park itself (CDRLC is responsible for research permitting and improving research design so that research is useful for park managers). That discussion led to the park funding intensified work on the movements of mule deer within the park from our base research dollars (CDRLC finds funding for important management-related research). The work on tonsillar biopsies was funded by Colorado Division of Wildlife, National Institutes of Health, and National Science Foundation award #DEB/0091961. To the alarm of both state and park managers, the research on deer movements revealed that a small number of mule deer were crossing the Continental Divide and potentially mingling with deer on the west side of the park (CDRLC provides research results to park staff). The companion research demonstrated that the CWD prevalence in male deer was approximately 12–14%.

The pair of studies demonstrated the possibility for the movement of CWD into an area of the state of Colorado where it was previously unknown. This resulted in substantial management discussions between park and Colorado Division of Wildlife managers as to how to handle this problem (CDRLC communicates scientific results to help in management decision-making). The first suggestion, which was quickly determined to be unrealistic, was to kill any mule deer on the east side of the park that approached the Continental Divide. An alternative, to slaughter a substantial proportion of the mule deer population on the east side of the park to reduce densities and thus reduce the motivation for movement, was also quickly determined to be not feasible. Fortunately, park resource management staff were able to obtain funding to apply the results of the tonsillar biopsy research on a management scale (incorporating research results into management actions is a CDRLC function), and Colorado Division of Wildlife agreed that this would be a good test of this diagnostic tool, along with culling of infected animals, as a management strategy. While very expensive as a management strategy, tonsillar biopsy and culling of CWD-positive animals might be possible in areas such as national parks where untargeted culling might not be feasible.

While this work and additional work on CWD is still ongoing, these and other efforts have resulted in an archive of CWD-positive tissue maintained by Colorado State University under contract with the NPS Biological Resources Management Division. Most CWD management activities never test individual animals for CWD but simply slaughter a percentage of the population to reduce density, or they retain CWD-positive tissue for their own research activities. Thus the tissue in our archive is one of, if not the only, source of CWD-positive tissue for researchers trying to develop rapid field tests and/or vaccines to identify and combat CWD. To date, the park has issued six research permits for work with tissues from our archive in the hope of combating CWD (making research activities as effective as possible by encouraging sharing samples and research permitting are CDRLC functions). The results of this research have the potential to address this disease not only in our park, but also to provide information for managers facing this disease nationally. Clearly many groups deserve credit for the success of this effort, and CDRLC's role was not the largest. Nevertheless, we can point to real contributions to making this work more successful and effective than it would otherwise have been.

The future

Challenges to be faced in the future include the realization that there are limits on the amount and kinds of research that can occur, in addition to the limits imposed by the number of beds available for researchers. There are limits on staff time; thus only a finite number of researchers can be supported. There are also real limits to the number of research projects that can occur based on space to work without unduly interfering with visitor experiences, the number of collared animals visitors and park staff will tolerate, the number of visitors available to be surveyed without causing disruption, the number of permanent plots that can be established in the park, the number of plants that can be collected without harming a population, and so forth. The park is wrestling with questions of what limits to put in place, how to coordinate research so that samples can be used by multiple projects, and how to deal with researchers with funded research for which the limit has been reached. These have not proven to be easy questions to answer, and will only increase as more researchers are attracted to doing research in Rocky Mountain National Park.

Often people unfamiliar with the Continental Divide Research Learning Center ask to "see" it. RLCs are programs, not facilities. Our efforts include assuring high-quality research is accomplished in the park by issuing research permits, funding research, and providing logistical support; providing research results to a wide variety of audiences; and assuring those results are considered when management decisions are reached.

Low-Carb Planning: Challenges in Streamlining the National Park Service's Approach to General Management Planning

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Thomas Vint, chief landscape architect of the National Park Service (NPS), wrote in the 1946 *Quarterly Planning and Civic Comment* that "to plan the development of a national park or national monument requires no specific magic." That cheerful statement was penned before there was a National Environmental Policy Act (NEPA), Wilderness Act, Wild and Scenic Rivers Act, National Historic Preservation Act, Clean Air Act, Clean Water Act, Endangered Species Act, Government Performance and Results Act, Coastal Zone Management Act, Native American Religious Freedom Act, Federal Advisory Committee Act, Freedom of Information Act, Telecommunications Policy Act, Director's Order #75A on Civic Engagement, and a host of other challenging and potentially conflicting laws, regulations, executive orders, policies, and procedures.

Vint did, however, anticipate the need for good information about resources, visitor carrying capacity, and money:

> It is like any other job of planning the use of land for human enjoyment. It is necessary to know the land involved thoroughly, to know how people are to use it and about how many will use it at one time. That information should state the problem, however it is too frequently incomplete. Next it is necessary to work out a design that is satisfactory to those in authority. Then to make it a reality all that is needed is to finance and to build.

In 1978, Congress adopted a law that directs the secretary of the interior to develop and update on a timely basis general management plans (GMPs) for each unit of the national park system. Those plans are required to do pretty much what any "master" plan should do: describe how resources will be protected, determine what facilities are needed, identify carrying capacity, and discuss any potential changes in the park boundary that might be necessary. If Congress had not passed that law, it seems that every park manager would need to know answers to those questions. Although a lot has changed since 1946, making plans that are satisfactory to those in authority and finding money to finance the work that needs to be done continue to be challenges.

Vint's idea that park planning requires no special magic returned to the stage in 1994 when the planning program managers undertook a "future search" to address slow progress in getting plans completed for the (now 388) parks, and the perception by many superintendents and regional directors that plans took too long and cost too much.

This effort enlisted representatives of parks, regional, planning teams, NPS programs, and other agencies to develop a vision about the purposes of planning and its value to management, and to define a vision for the future that could be implemented. The result of this initiative was a series of actions adopted by the program managers designed to eliminate the organizational barriers to flexibility, creativity, and cooperation in the planning process.

Parallel with the planning program's internal efforts to improve its processes, the National Park Service was engaged in a variety of reinvention, reorganization, and realignment efforts. Most important to the planning process were re-engineering initiatives in the Denver Service Center that confirmed the suspicion that a great deal of site-specific or project planning work in GMPs was never implemented. Efforts continued through the1990s to find the "ingredients" in the planning soup that might be responsible for excess fat. The hope was somewhat like that promised by the Adkins and South Beach diets: by cutting out the "carbs" we could have all the planning services we needed and still have a lean, healthy program that met the needs of park managers.

In 1998, Director's Order #2 was adopted to further the work initiated four years earlier. This policy statement reaffirmed some of the ideas expressed by Vint in 1946: "[T]he plan is based upon an understanding of the significance and purpose of the reservation.... Planning is a continuous process.... [C]onsultation with authorities outside the Service is sought.... [A]ll indications are that people will come in greater numbers than before and facilities to accommodate them are inadequate...."

Director's Order #2 made some revisions in the planning framework to avoid duplication and inconsistency. The requirement for a "statement for management" described in previous planning guidelines was dropped, as was the "outline of planning requirements." Both of these documents were considered at the time to be redundant with the anticipated role and function of the park strategic plan and annual work plans. But the most important step toward reducing the "carbs" in the general management planning process was to focus on establishing broad visions and desired conditions for park resources rather than get bogged down in details of development projects and other actions that might not be imminent. Director's Order #2 expired in 2001 and effectively migrated to Chapter 2 of the NPS Management Policies that were adopted in that year.

As background information for the update to the NPS planning framework, the park planning division in the Washington Office initiated a review of projects in the past decade to determine the major factors that contributed to time and cost. The review of a representative sample of projects led by the Denver Service Center found they ranged from $109,000 to $768,000, with an average cost of $309,000 and an average duration of 52 months.

Estimates of the cost to complete GMPs for the parks on the servicewide priority list for 2002–2007 range from $160,000 for a relatively small-scale amendment to $2.1 million for a GMP in Yellowstone National Park. Notwithstanding a variety of efforts to find ways to streamline planning, the average cost of GMPs completed in 2004 was $520,000. Inflation might account for a substantial portion of the 40% increase in average plan costs since 1994, but the perception that plans cost too much and take too long persists.

A 1994 analysis of GMP cost and duration confirmed suspicions that the major contributors were compliance documentation, complexity of issues, and changes in project direction. The review process and changes in direction were also highlighted as not always being perceived to be worth the time and cost they involved. However, the sample of superintendents, planning team leaders, and regional office coordinators (60 total interviews) agreed that some of the most important results of the plan were clear definition of management objectives, improved public understanding of park purpose and values, as well as guidance for facility development.

During the 2005 George Wright Society conference, a panel of people with extensive and diverse experiences with the GMP process was invited to reflect on some lessons learned from their own efforts to complete plans that met park needs. The panel members included: Linda Canzanelli, superintendent of Biscayne National Park, Florida; Bob McIntosh, associate regional director for planning and partnerships, Northeast Region; Debbie Darden, deputy superintendent, New River Gorge National River, West Virginia; Jan Harris, planning branch chief, Denver Service Center; David Graber, science advisor, Sequoia-Kings Canyon National Parks in California; and Dennis Schramm, program analyst, Washington Office. These panel members brought experiences from dozens of other parks where they had worked or been part of a planning team.

In response to the question of why parks undertake GMPs, the discussion highlighted the "political" forces that frequently are at work. Secretary of the Interior Bruce Babbitt's interest in coral reefs was a driving force behind initiation of the new plan for Biscayne. At Sequoia-Kings Canyon, questions about the future of private cabins under permits inherited from the Forest Service were directed to a GMP process through agreements between National Park Service leadership and the local congressman. In the Northeast Region, many newly authorized parks are lacking any document to guide management and need to engage the public in charting their future.

Other parks cited the need to look at issues holistically and engage the public as drivers for the GMP. Getting the public interested, and sustaining their engagement in what appears to be a lengthy bureaucratic process, were identified as major challenges. Although the GMP provides a framework for engaging the public, perhaps superintendents who are inclined to reach out to the public already do so and they don't need any new processes or directives to encourage them.

Civic engagement, especially as practiced in the Northeast Region, has been very effective in revealing stories about parks that need to be told but are often overlooked. This requires a much more focused effort than just inviting the general public to comment. The approach for New River Gorge needs to be tailored to the residents of the area, many of whom have a view of the park that is based on their experience in dealing with railroads and coal and timber companies that formerly managed the area.

The situation at Sequoia raises another set of questions about who is being engaged and the limits of efforts to reach negotiated agreements among "stakeholders." In that case, efforts to reconcile competing interests of hikers and horse or other pack stock users may have found a solution that is good for those groups but not necessarily for the rest of the public.

Work on the Rosie the Riveter World War II Homefront National Historical Park in Richmond, California, has yielded more than 10,000 calls from former "Rosies" who worked in factories to support the war effort. This type of response is exceptionally valuable, but it highlights the possibility that a really successful campaign to engage the public will quickly exhaust the ability of park staffs and planning teams to manage all the useful information.

Good data and science are widely recognized as essential prerequisites for park planning. The Northeast Region has made exceptional efforts to make sure that basic resource data collection and analysis are coordinated with schedules for anticipated GMPs. However, even for parks such as Sequoia with a long history of research, it appears that the data needed about the resources and the visitors often do not become evident until the planning process is well underway. The experience at Biscayne in addressing fisheries management issues provides another example of the challenges in using science for management decisions, as competing sides of the issue bring forth contradictory data and experts. Park planning is often an exercise in reconciling competing values rather than a quest for the scientifically "correct" answer.

Few recent discussions about the cost and time to complete GMPs avoid focusing on the compliance process. National Park Service planning policy since 1998 has sought to develop management prescriptions that define desired conditions (what) without getting into all of the details (how) of those conditions will be achieved. The hope is that by staying general, the plans can have a useful life of 15–20 years and be effective in addressing changes in technology, patterns of visitor use, and resource characteristics that we cannot reliably predict. However, National Park Service environmental planning policies and guidelines (Director's Order #12) direct that GMPs will be accompanied by an environmental impact statement (EIS). Although there are procedures for seeking a waiver, the compliance processes for NEPA and the National Historic Preservation Act are often cited as reasons why the ideally broad, general plans are pushed into very detailed, specific analysis of environmental consequences. Recent emphasis on considering life-cycle costs are another source of pressure for more detail in general management plans.

Some observers suggest that the Forest Service's proposed new (2005) planning rules that would categorically exclude forest plans from NEPA is the right approach. Others wonder if doing environmental assessments on some park GMPs is a better path. Generally, much of the bulk of EISs today responds to the legacy of past lawsuits, and legal guidance suggests that we are better prepared to fend off challenges by doing EISs. Further evaluations might be useful to see if relatively detailed analyses are needed for broad goal-setting plans, and if the environmental analyses accompanying GMPs are really being used to help make better-informed decisions. Could our EISs be improved by being less lengthy, and can we do as the NEPA regulations suggest and prepare analytic, not encyclopedic, documents? This may be one arena where some of the "carbs" could be reduced while producing lean, healthy plans.

Reflecting on her experience with a GMP for Gettysburg, Debbie Darden has described parts of the process as the "most difficult, frustrating, and thoroughly rewarding" in the experience of the park staff as well as the planners. Ultimately, while many superintendents grumble about the cost, duration, and staff time needed for a GMP, evaluations of completed projects most often conclude that the process was worth the time and effort.

The cost of preparing GMPs for national parks is relatively modest when compared with the cost of preparing management plans for national forests and resource management plans for the Bureau of Land Management, (which has a planning budget about seven times greater than that of the National Park Service). When plans are in progress, park managers and the public often feel that they will never end. But planning for future generations inevitably involves addressing extremely complex and controversial questions of competing ideas and values. The ideal result of our planning processes is engagement of the park staff and all the stakeholders, or communities of place and of interest, and agreement on the conditions that we should be seeking to sustain.

In Thomas Vint's era, planning for parks involved looking inward to make informed decisions about physical infrastructure. Park planning for the future requires looking beyond park boundaries, linking to a national system of protected areas, and nurturing partnerships that help sustain park values. The cost and time to complete a plan can be inconsequential in relation to the costs for restoring an ecosystem, rehabilitating a historic structure, or maintaining and staffing a facility throughout its life cycle. If planning is considered part of management rather than another task to be done, it might just become a relatively inexpensive and effective way to achieve a healthy, sustainable future.

Lake Mead's Cold War Legacy: The Overton B-29

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Introduction

On July 21, 1948, a B-29 bomber crashed into Lake Mead while engaged in top-secret research. It was not until summer 2002 that the park learned that the plane had been found by local divers after unpermitted side-scan sonar searches. The discovery of the wreck set in motion a storm of legal, archaeological, and management issues that pulled the Park Service in many different directions. This paper discusses some of the historical, legal, archaeological, and management issues that came to bear on this unique cultural property.

History

In 1940, as Nazi troops blitzkrieged their way across Europe in a seemingly invincible rush, American strategic planners began to face the possibility that all of Europe would eventually fall. If Europe fell, America would stand largely alone against German and Italian fascism and would have to develop the weapons necessary to pursue a transatlantic war. One of these weapons was a four-engine heavy bomber known as the Boeing B-29 Superfortress.

The B-29 was conceived as early as 1938, designed in 1940, and first flew in September 1942 (Figure 1). Pushed by wartime imperatives, the Army ordered the construction of factories to build the plane before the design was finalized and initiated production before flight testing was finished.

The design of the B-29 benefited greatly from Boeing's experience building other large four-engine planes, including the Model 299 (B-17), the 307 Stratoliner, and the 314 Clipper. The B-29 was the heaviest airplane of its day and had numerous technological innovations. It incorporated a pressurized crew cabin that allowed the plane to fly higher than any other bomber, thus staying above enemy fighters and anti-aircraft weapons. The B-29's computer-aided defensive

Figure 1. The Boeing B-29—the largest, most sophisticated bomber of WWII. Photo courtesy United States Air Force.

armament system, remotely operated from crew stations, controlled twelve .50-caliber machine guns and a 20-mm cannon. The Norden bombsite, a top-secret instrument throughout the war, was an integral part of the plane's offensive capabilities.

The B-29 was made primarily out of aluminum alloys that gave the plane its great strength and low weight. The combination of a specially designed airfoil and the power of four super-charged, 18-cylinder Wright R-3350 Cyclone engines allowed the B-29 to fly 3,250 miles, carrying 10,000 pounds of bombs, at 358 miles per hour.

The effort necessary to develop the B-29 was rivaled only by the effort to develop the weapon to which it would be forever linked—the atomic bomb. The size and weight of the first atomic bombs meant that the B-29 was the only aircraft in the Allied arsenal able to carry this weapon from bases in the Pacific to targets in Japan.

Even before the B-29 entered combat service in mid-1944, work began to prepare a squadron to drop the atomic bomb. Seventeen planes were taken directly from the Martin/Omaha assembly line and modified for their ultimate mission. These modified planes formed the 509th Composite Bomb Group.

The 509th was officially formed on December 17, 1944, and was the first unit ever organized and trained to use atomic weapons. On August 6, 1945, Colonel Paul Tibbets, Jr., flew *Enola Gay* to Hiroshima, Japan. and dropped "Little Boy," a 9,000-pound atomic bomb, which exploded and vaporized an estimated 70,000 people. Three days later, on August 9, Major Charles Sweeney flew *Bock's Car* to the city of Nagasaki and dropped "Fat Man," a 10,000-pound atomic bomb, which killed an estimated 40,000 people. Many more Japanese would die in the weeks and months that followed from burns, infections, and radiation poisoning. The world was shocked and horrified at the power of these weapons. The war in the Pacific ended on August 14, 1945, and Japan formally surrendered on September 2.

The Cold War and the missile race

Following the cessation of hostilities in the Second World War, the uneasy alliance between the U.S., Britain, France, and the Soviet Union collapsed. With German fascism swept aside, the world realigned itself along the competing axes of communism and capitalistic democracy. This new geopolitical drama stretched for almost 50 years in a tense stalemate based on the deterrent value of mutually assured destruction. We think of it now as the Cold War.

The Cold War primarily took the form of a massive arms race, the occupation of Eastern Europe by the Soviet Union, and proxy power struggles which devastated developing countries in Asia, Africa, and Latin America. These struggles crushed aspirations for independence and democracy for the majority of the Third World throughout the 1950s, '60s, and '70s. Brinkmanship, the desire to hang on to old colonies, and arrogance often fanned proxy struggles into armed conflict, most notably in Korea, French Indochina, British Malaya, French Algeria, and various other places in Africa, South America, and the Middle East. Both the Western powers and the Soviet Union sought a strategic advantage in weaponry. Foremost in this race was the manufacture and delivery of nuclear weapons, objectives heavily dependent on scientific capability.

In the forefront of this arms race were the scientists and scientific institutions of the world's leading powers. Building on Nazi Germany's technological achievements in rocketry, both the Soviets and Western powers sought to develop long-range missiles that could strike each other's nations across the vast expanses of ocean that separated them.

The Upper Atmospheric Air Research Program, the V-2 rocket, and ballistic missiles

In America, leading academic institutions, including the Massachusetts Institute of Technology (MIT), Harvard, Princeton, and Johns Hopkins, joined with the Department of Defense's research laboratories to solve the technical problems associated with inter-continental ballistic missile (ICBM) use. Captured German V-2 rockets became test vehicles for a research program that investigated the physical properties of the upper atmosphere and sought to solve problems associated with guidance, range, payload separation, and re-entry of missile warheads from space.

Most rocket flights investigated the physical properties of the upper air and tested the reliability of rocket designs. Among the variables investigated were solar radiation, magnetic fields, and radio wave propagation. Many of these experiments were conducted under the rubric of the Upper Atmospheric Air Research Program. Extensive efforts were also made to develop guidance systems that would ensure missile accuracy over long distances. Experiments were conducted that aimed to determine altitude by measuring cosmic rays in the atmosphere. Among these was a system that aligned instrumentation at the sun and used this as a reference for determining the position of a missile in relation to the earth's surface. An early form of this "Sun Follower" system was tested on V-2 and Aerobee rockets. Johns Hopkins University's Applied Physics Laboratory also built a version called "Sun Tracker." While engaged in experiments with a Johns Hopkins Sun Tracker, the B-29 (serial #45-21847) that currently sits on the bottom of Lake Mead crashed on July 21, 1948.

B-29 serial #45-21847

B-29 serial #45-21847 was constructed at the Boeing plant in Wichita, Kansas, under the last production order issued by the U.S. Army to build B-29s. The plane was delivered to the U.S. Army Air Force on September 13, 1945, eleven days after Japan surrendered. Following its delivery to the Army Air Force, 45-21847 was modified several times for reconnaissance roles and later for participation in the Upper Atmospheric Air Research Program.

On the morning of July 21, 1948, under the command of Pilot Robert Madison, 45-21847 took off from Armitage Field, China Lake, California, to test the Johns Hopkins Sun Tracker. On board were Co-Pilot Paul Hessler, Flight Engineer David Burns, Scanner Frank Rico as well as Scientist (and Johns Hopkins graduate student) John Simeroth. The modified B-29 covered the 200-mile distance to the test area just east of Lake Mead in less than an hour.

The mission profile called for the plane to ascend to 35,000 feet then descend "as low as possible" while Simeroth took readings using the Sun Tracker. As the plane descended over Lake Mead, Madison apparently lost depth perception above the smooth water. With an indicated airspeed of 230 miles per hour, the huge bomber hit the water with a glancing blow. The contact with the lake was catastrophic for the B-29 and three of the four engines were torn off by the impact. The pilot managed to wrestle 45-21847 back into the air and then ditch the plane in the lake in a controlled crash; all members of the crew managed to get out alive before the B-29 sank. The five-man crew scrambled into the plane's emergency life raft and was rescued approximately five hours later by a speedboat from Boulder City, Nevada.

NPS involvement and the searches for 45-21847

National Park Service (NPS) involvement with the B-29 began on the day of the crash when Lake Mead staff coordinated the rescue of the downed aircrew. With the active hostilities of World War II ended, there were thousands of surplus B-29s available for research and the plane was not a unique or even particularly valuable item at the time of its loss. NPS researchers have not yet found any historical documents to indicate the extent to which the Army Air Force attempted to find and recover the crashed and sunken plane. The general location of the plane remained known, however, and as years passed the aircraft grew in value as a historically rare remnant of World War II and the Cold War.

Informal and unauthorized searches are documented as early as 1986 when Co-Pilot Paul Hessler assisted a team searching for the plane with a robotic submarine. Beginning in 1994, Lake Mead National Recreation Area fielded numerous formal requests on the part of private "warbird" collectors to search for and recover the wreck of 45-21847. The NPS position has consistently been that the plane is in Park Service jurisdiction, belongs to the government, and will not be ceded to an individual or group that finds the wreck. This position has been received with varying degrees of grace by interested collectors. In 1994, for example, collector Bill Warren sued the park over the rights to find and salvage the aircraft. Although Warren lost his case in court, the suit derailed NPS efforts to find the wreck using a partnership with Department of Defense technology contractor Bechtel. Another NPS initiative, listing 45-21874 on the National Register of Historic Places, was partially successful and the plane was determined eligible for listing. Full listing necessitated actually providing the location of the plane.

In 1997, the park launched a second search for the B-29 in partnership with Bechtel. The park was concerned that a resource of great national importance to the American people within the administrative boundaries of the park was as yet unlocated and undocumented. The 1997 search was unsuccessful.

The aircraft was eventually located in 2000 by an individual who had been searching for the wreck using side-scan sonar without a permit, a violation of 36 CFR 2.1(7). NPS was never notified of the find. The individual who did the illegal side-scan search organized a dive group and in September 2001 commenced diving and filming activities. The team removed artifacts from the aircraft and crash site for almost a year until park staff was notified by a media contact on August 6, 2002, that a press conference was planned at the end of the week to announce the discovery of the B-29.

After the press conference the individual who had located the aircraft informed NPS that he had been advised by his attorney not to give NPS the coordinates of the aircraft. This set in motion a chain of events that would create another legal battle. The park immediately placed a diving restriction on the Overton Arm of the lake—the general location of the aircraft—to prevent further unauthorized diving on the site. In addition, NPS turned to the Bureau of Reclamation (BOR), which had just used multi-beam sonar to map sedimentation in the lake, for the development of new capacity tables for the reservoir. BOR reprocessed the data that allowed park staff to locate the aircraft. Barred from diving on the plane, the individual who first located it turned to federal court and filed a motion for a temporary restraining order prohibiting any NPS dives. He also filed an admiralty salvage claim to gain possession of the aircraft.

Prior to the discovery of the plane, the park had been in contact with the NPS Submerged Resources Center (SRC), which was willing to assist with technical diving, systematic mapping, and baseline documentation of the aircraft. Once the plane was located by the park, operations were conducted in fall 2002 and spring 2003. Since the plane was located in very deep water, the team needed specialized diving and documentation equipment. SRC recorded evidence of impacts to the aircraft resulting from uncontrolled diving activities, gathered baseline data on corrosion and preservation of the plane, created information that could be used in public outreach and education, and provided the park with information used to create several options for the future management of the aircraft (Figure 2–5).

Legal and management status as of April 2005

When the individual who found the plane filed an admiralty salvage claim in Federal District Court in Las Vegas, he created a number of logistical as well as legal problems for NPS. Fundamentally, NPS does not deal with issues of admiralty law so turned to the U.S. Department of Justice for legal assistance. A second aspect of the admiralty claim was that the federal judge was unfamiliar with the arcane aspects of admiralty salvage law. The federal government case revolves around five main issues:

Figure 2. Site plan of B-29 lost in the Overton Arm of Lake Mead, created by NPS Submerged Resources Center.

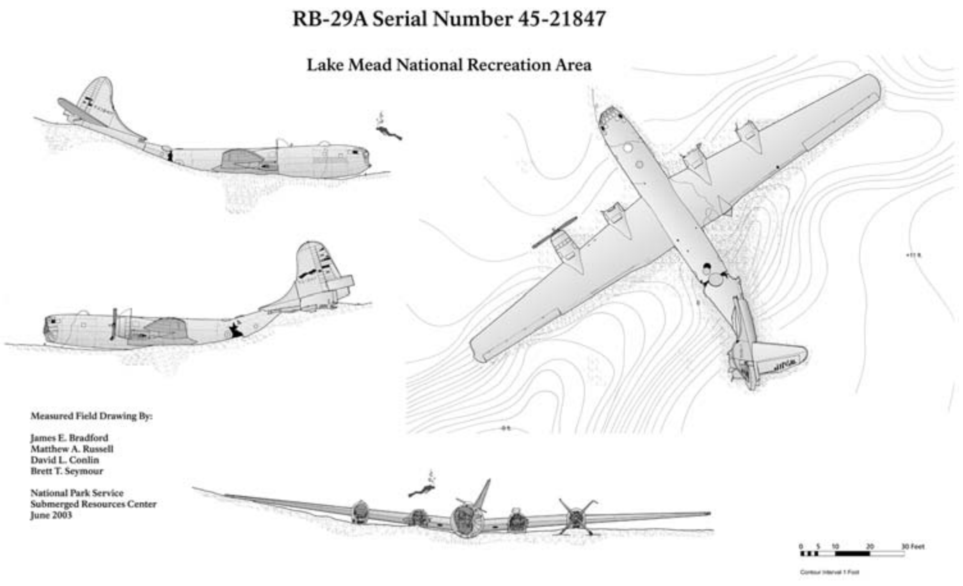

Figure 3. Matt Russell, NPS Submerged Resources Center archaeologist, mapping the Overton B-29. Photo courtesy NPS (Brett Seymour).

Figure 4. Jim Bradford, NPS archaeologist, documenting the Overton B-29. Photo courtesy NPS (Brett Seymour).

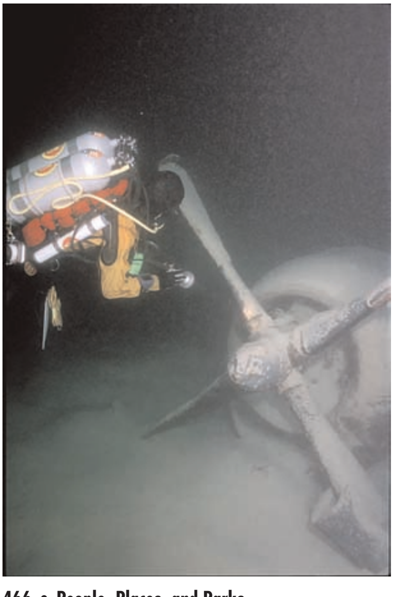

Figure 5. Matt Russell, NPS Submerged Resources Center archaeologist, documenting the single remaining engine on the Overton B-29. Photo courtesy NPS (Brett Seymour).

1. The mission of NPS is to preserve and protect natural and cultural resources under its stewardship and to provide for public use in such a way as to leave them unimpaired future generations. It is the NPS responsibility to ensure the protection of the B-29.
2. The Overton B-29 was located 160 feet above the bed of the Virgin River on federal property managed by NPS.
3. While the Air Force in 1962 issued a memorandum stating that it abandoned crashed aircraft, the federal government as a whole did not. The B-29 was actively searched for by the NPS over several decades. When its location was determined, NPS took measures to ensure its protection, including restricting access and completing the first phase of a condition assessment.
4. The individual who found the plane had located the B-29 by illegally using a side-scan sonar. The dives they conducted resulted in severe damage to the plane and to the artifacts they removed.
5. The Overton B-29, located in a cold lake environment, was stable, and measures could be taken to further stabilize the cultural resource. NPS would look at a variety of strategies to ensure public understanding and enjoyment of the site.

As of April 2005, the salvage claim is on-going and unresolved. The temporary restraining order to prevent NPS from diving on and managing the site was denied and NPS has been declared the temporary custodian of the plane. NPS is moving forward with plans to manage the resource in a manner consistent with its larger mandate to preserve resources "unimpaired for future generations," while at the same time working with the American people to maximize our access to, and enjoyment of, this unique artifact of the Cold War.

FOIA and Protecting Cultural Resources

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The Freedom of Information Act (FOIA)[1] provides citizens access to federal agency records. Sunshine laws, in some states, have a similar function at the state level. FOIA mandates which federal agency records must be accessible by law, and FOIA and other laws indicate which records may be withheld. Releasing information on cultural and natural resources may, under certain circumstances, undermine the protection of those resources. The National Park Service (NPS) and other federal bureaus and agencies must be cognizant of situations when withholding information is warranted and legal authorities for withholding. This paper outlines the basics on releasing and withholding information about NPS cultural resources.

What kinds of information are subject to FOIA?

Information in federal agency records is subject to FOIA. Records include books, papers, maps, photographs, machine-readable materials, or other documentary materials—but not all such materials meet the definition of federal agency records under FOIA. Federal agency records must be made or received by federal agencies in transacting public business.[2]

Does FOIA apply to NPS museum archives?

FOIA applies to some, but not all NPS museum archives. NPS museum archives are documentary materials, including papers, maps, photographs, and machine-readable materials, managed as part of NPS museum collections. NPS museum archives include resource management records, which are federal agency records subject to FOIA. FOIA does not apply to other nonrecord museum archival collections. Museum catalogue records, and other museum management records, are subject to FOIA because they are records NPS created to manage and control museum collections. The following examples illustrate when FOIA does and does not apply to various types of documentary materials.

- A Thomas Edison letter donated to a park is not a record. In fact, the entire Thomas Edison collection at Edison National Historic Site was donated and is not subject to FOIA.
- A map that a park archaeologist creates is a resource management record maintained in the park's museum archives. It is subject to FOIA, although numerous exemptions apply to protect the mapped archaeological resource.
- The park cooperating association's records in the museum archives are not federal agency records. They are not subject to FOIA.
- A deed of gift that a donor and a park superintendent sign is a record and subject to FOIA, although privacy exemptions may apply.

- The superintendent's annual report is a record managed in the park's records management program, not in the museum archives. It is subject to FOIA.

When should NPS release cultural resources information?

NPS should release cultural resources information unless it qualifies under an exemption. If information is protected, NPS should withhold it unless disclosure would further the NPS unit's mission and would not create unreasonable risk of harm, theft, or destruction of the resource, and would be consistent with other laws protecting the resource.

What are the primary authorities for withholding information about cultural resources?

FOIA lists nine exemptions under which information may be withheld:

1. Classified national security information;
2. Records related solely to the internal personnel rules and practices of the agency;
3. Information exempted from disclosure by another statute;
4. Trade secrets and commercial or financial information that is privileged or confidential;
5. Documents that are normally privileged in the civil discovery context, including agency predecisional, deliberative records;
6. Records containing information about individuals when disclosure would constitute a clearly unwarranted invasion of personal privacy;
7. Certain records or information compiled for law enforcement purposes;
8. Records relating to the regulation of financial institutions; and
9. Geological and geophysical information and data concerning wells.

In addition, the following laws, specific to protection of natural and cultural resources, provide exemptions to FOIA: National Historic Preservation Act of 1966, as amended (NHPA);[3] Archaeological Resources Protection Act of 1979, as amended (ARPA);[4] Federal Cave Resources Protection Act of 1988 (FCRPA);[5] and National Parks Omnibus Management Act of 1998 (NPOMA).[6]

Section 304 of NHPA requires federal agencies and other public officials receiving grant assistance pursuant to the act, after consulting the secretary of the interior, to withhold from disclosure to the public information about the location, character, or ownership of historic resources if the secretary and the agency determine that disclosure may cause a significant invasion of privacy, risk harm to the historic resource, or impede the use of a traditional religious site by practitioners. When such a determination is made, the secretary, in consultation with such federal agency or official, must determine who may access the information.

Under Section 9 of ARPA, federal agencies must withhold information about the nature and location of any archaeological resource for which the excavation or removal requires a permit or other permission under federal law unless the federal land manager determines that disclosure would further the purposes of ARPA or the Reservoir Salvage Act, as amended,[7] or that it would not create a risk of harm to such resources or to the site at which such resources are located. ARPA provides an exception requiring federal land managers to release information about the nature and location of archaeological resources in a state upon a governor's written request stating the specific location and purpose for which the information is sought and a commitment to protect the information from commercial exploitation.

FCRPA prohibits release of information concerning the specific location of any significant cave unless the secretary of the interior determines that disclosure would further the purposes of the act and would not create substantial risk of harm, theft, or destruction to the cave. It makes an exception for the secretary to release information about significant caves upon written request of federal and state government agencies and bona fide educational and research institutions. Such written requests must state the specific location and purpose for which the information is sought and include assurances satisfactory to the secretary that adequate measures are being taken to protect the confidentiality of such information and to ensure the protection of such caves from destruction by vandalism and unauthorized use.

Section 207 of NPOMA states that, except as noted below, NPS may withhold information concerning the nature and specific location of the following resources:

- Endangered, threatened, rare, or commercially valuable national park system resources;
- Mineral or paleontological objects within units of the national park system; and
- Objects of cultural patrimony within units of the national park system.

The above information may be withheld unless the secretary determines that disclosure of the information would further the purposes of the unit of the national park system in which the resource or object is located and would not create an unreasonable risk of harm, theft, or destruction of the resource or object, including individual organic or inorganic specimens; and disclosure is consistent with other applicable laws protecting the resource or object.

What is an "object of cultural patrimony" as used in NPOMA?

"Object of cultural patrimony" is not defined in the NPOMA. NPS plans to provide the definition in NPS Reference Manual #66B, "Handling Protected Information," when it is issued. The definition needs to be tailored to apply specifically to national park system resources and include the following concepts:

- NPS must identify the item as having importance for archaeology, history, ethnography, literature, art, physical or natural sciences, or culturally associated groups.
- The object must be within the administrative jurisdiction of a unit of the national park system.

These concepts reflect National Park Service considerations and are very similar to the definition of "cultural property" in the 1970 UNESCO [the United Nations Educational, Scientific, and Cultural Organization] Convention on the Means of Prohibiting and Preventing the Illicit Import, Export, and Transfer of Ownership of Cultural Property[8] and the definition of "cultural objects" in the 1995 UNIDROIT [the International Institute for the Unification of Private Law] Convention on Stolen or Illegally Exported Cultural Objects.[9]

What are some examples of information documenting the nature or character of a cultural resource that is likely to be withheld?

The following examples show when NPS might want to withhold information documenting the nature or character of a cultural resource:

- Certain architectural drawings of a monument that is a national icon might be withheld because terrorists could use them to determine where to plant a bomb to damage or destroy the monument.
- Information in field notes documenting numerous graves under the floor of a Spanish colonial church at an archaeological site that is open to the public might be withheld because releasing that information would create a high risk of disturbance and looting of the site.
- Information on the appraised value and location of a museum object could be withheld if release would increase the risk of theft.

What are some examples of location information that is likely to be withheld?

In the following situations, NPS might be likely to withhold information on location:

- Information on the location of archaeological sites that are not formally open for public visitation is routinely withheld to protect the sites from looting and vandalism. This information is in archaeological resource management records and museum records associated with artifacts from archaeological sites. For example, that the wreck of the HMS *Fowey* is within the boundaries of Biscayne National Park is public knowledge; however, the park has successfully denied a FOIA request for the specific location of the shipwreck.
- Information on the location of caves that are not formally open for public visitation is routinely withheld to protect the cave resources, whether natural or cultural, from theft and vandalism, as well as to protect the sensitive cave environment from contamination.

Can parks protect the confidentiality and physical integrity of sacred sites?

Although Executive Order 13007, "Indian Sacred Sites,"[10] instructs agencies to accommodate religious practitioners from recognized American Indian and Alaskan native tribes in access to and ceremonial use of Indian sacred sites on federal land, to avoid adversely affecting the physical integrity, and to maintain the confidentiality of sites as permitted by law, it does not provide a specific FOIA exemption.

NPS cannot promise confidentiality of records created about sacred sites, unless that information falls under one of the nine FOIA exemptions, including exemptions provided by other laws. Effective management of the information collection process is the best approach to protecting confidential information about sacred sites. A park that collects and maintains the minimum information needed to justify administrative decisions and ensure that public trails avoid a sacred site reduces the risk of releasing sensitive information under FOIA. If releasing that information might result in harm to the resource, information about the nature (or character) and location of the resource could be withheld under exemptions in NHPA, ARPA, and, if the site is an object of cultural patrimony, NPOMA. In addition, information about the character or location of the resource could be withheld under exemptions in NHPA if release would cause a significant invasion of privacy or impede the use of a traditional religious site by practitioners.

Can parks protect the confidentiality of ethnographic research notes?

NPS cannot guarantee to maintain the confidentiality of records created during ethnographic research (for example, records of consultations) unless the information falls under one of the nine FOIA exemptions, including exemptions provided by other laws. Although ethnographers use FOIA exemptions 3–6, exemption 6, addressing privacy, is the most used. The NPS ethnographer community is developing procedures to minimize the amount of confidential information that goes into federal agency records and is therefore subject to FOIA, and to maximize use of the privacy exemption to protect confidential information in those records.

May NPS withhold previously released cultural resources information?

NPS may withhold information about the nature and location of cultural resources if that information has changed since its previous release. For example, a national park may have allowed researchers to view a 1960 catalogue record for a painting showing its value at $200. The recorded value has now changed to $5,000. That information, as well as the location and other sensitive information, could be withheld even though it was released previously. The nature of the resource, the value, has changed, now placing the resource at an unreasonable risk of theft.

May NPS now withhold cultural resources information released before 9/11 even if the nature or location of the resource has not changed?

The answer is not known. Some parks may now withhold previously released information on cultural resources that are at higher risk after 9/11. The nature and location of the resource may not have changed, but the risk has changed. Whether this position will be upheld may be decided by the court system. A theoretical example of when a park might want to withhold cultural resources information that was released prior to 9/11 follows.

In 1990, a historical park that is a national icon released information from a fire protection survey for a historic structure that is a national historic landmark. The park now decides that releasing that information heightens the risk that terrorists might use the information to damage or destroy the resource. Under NPOMA, the park can withhold that information because release would be likely to cause an "unreasonable risk of destruction." The park could also cite NHPA, which refers to a "risk of harm." In addition, the park may assert that the nature of the resource has changed—it is now identified as a terrorist target.

As with many FOIA requests, the Office of the Solicitor should review the proposed response. If the information is withheld and challenged, courts will make the final decision on whether this position will be upheld.

How is cultural resources information often released inadvertently?

Allowing contractors, researchers, permittees, and partners to access sensitive data without a written provision limiting use and release of confidential information may result in inadvertent release. Even when a confidentiality clause is in effect, employees should be cautious about releasing sensitive information, since there is some legal uncertainty as to whether confidentiality clauses will be held to be enforceable. When an employee provides information to the public, while remaining ignorant of the potential impact to the resource, the employee may put the resource at substantial risk. Employees and volunteers who create and maintain records without flagging sensitive data increase the risk that others will unwittingly release that data. Employees who fail to involve the FOIA officer in establishing standard operating procedures for responding to public requests, including FOIA requests, may also inadvertently release data.

How can NPS avoid inadvertent release of cultural resources information?

Employees who take the following precautionary actions are likely to avoid inadvertent release of cultural resources information:

- Include confidentiality clauses in all contracts, agreements, permits, and research permissions;
- Mark sensitive data as restricted when creating records;
- Consult the FOIA officer early in the FOIA process; and
- Consult the relevant resource manager about potential impacts to resources.

Any FOIA request is a challenge, but employees will best meet that challenge if they anticipate the request as they create and manage records. With careful management of federal records pertaining to natural and cultural resources, knowledge about sensitive data and the FOIA process, and early involvement of the FOIA officer, NPS employees should be able to make sound decisions about when to release information for public benefit and when to withhold information to protect NPS resources.

Endnotes

1. 5 USC 552.

2. Federal records include all books, papers, maps, photographs, machine-readable materials, or other documentary materials, regardless of physical form or characteristics, made or received by an agency of the United States government under federal law or in connection with the transaction of public business and preserved or appropriate for preservation by that agency or its legitimate successor as evidence of the organization, functions, policies, decisions, procedures, operations, or other activities of the government or because of the informational value of the data in them (44 USC 3301).

3. 16 USC 470 et seq.; see Section 304 (16 USC 470w-3) regarding limitations on access to information.

4. 16 USC 470aa–mm; see Section 9 (16 USC 470hh), on confidentiality of information concerning nature and location of archeological resources.

5. 16 USC 4301–4310; see Section 4304 on confidentiality of information concerning nature and location of significant caves.

6. 16 USC 5901 et seq.; see Section 207 (16 USC 5937) on confidentiality of information.
7. 16 USC 469–469c-1.
8. In the 1970 UNESCO Convention, "cultural property" means property which, on religious or secular grounds, is specifically designated by each state as being of importance for archaeology, prehistory, history, literature, art, or science and which belongs to certain listed categories. See http://www.unesco.org/culture/laws/1970/html_eng/page1.shtml.
9. Under UNIDROIT, the definition for "cultural objects" refers to objects which, on religious or secular grounds, are of importance for archaeology, prehistory, history, literature, art, or science and belong to one of the categories listed in the annex to the Convention. See http://www.unidroit.org/english/conventions/c-cult.htm.
10. See http://www.cr.nps.gov/local-law/eo13007.htm.

Archaeology and the Warriors Project: Exploring a Buffalo Soldier Campsite in the Guadalupe Mountains of Texas

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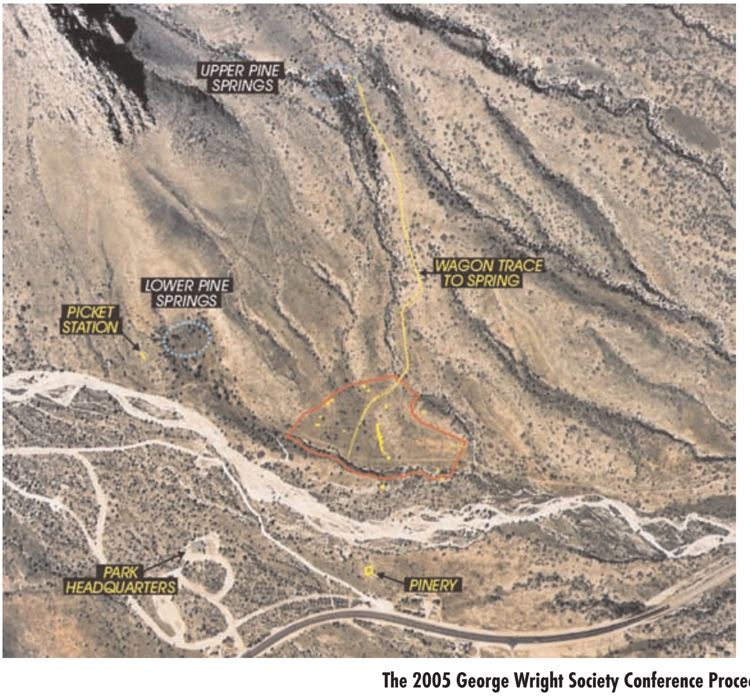
In the summer of 2004, Howard University and the National Park Service began investigating a military campsite in the Guadalupe Mountains of Texas, thought to have been occupied by the Buffalo Soldiers during the Apache Wars of the 1870s. This fieldwork was an extension of the Warriors Project, a multi-year program initiated by the Park Service in 2002 for African Americans and American Indians to discuss their mutual past on the western frontier. The project began as historical research carried out jointly by Haskell University, an American Indian institution in Kansas, and Howard University, a historically black college and university in Washington, D.C., through the National Park Service's Desert Southwest Cooperative Ecosystem Study Unit (CESU). By December 2003, this phase was completed (O'Brien 2004) and the Warriors Project turned to archaeology.

The existence of the Pine Springs Camp (41CU44) had long been known. Located on the eastern slopes of the Guadalupe Mountains, it overlooks the Pinery, one of the Butterfield Stage Trail stations (Figure 1). It is also situated near the modern road and the Guadalupe Mountains National Park visitor center. According to local historians, it was one of many army outposts that proliferated in the American West during the 19th century, with detach-

Figure 1. Aerial view of Guadalupe Mountains National Park showing the location of the Pine Springs Camp on the east slope of the mountains (photo by Bruce Moses, 2004).



ments from various forts occupying it intermittently both before and after the Civil War (Gilmore 1970; Shafer 1970). It also housed the Civilian Conservation Corps in the 1930s (Gilmore 1970) and a goat-herding operation before becoming park land (Fred Armstrong, personal communication, 2005).

Archaeologically, the Pine Springs Camp was first explored in 1970 by the Texas Archaeological Society field school. Field school members surveyed the site, which is situated on a north–south slope between Upper and Lower Pine Springs (Figure 1). They noted regular concentrations of stone rubble, some of them burned, aligned parallel to the slope, which they tentatively identified as military campfires (Figure 2). The crew mapped these features and an adjacent wagon road that ran from the Butterfield station to Upper Pine Springs (Figure 1). They also collected a few artifacts (bottles, nails), mostly from the rubble concentrations. Historian John Wilson dated these objects to the mid-to-late 1800s, but as field director Kathleen Gilmore (1970) observed, only excavation would clarify the features' chronology. That excavation would come 34 years later, under the auspices of the Warriors Project.

Fast-forward to 1997–1998, when Charles Haecker of the National Park Service revisited the Pine Springs Camp. Haecker, a military archaeology specialist, confirmed that the rock concentrations were indeed the remains of military hearths and that a ring of rocks on top of a nearby knoll was in fact a former picket station. He found evidence for subsurface artifacts by metal detecting and identified a dump, a temporary structure, and two additional picket stations south of the hearths. Historical records suggested that the camp was primarily occupied by the 9th and then the 10th Cavalry Buffalo Soldiers in the 1870s. From this brief reconnaissance he proposed further investigations at the site.

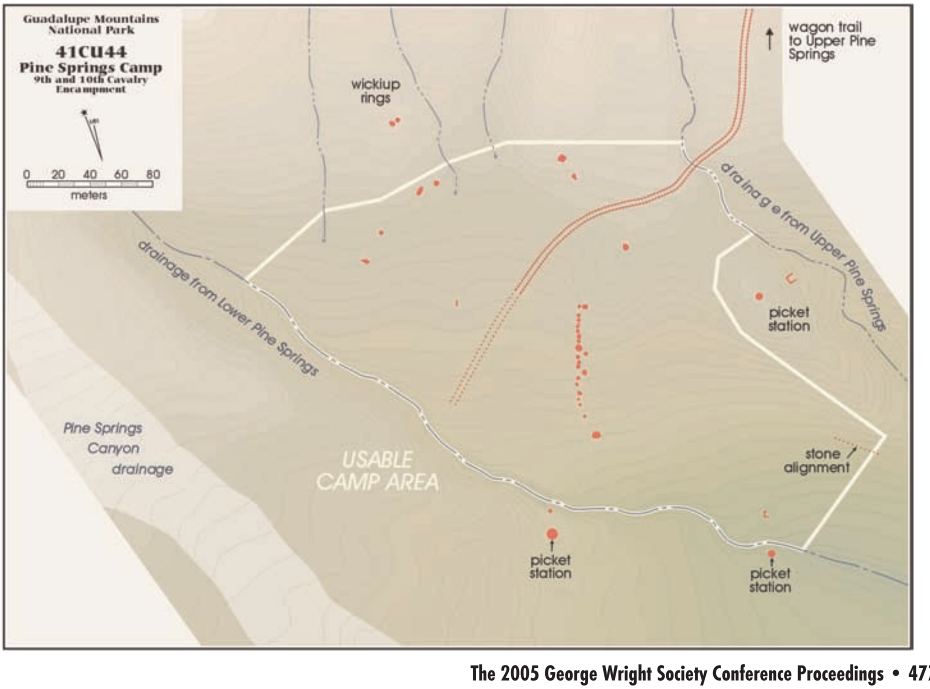
Figure 2. Rock concentration/military campfire (photo by Texas Archaeological Society Field School, 1970; courtesy of Anne Fox).

The identification of the camp with Buffalo Soldiers provided the impetus to create a unique archaeological project, sponsored by the Desert Southwest CESU. In July 2004, Haecker and the author led a team of 10 students in a two-week field school at the site. Participants comprised five college students from Howard University and five high school students, including three from the Mescalero Apache Reservation. Other participants included volunteers and staff members from the park, who came when they could. The field school, documented on film by a Howard student, proved hugely successful. The high point of the season was a visit by Mescalero Apache elders, who honored us by coming out to the site and sharing their knowledge of local resources.

While we are still assessing the data from our exciting season, preliminary observations can be made about what we found. Our main goal was to survey and map the entire camp in order to situate it within its larger landscape. We completed a detailed topographic survey of nearly 60 acres, including the line of hearths, the wagon road, and the three known picket stations (Figure 3). As we expanded the map we discovered a short defensive breastwork west of the hearth line, overlooking Lower Pine Springs. The campsite was clearly far more extensive than originally thought.

Of the terrain mapped, approximately 15.25 acres (21,714 sq m) were level enough to have been used by the soldiers, and there is evidence for activity areas. Each campfire in the long hearth line probably represented a "mess unit" of four or five men who cooked and ate together, and slept in tents nearby (Charles Haecker, personal communication, 2004). The discovery of dark grey limestone slabs next to several hearths supports this idea. According to Gorden Bell, geologist for Guadalupe Mountains National Park, this limestone was quarried from an outcrop to the south of Pine Springs, across the modern road. Based on descrip-

Figure 3. Map of Pine Springs Camp showing usable camp area (photo by Bruce Moses, 2004).



tions of 19th-century Army camp construction, we think these rocks were carried onto the site for use as footings for temporary canvas and/or wood structures—either dog tents or the Sibley tents used in winter (University of Texas–Austin School of Architecture, undated; Rickey 1972:221).

There also seems to have been a designated wagon maintenance area. West of the hearth line, near the old road, we found wagon harness pieces on a rise. Nearby, dark grey limestone slabs arranged in a large, rectangular shape suggest a temporary structure with a chimney. A short distance away is another, similar outline of stones, slightly smaller. The rocks are the same as those used near the campfires and the similarity in construction suggests that these two structures date to the same period as the hearths. They might represent the remains of storage huts, or even a smithy and a surgery. Surgeons accompanied several of the later Buffalo Soldier expeditions and a blacksmith accompanied at least one of them (Bruce Moses, personal communication, 2004).

Other remains observed during the survey include a hearth located north of the campfire line and separated from it by a small knoll or rise (Figure 3). The knoll would have afforded this location some privacy and a commanding view of the entire campground. Nearby is one of the picket stations. These factors suggest the hearth was used by the commanding officer(s) of at least one of the military expeditions. Though we metal-detected around this feature, we found nothing diagnostic to tell us when it was occupied and whether officers or enlisted men used it.

Army remains were not the only ones found. On the same low rise with the wagon pieces we discovered two *wickiup* rings. Other *wickiup* rings were discovered on a ridge near the breastwork and a possible mescal roasting pit was located close to the proposed officers' quarters. Finally, stone tools and debitage were found in most parts of the site.

Additional evidence of military camp activities came from excavations of the hearths and from a careful survey of the ground near them. While most of the campfires follow roughly the same alignment, a few are off-line to the east, thereby suggesting at least two periods of occupation (Figure 3). We chose to excavate an example of each. Operation A was a shallow, 3x3-m excavation around one of the hearths in the main alignment. Like most of these features, it consisted of light grey limestone packed in a rough circle around sandstone quarried from a nearby ridge. According to Gorden Bell (personal communication, 2004), sandstone was more heat resistant than limestone and would have lasted longer in the hearths. The depth and spread of the ash here suggest long-term use.

Only a few artifacts were found near the hearth, all of them dating to the late 19th century. A button each from a suspender and a fly suggest that soldiers changed their clothes nearby—either inside or outside a tent, as the fly button came from either trousers or a tent fly. Cut nails near the hearth, probably from ration boxes, and a can lid fragment indicate the soldiers in this mess unit were preparing meals, most likely a delicious menu of hardtack and beans. Rations would have included salt bacon, dry beans, hard tack, and green coffee in the bean (Rickey 1972:220). Canned beans were also common (Charles Haecker, personal communication, 2004). An as-yet unidentified animal bone may indicate that the soldiers hunted to supplement their diet. The records of other expeditions indicate wild game was plentiful in the Guadalupe Mountains (Schreier 1976). Other items found here included a Lorillard tobacco pouch tag, post-1870, that suggests smoking was enjoyed. A pen nib found a little further away may also date to this period. Some of the Buffalo Soldiers were literate and the officers, of course, had to fill out reports.

Operation B revealed a similar range of materials plus a few surprises. It comprised a 4x3-m unit placed around a crescent-shaped, sandstone hearth east of the main alignment. Next to the campfire was some of the dark grey, "imported" limestone. This hearth had a complex stratigraphy. Underneath we found what appears to be a small, box-shaped oven made of slabs, roughly 25x50 cm (Figure 4). At first we thought this oven might be prehistoric, as one of our Apache visitors told us that the Lipan Apache, who once lived hereabouts, had adopted this kind of slab-style oven from the Pueblos (Zelda Yazza, personal communication, 2004). As we excavated, however, we found long, cut nails mixed into the ashes and soil within the oven, and a tin can lid from the late 1800s lay at the bottom. Either the soldiers re-used an Apache oven or they constructed it themselves. In either case, the existence of the oven implies that soldiers also baked. This idea is supported by the unusual can lid found at the bottom. It was smaller than a regular food tin lid, and made to be recloseable, suggesting something like a baking powder container. The quantities of ash and charcoal found associated both with the hearth and the oven suggest they were used for a long time. The fact that the two were stratigraphically juxtaposed further indicates at least two periods of occupation, both substantial.

Other finds around the Operation B hearth included numerous framing nails and spikes. Framing nails would have been used to build temporary wood structures. Spikes were made for heavier duty such as bridge and road building—activities generally reserved for the infantry (Charles Haecker, personal communication, 2004). It is unclear why such a

Figure 4. Operation B "oven" during excavation (photo by Eleanor King, 2004).

large number of these nail types were found around this particular hearth. Possibly, infantrymen used the campfire. They often accompanied the cavalry on mission, especially on expeditions to the Guadalupe Mountains, whose abundant pine trees supplied lumber to the forts (Charles Haecker, personal communication, 2004).

Haecker ran systematic metal detection transects across the dump south of the hearth line and found that it dated to the 20th century. Other transects and an intensive survey near the hearths produced more nails and a steel box strap, a testament to the importance of boxes in camp life for munitions as well as rations. More rare were finds of military buttons and cartridges of various calibers, including one from 1878 and two Minié bullets. A Dutch oven fragment, found east of Operation B, might indicate that soldiers supplemented their government-issue frying pans with equipment they preferred—a common occurrence (Rickey 1972:220). Glass bottle fragments from the same area indicate that the soldiers washed their hardtack down with something stronger than water. Finally, horseshoes and nails scattered lightly everywhere support a cavalry presence.

Our initial assumption was that the campsite was used for short periods of time, principally by the 9th Cavalry, during the early 1870s. Thanks to the generosity of Anne Fox, a participant in the original 1970 project, we had records tracking which Army units were there. Company K of the 10th Cavalry from Fort Davis, Texas, under the command of Captain Thomas Lebo, occupied the site the longest, for several months in both 1878 and 1879. From this base, Lebo would lead 10-day forays into the mountains, hunting for the elusive Mescalero Apache and then returning to Pine Springs to re-supply. Significantly, in 1878 he was accompanied by a 25th Infantry detachment (Lebo 1979). These longer occupations fit well with what we found. The amount of labor invested in the campfires and associated, semi-permanent structures and the quantities of ash suggest a group that stayed awhile. The two-period stratigraphy in Operation B's hearth may even indicate re-use of a favorite spot, perhaps at one time by infantry members. Certainly, the artifacts found around the site are consonant with a late 1870s military presence.

Both records and finds further show, however, that this locale has been repeatedly and intensively used since prehistoric times. Stone tools attest to pre-contact usage, and during historic times many people passed through. The Butterfield Stage stopped close by, of course, and the two Civil-War era Minié bullets as well as other records suggest that the Union Army's "California Column" came through as well (Schreier 1976). The campsite's attraction became clear when park staff told us that Lower Pine Springs was the major water source before a 1930 earthquake closed it off (Figure 1). To this day, a sizeable streambed still channels deep floodwaters during rain (Janice Wobbenhorst, personal communication, 2004). Captain Lebo himself notes in his dispatches that there was enough water for four or five cavalry companies and that the grass was abundant and nourishing (Lebo 1879)—a far cry from today's desert environment. Situated between two flowing springs in exceptionally dry country, the area would have been a magnet for prehistoric and historic human occupation. Indeed, finds at the site even suggest that groups hostile to each other took turns occupying it. A cut brass cartridge and the bottom of an 1870s glass bottle, apparently retouched as a scraper, indicate the Apache came back at least to forage for useful items in between military occupations. One might even say that the site represents an early example of a time-share system.

Much remains to be learned from the Pine Springs Camp. Additional archival research has already yielded promising information on the Buffalo Soldiers who were there. Further archaeological research in summer 2005 will help refine the chronology and clarify the multiple uses of this intriguing site.

Acknowledgments

The Buffalo Soldiers Archaeology Project was funded by the National Park Service, Howard University, and Guadalupe Mountains National Park, and facilitated by Pat O'Brien of the Desert Southwest Cooperative Ecosystem Study Unit. Local park staff helped greatly, especially Fred Armstrong, Jan Wobbenhorst, and John Lujan. I am indebted to my project colleagues, Charles Haecker, Heather Young, Bruce Moses, and Darcie Flanigan, and to the students, Eric Berry, Kelley Chatman, Don Comanche, Jordan Comanche, Sonny Comanche, Alina Epstein, Nicole Jimenez, Damian Kibby, Kito Nzingha, and Linsey Richbow, for their hard work. Volunteers helped, too, particularly Betty and Carl Brockmann, Chelsea and Billy Tarango, Bill Brown, Patricia Moses, and Amber Vasquez. Anne Fox has my deepest gratitude for sharing her thorough research. Finally, I owe Charlie and Bruce, who provided key information and commented on earlier versions of this article.

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Developing Sustainable Design Guidelines for a Dynamic Landscape

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To implement a meaningful and appropriate treatment for the rehabilitation of the Dyea historic townsite, sustainable design guidelines must be developed through an interdisciplinary approach. Resource specialists, park managers, and facility designers must find productive ways to work together that will result in the balance of resource conservation and visitor satisfaction. To date, much of the planning work has dealt with the proven methods and techniques used to construct infrastructure, but the challenge is defining the ongoing process needed to find common solutions to the varied perspectives on design guidelines for a dynamic cultural landscape. Dyea historic townsite, located in Klondike Gold Rush National Historical Park, poses serious contradictions to traditional preservation and park management methodologies due to the scale of its dramatic landscape, which is a tapestry of natural and cultural resources, often with conflicting protection strategies. Although Dyea resides within a historical park, the three categories first recognized in Secretary of the Interior Stewart Udall's 1964 policy objectives for the National Park System, those being *natural*, *historical*, and *recreational,*[1] all apply here.

Situated within an active glacial watershed and with a historical record barely visible in archaeological remains now cloaked by emergent forest, Dyea represents a formidable challenge in developing a functional master plan that addresses overall patterns of change. Nearly two years ago, the effort to preserve the historic townsite of Dyea was innovatively taking form through the collective talents and dedication of resource specialists and designers. A sustainable design approach for interpreting and developing this rapidly evolving landscape meant to re-define the traditional National Park Service (NPS) paradigms used to create park facilities. It was George Wright who cited the need for master plans to include natural resource information—rather than "contemplated and completed physical development only."[2] Taking this approach one step further, the cultural landscape treatment of Dyea called for consultation and involvement from all resource areas and programmatic teams. While the technical methodology seemed logical and flawless, the melding of the NPS Cultural Landscape Program with the agency's standard design process has been challenging, yet productive.

Park employees are dedicated to providing the best possible management for the historic townsite, which is a part of the Chilkoot Trail Unit. However, the composition of the staff evolved from the management and maintenance needs of developing the Skagway Unit (a twenty-block municipal downtown revitalization) and improving recreational use of the Chilkoot Trail (one of two historic corridors within the park that link to Canada and the gold fields of the Yukon River drainage). Anything truly creative results in change, and if there is one thing a well-run bureaucracy or institution or major corporation finds difficult to handle, it is change.[3] Until the most recent effort to give proper recognition to the cultural landscape of Dyea, the park has endeavored to inventory and monitor archaeological features (including the few remaining visible structures), maintain basic public access, and provide a law enforcement presence. The introduction of minor visitor amenities and traffic control devices has been necessary and installed with the best of intent, but these improvements have been implemented without design guidelines emanating from a comprehensive cultural landscape treatment. The general management plan's (GMP's) preferred alternative recognized that the cultural landscape of Dyea has changed. "Selected townsite streets and ruins, now overgrown with trees and brush, would be cleared…." [4] Since the park has decided to utilize the specific proposals found in the cultural landscape report (CLR) in a public review process to reaffirm the acceptable development of Dyea, a grudging acknowledgement to such change has begun.

The implementation process from this point on must attempt to keep the park staff attuned to a new order of development. Minor improvements will continue to be scheduled annually as part of the seasonal maintenance work plan, but more significant construction projects have been coordinated to align with the anticipated form of the cultural landscape treatment. Resource specialists responsible for the preparation of the CLR have gone on record recommending the park consider all improvements to be temporary until the final planning document, presumably a type of development concept plan (DCP), is approved. Because it could still be a number of years before the public planning process can be funded, a decision rendered, design work completed, and construction begun, interim planning tasks will maintain momentum while supporting any ongoing maintenance projects and management initiatives. A simple linear process has been depicted to provide sequential guidance to the park.

Essentially, the CLR sets the parameters for each successive step. The park has yet to decide the extent of public input into a visitor experience and resource protection (VERP) document, but its results, when combined with the CLR, will formulate the basis for the DCP. A DCP process will utilize the CLR recommendations as one of a number of concept alternatives presented for public comment. Just as the original 1996 GMP for the park offered planning alternatives for each of the park's four units, the DCP will suggest a full spectrum of development specific to Dyea. This action will be significant for the park, because it will enable park management to make its decision based on (1) a comprehensive set of scientific data that did not exist at the time the GMP was written, and (2) a formal recognition of the cultural landscape as a framework for any development.

Even before the DCP is started, the task of developing a comprehensive program will ensure that the overall needs of the area are defined. This program will serve to specifically identify facility descriptions, intent, quantities, and requirements to designers in the later stages of this process. As a part of this program development, resource specialists and park staff will mutually develop *design guidelines* that will provide direction and influence to designers with regard to selection of materials, construction techniques, product selection, massing, form, and appearance. These design guidelines are currently being developed by the park staff with the guidance and technical assistance of the NPS Alaska Regional Office and are intended to provide specific reference to management personnel who are administering programs and activities; architects, landscape architects, and engineers who are designing facilities; and maintenance and construction staff who are purchasing, fabricating, and installing improvements specified by the agreed-upon treatment plan. Only when all projected uses have been brought into consonance with the character of the land will a sound master plan be produced. This is, of course, a continuing process, requiring constant reappraisal, adjustment, and readjustment.[5]

The development of design guidelines with respect to meeting *sustainability* standards set by NPS will not be done in spite of Dyea's needs but instead give special recognition to the place and to the intended interpretation to be provided to the visiting public. Dyea offers the opportunity to test "the springboard from which a new ethic of combined environmental protection and landscape design must emerge...."[6] Conservation of existing cultural resources, rehabilitation of current transportation corridors, re-use of vegetation and other natural resources for infrastructure, and construction sequencing to minimize physical disturbance are some of the goals intended to have Dyea represent a sustainable approach to cultural landscape treatment. Sustainable methodology must also speak to the selection of construction materials, their placement in an evolving landscape, and the routine maintenance that will need to be responsive to change. The cumulative effort should focus on a consistent interpretive message to visitors that the NPS has chosen to develop Dyea in a sustainable manner so that this historic and yet dynamic place can be better appreciated and understood.

Endnotes

1. George B. Hartzog, Jr., *Battling for the National Parks* (Mt. Kisko, N.Y.: Moyer Bell, 1988), 102–103.
2. Richard West Sellars, *Preserving Nature in the National Parks: A History* (New Haven, Conn.: Yale University Press, 1997), 102.
3. Max DePree, *Leadership is an Art* (New York, New York: Dell Publishing, 1989), 33.
4. National Park Service, *General Management Plan, Development Concept Plan and Environmental Impact Statement, Klondike Gold Rush National Historical Park* (NPS Document D-68A, 1996), 2.29
5. John Ormsbee Simonds, *Landscape Architecture: A Manual of Site Planning and Design* (New York: McGraw-Hill, 1983), 299.
6. Linda Flint McClelland, *Building the National Parks: Historic Landscape Design and Construction* (Baltimore: Johns Hopkins University Press, 1998), 485.

Fortifications: Identifying Their Significance

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Our American fortifications, which at one time represented the defense of the territories, today have become a fragile system. Fragile because they must survive in a world where they are not understood for what they are: historic landmarks. Having lost their original context, they must survive in a new one for which they were not conceived, accommodating such things as electrical, water supply, heating, and air conditioning systems; soft drink dispensing machines; Internet wiring; modern plumbing; offices; and kitchens equipped with cutting-edge appliances—to mention a few. These and more constitute a long list of threats to protected sites.

But perhaps one threat to this fragile heritage that goes unnoticed is the lack of knowledge regarding its significance and, consequently, inadequate interpretations of its significance.

Effective interpretation of a heritage site is the result of knowing its significance along with responsibly documenting what the site represents and signifies. It means being clear about why and who envisaged the structure, its use, its construction, its history.

Without this primary information, our possibilities for interpreting the site fairly and appropriately are greatly reduced. At the same time, the chances increase that aggressive and inappropriate interpretation of the significance of the landmark will occur. This kind of interpretation contravenes the site's authenticity and converts well-intentioned protection efforts into threats themselves, ones that work against this fragile heritage.

When we talk about the rescue of our American fortifications, how many times does the image come to our minds of a numerous team of historians or researchers hunting down documentation that will reveal the significance of the complex or the particular monument, rather than architects hard at work designing methods to salvage walls and deteriorating historic material? Even though during the last two decades there have been a considerable number of publications, both in the Spanish- and English-speaking worlds, regarding defensive structures, one of the remaining obstacles is the lack of broader and deeper historic research on primary sources.

In view of the increasing interest in renewing the American fortifications, which has been expressed by various global entities, it seems to me of vital importance to keep in mind that in the effort to rescue these structures we should not lose sight of the fact that as part of the process we also have to rescue the history of the site, the history that is to be found in the documentation. Documentation is the tool that will allow us to be most accurate in our rescue efforts in terms of interpretation, reuse, and management of American fortifications.

I have personally witnessed several initiatives directed at recovering this particular American heritage. These initiatives underscore the pressing need for taking a step back and recommencing with historic research, a much-needed first step. If we want to be effective in leading recovery efforts and in using and managing these ancient fortifications, while highlighting their significance in our times, we should first turn to the archives to search out the truth about the fortifications. After that decisive first step, we will then be in a position to evaluate and interpret them.

I would like to briefly share some successful efforts that have been made on documentation rescue for the fortifications systems at San Juan National Historic Site in Puerto Rico. This is a monumental complex begun in the 16th century by Spain, which recognized the importance of the San Juan Bay as a secure base for naval operations from which all vessels entering the Caribbean could be controlled. Today, the National Park Service manages the national historic site and is responsible for the management and protection of the complex of the principal fortifications of the city of San Juan, which were declared a World Heritage site in 1983.

The 1797 project

In 1995 we began a research project on the British attack on San Juan, Puerto Rico, that occurred in 1797, and was to be the last British attack in the Caribbean during the 18th century. Spanish primary sources had been studied, but not the British primary sources. After two years of research, heretofore unmentioned documents were found in the British archives. Notable was the discovery of an unedited map of the British campaign signed by General Sir Ralph Abercromby on the island of Trinidad, where he stopped immediately after his withdrawal from the island of Puerto Rico following the failed attack. Along with the map, there was accurate information on the number of British losses and on the fact that, much to our surprise, the battle of resistance minimally involved the fortifications and had mostly occurred in the area of the Martin Peña Bridge, a mangrove that divided the island of Puerto Rico from the islet of San Juan.

The 1898 project

The search for documentation on the state of the fortifications in San Juan at the time of the Spanish-American War at the General Military Archives in Madrid resulted in the discovery of a vast collection of historic documents. Exactly at the time the centenary of the transfer of Puerto Rico from Spanish to American rule (1898–1998) was being celebrated, in an unprecedented event we suddenly found ourselves with a vast treasure of documents of incalculable historic value on our hands. Almost 4,000 boxes of uncatalogued documents on the Philippines, Cuba, and Puerto Rico were waiting to be researched. The National Park Service, along with the Office of the Official Historian of Puerto Rico and the Department of History at the University of Puerto Rico, immediately entered into conversations with the Institute of Military History and Culture at the Spanish Defense Ministry with a view to preparing an inventory of the recently discovered materials.

As a result of this first stage of the negotiations, a preliminary inventory of the documents was prepared by the National Park Service. In turn, this preliminary inventory paved the way for an agreement between the Puerto Rico House of Representatives, through the Office of the Official Historian, and the Institute of Military History and Culture in Spain, the first such international agreement between these institutions. In addition, a catalogue was later published, titled *Documentación de Puerto Rico en el Archivo General Militar de Madrid,* by the Spanish Ministry of Defense in 2002.

The importance of this discovery for Puerto Rican historiography lies in the richness of documentary information on unresolved aspects of the last years of Spanish rule which had remained in the wake of the Spanish-American War. The fortifications of the city of San Juan came to the fore during that conflict when, on May 12, 1898, they were bombarded by Admiral William Sampson's fleet.

This collaboration resulted in the transfer to Puerto Rico of these documentary resources on microfilm and CD-ROM formats, including almost 1,000 telegrams related to the Spanish-American War campaign, whose existence had been unknown; documents on the military and civil organization of the overseas province during the 19th century until the last days of Spanish colonial rule in 1898; as well as documents spanning the 16th to the 18th centuries which refer to the island. There is also an important cartographical collection of 590 maps and drawings that are extremely useful for the history of architecture and military engineering in Puerto Rico, particularly for the analysis of urban development in the city of San Juan.

The most significant blocks of information are those related to military campaigns in Puerto Rico, the internal structure of the Spanish military system on the island, the organization of the Army in Puerto Rico, the development of foreign relations and of those with neighboring provinces, and finally, the peace negotiations and the Spanish evacuation of Puerto Rico. The first stage of this project directed at rescuing this valuable documentary collection culminated successfully in the publication by the Spanish Ministry of Defense of the catalogue of the documentation related to Puerto Rico in the General Military Archive of Madrid (referred to above), along with an exhibition of some examples of the documentation.

The San Juan Walls project

A second phase has allowed us to design and prepare an exhibition based on these newly discovered resources and to use a selection of the documents, maps, drawings, and photographs for the enjoyment and reflection of community members and visitors at large. The exhibition reveals the military, economic, social, architectural, and cultural dimensions of the historic significance of the San Juan walls and Fort San Cristóbal, as guardian of the so-called War Zones. The area came to the fore in the city's growth beyond its walls and assisted at the birth of the Puerta de Tierra neighborhood that developed on the demolished remains of the old walls after an intense fifteen-year struggle between the residents and Spanish government authorities.

To conclude: it is of vital importance to keep in mind that, in the effort to rescue these structures, we should not lose sight of the fact that as part of the process we also have to rescue the history of the site. That history is to be found in documentation, which is the tool that will allow us to be most accurate in our rescue efforts in terms of interpretation, reuse, and management of American fortifications. Documentation is our most effective ally in protecting the authenticity of our heritage.

Critique of "Native Plant Gathering Along the Village Chain Routes of Yosemite Genealogical Family Use Districts"

David Andrews

[Editor's note: this critique was received by the GWS in June 2006. Gaskell et al. have not responded to an offer to issue a rejoinder.]

Regarding Sandra Gaskell et al.'s "Native Plant Gathering Along the Village Chain Routes of Yosemite Genealogical Family Use Districts," there is a misconception that the Southern Sierra Miwuks were the original Indians of Yosemite and the primary group of Chief Tenaya's band.

Lafayette H. Bunnell was the only person to meet and write about Chief Tenaya and his band, aside from a reporter embedded with the Mariposa Battalion. Both Bunnell and the reporter wrote that Tenaya's band was primarily made up of Mono Paiutes and not Miwuks. Not once is the name "Miwuk" mentioned in both of their accounts. There are many references in both accounts to the original Indians of Yosemite being Mono Paiutes.

There was a group that later became the Miwuks in the area, composed from a combination of different tribes. Unfortunately, members of this group were the ones who assisted James Savage, the man who captured Chief Tenaya. They were brought up from the valley to work for James Savage. Savage had made alliances with certain chiefs to have their people dig gold for him. They were the ones who coined the name "Yosemites" for Tenaya's band because they feared them. It is true that modern-day Miwuks are made up of different tribal groups, including Paiutes, but historical accounts show that the Miwuks were the ones who assisted James Savage, and were not the original band of Chief Tenaya.

It took Bunnell several years to write his memoirs; during that time A.L. Kroeber and other ethnologists had gone to Mariposa and spoken to Miwuks. They were the same Miwuks who worked for James Savage.

Also, Lancisco Wilson was Paiute and not Miwuk.

We Paiutes are interested in the true history of the Indians of Yosemite. We believe that history should be accurate, especially the history of Yosemite. Lafayette H. Bunnell documents the first contact between non-indigenous people and Natives (see reference below). It is the only book with the original accounts of Chief Tenaya's life.

References

Bunnell, Lafayette H. *The Discovery of the Yosemite, 1851, and the War that Led to that Event,* on downloadable PDF file. On-line at http://esnips.com/web/YosemiteIndiansWebResearch. To read the account without downloading the PDF, go to http://www.abovecalifornia.com/lib/Houghton/18.php.

Chief Tenaya, a short biography of the story of Chief Tenaya, with sources. on-line at http://en.wikipedia.org/wiki/Chief_Tenaya.

Early Chiefs and Captains of Yosemite. This website lists the original Chiefs and Captains of Yosemite. Lancisco Wilson, who is mentioned in Gaskell et al.'s paper, was a Paiute headsman, and is buried in Yosemite cemetery with a "Piute" grave marker. On-line at http://thehive.modbee.com/?q=node/153.

Hetch Hetchy, Our Beautiful Valley. This website has the earliest story of Hetch Hetchy and the Paiutes who roamed that area, with historical references. On-line at http://thehive.modbee.com/?q=node/180.

Russell, Carl P. *100 Years in Yosemite: The Story of a Great National Park*, Chapter III, "White Chief of the Foothills." The website referenced below describes the September 1852 death of James Savage and how the Miwuks and other reservation Indians cried over his death. This was a year before the death of Chief Tenaya, who was hiding amongst his brethren at Mono Lake during the time of Savage's death. On-line at www.yosemite.ca.us/library/one_hundred_years_in_yosemite/savage.html.

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