Introduction and Acknowledgments

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The theme of the 2009 George Wright Society Conference on Parks, Protected Areas, and Cultural Sites, "Rethinking Protected Areas in a Changing World," was reprised from the 2007 meeting. The Conference Committee felt it was appropriate to repeat the theme as a challenge to the community of park and resource professionals to assess the large-scale changes that are transforming the world. Climate change, shifting demographics, the erosion of biological diversity, the democratization of heritage, and the rise of civic engagement were just a few of the trends taken up at GWS2009. In addition, a large range of other topics were discussed, spanning the entire spectrum of natural and cultural resource disciplines and the social sciences. The conference was held in Portland, Oregon, March 2–6, and was the 15th in a series of conferences that date back to 1976.

A record crowd of 1,050 attendees made the week a busy and exciting one. There were many highlights during the meeting, but I would give pride of place to three. First, the opening plenary, which featured the screening of an excerpt spotlighting George Melendez Wright from the Ken Burns/Dayton Duncan film "America's Best Idea: The National Parks," presented by the filmmakers themselves. Their documentary subsequently aired on PBS in September 2009. The plenary session was made even more special by the presence of the extended family of Pamela Wright Lloyd, one of George Wright's two daughters. Second was the presence of Pam and her husband Jim Lloyd at a breakfast honoring the winners of the George Melendez Wright Minority Student Travel Scholarships. Third was the Native Film Night—another emotional and moving event where thought-provoking short films prompted many Native (and non-Native) attendees to share their ideas and experiences.

This proceedings volume contains more than 60 papers that are broadly representative of those presented at the conference. It is available in both paperback and as PDF files of individual papers downloadable from the GWS website.

The GWS is grateful to the many people who made GWS2009 possible. At the heart of the effort is the Conference Committee. Chaired by Stephanie Toothman, the other members were Brad Barr, Rebecca Conard, Rolf Diamant, Melia Lane-Kamahele, Abby Miller, Rebecca Stanfield McCown, John Waithaka, and Stephen Woodley. Equally important are our two principal organizational sponsors, both of whom have worked with us for many years: the National Park Service and the U.S. Geological Survey. We also welcomed HDR, Inc., as a conference supporter.

Beyond that, the GWS is grateful to the many individuals who helped make this conference happen. For securing vital funding for the conference, our thanks go to Bert Frost and John Dennis of the National Park Service, Sue Haseltine of the U.S. Geological Survey, and Bill Schenk of HDR, Inc. We thank all the people who organized the slate of field trips. We also express our appreciation to all the institutions and individuals who helped sponsor the George Melendez Wright Student Travel Scholarships and the Native Participant Travel Grants; here, we particularly thank Gillian Bowser and Sharon Franklet, respectively, for

their tireless efforts on behalf of these programs. Beyond this, many others provided assistance on various aspects of the conference—to all of them, we extend our sincere appreciation.

Last, but not least, a special thanks goes to Samantha Weber for her able editing of this volume.

The next conference will be held March 14–18, 2011, in New Orleans, Louisiana.

Geoparks: Creating a Vision for North America (panel discussion summary)

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Background

The Global Network of National Geoparks is a network of 56 parks in 18 countries, assisted by United Nations Educational, Scientific and Cultural Organization (UNESCO), that provides opportunities for geotourism, interprets geological heritage, assists local economies, supports research and understanding of geological processes, and connects people to the landscape. As defined by UNESCO, "A Geopark is an area with a geological heritage of significance, with a coherent and strong management structure and where a sustainable economic development strategy is in place … geological heritage and geological knowledge is shared with the broad public and linked with broader aspects of the natural and cultural environment, which are often closely related or determined to geology and landscape." In this session, a panel of international experts on geoheritage presented the geoparks concept and led a discussion of how and where geoparks may be applied within the North American community of protected areas.

Panelists

- Robert Missotten, Chief, Global Earth Observation Section, UNESCO, Paris; r.missotten@unesco.org
- Tim Badman, Special Advisor, World Heritage Programme on Protected Areas, International Union for Conservation of Nature (IUCN), Geneva; tim.badman@iucn.org
- Wesley Hill, International Secretariat, Geological Society of America, Boulder, Colo.; whill@geosociety.org
- Lindsay McClelland, National Park Service, Geologic Resources Division, Washington, D.C.; lindsay_mcclelland@nps.gov

This panel was organized by Suzette Kimball, Associate Director for Geology and International Programs, USGS, Reston, Va.

Summary of panel discussion

The session was attended by forty to fifty individuals, including representatives from the National Park Service (NPS) and other land managers. In the audience were Jonathan Putnam, Western Hemisphere Affairs and World Heritage, NPS, and John Dennis, Deputy Chief Scientist, NPS.

1. Welcome

In the absence of Suzette Kimball, Richard Calnan (USGS, rcalnan@usgs.gov) chaired the panel session. Rich welcomed all the attendees and extended a special thanks to the panelists for their participation. Rich provided an overview of UNESCO, and the history of U.S. cooperation with UNESCO, which included the USA rejoining UNESCO in 2003. He mentioned the UNESCO conservation efforts (World Heritage Program, World Network of Biosphere Reserves, and the Global Geoparks Network (GGN)). He then gave a brief overview on GGN, an initiative established in 2004 to provide an elevated global platform where geological heritage sites can cooperate. Currently, there are 56 national Geoparks in 18 countries: Australia, Austria, Brazil, China, Croatia, Czech Republic, France, Germany, Greece, Ireland, Italy, Iran, Malaysia, Norway, Portugal, Romania, Spain, and United Kingdom. It was pointed out that there are none in North America.

2. UNESCO Geoparks initiative

Robert Missotten (UNESCO) began his presentation with an overview of the World Heritage Program and Biosphere Reserves, which is under the Man and the Biosphere Programme (MAB). World Heritage sites and Biosphere Reserves are internationally recognized by UNESCO through a convention or a statutory framework. The World Heritage List currently lists 878 sites, with seven percent primarily geological/morphological in nature. There are 531 Biosphere Reserves in 105 countries. The Reserves serve as environmental research and monitoring sites. He stressed that the GGN is more of a bottom up approach than the top down approach of the World Heritage and the Man and the Biosphere initiatives.

The Network of National Geoparks has three components: conservation, sustainable development and tourism, and education. UNESCO's role in GGN is to provide a platform for regional and international cooperation, set standards, provide policy advice, and lend visibility, global recognition, and UNESCO's label of excellence. UNESCO serves in an advisory role. providing international experts to evaluate a geopark once a nomination is submitted. Geoparks are admitted to the GGN by decisions made at the International UNESCO Geopark Conference, held every two years. There are guidelines and criteria available for the creation of a Geopark (www.unesco.org/en/earth).

The cost associated with setting up a Geopark varies. The planning and application costs are different among countries because of the expertise available, the size of the project, and the partnerships involved. The cost of preparations for and running of a Geopark also varies, and can include evaluation costs, member participation costs in GGN activities and meetings ($7,500 to $15,000), site management costs handled by local organizers ($75,000 to $3.6 million), and revalidation (conducted every four years).

Visitor statistics are difficult to determine for Geoparks, but where statistics are available, it is noted that once parks become members of GGN, visitation has increased by as much as 25 percent. Robert ended his presentation by emphasizing the benefits of joining the GGN, including jurisdiction and participation at the local level; socio-economic stimulus to local economy; and improved awareness by decision makers, media, public, teachers, and young people about geologic heritage and conservation. Useful websites for information on geoparks include UNESCO (www.unesco.org/en/earth), and European Geoparks Network (www.europeangeoparks.org/).

3. The World Heritage Convention and geological heritage

Tim Badman, IUCN, presented an overview of the World Heritage Convention, which was established in 1972 and is among the most widely accepted international conservation treaties. The Convention provides for the protection of those cultural and natural sites deemed to be of outstanding universal value. As of 2008, there are 878 sites on the list: 679 are cultural, 174 are natural, and 25 are mixed. In North America, there are a total of 62 sites, of which 39 are cultural and 23 are natural. The Convention is governed by an elected Committee of 21-nations that reviews nominations (made by member countries) to the World Heritage List, and designates World Heritage Sites. The USA and Canada are currently on the Committee; their terms end in 2009.

To be on the World Heritage List, sites must be of outstanding universal value and meet at least one of ten selection criteria. There are two sets of criteria that the Committee applies: one set for cultural sites and another set for natural sites. The Earth Science Criterion (viii) recognizes places that are: "outstanding examples representing major stages of earth's history, including record of life, significant ongoing geological processes in the development of landforms, or significant geomorphic or physiographic features." The World Heritage List has 74 properties that have been inscribed under this criterion with a primary value for Earth Science. A framework for the application of the Earth Science Criterion has been established under the following 13 themes: tectonic and structural features; volcanoes/volcanic systems; mountain systems; stratigraphic sites; fossil sites; fluvial/lacustrine and deltaic systems; caves and karst systems; coastal systems; reefs, atolls and oceanic islands; glaciers and ice caps; ice ages; arid and semi-arid desert systems; and meteorite impact sites.

Tim stressed that local involvement in the nomination process is critical. Alternative mechanisms to complement World Heritage listings are necessary. The Convention is highly selective and can only recognize a limited number of the most important global sites that are of outstanding universal value ("the best of the best"). Geoparks should be seen as a viable and effective mechanism to complement World Heritage listings and to recognize internationally important sites. There needs to be clarity regarding the Geoparks concept, and the expected standards of both values and management in UNESCO Geoparks. Also, regional networks are needed to complement the arrangements in Europe and China and to ensure a greater geographical spread of Geoparks. Full local community involvement in Geoparks is encouraged and resources for coordination of Geoparks are an issue. He concluded by stating the Geoparks initiative is still in its early days and experience is being gained in the concept and IUCN is fully supportive of its continued development.

4. GSA perspective on UNESCO Geoparks initiative

Wesley Hill, of Geological Society of America (GSA), began with a presentation of the GSA mission and vision. GSA is interested in three components of Geoparks: conservation of our most significant geological features and sites, education of visiting public and research, and geotourism to increase public interest in our geoheritage. Geoparks provide an international structure to link designated national geoheritage sites around the world under a common global umbrella. By participating in Geoparks, the U.S. designated sites would be brought into the established family of global Geoparks. This could provide increased opportunities for networking with site managers from around the world and provide global recognition and prestige for the Geopark site. The benefits of Geoparks site include opportunities to highlight geoscience research and information to local residents, policy makers, media representatives, and local schools; wider recognition and a higher profile of the site; public education spotlight on geoscience topics including volcanoes, earthquakes, tectonics, minerals, caves, and paleontology; and promotion of the site's geological heritage and its role in the history of the local area. Geoparks provides opportunities to increase geotourism in the area exposing the public to a wide range of geoscience topics.

The International Union of Geological Sciences (IUGS) partners with UNESCO on geological initiatives and is a supporter of Geoparks. IUGS is one of the largest scientific organizations in the world, and has approximately 120 member countries.

The role of UNESCO in Geoparks: UNESCO provides only endorsement, and has no control over any Geoparks. Ownership lies at all times with the host nation and with the host authorities. UNESCO's role can be best described as a type of quality branding.

The GSA, which is a member of the scientific geologic community, is interested in partnering with land managers, scientists, the tourism industry, and educators to see increased public exposure to and education in the geosciences through the Geoparks initiative. However, GSA cannot go about this alone and needs your support to help develop the program in the U.S. To start the program in the U.S., the following is needed: feedback from the field, approval of U.S. Geoparks, development of a U.S. Geoparks working group, development of U.S. guidelines from the existing UNESCO Global guidelines, announcement and marketing of the program to potential sites, and development of the application process.

Wesley also mentioned that GSA is currently assisting with the GeoCorps Program. GSA, through the GeoCorps program, strives to increase the number of geoscientists on-the-ground, assisting with public land management and protection of geologic resources. GSA's possible roles in Geoparks would be, with organizational funding support, to provide assistance in developing a U.S. Geoparks program strategy; as a non-governmental organization, to help organize and participate in a U.S. Geoparks working group committee (made up of land management agencies, tourism industry, geoscientists, educators, etc.); to provide assistance managing the Geoparks application process; and potentially to provide support from GSA member geologists.

5. Geoparks and the National Park Service

Lindsay McClelland, of the NPS, presented the NPS perspective on Geoparks. The NPS is currently assessing its participation in a U.S. Geoparks program. The agency is coordinating the effort through its Geologic Resources Division and Office of International Affairs. Briefings have taken place at the Associate Director's level, and the NPS is working with the Geological Society of America (GSA) and the USGS. NPS managers have expressed concerns about Geoparks, including the need for Geoparks if NPS is already participating in the World Heritage Program; the amount of work, including administrative burden required for the process; public opinion; actual benefits of Geoparks designation; and demonstration of socio-economic impacts, such as increased visitation.

Most of the World Heritage Sites in the USA are icon parks that are well known to the public, and have high visitation. The sites generally either include the entire park, or are contained within the park. Examples include Yellowstone, Everglades, Grand Canyon, Hawaii Volcanoes, and Great Smoky Mountains. Potential U.S. World Heritage nominations, for as long as the next decade, will be taken from the 2008 tentative list, which contains mostly cultural sites, but also includes two geology-focused parks (White Sands and Petrified Forest), and the Papahanaumokuakea Marine National Monument.

There may be opportunities where a Geopark can complement a World Heritage Site. For instance, currently many sites with great geologic significance are larger than a single park. The NPS may manage only a small part of the geologically significant area, and other multiple-use agencies, such as the Bureau of Land Management (BLM) and U.S. Forest Service (USFS), manage much of the remaining geologic area. The World Heritage Convention has strict protection standards that are a poor fit for multiple-use agencies. The Geoparks concept is a better fit for sites with multiple landowners and managers it will accept certain economic uses, and it does not require demonstration of global significance.

The next steps for the NPS: work with GSA to draft U.S. Geoparks criteria; assess park interest based on draft criteria; seek information on Geoparks program benefits from other nations; coordinate with other agencies (USGS, BLM, USFS); clarify the role of GSA and the geologic community; brief NPS Directorate and Interior Department officials; seek interest and support from other organizations, such as the Association of American State Geologists; and prepare a multiagency proposal for the U.S. National Commission on UNESCO and the State Department's International organizations bureau.

New National Parks for the Next Century

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What could a structure on 0.02 acres in downtown Philadelphia have in common with 13.4 million acres of wilderness in Alaska? The Thaddeus Kusciuszko National Memorial and Wrangell–St. Elias National Park and Preserve reflect the extremes of size and resource types in the national park system. Although these disparate sites are managed by the same agency, they seem to have little else in common beyond being listed in the National Parks Index.

In 1978 Congress declared that the areas managed by the National Park Service (NPS): "though distinct in character, are united through their inter-related purposes and resources into one National Park System as cumulative expressions of a single national heritage"(Dilsaver 1994, 374). With such an ambitious vision, we could hope that some logical scientific and scholarly framework and process guides the growth of the system. In fact, the growth of the system has been characterized more by sporadic responses to opportunities than by any organized planning.

In 1936 the advisory board on national parks buildings and monuments suggested that the key consideration in selecting new parks is that they should be "outstanding examples of their respective classes" (NPS 2005, 104). This standard of seeking the best examples of each resource type was reflected in the 1972 National Park System Plan, the only document prepared by the National Park Service with such a title. This "system plan" provided a framework of boxes to be filled like a bingo card to get a full set of what some scientists and scholars considered at that time to be the sites that characterize the national heritage. However, the plan did not articulate a clear vision of what the system should accomplish or any sense of priorities for what might be most important to achieve some goals.

Envisioning the future shape of the national park system usually has expansionist overtones, but there have been cycles of proposals to shrink that system. For example, in 1954 the national park system advisory board considered proposals by the Department of the Interior to make certain areas of the system available for administration by state or local governments, suggesting 13 candidates. In 1981 Secretary James Watt made a similar request for the advisory board to investigate the potential divestiture of parks. In 1978 Congress directed the National Park Service to submit an annual list of not less than 12 candidates for addition to the system, providing an opening for the "park a month club" tag line. In the 1990s Congress considered another swing from expansion to contraction in the form of legislation that would remove units from the national park system using the model applied to military base closures. Instead of the base closure model, Congress withdrew NPS authority to study new parks without specific authorization and abandoned any interest in developing a system plan.

As the National Park Service approaches its 100th anniversary, what might be ahead for the next century? The National Parks Second Century Commission, an independent group of distinguished scholars, scientists, and former legislators, has been asking this question and suggesting that the national park system should evolve with some thoughtful design. The commission's report is scheduled for release in the fall of 2009, and the summary below outlines some preliminary ideas about how to approach defining the future shape of the system. Many of these ideas were reflected in discussions during sessions at the George Wright Society Conference in March 2009.

Ideally a first step in designing a system would be to have a vision, and in the last 20 or 30 years very few individuals or organizations have even attempted to articulate one for our collection of national parks.

The second century commission's committee on future shape has envisioned a system that works effectively for everyone: plants, animals, our ancestors, and generations to come. One key part of a vision for the future system of national parks is that it should contribute to the preservation of biological diversity. This presents enormous challenges since the areas managed by the National Park Service comprise about 1.5% of the land in the lower 48 states. Preserving biological diversity or even helping to reduce the rate of loss is a global issue beyond the reach of any one agency, especially one that lacks jurisdiction over 98.5% of the nation's landscape.

Most of the 243 units of the national park collection containing natural resources were selected for their spectacular scenery, rather than biological productivity or diversity. As a result, the national parks have been characterized as high and icy, with low productivity soils (Svancara and Scott 2007). The national wildlife refuge system is characterized by being low, wet, and populated by ducks. Even a substantially expanded national park system is not likely to succeed in preserving biological diversity, but in combination with lands managed by others it might be a start. For example, the Land Trust Alliance reports that about 39 million acres, an area almost as large as the national park system in the lower 48 states, are being protected by conservation easements held by private organizations. With a mission to "conserve, protect and restore nationally significant landscapes recognized for their cultural, ecological and scientific values for the American public," the national landscape conservation system under the Bureau of Land Management encompasses approximately 27 million acres that also might be an important part of the larger picture. Add almost 30 million acres of designated wilderness managed by the Forest Service, and the scope of protected areas takes on a new dimension.

A somewhat less ambitious vision might be for a collection of national parks that have their ecological integrity intact. This commendable goal quickly confronts the challenge of addressing a vast array of threats to ecological integrity that originate in whole or in part on lands beyond park boundaries. For example, only five of the national park units in the lower 48 states encompass enough land to perpetuate a viable population of large mammals. Even with 2.2 million acres, Yellowstone is a small fraction of the larger ecosystem that by some estimates encompasses 18 or 20 million acres (Greater Yellowstone Coalition). Protecting the natural processes and the historic settings of our national parklands requires engaging a host of other federal agencies with sometimes conflicting missions, as well as private landowners who are not always motivated by a concern for our national heritage.

Discussions about the role of national parks for the next century often call for a new vision, but the cultural resources programs of the National Park Service offer an established model that might help chart a course for the future of natural resource protection. The

National Historic Preservation Act of 1966 (NHPA) assigns responsibility for leadership in historic preservation to the Secretary of the Interior and provides a suite of tools to encourage other agencies and the private sector in achieving its goals. Recognizing that preservation of historic properties is beyond the capability of any one agency, the NHPA is designed to enlist a wide range of partners in protecting the nation's cultural resources. On the other hand, several different agencies and organizations can claim leadership responsibility for the protection of natural resources, biological diversity, and ecological vitality: Fish and Wildlife Service, Forest Service, Natural Resources Conservation Service, and The Nature Conservancy, for example.

Three concepts to help shape a national park system for the next century include:

1. A new national network. Although they may reflect the "best idea America ever had" the national parks should be recognized as a relatively small but critical part of a national network of protected areas managed by other agencies, state and local governments, and the private sector. The success of this network relies substantially on local citizens to make informed decisions about what they value and want to protect. NPS, or another entity like The Nature Conservancy, could become the catalyst and convener of regional and national efforts to conserve biological diversity and cultural heritage, recognizing the need for many agencies and organizations to be part of this work. Some of the key players in this larger system include the national wildlife refuge system, and the national landscape conservation system managed by BLM, and national monuments, wilderness areas, and national recreation areas managed by the Forest Service, wild and scenic rivers and trails that connect these areas, state parks, and land trusts. Identifying, managing, and evaluating the effectiveness of a protected area network would be a step toward following the spirit of the Convention on Biological Diversity (www.cbd.int), adopted by every country in the world except the United States and the Vatican.

"Our vision for the 21st century is an interconnected network of open space across the landscape that supports healthy ecosystems and a high quality of life for Americans. Fully realized, this network will include … public land, riparian areas and wildlife corridors, and urban green spaces. Private and public open spaces will complement each other across the landscape to provide ecosystem services, wildlife habitat, recreation opportunities, and sustainable products." This captures a clear vision for the future, but it did not come from the National Park Service. It appears in an open space strategy adopted by the Forest Service (USFS 2007, 4).

2. A new national park system plan. The National Park Service could be directed by Congress or the President to develop a system plan that defines its place in this larger network. This system plan for national parks would identify priorities for the type of areas that should be managed by the National Park Service to serve as models for a stewardship ethic. For natural resources, the system plan would recognize the importance of representation, resiliency, and redundancy, but look beyond NPS "units" to consider how other lands contribute to an effective system. For cultural resources emphasis would be placed on recognizing and protecting sites that tell stories that will promote civic engagement, highlight the diversity of the American experience, and inspire new generations. A real system plan could also highlight the opportunities to consider sites that reflect a combination of natural and cultural resource values rather than separate them into distinct categories.

This system plan should reflect the strong public interest and congressional support for National Heritage Areas, where NPS is a partner and catalyst rather than a land manager. Pursuing a goal of spreading the national park ethic suggests a much broader view of the National Park "System." The public and their elected representatives have expressed their strong support for NPS as a partner by authorizing 40 National Heritage Areas since 1983, and authorizing 9 more in the most recent Omnibus Public Lands Act. Nevertheless the Heritage Areas have been treated as an additional burden rather than embraced as part of the core mission of the National Park Service.

The idea of promoting a stewardship ethic, including reverence for the earth, may seem radical when so much attention and energy in NPS is focused on operational shortfalls and facility maintenance backlogs. Perhaps a goal for the system could be: "to assist in the development and application of an environmental stewardship ethic for our society, based on ecological principles, scientific knowledge … and a sense of moral responsibility." This goal may seem new and ambitious for NPS, but the words come from the U.S. Fish and Wildlife Service's manual (USFWS 1998, part D).

3. New strategies to protect parks as part of sustainable communities. A recent study on the state of the parks by the National Parks Conservation Association (NPCA) found that adjacent land development represents a significant threat to natural resources in 89 percent of the parks assessed, and development beyond park boundaries also threatens the integrity of cultural resources (NPCA 2008). Park boundaries cannot expand indefinitely, and NPS needs to enlist the cooperation of its neighbors to help assure that resources are unimpaired for the benefit of future generations. Congress could authorize NPS to apply a suite of tools and incentives around national parks to help perpetuate sustainable communities and the integrity of landscapes. These could include tax incentives for conservation of natural areas, parallel to those that encourage preservation of historic resources. Technical assistance, grants, and authority to acquire conservation easements are other tools to be applied. This suite of tools could be similar to the national heritage area designation, but available around each unit of the national park system. Legislation or executive orders also could require consultation and consistency for actions by other Federal agency undertakings, permits, grants, and licenses. Section 106 of the Historic Preservation Act, and the Coastal Zone Management Act offer examples of consultation and consistency requirements that could help protect parks. The Advisory Council on Historic Preservation could serve as a model of an institution that would help resolve conflicts over projects, licenses and permits that might damage park resources.

These and other ideas being considered by the National Parks Second Century Commission will have a wide variety of implications for the organization, funding, and management capacity of the National Park Service. Several previous evaluations of the National Park Service and system have produced recommendations that languished with the changes of administrations. The current commission includes several distinguished former legislators and other members who are committed to seeing action on their recommendations. Many of those recommendations can be expected to reiterate a vision expressed by the national park system advisory board's 2001 report on "Rethinking the National Parks for the 21st Century": that by caring for the parks and conveying the park ethic we care for ourselves and act on behalf of the future. The larger purpose of this mission is to build a citizenry that is committed to conserving its heritage and its home on earth.

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Preparing the Next Generation of Protected Area Managers and Researchers: A Panel Discussion on the 2008 ParkBreak Program (panel discussion summary)

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Background

In 2016, the National Park Service (NPS) will celebrate its 100-year anniversary. In preparation, the agency and its partners have stepped up efforts to be world leaders in natural and cultural resource stewardship by engaging the next generation of park managers and natural resource management scientists through the Centennial Initiative.[1] Over the next 100 years, continuous challenges, both predicted and unknown, will drive the operation of the NPS and other land management agencies. For example, shifting demographics, and population migrations closer to NPS units will create new target audiences. Advances in technology, and trends in youth activity levels will require adaptation of education and outreach methods. Climate change will continue to pose challenges for resource managers, and in some cases necessitate development of new management strategies. Future NPS employees may contend with increased visitation pressure, and the dilemma of how to balance use and preservation. Collaborative management will become more important to ensure the public is engaged in the decision making process, thus adding relevancy to the NPS. Additionally, within the coming decade, a large turnover of NPS employees will create a need to fill many vacant positions with the next generation of conservation-minded stewards.

This new cohort of scientists will be required to promote the same tenets developed by previous NPS employees, such as appreciation of nature, preservation of history, and pride in places of national significance. However, the new cohort must also develop innovative methods of sharing the conservation ethic in light of the challenges mentioned above, namely shifting demographics and competition with the numerous avocations available to today‘s public. By attracting young, bright, and diverse conservation professionals, the NPS will continue to share its mission and proceed towards its goals, while gaining the unique perspectives of a youthful generation that may better engage the current public.

For the sake of successional planning, the NPS, United States Geological Survey (USGS), George Wright Society, Texas A&M University, and the Student Conservation Association sponsored and organized the inaugural Park Break program, which took place in March 2008. Park Break manifested as a week-long series of theme-based seminars designed to expose graduate students to critical land management issues in a field setting, connect students with conservation leaders, and exchange perspectives on the future of park and protected area management. This undertaking introduced small groups of graduate students to pertinent issues faced by protected area managers, thereby contributing to their professional development. Selected through a competitive application process, students attended one of four sessions associated with a relevant theme. Acadia National Park hosted seven students to discuss the role of civic engagement in protected area management. Delaware Water Gap National Recreation Area hosted eight students to discuss the tenants of conservation policy. Gateway National Recreation Area hosted six students to interface challenges of global climate change with protected area management. Indiana Dunes National Lakeshore hosted eight students to explore opportunities and drawbacks to management in the wildland-urban interface. This unique experience gave graduate students an insider look at the issues facing the NPS, and provided them with the opportunity to interact with park managers in an intimate setting.

During the 2009 George Wright Society meeting, approximately one year after completing the 2008 Park Break program, interested students organized a panel discussion to provide program organizers with feedback, recruit potential students, communicate with future park hosts, and share students' perspectives on program effectiveness. This paper outlines impacts of Park Break 2008, summarizes the participants' suggestions on how the program could improve, and offers several insights into how land management agencies and professionals can effectively bring the new generation of scholars and professionals into the fold of natural and cultural resource management.

Impacts of the program

The 2008 Park Break program was a resounding success. Statements about the uniqueness of the opportunity recurred throughout the discussion. Panel participants greatly appreciated being engaged in a forum to share their perspectives on the Park Break program. Many emphasized the effectiveness of place-based learning to better understand the issues faced by the NPS. During Park Break, students conversed with resource managers about case studies related to their Park Break theme that personified the challenges at each park. The student participants served as a focus group to explore varying issues and perspectives. This technique was engaging because it encouraged them to share individual insights on how parks could potentially solve specific challenges. An overall theme within all Park Break sessions was consideration of how parks and protected areas will remain relevant for the next generation. Reflecting on how to grapple with the challenges of resource management, one student said, "We saw how the idea of conservation was manifested at a particular park and learned how managers apply the theories we've learned about in classroom settings."

One of the main goals of the panel discussion was to recruit potential park hosts and share this opportunity with other students at the George Wright Society meeting. Several park superintendents and staff expressed interest in hosting Park Break students in the future. Employees and collaborators from 2008 Park Break sessions also attended the panel discussion to share their insights into the program. A number of audience members were

2009 Park Break fellows and hosts, held the following weeks at the Delaware Water Gap, North Coast and Cascade Network parks, and Great Sand Dunes National Park and Preserve.

Panelists reflected on the atmosphere surrounding the Park Break experience. The host park managers were enthusiastic about students selecting their protected area as a destination for spring break, as such, providing a welcoming environment and excellent accommodations. The student participants felt respected and engaged by the park employees. One student joked, "We were treated like royalty at these parks; normally as graduate students we're on the low end of the totem pole." At Delaware Water Gap for example, the superintendent and assistant superintendent attended the majority of the session, sending a clear message to their park staff that the perspectives of the Park Break participants were important to consider. At Indiana Dunes, staff from both the NPS and USGS trickled in and out of the presentations all week. Each day, more and more employees showed up to listen to the discussions as word spread about the Park Break program. At Acadia, the chief of resource management attended all sessions and facilitated a wealth of speakers from many of Acadia's active partners, both governmental and non-governmental to demonstrate and discuss the importance of civic engagement in the success of Acadia.

The panelists also discussed the procedural aspects of the program such as the preparation material. Students felt sufficiently prepared, because a priori they were provided with seminal pieces of literature selected by the host parks to ensure that they would have a basic understanding of each area. This material taught students about key points in history that have influenced how conservation evolved, exposed them to the natural history that serves as a backdrop for addressing conservation, and covered the major challenges facing parks today. Their discussions ranged from small-scale topics, such as invasive species management, to bigger-picture issues, such as integrating social and ecological goals in NPS decision-making.

For some participants, Park Break significantly influenced and shaped their graduate research. For one of the students, it demonstrated a new avenue of research that she could pursue. As a student previously trained in the biophysical sciences, she was removed from the realm of social science research, yet always had a desire to work in outreach and extension. By the week's end, she learned that civic engagement is legitimate scientific research. Her experience at Park Break shifted the focus of her dissertation research to the theme of how civic engagement techniques could be used to better achieve conservation goals.

Park Break served as an important networking opportunity, as students connected with other professionals they may continue to interact with throughout their careers. One student in particular, took advantage of this opportunity to secure a summer position working with Acadia National Park on visitor use issues. After lengthy conversations with park staff, the experience also provided the student with a dissertation topic. The connections students made with the broad swath of speakers at each respective Park Break site will be invaluable to propel them forward in their future careers. In an interview with a local newspaper that reported on the Park Break session at the Delaware Water Gap, one student emphasized the importance of networking with the variety of speakers and panelists, as well as the bright group of graduate student participants.[2]

The Park Break program exemplified the need for collaborations as an integral part of effective park management. For example, the Indiana Dunes Park Break session had eight students from eight different universities spanning California, Missouri, Texas, North Carolina, South Carolina, Florida, Vermont, and Michigan. Programs of study varied just as greatly, with roughly half the students holding strong training and experience in the social sciences, and half with a background in the biophysical sciences. Stated as a major gain of the program, the opportunity to work collaboratively with such a diversity of students is uncommon in many degree programs today. Students were able to foster these relationships by working together on student-led papers to be published in a special edition of *The George Wright Forum* or a similar outlet. Student participants have communicated by email and phone to develop and combine their ideas into critical thoughts for publication. Thus, the networking among Park Break students will greatly contribute to their future careers, as well as future management of parks and protected areas.

Potential areas of improvement

While the 2008 Park Break Program was highly successful in its objective to expose graduate student to the challenges faced by resource managers, there were several areas in need of improvement as identified by the panelists. First, no active recruitment took place at the parks despite the existence of multiple programs such as the Student Temporary Employment Program (STEP), the Student Career Experience Program (SCEP), and similar initiatives designed to help students transition from academia into professional careers. Students should also be aware of funding opportunities such as the Canon Scholarship or similar efforts that may be developed in its absence. Along a similar vein, discussions about how students' research interests align with different branches of the NPS could help to bring in 'green blood' and encourage students to envision how they can contribute to particular aspects of NPS management. Engaging students in conversations about these resources and teaching them about the stepping stones that are currently in place, will ensure that the new generation of young scholars are prepared to move into resource management positions in the future. Panelists also stated that it is essential for the students attending Park Break to get as much time engaged with the resource as possible. The program at Acadia was primarily held inside and there was very little time to get out into the park, mainly due to the rough winter weather on the coast of Maine. When considering future Park Break sites, location should be strongly taken into consideration to maximize time students can interact with the resource. Student participants also identified the potential benefits in diversifying the Park Break program to include cultural and historical units within the NPS.

Conclusion

As student participants of the 2008 Park Break program, it is our hope that Park Break may continue into the future. Improving our understanding of management challenges and agency operations, and developing skills in collaborative thinking are critical to our growth as students interested in park and protected area management. We, the student participants, appreciate the effort required to facilitate this program and hope that similar experiences will be available to help us, and our colleagues, become better conservation professionals. Additionally, we feel that managers and scientists involved at host NPS units would benefit from the Park Break program through the fresh perspectives and enthusiasm offered by each group. A comment from a participating scientist at Acadia stated the discussions were "beneficial for the professionals who volunteered their time to participate. I think it was fantastic that the students were highly engaged in their work. Their questions showed their high knowledge base. So it was a great discussion because it gave the students direct access to the professionals (in the trenches)." Agencies involved with the Park Break program stand to gain from recruiting students interested in careers in land management, and by passing along their knowledge, thus better preparing the students for the complex challenges land management can pose.

In the forthcoming 100 years, changing social, political, and physical climates will require the best and brightest of the next generation entering the workforce. With recruitment and development programs like Park Break in operation, the NPS and other land management agencies will be able to actively prepare incoming employees to best serve their respective missions and recruit students who may otherwise be unaware of the opportunities that exist in participating agencies. The purpose of this panel discussion was to highlight the successes of the 2008 Park Break program thereby encouraging managers, GWS board members, and students to become involved and offer support. By outlining how Park Break can and will benefit managers into the future, we hope to have shown the importance of the program's persistence and perhaps encouraged the birth of similar programs.

Endnotes

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Modernization of "Multiple-Use": A Forest Resource Protection Concept for Bosnia and Herzegovina

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Introduction

After an assessment of certain forested landscapes in Bosnia and Herzegovina, the importance of understanding both the bio-physical environment along with forest use and settlement are factors that influence policies for protected area management. Historical legacies of human uses and settlement must be factors to influence how protected areas are managed today, especially in regions of conflict with complex histories. A new model is needed to bridge the gap between protection in isolation from history and human use in a modern world. The modernization of multiple use can be a new approach to providing policy support to economic development and resource protection in present day Bosnia and Herzegovina (BiH).

Current status of land and people in BiH

Bosnia and Herzegovina today is a relatively new (1992) developing country with a 12,000 year history in southeast Europe. BiH is regionally located in the Balkans and in the former Yugoslavia during the period of 1918 to 1991. It lies in a region of historical conflicts and this history influences its land use policies and economy to this day.

BiH is about the size of West Virginia, (5.1 million hectares). Only about 20% of BiH is considered to be arable land, while 80% is classified as mountainous, karst, steep topography and forested landscapes. Dennison, in a review of the current Bosnian Forest and Wood Sector in 2006, estimates that 50% of BiH is covered by forests, and 80% of that forest is considered to be publically owned (2.1 million hectares). Dennison estimates the forests are (and have traditionally been) managed almost exclusively for timber production and only 6% of all forests are not classified as production forests.

Current population is 4.5 million people, with a growth rate of 1.003% (very low). Birth rates are at 8.8 births per thousand, about average for Europe, but low for developing countries. Estimates are that 1 in 5 of the people lives below the poverty line. The unemployment rate estimated in 2007 is 45%, with the "grey" economy probably reducing that amount to 25–30%. Dennison estimates that 15% of the population (500,000 people) now depends directly on the forest and wood sector for jobs.

No explanation of demographics can be given without some understanding of the complex ethnic population, religious, and language differences. The three major ethnic populations are Bosniaks (48%), Serb (37.1%), and Croat (14.3%). The three major religious groups are: Muslim (40%), Orthodox Christian (31%), and Roman Catholic (15%). The remaining 14% are a multitude of other religious beliefs. Following this tripartite delineation are three languages: Bosnian, Serbian and Croatian.

History and the wars of Yugoslavian succession

Ethnic differences can be partially explained through the rich and complex history of the Balkans. Beginning in prehistory at one time or another, the Illyrians, Greeks, Romans, Slavs, Ottomans, Austrian Hungarians (Hapsburgs), Italians, Nazi Germany, Stalin, and Marshal Tito and his people's republic of Yugoslavia, all tried to rule this harsh land and independent people.

From these complex historical contingencies, a new nation of Bosnia and Herzegovina evolved from the remnants ("rump") of Yugoslavia in 1992. In 1992, ancient conflicts resulted in a confusing modern war. The conflicts were between: Croatia and Serbia, Croatia and Bosnia, and between Bosnia and Serbia. Each had their own reason for fighting. The United Nations had a nebulous "peacekeeping" role, and the European Union wasn't sure if it wanted to be involved. The United States belatedly took the lead in negotiating an awkward peace: The Bosnian Dayton Peace Agreement in 1995. Until the Dayton Peace Agreement, the people and the resources suffered greatly.

The resulting post-Dayton federal government structure is defined as a joint, multi-ethnic and democratic government charged with conducting foreign, diplomatic and fiscal policy. The centralized national structure is characterized by a three member presidency (Bosniak, Croat, and Serb), and each is elected by popular vote for a four year term. The chairmanship of the presidency rotates among the three every eight months. Currently, 2500 joint European Union forces (EUFOR) remain.

A second tier of government below the high federal is comprised of two entities, roughly equal in size: The Bosniak/Croat Federation of Bosnia and Herzegovina (FBIH) and the Republika Serpska (RS), composed of Bosnian Serbs. The entity level, roughly equivalent to "states", is responsible for most of the day to day government activities and social services. Resource management is the responsibility of the entities.

Assessment of forested resources in 2007: A BiH case study

As a component of United States Agency for International Development (USAID) support to the national government of Bosnia and Herzegovina, I contracted through the implementer of the program (Emerging Markets) in September of 2007 to assess a select group of forested recreation sites and the Sutjeska National Park and make recommendations for management in the context of tourism development.

The assessment built on the *integration* of environmental values, social conditions and economic opportunities (tourism) to create meaningful on the ground strategies for improving the studied areas.

Two approaches based on recent science were developed and applied to the subject areas. First, a general assessment was made of the basic ecological integrity of the areas (absent a definitive inventory and interdisciplinary review of literature for the area). The technique for this assessment is a based on a broad scale assessment of forests throughout Europe (Puhe and Ulrich 2000).

Secondly, current government management efforts to protect forest wildland natural values were assessed based on a general model of management to provide for sustainable tourism. This general approach is modified from a methodology for developing sustainable tourism, developed by Eagles, McCool and Haines (Eagles et al. 2002).

The final study assessed current ecological status and management policies using the set of developed criteria, applied the criteria to each area (by observational and interview techniques) and then evaluated and observed the existing situation. From both the ecological and management assessments, current status is evaluated, risks to meetings goals is assessed, and opportunities for improving policies and management are provided as recommendations.

Results of the assessment of Bosnia and Herzegovina forested landscapes

Major findings focused on major institutional structural weakness in strategic planning, resource management objectives and budgeting. In addition, confusing categories of resource protection zones in the protected areas (built upon on modifications of IUCN classifications) left on the ground management in disarray in the case of the prototype area (Sutjeska National Park) of the study. Sutjeska was declared a National Park in 1962 by Tito, primarily as the location for one of his major World War II battles and to maintain one of his many hunting lodges. Sutjeska is 10,595 hectares, (26,180 acres) and sits on the border between BiH and the new nation of Montenegro.

The main conclusions of the assessment recommendations were directed towards institutionalizing by government action new policies of sustained, continued traditional use, with a strong component of protected area management. The standards for forest stewardship and sustainability must be elevated.

Effectiveness of existing protected area management was also a major concern. Within the Sutjeska National Park is a relict beech-spruce forest that represents what a significant part of the forested landscape in Europe may have looked like before modern human disturbance. This area is called the Perucica Forest Primeval, and represents one of the largest tracts of "virgin" forest left in Europe. The approximately 1434 hectare forest sits in a hard to access high mountain valley. It sits adjacent to Maglic, the highest mountain in BiH at 2386 meters.

Sutjeska is delineated into five management zones which vaguely relate to protection and direct forest management. One of these zones is the Perucica Primeval forest. It is delineated on paper as a strict protection area, and probably is similar to the category III (National Monument) of the International Union for Conservation of Nature (IUCN) classifications. It deserves a strict management classification, and tight restrictive management to protect its unique values. For example, forest extraction was not allowed, but hunting and livestock grazing are allowed.

The Perucica appears as an area with high ecological integrity and biodiversity, and management standards should strive to maintain these conditions. The surrounding lands, still labeled as national park, are different. Forest extraction is allowed for example, in these buffer areas. In some of these lands, sustainable use could continue if the focus is on protection of the Perucica. It would make sense to manage the surrounding areas for ecological integrity and the biodiversity of the Perucica, rather than just the illusion of "naturalness."

The reality for on the ground management is none of the Sutjeska Management zones were actually being managed as a national park per any of the IUCN classifications. The title of national park was a title in name only for 92% of the entire national park. Only the 8% of the area within the Strict Nature Reserve Perucica Primeval Forest designation could nominally be considered to be almost managed as a National Park protected landscape, although a tangible plan for management actions did not appear to exist.

The modernization of multiple use

So what type of land use policies could be used to protect rare and irreplaceable values, be supported by local people, and be supported by higher level government institutions?

The existing BiH approach with its legacy of utilitarian multiple use lacks implementable characteristics. It lacks governmental budgetary and agency support to protect specific lands. It lacks economic development certainty which in turn generates political resistance to protection of forest resources as compared to "open use of the commons." It lacks standards for sustainability, and base level practices that manage for ecological integrity. Current unplanned multiple use is business as usual, and does not adequately plan for protection of unique resources.

To make on the ground management effective, a broader array of protection and use needs to be developed. These broader categories can take into account the historical uses of the forests, along with the needs to protect the unique Perucica. For example, the IUCN category VI areas (74% of the forested area) could be supported by a consensus based plan that assures sustainable forest management and protection of unique values, like the Perucica. Development of this plan should be general enough to assure continued utilitarian use (to get support of local communities), but specific enough to have standards of sustainable forestry, that provides for bio-diversity, protection of watershed and soils. The trick to this would be to get a consensus of the local communities (which represents forest products industries), and international park stakeholders and the international scientific community.

The new paradigm

Adrian Phillips, a British expert in protected areas, has proposed a new paradigm for protected areas in the 21st century, and expands upon the logic of practitioners that has evolved over the last 30 years. He proposes a variety of criteria that reflect changes in thinking for protected areas that provides for more human use, and understanding of the historical role of indigenous people. His approach liberalizes the spectrum of the IUCN classes, more in the category VI areas. His new paradigm articulates clearly what is needed for BiH protected landscapes, and is reinforced by the complex history of the long used forested landscapes. In areas with a long history of use and subsistence, the difference between protection and use should be narrowed, not expanded, and not separated by illusions of what may or may not be "natural" conditions.

Conclusion: Current geopolitical contingencies

Bosnia and Herzegovina is planning for the future. International pressure is focused on protecting unique areas that they have now, and internal pressures is to take care of economic development. A critical part of the potential future success in Bosnia and Herzegovina will be to develop policies that take into account their complex histories, the complex demands of their multi-ethnic cultures, and using their emerging democratic institutions develop plans that work for them. A modernized concept of use should provide that difficult balance between human use and protection of irreplaceable values. The modernization end game is to join the European Union (EU), and realize economic development opportunities EU acceptance would generate.

Currently, the independent nation of Kosovo is proposed from parts of Serbia. Kosovo would be an ethnic Albanian enclave, surrounded by the nation of Serbia. The Bosnian Serbs in the Repulika Serpska (RS) (where Sutjeska National Park is located) have threatened that if Kosovo can become independent, then they will demand their independence. Conflict never seems far from current events in the Balkans.

When I visited the Sutjeska National Park and observed the majesty of the surrounding mountains straddling the border between BiH and Montenegro, the populist idea of a "peace park" seemed like an overwhelming opportunity. I naively proposed the concept, and was surprised by a cool reception for the idea. I concluded the concept of a transborder peace park needs work, and must be approached with a great deal of sensitivity. The idea must deal with the complexity of governance, and history. It can't be a simplistic approach.

In a comprehensive study of "peace park" feasibility, Ali acknowledges the political context that supports furtherance of the idea. He argues for the pragmatic over the naïve, by concluding that "Environmental issues can be an important entry point for conversation between adversaries, and can also provide a valuable exit strategy from intractable deadlocks because of their global appeal. However, they cannot be taken in strategic isolation and are usually not a sufficient condition (by themselves) for conflict resolution It seems apparent that the United States has lost any moral authority it may have had to be promoting the idea. International cooperation is good, but the arrogance of the idea of a peace park is problematic.

Recently BiH has taken another major step forward. The World Bank in 2008 funded a program to institutionalize BiH protected areas, and merge the protected area approach into the government structure. They are starting to plan, draw lines on maps, and work with local government structures and people. Hopefully this approach will be broad based (locally, regionally and internationally) and not just a cookie cutter approach by an arbitrary application of one size fits all IUCN categories.

Practices for protected areas in regions of conflicts can be advanced by practical decisions about current land use. Sutjeska National Park can be a model for progressive protected area management. People looking for agreements could find something to agree upon. The results could be local communities that agree about future jobs in the forests. Others could agree upon economic development through sustainable forest practices, forest protection or tourism. Improved management of Sutjeska could generate support, and support could translate to more positive cross-border relationships.

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Military Overflight Management and Education Program—Immersion and Communication

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Park background

Sequoia and Kings Canyon National Parks (SKCNPs) are in the southern Sierra Nevada of California and contain some 865,000 acres of land ranging from foothill to alpine environments. Twelve of the fifteen 14,000-foot-high (4267m) peaks in California are contained within these High Sierra parks, including the highest peak in the lower 49 states, Mt. Whitney at 14,495 ft. (4418m) elevation. The parks are very popular for backpacking and recreational stock use, hosting some 30,000 annual wilderness visitors spending some 100,000 nights camping in the parks' wilderness.

Sequoia and General Grant national parks (NPs) were established in 1890. These parks were: "set apart as a public park, or pleasure ground, for the benefit and enjoyment of the people" and to "provide for the preservation from injury of all timber, mineral deposits, natural curiosities or wonders within said park, and their retention in their natural state." General Grant NP later evolved and expanded to become Kings Canyon NP in 1940 when its purpose was stated as: "That in order to insure the permanent preservation of the wilderness character of the Kings Canyon National Park, the Secretary of the Interior may limit the character and number of privileges that he may grant within the Kings Canyon National Park."

The passage of the Wilderness Act in 1964 included a directive to the Secretary of Interior to survey park land for wilderness designation. SKCNPs did the survey and eventually recommended that some 800,000 acres be designated. Congress did not accept all of these lands, but on September 28, 1984, the California Wilderness Act was passed, designating 723,000 acres to be managed per the mandate of the Wilderness Act.

The Wilderness Act defines what wilderness is and should be:

- A place *in contrast to places where man and his works dominate the landscape.*
- Where the earth and its community of life are untrammeled by man.
- Where man is a visitor who does not remain.
- Land retaining its primeval character and influence.
- Generally appears to have been affected primarily by the forces of nature.
- Where *the imprint of mans work is substantially unnoticeable.*
- Has *outstanding opportunities for solitude* and primitive recreation.

SKCNPs lie between the Central Valley and the Owens Valley/Mojave Desert in California, each containing vast open spaces. The southern Owens Valley and the adjoining Antelope Valley were and are home to notable aviation pioneering; much of it happening at what is now the Air Force Flight Test Center (AFFTC) at Edwards Air Force Base (where the sound barrier was broken by Chuck Yeager). Over time as commercial air travel has grown, "free" military airspace has subsequently shrunk. To protect their aviation training needs, the joint military services formed the R-2508 Military Aviation Training complex (R-2508) in 1995. The R-2508 consists of some 19,600 square miles and includes airspace over SKCNPs, Death Valley National Park (DVNP), Mojave National Preserve, China Lake Naval Air Weapons Center (NAWC-CL), AFFTC, and Ft. Irwin National Training Center (US Army). Its management is conducted by a Complex Control Board (CCB), consisting of aviation staff from the three installations, and overseen by a Joint Policy and Planning Board (JPPB), consisting of the commanders of the three military installations.

The value of the R-2508 is as a large diverse designated military airspace. It ranges in altitude from 282 feet (86m) below mean sea level (MSL) at Badwater in Death Valley NP, to 14,495 (4418m) above MSL at Mt. Whitney in SKCNPs. The airspace is used by all military services for training and test missions. The single largest user is Lemoore Naval Air Station, located west of SKCNPs in the Central Valley. Lemoore planes fly directly over SKCNPs to access the R-2508, averaging 70–80 flights per day over the parks.

The history of "problems"

The potential for problems stems from mixing a sophisticated flying machine and a pilot who is trained and encouraged to test his skills and his jets' capabilities over a federally designated wilderness. The outcome of this has been what is known as "low-flyers" over the parks. Low-flyers are those jets/planes that operate in close proximity to the ground, and can be very disturbing to wilderness users, and even a safety hazard, due to the extreme noise and sound concussions they generate. This problem has been in existence at SKCNPs since the 1950's, essentially since jet aircraft have been operating. Through the years, park management and the visiting public have complained to local military base commanders about the intrusive and unwanted noise. Upon designation of the SKCNPs Wilderness in 1984, the military voluntarily instituted an aviation floor of 3,000 ft. (914m) Above Ground Level (AGL). Though the military accepted this restriction on paper, there was little action to inform pilots or enforce the limit. As a result, the new, at the time self-imposed restriction led to no change in the number of low-flyer incidents.

In the early 1990's Lemoore Naval Air Station in the Central Valley, with SKCNPs between it and the R-2508, went through a National Environmental Policy Act (NEPA) compliance process in seeking to expand how many fighter jets were based at the installation. The NPS, via SKCNPs, commented on the plan and requested analysis of the effects of the proposed action on SKCNPs. The Department of Defense (DOD) made a determination that SKCNPs did not have standing due to the fact that the airspace is not controlled by the NPS and thus refused to consider impacts to the parks. SKCNPs protested this denial and obtained a hearing with the Council on Environmental Quality in 1999. This hearing led to the recognition of the parks as affected entities and DOD then altered its documents and actions to reflect effects on the parks.

The program

At the same time the issue of SKCNPs' "standing" was playing out, the parks were involved in advancing dialogue with national and local military leadership. Park managers, in the form of the Superintendent, Chief and District Rangers, and Wilderness Coordinator were working to build understanding of the NPS' mission with the military. It began with face to face meetings, and eventually evolved into a wilderness pack trip, starting in 1996.

This annual multi-day pack trip in SKCNPs takes local and national military leaders and NPS managers out for a wilderness immersion in order to facilitate better understanding of each others' missions. The informal nature of the setting and venue allows for free and open dialogue to discuss general and specific issues, such as wilderness soundscape protection, need for military aviation readiness and related topics. The parks have continued to develop and present the issue of common mission. That is, the military and the NPS are similarly charged with protecting values and resources. The scale and methods are different, but the basic purpose is the same. If the military, via rogue pilots, does not follow its own rules and deviations occur, the military is actually undermining its own purpose and effectiveness, and working counter to its identity of discipline and responsibility to carry out the will of the citizens of the United States. This approach allows the discussion to go beyond the problems of SKCNPs, and informs military leaders that this problem exists in other wilderness and park areas of the country and that they have the ability, at their current and future posts, to act to improve wilderness character.

NPS managers have since been invited to provide input into R-2508 planning and operations. The Complex Control Board meetings deal with day-to-day operations and are often attended by SKCNPs staff to provide input and receive information. The Joint Policy and Planning Board (installation commanders) meets twice yearly and has been hosted by both SKCNPs (twice) and DVNP within the past four years, and has provided a key contact opportunity for military and park leadership. Other interactions have included base and park orientations for managers, attending change of command and retirement ceremonies, sitting on committees that deal with relevant issues, and frequent emails and phone calls.. These regular and varied contacts have led to excellent rapport, empathy, and credibility between the military and the NPS (beyond SKCNPs).

The military and NPS have cooperatively developed a sophisticated method of determining when pilots are in deviation, i.e. less than 3000 ft. (914m) from the ground. Park field staff provide information on observed low-flyers to park fire dispatch. This information is relayed to the R-2508 air traffic control which checks radar tapes and then verifies whether it was a deviation, a non-deviation, or an unknown. The determination is then relayed back to the park. If a low-flyer is verified as a deviation, then a letter from the commander of NAWC-CL or AFFTC, depending on which service is involved, is issued to the pilots' commanding officer and the pilot is disciplined.

Another example of cooperation, into which SKCNPs had input, is the U.S. Air Force and NPS Western Pacific Regional Sourcebook (2002). This publication documents each entities' mission and details aviation and overflight information for each installation and park unit in Arizona, California, Nevada, and the Pacific Islands. It also provides guidance for military and park managers on how to work cooperatively on developing relationships and solving problems. The Sourcebook is considered an exemplary work in providing background on the missions of the Air Force and NPS.

Results

The results of these combined and continuous communication and education efforts have been notable. The number of reported low-flyers has shown continuous reduction over the past 15 years, dropping to near zero for a couple of years. This is in spite of more aggressive and sophisticated methods of relaying and following up on low-flyer reports, and more and better educated reporting staff.

The military leadership of the R-2508 also responded to NPS input in 2000 by issuing a memorandum to all pilots to voluntarily observe a floor of 18,000 ft. (5486m) MSL while overflying SKCNPs. This memorandum was generated and signed by the Joint Policy and Planning Board and remains in effect.

Deviating pilots are more frequently held accountable for their actions. One Nevada installation was banned from using the R-2508 for one year after consistently violating low-flyer rules. Another unit was given notice that they would be banned if they had one more deviation. The NPS does not request specific information on individual disciplinary actions as this is an internal responsibility of the military. We do know that if pilots are found in deviation, there is a disciplinary repercussion, sometimes severe.

We believe that there have been and are continuing positive effects of our contacts that extend beyond SKCNPs and central California. When we assess the individuals with whom we have interacted over the years, we find that several of them have moved on and up through the military ranks into very influential positions. We believe that the message we have instilled within them is one that they will use while making decisions about military aviation. Some examples of high ranking and influential military personnel that have participated in our pack trip include; Commander, Naval Air Systems Command, Patuxent River, Maryland; Commander, Air Force Security Assistance Center, Air Force Materiel Command, Wright-Patterson Air Force Base, Ohio; Director of Engineering and Technical Management, Headquarters Air Force Materiel Command, Wright-Patterson Air Force Base, Ohio; and Commander, Air Force Flight Test Center, Edwards Air Force Base, California.

The future

Challenges to keep the program functioning well involve insuring that there is adequate funding to run the programs, primarily meeting the costs of the pack trip and travel.

There is also the issue of the R-2508 airspace and its general non-use by commercial air traffic. Currently, if there are time-blocks that are not being used by scheduled military traffic, the airspace is opened up to commercial traffic. And though these flights do not generate significant noise, due to their high altitude, they do generate notable long-lasting vapor trails. These vapor trails are yet one more "imprint of man" on the wilderness environment, and hence undesirable. We have been working with R-2508 leadership to hold their ground in not releasing the airspace to commercial flights, though this is meeting with some resistance. The resistance is primarily grounded in reduced fuel, i.e. costs, for commercial operators. The Federal Aviation Administration is also a significant player in these decisions, and they almost exclusively side with the commercial airlines.

There is also a need to continually refine the radar coverage to better determine when deviations occur. The remote and radical terrain makes radar ineffective in certain areas. It is desirable to have better coverage so that findings on low-flyer reports can be more thorough and definitive.

Continuing to educate pilots, who are very transient, about restrictions and reasons behind the restrictions will also remain a challenge. It is our goal that pilots will not see restrictions as things to get around or break without getting caught, but as one more way that they are working to preserve the values of the country. It is our goal to let them know that a moment of fun for them may result in moments of unpleasantness for scores of people on the ground, the very people whose values the pilots are working to protect.

This program has required, and is continuing to require, significant focused effort to build rapport as personnel and situations change. As documented through tangible results, it has proven to be quite effective. Much like any relationship, it needs work to keep it functioning well and viable. We look forward to the challenges and to continue to work toward the improvement of SKCNPs' wilderness character. We believe that positive pressure, continuously applied through immersion and education, will lead to better quality wilderness which in turn leads to better experiences for the visiting public.

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Science Communications: Successful Strategies for Collaboration (panel discussion summary)

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The National Park Service has more information about the condition of natural resources than ever before. It is increasingly important that we translate information into simple messages to inform and connect people to these special places. In their opening comments in the first plenary session of the 2009 George Wright Society biennial conference, Ken Burns and Dayton Duncan reminded us to be good scientists first, but to share our findings through compelling stories with everyone. Appropriately, a concurrent session in the final hours of the conference returned to the topic of science communication. This session explored science communication from researching the barriers to effective science communication, to formulating recommendations for best practices, to on-the-ground efforts to inform park staff and visitors.

In designing a natural resources communication strategy for the San Francisco Bay Area Network, National Park Service and partner staff members were surveyed about current communications practices, preferred information sources, and obstacles to getting sufficient natural resources information. Their responses revealed that more often than not, information was presented in a way that was too technical to be useful, and that information needs were similar among people in a particular division or group regardless of what park they work in.

The surveys also provided insights into how natural resources information is currently being communicated and how these processes can be improved. By far, the primary means for sharing information was personal communication between staff members—including meetings, through conversations with coworkers, and/or knowing whom to call with questions.

Many respondents had not heard of the existing information sources they were being asked to evaluate, including existing websites, newsletters, e-mail updates, reports, fact sheets, and presentations. Most found it hard to get information when they needed it because it is scattered among various websites or local network drives. Partners found it particularly difficult to access park sources, because they cannot access network drives and are often not on park e-mail distribution lists. To help resolve these issues, a majority of respondents asked for a one-stop-shop website to house a wide variety of information. Other recommendations included:

- Establish a contact list of experts whom employees may call when they have a question.
- Encourage opportunities for personal communication such as meetings and field trips.
- Produce more concise briefings, factsheets, and newsletters with visuals.
- Expand and improve current newsletters and e-mail updates.
- Include executive summaries on all annual reports.
- Produce an annual state of the resources update.
- Develop a Power Point road show describing the network.
- Hold an annual science symposium.
- Expand the existing brown bag lunch series.

The first phase of developing a communication plan for the North Coast and Cascades Network similarly examined perceived motivations and barriers to communication between and within divisions gathered through a quantitative survey and 24 qualitative interviews. Research revealed that the most commonly reported reason for lack of communication between resource managers and interpreters was time. Holding true across divisions, interviewees felt overwhelmed by current responsibilities and unable to take on additional work.

Additionally, scientific information collected in the field does not always reach the public or interpretive staff. Interviews revealed that it was often unclear whom, if anyone was responsible for relaying information or determining which information should be communicated. There is currently no standardized process or procedure in place to translate scientific information to the public. Recommendations include increasing regular communication between divisions, standardizing the process of information flow, incorporating communication responsibilities into work plans, and hiring a full-time science liaison to work with both resource managers and interpreters. Consideration of the motivations and barriers to communication led to the strategies recommended in the communication plan.

Lessons learned from five years of developing a science communication program in the Heartland Inventory and Monitoring Network echoed these research findings. Early efforts by the network to provide interpretive materials to parks had mixed success, primarily attributed to the difficulty of linking natural resource information to park specific resource issues in material designed for use across 15 network parks. Engaging park-based interpreters and education specialists in meetings with resource managers and network scientists led to the development of more focused and effective products. An interdisciplinary working group organized a meeting in 2008, this time with an interpretive writing focus that incorporated natural resource information. The final presentations of this session highlighted on-the-ground projects that emerged from the workshop.

Citizen science bolsters Heartland Network monitoring at Herbert Hoover National Historic Site, Iowa

Breeding birds are a "vital sign" for prairie conditions at Herbert Hoover National Historic Site. The Heartland Network inventory and monitoring program completes breeding bird surveys in the park only one out of every four years. These data gaps are not a problem in long-term monitoring, but they hamper short-term decision-making. To fill this gap in monitoring, the park asked the local bird-watching community for volunteer help. The volunteer program is a way to involve citizens directly in preserving park resources.

The Heartland Network developed a user-friendly guide to breeding bird identification and a protocol to ensure that interim monitoring by volunteers remains compatible with the network's monitoring. A Park Stewardship grant of $1,500 paid for necessary supplies and equipment. After training in field methods, volunteer birders from the Iowa City Bird Club surveyed breeding birds at the park in 2008.

Interpreters also help make the scientific data collected in these surveys accessible to the public. Simple, low-cost products like web pages, a park-specific bird checklist, and an outreach slide presentation incorporate interpretive messages that relate specific resource management issues, projects, and research to the park's visitors.

Any project that requires good science and good communication with the public is an opportunity for interpreters and resource managers to collaborate. If you think you don't have time for collaboration, think again. Collaboration adds value to the hard work already being done by both resource managers and interpreters. With critical problems that threaten the integrity of park resources, can you afford not to do this?

Interpretation and natural resources collaborate at Hopewell Culture National Historical Park, Ohio

Hopewell Culture National Historical Park consists of five separate units totaling 1,170 acres. Each unit protects a vast earthen-walled enclosure and mounds, remnants of the prehistoric Hopewell Culture (200 BC-AD 500). Protecting and interpreting the significance of these resources has been an on-going challenge. The park's Interpretive division and Resource Management division have been collaborating to improve effectiveness in meeting these challenges, with close collaboration planned on future projects.

The main challenge to interpretation has been the current condition of the earthworks. All of the geometric earthworks are situated on prime agricultural land and 200 years of plowing has eroded them to the point where they are no longer easily visible to the untrained eye. This also presents a challenge for resource management in that a stable grassland cover must be established above-ground to protect the archeological resources below-ground. An essential component of meeting this challenge is to generate public support for resource management practices and to encourage public cooperation in protecting the resources.

To this end, interpretive waysides have been set out in our grasslands to help the public understand management strategies for stable grasslands. Additionally, pages have been added to the park's website to help the public understand the importance of the grasslands, as well as inventory and monitoring (I&M), and how they can get involved. Other collaborative activities include school programs, special events such as the annual Hopewell Discovery Days, and involving volunteers and partnership organizations in our scientific I&M procedures.

In the future, the Interpretive and Resource Management divisions will collaborate in an interpretive mowing project. This project will consist of mowing the grasslands to bring out the footprints of the earthworks. Different mowing regimes will be tested and a rotation will be established to prevent invasion by woody vegetation and to minimize the impact on grassland nesting birds.

Conclusion

A wealth of compelling stories exists about the natural resources of National Parks, and they are often woven within the cultural and historical events we commemorate. While we acknowledge the challenges to sharing these stories, it is incumbent upon us to do so in order to protect park resources unimpaired for future generations. Experience demonstrates that sustained, modest effort can achieve substantial results.

These examples from the San Francisco Area Network, the North Coast and Cascades Network, and the Heartland Network illustrate the benefits of collaboration. Interpreters, scientists, and resource managers are professionals, and have specific sets of skills and knowledge. Collaboration between professionals will result in more effective and engaging science communication that reaches the intended audiences. Collaborative science communication efforts benefit parks and visitors by raising awareness about park resources and more deeply connecting visitors to their heritage and developing stewardship ethics. Finally, collaboration may seem like an additional expenditure of valuable time, but results of that effort will bring greater benefits to the park than each individual or division working separately.

Partnerships in Communication: Recent Advances in Virtual Research Learning Centers

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Introduction and background

The Greater Yellowstone Science Learning Center (GYSLC; www.greateryellowstone.org) and Learning Center of the American Southwest (LCAS; www.southwestlearning.org) are part of a national network of National Park Service (NPS) research learning centers established to facilitate research efforts, support science education opportunities, and transfer science information. Research learning centers are designed to meet the unique needs of their park units, resulting in a high degree of variation in facilities, staffing, and activities across the national network. As unfunded research learning centers within the Natural Resource Challenge (NPS 1999), the GYSLC and LCAS felt that web sites were a cost-effective use of available technology to share resource information with managers and the public.

Over the past three years, the GYSLC and LCAS have worked with many partners to develop web sites that fulfill their priority needs: science outreach and supporting science-based decision-making. Each partner brings its unique perspectives, needs, resources, and ideas. Partners help the GYSLC and LCAS meet funding needs, develop the structure of the sites, and contribute to related science outreach activities. Through a collaboration among 51 park units in five Inventory and Monitoring (I&M) networks, three Cooperative Ecosystem Studies Units, partner scientists, four nonprofit partners, and one corporate sponsor, these "virtual" research learning centers have leveraged partnerships and technology to make information and scientific results about natural and cultural resources accessible to a variety of audiences, primarily managers of protected areas and other resource specialists (Figure 1). The web sites are portals to integrated inventory, monitoring, and research information acquired through the collaborative efforts of other NPS Natural Resource Challenge programs (e.g., I&M networks, Cooperative Ecosystem Studies Units). Recent advances in development of the web sites have greatly enhanced their efficiency and potential for use.

Resource-centric organization and content

The GYSLC and LCAS web sites were developed in tandem, which allowed collaborators to share ideas and best practices with each other, and more efficiently produce and develop content. Throughout the partnership, the GYSLC and LCAS strove to agree on a level of

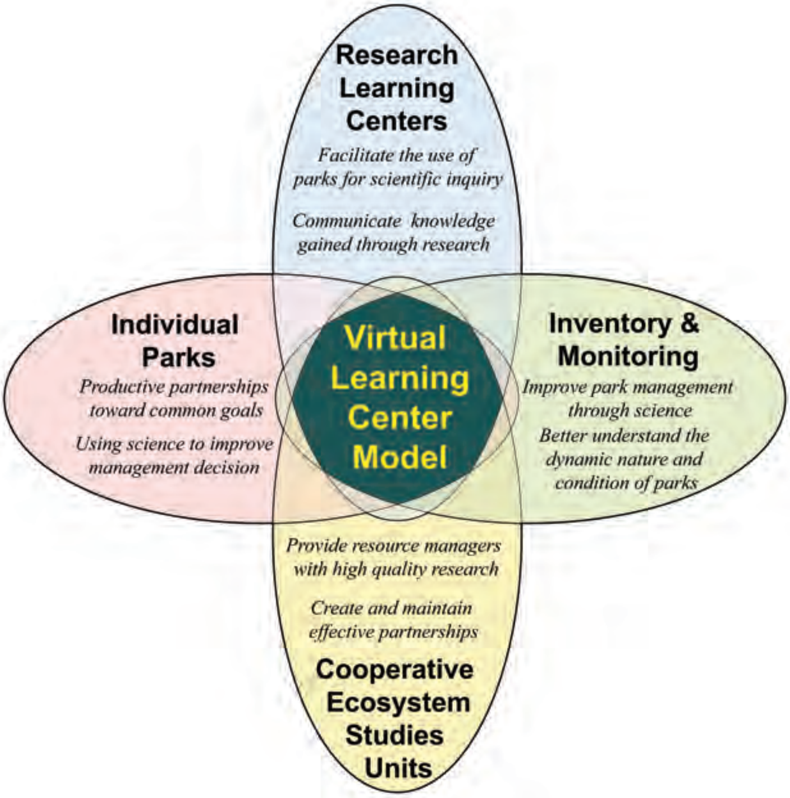

Figure 1. The virtual research learning centers leverage partnerships and present integrated resource information acquired through the collaborative efforts of other Natural Resource Challenge programs and individual parks.

consistency in order to make navigation of the sites easier for users, while maintaining the flexibility of the sites to meet the individual needs of each research learning center (Figure 2). An early product of this partnership-driven development process is the resource-centric organization of the web sites. To make science available and accessible to managers, the sites and communication products are organized around resources rather than the programs that guide management and research. This approach provides context and meaning to the separate pieces of data and information produced by these programs and builds on the work of staff and partner scientists. Resource topics are also navigable by park unit and searchable, including multi-faceted, full-text searches of documents posted on the sites, which provide users with choices in how they prefer to access information.

Partners also contribute to the development of the sites' organization and communication products, providing input on what information the content should include and how it should be presented. The sites take a "drill down" approach, presenting information in increasing detail from "wide lens" general concepts at the resource level to "narrow lens" supporting information that provides project-specific results (Figure 3). Each product presents a different level of detail about a resource or project.

Figure 2. The GYSLC and LCAS web sites were developed in tandem and share a similar navigation structure and products.

The core communication product of the web sites is the resource brief. This concise, plain English, one-page document explains why a resource is important to managers, its status and trend, and a discussion of the factors driving the status and trend of that resource or other management issues. The text is complemented by simple graphics and is based on data collected by NPS staff and research partners. The resource brief is a venue to put research into context for managers. Park managers within both of the virtual research learning centers find this product to be especially useful for quickly finding information about the status of a resource and tracking ecosystem health.

The second core product is the project summary, a flexible, 1–2 page summation of the details of a project with contact information. The label "projects" is broad—it covers long-

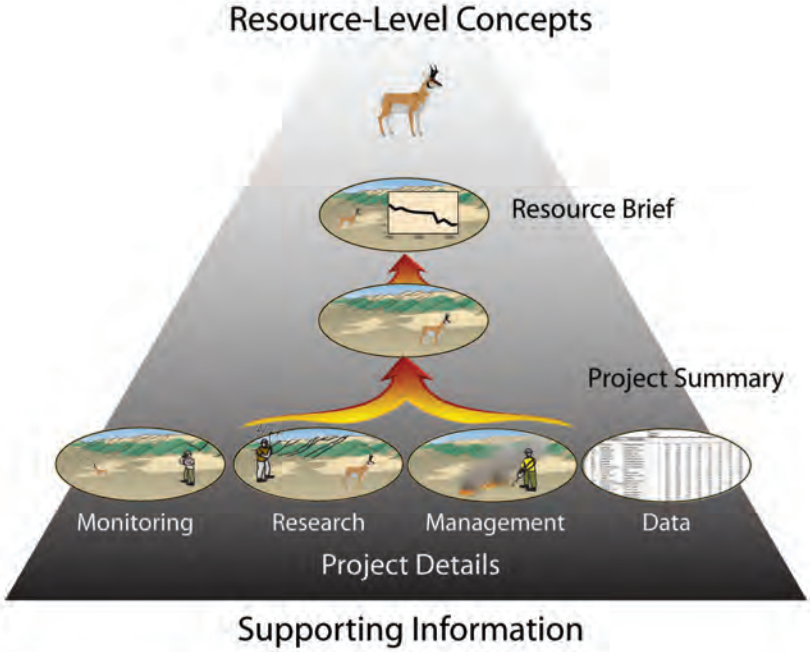

Figure 3. The GYSLC and LCAS present resource information in increasing detail from general concepts (e.g., in a resource brief) to project-specific results (e.g., in a project summary).

term I&M network and park-based activities, graduate research, cooperators' studies, educational programs—anything related to the study or management of a resource, regardless of agency or institution. The GYSLC and LCAS worked closely with the staff of their associated I&M networks in the development of the project summary and other products. The GYSLC and LCAS are comprised of the same parks as their associated I&M networks, which enables the research learning centers to maintain close working relationships between programs—this overlap in organization varies throughout the national research learning center network. This collaboration created some similar documents that met the needs of both I&M programs and research learning centers.

The web sites are also portals for the supporting information authors draw on to create the resource briefs, project summaries, and intervening products. This information from multiple agencies and organizations ranges from theses to management activities to I&M reports, such as annual reports and protocols. Individual, full-length documents, such as study plans, completion reports, reports to managers, or annual reports, which can often be obtained only by request from the author or a library, can be posted on the web sites. GYSLC and LCAS managers appreciate the convenience of quickly accessing park management information on the Internet. Documents on the web sites are always available and can even be accessed by a manager's web-enabled cell phone while traveling. Posting documents on web sites resolves issues of the availability and accessibility of public documents, particularly paper copies, which may be filed in desk drawers or tucked away on unorganized shelves, and may be inaccessible when staff are working in the field or managers are working after hours. Electronic files of public documents on network and local computer drives subject to an individual's filing system are also often difficult to find, particularly when the file "owner" is no longer managing the files.

Interweave natural and cultural resources

The flexible framework of the GYSLC and LCAS web sites allows resources to be viewed in a regionally holistic manner that extends beyond park boundaries and encourages exploration at multiple levels of scale and detail. This approach highlights the significance and connectivity of smaller parks with their larger neighbors and helps de-emphasize the artificial boundaries between "natural" and "cultural" resources. Because of this flexibility, the sites are able to interweave natural and cultural resources in new ways, report more fully on a resource, and show the interaction and interdependence of these resources.

The LCAS is finding interesting, new ways to present artifacts and archeological resources. Using videos and animation, artifacts can be examined in detail, which may reduce the need to travel to remote sites to access museum collections. The LCAS is also developing an interactive timeline piece that helps users understand the natural and cultural context of parks and their resources. The web sites are opportunities to creatively present and interweave resource information. In addition to presenting transcripts and videos of oral histories and other stories about our resources and heritage, this content may also include the stories of the people that contributed to their management, such as retiring NPS managers.

Opportunities to increase retention of institutional memory and outreach

In addition to providing information to support science-informed decision-making, the sites are opportunities to share how resources are being managed. Managers can share successes and lessons learned and support the retention of institutional memory. The sites can be used to show how accomplishments were made or missed through case studies of management actions that document the process and techniques of a project. The GYSLC and LCAS sites may also show how science is applied in parks by sharing management plans and updates on the progress and strategies of programs like the Exotic Plant Management Teams. The LCAS is leading this effort and developing ways to document and share the restoration process of prairies in the southern Great Plains. These management "modules" promote transparency in and accessibility to the work of public land managers. This helps partners cooperatively develop the way science is effectively applied in park management. In Yellowstone National Park, managers are using the GYSLC site to help manage current projects and provide research permit and logistical information for scientists who want to conduct research in parks. The web site will be used to streamline the researcher check-in process and communication with park staff.

The research learning center web sites are also tools for communicating research needs and gaps to an invested audience of multi-disciplinary researchers and the education community. The GYSLC and LCAS are just beginning to explore how the web sites may be used to connect students and educators at a variety of levels to research in parks. The web sites reach a committed audience and can be a forum for volunteer opportunities, field institutes, and announcements of scholarship and fellowship opportunities. The sites can be an outlet for the data that volunteers and students collect during bio-blitzes. Beyond making the data available to the partners involved in its collection, this accessibility enables the results to be used in a meaningful context, such as a classroom. Over time, citizen scientists could see the connections of their work to other research in communication products like a resource brief.

Leveraging partnerships and technology

Partners have helped the GYSLC and LCAS make leaps in enabling the web sites to creatively meet their research learning center's priority need, science outreach, both through the development of technical infrastructure and content. Through the process, the GYSLC and LCAS have shared information about NPS resources with their partners and the larger community.

With the help of partners, the GYSLC and LCAS recently made advances improving the web sites' accessibility, flexibility, and user-friendliness. Montana State University, a university partner, is helping "renovate" the "architecture" of the web sites. The new structure allows users to input products and other content with tags and metadata that indicate where it should appear on the site. The web sites now dynamically populate pages based on these tags and other metadata. The system dynamically produces or edits menus and pages based on an item's associations and the site will not display a menu that does not have content yet. This process is automatic with Drupal, the free and open-source content management system software used for the sites. The content management system also features a sophisticated and flexible taxonomy, meaning each resource can be listed under multiple categories and the products can be tagged to appear under multiple topics. The flexible taxonomy illustrates the intertwined nature of natural and cultural resources.

Authorized users also input metadata for products about the content, such as who helped produce it and when it was last updated. This information can be quickly called up with a content tracking system. These users also have the ability to access and upload content from any location with Internet access, allowing partners and parks to efficiently contribute to the site. With the searchable metadata, users can also track the production and review process for each product using the searchable and sortable metadata. This information strengthens the site's accountability and transparency.

An ongoing challenge for both the GYSLC and LCAS web sites is the production of new content. Many I&M products posted are created through the program's own reporting requirements and prepared for posting. Topics investigated and monitored by park staff or cooperating agencies may require more effort to produce. The GYSLC and LCAS have used park staff, university cooperators, seasonals, researchers, interns, and I&M staff to develop content. To simplify the content development process, the GYSLC and LCAS created product content guidelines to promote a reasonable degree of consistency among writers. There is also a review process in place that includes review and approval by experts and park staff for sensitivity, accuracy, compliance with policy, and visual consistency. The approved content is posted by someone with access privileges and training. The GYSLC and LCAS attempt to keep our products up-to-date by reviewing and updating content annually or when critical information changes.

End-users of the web sites will benefit from recent advances that increase the functionality of project pages that include details of past and present activities related to resources. The pages are now sortable and searchable. The GYSLC and LCAS partners are also working on the development of templates of the web sites that are transferable to other research learning centers. Partners are also looking at ways to further integrate the Natural Resource Challenge programs and data and potentially display data from existing NPS databases such as NPSpecies, NatureBib, and DataStore on these web sites.

Conclusion

The GYSLC and LCAS web sites are products of strong relationships with partners and highlight the truly collaborative nature of the research learning centers. This approach resulted in a venue to communicate integrated scientific results about the natural and cultural resources, and make science accessible to managers and the public in an efficient, accessible format. They are reflections of the collaboration between partnerships and programs, each of which bring their own perspective, needs, ideas, and resources. The GYSLC and LCAS web sites are opportunities to expand institutional memory by recording how a protected area accomplished something or might have done something differently, but also by capturing the intertwined stories of our natural and cultural heritage, and those of the people who managed them.

Acknowledgments

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An Examination of Live Interactive Virtual Explorations at Cabrillo National Monument in Southern California

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Introduction

Although San Diego's Point Loma peninsula bristles with antennas and high-tech military communication equipment, high-speed Internet connectivity to the Cabrillo National Monument intertidal area, which is managed by the National Park Service, is problematic due to its hard-to-reach location—beneath jagged cliffs of sandstone along the Pacific coastline.

Meanwhile, nestled in a valley almost 60 miles northeast of Cabrillo tidepools sits the Pala Native American Learning Center, where youth attend preschool, tutoring sessions, and other educational programs. Similar to the tidepools, Pala Learning Center's access to the high-speed Internet is challenging. Envisioning a live interactive virtual fieldtrip between these two hard-to-reach sites once seemed like a far-fetched notion.

A unique collaboration between the Tribal Digital Village Network (TDVNet), a National Science Foundation (NSF) research project called the High Performance Wireless Research and Education Network (HPWREN), the National Park Service, and the Pala Learning Center have ushered this concept from imagination to reality.

Wiring remote reservations to the high-speed internet

It all started with a kernel of an idea planted and tended by the HPWREN research project team which hails from the University of California at San Diego, Scripps Institution of Oceanography, and San Diego State University. Back in 2000, these researchers connected not only Pala Native American Learning Center, but also learning centers at Rincon and La Jolla reservations to their high-speed network, which allows users to access the Internet at speeds much faster than the typical cable and DSL connections.

Once these three tribes were connected to HPWREN, the Southern California Tribal Chairmen's Association used the connections as a model to create the TDVNet, which was originally funded by Hewlett Packard back in 2001. Not only does the TDVNet provide high-speed Internet connectivity to San Diego County Native American tribal communities, but TDVNet staff members continue to work closely with HPWREN researchers on novel applications for their high-speed connections.

From online tutoring to real-time tidepool exploration

The high-speed TDVNet provides the Native American community in San Diego County with unique educational opportunities ranging from online tutoring to real-time tidepool exploration. Specifically, HPWREN researchers work with the Learning Center, the TDVNet, and National Park Service staff members to enable participation by Pala youth in Live Interactive Virtual Explorations at the Point Loma tidepools, managed by Cabrillo National Monument.

At the education site, the Live Interactive Virtual Explorations (LIVE) setup consists of an Internet-connected computer running an IP-based videoconferencing software (e.g., Skype or Polycom), a microphone, speakers, and a projector. On the science end, the LIVE backpack system consists of a lightweight backpack (Skull Candy brand) with external shoulder-strap speakers, a Recycled Dell laptop, a Canon 250 digital video camera, a headset, external microphone, and several additional components (e.g., dual audio adapters, batteries, etc). This setup allows both ends to easily send and receive both video and audio—in real-time.

Using the lessons learned from the experiences with the Native American community, HPWREN and NPS researchers are now expanding these Cabrillo LIVE activities to additional audiences. Cabrillo LIVE activities with the Pala Learning Center, the Reuben H. Fleet Science Center, the California Science Center, and Mountain Empire Middle School are the four case studies presented in this paper.

I. Cabrillo LIVE case study: Pala Native American Learning Center

The University researchers were interested in understanding potential impacts of LIVE activities upon youth participants and whether or not such virtual fieldtrips provide children with the same type of educational experience as actually going to the tidepools. An informal activity between a group of after-school Pala Learning Center elementary school students and the intertidal area provided insight for researchers regarding the initial LIVE activities.

Prior to the tidepools tour led by a Cabrillo National Monument interpretive ranger, the Pala Learning Center students were given an explanation and able to ask questions about the geology of the area as well as the overall intertidal area at Cabrillo. This took place in a classroom at the learning center and was facilitated by a local geologist, who is known as "Doc" on the reservation as she works with San Diego reservation youth on a regular basis doing science activities. The geologist discussed the sandstone formations found at Cabrillo while an HPWREN researcher provided worksheets and hands-on manipulatives (native southern California sea shells) for the students prior to the LIVE activity. After the introductory activities were completed, the real-time virtual fieldtrip allowed the students to communicate with the Cabrillo park ranger located at the intertidal area. Equipped with the LIVE backpack system (laptop, digital video camera, and headset), the park ranger led the tidepools tour while the children asked questions from their classroom seats sixty miles away (Figure 1).

Though none of the participating children had been to an intertidal area, they were all familiar with the ocean in general and appeared to enjoy both the pre-activities and the virtual real-time tour of Cabrillo tidepools. When informally queried after the LIVE activity, most children said that they learned the most by talking with the park ranger and asking him questions about the animals found in the tidepools. A more thorough study that examines this hybrid approach of science education would be useful; meanwhile, additional informal case studies have been completed.

Figure 1. Children watch a LIVE tidepool tour from their classroom.

II. Cabrillo LIVE case study: Reuben H. Fleet Science Center

Using lessons learned from the Pala case study, the researchers modified the hands-on activities at the education site (in this case, the Reuben H. Fleet Science Center) to include not only marine life, but also marine vegetation samples. Twenty five middle school girls were among participants at the LIVE activity between the Cabrillo intertidal area and the Reuben H. Fleet Science Center. Participation in a week-long "Women Scientists in Action" camp at the Center included both classroom activities and an array of science experiments. The LIVE activity allowed the camp youth to focus their studies on marine biology and geology.

Prior to connecting the Science Center end with the Cabrillo end, the girls were presented with an overview regarding the Point Loma intertidal area's geology by the geologist that assisted with the Pala Learning Center activity. After this introduction, two NPS rangers (a Cabrillo interpretive ranger and the Cabrillo Chief of Natural Resources Management and Science) took the girls on an interactive exploration of the intertidal area. An additional aspect of the activity focused on the HPWREN-connected real-time cameras, which allow people from around the world to view the Cabrillo intertidal area (Figure 2).

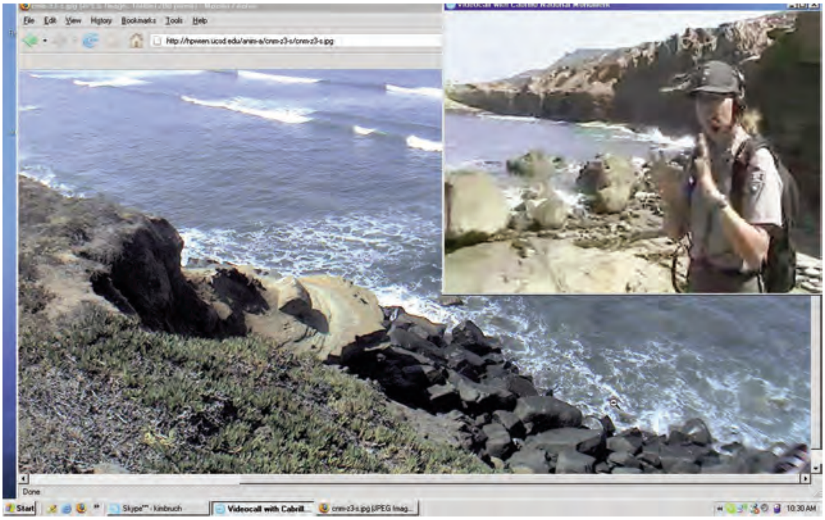

Figure 2. Real-time images of the Cabrillo intertidal area..

While the park rangers discussed the intertidal area with the girls, the Science Center staff set up the hands-on activity, which consisted of marine life and vegetation identification. There were three samples of local marine vegetation as well as three samples of local marine sealife. The girls were given worksheets and asked to identify each species based on the knowledge gained from the LIVE activity. An additional worksheet quizzed the girls on knowledge gained regarding the geologic formations at the intertidal area.

Upon completing the interactive session with the NPS rangers via LIVE and the hands-on activities, the students filled out informal surveys. Several of the respondents suggested improvement in video resolution while others said that they felt the entire presentation was "fantastic," "great," and "good." Many of the informal survey respondents commented that they most liked the real-time crab shown from the intertidal area during the presentation (Figure 3).

III. Cabrillo LIVE case study: Mountain Empire Middle School

This experiment involved students sitting in a classroom at a rural San Diego middle school (Mountain Empire) and the Cabrillo marine biologist, who worked with the students' science teacher to focus the LIVE activity on ocean terracing. Before answering an array of questions posed by the students, the biologist first explained how terracing causes vary, but typically involve erosion. Less resistant rock layers are eroded away and often form overhanging ledges that protect the interidal creatures from strong currents and predators. After this brief explanation of terracing, the middle school students were able to ask questions in real-time, which allowed for an abundance of thought-provoking conversation about ocean terracing as well as other aspects of the intertidal area at Cabrillo.

The setup for this activity varied a bit from the other case studies; that is, a Macintosh laptop was used on the education end while the HPWREN LIVE backpack (as well as a tripod) was used on the Cabrillo end (Figure 4). The weather at the coastal end was quite foggy

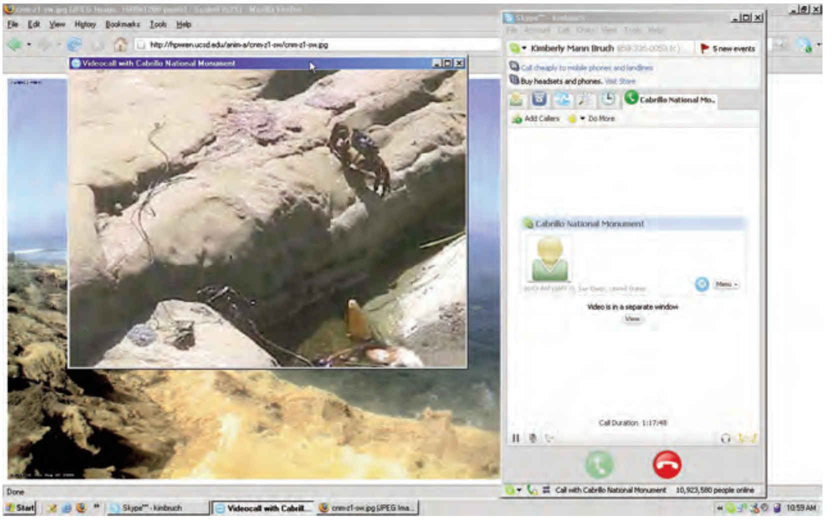

Figure 3. A crab from the intertidal area shown in real-time.

Figure 4. The HPRWEN LIVE backpack and tripod set-up..

and prevented detailed vision of the sandstone cliffs at the intertidal area. However, the students were very interested in the difference between the coastal fog and the sunny climate at their nearby (60 miles) location.

For this case study, the middle school science teacher collected informal data from the students:

- "What I found interesting is that I found out what a terrace was. I would like to learn more about where are the most terraces and do any animals live in the terraces. One suggestion to make the field experience better is if we could visit the terraces."
- "What I found interesting is that we got to see the beach. I would like to actually get there."
- "We got to see the fog, all the fossils we saw on the ground were interesting. We need to get there and see everything. We need to actually go there."
- "We got to see the terraces and fossils that are in the cliffs. We should go in the water and look under water at the terrace."
- "What I found interesting was that it was live and we got to ask questions about the terraces which are cool. One suggestion to make the field experience better is actually going to the beach so we can view it better and it's more fun."
- "I found the backpack interesting, but what kind of creatures live on the ocean floor. And actually going there is better."
- "It was so realistic I felt like I was there. If people use to live around there I would like to know more about that. I would like to have our own computer with a webcam instead of looking up front of the room."
- "I liked when we learned about the tidepools and how they worked when we got to learn about the details and important things about the tidepools and we got a good footage. I would like to know more about the terraces. To actually try going to the field trip and go there to experience it ourselves and not do the computer thing."
- "I thought the field trip was cool because I learned more about terraces and how they are made and how long it took for them to fully develop. I would want to learn more about the terraces and actually go there and not on web cam."
- "What I found interesting about yesterday's field trip was how old the terrace can get. What I would like to know more about is the new terraces forming. One suggestion to make the field experience better is going there."

IV. Cabrillo LIVE case study: California Science Center

The case study between Cabrillo intertidal area and the California Science Center in Los Angeles was one of the researchers' first attempts at LIVE activities. Third grade students from the Science Center School participated in a real-time fieldtrip between a classroom-type setting at the Science Center and the tidepools. The LIVE activity allowed the students to directly communicate with an NPS education ranger as well as watch real-time video from an underwater camera attached to a submersible Remotely Operated Vehicle (ROV).

The ROV camera was able to send back real-time underwater video of anemone, hermit crabs, coralline algae, kelp, and sea grass. Simultaneously, the students discussed what they were seeing with the NPS ranger on the Cabrillo end. As there was an encroaching storm during the activity, the youth seemed to be most interested in how such small marine life survives in an environment with big waves and cold temperatures. The education ranger was able to show the answers in real-time, rather than just using words for an explanation. For example, one student asked what would happen to the creatures in the event of a hurricane and the ranger showed them smaller rocks, which would be tossed around, and larger rocks with crevices in which animals would likely be minimally impacted by a hurricane.

The use of the ROV made this first case study perhaps the most interesting. Use of the ROV during additional such activities has been problematic, however, due to staffing. In order to run the ROV while simultaneously conducting a meaningful LIVE activity takes a number of people at the Cabrillo end, which is not always feasible.

Conclusion and future research

While the University and NPS researchers continue to work together for additional case studies, a LIVE backpack manual has been created to ease the use of the technology on the Cabrillo end. This LIVE backpack manual allows a park ranger to easily slip on the backpack system and provide a glimpse of the Cabrillo intertidal area to students sitting in their classrooms. The biggest challenge is the videoconferencing software that is currently being used (Skype and Polycom) as a large number of schools employ firewalls that prevent the use of such applications. Because of this, the researchers are limited to working with education sites that do not have such firewalls.

In addition to this software challenge, which is being addressed by continued research and experimentation with alternative IP-based videoconferencing software, the hands-on activities are also somewhat challenging. While LIVE participants are clearly interested in the education site activities and appear to learn from them, a more formal evaluation of how these enhance their science education would be worthwhile. Such a study was conducted by Tan, Liu, and Chang in 2007; they focused on the impact of a combination of traditional classroom experiences with remote outdoor learning and found significant increases in learning among the participants. Additional studies by scholars such as Sun, Lin, and Yu (2008) and Mazzolini and Maddison (2007) might be considered as models for evaluating impact and how best to proceed with LIVE activities.

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Real Science: Real Connection to Parks

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National parks are known for providing educational experiences for learners of all ages and for creating special park programs for school-age children. In addition, a number of national park Research Learning Centers (RLCs) have created programs that provide professional development for science teachers. Outreach to science teachers grows out of the RLC mission, which recognizes the importance of promoting science literacy as a key element of informed stewardship.

Working with teachers is an efficient way of multiplying the resources of park staff and partners. Once a science teacher understands some of the scientific research and science-related issues in the parks, that teacher can, year after year, bring successive classes of students into contact with this research and these concerns. Moreover, teachers provide parks with a way to take their scientific message out to students who are geographically distant from a park and who could not easily participate in on-site learning.

This paper focuses on the experiences of three Research Learning Centers, based in three different parks, with different approaches to teacher professional development.

Schoodic Education and Research Center at Acadia National Park

Acadia's Schoodic Education and Research Center (SERC) is managed by Acadia Partners for Science and Learning, a non-profit organization. Acadia Partners also develops educational programs and oversees educational research at SERC.

In 2007, working with support from the Maine Department of Education, and in partnership with the University of Maine's Senator George J. Mitchell Center for Environmental and Watershed Research, Acadia Partners initiated a professional development program intended to (1) introduce teachers and students to scientific research and issues at Acadia, (2) assist teachers in engaging students in field-based science in forests and watersheds around their schools, (3) provide teachers and students with the opportunity to participate with working scientists in authentic research, and (4) improve science literacy.

The work with teachers builds on Acadia National Park's mercury research; the park has been engaged in research into the sources, movement, and concentration of mercury in the park ecosystem for more than two decades (Kahl et al. 2007). Recent advances in mercury measurement technology have dramatically reduced the cost of analyzing mercury content in soil and tissue samples (EPA 2007). Acadia Partners recognized that the decrease in cost created an opportunity to engage students in a citizen science project that could measure mercury content in soils, macroinvertebrates, and fish from different sites around schools across Maine. Citizen science projects combine useful observation or data collection with an opportunity for non-scientists to learn more about scientific principles, problems, and processes. Citizen science is typically conducted as informal science education. Acadia Partners decided to explore using it in a formal education setting.

The project gives teachers the content knowledge and skills to use mercury research as an integral part of science education in the areas of ecosystems, food webs, evolution, human health, earth science, and statistics. The program currently supports more than 20 teachers working with more than 300 high school students in a dozen schools.

Assessment of teacher and student activity over the first two years of the project has included structured classroom observation (Piburn et al. 2000), use of concept maps to capture teacher understanding of the watershed system and its relation to course objectives (Novak and Gowin 1984), surveys of teacher and student understanding of the nature of science (Liang et al. 2006; Odgers 2003), interactions with teachers during summer and in-service training workshops, and a review of student understanding of science as evidenced in student poster presentations.

Research findings and project evaluation to date suggest that combining citizen science and formal science education opens new learning possibilities while also presenting a few new problems. Positive outcomes include greater awareness of Acadia National Park, of mercury as an environmental problem, and of where mercury comes from. Response from teachers has been that this project satisfies an important, difficult-to-fill need to engage students in meaningful scientific work.

Cautionary observations include the following:

1. This kind of professional development takes time. Most teachers need more than one year to get comfortable with undertaking field research as part of their course structure.
2. Many teachers need help and training in working with data, including help with basic research design and statistics.
3. It is easy for teachers and students to get wrapped up in the mechanics of data collection and to not spend time on higher level learning associated with creating hypotheses, designing studies, or thinking about the systems underlying observed results.

One of the more striking findings emerging from the project is that most of the students in the program hold naïve and even misleading views of what science is all about. In surveying the beliefs about science held by more than 250 students in 8 different schools we learned that the overwhelming majority believe that "Scientific theories exist in the natural world and are uncovered through scientific investigations." In other words, scientific understanding is a pile of facts, rather than something constructed on the basis of evidence. Consistent with this, most students believe that "Scientists follow the same step-by-step scientific method" and that "When scientists use the scientific method correctly, their results are true and accurate." Further, students believe that "Scientists do not use their imagination and creativity because these conflict with their logical reasoning."

These survey results suggest that students are at risk of leaving high school poorly prepared to make judgments as citizens about matters where scientific understanding is undergoing rapid change and reconstruction, such as global climate change. A key research question that Acadia Partners will continue to pursue is whether hands-on engagement with professional scientists and meaningful problems has the effect of leading students to a richer, more realistic view of what science is and does.

Mammoth Cave International Center for Science and Learning

In 2006, the Mammoth Cave International Center for Science and Learning partnered with Mammoth Cave National Park and the National Association of Geoscience Teachers to pilot a GeoScience-Teacher-in-the-Park internship. The summer internship paired local teachers with researchers at Mammoth Cave National Park. Each intern worked 200 hours, gave two public presentations about their experiences, and produced an educational product for use in their classrooms and to share with other teachers. The 2006 pilot internship has become a successful annual summer internship program.

Throughout the summer, the teachers work on a variety of geoscience-related research and monitoring projects. Past projects include obtaining coordinates for the park's remote cave entrances and permanently marking them, assisting with a long-term cave cricket monitoring project, and collecting water samples for an *E. coli* monitoring project. All the interns have been amazed by the variety of research occurring at the park. One intern stated, "I did not know the extent of research happening at Mammoth Cave National Park. The Geoscience-Teacher-in-the-Park program gave me first-hand experience with many different projects. The most valuable part is that I will be able to take my experiences and share the real-life examples with my students."

By design, the internship program focuses on local teachers. Since the karst ecosystem extends beyond the park's boundaries, many interns and their students have sinkholes, springs, and caves in their backyards. What the teachers learn during their internships is therefore directly applicable to their lives and their students' lives. The internships also provide strong community outreach opportunities. The teachers not only share their experiences with their students, but also with friends, families, and other community members.

In addition, the local focus facilitates the formation of a teacher support network that benefits both the interns and their coworkers. In Kentucky, elementary education students are not required to take a college geology course which leaves many new teachers feeling unprepared to teach the subject. The interns' hands-on experiences give them the knowledge and confidence they seek. The educational products they develop as part of the internship help spark ideas for additional karst-related opportunities for their students. The former interns also become sources of information and guidance for their coworkers. Often the former interns will even volunteer to return the following summer to work with new interns.

As with any project there are challenges. One challenge is finding sustainable funding to continue the program. Other challenges include matching research projects with interns. Not every project is suitable for teacher participation, and not every teacher is interested in or able to participate in every "suitable" project. Scheduling can also be a challenge, since the teachers' schedules need to be coordinated with the researchers' schedules. However, for some projects the teachers work together to collect data without constant researcher supervision. In these cases, the interns' schedules must also be coordinated. Having even numbers of interns minimizes this challenge.

Each year the internship grows in popularity. Through the internships, the teachers gain hands-on research and management experience that provides them with the knowledge and confidence to incorporate more karst geology into their classes. The former interns are all strong advocates for the program and actively work with their coworkers to increase karst-related activities in their schools. Mammoth Cave National Park's Environmental Education Division continues to work with the former interns, and this has resulted in new partnerships with several area schools. For the park, the internships build valuable community relationships and help disseminate research information to the public. For these reasons, the Geoscience-Teacher-in-the-Park internships are viewed as a great success by everyone involved with the program.

Appalachian Highlands Science Learning Center

Working in partnership with Great Smoky Mountains National Park, the Great Smoky Mountains Institute at Tremont and Discover Life in America, the Appalachian Highlands Science Learning Center (the "Center") has been creating in-depth summer science institutes for middle and high school teachers since 2002. The goals of the "Smoky Mountains Science Teacher Institute" and the "Advanced Science Teacher Institute" are the following:

1. Give teachers opportunities to work alongside research scientists, creating mentoring relationships.
2. Provide teachers with classroom materials and curriculum that allow them to do inquiry-based teaching in their classrooms.
3. Provide teachers with the skills they need to engage students in a complete scientific investigation, with a special focus on how to analyze data they collect.
4. Create opportunities for increased park stewardship as teachers use resources from Great Smoky Mountains National Park in their classroom.

Each year the topics of the one-week Science Teacher Institute vary depending on the research occurring in the park. Each spring the Center reviews research permits, seeking out scientists working on questions relating to critical park issues. Additionally, the Center uses the workshops to increase exposure to curriculum-based citizen science fieldtrips focused on monitoring impacts of ground level ozone on plants, terrestrial insects, aquatic macroinvertebrates, lichens and salamander populations. Each of these projects has an on-line database that allows teachers to track data collected in the park by students. Since it is not necessary to visit the park to participate in these studies, teachers are taught how they can replicate the studies and use the database to compare their findings to those in the park. This gives teachers the tools they need to allow students to conduct complete scientific investigations.

Program evaluations revealed that teachers wanted more support in conducting scientific investigations. Some were uncomfortable with developing questions and hypotheses and some felt they needed to improve data analysis skills. In response, the Center developed the Advanced Science Teacher Institute, which focuses less on collecting data and more on what you do with it. In this workshop teachers follow one study through the entire process of formulating questions, developing hypotheses, and collecting and analyzing data with the researcher. Past workshops have looked at ground-level ozone impacts on plants, acid deposition effects on snail populations, and millipede and salamander populations in the presence of an exotic earthworm that depletes leaf litter. Data analysis includes not only working with numbers in Excel spreadsheets but also learning how to use free GIS software to map data points.

Evaluations of both workshops have shown that they successfully provide teachers with real-world research they can bring back to their classrooms to strengthen their students' skills and understanding of the scientific process. While some of the teachers come back to the park with their students, those who can't still have opportunities to connect with Great Smoky Mountains National Park through the on-line databases.

The main challenge with these workshops is sustainable funding. For six years, the Center has been able to obtain funding for the $400 per teacher cost from various grants. The fundraising is time consuming, and funding shortfalls have occasionally forced cancellation of the Advanced Science Teacher Institute. Another challenge is finding the right researchers to interact with the teachers. They must be able to talk about their area of study in an engaging way and should have field collecting activities that are easy and inexpensive to replicate. A positive outcome of working more closely with researchers is that they can sometimes make suggestions about how to develop engaging educational materials for research grants. This has resulted in funding for the workshops from the Environmental Protection Agency and the National Science Foundation.

To view the online databases, visit www.handsontheland.org/monitoring/checkup.cfm.

Conclusions

These three programs show that there are a number of fruitful ways in which national parks and other organizations can support teacher professional development and thereby engage teachers more closely with the scientific work underway in national parks. Despite differences in approach, the three programs reviewed in this paper share important common characteristics.

Each of these programs is a significant undertaking. The teachers require support over time to be successful in bringing park science into their classrooms; although summer institutes are an important part of any professional development offering, it is the support over the course of the school year that enables teachers to succeed in applying the ideas and techniques encountered in a summer institute. The ongoing need to pursue financial support is another reason that these programs are significant undertakings.

In each of these programs teacher success depends on including a focus on pedagogical practice as well as on scientific knowledge and methods. In particular, teachers need help in working with data, in integrating the park-based science into the curriculum in their schools, and in moving beyond mere "doing" to higher level science learning.

Success for each of these programs depends on partnerships that make it possible to develop financial support and to bring researchers in colleges and universities together with park scientists and educators.

Perhaps the most important shared feature of these programs is that teachers express great interest in them: Teachers see the scientific work in national parks as an opportunity to meet the too often unfulfilled need for meaningful scientific learning. By addressing this need, the National Park Service, working through its Research Learning Centers, connects students to the parks. Acquiring resource knowledge and developing connections to parks are the first steps toward stewardship.

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Engaging Native Alaskan Students and Their Community in Local Hot Springs Research: A Project Designed to Increase Geoscience Education

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Cultural heritage of Alaska Native tribal groups is based on a knowledge of, and experience with, the natural world. Traditional ecological knowledge encompasses an understanding of habitats, ecological communities, cycles, seasonal variation, and the history of plant and animal species. Despite these cultural traditions, Native Americans are the most underrepresented minority in science. Our project seeks to engage Haida Alaska Natives in the geosciences by offering them an opportunity to collaborate in a variety of field and laboratory, inquiry-based projects we develop at hot springs in their local area.

Our project has four main aims: first, we are developing a curriculum that brings geoscience to the students from a culturally relevant perspective. Science curriculum modules founded in "western" ideologies need to reflect traditional ecological knowledge that has been used by the community for hundreds of years, and was developed for their survival as hunters and gatherers. Second, the curriculum developed during the course of this project will be translated by local linguists into the Haida language. The Haida language is an endangered dialect, and though few individuals fluently speak or read Haida, this will be the first time science curriculum has been written in the native language. Translating the curriculum to the native language will also reveal the native perspective on scientific concepts, and help preserve the language. Third, we are working in collaboration with the teachers to obtain additional resources they need to facilitate the integration of new scientific concepts into their current curriculum. Fourth, we are emphasizing current research topics and techniques, and presenting them in such a way that the student can easily grasp how such skills can be used in the context of future career possibilities.

Building relationships with the schools, families, and tribal elders will be crucial to attracting Alaska Native students to the geosciences and encouraging them to pursue a college education. Like all students, native students will benefit from long-term productive interactions that build their confidence in the sciences. Students will be able to experience a mixed-methods approach in our curricula, which will involve lectures, and hands-on field and laboratory inquiry-based activities. The majority of the students we will work with are first-generation college students whose parents are unfamiliar with the college application process and the range of post-secondary education opportunities available for their children. Given that potential first-generation college students make decisions about attending college before they get into high school our efforts will include working on part of the project with middle-school students. A strong relationship with the community is important in providing a positive support system throughout a student's educational career.

Native American students are two times more likely to attend two-year tribal colleges than four-year universities, and native students who develop mainstream social competencies are most likely to be successful in college. In native villages, professional staff are predominately non-Native (95% state wide in Alaska), with an annual turnover rate of 30–40%. Students will be introduced to a variety of possible future career opportunities related to the field of geoscience, most of which will be interdisciplinary (geology, biology, and chemistry), in an effort to encourage them to become teachers and scientists that could return to the village with new knowledge-base resources that they could transfer to the next generation of students.

Students will gain an understanding of and appreciation for the geosciences from a variety of methods, which include lectures, hands-on field- and laboratory-based exercises, and collaborative interactions with a multidisciplinary group of scientists. Students will collaborate with us on an actual research project, and travel to a culturally-relevant field site that has a carbonate-depositing hot spring. We will exam the impact of the local geology on the spring chemistry, and study the spring microbiology and mineralogy. Local tribal and community members will help reveal more about the ecology of the surrounding area, and discuss what they know about how activity at the hot springs has affected the local fresh water streams and nearby fishing grounds offshore.

In summary, the project includes the following goals:

1. Recruit and retain Alaska Natives into fields that involve the geosciences.
2. Promote geoscience education to Alaska Native students, parents, teachers, and the community.
3. Increase the number of Alaska Native students majoring in the geosciences, or improving their academic performance in the geosciences, or both.
4. Enhance working relationships between Alaska Native students and various federal agencies (e.g., National Science Foundation, NASA, US Department of Agriculture, Environmental Protection Agency, Department of Education).
5. Introduce students to career opportunities and the art of scientific investigation by having them participate and collaborate in field and laboratory research projects.
6. Provide an overview of the types of professional ethics and expectations the students should have when considering scientific career choices (e.g., discuss the principles of scientific integrity, responsible conduct during research investigations, and the need for high ethical and professional standards).
7. Develop and implement a comprehensive assessment strategy that will allow us to evaluate qualitative and quantitative aspects of the curriculum, and enable changes and modifications to the program.

To achieve these goals, we will establish an interdisciplinary collaborative team at Portland State University and Oregon Health Science University for the purpose of enhancing science education and building professional and personal partnerships between researchers and rural Alaska Native communities.

Summer workshop

A workshop taught at Hydaburg, Alaska, on Prince of Wales Island will provide the participants with hands-on training in the use of specific laboratory equipment. Field- and laboratory-based exercises will be used to assist with the development and dissemination of educational materials. The workshop will provide inquiry- and discovery-based learning opportunities that can be modified and used throughout the following academic year in the classroom. Daily activities will focus on the introduction of new scientific topics, completion of the previous day's activities, and group discussions. We will strive to develop guidelines for integrating the activities into the classroom at various age levels. Community elders will visit the students each day, speak about the importance of education, and encourage students to pursue higher education goals.

A web portal based out of Portland State University will be used for post-workshop discussion, questions, and workshop feedback and assessment. Participants will be given the opportunity to communicate via a blog initiated during the workshop. The blog will be used to gauge how students feel about how their participation in specific activities has influenced their perception of geoscience and how they may use the knowledge gained.

Long term goals of the project include hosting a summer internship for some of the students at Portland State University and the Oregon Graduate Research Institute, which would allow them to gain additional "bench" and microscopy skills, and experience in a professional laboratory setting. It is extremely difficult for native students from rural communities to integrate into mainstream culture successfully, especially in a highly-populated metropolitan or urban setting, to which some attribute the high college dropout rates among native students. Summer internships would expose students to current research methodologies, and provide them with short-term exposure in an urban university setting, an opportunity we hope will help recruit and retain native students. Feedback from the summer internships will also provide us with a native student perspective on what types of challenges they feel they would face by leaving their community to come to a metropolitan- or urban-based university setting.

The multidisciplinary field of geoscience presents an excellent platform upon which to introduce young minds to the excitement and wonders of science. Geoscience encompasses disciplines as diverse as geology, microbiology, biochemistry, physics, and chemistry, appealing to a wide population of young scientists. Geoscience education presents an opportunity to attract promising students to fields they can pursue that would allow them to contribute back to their communities.

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Gaining and Understanding Tribal Perspectives: Olympic National Park's Applied Anthropology Program and its Recent MOU

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There are more than 570 federally recognized tribes and Alaska Native groups who have unique political status as sovereigns, and National Park Service (NPS) managers must recognize and respect this relationship. The status is based on a government-to-government relationship with the NPS, the direction for which is required by the U.S. constitution, treaties, statutes, and other court decisions, all spelled out for park managers, as the care takers of numerous aboriginal homelands, in the NPS 2006 Management Policies.

Legislative drivers justified creating a position for a cultural anthropologist in the NPS Washington, D.C., Program and Policy Development Office in 1987. Especially important at the time were the National Environmental Policy Act, the American Indian Religious Freedom Act, and the Alaska National Interest Lands Conservation Act. Each called for consultations between representatives of Federal agencies and the tribal government whose lives were affected by agency decisions. As a result the NPS hired Dr. Muriel Crespi as Chief Anthropologist. Dr. Crespi wrote the first NPS management polices (in 1988) that addressed the official NPS position regarding Native Americans. These became the foundation for the NPS applied anthropology or "ethnography" program.[1]

The next decade brought a sea-change with respect to recognition of American Indians and other traditionally associated groups in park management decisions. The requirement to consult Native Americans was reiterated throughout the NPS management policies and other policy documents. The management policies explicitly acknowledged a relationship that continued to exist between the integrity of park resources and the integrity of tribal life that required consultation with associated contemporary Native Americans when NPS actions might impinge on them. Concomitantly, the Service obligated itself to protect resources in ways that reflected "informed concern" for the contemporary people and cultural systems traditionally associated with them. Soon after, NPS regional offices began to hire anthropologists, as did a few parks, such as Olympic.

As anthropologist at Olympic National Park for over 20 years, I began working with eight peninsula tribes (Elwha Klallam, Jamestown S'Klallam, Port Gamble S'Klallam, Skokomish, Quinault, Hoh, Quileute, and Makah) to ensure that the park had an accurate understanding of the basis for the relationship these tribes have to the park, such as the treaties that protect tribal rights. I wrote the park's Ethnographic Overview and Assessment in 1997 and identified aspects of tribal culture so that park staff, such as the resource education division, could accurately interpret tribal culture, and I pointed out ways that the park could carry out consultation when park actions might affect one or all of the eight associated treaty tribes.

In the process of consultation for the park's five year General Management Plan, I met with the eight tribes on numerous occasions with two succeeding superintendents. At each meeting the same comment came up. "These meetings are great, because we really never hear what's going on at the park," and the park felt the same way. "Let's have more meetings, but not necessarily when something needs to be resolved." Everyone felt it was important to meet on an annual basis to share information about what each other was planning in the upcoming year.

As a result of this desire and some specific fishery and flooding issues, the Northwest Indian Fisheries Commission (NWIFC) assisted the tribes in putting together the very first meeting with the park to discuss a Memorandum of Understanding that would address laying out the framework for annual meetings. Pat Parker, from the NPS American Indian Liaison Office brought in Charles Wilkinson, Native American Law Professor to facilitate the meeting, and we began the process of identifying what we wanted the MOU to say to guide us in our commitment to meet annually and how to conduct our communications. We set up a committee with a representative from each tribe. Bill Back of the DOI solicitor's office was elected to take on the duty of ensuring the language was legal, Fran Wilshusen from the NWIFC, Gary Morishima from the Quinault Indian Nation, and I worked on the drafts, distributed them for feedback, edited them, and redistributed them prior to each meeting. Within one year we had a document that everyone approved and we held a signing ceremony in July of 2008, at Ocean Shores.

The MOU created a commitment for meaningful tribal consultation and highlighted some areas where we could work more collaboratively. The agreement didn't change the park's responsibility; it just strengthened the desire proclaimed by all parties to work together. As someone said during the process, the real value was in the process we undertook, the time and commitment to work together, and the great communication required to write the MOU.

There is fairly frequent change in tribal chairs and park superintendents, so each successive leader will now know that we are all committed to this process, and they can refer to the MOU to create individual agreements between the park and a specific or several tribes on individual issues. Each division within the park, and the corresponding tribal office, can now be expected to work together much more in their research and fieldwork, and share results.

Olympic's new superintendent, Karen Gustin, started work the day of the signing ceremony. She believes the MOU is seen by all parties as a very important anchor. There will be tiered-off agreements with individual tribes, based on initial issues that are attached to the MOU as an appendix, which we had prioritized in the first work group session. She sees the park and tribes having regular team meetings, she has already committed herself to meeting with all of the tribes, and is gearing up for the first annual meeting in August.

This MOU will have longevity beyond the turnover of park and tribal employees for decades to come, and stands as a guidepost for a future of meaningful collaboration and shared understanding.

Endnote

1. Unfortunately there is currently no lead for the ethnography program in Washington, D.C., as Dr. Crespi passed away in 2003 and the chief ethnographer position remains vacant.

Game-Theoretic Insights into Effective Cooperation Among National Parks and Indian Tribes

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For most of the twentieth century, U.S. land management agencies saw their missions largely in terms of what happened inside their own units. However, recent decades have seen transboundary collaboration playing an important role in what managers do.

Many have advised managers how to make collaboration better, in the form of generalities such as "communicate better," "collect more information," or "institutionalize consultation." This advice doesn't help managers prioritize very well. As we will see, information collection and better communication can be irrelevant to solving some types of cooperation problems. In other cases, we should not expect any collaboration at all. The most important distinctions in most of this paper are between "coordination" and "collaboration"(Snidal 1985; Stein 1982). These affect the role of communication, information gathering, and the usefulness of institutions.

Modeling collaboration

This paper examines cooperation between U.S. agencies and Indian reservations (see Ashley and Hubbard 2004; Burnham 2000; Keller and Turek 1998; Spence 1999; Wilson 2002). To model such collaboration, this paper will use very simple game theory, with only two players, each with two choices. Game theory finds the solution to such choice problems with the concept of a Nash equilibrium, in which neither player has an incentive to change her choice unilaterally if the other person's choice doesn't change either.

Coordination problems. Pure coordination problems lack any substantive disagreement. One simple example is deciding whether a country should require that everyone drive on the left or the right of the road. No one cares what we decide, but we all want to drive on the same side.

Such problems are regularly found in National Park Service (NPS)-tribal collaboration. Imagine a wildlife population that could be studied with several different survey methods. If the wildlife crosses boundaries, there's clearly an advantage to developing a common survey methodology.

PURE COORDINATION		Tribe	
		Method 1	Method 2
NPS	Method 1	1 1	0 0
	Method 2	0 0	1 1

This is a pure coordination game, as shown in the adjacent box. (I arbitrarily set the payoffs at 1 if they coordinate, 0 if they don't.). The upper-left and lower-right boxes are each Nash equilibria, as no one will change away from such an outcome. This game is easily solved with communication (Crawford and Sobel 1982), with players announcing their intentions and then acting on them when they agree. This fact yields our first claim:

Claim C-1. Communication helps solve Pure Coordination problems.

Scientists working for land managers confront such problems frequently, and move to common methods without political difficulty.

One variant of this game is coordination when the two sides disagree. We often see this problem in cultural interpretation. The NPS and an affiliated tribe may tell the story of a park's history differently but both sides prefer that casual visitors to the park receive a single story.

COORDINATION WITH DISAGREEMENT		Tribe	
		Version 1	Version 2
NPS	Version 1	2 1	0 0
	Version 2	0 0	1 2

Both the upper-left and lower-right boxes are equilibria: neither side has an incentive to switch unilaterally. History plays an important role in the outcome of the game. If the NPS has been telling "Version 1" for a long time, and the tribe has acquiesced, the tribe may not be able to start telling a different story. Thus,

Claim C-2. History often determines the outcomes of Coordination games when the two sides favor different solutions to the game.

This dependence on history can be frustrating for the side, usually the Tribe, coordinating around their second-best outcome (or simply being silent). However, the last few decades have seen NPS interpretation change at many locations, for reasons external to this game.

For example, Little Bighorn Battlefield National Monument (née Custer Battlefield National Monument) had focused interpretation on Custer and the 7th Cavalry. Its new name reflects an act of Congress and underlying changes in social beliefs. These social changes led to a desire to treat both sides of the battle as "Americans." The result, in terms of the game, is a shift in NPS preferences such that the lower-right box above now has preferences {2, 2}, with {1, 1} in the upper-left box. Working together, the NPS and Native Americans shifted interpretation from Version 1 to Version 2.

Stag hunt. Many situations of NPS-tribal collaboration can be classified as "Stag Hunt" problems. This game takes its name from Rousseau's parable about two people in a state of nature who can hunt either hare or stag. They must work together for stag, which both prefer to hare. This is shown with a payoff of 4 in the figure. However, either one could catch a hare by herself. If A hunts hare, she catches one and eats it, with an outcome in the lower row of the figure (depending on what B does). Finally, if A hunts stag but B wanders off and gets a hare, A goes hungry—her worst outcome.

STAG HUNT		B	
		Stag	Hare
A	Stag	4 4	1 3
	Hare	3 1	2 2

There are two Nash equilibria here: {Stag, Stag} and {Hare, Hare}. But if both players are hunting hare, they would like to switch to stag. Neither has an incentive to switch unilaterally, but communication solves the problem easily if players announce, "I'll hunt stag if you will," and then switch simultaneously at an agreed time. Two main propositions follow:

Claim SH-1. Assuring other players of your intentions and actions is central to solving Stag Hunt problems.

Claim SH-2. Communication, and institutional mechanisms for communication, provide assurance and help solve Stag Hunt problems.

One example is the collaboration among national park units and the Grand Portage Indian Reservation to address the threat of Viral Hemorrhagic Septicemia (VHS) in Lake Superior (NPS and Grand Portage Band 2008). Taking unilateral actions against an outbreak of VHS would be ineffective, so no party has an incentive to do anything unless it knows that others will help. If others help, then everyone prefers to take aggressive actions against the spread of VHS. In this plan, the park units and the Grand Portage Band of Chippewa agree to common responses before and after the appearance of VHS in Lake Superior.

The emphasis on institutional mechanisms and communication when deeper collaboration is necessary—that is, in the event of an actual VHS breakout—is an excellent response to Stag Hunt problems. As Claims SH-1 and SH-2 suggest, these actions will help participants move from inaction to action when it is necessary.

Prisoners' dilemma. The Prisoners' Dilemma (PD) is probably game theory's most famous game, reflecting the mixture of cooperation and conflict between the players. In PD, two players may "cooperate" or "defect" in addressing some common problem. Mutual cooperation, CC, is better for both than mutual noncooperation (defection), DD. It's tempting not to live up to one's commitments, so A prefers DC to CC. Being cheated on is the worst outcome, so for A, CD is worse than DD and all other outcomes. B's preferences are symmetric (see figure).

PRISONERS' DILEMMA		B	
		Cooperate	Defect
A	Cooperate	3 3	1 4
	Defect	4 1	2 2

The central dilemma is that DD is a Nash equilibrium, while the mutually preferable CC is not—each player would rather switch to playing D, given that her partner is playing C. If this game is played once, there is no way around this problem.

If the game is played repeatedly, mutual cooperation may be feasible. Players will monitor one another's behavior, so that if either cheats the other one will know. Cooperation further requires some punishment or enforcement mechanism so that if cheating is detected it will be punished.

Whereas communication was important in Stag Hunt, communication is unnecessary in establishing cooperation in the PD. Each player will lie about their intentions, hoping to take advantage of the other.

Claim PD-1. Cooperation in the Prisoners' Dilemma requires repeated play and a long time horizon.

Claim PD-2. Cooperation in the Prisoners' Dilemma requires monitoring and enforcement mechanisms.

Claim PD-3. Though information about compliance can be important ex post, ex ante communication is unnecessary for cooperation in the Prisoners' Dilemma.

Prisoners' Dilemma applies to a wide range of contractual settings in which each party offers something to the other party in exchange for something else. One example, with negotiations still in progress, is management of the South Unit of Badlands National Park inside Pine Ridge Indian Reservation (Burnham 2000, chapter 3). Past NPS actions have often been problematic for the Oglala Sioux, and the reservation would also like to manage the lands in ways different than what the NPS would like.

The NPS and Oglala Sioux are currently discussing several "concepts" for future management, from the status quo (NPS management) through shared management to a change of status as a tribal protected area under Oglala Sioux management (NPS 2008). Some seem likely to raise PD questions. How will each side monitor the other's actions? How will each side respond to real or perceived violations of agreements or non-written understandings?

Chicken. While PD's mixture of conflict and cooperation reflects a greater degree of conflict than does Stag Hunt, Chicken is even more conflictual than PD. There is a common interest in avoiding the worst outcome, DD, but conflict exists over exactly *how* to avoid this outcome. The central conflict comes from the existence of two pure-strategy equilibria, DC and CD. In each of these, there is a clear "winner" (A and B, respectively).

PRISONERS' DILEMMA		B	
		Cooperate	Defect
A	Cooperate	3 3	1 4
	Defect	4 1	2 2

In Chicken, each player will want to demonstrate her "commitment" to "winning" the game. If this commitment is credible, and believed, then the other player will concede (play C). Communication may help players commit to winning, but they will also find it advantageous to lie about their true commitment. As a result, many communications are not believable. Thus:

Claim C-1. Players will attempt to establish a credible commitment to "winning" a game of Chicken

Claim C-2. Players will likely communicate as part of their attempts to establish credibility, but these communications will likely not be believed.

Consider the case of Native human remains and archaeological artifacts before the Native American Graves Protection and Repatriation Act (NAGPRA) of 1990. People and organizations holding Native remains and cultural objects were in the condition of the DC outcome, with a credible commitment to holding on to them. After NAGPRA, the property rights in these holdings shifted abruptly to Native communities culturally affiliated to them. Tribes could, if they wish, demand immediate return of everything, to the horror of curators.

Because they lacked the infrastructure to handle the immediate return of all human remains and cultural objects, Native Americans moved more slowly. Compromises, such as Native loans of cultural objects to museums, were attractive in some cases, as were training programs to develop Native expertise as they developed their own collections. Negotiations over such compromises were always held in the shadow of the Native ability to demand immediate return, which Chicken represents as a credible commitment to defection.

Deadlock. Our final, and most conflictual game is Deadlock. As its name suggests, cases of Deadlock are not amenable to solution. Collaboration will not occur, with or without communication.

"Deadlock" is a family of games, symmetric and asymmetric. In the symmetric form, neither side wants to collaborate. The symmetric illustration simply reverses both sides' payoffs in PD, switching CC and DD. Both sides will choose Defect no matter what the other side does. Unlike PD, the players do not wish to move to CC, so there is no collaboration problem.

PRISONERS' DILEMMA		B	
		Cooperate	Defect
A	Cooperate	3 3	1 4
	Defect	4 1	2 2

A more interesting situation occurs when one side would like to collaborate but the other side is not interested. One example is management of wildlife that moves from the higher elevations of Glacier NP to lower-elevation winter habitat on the Blackfoot Indian Reservation. Tribal members hunt several of these species, including elk, deer, bighorn, and bear. Tribal members also conduct guided hunts for outsiders, and the tribe advertises that its location allows outsiders to hunt the abundant wildlife of Glacier NP. Such hunts reduce the number of animals that return to summer habitat inside the park, creating an issue of concern to the NPS.

Because of the tribe's poverty, the reliance of many members on hunting for meat, and the income potential from guiding outsiders, the Blackfoot Indian Reservation is clearly best off managing the hunting on its lands without reference to NPS management concerns. In contrast, the NPS would prefer to restrict hunting so as to increase the wildlife population, though in the case of elk the NPS usually wants a smaller population.

ASYMMETRIC DEADLOCK		Blackfoot Indian Reservation	
		Cooperate	Defect
NPS	Cooperate	3 2	1 4
	Defect	4 1	2 3

The adjacent game illustrates asymmetric deadlock for species other than elk. The Nash equilibrium lies at DD. The NPS prefers mutual cooperation (CC) to mutual noncooperation (DD). Because the Blackfoot prefer DD to CC, NPS desires for cooperation will not yield fruit—the tribe strictly prefers the status quo. Whenever we observe a failure of cooperation, Deadlock should always be kept in mind as a possible solution.

Summary

These various games fall into three rough groups, coordination (Coordination, Stag Hunt), collaboration (PD, Chicken), and Deadlock. Communication plays an important role in coordination games, helping both sides find mutually-beneficial outcomes. Communication is irrelevant in Deadlock, since there is nothing to coordinate. Communication plays a more ambiguous role in Chicken and PD. As I have discussed, communication might help coordination in repeated-play Chicken (and by extension in PD), though both sides also have an incentive to lie.

Conclusions

This paper has sought to clarify the conditions for successful cooperation across a variety of settings. Information, institution-building, and the influence of history on coordination have provided recurring themes. If this analysis is right, then studies of Native–NPS cooperation should not make unconditional claims about the effects of "consultation" or "building relationships." Instead, studies should make conditional claims that building relationships is valuable under condition X but not under condition Y. In a world of time and budget constraints, such conditional claims help decision-makers set priorities among the range of worthy initiatives that cannot all be accomplished.

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Healing Landscapes: A Historical Perspective

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Introduction

This paper navigates through different worlds and worldviews on its way to a discussion of indigenous sacralised landscapes. It moves through the worldmaking process, with its frames of reference and social imaginaries, to interrogate the shape of "true knowledge." This includes an examination of how the sacralised landscape is marginalized by the dominant social imaginary, and proposes an avenue of understanding for more fair and fit intimations of indigenous sacralised landscapes.

Exploring the social imaginary

Social imaginaries are comprised of paradigms with their core values, systems of signification, and a background metaphysic that provide order and unity to experience. Just as there is no ultimate proof for the proof of science, there is no standard for constructing, accepting, or rejecting a paradigm beyond what Thomas Kuhn characterized as the assent of the relevant community. Nelson Goodman reminds us that:

> If I ask about the world, you can offer to tell me how it is under one or more frames of reference; but if I insist that you tell me how it is apart from all frames, what can you say? We are confined to ways of describing whatever is described.[1]

Extending outward from a social imaginary are analytic practices, each with their particular shape and logic. These practices and their practitioners "define what counts as reasonable evidence and as rational investigation into truth or falsehood in the first place."[2] Marc Auge identified this as the "ideo-logic" that defines the sum of the "possible and the thinkable within a single society."[3] I have examined several of these analytic categories—self, time, space, and causality—that signify two very different social imaginaries: the tribal sacralised and the Western analytic. In this paper I will discuss one of these categories: space.

The politics of space and the influence of ideology have been characterized by Ruth Kark who distinguished between civil societies and societies based on kinship. In civil societies concepts of land are instrumental, economic, rational, legal (embodied in individual property rights) and territorial. In societies based on kinship the relationship of an individual or group to land is paramount and relations are largely governed by norms of interaction with the land. Concepts of land are mythical, religious, symbolic, animistic, and sentimental. The spatial kinscapes extend out from the location and from the present encounter and are contingent upon a larger spatio-temporal field of relationships.

The belief in *loca religiosa* landscapes is a recurring theme among Native American communities where inanimate objects and natural forces are considered alive. This discernment goes to the heart of Native American ways of knowing that "spiritual power is infused and diffused throughout nature in general, as well as at interconnected spatialized places, and that knowledgeable people are participants in that power.

In indigenous communities this sacralised personhood of nature, "is not a metaphorical extension of human attributes. Personhood is literal."[4] Nor is this relationship equivalent to the spiritual contemplation between deity and human subject encouraged by the Christian tradition. It comes through "knowledge of the land and its agency [and is] not primarily the result of contemplative activity but of active engagement" with the landscape.[5] These spatio-temporal spaces of emplacement are part of the *illud tempus*: the time of origins and emergence.

Nurit Bird-David described the agency of animated landforms as the "affordance" to produce and reproduce sharing relationships.[6] Lyall Watson insists that "we are born animists" that he described as

> a fortunate disposition and a time in both personal and human history when we are closest to nature … most accessible to a connection that provides a real sense of the presence of power around us. It lasts only as long as we let it, beginning to slip away as soon as we become more demanding, more distant, more inclined to ask inappropriate questions that push the presence away.[7]

The ontological and methodological status of the animated agency in landscape has been taken up by a number of writers, including Martin Hollis and Steven Lukes. Drawing on their experience among African cultures, they distinguished between Primary theory, that is "filled with middle-sized, enduring objects" and the "push-pull conception of causality," with Secondary theory that illuminates a "radical hiddenness" of entities and processes and transcends the limited causal vision postulated by Primary theory.[8]

In the Western analytic, the production of true knowledge of landscapes is grounded in the regime of power of hierarchized formal scientific discourse and its dream of *mathesis universalis*. It is directed and adjudicated by instrumental reason, naturalistic materialism, mechanical/efficient causation, and utilitarian rationalism. This regime of power, part of the larger project of modernity, adjudicates what counts as reason, argument, or evidence, along with the anonymous rules governing discursive practices and the network of a force field of power relations of which these rules are a part. For Bird-David the most intriguing question is

> why and how the modernist project estranged itself from the tendency to animate things. How and why did it stigmatize 'animistic language' as a child's practice, against massive evidence? How did it succeed in delegitimating animism as a valid means of knowledge, constantly fending off the impulse to deploy it and regarding it as an 'incurable disease'?[9]

The provincialized landscape

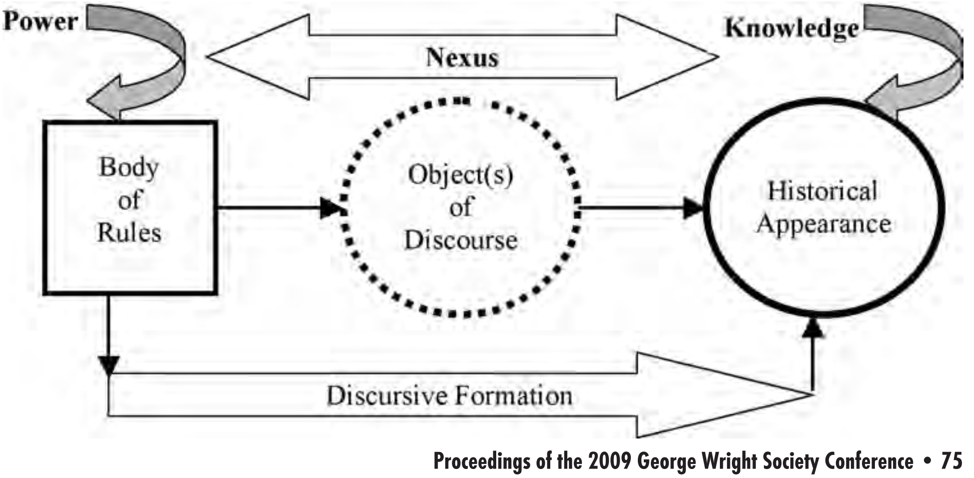
Part of the answer might be found in the "provincialized" landscape. Patricia O'Brien asserted that power, rather than the sovereignty of the self or the rights of personhood, is the organizing principle of Western civilization. Taking a cue from Michel Foucault's power-knowledge nexus, O'Brien insists that one must always ask: "Where is the power in the knowledge?"[10]

The power-knowledge nexus has four primary characteristics. First, it is ubiquitous in the sphere in which it operates. Second, it is a field of struggle between oppositions for domination in which the parties stake their claim for deciding who is empowered to say what is true. Third, it engages both unconscious and surface structures to create and adjudicate systems of knowledge and their discourse. Finally, it is a process, not a place; an unstable equilibrium of power-knowledge relations whose genealogy punctuates history. In this space of domination and resistance, truth is produced according to the rules defining the production of truth."

The project of modernity, according to the historian Willie Thompson, consists of institutions that serve as mechanisms of authoritarian control (that have now reached "monstrous proportions"), operating by way of self-policing subjects and ideologically positioned ways of knowing what is real and true knowledge. As the first movers who impose the rules of the game, the scientific regime of power and its constellation of governmentalities create the space, or *habitus*, "where truth is produced."[11] The function of the nexus is to create propitious angles that allow things to appear as true knowledge while ruling out other explanations or understandings. Regimes of power also provide the subjects with acceptable avenues for resistance, including jural-legal, legislative, and educational avenues, that serve to domesticate resistance.

One example is the bounded space of the American Indian reservation. The reservation system afforded an opportunity to simultaneously punish and reform indigenous societies through careful supervision within artificially bounded territories. They provided a venue for the deployment of what Foucault describes as the "micro-physics" of power and governmentality: the strict ordering of space and time to create a more accommodating disciplinary of utility and obedience. In a manner similar to Jeremy Bentham's Panopticon—a prison designed around a central observation tower—these bounded and ordered spaces provided a sense of constant scrutiny in which the structure of the reservation would modify behavior,

Figure 1. The power–knowledge nexus.



and gradually adjust the inhabitants to new relations of power, modes of knowledge, and styles of reasoning.

The effect of the regime of power in relation to indigenous ways of knowing was not only to adjust behavior, but also to modify habits of mind through the power of discipline over both body and mind. Institutional control takes the form of various religious orders as well as the socializing disciplinary of conventional education, the regulations of the capitalized workplace, ersatz jural-legal institutions, bureaucratized as opposed to ancestral systems of governance, as well as the marginalization of indigenous languages and traditional religious practices that signify the sacred.

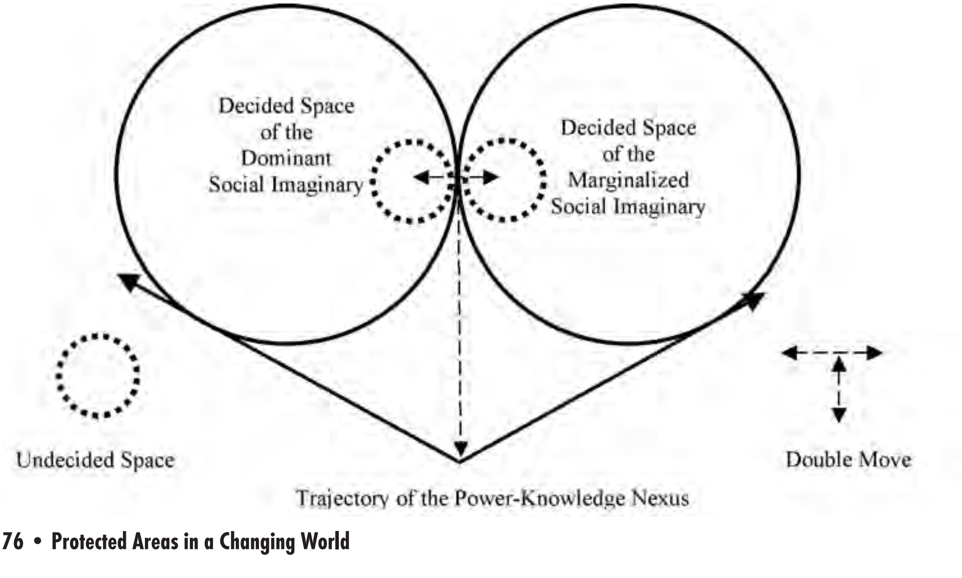
Signifying the sacred

An interrogation of power-knowledge, its relationship to the designation of true knowledge, and the double move of reflexivity and historical imaging, provides a means for disengaging from the hegemonic position through a portal that facilitates the apperception of the social imaginary of the "other."

The first move requires an effort to cultivate a subsidiary awareness of the indigenous framework and its worldmaking properties. The purpose is to engage the social imaginary inherent in the indigenous view of the natural world. Beyond the fairness and fitness of this discourse are the positional relations between the dominant and marginalized social imaginaries. Marginalized by the larger social imaginary, the indigenous social imaginary persists an avenue of opposition and resistance, and as a means for reinvigorating and in some cases reconstituting ancestral beliefs.

The application of Foucault's model illuminates routes of resistance and emerging ways of worldmaking through the limited realm of agency in the undecided space. Foucault proposed that the social subject "constitutes himself in an active fashion, by the practices of the self" even though these practices are "not something that is invented by the individual."[12]

Figure 2. The domains and trajectory of the social imaginary.



The subject escapes the normalizing effects of modern power by exploring the limits to authorized forms of subjectivity within an undecided space, and by asserting our capacity for freedom by producing ourselves as works of art and a critical ontology of ourselves that

> has to be considered as an attitude, an ethos, a philosophical life in which the critique of what we are is at one and the same time the historical analysis of the limits that are imposed on us and an experiment with the possibility of going beyond them.[13]

What is common to the work of Goodman, Foucault, and the others is the importance of the artistic understanding—not the arts, *per se*, but the undecided space of the artistic disciplinary. In her analysis of Native American literature, Lee Schweninger points out the importance of this portal of understanding by way of Native American literature, stating that

> the study of Native American literature as nature writing can provide . . . an understanding of Native American ecology and culture that will lead to a better understanding of and appreciation for the culture and . . . a better understanding of the dominant Western, Euro-American culture.[14]

The second step in this "double-move" interrogates the historical origins, evolution, processes, products, ends, and consequences of the modernist worldmaking enterprise and its signifiers. The aim of this move is to make explicit the construction, deployment, and reinforcement of the signifiers of the dominant social imaginary—to include its role in setting the legitimate limits of discourse—that serve to silence alterity and that ignore the positional relations of the dominant to the subaltern. This includes an analysis of the historical roots of the postmodernist hegemony and "the all-pervading power of representation."[15]

Concluding remarks

In indigenous communities, the ideo-logic of the moral center is linked to the empowered, restorative power of nature, of human relations, and the interconnections between, around, and beyond them. In that sense, the indigenous social imaginary that grows out of the past is in direct conflict with the secular religion of economic growth has been the decisive factor in this nation's use of nature. The attempt to marginalize the sacralised landscape, and the importance of opposing it, was forcefully expressed in the lines of a poem by Leslie Marmon Silko:

> So they try to destroy the stories
> Let the stories be confused or forgotten.
> They would like that.
> They would be happy
> Because we would be defenseless then.[16]

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Climate Change and Tribal Consultation: From Dominance to Détente

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Introduction

As climate change progresses, consultation with indigenous peoples can be a critical tool for shaping agreements to protect natural and cultural heritage. For indigenous peoples, cultural survival is at stake. For the Parks, the ability to maintain a preservation and conservation mission is at stake. Climate change as a phenomenon is ridiculously complex, stretching across the arenas of scientific inquiry, policy-making, political boundaries, and economics. Stronger relationships between tribes and agencies can set forth a defense against a muddling, fragmented approach to a common threat. And it is something that we can all accomplish.

The model of consultation as an agreement-making process emerged after the period of self-determination and self-governance in the 1970s in the United States. Earlier, treaty-making as a consent system settled boundary issues, but it left a level of persistent conflict for implementing environmental policies. Assertions of federal dominance prolonged tension and conflict in intergovernmental relations. Consultation developed as a framework for reducing conflict and enlarging the area of shared interests during a time when most government land-management agencies moved to policies of ecosystem management. At the same time tribes moved to self-determination policies, and consultation moved to participatory decision-making. The potential impacts of climate change suggest that consultation policies and frameworks need to be further strengthened to face unpredictable events and serious impacts on natural and cultural resources. Today, boundaries melt nearly as fast as the arctic ice. Animals and plants cross boundaries or reach barriers, land masses and coastlines change, and access to traditional resources becomes difficult. Getting it wrong by getting stuck in conflict is not an option. Increased understanding of the legal, social, cultural and political context of consultation and agreements makes the case for a survival toolkit as "We are entering an era where we are looking out for each other" (Williams 2009). Détente, as recognition of the legitimate role of multiple authorities and partnership, replaces dominance when the endgame is to mitigate the impacts of climate change.

Tribes hold water rights and land, so they come to the table with resources of great importance to the ecosystem. They move from a reactive position and take the initiative to ask the questions, call meetings and define strategies. Tribes have an equal stake in the process and the outcome, and so "should play an equal part in deciding the shape of the system" (Deloria 1995, 10). The rebalancing of the consultation system is nowhere more evident than in Obama's change, echoed by Interior Secretary Salazar, from government-to-government language to that of nation-to-nation, for consultation.

Steps in consultation

Identification of authority. The first step in an effective consultation process is for all parties to identify themselves and their authority to be in a formal consultation process. This step can be taken through a memorandum of understanding or memorandum of agreement, as a means of establishing trust and credibility. These agreements may need flexible provisions to accommodate multi-lateral negotiations in addition to bi-lateral negotiations. Increasingly, tribes are coming together in multi-lateral entities, like the Northwest Indian Fish Commission, or the National Congress of American Indians.

Who shall treat? Higher-level employees who are empowered with authority to make decisions need to be involved in key decisions around climate change. At the same time delegation of authority to people with special expertise to make agreements in detailed matters remains important to success and speed of decisions. Often, getting external brokers who stand between tribes and agencies out of the way increases speed.

Strategy-building. The third step emerges to identify strategies with specific tasks, time, and resource commitments. Through strategies, much important work can be accomplished, short of making laws or applying to the courts. The consultation process allows tribes and agencies to craft site-specific and issue-specific actions in tailoring strategies from the bottom up. Cooperative agreements or compacts and contracts are useful to identify roles, tasks, and responsible parties, along with budgets and funding sources. Multi-lateral strategies are not easy, and all parties need expanded capacity and training to achieve success.

Working across boundaries

Tribal trans-boundary efforts. Examples of tribal initiation and management of trans-boundary consultation processes are significant for understanding the process. The Salish Gathering in the Northwest provides an example of tribal initiation of meetings to deal with the impact of climate change on both sides of the U.S.-Canada border. States also play an important role in multilateral agreements for climate change that include tribes. Many examples of state and tribal negotiations resulting in agreements can be found in enforcement and environmental regulations (Reed and Zelio 1995, 72–73). In some states, like Oregon, conservation easements carry specific components enabling the holder to protect air and water values, and provide for tribes to obtain cultural conservation easements to protect cultural values (Olmsted 2009). Tribes have the flexibility to use the tools of private property ownership themselves, or cooperatively in combination with the land-into-trust process, to achieve otherwise unattainable goals on private property. The Sinkyone Tribal Wilderness and the Arleco Creek project of the Lummi Tribe are examples of such interactions that extended the borders of influence to protect a larger landscape.

Jurigenesis, traditional ecological knowledge, and consultation

Cultural rights bleed into legal rights as tribes enter into consultation with a set of important assumptions. From their position, indigenous rights are pre-existing and prior rights bound in customary practice that forms its own body of common law and lands that they ceded in treaties or other agreements. It is asserted that all that was not specifically given up is retained as a pre-existing right. Prior rights, such as water rights, demonstrate this position and many tribes are concluding their water settlement agreements. Climate change impacts these rights, as well as National Parks, by changing access to natural and cultural resources. Besides loss of ecosystem services, climate change has profound impacts on the cultural and religious practices of people around the world, and threaten traditional knowledge about innovative responses and practices. "When adapted to functioning ecosystems on tribal or on adjacent lands, traditional ecological knowledge defines special frameworks and practices that support the cultural, political and economic life of the tribe,"(Stumpff 2006) so these impacts reverberate within and without boundaries.

In the cultural context, stories and narratives act as analogues to precedent, and they provide the reasons and reinforcement for consensus about broad principles, while they justify or criticize certain deviations. (Borrows 2002, 14) They can be regarded as the authoritative basis for law and regulation by tribal members. They are guidance, more gyroscope than compass, and require specific internal interpretation to deal with dynamic issues, like climate change. Burrows describes the process of applying cultural narratives to decisions and rule-making as jurigenesis (Borrows 2002).

Given a deepening cultural understanding, agreements based on harmonizing interests between distinctly different bodies of law becomes possible. The following table suggests some mechanisms for harmonizing the process across different cultures and bodies of law.

The rolling carpet of doom: Climate change, parks, and tribes

Current scientific opinion points out that we are living in a time period within some sort of a tipping point range for climate change, that leaves us teetering at the edge. Reducing carbon emissions by 15–20% below levels of 2000 by 2020 is required (UCS 2008). Concurrently, we work on solutions outside the usual range of Western science and indigenous knowledge, with ecological impacts that may be difficult to predict, and are largely unknown. Because indigenous knowledge provides information about phenomena at the extremes and at the center, while offering alerts to problems in the ecosystem, it is key to agreement-making. The Quileute know something is wrong because there are no smelt eggs in time for Honoring Elders Day to make "stinky eggs," so they know the smelt are out of balance often before scientists realize that this keystone species is faltering.

Why agree? Agreements are needed now for some of the known and likely impacts, and

Table 1. Mechanisms of harmonizing multiple legal cultures.

Relationships over time establish trust.
Sui generis doctrine – Legal implications of cultural differences: uniqueness requires recognizing different categories, what is missing in common law requires that examples applied examples be drawn from appropriate legal, social and regulatory bodies in different cultures..
Negotiation
Expanding each parties' notion of the others foundations in law, history and culture
Recognition of dynamic nature of common law
Creative use of conservation easements, cultural easements and other mechanisms provided through state law for private property
Recognition of the current status of federal and tribal authority as a basis for action
Utilize tools from existing law: self-governance compacts, self-determination contracts, annual funding agreements with Indian tribes under the Indian Self-Determination and Education Assistance Act of 1975 (P.L. 93-638) as amended and additional new and innovative types of agreements

our ideas about boundaries and access may need to change if we are to preserve ecosystems. Animals are moving. Will the Tulalip become "People of the Mahi Mahi" instead of "People of the Salmon," Tulalip Tribal Natural Resources Director Terry Williams asks. In addition to exotic species that thrive and out-compete natives in the changing environment, southern native species are turning up in northwest waters. Animals are moving north. Alpine and high-mountain species may be most at risk, since they cannot go higher. Tribes hold indigenous knowledge about the habits and migration routes of many species and they can act with considerable flexibility. Should assisted migrations become necessary due to climate change, tribal partnerships can be critical operational partners, especially when agency authorities to carry out such activities are lacking and there may even be an appearance, but not a substance, of violating the agency mission.

Forests may receive serious long-term impacts, since trees cannot adapt quickly by moving, and old-growth is not easily replaced. If, in fact, large forested areas are lost, as predicted for Alaska, due to increased fire or other climate-related impacts, species relocation and plant relocation may also come into play, and reliance on tribal partners for knowledge and practice will be important. Where there are trust responsibilities to American Indians and Alaska Natives, agreements ensure that these are met, especially when large changes in accessible species take place. If permafrost becomes grasslands, then replacement species like buffalo may be the only means of continuing subsistence rights. Root systems are impacted by heat in the soil; insect infestations increase. Herbaceous plants used for cultural and medicinal purposes may not be available. Already, basket makers note that the beargrass is smaller and smaller. Exotic species and disease are likely to proliferate. If a tribe or agency puts significant resources towards reducing pinebark beetles, it is going to be important that compatible and effective controls are used on adjacent jurisdictions. Many climate change scenarios suggest actions similar to those listed below.

The process of consultation: Nuts and Boldts and détente

Consultation is not the same thing as consent, since consent implies absolute power to accept or refuse, though it often takes place in the long shadow of treaties, that were, at least

Table 2. Initiate innovative administrative harmonizing mechanisms.

Develop a cross-departmental cross-governmental approach, including budget, to deal with significant climate change problems (possible model is the fire budget) to reduce delays and increase effectiveness:
Initiate institutional practices like talking circles to reduce conflict pre and post agreement and to assist in harmonizing interests and finding out whether or not a conflict really exists.
Identify areas of common interest like riparian restoration to build relationships before climate change reaches crisis proportions in its impacts
Establish standards for problems like water quality that are exacerbated by climate change to establish standards.
Look for ways to create, share and exchange green energy programs, infrastructure and use with Tribes developing local and regional models
Engage tribes in multi-departmental agreements for solutions such as carbon offsets, habitat protection, and energy conservation
Wider use of traditional indigenous knowledge as covered in Secretarial Order 3206 as a model (ESA) and the Convention on Biological Diversity

legally, consensual in their nature. The plenary power of congress affects tribes while the trust doctrine applies to federal agencies as they work with tribes. In consultation, one party has the power to make the final decision, not as a right, but as a matter of law and power, and that party is usually the federal government (Deloria 1995, 9). Yet negotiation and compromise are required to achieve the support and general agreement that consultation implies, and to find out what tribes want. In some regions as well as nationally, court cases set the tone for consultation. The Boldt decision on the implementation of tribal treaty rights colors consultation in the Northwest, and provides tribes with protective parameters around their rights to usual and accustomed sites for fishing, hunting, and gathering activities.

Today, tribes hold significant resources, especially the rights to water resources, so they come to the table with resources of great importance to the ecosystem. The sea change in relationships is underway as tribes take the initiative to ask the questions, call meetings, and create partnerships through federal, state, and private relations. Under conditions of climate change, the equity principle becomes self-evident, as all have a stake when plants and animals move across boundaries, and water resources become unpredictable. Because of this, tribes have an equal stake in process and outcome, and so "should play an equal part in deciding the shape of the system" (Deloria 1995, 10). The rebalancing of the consultation system is nowhere more evident than in Obama's change, through Interior Secretary Salazar, from government-to-government language, to that of nation-to-nation, for consultation. It is a time when all nations should come together to protect the resources.

TAKE ACTION
BUILD TRUST
HARMONIZE IN THE FACE OF SURPRISE
THE POWER OF PLACE IS IN YOU

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On a Scale of 1–10, Exactly How Sacred is It? Evaluating Tools for Integrating Tribal Resources in the Planning Process

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Developing evaluative tools in a National Environmental Policy Act (NEPA) process is often seen as a standard process, yet the resource challenge can be immense. Evaluating affects upon cultural resources, especially those whose significance lie in their cultural values, is especially difficult in situations where tribal uses still exist. This paper will focus on examples from Grand Canyon National Park (GCNP) where tribal values, and the need to evaluate traditional cultural properties, has led to interesting applications of standard analysis tools so that tribal values are better integrated into the decision making process. Recognizing and protecting these resources, including ethnographic landscapes and soundscapes, are central to the integration of tribal concerns, providing a way for park managers to get beyond consultation.

Over the past 15 years, NPS resource managers at GCNP have been engaged in a multitude of consultations regarding projects and programs that have the potential to affect resources of concern to the affiliated Indian tribes of the area. In this discussion, I will focus on two specific projects, the revision of the park's Colorado River Management Plan (CRMP) and the Aircraft Overflights Plan, both of which evaluate affects upon resources from vastly differing points of view. In the CRMP, we addressed tribal perspectives from the tribal origin, or emergence place, of many of the tribes themselves, the Colorado River, deep within the Grand Canyon. In the overflights plan, we are viewing the very same origins of the Grand Canyon from thousands of feet above the ground surface.

The Colorado River in the Grand Canyon has considerable significance for many of the indigenous peoples of the region. For the Hopi people, the river and canyon are referred to as the "Salt Canyon," *O'ongtupka*, representing the place of emergence of their people into the fourth world. The people originated from the *Sipapuni*, deep within the canyon, and upon death, the spirit returns to the canyon. For the Navajo people, the river is the river of never-ending life, *Bits'iis Nineezi*, a sacred being in and of itself. The confluence of the Colorado and Little Colorado rivers represents the sacred male and female beings (Figure 1). The rivers also represent cultural boundaries. For the Zuni people, the rivers represent the umbilical cord that connects them to their place of origin deep within the canyon. For the Pai people, the canyon and the river are "*hakatai'a,*" the backbone. The Southern Paiute people have identified a place deep within the canyon where they cross over when they leave this world. Separating the river from the canyon is a difficult task and we, as NPS managers, are often placed in the position of trying to compartmentalize a sacred landscape in order to meet the legal requirements of NEPA or the National Historic Preservation Act (NHPA).

Colorado River Management Plan

In 2006, the park completed a revision of the Colorado River Management Plan (NPS 2005). This is primarily a visitor use management plan that specifies actions to conserve park

Figure 1. View of the confluence of the Little Colorado and Colorado rivers within the Grand Canyon.

resources and the visitor experience while enhancing recreational opportunities on the Colorado River through GCNP. Many of our affiliated tribes participated in the development of the plan, with the Hualapai Tribe acting as a cooperator in the development of the plan.

Park staff routinely host tribal consultation river trips where tribal members can interact with park staff and the resources of the canyon. These trips provide opportunities for tribal representatives to provide feedback to park resource managers about the condition of resources, impacts they are observing and recommendations for park management actions. As we interacted with tribal representatives concerning the status of resources along the Colorado River, many expressed concern with the number of visitors in the canyon, physical impacts to archaeological sites, and the appropriateness of certain activities conducted by recreational users of the river. Evaluating physical effects to historic properties is relatively simple; evaluating the effects of numbers of visitors and their behaviors proved to be more complicated.

When we developed strategies for the evaluation of physical impacts to archaeological sites, campsites, trails, etc., we employed standard evaluative techniques based upon the concept of "limits of acceptable change." We established baseline resource conditions and evaluated the alternatives based upon likely changes to those conditions. Evaluating the potential impacts to traditional cultural places (those that may or may not meet National Register criteria) proved to be more challenging, requiring additional tools to insure we were accurately portraying effects that may be experienced by traditional practitioners.

After discussing with tribal representatives the resources that may be affected by visitation, we identified a number of locations known to have traditional associations and used them as characteristic of traditional cultural places throughout the river corridor. Since the location and nature of many of the sacred places are known only to the traditional leaders of the various tribes, we used well known sacred locations, such as the confluence of the Colorado and Little Colorado rivers, Vasey's Paradise, Deer Creek narrows, and Havasu Canyon (Figure 2). GCNP, through partner universities, developed a computer simulation model of river trips, allowing resource managers to manipulate launch patterns and types of trips in order to predict downstream congestion and crowding. Our goal was to use the river trip simulation model to estimate the number of people at one time and within any given day visiting these locations. With that information, we were able to evaluate potential effects to traditionally important locations within the Colorado River corridor. That information aided park managers in choosing the preferred alternative that provided for no more than 100 people at a time at any of the significant locations identified as culturally sensitive. Now that the plan has been implemented, we will be monitoring visitation at these special locations in the hope that our modified launch pattern resulted in the hypothesized reductions of people at one time. These results will provide necessary information for modifications in the visitation pattern if the number of people at one time is exceeded.

Aircraft Overflights Plan

In 1996, the park began working with the Federal Aviation Administration (FAA) on special flight rules within GCNP. This work resulted in an environmental assessment and rule in 2000 that identified specific flight routes and elevations within the special flight rules area. GCNP and the FAA initiated a new environmental review in 2006. This new effort is intended to assist the park in the "substantial restoration of natural quiet" to the park as mandated by the 1987 Overflights Act. Over 90,000 aircraft overflights occur annually over GCNP, and hundreds of flights a day transit over the park on their way east-west and north-south. Restoring the natural soundscape of the canyon has, and continues to be, a challenge (Figure 3).

Over the past thirteen years, we have been working with the affiliated tribes and the FAA on identifying traditionally associated resources and ways to mitigate impacts to them from the sounds created by aircraft overflights. The FAA is not as familiar as the NPS with incorporating tribal values into their planning process and early on staff from the FAA asserted to the Havasupai and Hualapai tribes during a consultation meeting that the FAA "owned" the air. The reaction from the tribal officials present at the meeting was one of amazement, immediately resulting in the Havasupai chairman reading the tribal constitution to the FAA officials. This experience led to the NPS becoming more directly involved in identifying culturally sensitive resources and working with tribal representatives on ways to evaluate impacts to traditional users.

Although unfamiliar with assessing impacts to traditional resources, the FAA briefly assigned a cultural resource specialist to the 1996–2000 effort. While attempting to define a flight corridor that avoided locations identified by tribal practitioners, FAA officials asked tribal representatives to rank the significance of their sacred places, i.e., on a scale of 1 to 10, how sacred is …? That question clearly illustrated the FAA's lack of understanding of tra-

Figure 2. Vasey's Paradise, a spring important to native people, deep within the Grand Canyon.

ditionally valued places, and the need for the NPS to become more directly involved in assessing affects on tribally identified resources.

In the current effort, the NPS has asserted its role in identifying and evaluating impacts to resources on the ground, and within NPS jurisdiction. In order to do that, we have employed a number of evaluative tools that incorporate perspectives gained through tribal consultation with acoustic measurements such as "speech interruption," "noise free intervals," and simple acoustic decibel measurements. We chose representative cultural locations within the park for modeling purposes, and are currently in the process of analyzing the effects, and determining if these metrics represent a true evaluation of effects on cultural properties.

The padding of feet in the pueblo, the song of the canyon wren welcoming the morning, prayers offered in the kivas—these are all sounds that exist today in the canyon, which can connect people to sacred places. All of these images represent important sights and sounds (the ethnographic landscape) that deserve protection from both the visual and audible intrusion of the sights and sounds associated with aircraft overflights over the landscape. Finding ways to identify the resources of concern and appropriately characterize them, without compromising tribal values, is our challenge and we hope to continue working with our affiliated tribes toward that end.

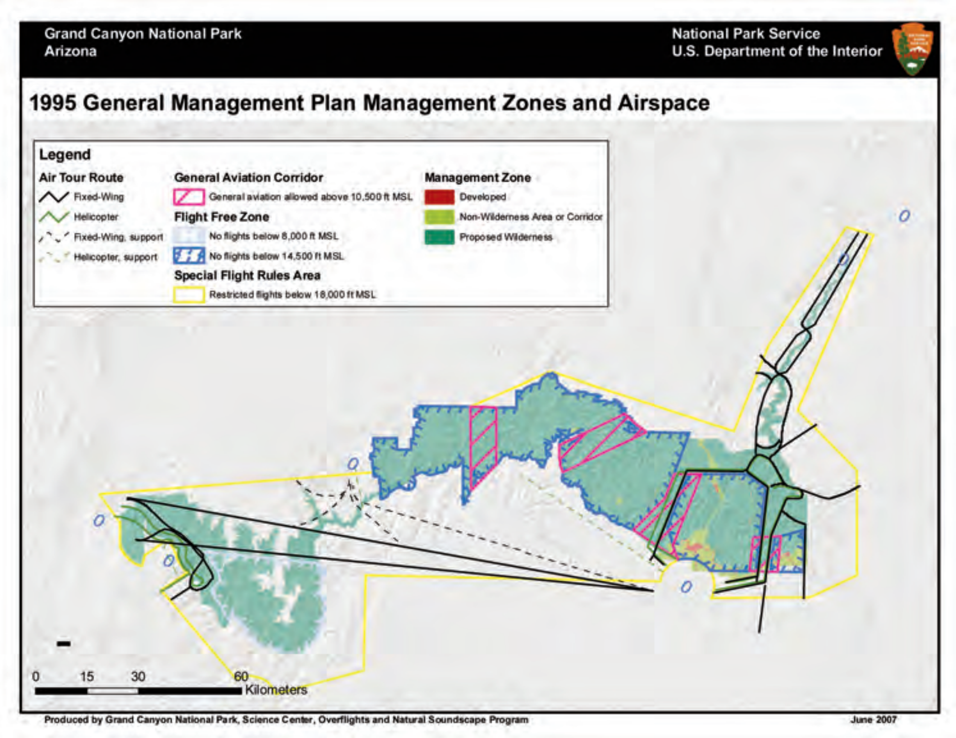

Figure 3. Aircraft flight corridors and zones within Grand Canyon National Park.

Conclusion

In the examples described above, I have attempted to illustrate the challenges we face in trying to characterize traditionally valued resources while accurately representing the impacts these resources may receive from agency actions. Recognizing the sensitive nature of the resources, the sensitive nature of the information, and the needs of both the agencies and affected tribes to make progress in understanding how actions can affect traditional resources has allowed us to propose ways in which traditionally valued resources can be evaluated in a NEPA process. Although the process can be seen as the antithesis of how tribal people view resources of concern, the approaches we have suggested provide ways to quantify the unquantifiable and recognize the effects of our actions on these significant resources. The approaches may not be perfect, but they are a tool to insure that tribal perspectives can be integrated into agency actions, rather than being ignored for lack of a creative way to include them.

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Climate Change Monitoring and Installation of GLORIA at Great Basin National Park

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Introduction

One of the areas where climate change impacts are most likely to be detected quickly is on mountain tops due to the restricted area, harsh climate, and short growing season. To detect these high elevation changes, a consortium of universities and agencies initiated talks in Europe in 1996. The Global Observation Research Initiative in Alpine Environments (GLORIA) program was born and quickly spread to other continents, with the goal of using a standardized approach so that data from different regions can be compared. The GLORIA project collects quantitative information, including species richness, species composition, vegetation cover, soil temperature, and length of snow cover period. It also assesses the potential risks of biodiversity losses due to climate change by comparing the current distribution patterns of species, vegetation, and environmental factors along vertical and horizontal gradients. At present, forty seven target regions have been established in mountain ranges around the world, with nine in the western USA.

Study area

Great Basin National Park is located in east-central Nevada (Figure1) and contains four of the ten highest peaks in Nevada. Its location in the Great Basin makes it an ideal place to study climate change, and in 2008 it became part of the GLORIA network.

Methods

Mountain peaks in the area were evaluated with the goal of selecting four summits of different elevations ranging from timberline to the region's highest elevation. The peaks needed to have the same climatic conditions, the same bedrock type, cone-shaped peaks, sufficient vegetation to measure, and little to no human land use.

The sampling design followed the GLORIA field manual (Pauli et al. 2004):

1. Sixteen 1 m x 1 m permanent quadrats, with four in each main cardinal direction.
2. Four 10 m x 10 m permanent quadrats.
3. Summit area sections, with four sections in the upper summit area (from 0 to 5 m from the summit) and four sections in the lower summit area (between 5 and 10 m from the summit)—the size of the summit area section was not fixed but depended on the physical structure and slope of the peak.

In addition, a datalogger programmed to record temperature every two hours for the next five years was buried on each side of the mountain. All grid points and datalogger loca-

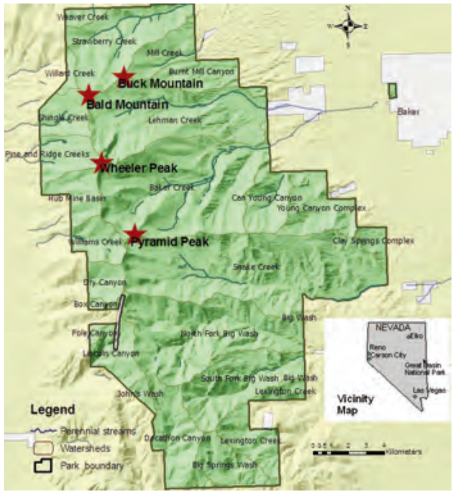

Figure 1. Buck, Bald, Wheeler, and Pyramid Peaks were chosen as part of the GLORIA project in Great Basin National Park, located in east-central Nevada.

tions were photographed to assist in the rereading of the plots and retrieval of data-loggers in five years.

Results

It took six days to complete the setup, plant identification, and data gathering on four peaks (Wheeler, Pyramid, Bald, and Buck), ranging in elevation from 3,347 m to 3,981 m. Sixty-seven plant species from 22 families were found within the plots. The Gramineae and Rosaceae families had the most species, 12 and 7, respectively. Although many species were similar to those found in the Sierra Nevada mountains, one species was endemic to the Snake Range, *Eriogonum holmgrenii* (Figure 2).

Out of 64 quadrats across the four summits, only 20 had vascular plants, and only 10 had 3 or more species present. The number of quadrats with vegetation present ranged from 0 (Pyramid) to 7 (Bald) quadrats.

Wheeler Peak had the least plant diversity, with just 11 species, while Bald Mountain had the most, with 42 species. Flora found on all four peaks included *Poa secunda, Trisetum*

Figure 2. Close-up of *Eriogonum holmgrenii.*

spicatum, Polemonium viscosum, and *Selaginella watsonii*. *Phlox pulvinata* was found on the three higher peaks, but not on Buck Mountain. A number of species were found on the three lower mountaintops but not on Wheeler: *Arenaria congesta, Minuartia obtusiloba, Erigeron leiomerus, Potentilla ovina, and Castilleja nana*.

Twenty-five plant species were found on Buck Mountain, elevation 3347 m, the peak with the most woody vegetation. Species found only on this peak were: *Mertensia ciliata, Pseudostellaria jamesiana, Juniperus communis, Carex pelocarpa, Piptatherum exiguum, Picea engelmanii, Aquilegia caerulea, Rubus ideaus, Penstemon humilis,* and *Penstemon leiophyllus.*

Bald Mountain, elevation 3524 m, had the most diversity, with 42 species. Species found only on this peak were: *Antennaria corymbosa, Sedum lanceolatum, Draba albertina, Poa fendleriana, Luzula spicata, Astragalus platytropis, Lewisia pygmaea, Ranunculus adoneus, Sibbaldia procumbens,* and *Heuchera parvifolia.*

Pyramid Peak, elevation 3633 m, hosts 30 plant species, including the endemic *Eriogonum holmgrenii*. Other species found only on this peak: *Rhodiola integrifolia, Arabis lemmonii, Draba reibata, Calamagrostis purpurescens*, and *Cymopterus nivalis.*

As expected, the highest peak in the study and in the park, Wheeler Peak at 3981 m (Figure 3), is home to the fewest (11) species. Three species were found only on this peak: *Oxyria digyna, Primula parryi,* and *Ranunculus eschscholtzii*.Additional data analysis is ongoing. Data has been entered into the GLORIA database, a common data archive that will allow comparisons of different regions.

Conclusions

Despite a large number of peaks in Great Basin National Park, finding four peaks for the GLORIA project was more difficult than anticipated. Differences in bedrock excluded some peaks, while others had virtually no vegetation on them. In the end, three ideal peaks were selected, along with one, Buck Mountain, that had more woody vegetation on it, which made it more difficult to lay out transects.

Modifications of the GLORIA protocol proposed for the re-sampling in 2013 include adding supplemental quadrats. These additional quadrats will help detect trends in species abundance and patterns of change. Due to the large amount of tree cover on Buck Mountain, we rec-

Figure 3. View of Wheeler Peak from Buck Mountain..

ommend adding 'stem count by size class' and 'tree canopy top cover' as additional data fields for the 1 m x 1 m quadrat and 10 m x 10 m quadrats.

The GLORIA project is long-term, requiring people who are familiar with the protocols, and who have excellent botanical skills. It is especially important for an area implementing this project to reach out to numerous agencies to find the expertise needed, and to help foster a wider appreciation of the GLORIA site so that the project will continue long into the future.

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Modeled and Actual Impacts of Fire Management on Carbon Sequestration and Greenhouse Gas Emissions in Yosemite National Park

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Introduction

Humans dominate, or substantially influence, a growing number of processes that underpin cycling of both carbon and nitrogen at regional to global scales (Vitousek et al. 1997; IPCC 2007). Some effort in recent years has been spent on exploring the potential of forests to "sequester" more carbon, and potentially offset emissions in a carbon trading market. In the National Park Service, quantifying carbon has largely been an academic exercise, because park management was thought to have little need or opportunity to manipulate how much carbon could be stored on park landscapes. In fact, research shows that there is little guarantee that forests not actively cultivated for optimized carbon sequestration will be able to accumulate any more carbon than what they already hold (Mitchell et al. 2009).

On the other hand, recent research has shown that fire management may exert a significant influence over these cycles by changing (or not changing) forest stand structure, composition, and/or forest successional pathways (Hurteau et al. 2008). Yosemite's fire management program has long been on the forefront of managing fire on its landscapes, employing science-based fire prescriptions for over 30 years on some parts of the landscape to "reintroduce" landscapes to more "natural" fire regimes. Yosemite has built some of the most comprehensive and spatially extensive databases documenting vegetation type, fuel bed characteristics, fire behavior, effects, and severity in the country (van Wagtendonk et al. 2002). More recent work has formalized protocols that leverage these datasets as input for fire models that can be used in scenarios quantifying the impact of different fire management actions (or inactions) on forest landscapes (Miller and Davis 2009).

The objective of this analysis was to assess the potential versus actual impact of alternative versus current fire management policies (respectively) on the amount of aboveground biomass and carbon stored on Yosemite's landscape.

Approach and methods

Spatial and temporal extent. This analysis focuses on the south fork of the Merced River watershed (Figure 1) at a spatial resolution of 30 m. Temporally, this analysis accounts for the impacts of fire and successional (e.g., fuel accumulation and stand structure; Davis et al., forthcoming) processes at 1-year time-steps for the period 1994–2004. Each pixel was

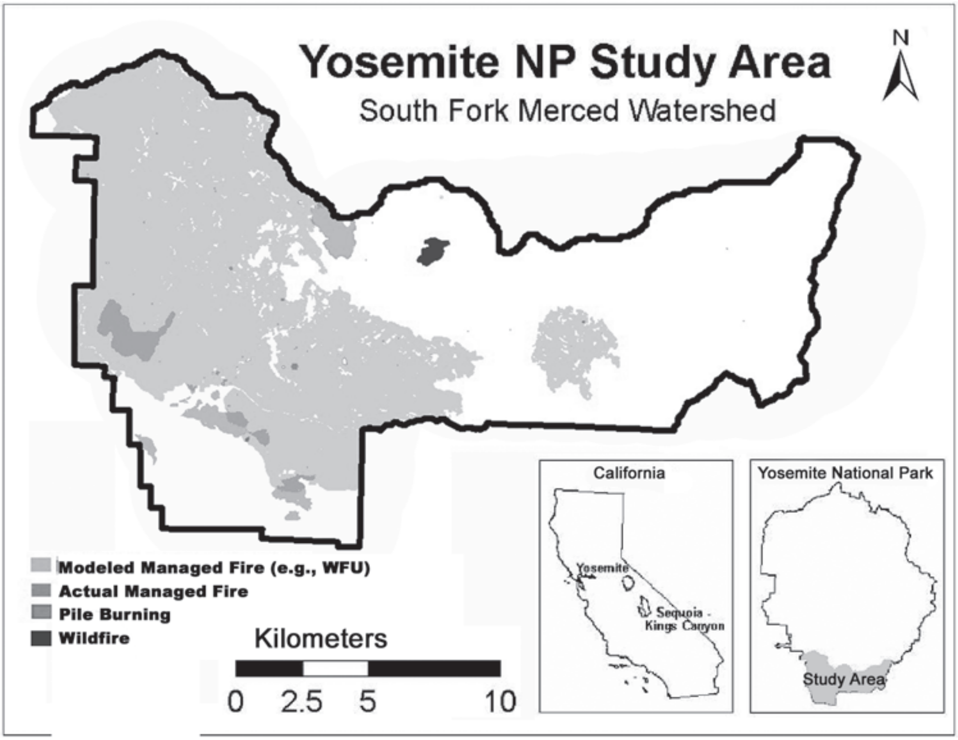


Figure 1. Spatial extent of analysis within the South Fork Merced Study Area. Only biomass from pixels in shaded areas (13,308 ha), where fire actually occurred or where it was modeled to have occurred (1994-2004), were included in this analysis.

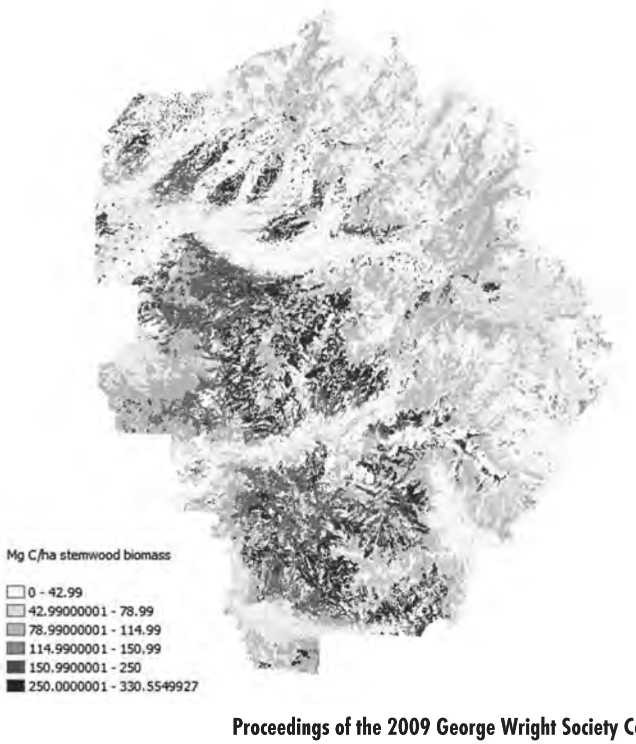
assigned a spatial fuel model (Scott and Burgan 2005), and fire spread for each suppressed lightning ignition was modeled in FARSITE (Finney 1998), using these fuel characteristics, combined with historical meteorological data from the closest available meteorological stations (Miller and Davis 2009). FARSITE is a fire modeling tool that uses spatial information on topography and fuels, along with weather and wind data to simulate wildfire behavior and spread. The specific techniques and inputs for this retrospective FARSITE modeling are detailed by Davis and Miller (in preparation). The resulting perimeters of these modeled fires define the spatial extent of this analysis (Figure 1); pixels outside these perimeters were excluded from the analysis.

Fuels and biomass quantification. In each 30 m x 30 m pixel, and at each annual time step, this analysis quantified the impact of any fire on each of five layers of biomass (duff, coarse woody debris, surface fuels, canopy fuels, and stemwood biomass). Duff and coarse woody debris were estimated in collaboration with Yosemite fire managers and fire ecologists by combining plot-level fuels measurements in the study area, and assuming those values represented the relevant vegetation type. A combination of aerial photography, plot data and expert opinion were used to create the surface and canopy fuel layers (T. Caprio, pers. com.). Succession models were used to estimate fuel consumption and the subsequent re-accumulation of surface fuels (Davis, forthcoming), but duff and coarse wood debris accumulation were not explicitly treated. Fire severity maps were used to adjust the five biomass layers in each of the 11 years.

In a separate exercise, stemwood biomass (Figure 2) was quantified using a set of over 200 1/10 hectare (ha) plots in which diameter at breast height (DBH) was measured for every tree over 3 cm DBH. The biomass in each of the major conifer species was calculated using allometric equations (Means et al. 1994). Where possible, equations represented data collected in the Sierra Nevada (e.g., *Abies* spp., *Pinus* spp.), however some data from other regions (e.g., Pacific Northwest Cascade range and the Rocky Mountains) were used for some species. To avoid overestimating biomass, trees with DBHs under the range given for each equation were not counted, and trees with DBHs that exceeded the upper end of the range were assumed to have the biomass corresponding to that upper end value and no higher. Plot biomass totals were summed and assigned to a vegetation type, both by using the 1997 Yosemite vegetation map, and by checking these values against plot-based vegetation types reported in plot notation. The average of all plots in a given vegetation type was taken as its representative value, and applied via lookup table to the Yosemite vegetation map (AIS 1997).

Variability for these preliminary stemwood biomass carbon estimates was high (relative standard deviations 50% or more), and differences between vegetation types were not necessarily statistically significant. Nonetheless, the calculated stemwood biomass values match

Figure 2. Distribution of biomass C in Yosemite. Only pixels in the 13,308 ha analysis area shown in Figure 1 were used for the purpose of this analysis.



anecdotal observations of the relative amount of biomass in these layers for the different vegetation types (M. Beasley, pers. comm.), and fall within the range and the general spatial pattern exhibited by satellite-based above-ground carbon estimates (Potter 2009; NASA).

Fire severity scenarios and biomass reduction assumptions: Fire severity estimates were the key to estimating the impact of fire on biomass. Three severity classes were used, corresponding to the effects detectible from satellite relativized normalized burn ratio (rdNBR) measurements (Miller and Thode 2007). Under this remote sensing scheme, (1) low severity corresponded to no detectable canopy reductions, (2) medium severity corresponded to some isolated torching and canopy scorch, and (3) high severity corresponded to a completely blackened canopy, indicative of nearly complete tree mortality. For the purposes of this exercise, any stemwood from a tree that was killed was assumed to be an immediate emission to the atmosphere, even though some fraction of those emissions would be the result of a more long term decay process rather than immediate combustion by fire.

Severity was calculated as a raster map in each of the 11 years of analysis, for each of three scenarios: (1) actual fire, (2) modeled fire, and (3) maximum severity fire. The same analysis that underpinned the FARSITE fire spread modeling also gave rise to these annual scenario-based severity maps. The "actual fire" scenario included all fires that actually occurred, including natural wildland fires and prescribed fires (Figure 1). The "modeled" scenario included all the above fires, plus those fires started by historically documented, suppressed lightning ignitions and modeled out to the end of the fire season. The maximum severity scenario was a one-year event that was applied in 1994. For this scenario, the maximum severity possible for each pixels fuel model was applied as a way to estimate the maximum amount of biomass reduction that could possibly be attributed to fire. Assumptions for specific consumption percentages under each of these severity classes for coarse woody debris, canopy fuels, and duff layers were based on composite burn index (CBI) values (Key and Benson 2004). In stepwise fashion, each year's fire and its associated severity were applied to each pixel, one year at a time. When the final 2004 value was reached, the five biomass layers were summed and total losses could be estimated by comparing to the 1994 totals.

Results and discussion

The resulting spatial patterns of relative carbon losses at the pixel scale (Figure 3) represent the total losses from all five biomass layers over the period 1994-2004. To show the overall effect of fire at the landscape scale, sums of the amount of biomass in each pixel over the 13,308 ha analysis area before and after each of the three scenarios are given in Figure 4.

Overall, these results showed that business as usual, as represented by the "actual fires" scenario, had little to no effect on the total amount of biomass on the landscape: they burned only 809 ha out of the 14,480 ha analysis area, releasing only .04 million metric tons carbon (MMTC) and allowing 99% of biomass of carbon to remain after the 11-year study period. Much more burned under the "modeled" fire scenario, releasing an order of magnitude more biomass of carbon (0.32 vs. 0.02 MMTC). Even though the entire 13,308 ha area of analysis burned, only 14% of the total amount of biomass on the landscape (0.32 out of 2.67 MMTC) was released to the atmosphere. Most of that 14% appears to have come from the

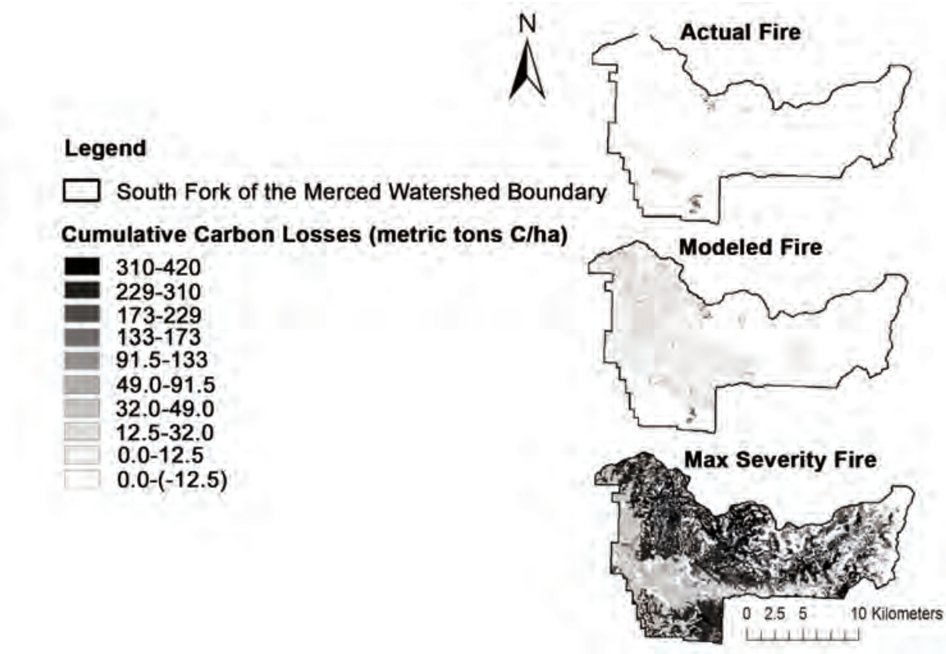


Figure 3. Actual, modeled, and maximum severity carbon losses or gains (metric tons C per ha, gains are displayed as negative values) due to fire in the South Fork of the Merced River (1994–2005).

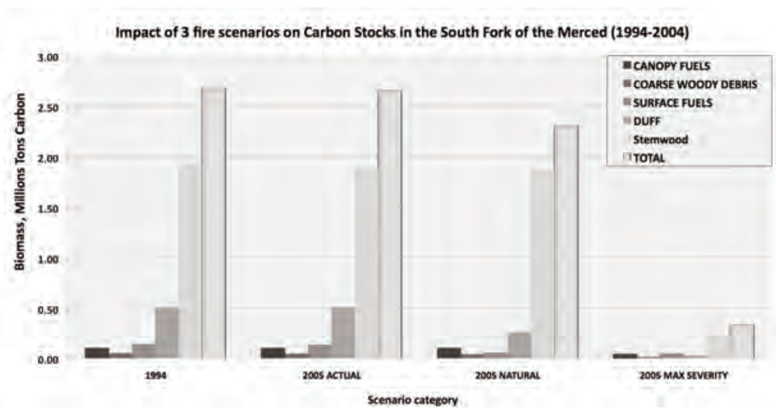


Figure 4. Sums for total C in all five biomass categories over the analysis area (13,308 ha) compared to 1994 values for three fire management scenarios. Total C drops only 14% after the natural fire, illustrating how resistant stemwood biomass, which is the bulk of this carbon sink, can be to natural fire regimes.

duff, coarse woody debris, and surface fuels layers, while canopy fuels and stemwood biomass stocks remained relatively intact (Figure 4). Some areas of high severity were seen in the modeled scenario and these could potentially have consumed that stemwood, but they did not represent enough of the landscape to reduce overall biomass substantially. Only the maximum severity fire scenario, which also burned every pixel of the 13,308 ha analysis area, but at the highest possible severity, substantially impacted the stemwood biomass, leaving only 12% (0.33 MMTC) of the landscape carbon stock intact, and releasing over 2.4 MMTC.

While these fluxes are relatively small as a percentage of the total carbon stock on the entire (~300,000 ha) park landscape (60 MMTC, just counting the stemwood), they are still very large relative to other fluxes in the Yosemite emission inventory. Net ecosystem productivity alone, at a relatively slow rate of 1 metric ton per ha per yr and taken over the entire park (approximately 300,000 ha), produces over 0.3 MMTC of losses, largely due to warming soils respiring more carbon than the photosynthesizing biomass fixes (Potter 2009; NASA). While some of these landscape and biomass based "leaks" might be recovered in subsequent, cooler years, or in less active fire years, projected net warming trends increase the probability that a substantial fraction of carbon losses from these landscapes will be "permanent" on the decadal, centennial, even millennial scales (Solomon et al. 2008).

These stocks are also much larger than even the largest fires that California has experienced. For example, a large 235,267 ha fire event in 2003 in southern California resulted approximately 2 MMTC (Potter et al. 2003). At the other end of the scale, the rest of Yosemite's greenhouse gas emission inventory (e.g., non-fire sources like mobile source emissions, heating, waste treatment) totals at most 0.02 MMTCE (Tarnay, unpublished data). The large size of this stock notwithstanding, it is not invulnerable to fire: if the above large, high severity fires become more frequent on the Yosemite landscape as the Western United States warms (Westerling et al. 2006), they have the potential to substantially reduce Yosemite carbon stocks, and dramatically increase greenhouse gas emissions. If the forests cannot regenerate fully enough to replace those big trees, these emissions and stock reductions have the potential to be permanent.

Conclusion

The sheer magnitude of Yosemite's forest carbon stocks, and the fire-driven emissions from it, have the potential to dwarf other sectors of the Yosemite greenhouse gas emissions inventory. Protecting Yosemite forests and the carbon they contain from uncharacteristically high severity fire is thus not only an ecological priority; it is a priority for minimizing greenhouse gas emissions. Our scenario-based analysis suggests that suppressing most fires (i.e., our "actual" scenario) does not necessarily protect the carbon stored in Yosemite forests. Rather, the key to protecting that carbon sink lies in preventing large tracts of high severity fire effects over the landscape. Modeled, naturally ignited fire, even though it burned 100% of the analyzed area, only released 14% of its biomass to the atmosphere, primarily because stemwood in fire adapted ecosystems is resistant to all but the most extreme fire conditions. To the extent that it can prevent uncharacteristic fire behavior by using these natural ignitions to remove understory vegetation and ladder fuels (but not the stemwood), fire management may be one of the few landscape-level tools for minimizing the potentially huge greenhouse gas emissions from our warming, fire-dependant forest ecosystems.

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Perceptions of Wildlife-associated Disease Risk: A Challenge or Opportunity for "One Health" in National Parks?

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Introduction

The "One Health" Initiative in the National Park Service (NPS), spearheaded collaboratively by the Wildlife Health Program and Public Health Program of NPS, is developing at a propitious time in the evolution of human-wildlife interactions in America. Some of us who study the human dimensions of wildlife conservation and management are concerned that many Americans may be showing signs of estrangement from wildlife. Disenchantment with human-wildlife interactions has grown during the last couple of decades, a period when experienced and perceived stresses in human-wildlife interactions have grown. We are uncertain how broadly and deeply the relationship has eroded, but disturbing symptoms of stress have been identified in what has been assumed by many in the wildlife conservation community to be essentially an indivisible relationship between Americans and wildlife. One wedge with potential to split this relationship is wildlife-associated disease and its management. To the degree a shift in attitude is occurring, all people interested in the future of wildlife conservation should be concerned.

In the context of wildlife disease/health management for protected areas such as national parks, if managers and communicators understood how people form their perceptions of wildlife-associated disease risk, One Health professionals could help curb public concern that might contribute to erosion of Americans' affinity for wildlife. Conversely, if managers and communicators do not carefully handle the language, actions and communication of the One Health Initiative, they could inadvertently cause the gaps to widen. We first provide background and evidence for our concerns and cautionary perspective. We then comment on the state of relevant empirical data in the human dimensions knowledge base. We describe briefly the importance of risk perception and communication, tying it to wildlife-associated disease and wildlife health management.

Background

Many species of wildlife have been restored during the last 100 years. Current and projected abundance and distribution of several species have expanded markedly. This, combined with human population distribution, is contributing to a remarkable rise in human-wildlife interactions. People across the landscape, and perhaps especially those living in suburban and exurban areas, are experiencing personally novel interactions with wildlife. Even farmers, ranchers, and other residents of rural areas are facing new situations with respect to wildlife.

While it is well documented that most people in the U.S. are interested in and value wildlife (USDI 2006), wildlife experts also contend that many people have concerns about co-existing with wildlife (Wobeser 2006). One can reasonably expect that these concerns temper enthusiasm for wildlife presence, whether people encounter wildlife as park visitors or neighbors of parks where wildlife are protected. Impacts of many types are demanding management attention, including disease risk (to people and domestic animals). As media coverage about diseases such as rabies, leptospirosis, Lyme disease, West Nile virus, "bird flu" (highly pathogenic avian influenza, HPAI) and chronic wasting disease (CWD) bombards the public, many wildlife species are characterized as threats to the health of livestock, companion animals, and humans. It is conceivable that over time such perceptions may contribute to wholesale change in public perspective about wildlife. We have already seen hints of this, as described briefly below.

Tracking people's experiences with wildlife over the last three-plus decades, research of the Human Dimensions Research Unit at Cornell University suggests increases in three kinds of impacts arising from human-wildlife interactions: (a) *economic* loss, (b) *safety* of people and pets, and (c) *health* of people, pets and livestock. Taken individually, perhaps none of these alone would be sufficient to reverse the largely positive attitudes Americans have demonstrated toward wildlife. Taken together, however, these human-wildlife interactions that threaten basic human health, safety and security needs are contributing to development of negative perceptions of wildlife that may be creeping toward a tipping point, or a threshold of tolerance of wildlife on the landscape.

What evidence do we have on which to base our concern? Admittedly, the human dimensions research base is thin, but a few studies provide some reinforcement for our concerns. Using CWD as an example, Wisconsin studies revealed that people dropped out of deer hunting because of concerns about CWD. One-third of hunters were concerned about eating deer because of CWD (Vaske et al. 2004).

- A study of hunters in eight western states indicated that the hypothetical combination of high disease incidence and a connection to human health risk results in cessation of hunting interest in the area affected (Needham and Vaske 2008).
- In NY, a survey of hunters and non-hunters revealed approximately 75% and 50%, respectively, were concerned about CWD with 3 out of 5 concerned respondents worried about human health (Brown et al. 2005).

CWD is not the only source of concern and hunters aren't the only people harboring concerns about disease associated with wildlife. For example, in Michigan, four out of five livestock producers, business owners and members of the general public expressed concern that deer had been found with bovine tuberculosis (TB) in northeast Michigan (Dorn and Mertig 2005).

Other studies that were not specifically designed to address wildlife-associated disease suggest a similar trend:

- In a 2007 study of suburban residents' experiences and attitudes associated with coyotes in Westchester County, New York, *every interviewee* mentioned the concern about disease associated with coyotes as a major issue for residents, even though the study focus was on encounters with coyotes that might present physical risk to people and pets and only one reported case of rabies in a coyote had been reported in the entire state in the previous 15 years (Hudenko, Siemer, and Decker 2008).
- Another recent study examined impacts from deer on community residents adjacent to the extensive open lands surrounding the Cornell University campus. Nearly 9 out of 10 residents had little or conditional tolerance of deer in their neighborhood. In addition, 59% agreed that deer in the area *create a serious safety risk* for people. Furthermore, and apropos to the One Health topic, half of the residents surveyed were *very* concerned about diseases carried by deer, with 38% believing deer present *a serious health risk*. This is in an area with no reported endemic deer-associated diseases that might normally be of concern to humans or their pets and livestock (e.g., Lyme, TB, or CWD) (Siemer et al. 2007).
- A longitudinal study of residents of the suburban community of Islip, New York, showed a marked increase in concern about Lyme disease and indicated a declining tolerance of white-tailed deer from 1984 to 1999. Concerns about Lyme disease increased strikingly, from 48% in 1984 to 96% in 1999. In 1984, over half of the Islip residents surveyed unconditionally enjoyed deer in their neighborhood, and 38% expressed some level of concern about deer. Fifteen years later, 78% expressed concerns about deer (Siemer et al. 2003; Decker and Gavin 1987).

Our cautionary perspective on the situation

We believe that the "One Health" initiative is coming at an opportune time because wildlife-associated disease is among an important set of impacts from human-wildlife interactions that may threaten basic human safety, health and security needs and cause a shift in attitudes about wildlife. Further, if predictions of wildlife-associated disease trends come to pass, the wildlife-associated disease component may soon lead the pack with respect to propelling an estrangement of humans and wildlife in many situations.

We believe this is a cause for concern, because looking forward, sustaining social support for conservation and management of wildlife, as a valued component of the environment, is uncertain, if we experience widespread reduction of public tolerance of wildlife. If we are heading toward a tipping point where the negative impacts of human-wildlife co-existence outweigh the positives, quite possibly the predicted increase in occurrence of wildlife-associated disease could accelerate an undesirable shift in Americans' attitudes about wildlife.

While none of us may want to think about the scenario we've painted, we nevertheless need to accept that it is plausible that the perception of disease-ridden wildlife could cause public sentiment about wildlife to devolve to pest status on a broad scale. This could have implications for visitation to parks where wildlife roam free and often close. Taken a step further, this scenario also suggests potential for decline in people's enthusiasm for being neighbors of parks and protected areas that could harbor wildlife that are free to roam into their backyards and their children's play grounds. Fortunately, this scenario is not a certainty, and it may be avoided (as suggested below), but we clearly need more insight on the human dimensions of wildlife disease management to guide management.

Human dimensions of wildlife health management

Many human dimensions considerations in wildlife disease management were identified a few years ago by wildlife managers and wildlife health specialists, several employed by NPS, in the process of developing a "managers' model" of the wildlife disease management system (Decker et al. 2006). They articulated the inherently anthropocentric or "human-based" motivation for wildlife disease management, emphasizing real or perceived effects of disease on some attribute of importance to *humans*. The salience of these effects, or risk perceptions, undoubtedly contributes to people's overall consideration of the value of wildlife on the landscape. If the balance of this evaluation tips toward various concerns dominating society's interest in wildlife, then the wildlife conservation community has a huge problem on its hands. Unfortunately, research provides little systematically-obtained insight about how people perceive wildlife-associated disease.

Risk perception and risk communication

The fields of risk perception and risk communication grew out of needs to manage human health hazards related to exposure to toxic wastes, nuclear power plants, or other potentially hazardous materials. Research over the last few decades has established that experts and the lay public perceive these types of risk differently (Morgan et al. 2002). Experts typically evaluate the need for management based on what is referred to as technical, objective or assessed risk that measures the probability and severity (likelihood of fatality) of a hazard. Assessed risk (our preferred term) is derived from scientific assessment, based on expert judgment, or a combination of both. Another kind of risk also plays heavily in management—perceived risk. Perceived risk is a layperson's beliefs and attitudes. That is, perceived risk has two primary components (Slovic and Peters 2006):

- Cognitive component—what people believe about the risk (e.g., its probability of causing harm).
- Affective component—how people evaluate the risk (e.g., dreadful).

Keeping in mind that perception is reality, from management and communication standpoints, public beliefs about a situation, whether based on scientific assessment of probability or not, become the reality from which people express their opinions to protected-area managers (e.g., park superintendents), elected officials, and policy makers (e.g., about parks in or adjacent to their community or landholding). Individuals make their decisions about personal and familial behavior (e.g., wildlife viewing, visiting parks) based on such perceptions. Much of what leads to impacts perceived by people is not related to the probability of harm, but rather the assessment of the potential outcome. Human dimensions research is a scientific way to improve understanding of risk perceptions. Effective risk communication addresses the target audience perceptions of risk, and focuses on what people need to know to make informed, independent judgments about risk, and improve their ability to control their exposure to risk (Morgan et al. 2002).

Risk communication and One Health

While risk communication developed out of public health concerns, it is being increasingly applied to wildlife management settings. In the context of NPS One Health, we are applying risk perception and risk communication theory to obtain insight about how people perceive wildlife-associated disease risks. By utilizing an established theoretical framework, we seek to avoid communication messages that inadvertently lead to over- or under-estimation of risk by the public. Instead, we aim to provide insight needed to develop messages that promote self-efficacy (a person's belief that he or she can take some adaptive response to reduce personal risk), societal efficacy (knowledge of actions that societal entities, such as NPS, can take to reduce exposure to risk), and response efficacy (a person's belief that an adaptive response will actually reduce a particular risk) (Evensen and Clark, forthcoming; Floyd, Prentice-Dunn, and Rogers 2000).

Concluding comments

First, do not take it for granted that the positive attitudes Americans have generally held toward wildlife are immutable. Second, we need to develop improved understanding of risk perception with respect to wildlife disease, through research into questions such as:

- What is the nature of perceived risk (cognitive and affective)?
- How do risk perceptions develop?
- To what extent are they cumulative?
- What can managers and communication specialists do to better inform people as their risk perceptions are developed?

If perceptions of risk associated with wildlife disease can be improved, perhaps the generally positive public opinion of wildlife can be sustained. We see two foci to the work ahead:

- Research-based human dimensions considerations should be integrated into comprehensive wildlife health and disease management.
- Wildlife disease management should be rapidly taking the lead as a conservation and social imperative.

We close by reiterating what may be at stake with respect to success of wildlife health and disease management. We think nothing less than the sustainability of wildlife as a valued component of the shared landscape for future generations lies in the balance. We hope in particular that the One Health Initiative in NPS contributes to ensuring that the clarion call "*No child left indoors*" is not answered by parents with the response "*No child will be allowed outdoors"* because of concerns about wildlife-associated disease.

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One Health as an Approach for Integrated Health Management in the National Park Service

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Wildlife diseases can be an important component of naturally functioning systems; however, more recently, human impacts on disease-causing organisms, their animal hosts, and the environment in which they exist, have led to emergence of diseases that are a significant concern to wildlife management in the National Park System. Traditionally, wildlife diseases have been managed in individual species or populations by melding information from veterinary medicine with wildlife biology. This approach certainly has merit in protecting valued wildlife resources, but in some cases a more expansive view may be warranted to protect health of other species as well.

The concept of One Health is an emerging integrated approach to health management. Multiple definitions of One Health have been proposed. Two of the most relevant to this discussion are as follows:

- The collaborative effort of multiple disciplines working locally, nationally, and globally to attain optimal health for people, animals, and our environment, and
- Cooperation between human and veterinary medicine and other scientific professionals to combat diseases that are shared between people and other animals (zoonotic diseases) to promote health of all species and the environment.

The concept of One Health is not new. The theory was promoted by William Osler and Rudolf Virchow in the 1800s and revived by Calvin Schwabe in the 1960s. And at the start of the 21st century it was the wildlife community, with leadership that included the Wildlife Conservation Society, which was a driving force in resurgence of One Health. Now many human and animal medicine organizations, including the American Medical Association and the American Veterinary Medical Association, have endorsed, and are promoting, the concept as a strategic change needed in health care transformation.

One Health is predicated on the fact that people, domestic animals, and wildlife share the same planet, the same ecosystems, and many of the same health threats. One Health includes more than infectious diseases, for example, water and air quality, health consequences of toxins, and effects of climate change on nutrition. However, the remainder of this discussion will focus on infectious disease as a template for application of One Health. Indeed, emerging infectious diseases have been a driver in the revitalization of One Health. At least 60% of human infectious disease agents can be acquired from other animal species and in the last 30 years, 75% of the emerging human pathogens have been zoonotic (originating in other animals), including West Nile virus, avian influenza, and Lyme disease.

Health care stewards of animals, humans, and the environment face unprecedented challenges associated with emerging pathogens, loss of biodiversity, climate change, and explosive human population growth resulting in habitat loss and increased wildlife/human interactions. Human activities reduce, modify, and degrade wildlife habitats in ways that can encourage disease emergence. Further, humans assist in the movement of pathogens around the globe, and locally domestic animal or human diseases can spillover to wildlife. Of course, wildlife are often victims of these occurrences, but often becomes viewed as the "source" or "vector" of diseases when diseases become established in wildlife populations and then threaten domestic or human health.

The National Park Service (NPS) brings humans and wildlife into proximity in natural areas. This proximity could result in negative interactions, or alternatively could provide a unique opportunity for the application of One Health-coupled systems approach to health management.

The NPS currently supports both veterinary and human medical expertise that function independently, but also perform collateral duties to *de facto* perform in a One Health approach. The NPS Biological Resource Management Division Wildlife Management and Health Program addresses servicewide wildlife health issues while the NPS Office of Public Health is charged with protection of visitor health.

The NPS Wildlife Management and Health Program is located in the Natural Resources Stewardship and Science (NRSS) Directorate. This program provides professional veterinary and wildlife management support to parks, regions, and the NPS directorate on policy and technical aspects of wildlife management, including wildlife diseases and their management, preventive health actions, and animal welfare issues. One Wildlife Health Team (including a veterinarian, biologist, and technicians) is available for disease investigation, response, and consultation with NPS units.

The NPS Office of Public Health is headquartered in the Visitor and Resource Protection (VRP) directorate, and has field staff located across the national park system. This program is charged by NPS Management Policies with identifying public health issues and disease transmission potential in the parks, and assisting park management and staff to reduce or eliminate these hazards. The Office of Public Health has a Medical Epidemiologist who coordinates disease detection and response, and leads a field staff of 10 regional consultants from various disciplines, who conduct on-site evaluations and consultations at NPS park units.

Using current funding and personnel, the Service is building a framework on which a broader, more formal One Health approach could be implemented. NPS is piloting joint disease surveillance projects, and a disease response team, as demonstration projects of the effectiveness of a One Health approach. The Service is networking with other agencies and organizations as demonstrated, for example, through membership on the national One Health Joint Steering Committee.

The NPS One Health approach contains five key focus areas: unified disease surveillance, interdisciplinary response, combined research agenda, consensus guidance, and interagency coordination.

Unified disease surveillance (detection). The two programs (Wildlife Management and Health and Office of Public Health) are working to develop, and ultimately combine, human and wildlife disease detection efforts and systems. Both programs have pilot efforts in place to detect disease transmission and outbreaks (or in wildlife, large unexplained animal die-offs). The strengths of these two systems can relatively easily be combined, improving detection capabilities, enhancing response, and increasing reporting efficiency for NPS park units (one stop shopping).

Interdisciplinary response. The two programs have recently formed a joint response team through collateral duties of a physician, a wildlife veterinarian, and a public health consultant. The team will serve as the initial Washington, D.C., office responders, and enhance park capacity to address an adverse health event involving humans and/or wildlife. The team has four objectives:

1. Facilitate rapid investigation of potential adverse human and/or wildlife health events.
2. Establish and streamline communication and response protocols, both within the NPS, and with external partners.
3. Enhance NPS capacity to respond to adverse health events and to develop interventions for disease control and prevention that are in agreement with NPS mission and policies.
4. Foster relationships between the NPS, state and local health departments, and state and federal health, agriculture, and wildlife agencies.

Additionally, efforts such as "Get the Lead Out!" while not strictly One Health projects, are excellent examples of multidisciplinary collaboration forged to improve the health of humans, wildlife, and the environment. Such examples show the importance of biologists and managers in implementing One Health.

Combined research agenda. Projects designed to explore and better define disease transmission issues within the NPS system, both wildlife and human, can be carried out using a One Health paradigm. This approach is not only an efficient use of resources but has the added advantage of providing a holistic understanding of disease transmission cycles, stresses on wildlife from human activities, and resource management issues. Further, understanding public perception of disease risk can help development of effective communication messages and intervention strategies. The NPS is just beginning to implement research to address some of these topics.

Consensus guidance. A One Health approach can provide NPS unit managers and staff with holistic, ecologically-based science guidance that they can use when making decisions about wildlife and visitor protection. Potential conflicts between management actions taken to protect wildlife and visitors can be avoided through a unified understanding of interaction of wildlife health, human health, and their environments. Examples of collaboration to reach consensus guidance have included development of a reference manual section on safe work practices for employees handling wildlife, guidance on meat donation from areas affected by chronic wasting disease, planning documents for highly pathogenic avian influenza, and recommendations on response to plague and rabies.

National interagency coordination. The NPS is a member of the national One Health

Joint Steering Committee which includes other human, domestic animal, wildlife, and environmental health agencies and organizations working toward implementation of a national One Health Commission. NPS employees also serve as leaders of One Health in their professional organizations and interagency planning efforts.

One Health is a concept whose time has come. NPS units will continue to hear more about One Health from both the Wildlife Management and Health Program, and the Office of Public Health. We encourage parks to explore local applications of the One Health approach, and to contact our staff as consultation or assistance is needed. Complementing ongoing individual discipline work with the synergy gained from a multidisciplinary One Health approach has the potential to take our efforts in environmental conservation and health to exciting new levels.

Implications of Hunting in Channel Islands National Park

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Since the creation of Channel Islands National Park, Santa Rosa Island has been the focus of struggles over Park Service management efforts. The controversy points to the ability of policy entrepreneurs to influence management of park units. It also highlights the piecemeal nature of enabling legislation for national parks, and contradictions within the Organic Act. These conflicts may have implications extending well beyond the island.

This paper grew out of a study of Channel Islands National Park. In addition to published information, this paper utilizes multiple interviews with stakeholders, and material from archival sources.

The park includes five islands (Anacapa, Santa Cruz, Santa Rosa, San Miguel, and Santa Barbara) and totals nearly 250,000 acres. The statute establishing this park was signed by President Carter on March 5, 1980 (Public Law 96-199). In addition to numerous significant natural and cultural resources, the islands experienced extensive human use prior to their acquisition by the park. Introduced domestic animals damaged habitat and disrupted eco-systems on several islands. By 1980, a number of introduced species were eliminated or removed from Santa Barbara and San Miguel Islands. Removal efforts and management hunting on Santa Cruz Island eliminated feral sheep and pigs from that island.

Introduced domestic and wild animal species were present on Santa Rosa Island at the time the park was created. The Vail and Vickers partnership operated ranching activities on the island since 1901 (Ehrlich and Vail 2000). Mule deer and elk were introduced for hunting purposes in the early 1900s, and a commercial trophy hunting operation was initiated in the 1970s.

Although "management" hunting for the purpose of maintaining healthy herds, preserving habitat, and removing non-native animals is within the overall conservation mission of the Park Service, sport or commercial hunting has been viewed as incompatible with the mission of Park Service units. Section 1 of the Organic Act identifies the fundamental purpose of these units as conservation of resources. Sport, commercial, or subsistence hunting is prohibited in national parks, except where "specifically mandated by Federal statutory law" (36 CFR 2.2 2005). The courts upheld this regulatory interpretation of the Organic Act (National Rifle Association v. Potter 1986). While Congress has authorized hunting in approximately 60 units of the National Park System that are designated as national preserves, national recreation areas, national seashores, and other types of units that are not "national parks," the only national parks that allow hunting are Grand Teton National Park, where Congress has authorized the Park Service to allow licensed hunters to act as deputy park rangers (for the park's elk reduction program) and in selected national parks in Alaska where traditional subsistence hunting has been specifically authorized.

Outside of these statutory exceptions, the only ongoing hunting activity in a national park is located on Santa Rosa Island, in Channel Islands National Park. To understand these circumstances on Santa Rosa Island, it is helpful to examine the history of the park. Although it took more than 40 years from initial recommendations until Congress created the park, the path to Channel Islands becoming a national park was similar to many parks in the system. The two largest islands were privately owned by interests that were skeptical about their inclusion in a national park. The Vail and Vickers partnership, which owned Santa Rosa Island, was initially opposed to including the island in the park. The language of the park's authorizing legislation includes several accommodations made to address political concerns associated with Santa Rosa Island.

After easy passage in the House of Representatives, the park's enabling legislation met opposition in the Senate, from California's Republican Senator S.I. Hayakawa and the Vail family. The Vail family objected to Santa Rosa Island's inclusion in a National Park. Following the defeat of a Hayakawa amendment to exclude the island, another provision was added, requiring acquisition of land on Santa Rosa be given "priority" over purchase of other privately owned land within the park. The papers of former parks sub-committee Chairman Philip Burton, contain multiple references to the desires of the Vail family, indicating that the enabling legislation's language on land acquisition was crafted with the Vail family in mind.

Once the park was established in 1980, it took several years for the Park Service to obtain sufficient appropriations for purchase of Santa Rosa Island, and conclude negotiations over terms of the purchase. The sale included a reservation of use and occupancy clause allowing Vail and Vickers to retain non-commercial use of a 7.5 acre area on the island for a period of 25 years. In addition a legislative provision permitted the park to enter a lease with them for "compatible" uses on the island.

Park Service ownership of Santa Rosa Island began in 1987. Initially, the Park Service did not establish meaningful presence on the island. Since the acquisition of the island, the park was encouraged by Republican members of the California Congressional delegation, including Senator Pete Wilson and representatives Lagomarsino, Seastrand, and Radinovich, to rapidly approve permits and take other actions favorable to Vail and Vickers. Since the park's creation, Representative Don Young (R-AK) was a key actor in efforts to influence park policy. Following the sale of the island, the park granted a five year special use permit to Vail and Vickers allowing ranching and hunting operations to continue.

Initially, the relationship between the park and Vail and Vickers was positive. Bill Ehorn, the first superintendent, and a driving force behind the development of Channel Islands National Park, developed a close working relationship with the Vail family. There may have been some understanding between Ehorn and Vail about maintaining "traditional" land uses on the island, including ranching and hunting. However, there does not appear to be documentation of any such agreement. While the Congressional record contains positive references to the Vails' management of the island, there is no language in the enabling legislation, the deed of sale, or park management documents indicating ranching or hunting activities would be permitted in the park.

In 1989, Bill Ehorn left Channel Islands to become superintendent of Redwood Naional Park. This began a shift from the personal relationships and informal understandings that appeared to shape early decisions concerning management of the island. The second superintendent of the park reported:

> My first major job when I got there was to renew the special use permit for the Vail's operation, and the original special use permit read like a special use permit that the Vail's had written permitting the Park Service to use the island. And I rewrote it to make it a Park Service document (Shaver 2007, 4).

The relationship with the former island owners changed and became strained. Concerns grew about the impact of ranching and hunting activities as park staff learned more about the population of endemic species on the island. As the park expanded its research activities, and attempted to assert greater management authority on Santa Rosa Island, its relationship with Vail and Vickers became more contentious. Park staff reported objections to research activities involving the island fox and noted that

> … the permittee pulls considerable weight politically, and the park carefully chooses the battles it wishes to fight with it. As it turned out, the park management chose not to pursue fox research on Santa Rosa (Coonan and Schwemm 1995, 22).

A source of conflict between the park and Vail and Vickers is the annual count of ungulates on the island.

The impact of Vail and Vickers operations on endangered species led to several legal actions including a suit by the National Parks and Conservation Association. A settlement agreement between the association, the Park Service, and Vail and Vickers required removal of cattle within 6 months and stipulated that it was the responsibility of Vail and Vickers to steadily reduce the number of ungulates ending with their completed removal by the end of 2011. It also stated that the ungulates on the island were the private property of Vail and Vickers (United States District Court 1998).

The status of hunting on the island was further complicated when Congressman Duncan Hunter (R-CA), the chairman of the House Armed Services Committee, pushed through highly unusual legislative provisions dealing with Santa Rosa Island. This language, included in the FY 2007 defense appropriations bill, was designed to ensure the continuation of hunting despite the court settlement. However, the language was clumsily worded and, in effect, only served to prevent the Park Service from assisting with the removal of elk and deer at the end of the settlement period. Despite efforts by Hunter and his colleague Don Young to maintain the Santa Rosa Island provision, it was repealed by the Consolidated Appropriations Act of 2008. While Vail and Vickers took no public position on this proposal, they, along with a limited number of veterans and military personnel, appear to have been its only beneficiaries. Although the motivations behind this episode remain unclear, this unusual amendment is a reminder of the impact that a single policy entrepreneur can have on the growth and development of a park.

Despite a comment by Tim Vail that "we are ranchers, not politicos" (Tiron 2006, 1), Vail and Vickers appears to have carefully crafted efforts to influence policy. The partnership has been represented in Washington by well connected advocacy firms with strong ties to the Alaska congressional delegation, including Mike Henry of Alpine Group, who is a former legislative aide for Representative Young. Tim Vail noted that Representative Young "has actively shown his support to keep the animals alive" (Tiron 2006, 1). Representative Young is among a group of Republican members of the Congress who communicated with the National Park Service and Department of the Interior on behalf of Vail and Vickers.

In 2009, trophy hunting continues on Santa Rosa Island. According to reports, trophy hunters are charged between $5,000 and $16,000 to participate in hunts (Capps 2006). According to an Assistant Secretary for Fish and Wildlife,"deer and elk hunting operations that currently close about 90 percent of the island to National Park Service visitors engaged in other recreational activities for 4 to 5 months every year" (Hogan 2006, 2).

On January 1, 2009, the park issued its final special use permit for Santa Rosa Island to Vail and Vickers. This permit "extends to the end of the period covered by the settlement agreement" and specifies that "under no circumstances will the Hunting Operation be authorized for the permittee, or any other entity, after December 31, 2011." The permit allows for hunting of deer and elk through the end of 2011 and includes a provision that the Park Service will share in "unusual" costs to remove animals remaining at the end of 2011 if, "the Permittee meets all deer and elk reduction requirements in every year prior to 2011," and meets other conditions demonstrating diligent efforts specified in the permit (NPS 2009, 8). Although detailed in the terms of special use permits and the settlement agreement, the management of deer and elk on the island has been an ongoing source of conflict between Vail and Vickers and the park. As recently as January 2009 there have been conflicts between Vail and Vickers and the park over counting ungulates and the results of those counts.

Given this controversy, there are questions about the actual number of ungulates remaining on the island. The uncertainty about the counts focuses attention on Vail and Vickers' efforts to reduce the number of animals on the island. These efforts, and their results, are particularly important to Vail and Vickers, given the potential costs if ungulates remain on the island at the end of 2011.

Discussion

This study is not complete. Although there is considerable information about forces shaping the issues described in this paper, more information is needed about the role of members of Congress, lobbyists, interest groups, and leadership within the Department of the Interior in decision making concerning Santa Rosa Island. Although this study benefited from interviews with many stakeholders, as of the time of this writing, we were not able to interview any of the principals in the Vail and Vickers partnership.

Although a period of transition may occur when units are integrated into the Park Service, this transition is still not fully complete, more than 30 years after Santa Rosa Island came under park ownership. Throughout this period, it appears that the park's ability to establish and enforce management authority over the island has been limited due to a combination of legal, organizational, and political constraints. These experiences may have implications for a range of pre-existing uses in units throughout the Park Service.

The Organic Act offers general guidance for the operation of national parks and similar units. However, in the case of Santa Rosa Island, neither the Organic Act, nor the park's enabling legislation appears to have been sufficient to ensure that pre-existing uses were managed in a manner consistent with the norm for parks in the system. Martin Nie writes, "Sometimes conflict is caused, or at least not resolved, due to what is in a law" (2003, 5329. He points to references to recreation and conservation in the Organic Act as an example and notes that, despite a significant body of legal and administrative precedent, "various interests have used the 'recreation mandate' as a way to challenge park decisions they do not like" (Nie 2003, 529). To obtain political support for park expansion or acquisition, the Park Service has accommodated pre-existing uses within park units, sometimes with long lasting implications. A senior Park Service official (Anonymous 2007), observed reserved or special uses granted to prior owners, like Vail and Vickers, often produce conflict near the end of the term:

> … they put up a fight and they put up every possible way that they fight it. Public forums, in the media, they fight it with lobbyists, they fight it politically with members (of Congress) that they have. They attack us on our science, they attack us on our polices. They use every possible way to keep the Park going.

The assessment more than a quarter century ago that "Congress has yet to articulate a comprehensive national scheme to meet the problems of incompatible private land uses" (Sax 1980, 711) remains an accurate description of the situation at Channel Islands. The reliance on piecemeal provisions in enabling legislation and limited effective policy guidance from Congress leave open the door for continual efforts to redefine policy by interest groups and policy entrepreneurs. Struggles over hunting on Santa Rosa Island directly impact Channel Islands National Park, but they also are a stage on which to fight broader policy battles over hunting in parks. While hunting activities on Santa Rosa Island appear destined to cease at the end of 2011, there are significant incentives for lessees to prolong the presence of ungulates on the island and draw the Park Service into a situation where it is forced to participate in the removal of these animals. Given the island's recent past there are likely to be further conflicts before the final history is written about hunting and introduced species in Channel Islands National Park.

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Declines in Yosemite's Bird Populations

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Introduction

Birds are sensitive indicators of environmental change in terrestrial ecosystems (Hutto 1998). Long-term monitoring programs, such as the Breeding Bird Survey and the Christmas Bird Count, provide invaluable data on spatial and temporal changes in bird abundances and population trends. However, population-trend data on Neotropical migrant birds, while suggesting alarming declines in some species, provide no information on primary demographic parameters (productivity and survivorship). Without demographic information, population-trend data alone provide no means for determining at what point(s) in the life cycles problems are occurring, or to what extent population trends are driven by causal factors that affect birth rates, death rates, or both (DeSante 1995). The lack of such information for migratory birds in particular is an obstacle to effective conservation actions, as it leaves unresolved whether critical problems that drive population declines are occurring primarily on temperate breeding grounds, during migration, or on distant tropical wintering grounds.

The Monitoring Avian Productivity and Survivorship (MAPS) program was established in 1989 by The Institute for Bird Populations to provide long-term demographic data on birds to aid in identifying the causal factors driving population trends (DeSante et al. 1995). In 1990, the MAPS program was established in Yosemite National Park, and Yosemite now hosts some of the longest-running MAPS stations in the country. Yosemite's MAPS stations provide reference points for assessing the effects of land use and land cover changes on bird populations throughout the larger geographic area (Silsbee and Peterson 1991). These changes may result from regional activities such as land conversion and forest management, or from broader-scale processes such as climate change. Monitoring vital rates and population trends at 'control' sites in national parks is especially important because the parks are among the few sites in the United States where population trends due to large-scale regional or global change patterns are relatively unconfounded with local changes in land-use practices (Simons et al. 1999).

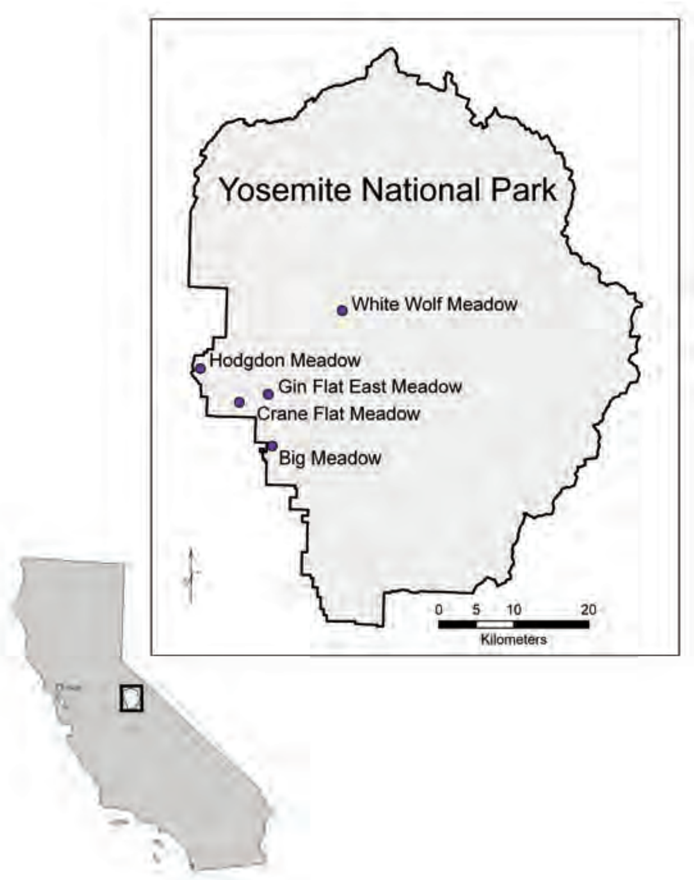
In Yosemite National Park, the MAPS stations target 25 species, including Neotropical-wintering migrants, temperate-wintering migrants, and permanent residents. Using MAPS data, the objectives of this study were (1) to determine if bird populations have changed significantly in Yosemite since the establishment of the Yosemite MAPS stations, (2) to identify proximate demographic causes of those population changes, and (3) to investigate how climate change may be affecting bird population dynamics by examining possible upslope shifts in one group of closely related species.

Methods

We operated five MAPS stations in Yosemite National Park at the same locations each year (Figure 1). The five MAPS stations, located along an elevation gradient in wet montane meadow surrounded primarily by conifer forest (except for Big Meadow which is located in riparian willows and mixed conifer forest that was largely consumed by a stand-replacing fire in 1990) from highest to lowest, were the following: (1) White Wolf Meadow, 2,402 m elevation; (2) Gin Flat Meadow, 2,073 m elevation; (3) Crane Flat Meadow, 1,875 m elevation; (4) Hodgdon Meadow, 1,408 m elevation; and (5) Big Meadow, 1,311 m elevation (Figure 1). The Hodgdon Meadow station was established in 1990, followed by White Wolf, Crane Flat, and Big Meadow in 1993, and Gin Flat Meadow in 1998. Station operation and data collection followed standard MAPS protocol (DeSante et al. 2008).

We identified 25 target species with adequate sample sizes for estimating adult population size, productivity, and survivorship. For each target species and for all species pooled, we examined 16-year trends in adult population size and productivity using data from all five

Figure 1. Locations of five Monitoring Avian Productivity and Survivorship (MAPS) stations in Yosemite National Park, California.



stations combined. For trends in population size, we first calculated adult population indices for each species for each of the 16 years, based on an arbitrary starting index of 1.0 in the first year of station operation or analysis. Year-to-year changes were used to calculate chain indices in each subsequent year by multiplying the proportional change between the two years times the index of the previous year, and adding that figure to the index of the previous year. We then used linear regression to determine the slope of these indices over time. Trends in productivity were calculated in an analogous manner by starting with actual productivity values in 1993 and calculating each successive year's value based on the constant-effort changes in productivity between each pair of consecutive years. For a more detailed explanation of trend analyses, see Pyle et al. (2006).

For each target species, we also calculated annual apparent survival rates of adult birds using modified Cormack-Jolly-Seber (CJS) mark-recapture analyses (Lebreton et al. 1992). These analyses were based only on capture records from the 14-year period 1993–2006. Using the computer program TMSURVIV (Hines, Kendall, and Nichols 2003), we calculated, for each target species, maximum-likelihood estimates and standard errors for adult survival probability, adult recapture probability, and the proportion of residents among newly captured adults using a between- and within-year transient model (Pradel et al. 1997; Hines, Kendall, and Nichols 2003). For a more detailed explanation of survivorship calculations, see Pyle et al. (2006).

In bird species, both productivity and survival vary with body mass: on average, the larger the bird species the lower the annual productivity and the higher the annual survival. To assess whether or not productivity and survival of a given species at Yosemite was as expected, lower than expected, or higher than expected based on its body mass, we regressed productivity indices and survival-rate estimates against body mass (log transformed to normalize the values) for all target species, and compared productivity indices and survival-rate estimates for individual species to the regression lines produced by these fits. We also compared productivity indices and survival estimates for each target species at Yosemite with values obtained from the Northwestern MAPS region as a whole (www.birdpop.org/nbii/NBIIHome.asp).

To investigate the possible role of climate change-driven elevation shifts in driving observed population changes, we focused on *Empidonax* flycatchers, a suite of closely related species in which population changes appear to have been substantial. For dusky flycatcher, willow flycatcher (*Empidonax traillii)*, Hammond's flycatcher (*Empidonax hammondii)*, and Pacific-slope flycatcher (*Empidonax difficilis)*, we assessed trends in demographic parameters at higher- versus lower-elevation MAPS stations, and examined how the abundance of each species relative to one another changed over time at each station.

Results

Populations of 12 species as well as all species pooled showed substantial declining trends ($r \leq -.3$ for a 16-year trend) (Table 1; all tests used $p < .05$ for statistical significance). The declines for golden-crowned kinglet, hermit warbler, chipping sparrow, and lazuli bunting were highly significant; those for western wood-pewee, dusky flycatcher, yellow warbler, dark-eyed junco, and purple finch were significant; that of warbling vireo and black-headed grosbeak were nearly significant, and those of hermit thrush and all species pooled were not significant. In contrast, populations of only five species showed substantial increasing trends ($r \geq .3$), which were highly significant for mountain chickadee, MacGillivray's warbler, and western tanager, and nearly significant for yellow-rumped warbler and song sparrow. Populations of the remaining eight target species showed non-substantial (absolute $r < .3$) trends. The trend for all species pooled is decreasing at a rate of –.9% per year, suggesting that total populations of landbirds in Yosemite have declined by 14.5% over the 16-year period (1993–2008).

For the same 25 target species, five species showed substantially declining productivity trends ($r \leq -.30$), which were highly significant for lesser goldfinch, significant for hermit thrush, marginally significant for Hammond's flycatcher and MacGillivray's warbler, and not significant for western wood-pewee. In contrast, 11 species as well as all species pooled showed substantially increasing productivity trends ($r \geq .30$). Overall, 15 of the 25 target species had positive productivity trends and ten had negative productivity trends. The productivity trend for all species pooled indicated an average annual increase of .027 per year.

Using 14 years of data (1993–2006) from all five stations, we obtained estimates of adult survival and recapture probabilities for 31 breeding species, including the 25 target species. Estimates of annual adult survival rate ranged from a low of .176 for golden-crowned kinglet to a high of .896 for Cassin's finch (*Carpodacus cassinii)*, with a mean of .485. Recapture probability varied from a low of .005 for Cassin's finch to a high of .678 for black phoebe (*Sayornis nigricans)*, with a mean of .263.

Empidonax flycatcher population dynamics changed at each station during the 14-year period 1993–2006 (nine-year period, 1998–2006, at Gin Flat Meadow) (Figure 2). Willow flycatcher has clearly declined in the Yosemite region as a whole, with a regression on adults per 600 net hours at all five stations combined indicating a significant decline ($r = -.735$, $p =$

Table 1. Assessment of vital rates for 18 species showing substantially decreasing or increasing 16-year (1993–2008) population trends at five long-running stations in Yosemite National Park.

Species	Trend and Significance[1]	Productivity	Survival Probability[2]
A. Decreasing Species			
Western Wood-Pewee (*Contopus sordidulus*)	- 3.8 **	slightly low	high
Dusky Flycatcher (*Empidonax oberholseri*)	- 3.2 **	low	slightly low
Warbling Vireo (*Vireo gilvus*)	- 1.5 *	low	expected
Golden-crowned Kinglet (*Regulus satrapa*)	- 6.1 ***	high, increasing	low/high
Hermit Thrush (*Catharus guttatus*)	- 2.7	slightly low	slightly low
Yellow Warbler (*Dendroica petechia*)	- 4.0 **	slightly low, increasing	high/as expected
Hermit Warbler (*Dendroica occidentalis*)	- 4.1 ***	high	high/as expected
Chipping Sparrow (*Spizella passerina*)	- 5.0 ***	low	as expected/high
Dark-eyed Junco (*Junco hyemalis*)	- 1.7 **	slightly high	as expected
Black-headed Grosbeak (*Pheucticus melanocephalus*)	- 3.0 *	slightly high, increasing	as expected
Lazuli Bunting (*Passerina amoena*)	- 6.8 ***	slightly low, increasing	high
Purple Finch (*Carpodacus purpureus*)	- 4.3 **	slightly high, increasing	unknown
B. Increasing Species			
Mountain Chickadee (*Poecile gambeli*)	20.6 ***	as expected, increasing	low
Yellow-rumped Warbler (*Dendroica coronata*)	5.5 *	slightly high	slightly low/low
MacGillivray's Warbler (*Oporornis tolmiei*)	8.3 ***	as expected, decreasing	slightly high/as expected
Song Sparrow (*Melospiza melodia*)	2.9 *	slightly high	unknown
Western Tanager (*Piranga ludoviciana*)	10.3 ***	as expected	high

[1] Significance of the declines in numbers of adults captured (*** $P < 0.01$, ** $0.01 \leq P < 0.05$, * $0.05 \leq P < 0.10$)

[2] Survival assessments are based on two comparisons: (1) with the expected value for the species based on body mass and (2) with survival in the Northwestern Maps region as a whole. When only one assessment is given it indicates that both of these comparisons coincided.

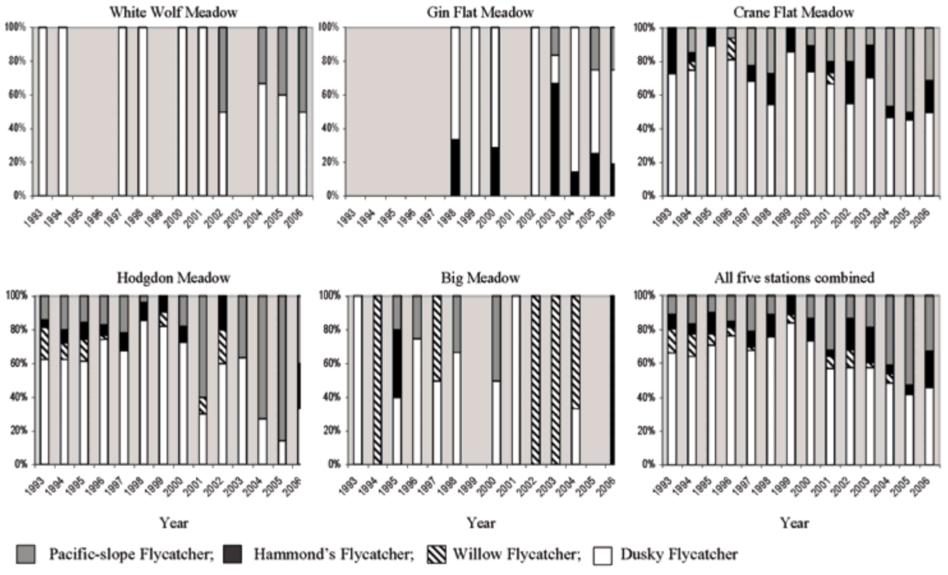


Figure 2. Proportion of the catch of adult *Empidonax* flycatchers comprised by each *Empidonax* species at five MAPS stations in Yosemite National Park, and at all five stations pooled, over the 14 years 1993–2006.

.003). Although still commonly encountered throughout the park, dusky flycatcher has also declined significantly at the Yosemite MAPS stations (r = -.810, p < .001), with the declines most prominent at the lower elevation stations, Hodgdon Meadow (r = –.918, p < .001) and Big Meadow (r = –.472, p = .089). A non-significant decline in Dusky Flycatcher was also noted at Crane Flat (r = –.411, p = .144), whereas at the two higher elevation stations, Gin Flat and White Wolf Meadows, populations show non-significant increases.

For Pacific-slope flycatcher, populations pooled across all stations have increased slightly (r = .353, p = .216), but examination of station-specific trends suggests up-slope shifts: populations have declined non-significantly at the lower elevation stations (Big Meadow and Hodgdon Meadow where the species has historically occurred in greater abundance than at the higher stations), whereas they have increased significantly at all three higher-elevation stations, Crane Flat (r = .675, p = .008), Gin Flat Meadow (r = .735, p = .037), and White Wolf (r = .756, p = .002). Likewise, although no population trends were significant for Hammond's flycatcher, populations have declined at the two lower-elevation stations (Big Meadow and Hodgdon Meadow), and have increased at the two higher-elevation stations where the species is captured, Crane Flat and Gin Flat Meadow.

Discussion

Populations of adult birds of all species pooled at MAPS stations in Yosemite have shown a substantial decrease of –.9% per year from 1993–2008. While this may not seem to be a large annual decline, when compounded over 16 years it represents a 14.5% decline. Sixteen-year population trends were negative at all four long-running stations, with 12 of 25 target species showing declines. In contrast, populations of only five species showed substantial 16-year increasing trends. Comparison of long-term population trends at Yosemite with long-term BBS trends from the Sierra Nevada physiographic strata and MAPS results from elsewhere in the Sierra suggests that population trends of most declining species at Yosemite are part of a broader Sierra-wide decline (DeSante, Pyle, and Kaschube 2005; Siegel and Kaschube 2007).

The estimated annual adult survival rates at Yosemite (calculated only for the period 1993–2006) appear to be relatively high compared with values for the Northwestern MAPS region as a whole (1992–2001; see www.birdpop.org/nbii/surv/default.asp). Estimates are higher than those of the Northwest Region for 20 of 29 species for which this comparison could be made, with a mean annual adult survival rate at Yosemite (.485) that was 3.0% higher than that of the Northwest Region (.471). In addition, DeSante et al. (2005) found that 11 of 17 species showed higher survival at Hodgdon Meadow than at equivalent elevations in Kings Canyon National Park. This suggests that survival of birds breeding at Yosemite is relatively high, overall.

Productivity on the breeding grounds appears to drive population declines or increases in Yosemite more than annual adult survival. We found that lower-than-expected productivity appears to be driving or contributing to the population declines of seven of the 12 declining species, whereas lower-than-expected survivorship appears only to be affecting the declines of one species (Table 1). Similarly, it appears that higher than expected or increasing productivity may be driving the population changes of three increasing species, whereas higher survival may be contributing to increases in two species (Table 1). Thus, overall, it appears that productivity at Yosemite is driving or influencing the population dynamics of ten of the 17 species showing substantial trends. Productivity is presumably affected by events on the breeding ground, thus declines in these species could be within the Park's ability to influence, through stewardship and/or management action.

Willow and dusky flycatchers are clearly declining in the Yosemite region as a whole. For dusky flycatcher, declines are most noticeable and significant at the lower elevation stations (Hodgdon Meadow and Big Meadow) and they are slight and non-significant at the mid-elevation Crane Flat station, whereas at the two higher elevation stations, Gin Flat and White Wolf, we see no evidence of declines. A similar pattern (though non-significant) is apparent for Hammond's flycatcher. For Pacific-slope flycatcher, populations have declined non-significantly at the lower elevation stations where the species has historically been more abundant than at the higher stations; and they have increased significantly at all three higher-elevation stations. Thus, populations of the three more-abundant *Empidonax* flycatcher species appear to be shifting upslope. For Hammond's and Pacific-slope flycatcher, this could suggest that ranges are actually extending up into higher elevations than in previous years. However, for dusky flycatcher, which already nests up to tree-line in the park, our results may indicate the beginning of a contraction in the species' range (with the low-elevation boundary moving upslope), rather than an expansion of the upslope boundary of the range.

If confirmed by more spatially extensive data collection, these upslope shifts are consistent with recent evidence suggesting upslope shifts of other montane taxa throughout North America, associated with global warming (e.g., Parmesan and Yohe 2003; Moritz et al.

2008). Furthermore, they may be bellwethers for more extensive changes in the elevational distribution of Yosemite's landbirds. The recent extirpation of Yosemite's breeding willow flycatchers (Siegel, Wilkerson, and DeSante 2008) and the park's declining bird populations associated with low productivity attest to the potential vulnerability of bird populations even in relatively pristine environments like Yosemite.

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Revisiting Spatial Patterns of Lightning Strikes and Fires in Yosemite National Park

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Introduction

In 2008, California experienced a dry lightning episode on June 21st that produced over 2,000 ignitions. During that time Yosemite National Park had only one start, which was suppressed. In early July, as California was experiencing smoke impacts from the June fires, Yosemite received 11 additional lightning ignitions over a five day period. Despite originating in the Fire Use Unit which would have allowed them to burn under prescribed conditions, all but two of the fires were suppressed due to air quality and resource availability concerns. Although the Sierra Nevada in California have an extensive history of lightning strikes and subsequent fires (van Wagtendonk et al. 2002; van Wagtendonk and Fites-Kaufman 2006), managers must consider factors other than ecology when deciding whether to suppress a fire. Yosemite National Park's extensive fire records (1930 to the present) have facilitated a study of the spatial distribution of lightning fire ignitions (van Wagtendonk 1994). Most of these fires were suppressed under the national fire policy of the time and could not be assessed in terms of fire size and area burned. In 1972, a Prescribed Natural Fire (PNF) program was established in Yosemite, allowing lightning ignited fires to burn under prescribed conditions (van Wagtendonk 2007). This paper revisits van Wagtendonk's (1994) analysis and updates it with fires from 1994 to 2007. Additionally, the distribution of the 2008 suppressed fires was compared to the results from this analysis. These fires were then modeled in FARSITE to determine potential fire size and acres burned had they not be suppressed.

Yosemite National Park covers 747,955 acres of the central Sierra Nevada in California and varies from 2,000 feet in elevation in the west, to 13,000 feet along the crest of the range. Along the elevation profile while travelling west to east, distinct vegetation communities can be seen. Lower montane forests occur between 2,000 and 6,000 feet, upper montane forests from 6,000 to 8,000 feet, and subalpine forests from 8,000 feet to tree line at 11,000 feet.

The Mediterranean climate of Yosemite is characterized by warm, dry summers, and cool, wet winters, with precipitation primarily occurring between November and April. However, a monsoonal flow from the south and southwest creates numerous thunderstorms, and is responsible for lightning and rain in the summer. At the lower elevations, where burnable vegetation is abundant, lightning is less frequent. The converse is true for the higher elevations: abundant lightning, sparse vegetation. The mid slope elevations are the confluence where lightning fire numbers and acres burned are maximized.

Methods

The same 1,000-foot elevation zones and 27 vegetation types grouped into eight categories by van Wagtendonk (1994) were used to determine the number of lightning ignitions and area burned, in elevation and vegetation categories. For the 2008 analysis, fire data from Yosemite National Park's fire history GIS spatial database were used. These data were updated each year at the completion of the fire season, dating back to 1930. Actual ignition point data were available for some fires, but where those data were not available, the center of each fire perimeter was calculated. These points were used for the spatial analysis of lightning ignition patterns. The 10-meter digital elevation model (DEM) was used to determine the elevation of the ignition, and the number of acres burned, in each of the eleven 1,000-foot elevation zones. The Yosemite 2004 Fire Management Plan/Environmental Impact Statement fire management units were used to determine how many fires could have been managed under the policy of Wildland Fire Use (WFU), which replaced PNF in 1998.

The ignition points for the 2008 fires were obtained from GPS points fire personnel assigned to those fires, while the elevation of each fire was determined using the 10-meter DEM. Nine of the 2008 ignitions were then modeled for growth using FARSITE (Fire Area Simulator, Finney 1998), three of which were modeled as a single ignition, point due to their timing and proximity, resulting in seven fires simulated. FARSITE is a fire modeling tool that uses spatial information on topography and fuels, along with weather and wind data, to simulate wildfire behavior. Due mainly to homogeneity in the fuel model inputs, FARSITE has a propensity to over-predict fire growth. To help compensate for this potential source of error, the model was only run when the Energy Release Component (ERC) was at or above the 90th percentile. The ERC is an index related to potential available energy that could be released by a fire, and is driven mainly by fuel model and fuel moistures. ERC was calculated from actual weather conditions gathered by the White Wolf remote automated weather station (RAWS). Based on advice from local fire managers, fire growth was simulated for eight hours per day when the ERC was at or above the 90th percentile and for a full 24 hours per day when the ERC was at or above the 97th percentile. The simulation was paused when the ERC dropped below the 90th percentile and resumed when ERC increased back to the 90th percentile. The vast majority of fire-growth occurs on these 'extreme' fire-weather days and will therefore be captured using these parameters. Simulations were terminated when the ERC dropped below the 90th percentile and didn't recover for the remainder of the fire season.

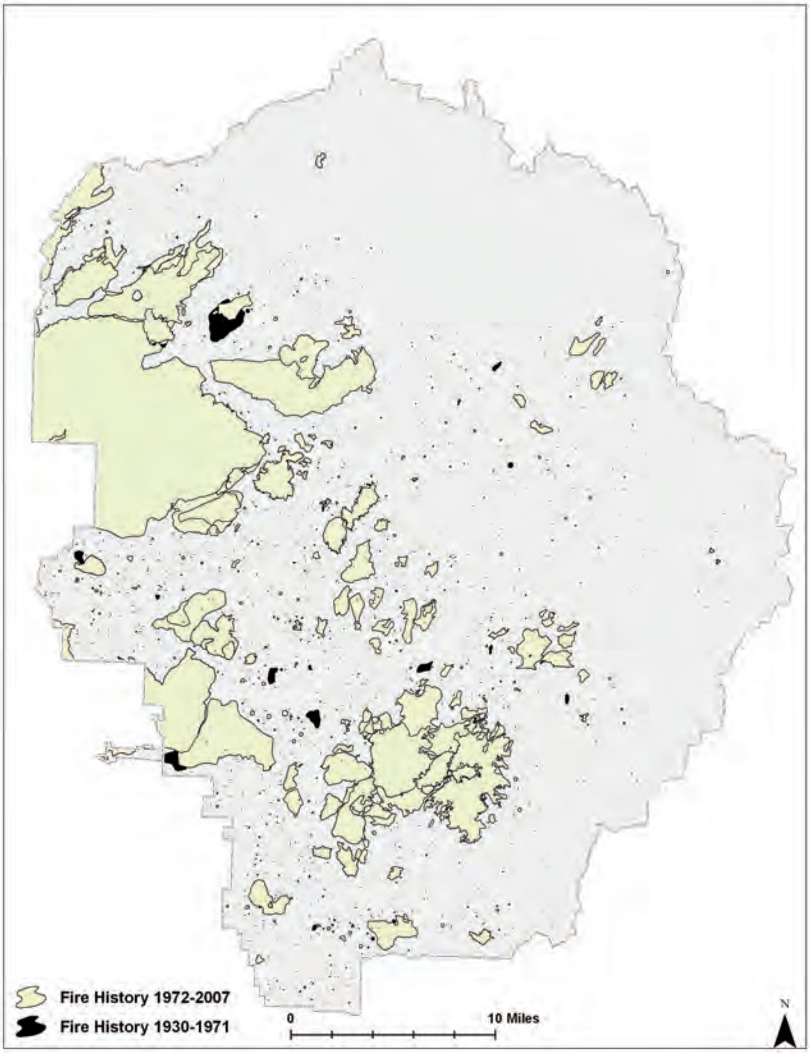
Results

Between 1930 and 1993, a total of 2,659 lightning fires burned in Yosemite National Park (van Wagtendonk 1994). The 7,000 to 8,000 foot elevation range had the most fires and acres burned in the park, with 744 fires burning 27,693 acres, accounting for one-third of the total area burned for that time period. After policy created the PNF zone in 1972, Yosemite recorded 1,095 fires in that zone. Of those fires, 908 were under ten acres, while the remaining 187 were ten acres or greater. The main reason for the large number of small fires was the fact that 633 fires were suppressed, despite originating in the PNF zone. Another reason is that many fires, especially in the PNF zone, were in areas of sparse vegetation and simply went out before reaching any significant size.

From 1993 through 2007, an additional 475 lighting ignitions were added to the data set, burning an additional 108,736 acres. This brought the total number of lightning fires since 1930 to 3,134, and the total number of acres burned to 181,278. Between 1930 and 1971 only 7,707 acres had burned due to lightning, but since 1972, 173,571 acres have burned (Figure 1). This is primarily due to the policy change that allowed the Park to manage fires for resource benefit, but also partly to the fuel accumulation from fire exclusion.

The total number of fires between 7,000 and 8,000 feet through 2007 increased to 888 fires that burned 46,498 acres, the largest numbers for any of the elevation zones (Figure 2). There is a normal distribution for fires by elevation and to a lesser degree for acres burned. However, there is a sharp decrease above 8,000 in acres burned, despite a large number of

Figure 1. Map of lightning fire history for Yosemite National Park. The dark areas show the 7,707 acres that burned from 1930 to 1971. The light areas represent the 173,571 acres burned from 1972 to 2007.



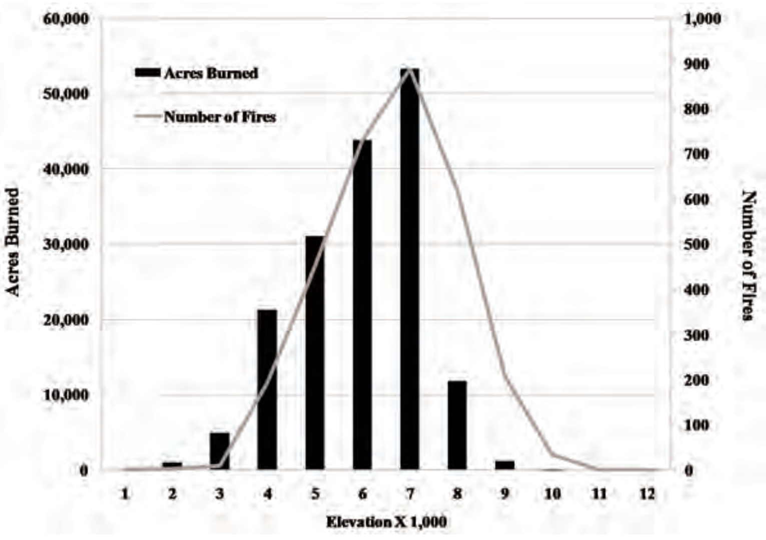


Figure 2. Distribution of lightning fires and acres burned by elevation. The left axis shows number of acres burned and corresponds to the dark bar graph. The right axis is for the light line showing the number of fires.

fires. These subalpine forests have a shorter growing season so are less productive than the vegetation communities lower in elevation, resulting in less available fuel and a shorter fire season. But just down slope, the upper montane vegetation community between 6,000 feet and 8,000 feet has the most lightning fires and acres burned in the park.

Between 1930 and 1971, Yosemite had 1,341 lightning ignited fires, while 1,793 occurred between 1972 and 2007. A total of 92% of these fires were less than ten acres in size. In this size class, between 1930 and 1971, there were 1,308 fires, and between 1972 and 2007 there were 1,594 fires. This increase, however, is much less than the increase of larger fires since 1972. For fires larger than 10 acres, there was an increase from 33, prior to 1972, to 199, as a result of the policy change that allowed for fire to return to the previously fire-excluded ecosystem (Figure 3). Based on the 2004 Fire Management Plan/Environmental Impact Statement fire management units, a total of 1,213 fires occurred within the WFU unit from 1972 through 2007. Out of all these fires, 48% were suppressed.

The FARSITE predictions for the seven fires occurring between July 8 and 13, 2008, did not initiate growth until August 1st, which was the first day since ignition that the ERC was at or above the 90th percentile. Some of the fires could have gone out between their ignition and August 1st. There were 29 days during the simulation where the ERC was above the 90th percentile, seven of which were above the 97th. As a result, FARSITE was 'burning' the landscape for eight hours per day for 22 days, and for 24 hours per day for seven days. On September 17th, the ERC fell below the 90th percentile and didn't recover before the end of the season, thus ending the simulation. Of the seven fires that were modeled (Figure 4), the Ten was the smallest, at 240 acres. The Cascade was predicted to grow to 4,767 acres, while the Flat, Hill, Cabin, Starr King, and PCF were predicted to grow together to

Figure 3. Fire size class with respect to PNF policy: 3,134 lightning fires have been detected in Yosemite National Park between 1930 and 2007.

Size in Acres	1930-1971	1972-2007	1930-2007	Percent
0-0.25	942	1,011	1,953	62.32
0.26-9.9	366	583	949	30.28
10-99.9	23	82	105	3.35
100-299.9	5	48	53	1.69
300-999.9	3	32	35	1.12
1,000-4,999.9	2	30	32	1.02
5,000+	0	7	7	0.22
Total	1,341	1,793	3,134	100

reach 36,550 acres, 22,730 acres of which burned in the WFU Unit.

Discussion

Fire history. In 2008, Yosemite had 12 lightning-ignited fires, 10 of which were suppressed despite originating in the WFU unit. The two fires that were managed as WFUs occurred above 9,700 and went out naturally. The ten fires that were suppressed ranged in elevation from 6,800 to 9,600 feet. Independent of recent fire history, weather, vegetation, smoke impacts, and fire resource availability, the data showed that the four fires above 8,000 feet could have been managed for resource benefit, because fires in the subalpine zone rarely grow to any significant size. The caveat, though, is whether red fir is part of the vegetation community, since it burns well and can be found above 8,000 feet. The other six fires occurred in the upper montane community, where the most fires and acres burned resulted.

Technology and policy. With the new 2009 fire policy, Yosemite will be able to manage a fire if it does move into the suppression unit and is not threatening values at risk. Fires could be managed for suppression near communities, and for resource benefit in areas that have had fire excluded for decades, yet pose no risk to anthropogenic features. With fire being treated as fire, thus eliminating the distinction between WFU and Suppression, Yosemite can more easily work towards its goal of acres treated by fire each year. Previously all lightning fires in the Suppression Unit could not be counted to achieve that goal. Now a fire can be managed for multiple objectives and, where applicable, acres treated can be counted even if part of that fire was being suppressed.

Additionally, technological tools like GIS and fire modeling that utilize a wide range of data can assist in determining how fires should be managed. Timely synthesis and presentation of this data in a meaningful manner is essential to making the right decision in fire management.

2008 California fires. 2008 was a challenging year for fire management in California, with many fires burning simultaneously throughout the state. This resulted in tremendous smoke emissions, and a drawdown of fire fighting

Name	Start Date	Elevation	Size
Old Tioga	6/21/2008	6,791	0.1
Pack	7/8/2008	6,921	0.1
Clark	7/8/2008	6,927	0.1
Fork	7/8/2008	6,931	0.1
Cabin/Arch	7/13/2008	7,334	6.0
Cascade	7/8/2008	7,580	0.1
Starr King	7/8/2008	8,006	0.1
Hill	7/10/2008	8,128	12
Flat	7/13/2008	8,131	0.1
Ten	7/13/2008	9,597	0.1
Sunrise	7/13/2008	9,738	0.1
Lewis	7/13/2008	10,371	0.1

Figure 4. 2008 fires. Fires are sorted by elevation. Start date and final size are also shown. The Old Tioga was not modeled in FARSITE, nor was the Sunrise or Lewis, which were managed for resource benefit, and self-extinguished. The Pack, Clark, and Fork fires were modeled as one fire.

resources. Yosemite, on the other hand, had a relatively quiet fire season, but did face smoke issues from the statewide fires, as well as the Telegraph Fire that burned near the park. Yosemite had many fires to choose from to manage for resource benefit, but managers understood the larger context in which they were operating, and chose to suppress all but two lightning fires. An interesting analysis that can be done in the future would be to calculate smoke emissions from the FARSITE modeled fires, and compare them to those calculated for the entire state. All major fires in the state were out by the time that FARSITE started modeling the Yosemite fires (August 1st).

Smoke levels measured at Yosemite Valley were in the good and moderate categories from the beginning of fire season until Yosemite started receiving smoke from the numerous fires in California. The Telegraph also impacted air quality in the park at the end of July. By August 1st, the air quality in Yosemite Valley returned to good and moderate with respect to human health impacts and remained so through the end of the fire season.

Decision support system. Yosemite has determined that a decision support system is needed to assist in how it manages fires. Data are being organized in a manner that will make its dissemination easier and more efficient. Included in this system would be the fire history analyses, Fire Return Interval Departure calculations, fuel succession models, FARSITE predictions, smoke emission models, historic weather records, topography, etc. Having an integrated approach can only help as the new fire policy is implemented in the face of global climate change.

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What If We Didn't Suppress Wildfires?

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The suppression of lightning ignited wildfires removes one of the most important natural processes from fire dependent ecosystems, yet resource specialists currently have no way of measuring or monitoring the effects of these management actions. Using Yosemite and Sequoia-Kings Canyon National Parks as case studies, we retrospectively and chronologically modeled suppressed lightning ignitions. We use the results of this analysis to illustrate the effects that past fire suppression decisions have had on these study areas.

FARSITE (Finney 1998) was used to determine where lightning ignitions may have spread had they not been suppressed. FARSITE is a fire modeling tool that uses spatial information on topography and fuels, along with weather and wind data to simulate wildfire behavior. Each suppressed lightning ignition that occurred between 1994 and 2004 was chronologically modeled using actual weather conditions. The spatial extent and severity of both modeled and real fires were used to update fuels data after each simulation year. Both the consumption and accumulation of fuel were accounted for using a fuel succession model (Davis et al. 2009). This fuel succession model was also used to determine the changes in fuel loading in the absence of the modeled fires. This resulted in two sets of fuel model data representing pre-fire season 2005 fuels, one for the modeled case and one for the real case.

In addition, two fire atlases were built: one including only the real fires that occurred between 1930 and 2005, and one that also included the modeled fires. These atlases were used to determine Fire Return Interval Departures (FRID) for both study areas. FRID is an index used by both parks to quantify departure from the pre-European settlement fire return interval (Caprio et al. 2002; van Wagtendonk et al. 2002). FRID is determined by calculating how long ago an area last burned divided by the characteristic fire return interval for the underlying vegetation type. For example, if a particular vegetation type has a characteristic FRI of 10 years and the time since last fire is 50 years then the area can be said to have a FRID of five. Lower values of FRID are more desirable than higher values.

Suppressing fire is classically viewed as a means of protecting resources. In the near term these resources can include man-made structures, culturally important areas, sensitive species, public safety, air quality, etc. Available resources for fighting fire and the risk of fire crossing jurisdictional boundaries are also important considerations. More recently, we have begun to realize that there are longer term, unintended consequences in suppressing all fires and that fire restoration, where feasible, can help to alleviate some of these consequences. Negative effects of long term fire exclusion include unnaturally high fuel loadings, impacts on the lifecycle of fire dependent species, such as the Giant Sequoia, and changes in vegetation type and distribution. It is because of these and other unintended consequences that both Yosemite and Sequoia and Kings Canyon National Parks implemented policies in the early 1970s under which naturally ignited fires would be allowed to burn in certain areas within the parks (van Wagtendonk 2007; Kilgore 2007). Unfortunately, even with these policies in place, most lightning-ignited wildfires are still suppressed due to concerns about unnaturally high fuel loadings resulting in uncharacteristically extreme fire behavior and effects, smoke impacts on surrounding communities, and the risk of fire crossing jurisdictional boundaries. The NPS has therefore not been able to restore as much fire to the ground as was seen in historic fire regimes. This may be partly because the risks of negative impacts of a wildfire seem more immediate than the risks associated with suppressing that fire. In addition, the risks of negative impacts have been more extensively studied and are consequently better understood than the benefits of allowing fires to burn.

One of the purposes of retrospective fire modeling is to demonstrate and quantify the benefits lost when fires are suppressed. Our case study on Yosemite and Sequoia and Kings Canyon national parks provided many insights into the benefits of restoring fire to the landscape.

We were able to demonstrate that allowing more fires to burn reduces fuel loading and creates barriers to future wildfires in the form of fuel breaks (Figure 1). Decreased fuel loadings can result in a reduction in uncharacteristically extreme fire behavior in future wildfires. An increase in the number and extent of fuel breaks can be helpful to managers when fighting undesirable fires and increase their ability to allow desirable fires to burn. When it is necessary to suppress future fires, fuel breaks created by past fires can slow or stop fire spread wherever they are encountered. This allows managers to concentrate their efforts on other parts of the fire perimeter. Knowing that there is a fuel break in place between an ignition and a point of value such as an historic cabin can make managers more confident about making the decision to let an ignition burn.

Another implication of the benefits of fuel reduction by fire was discovered through our retrospective analysis. We found that many real fires may never have occurred because their ignition points fell on areas where an earlier modeled fire had left little or no fuel remaining (Figure 1). This can lead to a reduction in the amount of initial attack efforts necessary in the future.

Next, we evaluated the impact of the modeled fires on FRID. We created two fire atlases for the calculation of FRID. The real fire atlas contained only those fires that actually occurred while the modeled fire atlas contained both the real and the modeled fires, minus those fires that were eliminated due to the fact that their ignition points were no longer viable because of the fuel reduction from an earlier modeled fire. We then calculated FRID using the two atlases to determine time-since-last-burn and compared the results. The modeled fires resulted in a dramatic decrease in FRID values across both study areas. This methodology allows managers to quantify the cost of suppressing fire in terms of the impact on FRID.

Of course not all of the suppressed ignitions we modeled could or should have been allowed to burn freely. A number of the modeled fires would have escaped park jurisdictional boundaries, grown to a larger size than is generally acceptable, had too great an impact on the air quality of surrounding communities, etc. Our purpose was not to argue against all

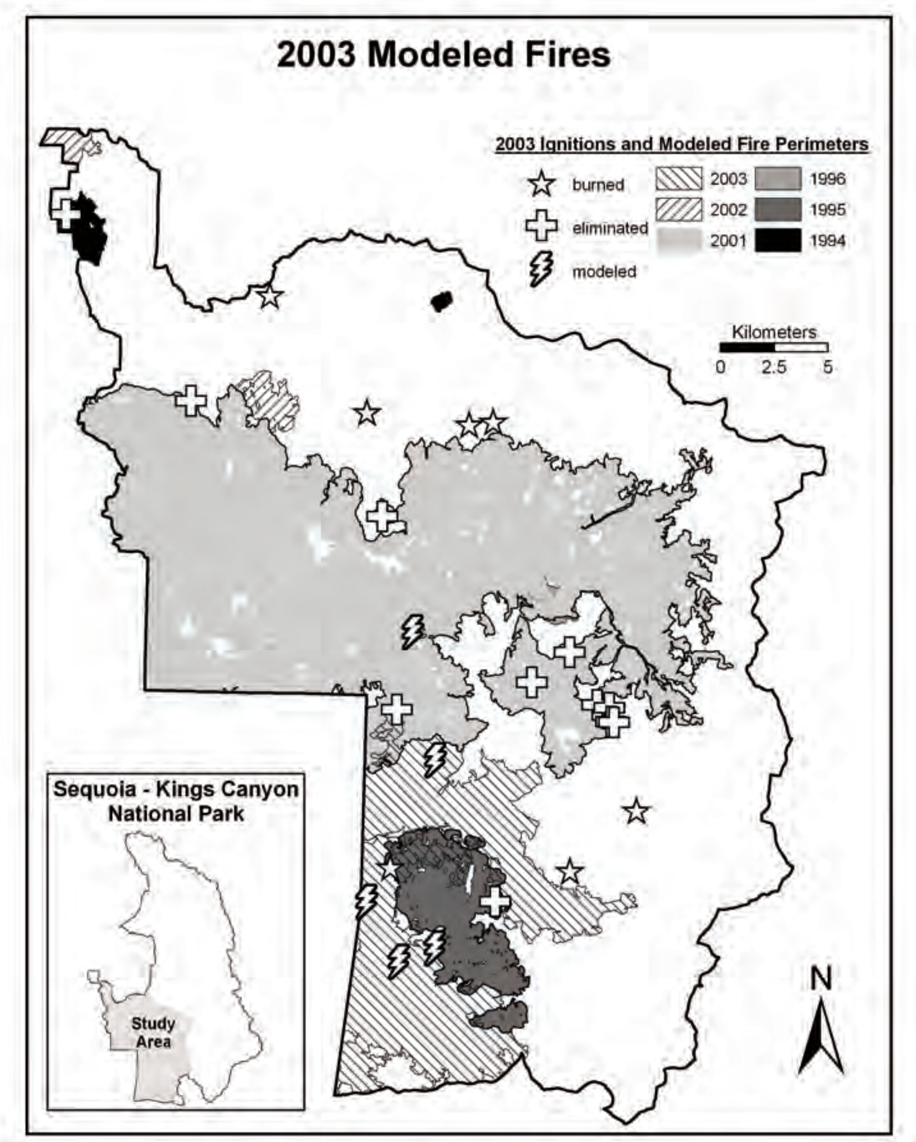

Figure 1. Map of all 2003 ignitions and 1994–2003 modeled fire perimeters. Illustrates the benefits of allowing ignitions to burn including the creation of fuel breaks which can modify future fire spread and reductions in fuel loadings which can eliminate future ignitions.

suppression, but rather to illustrate and quantify some of the benefits lost when fires are suppressed.

Ideally, the decision to suppress or not-to-suppress a fire considers the possible consequences of allowing a fire to burn *as well as* the consequences of suppression. We have demonstrated that as little as 11 years of suppression activities can have a dramatic impact on a landscape. When fires are suppressed, opportunities are foregone to create fuel breaks, reduce fire regime departures and decrease future extreme fire behavior by modifying fuels. An increased number of fuel breaks and/or a reduction in the quantity of available fuels can give managers more tactical options when deciding how to manage a fire. Retrospective modeling is a quantitative method that park managers can use to better understand, measure, and track the cumulative effects of their decisions from year to year. For a more detailed description of this study see Miller and Davis (2009).

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Interface Between Fire and Forests— Tree Management in the National Park Service

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Wildfires, management ignited prescribed fires, and mechanical fuels treatments in national parks have resulted in unintended consequences. Thousands of trees along roadways and power lines have been damaged or killed by fires. Furthermore, in 2007, 11,738 National Park Service (NPS) acres were mechanically treated under the National Fire Plan to protect park resources. Park foresters illustrated some outcomes and raised some questions about tree disposal, tree hazard prevention, and mitigation to include acceptable collateral damage or unacceptable safety hazards, and increased workload for park forestry crews.

It has been noted that the NPS needs clear and coherent policy and direction on how to manage these forest resources, including how to conduct biomass disposal and sales. We recommend that a Director's Order, with an accompanying reference manual and an NPS Biomass Disposal Desk Guide, be developed by fire and resource management professionals for specific policy guidance to allow for the sustainable disposal of woody biomass.

A certain degree of tree damage and mortality is an anticipated result of prescribed burning. When those dead or damaged trees are, or become, hazardous to traffic on adjacent roads or trails or to utilities, this ancillary damage becomes undesirable and requires mitigation. And, while a background level of mortality or damage is expected and largely unavoidable, excessive mortality or damage is, in most cases, both unacceptable and avoidable.

In the past, the undesirable effects of roadside, trailside, or utility corridor burning, namely tree mortality or damage, have been viewed as uncontested consequences of reintroduction of fire as a natural process, and ones for which mitigation funding was not available from traditional prescribed burn funding sources. This has not only increased the workload of already over-burdened park forestry and roads crews, as well as utility company line-clearing crews, but has also increased the NPS's tort liability due to the increased likelihood of roadside accidents from tree failure. At least one utility company has expressed concern over increased line-clearing costs in the aftermath of NPS burning in and adjacent to utility corridors, and has even passed costs back to the agency.

The solution requires a three-pronged approach: (1) recognition and prevention and reduction of fire-related mortality or damage, (2) substitution of mechanical treatment for or utilization of mechanical pre-treatment in conjunction with prescribed burning, and (3) availability of funding for pre-burn mechanical treatments and post-burn tree hazard mitigation.

While not entirely preventable, minimizing roadside tree damage and mortality requires first an awareness of the problem, and second, modification of the burn prescription, or technique, or both. Season, time-of-day, and fuel availability are all variables which can and should be manipulated to reduce burn severity adjacent to roads, trails, and utility corridors. Burning during cooler spring and fall weather, and burning earlier in morning or later in afternoon or evening are simple but effective means of influencing temperature, relative humidity, and fuel moisture parameters of burn prescription.

In addition, burning technique can be modified to favorably affect fire behavior and energy release components by reducing strip width in strip-head firing, or using backfiring technique instead. This in turn contributes to reduction in scorch height and basal cambium damage, both of which are factors in tree damage and mortality.

Substitution of mechanical treatment for, or use in conjunction with prescribed fire, such as has been conducted in Yosemite National Park, has proven to be an effective means of reducing roadside tree mortality and damage. This can either be done in-house with day labor, or under contract. If there is salvage value in material being removed then there are cost-reduction or cost-elimination options which will be discussed subsequently. The new tree hazard management directives for parks in the Pacific West Region states that management activities in and adjacent to developed areas—such as fire management and tree hazard mitigation—will attempt to minimize injury to living trees which are to be retained on the site. This includes damage to roots as well as the bole (trunk), and limbs of trees. Tree hazard abatement and mitigation may be required when individual trees in natural or wilderness areas that are killed or damaged by fire management, trail construction, ecological restoration, or other management activities, are within striking distance of a target, particularly if the damage leads to colonization by decay fungi, or insect attack.

Burned trees can fail (USFS), even trees with green crowns. Reintroduction of prescribed fire to western forests where fire has been excluded for long periods has been resulting in mortality of the large, old trees we are trying most to protect (Hood et al. 2007). Treatments such as raking can reduce overstory tree mortality (Laudenslayer, Steger, and Arnold 2008). It is imperative that prescribed fire project funding be available to address necessary pre-burn treatment, as well as post-burn mitigation, including administrative costs associated with developing and administering contracts.

Servicewide fire management officials have agreed to several items that will reduce public and worker risk from tree hazards, including encouraging pre-burn thinning and raking in project proposals. Also, *draft* language will be added to the NPS business rules for hazard trees which are created either through a prescribed burn, or an unplanned ignition that was managed according to the park's Fire Management Plan strategies and objectives.

Besides modifying fuel loading and arrangement, mechanical fuel reduction treatments result in more dependable species selection, improved taper of leave trees, and more controllable spacing of young trees. It can be a challenge for fuel managers to effectively communicate specifications to outside work crews, and mechanical thinning can result in damage to residual trees (pruning wounds, etc.).

When trees are to be removed from NPS areas, 16 USC sec. 3 allows for the secretary of the interior to, "upon terms and conditions to be fixed by him, sell or dispose of timber in those cases where in his judgment the cutting of such timber is required in order to control the attacks of insects or diseases or otherwise conserve the scenery or the natural or historic objects in any such park.... He may also provide in his discretion for the destruction of such animals and of such plant life as may be detrimental to the use of any of said parks...." 16 USC sec. 54 further states "the Secretary of the Interior may sell and permit the removal of such matured or dead or down timber as he may deem necessary or advisable for the protection or improvement of the park, and the proceeds derived therefrom shall be deposited and covered into the Treasury as miscellaneous receipts."

Additional agency guidance exists. NPS 2006 *Management Policies* advise that "Landscapes disturbed by natural phenomena, such as landslides, earthquakes, floods, hurricanes, tornadoes, and fires, will be allowed to recover naturally unless manipulation is necessary to protect other park resources, developments, or employee and public safety.... Efforts may include, for example ... restoration of areas disturbed by NPS administrative, management, or development activities (such as hazard tree removal, construction, or sand and gravel extraction) or by public use" (NPS 2006, 39).

How much biomass may be removed should be the difference between the amount of biomass to be retained on the site (desired future condition) and existing site conditions. Guides to estimate existing biomass and visualize treated condition are available for many forest types (e.g., Scott and Reinhardt 2005).

NPS Special Directive 82-6 states that wood and wood products are permitted to be removed when they result from approved development, construction, or resource management activities, or where removal is necessary due to a hazard or obstruction, or in historic, recreational, or development zones for: (a) maintenance of historic scenes, (b) maintenance of recreational environments, (c) rights-of-way, (d) vista clearing, or other approved reason. In such instances, the wood shall be disposed of as follows:

1. Quantities associated with work or activities incidental to, or the result of a contract, should be removed by the contractor. The reasonable net value of the wood should be calculated in the contract cost.
2. Wood and wood residue remaining from normal park operations may be allocated for park uses, such as heating public buildings, offices, and remote back country stations, and for park interpretive campfires. Surplus wood and wood products, however, shall not be supplied to concessioners for facilities or activities, nor to residents, nor to employees for residential heating inside or outside the park, nor for use in government quarters. Wood may be obtained, however, under paragraph three for such purposes.
3. Wood and wood products available in quantities or under circumstances beyond those needed for the park operations functions described in paragraph two shall be sold at fair market value, pursuant to 16 USC sec. 3.

Special Directive 82-6 was integrated into the NPS 2006 Management Policies. The gathering of firewood will be allowed only where subsistence use is authorized by federal law, or in specific areas designated by a superintendent in which dead and down wood may be collected for campfires or in small quantities for other uses within the park. Natural resource products that accumulate as a result of site clearing for development, hazard tree removal, vista clearing, or other management actions, will be recycled through the ecosystem when practicable. When recycling is not practicable, the products may be disposed of by other means. Disposal may be accomplished by contract, if the result of the work done under contract and the value are calculated in the contract cost, or by sale at fair market value in accordance with applicable laws and regulations. Wood that accumulates as a result of the management actions described above may also be used for park purposes, such as heating public buildings or offices, or for interpretive campfire programs.

The paper trail for disposing of woody biomass from NPS areas begins with Standard Form 120, Report of Excess Personal Property. Once the disposal document is executed, biomass with market value can be sold locally, or through the General Services Administration as a sale of government property. Biomass may also be disposed of locally through agreements (such as 122 Stat. 768 Public Law 110-229—May 8, 2008, Subtitle A—Cooperative Agreements sec. 301, Cooperative agreements for national park natural resource protection).

The Department of the Interior will allow service contractors to remove woody biomass generated as a result of land management service contracts wherever ecologically appropriate and in accordance with applicable law (48 CFR parts 1437 and 1452).

Values of forest products vary widely by geographic location, access to markets, local to international market conditions, manufacturer capacity, species, sizes, quantities, and sustainable availability. White pine might be premium in the west, but not in the east; black cherry may be in high demand throughout its range; lodgepole might be sought after in one district of a park and you can't give it away in another during a beetle outbreak.

A biomass desk guide is available from the U.S. Forest Service (www.forestsandrangelands.gov/Woody_Biomass/documents/biomass_deskguide.pdf); the NPS desk guide is in development.

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Integrating Resource Management in the Lifecycle of Wildland Fire Decision-making

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Introduction

This paper reflects my experience of fifteen years working as a biologist in various National Park Service (NPS) units. Since 2003 I have worked as a member of resource management staff where I had responsibilities for fire management plans and updates, coordinating fire incident resource advising activities, and preparing and implementing burned area emergency response plans. Most of this work has been focused in the Mojave Desert, an environment that has experienced a dramatic increase in fire frequency and fire size in recent years (Brooks and Matchett 2006), with more than one million acres burned since 2005. This escalation of fire activity has provided many opportunities for learning, including both confirming what we thought we knew and overturning some previously held beliefs about the impacts of fire and fire management activities. This dynamic fire setting highlights the need for resource professionals to continuously engage in wildland fire management. The following observations reflect my lessons learned regarding the opportunities and challenges for engaging resource managers in the life cycle of wildland fire decision-making.

Fire management plan

The development of a fire management plan (FMP) provides an opportunity to proactively engage resource management professionals with fire management professionals to determine the long-term future of fire and vegetation in a protected-area landscape. NPS policy requires that all parks with burnable vegetation must have an approved FMP and the accompanying National Environmental Policy Act compliance (NPS 2008). Specifically, the FMP needs to identify resource values at risk from either fire effects or fire suppression effects, identify resources that benefit from fire to determine the need for prescribed fire or opportunities to use wildland fire for resource benefit, and to identify altered fire regimes and the steps required to restore them. This is a prime opportunity to inventory fire-related resources. This is also a great opportunity to make use of the many recent tools and datasets available from the National Wildland Fire Coordinating Group and the National Interagency Fire Center. Datasets such as the Landscape Fire and Resource Management Planning Tools Project (aka LANDFIRE, www.landfire.gov) and Monitoring Trends in Burn Severity (http://mtbs.gov) increase our collective understanding of fire dynamics by providing consistent data on past fire frequency and severity as well as current vegetation, fuels, and fire regimes. To increase the effectiveness of the collaboration between resource managers and fire managers, it is important that resource managers be involved in the development of the full scope of the FMP, not just its environmental compliance document. For example, relevant appendices to the FMP may include a resource advisors guide and fire effects monitoring and research plan. This is also an opportunity for resource managers to work with fire managers to develop local operational guidelines to address resource concerns, such as decontamination protocols to prevent the spread of terrestrial and aquatic invasive species.

Planned activities identified in the FMP, such as mechanical fuel treatments or prescribed fires, provide many opportunities for collaboration between resource managers and fire managers, such as developing project objectives, monitoring strategies, and mitigation measures for any negative impacts on resource values. The remainder of this paper will focus on unplanned ignitions, where decision making and opportunities for collaboration occur within a compressed timeframe and in the presence of uncertainty and risk.

Fire incidents

For resource managers to engage in wildland fire incidents as resource advisors, known as READs (NWCG 2004), they must first be trained and equipped to serve in that capacity. Ideally a range of resource disciplines should be trained and available, including both natural and cultural resource disciplines. There should also be some planning to determine what actions trigger consultation and who will do the required emergency consultations with the US Fish and Wildlife Service and the state or tribal historic preservation officer. A call-out procedure and schedule should be developed in consultation with the local fire management officer to assure that qualified resource advisors are available whenever needed. It can be a challenge to get resource managers used to operating in an emergency response mode, where they must be reachable after hours and on weekends when many unplanned ignitions occur. Without this preparation, delays in READ availability are both a frustration to the duty officer and a threat to the resources because the fire burns and management actions occur with or without READ presence. Outside of fire season (pre-season) is also the best time to compile all of the relevant documents and geospatial data into portable media to be made immediately available for resource protection during fire incidents. External hard drives are a good tool for this use, and in protected areas with a dispersed staffing configuration, it may be necessary to have several identically loaded hard-drives staged at strategic locations for access by resource advisors, agency representatives, incident commanders, etc. Pre-season is also the time to work with local fire personnel to load resource constraints and other information in the Wildland Fire Decision Support System (2009).

During any fire incident, one of the ongoing tasks for the READ will be making recommendations regarding location of incident operations: incident command post, base camp, spike camps, staging areas, fueling areas, helibase and constructed helispots, retardant mix plant, and dip/draft locations. One of the biggest challenges for resource advisors is understanding the on-the-ground spatial needs of fire incident operations, and finding suitable locations that minimize new ground disturbance, without spreading the invasive plants that often grow in existing disturbed areas. In some landscapes it may be possible to plan where such operations may be located, and proactively remove exotic plants from those areas prior to the anticipated use. When a fire incident transitions to an incident management team and the number of incident personnel increases rapidly, it is critical that a resource advisor be available when and where these types of decisions are made.

During initial action, it is important that the READ be engaged, available, and useful to the incident commander. The presence of mobile geographic information system (GIS) capability and the having values-at-risk geospatial data on scene is critical to help inform the tactical decisions made by the incident commander. The on-scene availability of local guidelines and maps can be helpful in briefing incoming firefighting resources. One of the biggest challenges for a READ during initial action on an active fire is keeping up with a highly mobile work force. The dynamic situation of initial action on a rapidly growing wildland fire may result in incomplete incident documentation where critical incident operational areas or even constructed line may not be fully or accurately recorded and may be obscured by the advancing fire perimeter. For this reason, resource advisors should try to keep an annotated map of activities and locations that may warrant follow-up monitoring.

During extended attack, there will likely be the need for multiple resource advisors, possibly including fireline qualified READs on each division and a lead READ at the incident command post to participate in every briefing and planning meeting. For incidents running a 24 hour operation in two shifts, it will be necessary to have two lead READs in order to be at all of the required decision making meetings without violating the work/rest standards. Extended attack incidents are also an opportunity for local resource managers to get involved in wildland fire in ways other than resource advising, including technical specialists, GIS specialists, and information officers. The effectiveness of resource managers in meeting these incident needs will be dependent upon the amount of fire training and experience they have. At a minimum, completing the on-line I-100 introduction to incident command system training course enables all assigned personnel to understand the basics of the incident command system used to manage fires. To be qualified for other positions, resource managers will also have to meet the training and experience requirements as outlined in the current Wildland Fire Qualification System Guide (NWCG 2008).

Throughout any fire incident, local resource managers should pay attention to the type of fuel carrying the fire. Is it primarily carried in native or non-native fuels? Such observations may indicate how "natural" the fire effects are likely to be and help determine the need for post-fire actions. Also, fire incident information should be compiled daily, ideally in an annotated incident action plan and map book, and the lead READ should maintain frequent communication with the situation unit to develop complete documentation of fire management activities and impacts. Air operations may warrant special attention due to the potential for spreading exotic species and impacting aquatic habitats. It can be challenging to collect accurate information about air operations, but some questions to pursue include: From what source was raw water drafted/dipped and then where was it delivered? What type(s) of retardant was used, where was it loaded, and where was it delivered?

Post-fire response

During suppression repair, up to 90 days after the date of containment, resource managers should help identify and communicate suppression impacts to the incident commander or local fire management officer, depending on whether the incident has been turned back to the local unit. Such impacts may include cut fences, compacted soil around incident operation areas, and possible weed introduction or spread. Ideally, a resource advisor should be assigned to the suppression repair effort to assure that identified needs are adequately addressed and that no further impacts occur during this time frame, as such work is usually performed by less experienced crews and oversight is often provided by someone who is not on scene.

During emergency stabilization (ES), the focus is on the immediate protection of human life or critical natural and cultural resources from post-fire effects (USDI 2004), most commonly watershed effects. Typical treatments might include installation of structures or other efforts to stabilize soil and/or slow water movement. Treatments must be completed in one year and may be monitored and maintained for up to three years after the date of containment. Local resource managers must be involved in preparing the emergency stabilization plan, either in-house, or with the help of a regional or national burned area emergency response team. It is likely that local resource managers will be responsible for implementation of the approved treatments and/or activities, thus they need to understand the purpose of the treatment and be prepared to monitor its effectiveness and make adjustments as necessary throughout the implementation period.

During non-emergency burned area rehabilitation (BAR), the priorities are to repair or improve lands damaged directly by a fire and to rehabilitate or establish healthy, stable ecosystems in the burned area (USDI 2004). Typical treatments on protected lands managed by the Department of the Interior include repair or replacement of minor facilities damaged by fire, control of invasive plants, habitat restoration, or reforestation. These projects are competitively funded for up to three years post-fire. Plans are usually prepared and implemented in-house by resource managers from the local managing agency.

Finally, beyond ES and BAR treatments, it is incumbent upon resource managers to make sound recommendations to agency administrators to allow for recovery of the burned area. Such recommendations might include reconsideration of visitor use management decisions, such as area closures, use reductions, or restrictions on activities that could increase ground disturbance. The agency might also need to reconsider its own activities in a burned landscape, including deferral of livestock grazing and removal of feral animals (e.g. wild horses and burros) that would interfere with natural regeneration.

Conclusions

The experiences gained from a fire incident or post-fire response need to be used by both resource managers and fire managers to prepare for the next fire or next fire season. Such learning actions might include the following:

- Participate in the after action review.
- Implement fire effects monitoring strategy and analyze data.
- Invite fire effects research and incorporate findings.
- Use fire management plan annual updates to refine local guidelines and environmental protection measures.
- Use five-year fuel plan updates to incorporate new knowledge of fire and fuel dynamics.
- Update READ guide and datasets.

Wildland fire management is becoming increasingly technical and the outcomes of decisions made in fire management plans, fire incidents, and post-fire response have long-term implications for natural and cultural resources. Resource managers have the opportunity to bring their knowledge and skills to bear on these critical decisions. Both resource managers and fire managers have the opportunity to improve the outcomes of decisions through collaboration.

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From ATBI to BioBlitz: A National Strategy for Biodiversity Stewardship in Parks

National Park Service Biodiversity Stewardship Steering Committee[1]

Introduction

With increasing global threats, National Park Service units are becoming critical reserves of biodiversity. Many parks engage in efforts to improve their knowledge about biodiversity using various approaches. As an outgrowth of the Centennial Challenge, parks engaged in biodiversity stewardship have come together to develop a national biodiversity strategy to ensure that individual park surveys contribute broadly across the National Park System. This national approach will cultivate a support network that allows parks to learn from each other's experiences and expertise, develop guidance and support for the range of approaches to biodiversity stewardship, and coordinate data management and sharing.

The diversity of native species of plants and animals, and the genetic material they contain (biodiversity), is declining globally at a historically unprecedented rate. National parks may be responsible for becoming critical preserves of biodiversity in the face of increasing global change threats. National Park Service (NPS) lands are considered refuges of biodiversity due to their relatively undisturbed state, and serve as repositories of species and genetic biodiversity. Historically, biological surveys on NPS lands have focused on charismatic species such as birds, mammals, fish, amphibians, reptiles, trees, shrubs, and herbaceous plants. Biodiversity stewardship focuses on lesser known but more diverse groups of life forms such as: invertebrates, non-vascular plants, and fungi, among others. These taxa can serve as indicators to assess impacts of global threats such as climate change, or more local activities such as energy development, as well as predict likely outcomes of associated management actions. Improving our understanding of biodiversity in parks is crucial to managing ecosystems so they maintain adequate resiliency to withstand these threats.

A range of approaches helps parks meet their goals

Many NPS units are engaging in efforts to improve knowledge about biodiversity within parks using various approaches. These efforts range from the long-term, taxonomically focused All-Taxa Biodiversity Inventories (ATBIs), to large-scale ,short-duration BioBlitzes, in addition to ongoing inventories and subsequent monitoring efforts. For example, Great Smoky Mountains National Park, in Tennessee, has pioneered an ATBI since 1997. An ATBI is an intense inventory of all species in a defined area, such as a national park or natural reserve (Janzen and Hallwachs 1994). To date, this ATBI has discovered over 850 species new to science and over 6,250 species that are new records for the park. BioBlitzes are shorter duration (often weekend) mini-inventories that typically target particular taxa (Karns et al. 2006). Many engage school groups and "citizen scientists" of all ages. BioBlitzes can generate large quantities of data in short amounts of time and often highlight the educational aspects of biodiversity stewardship. They are an essential component of any ATBI.

Many parks conduct BioBlitzes but have not yet committed to a full ATBI. Others are working on longer-term efforts focused on specific taxa or microhabitats (or both) such as lakes or caves. In addition, NPS and the National Geographic Society are collaborating to host one large-scale BioBlitz each year, through 2016, the NPS Centennial. By improving our knowledge of biodiversity in parks, all of these activities support and enhance the basic conservation mission of NPS. In addition, they provide the public with opportunities to learn about natural resources in parks and to participate in stewardship of our nation's heritage.

Towards a national strategy

While individual parks have been conducting ATBI and BioBlitz activities since the pilot efforts of Great Smoky Mountains National Park, there has been a recent growth in interest. In 2008, nine parks were funded through the Centennial Challenge to conduct biodiversity stewardship activities. These parks and the Natural Resource Science and Stewardship Directorate recognized that although the attributes, resources, and special purpose of each park may indicate different approaches or intensities of activities to biodiversity inventory, outreach, and management, all biodiversity stewardship efforts share a number of needs that would benefit from a coordinated, national approach. These needs include the following:

- High quality data to maintain scientific credibility and meaningful participant activity. Data needs include species identification, database management, and curation.
- Volunteer management and logistical support, which are important considerations at any scale of activity.
- Coordinated efforts among parks, neighbors, and the scientific community, to improve efficiency and ensure that data contribute to the broader body of scientific knowledge.
- Evaluation tools to determine benefits to volunteers and citizen scientists.

The 2008 Centennial Challenge funded parks contributed a portion of their allocations to develop components of a national strategy that would provide support to other parks that are interested in conducting ATBIs and BioBlitzes and ensure that individual park efforts contribute broadly across the National Park System. The Biological Resource Management Division of the Natural Resource Program Center was identified as the point of contact for developing a national strategy, and funding was assigned to database development, social science assessment, and a national meeting. At the national meeting, a steering committee was formed comprised of representatives from the nine parks that received funding, and Great Smoky Mountains National Park, as well as a few other interested individuals. The steering committee has spent much of the past year achieving consensus on mission, vision, goals, objectives, and strategies that are inclusive of the very diverse approaches shared at the two sessions and group of posters highlighted at the 2009 George Wright Society meeting (see Appendix).

Share your experiences and expertise: How can diverse parks engage?

The national strategy is truly a grassroots effort and relies on parks contributing materials and expertise to assist each other. There are currently a number of opportunities that would benefit from contributions from parks engaged in the range of potential biodiversity stewardship activities. We welcome parks and partners to contribute in the following ways:

- Assist in developing and writing reference handbooks.
- Share resources such as existing guidance documents.
- Test interim database modifications.
- Help develop a curation strategy.
- Serve on the Steering Committee.
- Assist with Discover Life in America national conference planning.
- Pilot test instruments to evaluate benefits to volunteers.
- Provide feedback on Intranet websites: http://nrpcsharepoint/brmd/ATBI/default.aspx; http://science.nature.nps.gov/atbi/index.cfm.

By working together we can ultimately magnify the returns of any individual park's sampling and outreach efforts.

If you would like more information, to contribute to any of the above activities or to be added to our mailing list, please contact Kirsten Leong (kirsten_leong@nps.gov, 970-267-2191).

Endnote

1. The NPS Biodiversity Stewardship Steering Committee includes the following members:

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Appendix

Mission

The mission of the national biodiversity steering committee is to develop a system-wide coordinated approach to Biodiversity Stewardship on NPS lands that is: scientifically rigorous; assists parks in best meeting their individual scientific, educational, and stewardship objectives related to biodiversity; and encourages public engagement with science and biological resources.

Vision

The national strategy for biodiversity stewardship is recognized as providing NPS units across the system with the support structure and materials needed to engage in a suite of activities to improve understanding and conservation of biodiversity in parks. Regardless of scope and scale, activities are scientifically rigorous and data are integrated with NPS data management systems, such as NPSpecies. Biodiversity activities enable the public (including professional scientists, policy makers, and the general public) to recognize that NPS lands represent values and opportunities that extend well beyond basic recreation in the park; these lands have a unique value as protected storehouses of biological diversity and present unparalleled opportunities for biological inventory, research, and conservation. New knowledge provided by these activities enhances the basic conservation mission of the NPS by giving both managers and policy makers detailed information about resources parks protect. This knowledge adds to the tools, targets and opportunities needed for true, science-informed decision making. These activities also promote science-inspired and science-informed resource stewardship by directly engaging the public in their heritage. All of these benefits extend into the societies, ecosystems, and landscapes well beyond the parks' physical boundaries.

Goals

- Develop a strategy and network that facilitates internal communication about NPS biodiversity programs.
- Develop resources and guidance documents for the range of approaches to biodiversity stewardship.
- Coordinate management, presentation, and sharing of data.
- Coordinate specimen curation and identification needs.
- Utilize data for science-informed decision making.
- Inform and inspire resource stewardship through partnerships.
- Integrate NPS efforts with external biodiversity initiatives.

Guiding principles

- Biodiversity activities will develop NPS capacity for stewardship, both by building a stronger scientific foundation for management decisions and by developing public support and appreciation for science in parks.
- Understanding biodiversity is a fundamental component of the NPS core mission to conserve resources; we cannot conserve resources unless we know which resources are in parks.
- NPS lands are increasingly important areas for the study and conservation of biodiversity because they are prioritized for protection from the myriad threats to our nation's

rich natural heritage, which include climate change, energy development, altered hydrology, invasive species, pollution, and more.

- The attributes, resources, and special purpose of each park may indicate a need for different approaches or intensities of activities related to biodiversity inventory, outreach, and management.
- Different types of events may result in different kinds of data collection with different curation needs; however, for participant activity to be meaningful and for NPS to maintain scientific credibility, some level of usable scientific data must be recorded from all activities.
- Engaging the public takes many forms, ranging from partnerships with professional scientists, to volunteers, to school groups, to other NPS employees. The type of public involved will depend on specific park objectives.
- Coordinated efforts with partners, such as adjacent protected area managers, other neighboring landowners, state agencies, non-governmental organizations, and the scientific community are essential to improve our understanding of the diversity of park resources, potential threats, and to engage the public in their conservation.

National strategy steering committee objectives

1. Be the recognized as the "go to" NPS resource for guidance related to biodiversity stewardship activities and needs.
2. Develop reference handbooks and resources (e.g., research permit templates, sample curricula) for various approaches to biodiversity stewardship.
3. Articulate and communicate the scientific considerations present in different approaches to biodiversity stewardship.
4. Articulate and communicate the visitor services and public relations considerations inherent in different approaches to biodiversity stewardship.
5. Articulate and communicate the resource management considerations present in different approaches to biodiversity stewardship.
6. Broaden support for biodiversity stewardship within NPS and beyond the agency.
7. Apply models for NPS biodiversity stewardship within NPS and beyond the agency.
8. Apply results for NPS biodiversity stewardship within NPS and beyond the agency.
9. Most effectively harness existing networks and funding sources, e.g., Centennial Challenge non-Federal matching funds, 20% Fee Demo funds, the NPS Research Learning Center Network, the NPS Inventory and Monitoring Network, the Cooperative Ecosystems Studies Unit (CESU) Network.
10. Develop a series of proven, successful approaches that can justify the time, effort, and scientific results to stakeholders, including the scientific community and general public.

Long-term strategy

1. Develop relationships with scientific community and others involved with biodiversity stewardship, so that NPS is recognized by scientists as a potential partner, study site, or source of resource data.

2. Establish NPS as a key partner in existing consortia, such as ATBI Alliance, American Institute of Biological Science, Taxonomic Working Groups, Encyclopedia of Life, etc.
3. Strengthen NPS science program's ability to support biodiversity stewardship activities.
4. Develop internal communication plan to facilitate information sharing between parks.
5. Develop plan to evaluate benefits of public participation (both in terms of scientific contributions and attitudinal changes).
6. Develop sustainable funding plan.
7. Develop links with management (ensure results are more than "a species list"). How will results help park management plans within the park, and regional land use planning?
8. Address logistics related to scientific collections, such as data management, permitting and curation.
9. Address logistics related to people management, such as developing an Incident Command System, establishing a 1-800 number for the event, link to Volunteers In Parks.

Short-term strategy (Fiscal Year 2009 [ends September 30th, 2009])

1. User requirements contract to be completed—will result in refinement of national database, guidelines for data management.
2. Citizen Science Assessment Task Agreement to be completed—ensure results feed into strategy that can be broadly applied to evaluation of individual park efforts.
3. Utilize experience of parks to develop reference handbooks.
4. Develop funding sources.
5. Leverage face-to-face communication opportunities such as the Discover Life in America national meeting and George Wright Society biennial meeting to strengthen the network of parks engaged in biodiversity stewardship.
6. Further develop website to quickly disseminate information.
7. Update briefing statement and other high level national strategy communication.
8. Develop catalog of parks' experiences with biodiversity stewardship activities.

Glossary

ATBI. An ATBI is an intense inventory of all taxa to the species level to the degree possible in a single site, followed by on-going further inventory as needed by specific taxa and in-depth basic and applied biodiversity research and development (Janzen and Hallwachs 1994).

Bioblitz. A BioBlitz is part rapid biological survey and part public outreach event that brings together scientists and volunteers to compile a snapshot of biodiversity in a relatively short amount of time (Karns et al. 2006; Lundmark 2003). It is not intended to be an exhaustive inventory, but can contribute to a more comprehensive ATBI effort.

Biodiversity. The variety of living organisms considered at all levels of organization, including the genetic, species, and higher taxonomic levels, and the variety of habitats and ecosystems, as well as the processes occurring therein (Meffe and Carroll 1997).

Citizen science. Citizen science refers to participation of the general public as field assistants in scientific studies (Cohn 2008; Irwin 1995). Volunteers may have no specific scientific training, and typically perform, or manage, tasks such as observation, measurement, or computation.

Inventory. Natural resource inventories are extensive point-in-time surveys to determine the location or condition of a resource, including the presence, class, distribution, and status of biological resources such as plants and animals. Inventories are designed to contribute to our knowledge of the condition of park resources and establish baseline information for subsequent monitoring activities (NPS 2008).

Partner. "Partner" is an umbrella, generic term to refer to individuals, organizations, and other entities interacting in a relationship with the Department of the Interior, or its bureaus or offices, to achieve a common goal in support of the Department's mission (DOI 2008).

Public. The public includes all individuals, organizations and other entities who have an interest in or knowledge about, are served by, or serve in, the parks and programs administered by the NPS. They include (but are not limited to) recreational user groups, the tourism industry, tribes and Alaska Natives, environmental leaders, members of the media, permittees, concessioners, property owners within a park, members of gateway communities, and special interest groups; all visitors-domestic and international; those who come in person, and those who access our information on the world wide web; those who do not actually visit, but value, the national parks; and those who participate and collaborate with the NPS on a longer-term basis. One very important group that is not usually thought of as being part of the "public" is NPS employees (NPS 2007).

Water Science from the U.S. Geological Survey in Support of Park Management

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The U.S. Geological Survey's (USGS) Water Resources Division has a long history of collaboration with the National Park Service (NPS) to provide water science and data to help manage parks.

Streamgaging in parks

One area of frequent collaboration is streamgaging. The USGS operates about 545 streamgages in national parks. Usually the stage and streamflow data are sent by satellite radio telemetry to receiving stations, from which the near-real-time data are disseminated via the internet (http://water.usgs.gov/waterwatch/). The data are used for a variety of purposes, related to public safety, water supply, resource management, design of facilities, water rights, recreation, education, and climate-change monitoring.

In recent decades tight budgets in both agencies have led to a decline in the number of streamgages in parks, even while the protected acreage has been increasing. In 1970 there was one streamgage for every 62,000 acres of NPS land; in 2006 there was one streamgage for every 154,000 acres. A 2007 NPS survey identified 423 sites where existing streamgages were threatened with a loss of funding, discontinued streamgages need to be reinstalled, or a new streamgage was needed. In order to pursue some potential funding sources, both within and outside the federal government, to improve this situation, the list will soon be revisited with the help of NPS inventory and monitoring networks and regions. Special emphasis will be placed on streamgages that could be useful in monitoring the effects of climate change.

Many parks are realizing the potential for streamgages and their data to enhance the park's interpretive program, and are working with the USGS to put visitors and web users in touch with the information.

Interpretive water studies

In addition to streamgaging, the USGS also frequently collaborates with the NPS on interpretive hydrologic studies. Many excellent examples were featured in other presentations in this conference [this volume]. A few additional recent examples include:

- Evaluation of the regional flow characteristics of the Death Valley regional flow system in Nevada and California. In collaboration with the NPS and other agencies, the USGS has developed a three-dimensional, steady-state and transient ground-water flow model to help answer questions about boundaries of sub-regional and local flow systems, regional flow paths and fluxes, locations and rates of ground-water discharge, and impacts of human activities on the flow system.
- Connections among basin-fill aquifers, carbonate-rock aquifers, and surface-water

resources in southern Snake Valley, Nevada, near Great Basin National Park. NPS and USGS are working to improve understanding of hydrologic systems that sustain numerous water-dependent ecosystems on federal lands in Snake Valley, Nevada. Understanding these connections is important because proposed projects to pump and export ground water from Spring and Snake Valleys in Nevada may result in unintended capture of water currently supplying springs, streams, wetlands, limestone caves, and other biologically sensitive areas.

- Flood frequency and water stages for Potomac and Shenandoah Rivers, Harpers Ferry National Historical Park, West Virginia. Harpers Ferry, situated at the confluence of these two rivers, has historically been affected by flooding from both rivers. Either river may contribute individually to flooding, or the combination of flows may be the source of flooding. The prediction of corresponding water-surface elevations at Harpers Ferry is complex because of differences in rainfall distribution across the two regions and the timing of the peaks on both rivers.
- Influence of local recharge on water quality in Hot Springs National Park, Arkansas. The hot springs of Hot Springs National Park consist of a mixture of water from two recharge components: a primary hot-water component and a secondary cold-water component. Urbanization in the area near the hot springs has increased the potential for degradation of the quality of surface-water runoff and locally derived ground-water recharge to the hot springs. Comparison of analyses of samples collected during base-flow conditions from the springs in 2000 and during a storm event in 2001, with the results from earlier studies dating back to the late 1800s, indicates that little change in major, minor, and trace constituent chemistry has occurred, and that the water continues to be of excellent quality.

Information about USGS water programs, contacts, data, projects, and publications of interest to the NPS may be found on an internal NPS web site at www1.nrintra.nps.gov/wrd/USGS.NPS/.

Regionally downscaled climate-change and hydrologic projections for national parks

A web site supported by the U.S. Bureau of Reclamation, Lawrence Livermore National Laboratory, and Santa Clara University (http://gdo-dcp.ucllnl.org/downscaled_cmip3_projections/#Welcome) provides convenient access to an archive of regionally downscaled projections of temperature and precipitation for any area of interest within the conterminous United States. The geographic resolution of these projections is 1/8 by 1/8 degree of latitude or longitude. It is a relatively straightforward process to average the results of sixteen different climate-change models to project, within error limits, monthly temperature and precipitation for any national park for the next century, under up to three future carbon-emission scenarios. Furthermore, the USGS has recently published a monthly water-balance model (McCabe and Markstrom 2007), which can be applied to the results of the climate-change projections to provide estimates of future trends in a suite of hydrologic parameters such as evapotranspiration (based on the Thornthwaite equation), soil moisture, snowpack storage,

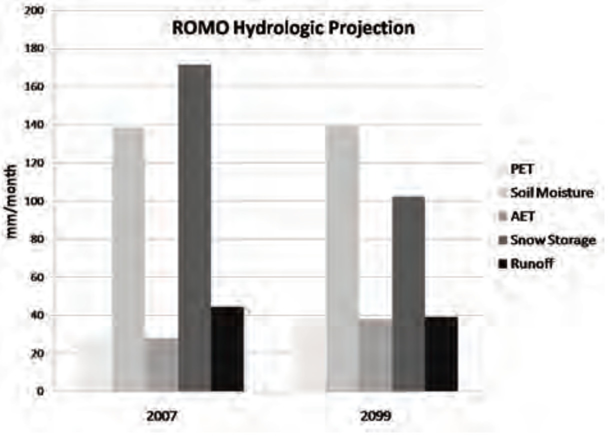

Figure 1. Projected changes in selected hydrologic parameters in Rocky Mountain National Park, Colorado, for the end of the century. Based on the average of 16 regionally downscaled climate change projections for the moderate A1B future carbon-emission scenario, and on projections from the USGS monthly water-balance model by McCabe and Markstrom.

and runoff, again within error limits. This model was used in conjunction with the regionally downscaled climate-change projection to project hydrologic changes for a part of Rocky Mountain National Park in Colorado. The results (Figure 1) showed that by the end of this century, even though precipitation is projected to increase slightly over the next century, the projected increase in temperature, and hence evapotranspiration, is expected to result in a decrease in runoff of about ten percent. The warmer temperatures are also expected to reduce snowpack storage by about forty percent, and to shift the onset of spring snowmelt about a month earlier.

Reference

McCabe, G.J., and S.L. Markstrom. 2007.
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Adaptive Management and Exotic Plant Management at Lake Mead National Recreation Area

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Lake Mead National Recreation Area (NRA) has been actively engaged in exotic plant management for many years and has learned a great deal about what works and doesn't work. However, the Park's resource managers have come to realize that lessons of the past may be of limited value in the future. Given the inherently dynamic nature of desert plants, lowering lake levels, as well as the realized and anticipated impacts of climate change, a new model is needed to speed up the learning process in a quickly changing landscape. To address this need, Lake Mead NRA is attempting to incorporate adaptive management into the Exotic Plant Management Plan currently under development. A series of decision flow charts have been developed to conceptualize how the outcomes of management actions will be analyzed and the lessons learned incorporated into future decisions in an iterative learning process.

Adaptive management has been defined in various ways since the 1970's when the concept first came into common usage. For the purposes of the Lake Mead Exotic Plant Management Plan, we use the following working definition, taken from the Department of the Interior Technical Guide (Williams, Szaro, and Shapiro 2007):

> Adaptive management is a decision process that promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. Careful monitoring of these outcomes both advances scientific understanding and helps adjust policies or operations as part of an iterative learning process. Adaptive management also recognizes the importance of natural variability in contributing to ecological resilience and productivity. It is not a 'trial and error process,' but rather emphasizes learning while doing. Adaptive management does not represent an end in itself, but rather a means to more effective decision and enhanced benefits. Its true measure is in how well it helps meet environmental, social, and economic goals, increases scientific knowledge, and reduces tensions among stakeholders.

The adaptive management process is six steps which must be completed sequentially:

1. Assess the situation.
2. Design a plan of action to achieve specific outcomes.
3. Implement the plan of action.
4. Monitor the intended and unintended results of the action.

5. Evaluate the actual outcomes against the predicted outcomes.
6. Adjust future decisions based on what was learned.

Adaptive management is incorporated into many aspects of the exotic plant management programs at Lake Mead NRA, as illustrated in the following figures.

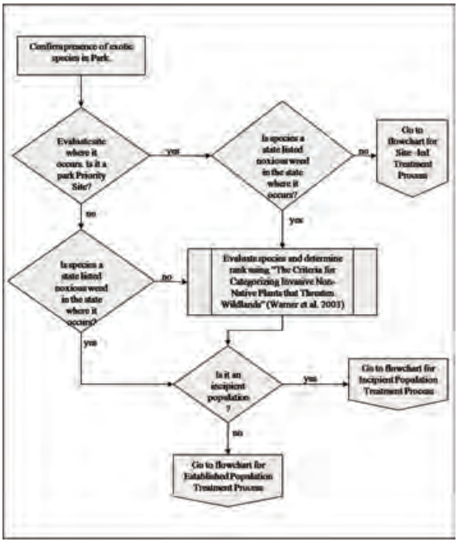

Figure 1. Situation evaluation process.

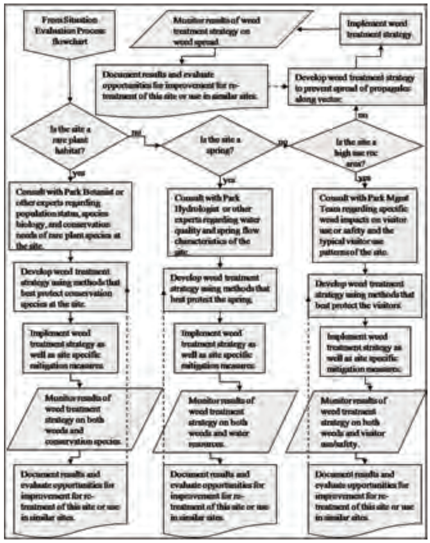

Figure 2. Site-led treatment process.

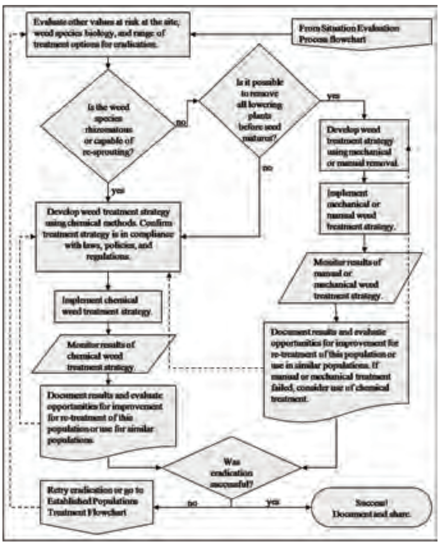

Figure 3. Incipient population treatment process.

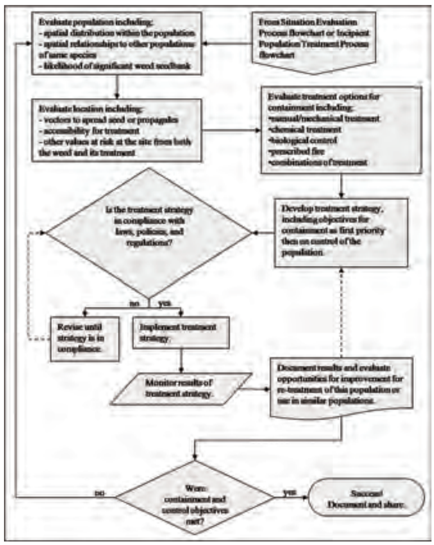

Figure 4. Established population treatment process.

We have also created flowcharts regarding chemical treatment and biological control. Collectively, these flowcharts are graphical representations of the incorporation of adaptive management into the exotic plant management decision-making processes. Adaptive management is a fundamental part of the park's Exotic Plant Management Plan (NPS forthcoming), which is currently in draft and expected to be completed in 2009.

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Research, Monitoring, and Management of Eastern Hemlock Forests at Delaware Water Gap National Recreation Area

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Introduction

Delaware Water Gap National Recreation Area covers approximately 70,000 acres (28,300 hectares) along the Delaware River in northeastern Pennsylvania and northwestern New Jersey. Forests dominated by eastern hemlock (*Tsuga canadensis*) cover about 5% of the park, but they are disproportionately important to park ecology and recreation. A majority of these hemlock forests are recognized as "Outstanding Natural Features" having "high intrinsic or unique values" (NPS 1987). Trout streams and scenic waterfalls are associated with many of these hemlock stands, and recreational activities like hiking, fishing, bird watching, picnicking, and general "sight-seeing" are very popular and concentrated in these areas.

Hemlock woolly adelgid (HWA), *Adelges tsugae,* is a non-native (Asian) insect pest of hemlock, and was first detected in the park in 1989. HWA is active in the winter, and populations are often controlled by cold temperatures; warmer winters (climate change) reduce this control on HWA populations. Since 1993, we have conducted a program to address the threats that hemlock woolly adelgid and the decline of eastern hemlock poses to valued park resources and visitor experiences. This program has included annual monitoring of HWA populations and hemlock tree health in permanent hemlock forest plots in the park, a variety of intensive studies of ecosystem characteristics and biodiversity associated with hemlock-dominated forests, and efforts to manage HWA and maintain hemlock-dominated ecosystems and visitor use areas in the park. This paper summarizes monitoring results and management activities.

Monitoring methods

Annual monitoring. A total of 78 permanent hemlock plots, each with 10 hemlock trees, were established within 6 hemlock stands in the park. The health of plot trees have been assessed annually using the U.S. Forest Service "visual crown rating methods." HWA infestation levels and the amount of new twig growth on plot trees have also been measured annually. An index of HWA infestation level for each stand was calculated as the average proportion of sampled twigs infested with HWA. Similarly, an index of new twig growth for each stand was calculated as the average proportion of sampled twigs having new growth.

Predictive model of hemlock decline and mortality. A mathematical model was developed to simulate the spread of HWA infestations throughout the park and forecast the resulting hemlock decline and mortality. A logistic equation was used to model the cumulative percentage of hemlock trees in the park that become infested over time:

$$\text{Cumulative percent hemlocks infested up to the year "y"} = \frac{100}{1 + e^{-r\,y}}$$

where e = 2.71828 (the natural logarithm), and r = the maximum rate of spread of HWA.

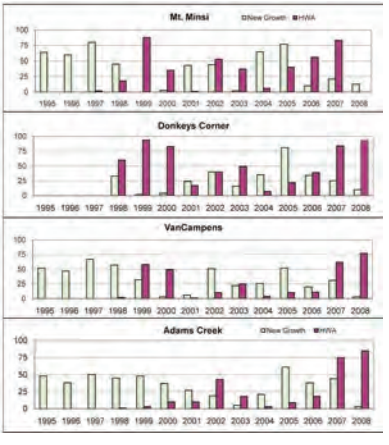
Data from research in the park (Eschtruth et al. 2006) was used to estimate r (r = 0.2608).

Hemlock trees decline and die in the model at assigned rates after having been infested with HWA. The model was set initially to fit the fact that in 1994, 93% of hemlocks in the permanent plots were "healthy," and none were dead. Hemlocks were removed from the "healthy" category in the model four years after HWA infestation. Hemlock mortality was modeled by assuming that 15% of hemlocks die 5 years after initial HWA infestation, 35% die after 10 years, 25% die after 15 years, 15% die after 20 years, 5% die after 25 years, and 5% survive indefinitely. The average time to hemlock tree mortality after HWA infestation in this model is just over 12 years.

Results

HWA populations and hemlock tree new growth. Figure 1 shows annual average HWA infestation levels and new twig growth at four stands during the past 14 years. Very high HWA infestation levels occurred in 1999–2000 (except at Adams Creek), and again in 2007 and 2008. Given the very high HWA infestation levels at these sites in 2007 and 2008, it is clear that the biological controls released in previous years (see below) have not been effective at suppressing HWA infestations to date.

Regression analysis of these data show that the amount of hemlock new twig growth in a given year declines systematically with higher HWA infestation levels in the preceding year (Figure 2). The equation describing this relationship is:



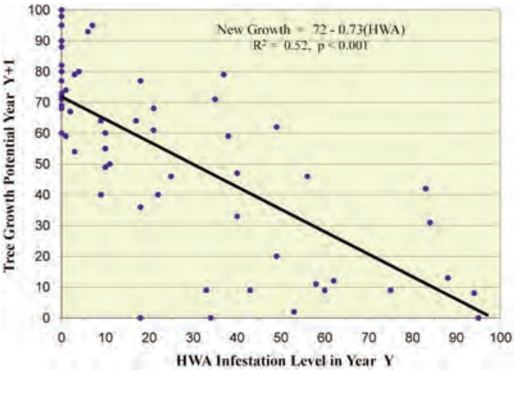


Figure 1 (left). Average annual hemlock new growth (percent of twigs producing new growth, light colored bars) and HWA infestation levels (percent of twigs infested with HWA, darker bars) at each of four monitoring sites, from 1995 through 2008. Data were not collected at Donkeys Corner before 1998.

Figure 2 (right). HWA infestations reduce the growth potential of hemlock trees: Regression equation enabling prediction of the amount of tree new growth next year from the HWA infestation level this year. The higher the HWA infestation, the less growth of hemlock trees the following year; every 1% increase in HWA infestation level reduces hemlock tree new growth by 0.73% the following year. Each data point represents one hemlock stand in one year; data presented is from six hemlock stands from 1995–2008 (hemlock growth potential was determined by the 90th percentile of hemlock tree growth in a stand; that is, only 10% of the hemlock trees in a stand produced more than this amount of new growth).

Predicted new twig growth in year "Y + 1" = 72 – (0.73 x (HWA infestation level in year "Y")).

Hemlock decline and mortality. As of 2008, 30% of hemlock plot trees had died, and all the surviving plot trees were in substantial decline; no healthy trees remained (Figure 3). The predictive model of HWA spread and consequent hemlock decline and mortality has underestimated the rate of hemlock decline and mortality in our monitoring plots to date (Figure 4). Even so, the model predicts that 50% of park hemlocks will have died by 2014, and 80% by 2022. The high HWA infestation levels of 2007 and 2008 are likely to accelerate hemlock decline and mortality in coming years.

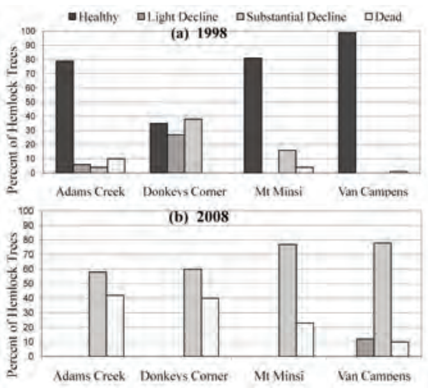
Management of HWA and hemlock

Our primary hemlock management concerns include the following:

- Increases in hazardous trees.
- Negative effects on aesthetics of visitor use areas.
- Negative effects on recreational activities.
- Invasions of alien plants.
- Impacts of white-tailed deer (*Odocoileus virginianus*) herbivory on vegetation.
- Alteration and disruption of micro-climates and ecosystem functions.
- Loss of native biodiversity, particularly losses of brook trout (*Salvelinus fontinalis*).
- Increased fire risk.

We've approached management of HWA and hemlock decline in the following ways:

- Identify and prioritize hemlock and HWA management concerns and goals.



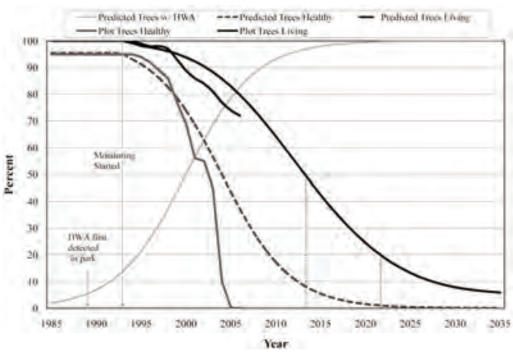


Figure 3 (left). Decline in hemlock tree crown vigor ratings in four stands between (a) 1998 and (b) 2008. No healthy trees remained at any of these sites in 2008, and all the trees at Adams Creek, Mount Minsi, and Donkeys Corner were either dead or in substantial decline.

Figure 4 (right). Hemlock health monitoring data compared to the predictive model of HWA spread and hemlock health decline (see text). The vertical dotted lines indicate the predicted dates when 50% of the hemlocks will be dead (2014), and 80% will be dead (2022).

- Identify visitor use and ecological values of individual hemlock stands.
- Prioritize individual hemlock stands for management actions, based on their visitor use and ecological values.
- Apply best available management practices to address specific concerns at prioritized hemlock stands.

Management actions we have taken in response to HWA infestations and hemlock decline include avoiding soil compaction from visitor use in hemlock forests, releasing biological control agents for HWA, chemical suppression of HWA, hazardous tree mitigation, installation of deer exclosure fences, planting native trees, and suppression of invasive alien plants in declining hemlock stands. To avoid soil compaction and damage to hemlock tree roots, elevated boardwalks were installed in high visitor use areas. Management actions have been matched with the specific ecological and visitor use values of each area. For example, at highly developed visitor use areas we have cut hazardous trees and applied insecticide to suppress HWA and keep hemlock trees alive. In contrast, in undeveloped hemlock stands that support a high diversity and/or rare native plants, we have worked to suppress invasive alien plants.

Biological control of HWA. Biological control agents provide the only hope in the foreseeable future of limiting the damaging effects of HWA in large or remote hemlock forests over the long-term. Since the year 2000, we have released a total of 75,700 black "Japanese lady beetles" (*Sasajiscymnus tsugae*), 4,500 *Scymnus sinuanodulus* beetles, and 5,512 *Laricobius nigrinus* beetles. We know these beetles have survived and reproduced to some extent in the park. However, the high HWA infestation levels observed in 2007 and 2008 (Figure 1) indicate that, at least to date, these beetles have had little or no meaningful effects on HWA infestation levels.

Chemical suppression of HWA. Judicious use of insecticides is the only practical method of HWA suppression, and of keeping individual trees alive in the immediate future. With support from the Forest Service, we've applied insecticide (imidacloprid) to suppress HWA infestations at priority visitor use areas in 2006, 2007, and 2008. This insecticide has proven to suppress HWA for several years after application (Evans 2009), although the insecticide must be applied to one individual tree at a time. To date, a total of about 2,000 hemlock trees have been treated by soil injection, and 650 hemlock trees by stem injection of imidacloprid. Each treated tree was tagged to document the year and season (spring or fall) of treatment. Soil injection has been the preferred method of application, because stem injection is more costly, requires more time, and is most effectively applied during limited hours in the morning. However, use of stem injection is required in wet areas and where trees are growing within 75 feet of surface waters.

Invasive plant suppression. We selected fourteen hemlock stands as priorities for invasive plant suppression, based on the following: stand size, location, and landscape setting; park management zoning; botanical resources (including rare species); and recreational use. All but one of these stands are within the "Outstanding Natural Feature" zone in the park. Targeted invasive alien plants include Japanese barberry (*Berberis thunbergii*), tree-of-heaven (*Ailanthus altissima*), multiflora rose (*Rosa multiflora*), garlic mustard (*Alliaria petiola-*

ta), and Japanese stiltgrass (*Microstegium viminium*). Prior to treatment, we conducted surveys to assess invasive plant populations and to identify treatment areas.

Invasive plants have been suppressed in 300 acres in 10 hemlock stands in the park to date. Park staff, NPS Exotic Plant Management Teams, and private contractors have been involved in this effort. A combination of mechanical removal and herbicide (glyphosate and imazapyr) treatments has been used.

Reforestation "demonstration" project. In 2005, numerous hazardous hemlock trees had to be cut within the Raymondskill Falls visitor use area in the park. A Reforestation Project was initiated at this area in 2006 to inform and demonstrate to visitors the effects of HWA and hemlock decline, and park management concerns and responses. The objectives of this project are the following:

- Eliminate or minimize populations of invasive plants.
- Maintain existing hemlock trees.
- Foster regeneration of eastern hemlock and other native trees.
- Minimize erosion and maintain good soil conditions for reforestation.
- Inform and educate the public.

These objectives have been addressed in a number of ways: treatment of most hemlock trees at this site with insecticide; installation of high-tensile, eight-foot high woven-wire fencing to ensure protection of native plants from deer browsing (Eschtruth and Battles 2008, forthcoming); planting a variety of native trees; elimination or major reduction of most invasive plant species at the site by applications of herbicide or mechanical removal; and posting educational signs at the site.

It is worth noting that the trees cut in 2005 were left on site to help minimize erosion, maintain good soil conditions, and foster regeneration of hemlock and other native plants. Although the downed trees may be perceived as un-attractive by some people, this is a temporary condition, and the aesthetic concern is far outweighed by the ecological benefits of leaving the downed trees on-site.

Conclusion

Hemlock woolly adelgid is only one example of problems caused by introductions of invasive alien species. The consequences of the introduction and spread of HWA are complicated and exacerbated by other environmental changes, such as the presence of invasive alien plants, elevated deer populations, and climate change. Efforts to control HWA infestations and mitigate the numerous effects of widespread hemlock decline and mortality on ecosystems, native biodiversity, and immediate human concerns (safety, aesthetics, recreation) are extremely difficult and costly, and have had limited success to date. Given such circumstances, how can we achieve the NPS mandate to conserve the parks "in such manner and by such means as will leave them unimpaired for the enjoyment of future generations"?

> Nature in the 21st century will be a nature we make; the question is the degree to which this molding will be intentional or unintentional, desirable or undesirable (Botkin 1990).

Acknowledgments

The efforts and support of many agencies, universities, and individuals have contributed greatly to this HWA-Hemlock Program over the years. In particular, park biologist Jeff Shreiner has contributed much to this program. Sustained support from the Forest Service has been critical, and is greatly appreciated. The support of Elizabeth Johnson, Pat Lynch, John Karish, and the park superintendents over the years is also greatly appreciated.

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Feral to Permitted to Preserved: Managing Scientific Collections Taken from National Parks

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Key National Park Service (NPS) scientific research and collecting permit conditions and procedures for permanently retained collections are often overlooked, later causing confusion in park, research, and repository communities. These procedures include obtaining signed agreements from proposed non-NPS repositories to accept specimens under NPS permit and loan conditions before permits are issued, identifying responsibility and funding for labeling and cataloguing specimens in permit applications, and using loan agreements whenever specimens leave parks. Some protocols, such as using material transfer agreements (MTAs) for certain circumstances involving microbiological research, are relatively unknown to parks. Permit coordinators, researcher applicants and permittees, park curators, and repository managers when collaborating effectively, experience high benefits and satisfaction. Four examples from parks with active research programs illustrate park-specific approaches to meet the needs of science and collections management within parameters of policy and standard procedures.

How parks manage scientific collections is occasionally is a point of contention. Some prospective museum repositories for NPS scientific collections claim museum policies prohibit acceptance of long-term loans, and say NPS should convey specimen ownership to the repositories. Others fear parks may arbitrarily recall collections on loan precluding benefits that might otherwise accrue to the repository through collections research and education programs. In addition, researchers often fail to meet the permit condition requiring that permittees complete labels and catalogue records for permanently retained specimens, leaving parks with unlabeled and uncatalogued backlogs. Some parks report researchers saying they will not work in parks because of permit conditions related to scientific collections.

NPS ownership of research specimens is based in law and has been acknowledged in court. NPS management policies and permit conditions state that collected specimens that are not consumed in or discarded after scientific analysis remain federal property. Vigilance in maintaining a chain of custody is important. Parks may negotiate and customize repository agreements to provide longer-term loans than standard loans and assurances against arbitrary or frivolous recall. Park curators provide researchers with templates and other tools that aid labeling and cataloguing. Consistent with policy and basic procedures, the four example parks have developed operating procedures that mitigate these concerns.

Yellowstone National Park

Yellowstone annually administers approximately 200 permits and approves approximately 40 new studies. Research topics vary, but focus on animals, plants/forestry, geology, and microbiology. Microbiology represents 25% of scientific research. Most studies retaining specimens (fewer than 50 permits annually) are in geology, botany, archeology or paleontology; however, some are in wildlife and other areas.

Fortunately, Yellowstone has sufficient staff and facilities to support its research and collections. The park has a full-time research coordinator and the new state-of-the-art Yellowstone Heritage and Research Center, completed in 2004, is staffed by a full-time curator, a full-time museum registrar and several museum technicians. It houses over 390,000 artifacts, several million archival items (and is an affiliated repository of the National Archives and Records Administration), over 21,000 specimens each for biology and paleontology, and over 1,500 geological specimens. It includes an herbarium with approximately 10,000 botanical specimens, as well as archeology and geology labs.

To ensure that permitted research does not create a collections management backlog, the permit coordinator and curatorial staff explain collections requirements to new applicants before the permit is issued. They advise researchers to do the following:

- Get an accession number from the park curator before starting work.
- Request catalogue numbers from the park curator when they know how many samples are suitable for the park's collection, typically within the first year.
- Meet all curation milestones to facilitate annual permit renewal, when the staff checks for compliance.
- Complete ANCS+ catalogue worksheets as data are analyzed and available. Sometimes, data analysis and completion of worksheets lags two to three years depending on the study design, study duration, and the year funds were budgeted for analyses.

The staff maintains a spreadsheet that tracks the status of each permit.

Planning specimen storage starts with the permit application. The curator consults the applicant and determines the best storage venue–either the park storage facility or, as needed, a specialized repository, such as the American Type Culture Collection for microorganisms. When proposing a repository, the applicant obtains the repository official's signature on the permit application, demonstrating willingness to house the specimens. When specimens are catalogued, the curator negotiates a loan agreement with the designated repository.

Park staff communicates the curation message to researchers early and often with one-on-one consultations, handouts, an annual orientation, and web access to information on scientific research permits (www.nps.gov/yell/naturescience/researchpermit.htm) and researchers' collections responsibilities before and after collecting (www.nps.gov/yell/parkmgmt/curatorial.htm).

Yellowstone is a pioneer among NPS units in permitting collection of microbiological materials and managing the resulting collections. Research on microorganisms results in unmodified and modified research results that are typically shared with other researchers. The scientific community uses material transfer agreements (MTAs) to document this sharing. Yellowstone completes MTAs when a permitted researcher wants to share research material with a third party for an unrelated investigation. The MTA defines the rights of the provider (NPS) and the recipient's organization regarding the material and future research results. Yellowstone uses MTAs to provide microorganisms and other materials, such as reagents, cell lines, plasmids, vectors, and chemical compounds. Consistent with permit conditions, the material remains federal property.

Acadia National Park

Acadia's scientific collections include specimens and associated records, such as reports, field notes, spatial and tabular data, photographs, proposals, and copies of permits. The total collection is 1.3 million items. Approximately 20% are scientific collections. Acadia also manages scientific collections from 12 other parks in the NPS Northeast Temperate Inventory and Monitoring Network.

Park scientific collections goals are the following:

- Ensure permanent care and organization of park scientific information.
- Facilitate collection of representative voucher specimens for park living resources.
- Provide excellent service to researchers, park employees, and the public seeking to access and use collections.

Annually, approximately 50 permitted studies, the BioBlitz, and the NPS Inventory and Monitoring Program generate specimens. For BioBlitzes, the lead taxonomist, whose permit covers all participants, is responsible for identifying and labeling specimens, and returning representative vouchers to the park. Most specimens are not retained, but are considered consumed during the event. Information on Acadia BioBlitzes is on-line at www.nps.gov/acad/naturescience/bioblitz.htm.

The park provides web-based information on park research opportunities, research guidelines, park-specific permit conditions, instructions on submitting associated documentation, BioBlitz activities, fellowships, and the NPS Research Permit and Reporting System (RPRS). The park-specific permit conditions require that researchers collecting specimens for permanent retention in the park collections contact the park museum technician to discuss collecting responsibilities, such as specimen preparation, disposition, and cataloguing before initiating field work (www.nps.gov/acad/naturescience/researchguidelines.htm).

A museum technician manages the collections, including acquisitions, cataloguing, and daily operations, and coordinates volunteers who are critical to cataloguing, collection organization, and housekeeping. The cultural resource program manager supervises program employees, oversees strategic planning, coordinates budgets and fund-raising activities, and provides back-up support. The chief of resource management administers the permits, coordinating curatorial responsibilities with the museum technician.

Managing collections generated by scientific permits proceeds as follows:

1. Researcher submits research proposal.
2. Resource management staff and permit coordinator review the proposal.
3. Researcher discusses collection outcomes with museum technician or the permit coordinator, or both.
4. Collection outcomes become park-specific conditions in the permit.
5. Museum technician or permit coordinator checks with researcher during and after fieldwork to ensure curatorial responsibilities are met.

Acadia's curation and permitting strategies vary according to circumstances. The researcher's curatorial responsibilities depend on the number of specimens acquired for the park's collection. If fewer than 300 specimens, the park volunteers complete the cataloguing, based on information from the researcher. For larger projects, park staff works with investigators at the proposal stage to ensure that the project budget covers cataloguing costs.

Acadia manages most specimens in the park's William Otis Sawtelle Collections and Research Center, but, under an agreement, the College of the Atlantic manages approximately 6,000 herbarium specimens. Student interns and "Friends of the Herbarium" provide care according to NPS standards.

NPS-funded studies submit two paper copies and one electronic copy of the final report and copies of associated records. Other studies submit two paper and electronic copies of the final report and are requested to submit copies of associated records. Acadia resource managers initiated a system to track project status and deliverables, including voucher specimens and associated records.

Future improvements will focus on coordinating with investigators, streamlining permitting processes, tracking deliverables, mitigating specimen ownership sensitivity, and funding.

South Florida Collections Management Center, Everglades National Park

The South Florida Collections Management Center (SFCMC) manages collections for five parks: Big Cypress National Preserve, Biscayne National Park, De Soto National Memorial, Dry Tortugas National Park, and Everglades National Park. Working with four permit coordinators, the SFCMC staff (one curator and a varying number of museum technicians) coordinates the management of specimens and data collected under research permits in these parks, which, in 2008, issued 153 new and managed 311 active permits. Specimens not consumed in analysis or destroyed remain federal property and become part of each park's museum collection.

SFCMC's scientific collections management strategy depends on integrating its staff into the permitting process, and communicating with the researcher from the time of application through submission of deliverables.

Collectors' responsibilities for specimens and data are stated in a web-accessible document (www.nps.gov/ever/historyculture/sfcmc.htm). These tasks are grouped according to whether they occur during the application process, or before, during, or after fieldwork.

During the application process, this step must be undertaken:

- Contact SFCMC staff by telephone to answer standard questions about the study proposal.

Before collecting, these tasks must be completed:

- Contact SFCMC staff to discuss the project.
- Obtain an accession number from SFCMC staff.
- Obtain cataloguing and labeling instructions from SFCMC staff.

During collecting, the following must be done:

- Collect data important for documenting specimens permitted for permanent retention.

Immediately after collecting, the most important tasks to complete follow:

- Contact SFCMC staff for a block of catalogue numbers.
- Catalogue permanently retained specimens using either an Excel data import/export template, or ANCS+, both provided by SFCMC staff. Follow cataloguing standards in the NPS Museum Handbook and the ANCS+ User Manual (see www.nps.gov/museum/publications/index.htm).
- Complete NPS labels that SFCMC provides or generate them from ANCS+.
- Sign an NPS loan agreement to retain the specimens for study and cataloguing.

One year after final data of collecting, complete the following tasks:

- Submit labeled specimens and original project documentation to the permit-designated repository.
- Submit electronic catalogue records to SFCMC.
- Submit copies of field records on acid-free paper to the permit coordinator's office. SFCMC catalogues field records, not researchers.

The permit coordinator and SFCMC staff must remain flexible to accommodate special circumstances, such as multi-park research permits, and changes in principal investigators.

Clearly stating deliverables in permits and park-specific conditions is critical. Using Excel spreadsheets, SFCMC staff tracks the researcher's progress in meeting the curatorial responsibilities and submitting deliverables. The south Florida parks' basic deliverables are the following:

- A comprehensive annual report (hard and electronic copy).
- Copies of field notes, images, videos, and other documentation.
- An electronic copy of data collected and metadata (see research data reporting require-

ments at www.nps.gov/ever/naturescience/researchdatareporting.htm).

- A list of all specimens/material consumed in analysis, with coordinates of collection sites and results.
- Voucher specimens and associated labels and catalogue records submitted according to SFCMC instructions.

Before importing data from researchers, SFCMC staff verifies data for conformance to ANCS+ standards, and makes corrections while the data remain in Excel.

In addition to specimens housed at SFCMC, specimens are on loan to nonfederal repositories. For example, SFCMC has a cooperative agreement with the University of Florida to manage wet specimens.

SFCMC's strategy for managing scientific collections and data shares the burden of responsibility among the researcher, permit coordinators, and SFCMC. Timely communications and actions on curatorial matters ensure cooperation and efficiency. Future goals involve improvements in issuing permits to park staff, funding cataloguing and labeling for park-initiated research, funding cataloguing for archival documents that non-NPS researchers generate, and tracking loans and deliverables.

Yosemite National Park

At Yosemite, a recently formed interdisciplinary permit team, including the permit coordinator, resource managers, and the museum registrar, is refining its standard operating procedures, affording an opportunity to better integrate curatorial responsibilities. In 2008, the team reviewed 118 applications, approving 108.

Museum guidance under development will achieve the following:

- Create a uniform approach to park permits.
- Describe curatorial requirements, including the requirement for researchers to label and provide catalogue data for permanently retained specimens.
- Attempt to address researchers' needs.
- State preferred techniques.
- Establish deadlines.
- Provide contact information.

Communicating park museum requirements to researchers before they go into the field is essential to ensuring that they capture required data and information in the correct format. When renewing a permit, they need to give a progress report on their curation responsibilities. If the researcher is not meeting requirements, the renewal is jeopardized. When a permit is approved, the museum registrar provides the museum requirements to the researcher via e-mail, copying the co-investigator, permit coordinator, and the park resource manager point of contact.

To comply with museum requirements researchers must deliver the following:

- Catalogue records produced using an Excel import spreadsheet capturing mandatory data in required ANCS+ formats.

- Hard and electronic copies of data, metadata, field records, two copies of a final report, and other associated records.
- Specimens with NPS labels and museum catalogue and accession numbers.

If the specimens are not to be housed in the park, the permit designates another repository. Although researchers are not directly responsible for loan agreements to repositories, researchers have related responsibilities to facilitate loans. The researcher must accomplish the following:

- Obtain agreement of a repository official, on Appendix A of the permit application, for any repository that the researcher recommends.
- Cooperate with the park to facilitate repository loan negotiations during the life of the project.
- Deliver specimens to the repository, or otherwise assist the park in completing the repository loan within one-year of the project's termination.

Yosemite is finalizing this museum guidance, gaining concurrence from the permit team and resource management staff, and planning a field test in 2009. Guidance will be posted with permit information on the park web site (www.nps.gov/yose/parkmgmt/businesswithpark.htm) and on the RPRS web site (https://science.nature.nps.gov/research/ac/parks/ParkInfo).

Future challenges include refining procedures based on feedback; improving final product completeness, customer service, and communication; and developing ongoing repository relationships. Learning new procedures burdens both researchers and park staff, but if the museum registrar is successful in establishing good communications, researchers become informed participants early in the process, and all parties are vigilant in tracking deliverables, the challenges will have been met.

Summary

Parks managing scientific specimens and associated records resulting from research and collecting activities have common requirements reflecting NPS policies, procedures, and permit conditions. How parks organize to meet these requirements varies depending on circumstances. Staffing, workload, expertise, availability of partners and volunteers, geography, park mission and research goals, outside research interests, funding, and other factors shape park strategies for managing scientific collections. Whatever the process, clear, early, and ongoing communication among the permit coordinator, the museum staff, the researcher, and designated repositories is critical to initial and long-term preservation of scientific collections and associated data for public benefit.

Restoration of the Upper Kawuneeche Valley in Rocky Mountain National Park

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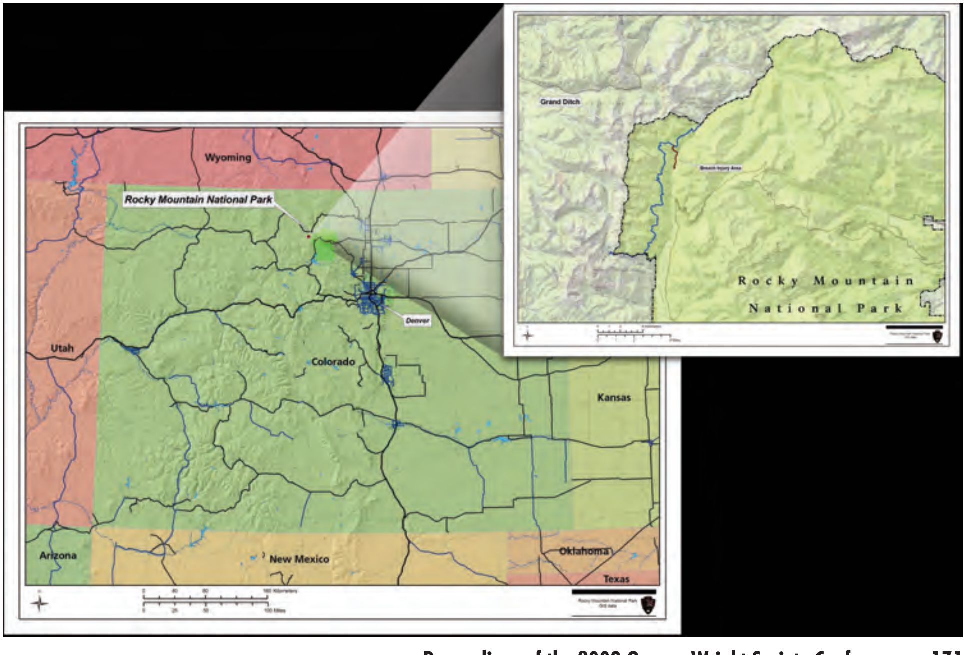
Introduction

The Grand Ditch, a trans-basin, water-diversion canal, breached its bank on May 30th, 2003, causing extensive injury to the upper Kawuneeche Valley area in Rocky Mountain National Park (RMNP), Colorado. The breach saturated an adjacent hillslope which gave way, sending a massive (~36,000 m^3) mud- and rock-slide down into Lulu Creek and the headwaters of the Colorado River, damaging upland, stream, riparian and wetland habitat over an approximately 2.4 km distance and 9 ha area. In 2008, the National Park Service (NPS) won a $9 million settlement from the Water Supply and Storage Company (WSSC), owners of the ditch, to restore the damaged resources. This is the largest settlement ever reached under the 1990 Park System Resource Protection Act (PSRPA, a.k.a. 19jj). Within days of the breach the park initiated a process to restore the injured area.

Figure 1. Location of the Grand Ditch Breach.



The breach

The actual cause of the Grand Ditch's failure is uncertain. It may have overtopped or it may have formed a seep that collapsed the ditch sidewall sending about 2.8 m^3/s (100 ft^3/s) flow of the ditch down a steep hillside, creating a flood that sent approximately 36,000 m^3 (47,600 yd^3) of boulders, trees and sediment cascading down into Lulu Creek.

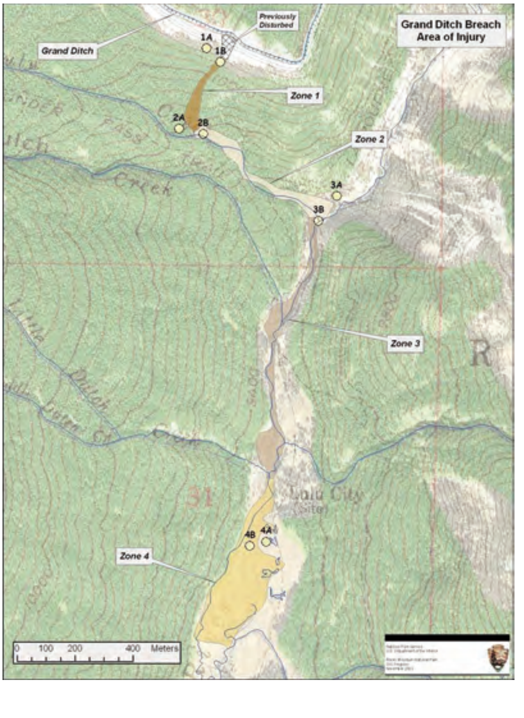
Lulu Creek flowed as a mud- and debris-filled torrent, gouging the streambed up to 2 m deep, widening the channel by as much as 10 times, and uprooting and depositing piles of trees and sediment throughout. When the torrent arrived at the low-gradient confluence with the Colorado River, it deposited sediment and debris in an alluvial fan up to 2 m thick. The sediment-filled waters continued downstream along the Colorado River clogging the channel and covering the floodplain with gravel, sand, and more debris.

Figure 2. Grand Ditch Breach (Zone 1).

About 1.6 km further downstream from the confluence, the flood arrived in the Lulu City wetland where it filled the existing channels and deposited up to 60 cm of silty sand onto the wetland, burying the existing vegetation and altering the wetland's hydrologic regime. Finer sediments were transported an additional 45 km downstream to Shadow Mountain Reservoir, where a visible delta was formed.

In all, about 9 ha (22 acres) and 2.4 km of stream, riparian, upland, and wetland habitat were injured. This includes over 20,000 trees destroyed, and approximately 50 different plant species affected.

Figure 3. Grand Ditch Breach Area of Injury ("A" and "B" indicate comparison plots in each zone).



The settlement

In 2006, the U.S. Department of Justice, on behalf of the NPS, filed a civil lawsuit against the WSSC, owners of the Grand Ditch, under the authority of the PSRPA, which provides for the payment of compensation by private parties for damages to park resources.

The court case preparations continued for another two years. In May of 2008, an out-of-court settlement was reached in which the WSSC agreed to pay RMNP $9 million in damages. This is the largest settlement ever reached under PSRPA.

Figure 4. Breach Impacts, clockwise from top left; Zone 1 (hillside), Zone 2 (Lulu Creek), Zone 4 (Lulu City Wetland), Zone 3 (Colorado River).

Resource damage assessment

RMNP and a team of cooperating researchers conducted surveys starting in the summer of 2003 to assess the nature and extent of the injuries caused by the breach. Assessment work focused primarily on defining the footprint and the approximate depth of the deposited materials, while characterizing altered stream morphology, groundwater elevations, water quality, and impacts to wetland, riparian, and upland vegetation. The stability of the gouge in the zone one hillside was also investigated.

Following the settlement, additional assessment work was conducted by researchers from both Colorado State University and the park to refine our understanding of the area's current hydrology—this includes stream hydrology, sediment transport, surface water-groundwater interactions, and groundwater elevations. These processes are being compared with nearby reference reaches to better understand the desired future conditions for the area. Ground-penetrating radar is also being used experimentally to map sediment deposit depths. This summer we will continue this research and conduct additional field work to refine volume estimates for the deposited material, survey for sensitive plant and animal species, monitor vegetative recovery, and set up long-term photo monitoring stations.

Restoration planning and implementation

RMNP is starting a two- to four-year process to complete an environmental impact statement to guide the restoration of the breach-impacted area. We will be gathering input from park staff, other agencies, and the public, to develop a set of restoration alternatives.

Key considerations will include short- and long-term potential impacts from restoration activities to the following: wilderness values; surface and groundwater hydrology; stream channel, floodplain, and wetland morphology and function; downstream water quality; sensitive plant communities and wildlife, such as helicopter operation effects upon mountain sheep lambing; visitor experience; and archaeological and historical sites.

Possible restoration options will likely include a mixture of the following, prescribed on a zone-by-zone basis: allowing natural restoration to occur where appropriate; stabilizing steep, unstable slopes with soil nail anchors and metal mesh fabric; using controlled water releases to help reconfigure stream channels; removing deposited sediment and redistributing it through the impacted area; removing downed timber, or using it in the restoration process, or both; re-grading and re-contouring areas to restore proper morphology and function; and native plant restoration with appropriate, locally gathered plant materials.

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Science and Strategies: Collaboration to Combat Marijuana Cultivation on Public Lands

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Background

Marijuana cultivation on public lands, primarily by Mexican national drug traffic organizations (MDTO), has exploded in the last five years. This illegal activity has resulted in serious landscape-level impacts with increasing threats to watersheds, vegetation and wildlife populations, as well as critical safety concerns ranging from booby traps to guards carrying weapons.

Science and strategies: Collaboration to combat marijuana cultivation on public lands

Collaborations among interdisciplinary teams can make a difference in the threat and impact of marijuana cultivation on park lands. Partnering law enforcement specialists, GIS modeling analysts, and resources specialists has created a powerful formula for curtailing this illegal activity through intelligence gathering, site locating, eradication, and restoration. Through increased participation and communication, resource specialists can significantly aid field efforts, including contributing to the development of early detection models, resource assessment protocols, and site restoration.

Impacts of marijuana cultivation on public lands

Throughout California, 3,641,328 marijuana plants were seized on state and federal public lands in 2008. This translates to approximately 9,100 acres of public land cultivation with a street value of over $14 billion. The cost of restoring these areas is $10-12,000 per cultivated acre. The footprint extends much further than the cultivation site (Figure 1), however, with the related impacts spreading 20 to 40 acres per acre cultivated (Figure 2). And that's just in the state of California for 2008. MDTOs are seizing on the mild climate and vast stretches of remote lands on the west coast to set up cultivation sites. Tightened security on the U.S.-Mexico border has convinced many MDTOs that it is easier to grow marijuana in

Figure 1 (left). Cultivation site in Whiskeytown National Recreation Area from the air.

Figure 2 (right). Related site impacts of campsite development.

the United States than to smuggle it into the country. The MDTOs take extreme measures to protect the plants, which can be worth $4,000 each. Marijuana cultivation has been identified as one of the most pressing issues facing public lands. Pacific West Region national park areas in particular have seen a dramatic increase in illegal marijuana cultivation including seizures at Sequoia and Kings Canyon National Parks, Yosemite National Park, Golden Gate National Recreation Area (NRA), Point Reyes National Seashore, Redwoods National and State Parks (Figure 3), North Cascades National Park Complex, and Whiskeytown NRA. In addition to obvious law enforcement and resource protection challenges, the skyrocketing cost of restoration and increased patrol personnel is not covered by existing operational budgets.

Examples of impacts seen on national park service lands:

- Trees and vegetation cleared for growing areas.
- Introduced chemicals (herbicides, pesticides, fertilizers, fuels) pollute watersheds and kill native species (Figure 4).
- Ditches and crude dams are created, and streams and other water sources are diverted—sometimes by as much as three miles.
- Extensive irrigation equipment is installed, leaving behind miles of irrigation tubing.
- Human waste and garbage are left by the ton after a completed harvest.
- Increased soil erosion due to cleared land, irrigation, diverted water, foot traffic, and camp areas.
- Unlimited poaching of wildlife and

Figure 3. A marijuana cultivation site in Redwood National and State Parks.

game for subsistence and trophies while occupying the site (typically involves 2–8 people for 5–7 months).

- Damage to cultural resources within the area.
- Increased visitor and employee safety risk due to heavily armed guards.
- Labor intensive patrolling and restoration efforts stretch already tight budgets.

Applying predictive modeling to inform investigators and resources specialists

With limited resources to help combat the growing occurrences, a method of focusing efforts was developed through modeling, using a geographic information system (GIS). Two habitat suitability model approaches, multiple logistic regression and weighted overlay, were compared in an effort to identify a best predictive model for marijuana cultivation sites. The models incorporate plant attributes and human activity. Plant criteria include attributes that are related to plant growth such as aspect, soil depth, and land cover. Human factors are site selection criteria, such as proximity to water and roads.

The multiple logistic regression model was evaluated as providing the best results. The model was applied to Yosemite, Sequoia and Kings Canyon, and Whiskeytown with 80 to 95% of historic sites plotting in the area identified as most probable for cultivation. The regression model process is still in development, and data collection and management standards are necessary to ensure better calculations in the future. GIS modeling and analysis of this type is a valuable and efficient means to support resource protection and law enforcement on public lands.

Cultivation site restoration case study—Sequoia and Kings Canyon National Parks

Most of what we know about restoring marijuana cultivation sites comes from the Sequoia and Kings Canyon, which are situated in a rugged, sparsely-populated area of California that is both ideal in climate and topography, as well as adjacent to a major highway corridor, making it desirable for illegal planting operations.

Sequoia and Kings Canyon have completed four consecutive years of marijuana site cleanup and restoration. Sequoia and Kings Canyon's goals are to disrupt the site use by growers by removing infrastructure, and to restore sites to a more natural condition. The highest priority is to remove the immediate evidence of camps, including irrigation hose, garbage, fertilizers, and pesticides. Vital information on location, size, aspect, topography, ground cover, etc., of cultivated sites is collected by resource specialists and law enforcement rangers, as well as quantifying and documenting the resource impacts of chemical use, land disturbance, and water contamination. This information helps define the extent of the impacts, improve future preparedness of staff, and predictive capabilities of scientists.

Work is accomplished with the cooperation of the California Conservation Corps, private contractors, volunteers, and California Air National Guard, and has included the removal of 18,500 pounds of garbage and 23 miles of hose, as well as the documentation and mapping of 105 cultivation sites, 37 camps, and 41 garbage pits. Challenges include working safely amid numerous job hazards, data management, information transfer from law enforcement to natural resource staff, monitoring restoration efforts, and continuing to fund work in the absence of a dedicated funding source.

Lessons learned

Effective partnerships are the key to success. Efforts must be made to develop alliances across disciplines, management boundaries, and agencies to create a successful outcome. Marijuana cultivation has proven to be a boundary-less resource issue that can be likened to light pollution, soundscapes, and air pollution.

Funding is sorely lacking to address this growing challenge. There is a need for a concerted effort towards shaping political will, funding sources, and the public's perception of the problem.

Consistent, clear communication is necessary to gain public and political support for keeping public lands free from marijuana cultivation. Messages need to communicate that at this level, it isn't a "choice" or "legalization" issue; it's about keeping public lands safe, protected, and intact for current and future visitors, and the resource damage is immense.

Invest energy and effort in early season disruption of growers' activities to prevent damage to natural resources, and break the cycle of degradation and restoration.

Standardize a single repository/data model for comprehensive marijuana data inclusive of case reports, arrests, surveillance, eradication, and restoration. Such standardization of data and data collection allows for much more effective trend analysis.

Parks Victoria's Management Effectiveness Evaluation Program: Where Science Meets Management

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Park managers around the world face a number of fundamental questions about the resources they are managing:

- How do we know if, and to what extent, our ecosystem and other park management objectives are being met?
- To what extent is the condition of our parks and visitor experiences changing and are these changes desirable or undesirable?
- How do we know whether our management actions are effective?
- How do we allocate resources to achieve the proposed management outcomes?

Different information users want to know the answers to different types of questions, including the following:

- Local or individual park managers want evaluation information that will assist them to improve their operational management decisions.
- Regional parks managers want evaluation information that can help influence how they allocate their resources to meet the best outcomes.
- Managers of parks networks want evaluation information that will provide strategic information about achievements, gaps and challenges.
- External stakeholders and Governments want evaluation information that will demonstrate whether the management of their parks are in capable hands.

What are our management goals?

Parks Victoria manages diverse landscapes for diverse objectives across 18% (4.1 million hectares) of the State of Victoria. These parks include 70 national, state and wilderness parks, 24 marine national parks and sanctuaries, various historic parks and reserves, 2,800 (mostly smaller) conservation reserves, 31 urban parks, as well as many indigenous cultural heritage places and post-settlement historic places. It also manages recreational use of major waterways, such as Port Phillip and Western Port around Melbourne.

With these diverse types of parks, Parks Victoria has very diverse management goals, including the following:

- Protection of representative examples of the most undisturbed terrestrial and marine ecosystems in the state.
- Conservation of diverse flora and fauna including the majority of states threatened species.
- Provision of essential ecosystem services to communities such as clean water.

- Protection of remnant vegetation both in rural and urban landscapes.
- Building understanding and support for healthy parks.
- Contribution to the states fire management program including wildfire, fire ecology and fire recovery.
- Developing and sustaining mutually beneficial relationships with traditional owners.
- Including protection and interpretation of significant cultural sites and places, employment and business opportunities and fostering connection to country.
- Provision of diversity, equity and quality in visitor experiences including recreational settings and facilities, education and interpretation and nature-based tourism.
- Provision of social and health benefits to communities.
- Contribution to the Victorian economy through nature based tourism and regional employment.
- Improvement of Melbourne's liveability through its urban parks system.

How can we evaluate our management effectiveness across all of these diverse goals?

In a national and international context, more systematic approaches to the evaluation of management effectiveness and reporting have grown significantly over the past decade with the dual aims of improving park management outcomes as well as being able to report these outcomes to the community.

Parks Victoria is implementing a comprehensive management effectiveness program which consists of four key components:

1. Application of the IUCN Management Effectiveness Evaluation Framework.
2. Implementation of a State of the Parks reporting program.
3. Building of the evidence base through scientifically robust monitoring programs (across natural values, visitor services, cultural values).
4. Application of evaluation findings through decision-support and planning tools for managers.

1. Application of IUCN Management Effectiveness Framework

The IUCN Management Effectiveness Framework has been adopted by a large number of countries and park agencies over the past decade (Hockings et al. 2006). The framework uses a systematic approach to evaluate management performance based on the adaptive management cycle. These include evaluation of park management "context," "planning," "inputs," "process," "outputs," and "outcomes". The evaluation tool uses a formalised qualitative survey of park staff, based on their knowledge (including knowledge of research and monitoring findings) and experience. While this qualitative information is very valuable for evaluation, it is not designed to replace robust monitoring programs. Indeed, the qualitative approach used in the IUCN framework can be highly complementary to science-based monitoring programs.

Parks Victoria has recently introduced its own Park Management Effectiveness Framework, based on the IUCN framework (Figure 1). The introduction of the framework is becoming an extremely valuable management tool, not only to enable systematic evaluation of management effectiveness across the parks network, but also to clarify, refine and integrate all of the key components of effective park management, such as planning, project management, and knowledge. It has clarified and improved the important links between park management objectives and performance indicators at different scales, as well as highlighting organizational strengths and gaps which have generated new directions for Parks Victoria's management. An advantage of this evaluation tool is that it can be applied at a range of scales, from individual park to the whole parks network, to assist park managers.

Figure 1. Parks Victoria's Management Effectiveness Framework.

2. State of the Parks (SoP) reporting

Parks Victoria produced its first State of the Parks report in 2000 which was the first in Australia and one of the first reports of its type in the world. The second SoP report was released in 2007. The SoP has four objectives:

- Contribute to a better understanding of park values, their condition and threats that impact on them.
- Summarise findings of the evaluation of management in delivering long-term objectives.
- Inform planning and decision-making (corporate to park level).
- Improve communication of park management to the public.

The target audiences for the SoP report have included both Parks Victoria managers (including Senior Executive and the Board) as well as the broader community (including government). Beyond the public report, which has focused on the whole parks network, the information collected through the SoP program is intended to provide valuable information for park managers about the local and regional effectiveness of their programs so that they can adapt their management programs accordingly.

The SoP program summarizes the previous five years in relation to the major activities, achievements, and management outcomes across each of Parks Victoria's output areas (including natural values, cultural values, and visitor services). It provides the following:

- Medium to long-term management objectives for each output.
- A framework of indicators and measures for each output.
- A summary of the current status, condition, and trends of and park values and assets, and on-going and emerging risks and threats.
- A summary of the major actions to achieve the objectives.

- A summary of the major information gaps, management challenges, and proposed responses.
- An assessment of outcomes weighted against management objectives.

The SoP program uses a combination of quantitative and qualitative data, including the following:

- Corporate and state-wide databases and datasets (e.g., Environmental Information System, Asset Management System).
- Commissioned reports such as risk assessments and asset condition reports.
- Monitoring programs (e.g., asset condition assessments, visitor satisfaction surveys, natural values monitoring data).
- A comprehensive staff questionnaire.

Over time it is expected that the reporting of management outcomes (particularly ecosystem condition) will be based on an increased proportion of quantitative data, based on more robust monitoring programs. Nevertheless Parks Victoria considers that the use of both quantitative and systematic qualitative data is an appropriate way to evaluate management effectiveness across all of its diverse management objectives. Evaluation based predominantly on quantitative monitoring programs will only ever be sustainable and achievable across a sub-set of parks and issues.

The SoP program has helped build an improved awareness of the need for objective evaluation of management within Parks Victoria. Some of the benefits and outcomes of the program have included the following:

- Building in of formal "review-time."
- The *process* of evaluation improves staff knowledge about their priority objectives, values and threats.
- The establishment of a framework of indicators for effectiveness with links to parks network objectives.
- Strong influence on corporate and business plan priorities.
- The application of SoP information with other planning and resource allocation tools to inform park priorities and strategies.
- Facilitating the introduction of new Parks Victoria initiatives, such as improved monitoring and information management systems.

While there have been a range of benefits arising from the SoP program, there are also a number of lessons learned for the future, including the following:

- The need for improved alignment of SoP "products" to meet the needs and expectations of different users. For example network scale strategic reports may be appropriate for Government and Senior Executives, however local and regional park managers need

information at more meaningful management scales, in more accessible and useable formats.
- The need to rationalize the number and types of indicators for communication to managers and the community.
- Greater effort to improve interpretation and application of SoP data for park managers and decision-makers at all levels.
- The need to review evaluation and reporting cycles, with staff seeking evaluation to be built more into routine management cycles.
- Further development and roll-out of new integrated monitoring programs to provide a stronger evidence base.
- The need for faster feedback of results to park staff, and more automated and accessible information management systems (e.g. web-based staff questionnaire, standardized data queries and park profiles).

3. Building the evidence base through monitoring and research

To improve the value and rigor of Parks Victoria's management effectiveness evaluation program, Parks Victoria is involved in a number of initiatives to apply a more science-based approach to management and evaluation. These include improvements to ecological monitoring programs, implementation of adaptive experimental management programs and new approaches to visitor management using social science techniques.

Ecological monitoring program

A recent review of ecological monitoring programs across Parks in Victoria's estate found that although there has been much monitoring activity over the years, it has been very difficult to determine the condition and trends of natural values in many parks due to issues such as inconsistent methods, insufficient sampling, and unclear objectives (Parks Victoria 2007). These concerns are not unlike those that a number of other park agencies have faced around the world.

Parks Victoria is currently developing a new, more strategic approach to its ecological monitoring, the "Signs of Healthy Parks" (SoHP) program. This new program seeks to accomplish the following:

- Improve our management based on evidence and good science.
- Detect change and trends in park condition.
- Determine the effectiveness of actions so we can adjust our management.
- Provide early warning systems for impending threats.

The SoHP program uses Parks Victoria's natural values monitoring framework which is based on three scales of monitoring: activity, effectiveness, and environmental outcome (Figure 2). It includes three broad indicator groups: landscape context, disturbances and threatening processes, and ecosystem condition and environmental outcomes.

The SoHP program is currently being trailed in six pilot parks, with draft monitoring plans developed. A range of "user-friendly" monitoring protocols and a monitoring guide have been developed and trialled to enable ranger staff to implement many of the programs.

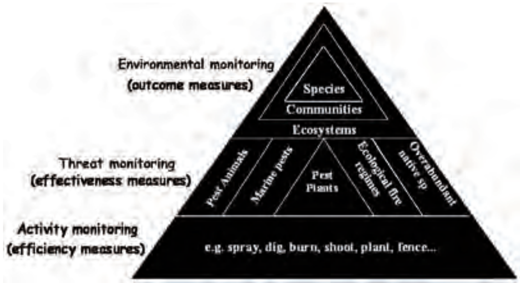

Figure 2. Parks Victoria's monitoring framework.

Using social science to inform visitor use planning and management

Since the mid-1990s Parks Victoria has been undertaking scientifically sound monitoring of visitors and the community. This includes monitoring of visit numbers, visitor experience and community perceptions of management. With more than a decade of robust visitor satisfaction monitoring data, that data has now been analyzed to produce a comprehensive picture of visitor preferences through market segmentation (Zanon, Shaw, and Hall 2008). Major segments defined include Nature Admirers, Urban Socials Trail Users, Passives and Other Users, Activity Centrics, Access Made Easy and Country Vacationer, each with their own characteristics. Further analyses have been conducted to identify individual sub-segments within each of the major segments. Subsequent analysis using Structural Equation Modeling provides evidence that the relationships between services and satisfaction are better understood when considering segments (Zanon, Shaw, and Hall 2008).

Parks Victoria has been using market segmentation of visitor use as a planning tool to feed into applications such as park management planning, tourism and marketing strategy, visitor risk management, and wild fire recovery plans.

Application of adaptive experimental management programs

Adaptive management decreases uncertainty in complex management systems, or decreases the risk of failure (or lack of sustainability) by making the uncertainty more explicit (Robley et al. 2008). In 2001 Parks Victoria initiated the Fox Adaptive Experimental Management (AEM) project in partnership with the Arthur Rylah Research Institute for Environmental Research (ARIER) to measure the costs and benefits of a range of fox control strategies, and more broadly examine the applicability of AEM for large-scale pest management programs. The five-year project has provided some important management lessons relating to techniques, costs, and sustainability of predator control programs including the following:

- Baiting across the landscape and throughout the year was effective in producing a sustained reduction in fox numbers.
- Seasonal or perimeter baiting does not result in a sustained reduction in fox numbers.
- Sustained effort is needed for sustained reduction in fox numbers.
- Lower costs do not necessarily equate to increased efficiency.
- Sustained management and monitoring effort are required to enable sufficient data to be collected to appropriate standards.

In another application of adaptive experimental management, this time for the invasive weed English broom (*Cytisus scoparius*), a scientific program has tested efficiency (costs/benefits) of different strategies, effectiveness in reducing broom cover and abundance, and response of native vegetation species (Allan et al. 2006). The AEM has informed the parks' weed management in Victoria's alpine area by providing new information on issues such as the effects of fire on English Broom reproduction and survival, timing of control programs, treatment frequency, effectiveness and impact of different herbicide treatments, environmental and other impacts of repeated, broadscale chemical control, and costs and resources required to achieve desired outcomes.

4. Applying evaluation findings for park managers—decision-support systems

Parks Victoria has developed the Levels of Protection (LoP) tool to aid planning and resource allocation by placing individual parks in a statewide and ecosystem context. LoP groups parks according to a number of biodiversity criteria, and allocates broad conservation objectives to each group.

Based on this biodiversity data, LoP establishes an index score for each park and a hierarchy of management response that is useful to park managers in defining the level of management effort to be applied in parks and reserves in each group, and for determining management and resourcing priorities. Six terrestrial (A1, A2, B, C, D, and E) and three marine (A, B, and C) LoP park groups have been defined. Each group has particular characteristics and broad conservation objectives, and an assigned standard for level of protection. The LoP tool has had a major influence on resource allocation across Parks Victoria parks network since its introduction. An equivalent system for visitor services standards, the Levels of Service, has also been developed which establishes broad objectives and standards at both the park and site scale.

Conclusion

Parks Victoria's management effectiveness program is designed to use the best available data, while recognising that park staff and expert opinion are valuable inputs into adaptive park management. A fundamental goal of the program is that park managers have access to meaningful, useful information to assist them in their many complex decisions.

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Evaluating Management Performance and Effectiveness for Protected Areas

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Introduction

This paper proposes an alternative to evaluating management effectiveness, by accounting separately the management and governance aspects, according to whether achieving the outcome is more in control of the park or the agency. The alternative, called the Ecosystem-based Management System, combines principles from ecosystem-based management and environmental management systems. It was developed from case studies from Mexico and Canada. The adaptive management review within the EBMS provides effectiveness scores for individual management objectives, components, modules, and the overall park management. The scores indicate the degree of achievement of expected outcomes for specific objectives, measured through indicators and targets. The EMBS model helps integrate the uniqueness of individual parks and track management effectiveness on the long term for individual parks and the whole system of parks.

The need for more accountability in natural resources and protected areas management has led organizations, such as the International Union for Conservation of Nature (IUCN), to release frameworks to evaluate management effectiveness (Hockings, Stolton ,and Dudley 2000). However, countries such as Canada and Mexico do not use the framework and park agencies in countries such as Spain and Argentina are adopting ISO standards (ISO 1996, 2000) to improve management or reduce environmental impacts from operations (M. Batiste and M. Di Paola, pers. comm.; PCA 2002).

Park agencies are struggling to evaluate effectiveness because of the diversity of indicators involved. Here, we present the model of an ecosystem-based management system for protected areas (EBMS) that combines principles from ecosystem-based management (EBM) and environmental management systems (EMS), approaches adopted to improve management in natural resource and business organizations, respectively (Mendoza, Quinn, and Thompson 2004). The purpose of the EBMS is to assist parks managers on the planning process and to facilitate the evaluation of management effectiveness through the integration of different types of indicators.

Methods

The design of the ecosystem-based management system model followed four steps:

1. Analysis of strengths and weaknesses of EBM and EMS.
2. Visits to nine case studies to identify criteria for the EBMS (below).
3. Literature and document review.

4. Interviews (56 informants) and document reviews to identify reporting or evaluation requirements and issues.

The case studies were four protected areas in Mexico and five in Canada. In Mexico was Izta-Popo-Zoquiapan National Park (Mexico-Puebla-Morelos); El Pinacate y Gran Desierto de Altar Biosphere Reserve (Sonora); Ría Lagartos Biosphere Reserve (Yucatán); and the Ajos-Bavispe y Buenos Aires Reserve for Protection of Flora, Fauna and Forests (Sonora). In Canada was Grasslands National Park (Saskatchewan), Fundy National Park (New Brunswick), Pacific Rim National Park (British Columbia), Point Pelee National Park (Ontario), and Waterton Lakes National Park (Alberta).

Results

Evaluation issues. The issues identified were organized by country, including both specific and general.

Mexico:

- The National Commission of Natural Protected Areas has endorsed the pressure-state-response model (OECD 2003) and the IUCN framework; however, the evaluation system does not follow them.
  - Indicators have been difficult to develop as suggested by the OECD and IUCN.
  - They mix variables, indicators, and targets, and measure mainly processes or inputs (CONANP 2001, 2006). This may be misleading for evaluating effectiveness of management or conservation.
  - Reporting is based on pre-determined strategic results; however, their use was not clear to staff.
- The results of evaluations de-motivated park staff, who perceived them as not representative of actual achievements.
- The environmental impacts of park operation and maintenance are not evaluated.

Canada:

- Parks use indicators of ecological integrity for the state of protected heritage areas report. Some aspects of interest for individual parks are not accounted in this report.
- The agency has provided eleven key indicators for environmental management; not all are relevant or applicable to all parks.
- A challenge is to develop and integrate indicators for different aspects (e.g. social and environmental aspects).

Both:

- Evaluation systems follow a top-down approach (agency to parks), which does not reflect appropriately all the priorities of individual parks.
- Parks' projects or activities not fitting into reporting may not count for evaluations; some

achievements may not be praised.

- It has been difficult to develop indicators that measure management output or outcomes.
- Evaluation systems do not show conflicts among outcomes of different objectives.
- Variations on available information are a challenge, e.g. type of indicators used, development stage of the parks, management categories, or parks' socio-economic and biophysical environment.

There are obstacles to implement the IUCN management effectiveness framework (Hockings, Stolton, and Dudley 2000):

- Governance indicators (e.g. legal status or law enforcement) are part of evaluations; however, park management has no control over those aspects.
- Management plan objectives and targets are not used for evaluation. Management plans are the main accountability tool at park level.
- The indicators evaluate planning, context, input, or process; only two out of thirty evaluate outcomes.
- Ecological integrity, biodiversity, and conservation outcomes are not considered for evaluation.

The ecosystem-based management system

To overcome these issues, and guide park management evaluation, we propose four principles:

1. Evaluation should focus on what park management commits to achieve (i.e., objectives in management plans). Evaluation should reflect achievement of conservation and management goals, expressed through objectives, indicators, and targets.
2. Parks should be evaluated based on elements over which there is management control. Often, governance aspects are not (fully) controllable by individual parks but by the agencies. Evaluations should reflect that.
3. Evaluations should clearly distinguish among performance, compliance, effectiveness, and efficiency. Effectiveness results from achieving planned outcomes. Performance results from achievement or compliance with inputs, outputs, or processes.
4. Protected areas are a tool for sustainable development; therefore, evaluations should reflect progress in environmental, economic, and social aspects.

In addition, these characteristics are desirable for effectiveness evaluation:

- Separate objectives, throughout the management cycle, based on who (the agency or the park) has more control over the planned outcomes.
- Use various types of indicators to track social, economic, environmental, and operational aspects.
- Selected indicators and weights by combining top-down (agency to park) and bottom-

up (park to agency) approaches to acknowledge the uniqueness of each park.

- Be able to measure performance or effectiveness according to the indicators used.
- Use aggregate indicators to summarize effectiveness in simple measures.
- Identify conflicting objectives or outcomes.
- Be compatible with the IUCN framework.

Structure

The ecosystem-based management system model (EBMS) follows the stages of the traditional management cycle: preparation, planning, implementation, and evaluation (this last called adaptive management review).

A planning hierarchy guides the management cycle (Figure 1). The higher levels are more general and reflect management principles, policies and regulations (national and international). The lower levels guide implementation and are more park-specific. They relate specific objectives to particular actions, desired targets, and indicators that show progress or success.

Like a decision tree, the hierarchy helps organize objectives into two modules and four components. The modules (Figure 2) separate objectives depending on whether the park or the central agency is the main responsible for the outcome:

- Module A: agency-driven objectives, indicators, and targets:
  - Aspects the agency is required to report on for national purposes.
  - Aspects the agency is required to report on for international agreements, treaties, and conventions.
  - Governance elements.
  - Objectives whose achievement is not direct responsibility of park managers and staff.

- Module B: park-driven objectives, indicators, and targets:
  - Park-driven priorities.
  - Park projects with partner organizations.

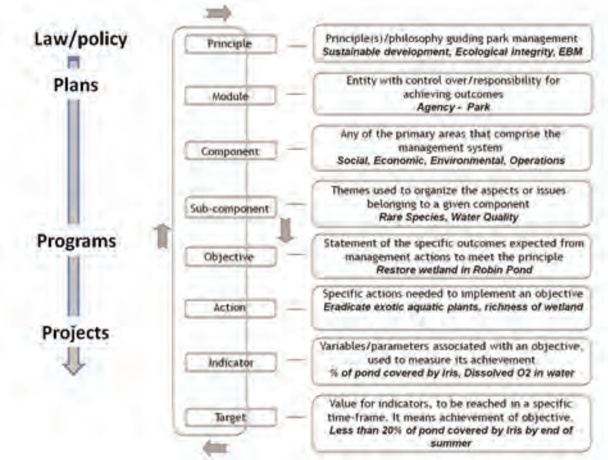

Figure 1. The elements of the Planning Hierarchy help organize objectives and links them to management principles and/or existing regulations.

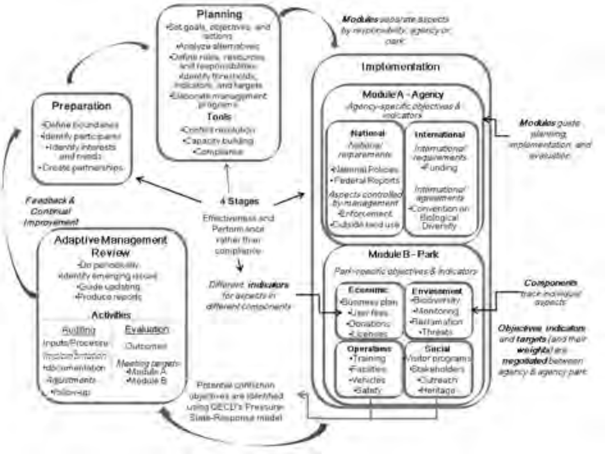

Figure 2. The Ecosystem-based Management System follows the four stages of the management cycle. The modules help organize management objectives and targets according to who has more control over the outcomes. Components separate objectives in four management areas for parks and two for the agency.

- Requirements for reporting to other national or international entities (e.g., park regional stakeholders or foreign funding organizations).

The basic components are social, economic, environment, and operations. There is flexibility to incorporate more components or levels if needed (e.g. sub-components). The implementation stage (not discussed here) integrates elements of ISO management systems such as training, communication, documentation, and emergency response (e.g. ISO 1996, 2000).

Adaptive management review

Keeping track of progress is one purpose of evaluations. However, tracking can be difficult if objectives or indicators change. Because of that, the adaptive management review of the EBMS uses scores and aggregates them to summarize effectiveness in single measures calculated with the formulas in Figure 3.

- The elements of the hierarchy (modules, components, subcomponents, or objectives) can be weighted to show their importance at different times or for different parks still allowing comparisons. For example, restoring trails could be a priority after a hurricane for a couple of years only, or a priority for park may be to control illegal activities while for others the priority is to develop visitor programs.
- A reporting period has a target to meet for an objective. The achievement is measured as percentage with respect to the target (0.0 = no progress, 1.0 = target reached).
- Scores can be obtained for any element of the hierarchy and for overall management. They act as benchmarks to track progress at different times for individual parks, for parks within a system, and for the agency.
- Reporting the scores of environmental, economic, and social components aims to show both commitment to sustainability and progress made in those areas. The operations component aims to show both the park's commitment to and progress toward reducing the impacts of its own operations.

- The EBMS measures management effectiveness based on outcomes, as defined by Hockings, Stolton, and Dudley (2000). If the indicators measure inputs, outputs, or processes, the scores will measure performance.
- The score of the agency module reflects governance and quality of coordination between it at the park.

The weights of the modules can be determined by the proportion of objectives in each one. To facilitate the agency's accounting, the weights of modules A and B could be constant among the national system or among categories. Agencies and parks should decide which objectives fit into each module, and the weights for different elements in the hierarchy. Over time, the scores can help compare effectiveness on different components for one park, or overall effectiveness for various parks.

$$\textit{Score per component} = \left(\frac{\Sigma \text{ of achievement per objective}}{\text{Total number of objectives}}\right) = 0.85$$

$$\textit{Score per module} = \left(\frac{\bar{X} \text{ achievement per component}}{\text{Total number of components}}\right) = 0.865$$

$$\textit{PA Final score} = \left(\textit{(Score Module A + Score Module B) / 2}\right) = 0.87$$

	Module B Park				Module A Agency	
Component	Env.	Econ.	Soc.	Opr.	Nat.	Int.
Σ Achievement of Objectives	8.5	8.8	8.3	9.0	9.7	8.0
# of Objectives	10.0	10.0	10.0	10.0	10.0	10.0
Score per component	**0.85**	**0.88**	**0.83**	**0.90**	**0.97**	**0.80**
Score per module				*0.865*		*0.885*
Total Park Score						**0.87**

Figure 3. Hypothetical example of the adaptive management review. Performance or effectiveness scores can be obtained for all levels in the hierarchy, including overall park management. The scores can show progress over time at different levels, and help compare among parks.

Discussion

To evaluate individual parks and compare among parks in a national system, the EBMS uses scores rather than indicators. The objectives can be ponderated with weighs according to their relevance. The adaptive management review relies on how well the management team has achieved the objectives' targets instead of relying on specific indicators.

Three factors influence the success when implementing the EBMS:

- Commitment to allocate human and financial resources needed.
- Commitment from individual parks, park agencies, and relevant stakeholders to adaptive management and learning.
- Willingness and flexibility to communicate and negotiate priorities, indicators, and weights.

The EBMS is developed from existing management plans, objectives, and indicators so it does not affect monitoring programs already in place. Although it will likely require more resources and effort than regular top-down approaches, its advantages and benefits for agencies and parks would compensate for that:

- Flexibility to update or change objectives and other elements of the hierarchy as they are met, or as parks' needs evolve, without affecting the meaning and comparability of final scores.
- Inclusion and use of diverse types of indicators (biodiversity, economic, social, etc.).

- Separation of park and agency priorities and recognition of park's achievements in both.
- Improvement in governance at park and agency levels and of evaluation's fairness and objectivity.
- Emphasis and evaluation of effectiveness and performance rather than compliance.
- Encouragement for innovation.
- Engagement of staff in the development and implementation of the EBMS, increasing their trust and motivation.
- Availability of detailed information on the condition and progress of individual parks.
- Acknowledgement of aspects not covered by agency's reporting systems.
- Inclusion of park diversity within a national system, e.g. ecosystems; stages of development, or categories.
- Consistency with other proposals for evaluation management (e.g. IUCN framework).
- Starting point for ISO certifications.

Conclusion

Top-down frameworks for evaluating park management effectiveness often reflect agencies' reporting priorities. Although they allow national comparisons and reporting; they may overlook some of the priorities or achievements of individual parks. Management effectiveness means delivering outcomes; however, it is often measured through indicators that reflect only inputs or outputs. The ecosystem-based management system suggested here combines agency and park needs (top-down and bottom-up approaches). It evaluates effectiveness or performance according to the type of indicators used. It focuses on the achievement of targets for specific objectives rather than on pre-determined indicators. This gives flexibility to update or modify objectives, indicators, and targets. It reports on sustainability based on the scores of environmental, economic, and social components. The EBMS is seen as more appropriate to reflect the diversity of natural and socio-economic conditions of protected areas within a national system. Although implementing this system requires more effort and coordination, and perhaps a change on institutional culture, it provides more detailed information. This can help improve planning and management and show achievements in management and conservation goals to all stakeholders.

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Mountaineering Management on Mount McKinley: Unraveling a Crisis at the 17,000-foot Level

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National Park Service ranger Bob Gerhard transferred from Mount Rainier to Mount McKinley in early 1976, and when he looked into how climbers were being managed on Mount McKinley, he saw a desperate situation (Gerhard 2005). Garbage was building up in the main camping areas, search and rescue capabilities were sorely lacking, nothing was being done to dispose of human waste, and guides were bringing scores of climbers—some with little climbing experience—to one of the world's most difficult climbing areas. And with the bicentennial climbing season quickly approaching, conditions promised to get worse before they improved. A crisis was clearly at hand. Conditions weren't always like this, however, and a quick overview of Mount McKinley's climbing history clearly illustrates both how the problem arose, and how it was resolved.

In the earliest days, of course, climbers were completely on their own. Before Congress established Mount McKinley National Park in 1917, seven parties, totaling 39 climbers, had attempted the climb and the last group, in the spring of 1913, resulted in four Alaskans standing on the roof of the continent, 20,320 feet high (Walker 2005). Given that success, no one tried to climb the mountain again until 1932. For the next 15 years, there was a heavy reliance on equipment testing and science as rationale for climbing, so perhaps as a result, the Park Service assisted many of these efforts by allowing air drops, and by hauling goods with dogsleds to the mountain's base.

It wasn't until 1947 that park ranger Grant Pearson put together the first, mimeographed packet of mountaineering regulations. Climbing parties in those days all approached the mountain from its north side, and they all left the Alaska Railroad at the McKinley Park railroad station. So climbers and rangers typically met at the park headquarters, just a few miles from the railroad station, where rangers would quiz the climbers about their tents and clothing, their proposed route, and food supplies. Climbers typically corresponded with park personnel months before they arrived, and in most cases, they were so experienced that rangers served as advisers rather than gatekeepers. This state of affairs remained throughout the 1940s and 1950s. Climbing was a rare activity in those days; the 1959 season, for example, witnessed only the 76th successful summiting of Mount McKinley, of 182 attempts (Pearson 1962).

In 1960, however, mountaineering management at the park hit its first rough patch when two parties high on the mountain came to grief within hours of each other. One party suffered a 400-foot fall resulting in a broken leg and a concussion, and an Anchorage woman in a nearby party developed high altitude pulmonary edema, or altitude sickness as it was known at that time. The Park Service had neither the staff expertise nor the technical capability to rescue anyone, and the U.S. Army also tried and failed to rescue the climbers. The heroes of the day turned out to be Link Luckett, who was able to land a helicopter on a narrow shelf at the 17,000-foot level, and a locally famous pilot named Don Sheldon, who some-how landed his fixed-wing plane on a snow shelf at the 14,000-foot level and hauled the injured climbers to safety (Greiner 1974).

The Park Service reacted to this event by coordinating with other agencies on rescue protocols. However, the Park Service still found it increasingly difficult to manage mountaineering on Mount McKinley. One reason was logistics. Most people were now starting their climbs on a glacier just southwest of the mountain, and the bush pilots who carried these climbers were based in the village of Talkeetna, more than a hundred miles south of park headquarters. Despite the intervening distance, NPS rangers continued to meet all climbing parties, usually by taking repeated train trips to Talkeetna and talking with climbers near the airstrip or the railroad station. An additional problem was numbers: during the early-to-mid 1960s, three to four times the number of climbers tried to climb the mountain than during the 1950s. The growing number of foreign climbers, many of them with an imperfect knowledge of English, was an additional challenge (Sheldon 1995).

The year 1967 brought new problems, however, because tourism authorities widely advertised the forty-ninth state because of the Alaska Purchase centennial. The response was huge; the number of garden-variety tourists to Alaska broke all previous records, and the year also brought a total of 83 people to the slopes of Mount McKinley—far more than ever before. The largest climbing group that year was a 12-man outfit called the Wilcox-McKinley Expedition (Figure 1). And for reasons that are still being debated, seven of the climbers from that party died on the mountain's upper slopes. The Park Service, at the time, still had no trained mountaineers on its staff and no technical mountaineering equipment, so all the agency could do was to monitor the worsening situation on the park's primitive radio system (Waterman 1998).

That tragedy, which resulted in weeks of headlines in the Alaska press, caused virtually everyone to criticize the Park Service, fairly or not. But the most vehement opposition came from the climbing community, who demanded that the NPS stop regulating climbers altogether. In response, the Park Service gave in, so instead of the inspection and informal interview of prospective climbers that had previously been the norm, future climbers were asked only to register, get a doctor's certificate, carry a radio, and report to park headquarters after returning from the mountain. Even those requirements, however, were not rigidly enforced; as a 1974 editorial noted, "the philosophy is that Mt. McKinley is the people's mountain, and it's up to the climber to arm himself with gear and judgment before climbing it" (*Anchorage Daily News,* July 10).

Despite that hands-off attitude, a host of factors were conspiring to make the NPS a more active partner in the mountaineering business. This was primarily because Mount McKinley was skyrocketing in popularity. In 1970, for example, a record 124 people attempted the climb, a number that increased to 203 in 1973 and to 362 in 1975. Mount McKinley, among some climbers, began to gain a reputation as a "technically easy mountain," and as a result, relatively unprepared climbers arrived at McKinley and rescue costs soared dramatically (Doherty 1976, 8).

In reaction to this growing popularity, climbers as early as 1970 began to complain about the "excessive" number of people on the popular West Buttress route, and a 1973 news article (*Anchorage Daily Times*, June 26, 23) was headlined "McKinley Like Grand

Figure 1. The twelve-man Wilcox-McKinley Expedition attempted to climb Mt. McKinley in July 1967. Severe weather and other factors resulted in the deaths of seven climbers from this expedition. Mountaineering Collection #13611, DENA, National Park Service.

Central." Along with the crowds came an increasing garbage problem, which became so onerous that University of Oregon volunteers, beginning in 1971, offered to haul away refuse from the most popular high-elevation camps. Though virtually all climbers were guilty of littering to some extent, some of the worst offenders were the climbing guides—and perhaps the best-known guide was a self-styled "pirate" named Ray Genet, who reveled in the freedom from regulation that the mountain provided for him (Shuler 1977; Waterman 1998).

This was the situation that Bob Gerhard, an experienced mountaineering ranger, found when he began working at the park in January of 1976. Gerhard knew that a record number of people would sign up for a bicentennial climb that year—and many of them would hope to celebrate July 4th on top of Mount McKinley. So to find out more, Gerhard and five other park employees spent most of June on the mountain. It was the Park Service's first presence on Mount McKinley since 1947 (Gerhard interview by Frank Norris, April 28, 2005).

The bicentennial climbing season resulted in ten deaths and a staggering $82,000 government rescue bill. These events were widely covered in the press, and many reporters wondered whether the mountain should be more intensely regulated. But Gerhard, at least initially, was reluctant to impose a strong governmental presence; instead, he deferred to the interests of the American Alpine Club and other climbing groups, and suggested that the agency should "regulate mountaineering activity as little as possible" (1977, 99).

The following year, however, the agency began to slowly re-institute some of the old policies that had worked so well prior to the 1967 disaster. Two rangers spent most of the climbing season in Talkeetna and talked to climbers about routes, medical problems, and expected hazards. The men also had two ten-day climbing patrols on the West Buttress route. Perhaps as a result of these efforts, no one died on the mountain in 1977, and rescue costs dropped dramatically. The park also instituted a "climb clean" policy, asking all climbers to pack out all of their garbage, gear, and fixed line, and they also installed the first pit toilet on the mountain (Gerhard 1978; Sherwonit 2002).

Beginning in 1977, the NPS let it be known that it had four major goals on the mountain: to emphasize safety, reduce rescue costs, cut down on the litter problem, and deal with the problem of human waste. All of those goals were jeopardized, however, by Mount McKinley's ever-increasing popularity. Throughout the 1980s, the annual number of climbers continued to rise until, in 1989, it exceeded 1,000 for the first time. Ever since that time, the Mount McKinley has remained a climbing mecca, and during the past decade the mountain has annually attracted between 1,100 and 1,400 people (Figures 2 and 3; NPS 1979–2008).

In order to emphasize safety, the NPS began limiting the number of guides on the mountain, and in order to obtain and keep their licenses, the guides had to prove that safety was an important part of their operations. And beginning in the early 1980s, volunteer medical personnel began to be stationed on the mountain. But given the mountain's notoriously bad

Figure 2. The increase in numbers of climbers attempting to climb Mt. McKinley each year, from 1970 through 2007, is illustrated by this graph. National Park Service.

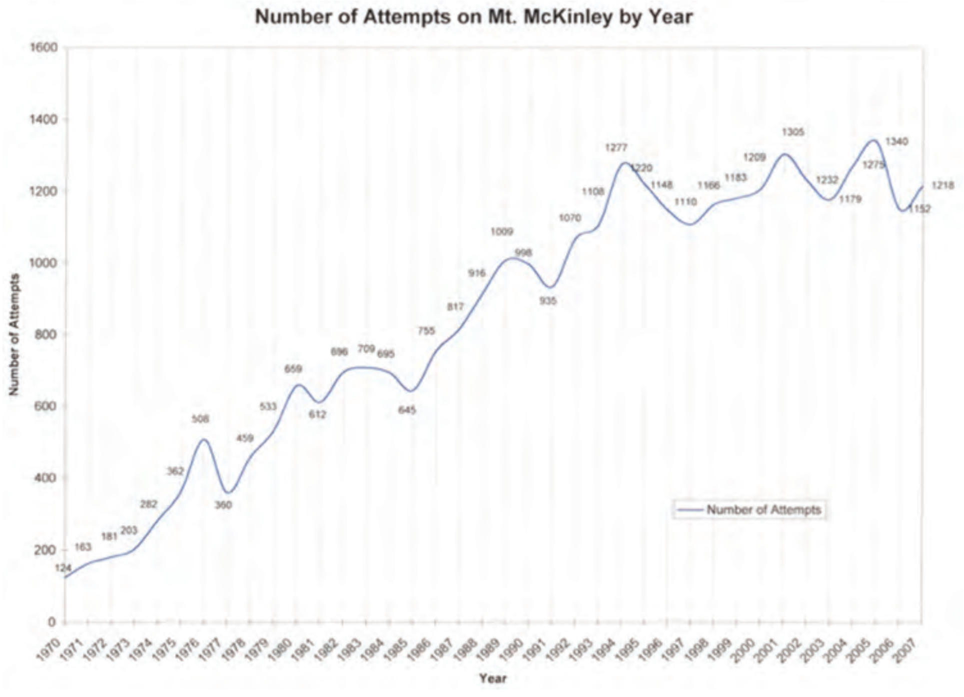

Figure 3. Crowding has been a problem on Mount McKinley since the 1970s. This photo was taken in May 2001 along the well-traveled West Buttress route. The NPS has recently set an annual limit of 1,500 climbers on Mt. McKinley. National Park Service, Roger Robinson Collection.

weather, climbing remained a high risk activity, and during the 1980s, 34 people died on the mountain, many of them foreign residents. In order to stem further losses, the Park Service in 1988 established a camp at the 14,000 foot level, and in 1991 it first stationed, at Talkeetna, a high-altitude Lama helicopter to use during the climbing season (NPS 1988, 1991). And in the late 1980s and early 1990s, it conducted a major foreign outreach effort (Figure 4; *The Economist* 1992; *Anchorage Daily News,* August 3, 1993, E-3).

Early results of the Park Service's efforts were mixed. But since the mid-1990s, the emphasis on safety has paid off, and during the last ten climbing seasons, only nine people have died on the slopes of Mount McKinley. That emphasis on safety, however, has resulted in rescue costs which in recent years have consistently topped $100,000 per year (NPS 2007b). These costs have brought forth calls from some legislators to share the government's financial burden with the climbers themselves. And to help defray those expenses, each climber now pays $200 for the chance to climb Mount McKinley (U.S. Congress 1999).

Progress was also made in cleaning up litter on the mountain. In 1983, for instance, a ranger stated that everyone involved had "waged an intensive campaign to reduce the amount of litter" and that "the mountaineers of today are climbing … with a much more sensitive ethic regarding litter and abandoned gear" (NPS 1983). Trash problems, however, tenaciously hung on, and they were not really solved until the year 2000, when rangers distributed blue plastic bags to climbers, with their food weighed at the beginning and end of each trip (Bol 2002, 26).

Figure 4. During the 1980s and early 1990s, the NPS undertook a major outreach effort to foreign climbers. Here, in a 1982 photo, ranger Roger Robinson speaks to a group of Japanese climbers. National Park Service, Roger Robinson Collection.

Confronting the problem of human waste, however, proved more difficult than with litter. By 1983, a ranger noted that at several places on the mountain, it became "harder and harder to find clean snow for cooking and drinking" (NPS 1983). So to confront the situation, rangers urged climbers to bag their wastes and toss them into the nearest crevasse, and they also built additional pit toilets. That policy remained until the year 2000, when ranger Roger Robinson tested the idea of a small, rectangular container that could serve as a portable toilet. That system had its flaws, so he worked with a manufacturer on the design of a light, cylindrical "Clean Mountain Can." These cans were passed out to about fifty climbers in 2001, and they proved so successful that rangers soon required them for the highest-elevation camps. In recent years, all climbers have been issued Clean Mountain Cans and have been expected to use them; a $100 fine awaits those who don't, and are caught (NPS 2000, 2004; Robinson interviewed by Frank Norris, May 1, 2007).

Because of the Park Service's leadership in confronting the problems of trash and human waste, longtime climbers can now testify that the mountain is far cleaner than it was in the 1970s and 1980s. And it's a far safer experience, too, with a death rate that is far lower than 20 to 30 years ago. By the end of last year's climbing season, more than 33,000 men and women had tried to reach the top of North America's highest peak (Figure 3). Just over half of those climbers—including more than 1,500 women—have successfully stood at the summit.

During the years that the Park Service has been dealing with climbers on Mount McKinley, management policies have often changed in response to the experiences, demands, and interests of the climbing community. Always, however, the Park Service has tried to steer a delicate course between adventure and freedom, on the one hand, and the need for safety and ecological integrity on the other. By most accounts, the present arrangement provides a balance that is broadly supported by both the climbing community and the public at large.

[Ed. note: The author recently released a two-volume administrative history of Denali National Park and Preserve, entitled *Crown Jewel of the North*. This article is a condensation of the mountaineering chapter from that history.]

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"True" Wilderness Preservation: Looking Forward to a Better Nature

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Wilderness management needs to adopt a new philosophy in order to better manage the lands as they were meant to be. Today's wilderness areas are dominated by values that oppose those originally set forth within the Wilderness Act of 1964. Management has been confounded by its own severe lack of humility and restraint, which is encouraged by advancements in the science of landscape-scale management. The United States' wildernesses are on a downward trend as the symbolic value, wilderness character, wildness, naturalness, and untrammeled values continually diminish with intentional, hands-on, intensive management. In order for this problem to be solved, our current wilderness management system needs to adopt the recommendations within *true* wilderness philosophy.

True wilderness preservation is a culmination of several current wilderness philosophy ideas with a slight alteration to give the idea a more concrete practical application. First, the "symbolic values [surrounding wilderness management] need to be legitimized" (Cole 2005, 23). Symbolic value is the essential foundation to wilderness preservation in the Lower Forty-eight, and has been slowly belittled and forgotten. Legitimizing the symbolism of wilderness preservation will allow it to regain its full power and influence. Next, an in-depth discussion of the meaning and key definitions within the Wilderness Act of 1964 will be presented. These are the components, which can be fully and truly realized only after the symbolic value has been restored to its original priority. Lastly, a concrete starting place for wilderness preservation will be defined.

The symbolic value of wilderness needs to be the first priority of wilderness management. It is not new and is one of the main tenets of those who created the Wilderness Act of 1964, and will empower wilderness character and the correct starting place for wilderness preservation. Howard Zahniser stated "we deeply need the humility to know ourselves as the dependant members of a great community of life . . . to know the wilderness is to know a profound humility, to recognize one's littleness, to sense dependence and interdependence, indebtedness, and responsibility" (Zahniser 1957, 37). Here Zahniser encapsulates the symbolic value concept. Wilderness is not only a set of physical characteristics, but also a gesture by humans to show humility, respect, and restraint for the natural world around them through actively allowing tracts of land to remain out of reach from intentional human manipulation. As Kaye states, "sacrifice for an ideal is the strongest gesture of respect. . . . Zahniser's words suggest that chief among our criteria should be the purpose of the action, the spirit in which it is carried out, and the effects it will have on our way of thinking" (Kaye 2000).

Sacrificing for ideal wilderness preservation—an act of humility, restraint, and respect—is not being carried out within our current wilderness management system. Achieving this symbolic value is not an end result of proper wilderness management, but rather the means (Cole 2005) and a starting place. "The prominence of the word untrammeled as a descriptor of the wilderness ideal suggests that the primary general symbolic value of wilderness is as a symbol of human-environment relationship characterized by restraint and humility"

(Cole 2005, 23). *True* wilderness preservation recommends that symbolic value be the first priority and most important guiding principle of wilderness management.

The widespread intentional manipulations of our lands within the wilderness preservation system are severely undermining the symbolic value of wilderness. "The arrogance of science, the belief that we know enough to correct problems created by earlier managers, or to compensate for environmental impacts, is often considered to be a hallmark of modern society" (Cole 2005, 25). Encouraged by increasing scientific research and knowledge, managers are becoming less humble in their decisions by allowing manipulation to continue. The current designation of 'natural' is an arbitrarily desired social distinction with significant limitations. First, managers need to fully comprehend the range of natural variability and the limitations of historical conditions (Landres et al. 1999). There is still a well-deserved debate over how applied historical ecology should be used for widespread land management (Landres et al. 1999). Next, Swetnam et al. (1999) explain that (1) our understanding of the range of natural variation is still assumption laden and incomplete, (2) several well documented cases have shown that assumptions can highly distort the quality and accuracy of the data, and (3) that "ultimately, decisions about 'desired' conditions, and what is 'natural' are inherently subjective and value laden" (p. 1202). Third, management agencies are experiencing difficulty in accessing or obtaining all the necessary data for an informed decision. Fire management and forecasting is a good illustration of where the problem of available data is apparent (Miller and Landres 2004; Miller and Parsons 2004). Lastly, "natural" does not include historical anthropogenic influence such as indigenous ignitions that most likely have shaped areas we now consider "natural" (Arno et al. 1997).

The increasing knowledge base surrounding wilderness and large-scale land management is useful, but should not be applied to trammeling our wilderness areas. Managers are unaware of all the factors that influence decisions and the unforeseen impacts of said decisions. Believing that we as a species are omniscient and therefore can restore poorly understood historic decisions is not appropriate in wilderness. Within those sacred boundaries we must be humble and accept that we are not omniscient and could be unable to restore a system to a certain state. Instead, this growing knowledge base needs to be applied to the areas surrounding wilderness, increasing their qualities as natural buffers. The constant trammeling through manipulation is decreasing the wildness of the wilderness system. Each time a manager allows a trammel to occur the strength of the symbolic value is decreased. If this continues, soon we will not be able to comprehend this idea, for it will be lost to the historians.

The symbolic value of wilderness is central to the wilderness idea and the philosophical justifications for its preservation (Cole 2005; Kaye). If managers continue to degrade this concept, the spirit of the Wilderness Act will vanish (Cole 2005). Within *true* wilderness philosophy, symbolic value is a central theme, embodying the need to show respect, restraint, and humility when agencies decide how to properly manage wilderness areas. Symbolic value and the related ethical values need to be accepted. Decisions should not be made simply by empirical values, but through ethical values, which give the symbolic value its needed foundation. This idea of symbolic value and what it entails is essential to keep in the forefront when reading the Wilderness Act and defining its key terms.

In order to facilitate the management of symbolic value, *true* wilderness preservation needs to be implemented through a diachronic lens. Federal agencies' currently use a wilderness concept with a synchronic view. The agencies usually look for the most pristine and natural areas for wilderness designation, only to become frustrated by the widespread impact of our species. This may have been more appropriate in the past, but it is not today. A diachronic approach is better suited. Here we have the idea that it is not the current state of wilderness, but its potential to enrich the symbolic value, wildness, and untrammeled qualities that are important. The desired future state is unknown to the managers, it is not a relapse into historic conditions, but rather an opportunity for the land to develop and evolve on its own. A diachronic path would recognize lands that need to be preserved, whether they are highly affected or not at all by humans, and designate them wildernesses because of their potential to enrich all the qualifying factors: "wilderness character," "natural conditions," "untrammeled," "unimpaired," and so forth. When these factors are met at a high standard, the overall symbolic value of the wilderness is also increased.

Within the range of key qualifiers in the Wilderness Act of 1964, "wilderness character" is the most important. It embodies the overall objective definition of wilderness, and contains many keystone qualifiers such as "natural conditions" and "untrammeled." In order for wilderness character to be complete, each of the terms comprising this subset of qualifiers will need to be fully realized. If these qualifiers are not properly understood then the concept of wilderness character will be corrupt. "The Wilderness Act does impose a general requirement … to manage wilderness areas so as to preserve the land's wilderness character" (USDC 2007, 6). The symbolic value is the modern application of the appropriate approach (hands-off management) needed to fully realize "wilderness character."

True wilderness recommends that "untrammeled" be defined as un-hobbled, or without any significant, intentional direct manipulation by humans. Untrammeled is closely connected to the symbolic value of wilderness. Wildness has become a synonym for untrammeled since both suggest "freedom from human control rather than lack of human influence" (Cole 2000, 5). If an area is untrammeled, then the symbolic value of leaving the area undisturbed and not manipulated is being brought about successfully. "The fundamental character [symbolic value] of wilderness is to be free from human manipulation" (Worf 1997, 30).

"Natural conditions" is currently understood to "mean that the influence of post-Columbian peoples should be generally absent" (Cole 2000, 5) and that it captures "this biological sense of wilderness" (Landres et al. 2000, 377). Within current wilderness management managers are trying to use science to ecologically restore wilderness ecosystems to their historic levels. Almost all of the time, this involves some sort of trammeling or direct manipulation of the wilderness ecosystem. In turn, every time a manager tries to manipulate the system, the overall symbolic value and wilderness character are detrimentally affected. The most important components of *true* wilderness preservation are maintaining the symbolic value of an area by humbling restraining ourselves to keep the area untrammeled by human forces.

Where humans fit into the sliding scale of "natural" becomes a heated point of contention for wilderness managers. *True* wilderness preservation's classification of humans as "natural" becomes a bridge between the social and natural disconnect between humans and nature. Biologically humans are natural; socially we remove ourselves from wilderness in order to omit our direct manipulative influence. The supposed dualism between wilderness and humans is a social, not a biological, phenomenon. *True* wilderness works to clarify this confusion by emphasizing that we as a social species are making the humble gesture to restrain ourselves from certain areas we socially designate as wilderness. This further explains *true* wilderness preservation's recommendation that humans may be allowed in the wilderness ecosystem as a biological agent (even though there needs to be some in-depth discussion on the definition of "primitive"), but human trammeling (even though biologically natural) is not allowed in wilderness for social reasons.

Determining "natural conditions" under *true* wilderness preservation is a difficult task because it does not follow our current assumption within society. First, under *true* wilderness preservation humans are considered natural. This includes human-related things such as migration of invasive species on cargo ships or global warming. Even though humans are considered natural, *true* wilderness preservation still depends on the social act of humans to humbly not manipulate the wilderness systems or degrade the values surrounding its preservation. Wilderness is a social distinction, not a natural one. Therefore our definitions of "natural conditions" are also social distinctions. Invasive species are a good example to explore this logic. Certain species were introduced by humans and are currently considered unnatural to their new environments. *True* wilderness preservation recognizes that their mode of transportation by human-made mechanical means is natural, but makes two social distinctions: (1) that in other non-wilderness areas we view them as unnatural and/or harmful, and (2) even though distinction one has a negative connotation we humbly allow for the wilderness ecosystem to deal with the naturally immigrated species on its own. Since under *true* wilderness preservation humans are considered "natural" in a biological sense, we must restrain ourselves from managing the wilderness for social reasons.

We as a society must also restrict human dependant systems and organisms from the wilderness. Again, this is not a natural designation since independent cattle in a wilderness area would be considered natural (as long as they are feral), but since our social use of them makes them dependant on us as a species, *true* wilderness preservation recommends making the social distinction and removing and/or abandoning any human-dependant organisms or systems within wilderness areas. If human-dependant organisms or systems were allowed to remain in wilderness areas we would be making a social decision to continue to degrade and manipulate both the wilderness ecosystem and the values set forth under *true* wilderness preservation. If we either remove or abandon the systems or organisms we are removing our influence. The abandoned cattle will either die off naturally or they will adapt and become independent feral animals. It does not matter whether the system or organism was there before the designation of wilderness, only that we are not actively or directly supporting the said subject's survival within wilderness areas.

In order to practically implement the concepts within *true* wilderness philosophy a formal baseline or foundation needs to be declared. *True* wilderness philosophy proposes that the time at which managers accept *true* wilderness preservation is when the managers should determine "natural conditions." Once natural conditions are set; the process of removing all those that are not natural such as human dependant cattle will need to commence. Afterwards the manager's job will be to maintain the highest level of wilderness character and symbolic value. This will be completely a hands-off approach within the wilderness boundary itself. However, outside the boundary, within non-wilderness land, many of the conservation techniques such as ecological restoration, and fire management should continue to work towards finding a more symbiotic relationship between human influences and other natural systems and their components. The buffer zones surrounding wilderness areas will play an active and important role in helping to preserve the land by giving it adequate ability and shelter from harmful non-intentional impacts. Declaring a formal baseline will be a key to successfully reaching the highest level of symbolic value and wilderness character within our wilderness preservation system.

The acceptance and application of *true* wilderness may be at the cost of other wilderness values. Biodiversity, scenic beauty, historical natural conditions, or ecosystem values may be significantly altered or lost forever. The spotted owl could become extinct, fire-adapted ecosystems could disappear or be permanently altered. Wilderness preservation needs to look towards the future and accept the detrimental affects of the past, rather than constantly trying to right them. The significant probability of drastic changes within our current wilderness ecosystems does not discredit *true* wilderness preservation. It is important to keep in mind the spirit of the Wilderness Act of 1964 and those who drafted its key language. In a world, heavily modified and manipulated by human culture and civilization, areas of land to be left alone are a rarity and much needed component to our culture and the world itself. *True* wilderness preservation recognizes the potential loss and change.

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Thirteen Years of Monitoring Campsite Conditions in Prince William Sound, Alaska

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Introduction

Since 1995, the authors and their colleagues have studied changes in resource conditions at 205 campsites in western Prince William Sound, Alaska. Located in south central Alaska, Prince William Sound has over 4,000 km of shoreline, with road access to two towns: Whittier and Valdez. Multiple land managers, including the United States Department of Agriculture Chugach National Forest, the State of Alaska, and private native corporations manage the land surrounding Prince William Sound and its intertidal areas. The 800,000 ha Nellie Juan Wilderness Study Area encompasses the western half of Prince William Sound. Recreational use of Prince William Sound has risen substantially since the early 1990s (Twardock and Monz 2000) with a probable further increase of use since the opening of the Whittier tunnel (formerly rail only) to vehicle traffic in 2000.

Using standard campsite assessment methodology (Marion 1995), with minor ecosystem specific modifications, individual sites have been assessed one to five times between 1995 and 2008 for parameters including vegetation loss, root exposure, damage to trees, stumps, trash, fire rings, signs of human waste, trails, and site size. Each site was also assigned an overall condition class. Average changes in parameters studied between 1995 and 2007 are compared to data collected in 2008. Preliminary findings suggest that while some sites have shown dramatic changes, on average, condition class, an aggregate rating of resource condition, has remained stable, if not declined. Transient impacts, such as trash and fire rings, have declined, while non-transient impacts, such as tree damage and root exposure, have increased. The number of sites with signs of human waste has increased.

History and methodology

In 1995 the National Outdoor Leadership School's (NOLS's) Research program and Alaska branch proposed and initiated a study to catalog recreational impacts in western Prince William Sound. Using methodology developed by Jeff Marion and David Cole, then–NOLS research scientist Chris Monz, Alaska Pacific University (APU) instructor Paul Twardock, and others did an initial assessment of 40 sites. Over the summers of 1996 and 1998, and those of 1999–2001 and 2004–2008, an additional 165 sites were visited.

Each site was measured using a standard campsite monitoring methodology (Marion 1995), with some ecosystem-specific modifications (Kehoe 2002). Sites were originally located using information from guides and charter boat operators, and by kayaking the shoreline, stopping at each beach with potential camping. If a site had measurable vegetation loss, the site was assigned a number, then parameter data and site measurements were recorded. Latitude and longitude (lat/long) were recorded for each site sporadically until 2007. In 2007 and 2008 all site lat/long were recorded with a geographic positioning system (GPS), in degree decimals, with an accuracy of 3–9 m using World Geodetic System 1984 datum (WSG 84). For all sites with measurable vegetation loss, a radial transect was completed, using a center point that was marked with a buried metal pin and dog tag with the site number. Sites without measurable vegetation loss were assigned an identifier with the last two digits of the year, and a letter (e.g., 08-A). Pictures of the site were taken, and maps of the site and its location were drawn on the data sheet. On subsequent visits, the site was relocated using latitude and longitude where available, pictures, and maps. The center point was then relocated using an electronic pin detector, and the site was re-measured and re-evaluated. For each visit, a condition class was assigned according to study specific definitions, as defined in the monitoring protocol. A condition class 0 has potential camping, but shows no sign of vegetation loss. A condition class 5 has significant vegetation loss and soil erosion. Site area was calculated from the radial transect data using a spreadsheet program developed by Jeffrey Marion. Sites with a condition class "0" were assigned a site area of "0" as typically no vegetation loss was observed. Some sites were given a condition class in the range of 1–5, but did not have a recorded measurement, possibly due to campers occupying the site. In these cases no site measurement was recorded. Data entry was checked for accuracy, by randomly sampling 10% of the data sheets.

Summary of data

Each site's parameters and size were summarized using Microsoft Excel. Every parameter was averaged per year, except human waste. For human waste, the number, and percent of sites per year, with signs of waste are reported. Forty-two sites were visited once, 122 sites 2 times, 35 sites 3 times, 3 sites 4 times, and 3 sites 5 times, for a total of 205 sites. Fourteen new sites were visited in 2008, leaving 28 old sites that were not revisited in 2008. Most old sites not revisited either could not be relocated, were occupied by campers, or time and weather prevented us from revisiting them. Table 1 summarizes the work between 1995 and 2007.

In 2008, 183 sites were visited, of which 18 were new. The 165 revisited sites account for 86% of the 191 sites visited between 1995 and 2007. Table 2 summarizes the 2008 findings.

Analysis of 2008 compared to 1995–2007

Comparing the 1995–2007 data to the 2008 data, most parameters have remained stable when viewed as categories. For example tree damage and root exposure are categorized as 0 = none/slight, 1 = moderate, 2 = severe. However when parameters are averaged, changes have occurred. For instance tree damage for the 1995–2007 period, and 2008 is none to slight category. However average tree damage did increased from .53 (1995–2007) to .63 (2008), an 18.9% increase. Root exposure also increased from .28 to .43, a 53.6% increase. The number of tree stumps increased from 1.19 per site to 1.67 per site, a 40.3% increase.

Total number of visits	238 visits of 191 sites
Condition class	2.55
Vegetation cover inside site	2.61 (6-25%)
Vegetation cover outside site	4.71 (51-75%)
Mineral soil exposure	3.04 (26-50%)
Tree damage	.53 (None/slight)
Root exposure	.28 (None/slight)
# of tree stumps	1.19
# of trails leaving the site	1.90
# of fire sites	.39
Litter/trash	1.38 (None)
Number of sites with human waste	17 (7% of total visited sites)
Site size (square meters)	47.48

Table 1. Data summary, 1995 to 2007.

Total number of visits	183 sites
Condition class	2.30
Vegetation cover inside site	3.49 (26-50%)
Vegetation cover outside site	5.64 (76-95%)
Mineral soil exposure	2.63 (6-25%)
Tree damage	.63 (None/slight)
Root exposure	.43 (None/slight)
# of tree stumps	1.67
# of trails leaving the site	1.83
# of fire sites	.18
Litter/trash	1.12 (None)
Number of sites with human waste	15 (8% of total visited sites)
Site size (square meters)	50.20

Table 2. Data summary, 2008.

The number of trails leaving sites decreased slightly from 1.90 to 1.83, a 3.7% decrease. The number of fire sites also decreased from .39 to .18, a 53.8% decrease. Litter/trash decreased from 1.38 to 1.12., a 20.3% decrease. Sites with signs of human waste increased from 7% to 8% of sites visited, a 14.3% increase. Average site area has increased from 47.48 to 50.20 square meters, a 5.7% increase. Finally, average condition class has declined from an 2.55 to 2.30, a 9.8% decrease.

An initial analysis also compared condition class, site size, and vegetation loss for 97 sites, with a minimum of 4 years between measurements (Table 3). Condition class declined from 3.3 to 2.7, with a paired t-test showing a p value of .001. Site size increased from 46.5 square meters to 57 square meters, with a p value of .305. Vegetation loss was 79.8 percent, compared to off site vegetation loss of 55.9 percent, with p value of .021. Though site size and vegetation loss are not considered significant, they do indicate a potential trend.

Impact parameter	Primary assessment	Secondary assessment	T value	P value
RCL (%)	79.8	55.9	2.39	.021
Condition class	3.3	2.7	3.4	.001
Site area (square meters)	46.5	57.0	-1.03	.305

Table 3. Change in campsite conditions over a minimum of four years: An examination of change in conditions on 97 campsites during a minimum of a 4-year period for selected impact parameters.

Impact parameter	Primary assessment	Secondary assessment	T value	P value
RCL (%)	95.1	61.6	1.95	0.05
Condition class	3.6	2.8	3.54	0.001
Site area (square meters)	42	52.9	-1.68	0.09

Table 4. Change in campsite conditions after 12–13 years: An examination of change in conditions on 56 campsites during a 12–13-year period for selected impact parameters.

Additionally a similar analysis compared condition class, site size, and vegetation loss for 56 sites with a12 and 13 years between measurements (Table 4). Condition class declined from 3.6 to 2.8, with a paired t-test showing a *p* value of .001. Site size increased 42.0 square meters to 52.9 square meters, with a *p* value of .09. Vegetation loss was 95.1 percent compared to off site vegetation loss of 61.6 percent, with a *p* value of .05. These results do show significance, and indicate a trend of increasing site size, increasing vegetation coverage in sites, and a decreasing condition class.

In 2004, we also started to informally look for invasive plant species. In 2008, we found our first invasive, pineapple weed (*Matricaria discoidea*), at the Shoup Bay Kittiwake rookery, 11 miles from Valdez. An opportunity exists to address the issue of invasives before they become widespread in Alaska. Educational efforts, such as encouraging users to rinse their gear with fresh water before embarking on their trips might discourage the introduction of invasives.

Discussion

Previous studies indicate that once initial impacts occur to vegetation, little additional change occurs with increased use (Hammitt and Cole 1998). The result of this study generally confirms that conclusion. The small drop in average condition class is countered by an increase in average site size. Since condition class is primarily determined by the amount of vegetation loss on site compared to off site, and not site size, this is not surprising. The decrease in condition class could be caused by shorter trip lengths by outfitters and guides, preventing them from reaching more distant sites. Furthermore, the hardening of sites by land managers probably focuses use, potentially decreasing use on nearby sites. When a site is not used, the Sound's abundant rainfall and temperate climate potentially encourage rapid re-vegetation. Transient impacts such as trash and fire rings have decreased, potentially from the efforts of land managers and educators to encourage Leave No Trace camping practices. Non-transient impacts such as tree damage, tree stumps, and root exposure have increased. Two possible causes are increased beach erosion exposing roots near high tide, and increased soil compaction. The increase in tree stumps reflects the durability of stumps and possibility of the increase of users with the ability and interest in felling trees. The increase of number of sites with signs of human waste confirms anecdotal reports. One potential reason is the change of Leave No Trace coastal practices, that stopped the practice of inter-tidal disposal, and encouraged upland disposal in shallow cat-holes. The increase in site size could indicate larger groups, or at least groups with more tents, using the sites.

Future studies should re-evaluate sites at a three- to five-year interval, and survey for invasive plants. Other studies should attempt to quantify the amount and distribution of use, and re-vegetation rates. With the initial assessments, and the work done in 2008, it is now possible to conduct a systematic monitoring of recreational impacts in Prince William Sound.

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A Cost Effective and Efficient Way to Assess Trail Conditions: A New Sampling Approach

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Introduction

Trails are important recreational facilities, and subsequently trail maintenance is a high priority for many park managers. Trails in poor repair, or trails that experience excessive use, can lead to poor visitor experiences and affect park resources through erosion, widening, and vegetation changes. Monitoring trail conditions is an important step for ensuring trail quality while controlling costs for expensive repairs and relocation (Cole 1983). However, budgets are often tight, so trail assessment and monitoring techniques must be time efficient and cost effective. Many trail networks are too long to evaluate in their entirety; here we explore a method for assessing trail conditions without examining the whole network.

Cole (1983) classifies trail assessment techniques into three major categories: replicable measurements (quantitative measures, usually implemented at a small number of points on a trail), rapid surveys (usually conducted at a larger number of points), and complete censuses of trail problems or conditions. With both replicable measurements and rapid surveys, sample points are usually distributed systematically. Similarly, Marion, Leung, and Nepal (2006) divide assessments into "sampling-based" techniques (encompassing Cole's [1983] replicable measurements and rapid surveys) and "census-based" techniques.

Currently, most trail assessment literature continues to include three particular trail impact indicators: changes in trail width (either the tread or the entire disturbed zone); changes in trail depth or incision; and general trail conditions which are often referred to as condition classes (Cole 1983; Marion, Leung, and Nepal 2006; Nepal 2003). Marion, Leung, and Nepal (2006) note that since the entire trail network must be walked to implement "sampling-based" techniques, combining those with "census-based" techniques requires little additional effort; thus, quantitative measurements, like trail width and depth, may be combined with qualitative measurements, such as descriptive classes, in order to get a more complete picture of the overall trail condition. The common assumption is that the entire trail network must be assessed and characterized to estimate overall trail conditions.

When trail networks are extensive, or time or financial resources are limiting, it may not be practical to measure the entire network. The challenge then becomes one of sampling the network. As Cole (1983) points out, subjective location of measurement points or segments makes it impossible to scale up estimates to the entire trail system, while ordinary techniques force crews to take a large number of measurements on trail segments that are in relatively good condition, and convey little information of interest to managers. Trail networks could be sampled by dividing the network into segments, and then selecting those segments at random. However, this technique may compound the problem by requiring excessive non-measurement travel time, often through problem or other highly informative areas that are not to be measured, simply to reach short segments that are designated for measurement.

In this paper, we briefly introduce randomized graph sampling (Ducey 2009), or RGS, a new but simple technique that allows efficient trail assessment. The technique takes advantage of the connectedness of trail networks, allows the use of auxiliary information to focus effort where problems are more likely, and also permits unbiased estimates of trail characteristics across entire networks.

Randomized graph sampling

RGS is a variable-probability sampling technique (Ducey 2009). The mathematical definition of a graph is a set of junctions connected by lines or pathways and as such a trail network matches the mathematician's definition quite well. For our purposes, we consider any trail network as being defined by the unique pathways that connect pairs of trail intersections, and we call any single pathway from one intersection to the next intersection a trail segment. Rather than sampling segments individually, we connect segments into reasonable sampling walks, and then sample from a list of potential walks.

RGS can be described as a six-step process:

1. Identify trail segments. The first step is to identify the sample population—essentially, whatever network or sub-network of trails is of concern—and to develop a list of the trail segments that comprise that network. An ordinary map or a GIS can be used to develop the list. Trail segments will not typically have equal length. In general, it is advantageous to include the segment lengths when developing the list.

2. Identify possible walks. A walk is defined as a reasonable and feasible sampling path connecting one or more segments. What is "reasonable" or "feasible" is defined operationally. For example, walks do not have to start and end in the same place, but that is often simplest for the data collector; and walks will typically begin and end at trailheads or other reasonable parking locations. The walk length should be determined by the time available for the inquiry. For example, if you have two people and four days to cover 16 walks then you would want the walks to be 4 to 5 hours each. This would allow each person to cover 2 walks per day, or 8 walks each, over the 4 days, for the total necessary samples. It is not necessary to develop a list of all possible walks. In general, walks will overlap and some segments will appear in multiple walks. The only requirement is that each segment in the network appears in *at least* one walk.

3. Determine sampling probabilities. Determining sampling probabilities involves two substeps: first, determining the selection probabilities for each walk, and second, calculating the inclusion probabilities for each segment. The selection probabilities for walks are used operationally for choosing which walks to sample; the inclusion probabilities for segments are needed for calculating the final estimates after measurements have been taken.

The simplest method of selecting walks would be to assign each walk equal probability. For example, if there are 4 possible walks, each walk would have a 1 in 4, or 25%, chance of being selected (Table 1). We call this approach the "equal probability design."

Walk (Selection Probability, q_j)	A (.25)	B (.25)	C (.25)	D (.25)	
Segment					Totals (p_i)
1	.25		.25		.50
2	.25	.25			.50
3	.25	.25		.25	.75
4			.25	.25	.50
5				.25	.25

Table 1. Equal probability design.

Walk (Selection Probability, q_j)	A (.18)	B (.23)	C (.27)	D (.25)	
Segment					Totals (p_i)
1	.18		.27		.45
2	.18	.23			.41
3	.18	.23		.25	.80
4			.27	.25	.59
5				.25	.32

Table 2. Probability-proportional-to-length design.

Walk (Selection Probability, q_j)	A (4/16)	B (2/16)	C (5/16)	D (5/16)	
Segment					Totals (p_i)
1	.25		.31		.56
2	.25	.12			.37
3	.25	.12		.31	.68
4			.31	.31	.62
5				.31	.31

Table 3. Assigned probability design.

However, equal probabilities are neither necessary nor (usually) efficient. A simple alternative is to assign probabilities proportional to walk length. With the probability-proportional-to-length design, each walk's probability of selection is based on its length, as a fraction of the total lengths of all walks in the list. Suppose our 4 walks have lengths of 18 km, 23 km, 27 km, and 32 km, for a total of 100 km. Then the respective walk selection probabilities would be .18, .23, .27, and .32 (Table 2).

A third alternative is to incorporate auxiliary information and assign the probabilities directly. Auxiliary information could come from a sophisticated model or, more likely, involve a simple scoring system based on local expertise. The goal of assigning probabilities is to focus sampling effort where problems are likely to occur, and as a result to decrease the final sample variance. The probability of selecting a particular walk becomes that walk's score, divided by the sum of the scores for the entire list of walks (Table 3). Each segment must have a probability greater than zero and positive. Rather, no segment or walk can have a zero probability of being sampled and all probabilities must be positive in order to calculate selection probabilities as described above.

No matter how the individual walk selection probabilities are assigned, calculation of the inclusion probabilities for segments is identical and straightforward. Let q_j be the selection probability of the j^{th} walk. Let d_{ij} be an "indicator variable" that tells whether the i^{th} segment occurs in the j^{th} walk; $d_{ij} = 1$ if segment i is in walk j, and $d_{ij} = 0$ if it is not. Then the inclusion probability p_i for the i^{th} segment is

$$p_i = \sum_j q_j d_{ij}$$

Examples of p_i for the equal probability, probability-proportional-to-length, and assigned probability designs are shown in the totals columns of Tables 1–3.

4. Select walks randomly. Regardless of which design is used, one or more walks must be selected randomly, either with or without equal probability. The number of walks to select can be based on a sample size equation (cf. Thompson 2002, 53–56; description of sample size equations is beyond the scope of this paper), but it may have to be based on the available time or financial budget for trail assessment. Typically, the more walks sampled, the lower the standard error of the estimate(s) of the feature(s) of interest.

5. Conduct measurements. As discussed above, there are several common trail impact indicators including trail width, incision, and qualitatively-defined trail condition classes (Cole 1983; Marion, Leung, and Nepal 2006). Whatever indicators are appropriate to local conditions and stated study objectives can be measured on all segments in the selected walks. The appropriate indicators should be decided in advance, as they may affect sampling time per km of trail, and thus impact both what constitutes a "feasible" walk and also the number of walks that can be sampled within the project budget.

6. Calculate estimates. Using the data from the sampled walks, it is straightforward to compute unbiased estimates of network totals (or means) of a variety of attributes for each sample walk. If Y is the network total of some attribute (such as the total number of meters in a particular condition class), then the estimate of Y calculated from the j_{th} walk is

$$\hat{Y}_j = \sum_{i \in j} \frac{y_i}{p_i}$$

where y_i is the amount of the attribute in the i^{th} segment; only those segments appearing in the j^{th} walk are used to form the estimates. If multiple walks have been selected, then the mean of the $\hat{Y}_j$ provides the best estimate of the total, and the standard error and confidence limits can be calculated from the $\hat{Y}_j$ using the usual formulae (Ducey 2009).

For networks of moderate size and complexity, steps 1–6 can all be completed using a simple paper map and ordinary spreadsheet software.

Kingman Farm sample study

To demonstrate RGS, and to compare sampling designs, we conducted a complete survey of nearly 5 km of forest trails at Kingman Farm in Durham, N.H. (Figure 1). We did not include trails on town or private land, trails in fields, or farm roads.

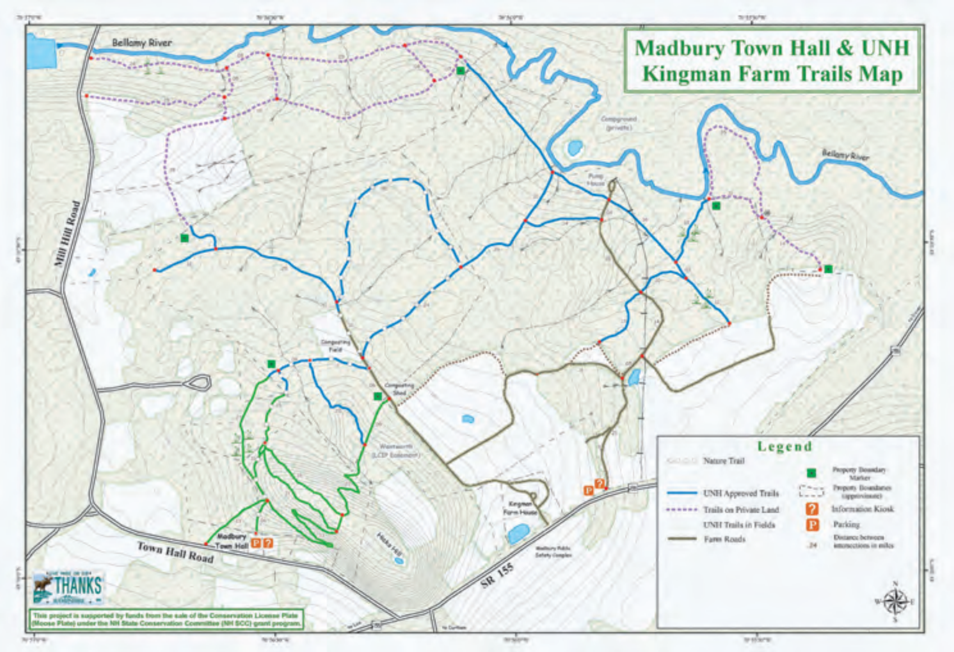

Figure 1. Kingman Farm trails.

Data collection

We took a series of qualitative and quantitative measurements at systematically-located points every 20 m along the entire trail network; this interval is considered adequate for this length of trail network (Leung and Marion 1999; Hawes et al. 2006). Distances were determined using a measuring wheel. At each sample point we measured trail width and trail incision (depth) as well as assigned an appropriate condition class rating. Trail width was defined as width of visibly trampled ground, and was measured using a tape to within 10 cm increments. Trail depth was defined as greatest depth of visible depression between noticeable banks on both sides of the trail. This was measured to the nearest centimeter. Condition classes were adapted from Nepal (2003) and Marion, Leung, and Nepal (2006) to local conditions: class 0, no apparent damage; class 1, lightly damaged; class 2, moderately damaged; class 3, highly damaged; class 4, severely damaged, or "hotspot."

Results

In total, we took measurements at 229 sites along 19 different trail segments. The total network consisted of 4,817 m of trails. For the purpose of this example, we focused on trail incision and condition class as primary impact indicators. According to the 229 sample points, approximately 840 m, or 17%, of the trail had incision deeper than 4 cm. Also, approximately 220 m, or 5%, of the trail was assigned a condition class greater than 1. Overall the Kingman Farm trails were in good condition with 3 of the 19 segments showing most of the damage.

We developed a list of 12 possible "walks" that included a combination of trail segments that would take approximately 3 to 5 hours to sample. Each walk was assigned a selection probability based on the design method. For example, for the equal probability method, each walk's selection probability was 1/12. For the assigned probability design, we adopted a very simple scoring procedure. Each segment was assigned one point as a base value, an additional one point if it crossed a mapped stream, and an additional two points if it crossed mapped wetlands. For example, if a single loop passed through two wetlands and had three river crossings, its total point assignment would be eight. In the assigned probability design, each walk's probability was its point score (obtained by adding the points on each of its segments) divided by the sum of the point scores of all walks.

Since, RGS is an unbiased method, the average estimate for each measured attribute is identical (and equals that which would be obtained by exhaustive measurement of the network) no matter which design is employed. However, the design does affect the variability of estimates obtained from single walks. Even the relatively crude assigned probability method employed in this study substantially reduced the sampling variance. The standard error of the average incision estimate of a single walk was 642 for probability proportional to length, 608 for the equal probability design, and a low 482 for the assigned probabilities design. This design also provided a lower standard error of the condition class risk estimate where probability proportional to length was highest at 284, equal probability at 271, and assigned probability at 243.

Conclusions

Trail assessment can be very time-consuming, and for most organizations, time is money. Having a design that reduces the total length of trails to sample in complex networks could improve the effectiveness and cost-efficiency of trail assessment and monitoring. Although RGS is a new technique, this preliminary study suggests that it may have several applications in the area of recreational ecology. RGS is an unbiased sampling method, but it takes advantage of the connectedness of trail networks while respecting operational constraints on sampling routes. The ability to reduce standard errors by using auxiliary information—even crude qualitative scoring techniques—should further improve the efficiency of RGS.

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It Takes Many Hands to Control Invasive Plants Along the Appalachian Trail

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Introduction

The Appalachian National Scenic Trail was first proposed in a 1921 article, "An Appalachian Trail: A Project in Regional Planning," by Benton MacKaye in the *Journal of the American Institute of Architects* (1928). As a regional planner, he convened an Appalachian Trail "conference" in 1925 in Washington, D.C. That gathering of hikers, foresters, and public officials laid the groundwork for the creation of a trail and envisioned a volunteer organization to build, manage, and protect it. It was completed north-to-south in 1937. Congress designated the trail as America's first national scenic trail and a National Park Service (NPS) entity in 1968. Today, through the efforts of volunteers, clubs, and agency partners, the trail extends more than 2170 miles from Maine to Georgia within a protected 250,000-acre greenway (ATC 2009).

The Appalachian Trail Conservancy (ATC) coordinates more than 6,000 volunteers who contribute about 200,000 hours every year. They focus on maintaining the trail treadpath, keeping vegetation out of the way of hikers, and recently, conducting citizen-science biological surveys. For quite a number of years, individual trail overseers noted with increasing alarm the biological threats of invasive plants along the trail. Due to the sheer magnitude of work in maintaining the trail's treadpath, however, the ATC and its 30 member clubs were reluctant to expand their mission to include invasive plant control.

The NPS Mid-Atlantic Exotic Plant Management Team initiated a short-term volunteer program along the trail's Northern Virginia section in 2008 as a pilot to determine if short-term volunteers could be used effectively to manage invasive plants. While the ATC and its member clubs clearly have successful programs based on long-term volunteer commitments, the pilot program intent is to demonstrate how to plan and execute a program where volunteers might work for only a few hours. It is certainly true that volunteers can be marshaled for such a task. The salient question is whether the resulting structure, activity, support, and outcomes are sustainable over the long-term. This paper describes the interim results of the trail's Northern Virginia short-term volunteer program to date.

Program development

As backdrop to the effort, the NPS Mid-Atlantic Team wrote a successful grant proposal in 2004, for the National Park Foundation and Tauck Foundation, to increase volunteerism at Shenandoah National Park. The grant enabled the creation of its short-term volunteer program. College interns helped program start-up, drafting an implementation plan and public outreach materials, and populating a database of potential sponsors and volunteers. The Team and interns set up volunteer events using the database to contact groups and individuals. After two and one-half years of field operations, park staff assumed administration of the program, convinced it was significantly contributing to, and sustainable within, their invasive plant management program (NPS 2008a).

Recognizing the need to augment invasive plant control efforts along the Appalachian Trail, the Mid-Atlantic Team initiated a pilot program in 2008, based on their experience at Shenandoah. Program start-up was rapid. Much of the programmatic material was directly usable. Shenandoah's computer database and public outreach tools were easily modified for use at the trail.

Activity and outcomes

The short-term volunteer program for the Appalachian Trail contributed hundreds of hours of fieldwork in its first partial year. That labor contributed to real accomplishment on the ground. Invasive plants are being controlled including Oriental lady's thumb, garlic mustard, mulleins, autumn olive, multiflora rose, wineberry, mile-a-minute vine, and Oriental bittersweet. When labors are directed at sites of high value, the results are significant. Threatened native species and rare habitats are being protected. Restoration to native and natural conditions is taking place.

From Earth Day through October 2008 (seven months) 377 volunteers contributed 879 hours to help control invasive plants along the Appalachian National Scenic Trail. Their work benefited 13.5 highly infested acres. The equivalent monetary value of their volunteer efforts for the short period equaled $17,149 (Independent Sector).

America needs an army of volunteers; and Americans are responding. Earth Day, April 2008, was the first volunteer event for this pilot program. Through the year, subsequent volunteer events included schools, summer camps, non-profit organizations, families, and individuals. Word-of-mouth became an important source of new volunteers. As an example, Girl Scout troops learned of other troop field events and called to set up their own events. The

Outcomes	Values	Comments
Acres benefited	13.5	Gross infested acres
Events	16	Spring: 6; Summer: 7; Fall: 3
Number of volunteers	371	April – October
Number of vol. hours	879	
Number of volunteers needed to treat one acre	28	Average
Average hours / volunteer	2.4	Range: 1.6 to 48.0
Average acreage /event	0.8	Range: 0.03 to 2.1
Volunteers / event	23.3	Range: 6 to 62
Percent children & adults	73 | 27	Children: 18 years and younger
Invasive species treated		Garlic mustard, Oriental lady's thumb, mile-a-minute vine, Oriental bittersweet, mullein, multiflora rose, wineberry, and autumn olive
Value of volunteer labor	$17,149	$19.51/volunteer hour

Table 1. Appalachian National Scenic Trail Short-term Volunteer Program, interim summary of outcomes, 2008.

same was true of a few schools. Individuals who heard about the program from previous volunteers initiated calls to be included in subsequent public events. Maintaining a positive public image is therefore essential to keeping the program vibrant and growing. Each event must run well and be led by staff and volunteers who effectively communicate the goals of the program, pass along interesting information, and exhibit appreciation for the contributions of volunteers.

Volunteers are a powerful way to accomplish work and grow a citizen base of support and advocacy. Starting with youngsters, short-term volunteer programs help instill an association of fun with the importance in their service-learning field trips. In an era of decreasing time outside in nature, volunteer programs offer an excellent way to "leave no child inside" (Louv 2006). While running volunteer events, NPS staff and volunteer leaders teach plant identification, discuss implications of exotic species invasions, describe how people can help fight invasives at home, and respond to volunteers' questions. Events help the public become more knowledgeable about the land and its management. Even if volunteers work only a few hours in a year (or ever), they can become a foundation of informed citizens that can speak about their enjoyment of park sites, and the hazards posed by invasive plants.

Striving for sustainability, an essential program objective is to develop volunteer leaders who can plan and run volunteer events. They become the longer-term linkage for managing short-term volunteers. As the ATC can attest, long-term volunteers naturally take on increasing personal ownership for the overall health and condition of the lands they manage. They become the best champions for resource protection and program augmentation because of their first-hand field knowledge. Typically, volunteer leaders have come from the ranks of senior citizens. Their families and professions take less of their time and they are looking for good ways to make a difference in their communities. High schools and universities are potentially good sources for citizen leaders. So far, that segment has not produced volunteer leaders for either Shenandoah or the Appalachian Trail. Though their energy is a great asset, their commitment is often fleeting due to the demands of school, and a transient lifestyle.

Collaboration to grow

Where work forces and budgets are strained by the current management demands, collaboration with other organizations is essential to expanding organizational potential. The Appalachian Trail short-term volunteer program was made possible by the help of the Appalachian Trail Conservancy, Potomac Appalachian Trail Club, National Audubon Society of Virginia, Defenders of Wildlife, National Parks Conservation Association, along with the National Park Service. As an example, those groups supported the 2008 National Public Lands Day event at Trumbo Hollow, near Linden, Virginia. They provided staffing, email and website advertising, snacks and coffee, and shelter. With the general public, the event attracted people from Girls Scouts of the USA and Boy Scouts of America, who are planning their own events in 2009 (Figure 1).

We believe short-term volunteers offer a productive and energized augmentation to the resource management potential of the Appalachian Trail. Time will tell whether the Appalachian Trail Conservancy and their 30 member clubs will adapt the model for their own needs.

Figure 1. Volunteers at the 2008 National Public Lands Day event listen as Biologist Kent Schwarzkopf explains the high value of resources in the area, and the primary reasons for their invasive plant control work that day. National Audubon Society, National Park Conservation Association, and the Potomac Appalachian Trail Club sponsored the event, along with the NPS.

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Connectivity: A Step Beyond Partnerships

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Throughout the United States, lands administered by the National Park Service (NPS) are being subjected to increasing pressure from housing and commercial development and the concomitant infrastructure needed to support these new population centers. Roads, powerlines, sewage treatment plants, and discharge sites are all necessary to support growing populations as they extend further into traditionally rural areas. The geographic areas nearby parks, forests, and other preserved areas are attractive to homeowners, resulting in the rapid and sometimes haphazard development of gateway communities.

In many areas the lands and waters in these communities are protected not only by the NPS, but by states, counties, municipalities, other federal agencies and non-governmental organizations, including land trusts. Many protected areas were designated at different times and for different reasons and rarely with a comprehensive strategic approach in mind.

The Delaware Water Gap National Recreation Area (DWG) is a prime example of federally administered lands facing increasing pressures from expanding urban areas. DWG is located within 90 miles of the greater New York/New Jersey metropolitan area, and over 56 million people in the large urban areas within 250 miles of the park boundary. The park manages over 40 miles of the Delaware River and nearly 70,000 acres in New Jersey and Pennsylvania. DWG is surrounded by 3 states, 6 counties, and 21 municipalities. According to US Census Bureau data all six of the counties bordering DWG are within the top 10 of their respective states for the percent per capita increase in population between 2000 and 2007. Pike County, Pennsylvania, has been the fastest growing county per capita in Pennsylvania since the 1990s until 2006, when it was bumped down to number two. Pike County also has the highest average commuting time of 46.2 minutes (state average is 25 minutes) for the state of Pennsylvania, and 70% of the working population over 16 works outside of the county.

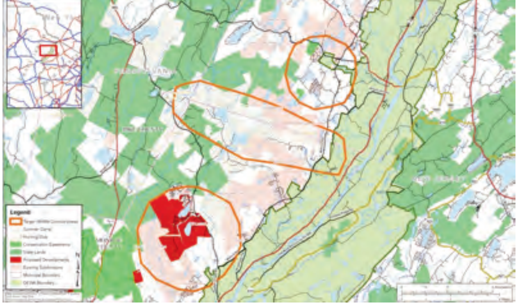
As a linear park, DWG is faced with the challenge of managing land and water at the bottom of the watersheds where the majority of the tributary watersheds are outside of the park boundaries. In areas surrounding the park there are other public lands with a total of 97,000 acres of state lands in Sussex and Warren counties, New Jersey, and 166,000 acres of state lands in Pike, Monroe, and Northampton counties, Pennsylvania. On the New Jersey side of the park there is direct connectivity to public land, however the Pennsylvania side is separated from public land by a development corridor. Residential developments directly bordering the park boundaries, particularly on the Pennsylvania side, have been growing since the formation of the recreation area in the mid-1960s.

In 2006, the superintendent directed park staff to begin looking at the possibility for connections between the state game and forest lands in Pennsylvania that could potentially serve as wildlife corridors. The first steps were to identify the primary riparian corridors, current land use, the proximity to NPS lands, and identify large undeveloped parcels. The goals were focused on areas where fee simple land acquisition, easements, and/or other open space options could maintain and improve the current connectivity of public lands. Through a simple Geographic Information System (GIS) exercise park staff members were able to identify three primary areas where connectivity was still feasible. These corridors within Pike County, Pennsylvania, could potentially connect the large Pennsylvania State Forest and Game Lands to the New Jersey State Forest and Park Lands with DWG, and the Delaware River at the center. Since Pike County is still a relatively rural area for the region, there still remain areas of large undeveloped parcels, many of which are being used as hunting clubs, summer camps, or agriculture. In recent years the financial benefits of developing agricultural lands has outweighed the back taxes penalties resulting from removing parcels from Act 319 lands (a Pennsylvania law that provides tax relief for agricultural uses, including forested plots).

The superintendent began promoting this concept to the Pennsylvania Department of Conservation and Natural Resources (DCNR) secretary and others through letters, meetings, and sharing the maps created by the Park. Simultaneously, several other local efforts were researching many of the same issues of preserving open space, and the rural character of the region. These efforts included, but are not limited to, the DCNR's Conservation Landscape Initiative and the Pike County open space, greenways, and recreation plan. After the superintendent shared the corridor map with the Pike County planning director, the park's GIS staff was contacted by the Pike County planning office to share GIS information regarding these priority areas, identified by the park, to help with the development of the their open space plan development. When comparing the areas identified by the NPS and those being looked at by the county, state, and others, many of the potential open space areas were located in the same vicinity. As a result, workgroups, such as the Pike County priority parcels committee, were formed with county, state, non-profit and NPS personnel to streamline efforts for identifying and prioritizing preservation. Over consecutive years, several other local groups have formed such as the Pike County rural preservation board, which manages a 10 million dollar bond to preserve open space in the county. Other efforts include two grassroots organizations, Common Waters, and the Upper Delaware River Roundtable, which were formed as a direct result of Park Service's regional planning initiatives.

Efforts by the park also began to engage local developers and resorts to facilitate discussions regarding the park assets, open space, sustainable development, and the mutual benefits provided by the park lands. Other federal efforts in the region include the newly authorized Cherry Valley Wildlife Refuge (February 2009) which abuts the southern end of the park. The Fish and Wild-

Figure 1. Map identifying potential corridors connecting Pennsylvania state and federal lands in Pike County, Pennsylvania.



life Service has also been working on authorization to expand the Wallkill Wildlife Refuge in New Jersey to the west, to connect to High Point State Park and Stokes State Forest, which ultimately borders DWG.

Across the country similar connectivity projects have been focusing on these same issues and goals of protecting the ecological benefits of a landscape, such as Mojave Complex in the California desert, the Yellowstone to Yukon Project, and the Everglades Complex in Florida. Research programs, such as NASA's PALMS program, looking at land use change surrounding NPS lands on a more landscape scale, have become more prevalent throughout the country. A national effort is underway through the Natural Resource Advisory Group to bring landscape scale connectivity actions to the forefront of NPS programs. The advisory group has developed recommended action items, program elements, and products to meet NPS needs regarding landscape-scale connectivity.

The NPS needs to address three gaps:

- First, the need for greater focus on the role of work beyond park boundaries.
- Second, to train personnel for a new era of public land management; to staff certain positions with landscape ecologists, conservation partnership specialists, and conservation real estate specialists.
- Third, to find the resources necessary to procure title or easements on properties, and to initiate appropriate management actions on these parcels.

Through establishing short and long term goals the NPS can help communities surrounding the parks to protect and enhance the landscape ecology that helped establish the public lands initially. Possible next steps for the NPS would be to conduct initial scoping of a landscape conservation program, continue and increase efforts to promote landscape conservation efforts near parks, develop formal ties to work with other organizations to identify areas of collaboration and leveraging, and prioritize acquisitions of current inholding and boundary properties that decrease edge-to-area ratios of parks.

Is Community-based Conservation an Effective Tool in the Llancahue Watershed, Chile?

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Introduction

The Llancahue watershed (1,300 ha), in southern Chile (Figure 1), has been owned by the Chilean government since the 1920s, and the property protects the water-supply watershed for the city of Valdivia. Unfortunately, the property currently appears abandoned in recent years due to a lack of resources dedicated to the protection and maintenance of the property. Consequently, the Chilean government granted the concession of Llancahue watershed to the University Austral de Chile in September 2008, with the mandate to develop a peri-urban park for Valdivia (around 130,000 inhabitants). The hope is that this public-private partnership will provide better management of the watershed and benefit the city of Valdivia by converting Llancahue into a recreational and educational space. Specifically, the university's goals for Llancahue include (1) maintaining or improving the water supply; (2) developing a peri-urban park for the city of Valdivia; (3) incorporating the local, rural community, Lomas del Sol, in the creation and maintenance of the park; (4) creating an outdoor, educational forestry laboratory; and (5) conserving the biodiversity of Llancahue, one of the best examples of old growth forest left in the Valdivian ecoregion. The Valdivian ecoregion is one of the most important hotspots for biodiversity in Chile and worldwide, due to the high number of endemic species present, and the rapid loss of native forests that has occurred in south-central Chile during the past 40 years (Armesto et al. 1998; Myers et al. 2000; Smith-Ramirez, 2004).

Llancahue watershed could be a conservation success story if the university can successfully partner with the local rural and urban communities to achieve conservation goals. In their ideal peri-urban park, the university would protect ecosystem services by engaging the neighbors of Llancahue to become good stewards of the land. The neighboring community, Lomas del Sol, would assist in, and benefit from, the education, ecotourism, restoration, and silviculture activities that the university would implement, through expanded employment and education opportunities. The final result would be a model park that is

Figure 1. Location of Llancahue Watershed, Valdivia, Chile.

sustainably managed, and where the citizens of Valdivia could enjoy and learn about the importance of old-growth forests, watersheds, and biodiversity.

Yet, the Llancahue watershed comes with its own challenges. Members of the Lomas del Sol community have noticeably been extracting wood and grazing cattle in the watershed since the mid-1990s. This community is willing to work with the university on this project, but they need alternatives to their current economic activities. They have little training or education in anything other than charcoal production and timber extraction. To further complicate matters, the university received the concession of this property without any financial assistance. They have aspirations to auto-finance the property through sustainable forestry management, private donations, or a management fee that would be added to the water bill, but all of these solutions will take time to implement. Thus, the two biggest challenges in Llancahue are working with the Lomas del Sol community to prevent destructive exploitation of Llancahue, and working with all stakeholders to develop concrete plans that can creatively and strategically use stakeholder resources and expertise to make this project a success.

Methods

The International Union for the Conservation of Nature (IUCN) model for community-based conservation in protected areas, also known as the protected landscape approach, provides guidelines on how to improve community participation in conservation management plans. The goal of this approach is to integrate biodiversity conservation, cultural heritage protection, and sustainable use of resources while fostering stewardship by the people living in the landscape (Brown, Mitchell, and Beresford 2005). The first step in the community-based conservation planning process is to determine the attitudes of local people toward conservation initiatives, and identify potential ways that local communities can benefit from the conservation area (Infield 1988; Fiallo and Jacobson 1995). During the Chilean summer of 2008–2009 (November through February), we used a mixed methods approach to determine stakeholder attitudes towards the Llancahue watershed, and will use this information to develop clearer management strategies for Llancahue.

A combination of semi-structured interviews (n = 70), formal meetings (n = 3), focus groups (n = 5), documentation of informal interactions, and observations was used to conduct the stakeholder analysis (Figure 2). Stakeholder groups can be divided into two major categories: the local campesino community, and institutional. The local campesino community, Lomas del Sol, lives beside Llancahue. Some members of this community use the watershed to harvest wood and graze their cattle. Institutional stakeholders in the region include governmental agencies, non-profit organizations, private industry, and the university. Eighty percent of the institutional stakeholders work in the field of natural resource management and the other 20% work in rural development, education, or tourism. The techniques used to engage these stakeholder groups varied slightly, and two different interview questionnaires were developed. The overall interview response rate was high (97%). Saturation was achieved in the responses to of all of our main research questions. We found that having key informants in both the Valdivian community and the Lomas del Sol community was critical.

Results

Figure 2. The authors met with the Lomas del Sol community in December 2008 to discuss the university's and community's visions for Llancahue, and to solicit feedback on potential benefits and challenges of the project.

Everyone interviewed (100%) felt that the Llancahue watershed needs protection, "even if it is not convenient for me" as stated by one resident of Lomas del Sol. Many Lomas del Sol residents suggested that the watershed should be closed completely through enforcement. When we asked participants about the biggest environmental change they had witnessed in their own lifetime, responses varied, but over two-thirds of all respondents cited the conversion of native forests to exotic plantations. This is reflected in the fact that the number one industry of the region is forest products, largely for export. The loss of native forest has put increased pressure on remnant native forest on which local, rural communities depend on selling firewood and charcoal to urban residents of the region—thus Llancahue is not an isolated conservation case in the region.

The Lomas del Sol community hopes (100%) the creation of the peri-urban park will create alternative livelihoods for them, yet they have their doubts about when this might occur. The Llancahue peri-urban park has been discussed for seven years before the concession was granted to the university in fall 2008. The community believes that the university can effectively manage Llancahue (100%) because they have the expertise. The Lomas del Sol community hopes to receive training, education, and better services, such as an improved roads and electricity, as a result of the peri-urban park. Many expressed concern that they were not ready to receive visitors who will come to the Llancahue peri-urban park in the future. There was an overwhelming interest within the community to receive capacity training in all types of activities from trail building, gardening, cooking, ecotourism, chainsaw certification, and forestry management. Additionally, many want to receive basic education, since most residents never completed an elementary education. Many Lomas del Sol residents have spent their lives cutting trees in the forest and making charcoal. When asked what type of work they would prefer, the majority of residents stated they would like to continue participating in forestry vocations such as thinning the forest, cleaning the forest, and trail building. Fewer residents had an interest in being guides, due to their lack of education.

Many residents want work to supplement the production of charcoal. Charcoal production is an important link between the community and the forest, and provides an important cultural aspect to the park. Charcoal is very important in Valdivian society because many social gatherings are centered around 'the asado,' or outdoor barbeque, where charcoal is used to cook large pieces of meat. Charcoal production in Lomas del Sol is unique, in that they build hand-made, earthen ovens each time they cook the charcoal (Figure 3). The production of charcoal could tell an important cultural story by linking the forest to the asado, and demonstrating this process to visitors (Figure 4).

Figure 3. Photo of the home-made, earthen oven used for the production of charcoal.

Figure 4. Community members are explaining the process of making charcoal to institutional stakeholders from Valdivia during a focus-group tour of natural and cultural resources in Llancahue.

The current level of charcoal production and firewood extraction is unsustainable. The current wood demand by the community for charcoal production is at least 0.6 solid cubic meters per month per family, or 144 m^3 per year for the entire community. This figure excludes extractive firewood demand which is greater then 0.6 m^3 per month for 10 or more families. The university only plans to mange 10 ha of secondary forest per year which would produce about 140 m^3 of wood on an annual basis. They hope to use half of this wood to pay for the implementation of the peri-urban park annually. The university needs to work with the community to employ them in the development of the peri-urban park, which can provide alternative income sources and reduce their dependence on carbon production. Yet we do hope to encourage a sustainable level of carbon production in Lomas del Sol to preserve this cultural aspect of the community. For these reasons, we suggest that the Lomas del Sol community is the most immediate challenge to managing the watershed sustainably as they directly threaten the integrity of the forest. This community can, however, also be Llancahue's most important asset due to the fact they provide a ready and willing workforce and add cultural significance to the park.

Although the university has many objectives for the watershed, stakeholders ranked the protection of the water supply and the protection of the old growth forest as their first and second priorities for management. Some stakeholders expressed concern about the impacts of recreational uses of the watershed on the water supply and the old-growth forest. The university must use science to monitor any new activities that are implemented in the watershed to insure that ecosystem services are not negatively impacted. The hope of the university is that they can demonstrate that the thinning of the secondary growth forest will increase water production, restore old growth conditions and produce revenue to finance the peri-urban park, as well as provide alternative economic opportunities for the Lomas del Sol community. The use of science and adaptive management will allow effective decision-making as to the uses of the watershed. Scientific monitoring of management decisions will additionally benefit the university as they have existing research expertise. Llancahue can provide an ideal and convenient location for applied graduate and undergraduate research in a variety of fields including forestry, ecology, geosciences, rural development and tourism.

Even though the university has exceptional research expertise, many stakeholders acknowledge that the assistance of and collaboration with other institutional partners is necessary for success. We feel that the creative and strategic use of stakeholder institutions to pool people and resources is necessary due to the lack of resources currently available to support this project, one of the most commonly cited concerns of institutional stakeholders.

Finally, an interesting result is that although Llancahue provides 80% of the cities water on an annual basis and is one of the last old-growth forest near the city, almost no stakeholders (<3%) thought that the citizens of Valdivia were aware of the Llancahue watershed or its importance. This may be due to the fact that Valdivia is surrounded by large rivers. These rivers are used for water production for about 20% of the year (during the summer dry period), but the cost of producing water from these rivers is six times more then the cost of producing water from Llancahue (Azurmendi 2004). Thus, there is a direct monetary benefit to the citizens of Valdivia if water production can be maintained or increased in Llancahue. A survey of articles in the *Diario Austral,* the daily newspaper in Valdivia, revealed that only two articles had been published on the Llancahue watershed during the past five years. Clearly another important first step in Llancahue will be to increase public awareness though outreach programs and environmental education in schools, the creation of a friend's group and use of the media.

Discussion

We suggest that engaging various stakeholder groups in Llancahue watershed will encourage them to become effective stewards and partners of the Llancahue peri-urban park. The Lomas del Sol community can be a great asset to the park by providing a willing work force and an important cultural aspect to the park. Institutional stakeholders can support the park through various university/institutional partnerships that can be incorporated into the management plan. Finally, the residents of Valdivia must be introduced to and educated about the importance of Llancahue watershed so they will identify with the park and want to protect the watershed for future generations.

For conservation initiatives to be a success in the future, conservation and development must occur simultaneously (Berkes 2004). From our perspective, this project could be a model of conservation that has benefits from the local to international level. The Lomas del Sol community will benefit if they can obtain better education, diverse employment opportunities, better services and preserve their cultural tradition. Valdivian citizens benefit by protecting their water supply and natural heritage, developing a space for recreation and environmental education and creating new revenue through ecotourism. If successful, this project could provide a model for sustainable community-based conservation and development in the region. Finally, this project is of international significance because it will help conserve one of the last old-growth forests in the Valdivian ecoregion, a hotspot for biodiversity in the one of the world's most diverse and endemic ecoregions that is quickly disappearing.

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The Apostle Islands and Pictured Rocks National Lakeshores on Lake Superior and Amenity-Supported Local Economic Vitality

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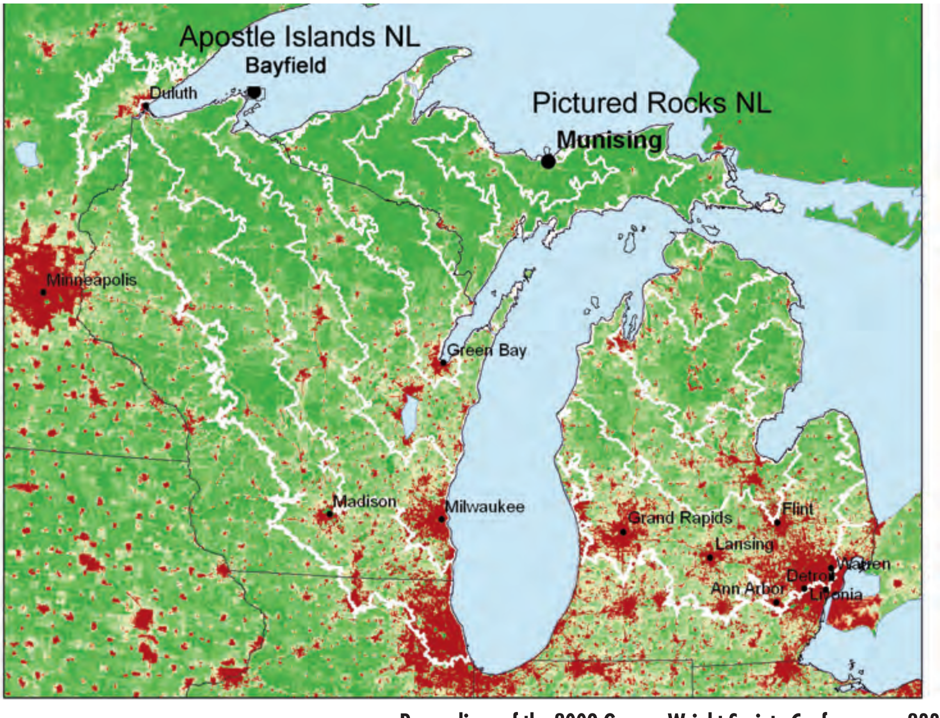
Introduction: Parks and local economic vitality

This study analyzes the various ways in which the Apostle Islands and Pictured Rocks national lakeshores on the south shore of Lake Superior affect the rural economies in which they are embedded. These national lakeshores are managed by the National Park Service.

Under the organic legislation establishing the national park system, these national lakeshore serve two functions: (1) "to conserve the scenery and the natural and historic objects and the wild life therein," (2) "and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations" (16 USC sec. 1).

Providing on-going access to the public to enjoy unique, high quality, natural wonders that are permanently protected establishes a direct link between the national lakeshores and the local economy: the expenditures of visitors to the national lakeshores tend to stimulate local economic vitality as that money circulates through the local economy.

Figure 1. Location of Apostle Islands and Pictured Rock national lakeshores relative to major population concentrations. One hour travel time zones. Map by Paul A. Lorah, University of St. Thomas.



This potential for national parks to stimulate local economies was an explicit focus of federal government policy to expand the national park system when the establishment of these two national lakeshores was debated in the 1960s. At that time the Kennedy and Johnson administrations were concerned about regional economic decline and persistent poverty in several rural regions of the United States, including northern Wisconsin and the Upper Peninsula of Michigan. The federal government saw the establishment of national parks as a way of drawing economic activity into these lagging rural areas.

The dual purpose of national parks, the preservation of natural landscapes and facilitating access for visitors, can lead to perceived conflict between the obligation to protect and the obligation to provide access. This, in turn, can be translated into a conflict between the needs of the local economy and the need to permanently protect the national park's natural systems. Echoes of that potential conflict could be heard during the first decade of the 2000s, in the public debate over the classification of parts of Apostle Island and Pictured Rocks national lakeshores as wilderness areas where motorized activities would be limited.

Despite these persistence of concern over a perceived conflict between landscape protection and local economic vitality, data from a variety of sources emerged over the last several decades suggesting that preserving natural landscapes, rather than depressing local economies, actually stimulates them. For instance, consider the impact of the strictest protection that a natural landscape can receive: classification as a national wilderness area. If counties containing such classified wilderness are compared to rural counties without wilderness, population growth rates for half a century have been two to six times faster in the wilderness counties, depending on which decade between 1950 and 2000 is used. Across all of those five decades population growth, primarily fueled by in-migration, has been almost five times faster.[1]

The enhanced rural economic vitality in areas around protected landscapes, whether they are national parks, wilderness areas, identified national forest roadless areas, state parks, or just federal lands, suggests that some other set of economic forces is operating that overcomes the assumed negative impact of restricting use and commercial development of those landscapes, and generates a net positive impact. Investigation of these examples of rural local economic vitality, despite landscape preservation measures, has led to the conclusion that residential location choice based on the attractiveness of particular areas, has stimulated in-migration into certain areas in pursuit of what is perceived to be higher quality social and natural environments, what have come to be called local "amenities."[2]

It is that possibility of amenity-supported local economic vitality in the regions surrounding Apostle Island and Pictured Rocks national lakeshores that this study explores. We consider several different pathways by which the unique natural landscape features protected by the national lakeshores may impact local economic vitality including the impact of:

- Temporary visitors drawn to the area and their spending.
- Part-time residents who facilitate visitation by owning a second home there.
- Retirees who choose an area for their new permanent residence because of the local amenities.
- Working-age households who relocate in the pursuit of local amenities that match their

preferences.
- Working-age households who choose to live in a preferred, amenity-rich setting while commuting to work elsewhere.

Trends in the regional economies since the establishment of the national lakeshores

As the Apostle Islands and Pictured Rocks national lakeshores were becoming realities in the late 1960s and early 1970, major changes were taking place in rural America. For the first time in the 20th century, the rate of population growth in rural areas exceeded that in large urban areas. Rural America was being repopulated as a result of net in-migration. That non-metropolitan "turn-around" took most demographers and economists by surprise. Although the post-World War II period had seen the suburbanization of America, those suburbs were growing around our large urban centers, continuing the concentration of population in those metropolitan areas. The rural "turn-around" was different. It represented an "ex-urbanization," people shifting their residence from large urban areas to smaller cities or rural areas.

It was this shift in population that got demographers and economists thinking seriously about the "non-economic" motivations for residential location decisions. As with the move from center city to suburbs, the move to rural areas represented a move away from employment and other commercial opportunities. Clearly households were interested in a broader range of characteristics in choosing a residential site than just economic opportunity or transportation costs. The site-specific environmental qualities, both social and natural, associated with a place also had to be considered. From this came the increasing attention to local "amenities" as a source of local economic vitality.

As the Apostle Islands and Pictured Rocks national lakeshores were getting established in the 1970s, change was also taking place in rural northern Wisconsin, along Lake Superior, and the border with Michigan's Upper Peninsula. One indicator of that change was the near doubling in the number of second homes during the 1970s. Across the counties south of Apostle Islands National Lakeshore (NL), and the Wisconsin counties southwest of Pictured Rocks NL, second homes grew by over 24,000, or 80 percent. Clearly change was afoot in the area.

Since 1969, both gateway counties, Bayfield, WI, for Apostle Islands NL, and Alger, MI, for Pictured Rocks NL, have seen significant economic vitality. Aggregate real income, per capita real income, and employment all grew significantly faster than for their home states as a whole. Population grew at about the same rate as the state. Rather than being economically depressed areas, these national lakeshore gateway counties led their states in economic expansion.

Whatever the impact of the creation of these two national lakeshores was on the local economies, that creation did not keep those rural economies from expanding significantly and out-performing the individual states in which they were located, as well as most of their neighboring counties. These relatively small National Park units were associated with enhanced economic vitality, just as communities adjacent to the much larger national parks have been. In that sense, the national lakeshores original advocates' expectations of renewed economic vitality were fulfilled.

	Percentage Change in Economic Indicators 1969–2006			
	Aggregate Real Personal Income	Per Capita Real Income	Employment	Population
Apostle Islands: Bayfield County	147%	96%	110%	26%
Wisconsin	113%	67%	86%	27%
Pictured Rocks: Alger County	186%	65%	69%	16%
Michigan	70%	48%	52%	15%

Table 1. The relative economic performance of Apostle Islands and Pictured Rocks national lakeshores' gateway counties. U.S. Dept. Comm. BEA REIS data.

The role of the national lakeshores in the local economies

As discussions at the time these two national lakeshores were created made clear, one significant local impact of National Park units on the local economy is associated with visitors and their spending.

The national lakeshores, however, also play two important roles beyond that of attracting temporary visitors. First, they provide permanent protection to unique local landscape amenities that may make the area a more attractive place to live, work, and do business. Second, the very classification as a unit in the National Park System signals to a national audience the presence of a high quality and protected natural landscape feature.[3] This draws people who are not familiar with an area to it where they discover not only something about the national lakeshore but also about the broader natural and social environment surrounding the national lakeshore. This, for a small number of visitors, may lead to further commitments to that place, including second homes or permanent residence.

People are not attracted to an area by just one feature or quality. It is the suite of qualities and experiences taken together that draw them. Although we have not tried to quantify it, these national lakeshores have played a vital role in drawing attention to the south shore of Lake Superior, and the amenities that northern Wisconsin and the Upper Peninsula have to offer. Visitation to these national lakeshores is a crucial part of this. But the economic impact does not end with the expenditures visitors to the national lakeshores make. The knowledge and understanding that visitors obtain about the lakeshores, as well as the gateway communities, and the other public recreation lands remain important into the future. That experience and knowledge will bring some of those visitors back, and some of the repeat visitors will become residents of the region, if not of the gateway communities. Like the initial visits to the national lakeshores, the national lakeshore is unlikely to have been the only thing drawing people back, but it is likely to be what introduced people to the area, and remains an important symbol of what the region has to offer residents.

For all of these reasons, the economic impact associated with visitor spending in the national lakeshores has to be seen as just one part of the overall contribution they continue to make to local economic vitality. But that visitor spending impact has been significant. Our estimate of the economic impact of visitors to Apostle Islands NL on the Bayfield-Ashland County economy was $12.9 million at the beginning of 2008. Our estimate of the impact of national lakeshore visitor spending on the Alger County economy was $7.7 million. The Apostle Island NL visitor spending was estimated to be 14 to 18 percent of all visitor spending in Bayfield and Ashland Counties. The Pictured Rocks NL visitor spending was estimated to be 59 to 67 percent of all visitor spending in Alger County.

Evidence of amenity-supported economic vitality in the vicinity of Apostle Islands and Pictured Rocks national lakeshores

We explored for evidence of amenity-supported local economic vitality in the area surrounding the two national lakeshores by a process of elimination. We first quantified the changes in total real (inflation removed) personal income received by residents over a nearly three-decade period, 1978–2006, after the establishment of these national lakeshores. We then analyzed the power of various changes in those economies to explain real income growth.

We began with the changes in real earnings in the traditional economic base: forest products and other manufacturing, mining, agriculture, and state and federal government employment. The popular view of these rural economies typically focuses on these sectors as the driving force of economic change, positive or negative. In Bayfield County which provides most of the access to the Apostle Islands, the traditional economic base contracted slightly, even though total personal income expanded significantly. In Ashland County, in which most of the Apostle Islands are actually located, changes in the traditional economic base explained about 30 percent of the change in personal income, when multiplier effects are included. For the two gateway counties combined, the change in the traditional economic base, even with multiplier impacts included, explained only 9 percent of the change in personal income.

For Alger County that surrounds Pictured Rocks NL, changes in the traditional economic base were more successful in explaining changes in the overall economy: With multiplier impacts included, all of the change in personal income could be explained by the changes in those basic industries.

We then considered the impact of the visitor economy, including the impacts of visitors to the national lakeshores, on the local economy. That visitor economy is clearly also part of the local economic base. For the Apostle Islands NL counties, the visitor economy, including multiplier impacts, explained about a quarter of the change in total personal income. For the Pictured Rocks gateway county, the visitor economy explained about a sixth of the change in total income.

We then explored the role of new permanent residents on the Apostle Islands and Pictured Rocks gateway economies. Both Apostle Islands' and Pictured Rock's gateway

Table 2. The impact of economic changes on changes in total personal income in the Apostle Islands and Pictured Rocks gateway counties, 1969–2006. Calculated from U.S. Dept. Comm. BEA REIS data.

Counties	% of Change in Personal Income Explained by Changes in				Total Change Explained
	Traditional Econ Base	Visitor Spending	Non-Employment Income	Commuting Out to Work	
Apostle Islands Region					
Bayfield	-4%	30%	72%	27%	125%
Ashland	30%	23%	75%	-33%	95%
Bayfield-Ashland	9%	27%	73%	3%	113%
Pictured Rocks Region					
Alger, MI	103%	16%	73%	-12%	181%

counties experienced net in-migration of about 10 percent between 1980 and 2006. In addition, the role of income not associated with current employment, income such as investment and retirement income, has grown faster than the overall economy, and now makes up over 40 percent of total personal income in the gateway counties. In the Pictured Rocks area 75 percent of this "non-labor" income is retirement related. In the Apostle Islands area 60 to 70 percent of it is retirement related. We focused on this source of local income because it is relatively "footloose," moving with people as they change their residential location.

The impact of these income flows not connected with current employment on the local economies appears to be substantial. In the Pictured Rocks area the growth in investment and retirement income was as great as the growth in the traditional economic base. In the Apostle Islands area where there was little growth in the traditional economic base the growth, the growth in retirement and investment income was many times that growth in earnings in the traditional economic base. In both areas, the growth in retirement and investment income, and other transfer payments, explained about three-quarters of the growth in total personal income.

Finally, we looked at the impact of people choosing to live in one county, while commuting out to work in another county. The attractiveness of a place as a residence, despite limited employment opportunities, can lead to a flow of income into the county of residence. In the primary gateway to the Apostle Islands, Bayfield County, for instance, over a quarter of personal income is the result of such out-commuting residents. Alger County, on the other hand, lost 12 percent of the earnings generated in the Pictured Rocks area as a result of workers living in other counties commuting in to work.

Conclusions

There is significant evidence of amenity-supported local economic vitality in the area surrounding the Apostle Islands and Pictured Rocks national lakeshores. Since the creation and development of these national lakeshores, their local rural economies have out-performed their state and surrounding county economies. The visitor economy, including visitors to the national lakeshores, have contributed significantly to this economic vitality, but other amenity-related changes have supported local economic vitality too. The increase in semi-permanent residents building second homes has been important. Net in-migration has also played a role. Retirement and investment income has increased significantly. In the Apostle Islands area, out-commuting to work has been important. The economic role of these National Park units has to be understood within this complex set of amenity-related changes, rather than being limited to only their role in attracting temporary visitors and their spending.

Endnotes

1. Gundars Rudzitis and Rebecca Johnson, "The Impact of Wilderness and Other Wildlands on Local Economies and Regional Development Trends," in *Wilderness Science in a Time of Change Conference Proceedings,* RMRS-P-15-CD, ed. David N. Cole, Stephen F. McCool, William T. Borrie, and Jennifer O'Loughlin (Fort Collins, Colo.: USDA Forest Service, Rocky Mountain Research Station, 2000), 15, Table 1. Update from 1990–2000, personal communication from Gundars Rudzitis.

2. See the collection of essays in Gary Paul Green, Steven C. Deller, and David W. Marcouiller, eds., *Amenities and Rural Development: Theory, Methods and Public Policy* (Northhampton, Mass.: Edward Elgar, 2005).
3. Stephan Weiler, "A Park by Any Other Name: National Park Designation as a Natural Experiment in Signaling." Research Working Paper (RWP) 05-09. Kansas City. Mo.: Federal Reserve Bank of Kansas City, (2005). Also see Stephan Weiler and Andrew Seidl, "What's in a Name? The Impact of National Park Designation," *Review of Regional Studies* 32:1 (2002), 97–111.

Causes and Potential Solutions for Conflicts between Protected Area Management and Local People in Germany

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Introduction

The designation of protected areas (e.g. national parks) often leads to conflicts between local communities and the area's administration. This phenomenon exists worldwide (Pretty and Pimbert 1995) and is probably as old as the national park idea itself. These conflicts often affect both the protected areas and the local communities as strained relations bear the danger of gridlock on park planning, conservation objectives or regional economic development. As national parks and surrounding communities are highly dependent on each other (Jarvis 2000), the task of managing stakeholder interests and potential use conflicts should be of high priority for park managers.

National parks in Germany (as much of Central Europe's protected areas) are often very vulnerable to such conflicts for a number of reasons. Their history is quite recent, with the oldest park having been established less than 40 years ago. On the other hand, the German landscape has been altered throughout many centuries, hence creating cultural landscapes, rather than unimpaired wilderness. Thus, the designation of national parks has caused conflicts in the past, mainly along the lines of the continuation of traditional uses vs. future (non-)development, often additionally fuelled by management issues (local vs. state vs. federal). Additionally, a high population density puts protected areas more likely close to urban areas. Against this background, the management of stakeholder issues in order to increase support among local communities remains one of the most important sociological challenges for German park managers.

This paper presents the results from a field study carried out in the Harz National Park, located in a North German low mountain range. The scope of the study was to identify and analyze existing and potential conflicts between park management and the local population. Based on the results, measures to improve local support for the park were proposed. A specific focus was put on known and hidden communication channels between stakeholders and the park's administration in order to develop a strategy that makes outreach more efficient.

National parks in Germany

National parks in Germany can be established under the Federal Nature Conservation Act, but are designated and managed by the federal states. As of 2009, 14 national parks existed in Germany, protecting a total area of approximately 9,621 km^2 (BfN 2009, cp. Figure 1). This includes marine areas which account for 80% of it. The terrestrial parks are equivalent to 0.54% of the land mass of Germany. The parks' sizes are typical for Central Europe, but compared to North American or African parks, they are quite small.

The reasons for opposing the designation of protected areas seem deeply rooted in Germany, mainly through emotional and cultural drivers that influence attitude towards nature conservation. Based on extensive research, Stoll-Kleemann (2001) developed a model that cites five causes as barriers to conservation which also strongly influence the attitude towards protected areas: a weak national constituency, conflicts with other government agencies, inadequate management, insecure or insufficient funding and conflicts with local people. Despite the fact that those conflicts as described are common to most German national parks, the parks' research activities still mainly focus on natural resource management. Socio-economic issues often seem to be managed by "gut feeling," although their importance has been on the rise in recent years, even though social scientists among park management staff are rare. Own research via an email survey during the process of preparing the main study revealed that out of the 14 national parks, only three of them had assigned the issue of monitoring the support among local communities a high priority and integrated this into their permanent management tasks (von Ruschkowski 2009).

Figure 1. National parks in Germany. Insert shows Harz National Park and parts of its surrounding communities. Map sources: Bundesamt für Naturschutz (Federal Agency for Conservation) and Harz National Park.

Harz National Park

Harz National Park encompasses about 247 km^2 of colin (the altitudinal zone between 150 and 300 m in the Central German hills) and montane habitat zones and is located in the German states of Lower Saxony and Saxony-Anhalt. From the North Sea inward, the Harz mountains are the first mountain range beyond the northern German lowlands, rising to 1,142 meters above sea level. The national park only comprises a minor area of the mountain range and features predominantly forests and bogs (peatlands). The forests have mainly been altered by logging and mining for at least the past 1,000 years, thus the vegetation is still far from a natural state in the elevations between 500 and 850 meters above sea level. One of the park's main management objectives is to turn the existing fir monocultured forests into a more natural state (beech-oak communities) over the next 30 years. Currently, barkbeetle infestations from the fir forest pose a potential threat to nearby, mainly privately owned forests outside the park boundaries. One of the park's biggest successes has been the successful reintroduction of the Eurasian lynx which now has become an important figurehead for this park.

Harz National Park was originally founded as two separate parks along the state lines (and the former borderline between East and West Germany) of Saxony-Anhalt (1990) and Lower Saxony (1994). Both parks were merged into the current Harz National Park in 2006, creating Germany's first (and only) interstate national park. The Harz region has been a strong tourism destination for more than 100 years. The number of visitors is estimated between 10 and 40 million visitors per year (including multiple visits and day visits). Still, the number of overnight stays indicates strong visitor use. For the year 2003, 4.2 million overnight stays were recorded by the local tourism umbrella group "Harzer Verkehrsverband" (von Ruschkowski et al. 2009).

Methodology

To address the research questions, a study design based on a quantitative survey was chosen. The sample size was set to be at least 200 households, a stratified random sample from selected communities in the Harz region that directly lie on or at the park's boundaries. The extensive questionnaire contained 41 questions with a total of 139 items, using a mix of closed and open questions that ranged from nominal to interval scale to allow multivariate analysis in selected cases. The survey was carried out in February and March of 2005. In most cases, the questionnaires were handed over personally to participants, leading to an overall 97.2% response rate. The data was coded and analyzed, using the statistical software package SPSS.

Results

The survey produced mixed results overall which made it difficult to single out specific reasons for a lack of local support for Harz National Park. Select results are presented in this paper. Overall, 40.5% of the sample (n = 205) had a positive attitude towards the park at the time of its designation in the 1990s, 27.3% were neutral and 22.0% opposed it, 7.8% of the respondents did not live in the area when the park was founded, 2.4% declined to answer this question. At the time of the survey, 15 (Eastern part) and 11 (Western part) years respectively had passed since the park's designation. Eighty percent responded that their attitude towards the park had not changed since then, while 5.9% indicated it was more positive, and for 7.3% it was more negative now. Therefore, the overall changes were insignificant, but it has to be pointed out that for the vast majority, the initial attitude seemed to persist after more than a decade. When asked about their satisfaction about the initial public involvement when the parks were established, only 17.1% of the respondents ranked the degree of participation at least somewhat or completely satisfactory. The correlation coefficient (Pearson) between satisfaction level and attitude towards the park was highly significant (r = .582**).

Personal impacts could be a key driver for the attitude towards the park. Seventy three point six percent of the respondents said they (themselves or members of their families) were not affected by the park. While 11.2% were positively affected (e.g. through the creation jobs), 13.7% stated they were negatively affected. Almost the same results applied when they were asked about the impacts on friends or neighbors. Thus, the overall impacts seem to balance themselves.

Establishing a national park means new rules and regulations for the local communities. As a logging region, the discontinuation of logging within the park's boundaries was probably the most noticeable change in the beginning, although the forests were state-owned and thus economic impacts were low, especially since many foresters were given the opportunity to transfer to the park administration. Still, many traditional uses exist in the region. While most laws in effect today are widely accepted by the respondents, there was one noticeable exclusion: picking berries and mushrooms was an activity carried out by many locals. Therefore, the ban on this activity was unacceptable for 56.5% of the respondents. This was by far the most unpopular regulation and also caused most comments throughout the survey. Similar results were reported from a study at Eifel National Park in Western Germany (Sieberath 2007).

The access to and the use of media and other information could highly influence people's knowledge about the park. The predominant media were the local newspapers. Two print publications (bi-monthly/quarterly) that include a four-page extra section on Harz National Park reached only 3.9% of the respondents, most of them reading these publications rather irregularly. The park's websites were used by 2.4% if the respondents. Overall, those outreach efforts that are tailored towards national park issues did not even reach five percent of the respondents. Not surprisingly, only 5.4% of the respondents said they felt "very well" informed about the park, 31.7% stated somewhat well, whereas 57.1% opted for less than satisfactory levels. At the same time though, 64.9% of the respondents stated they did not need any additional information about the park, putting the managers in a dilemma as people seem to lack information, but are not necessarily keen to be better informed. One of the important findings of the study was that 51.2% of the respondents knew at least one national park employee personally. This fact could play an important role in future outreach activities, especially since park employees were affiliated with positive impressions.

Discussion

Overall, the study could not determine a single outstanding cause that would explain resistance against Harz National Park among local people. Instead, a number of factors contribute to a positive or negative attitude towards the park. Many of these factors though lead to communication processes in the end. The park will not improve the situation by increasing outreach alone. Especially the fact that only insignificant attitude changes have occurred since the park's establishment despite extensive outreach efforts is a viable hint that quantity alone is not the deciding factor. Overall survey results rather indicate that an integrated approach is required. This would include strengthening communication on a personal level. The fundamentals are already present as park employees play a significant role as communicators and are mostly well-respected in the communities. As most of the surveyed communities are rather small and found in rural settings, a key aspect of this strategy is to address and involve local decision makers. Currently, participation and public involvement relies mostly on the formal requirements as stated in relevant laws and regulations, although the park administration has recently indicated a shift as informal public hearings and presentations were introduced as a new tool. Another worthwhile tool to use would be to involve local people by providing hands-on opportunities for them to learn the basics of park management. Experience from other protected areas show that such events help local people to make a personal connection to the park and understand the complexity of management decisions.

Different stakeholders certainly require different approaches, thus the park management should develop new initiatives tailored towards all stakeholder groups. Stakeholder management on a professional level is currently not practiced in any of the German national parks, usually the parks' outreach serves the "usual suspects." A more professional approach in this matter would most likely also lead to more efficient decision making and transparency of these decisions. Especially when small or traditional user groups are affected (as shown in the berry and mushroom picking case), dealing directly with these issues would allow for more simple, case-specific solutions.

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Innovative Transit Partnership to Enhance National Parks and Gateway Communities

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Introduction

Exploring national parks and other federal lands is a major past time for Americans and international visitors. Transportation and the national parks are intrinsically linked. Park roads, scenic overlooks, hiking trails, and related facilities are the focal points of many visits. Traffic congestion, vehicle-generated noise and air pollution, and deteriorating roadways are concerns at many national parks and other public lands.

The federal land management agencies, the U.S. Department of Transportation, state governments, local communities, foundations, regional organizations, businesses, and other groups are all responding to these concerns and challenges. The implementation and operation of new transit services within national parks, as well as between national parks and gateway communities, represents one approach to addressing these concerns.

At the federal level, the Intermodal Surface Transportation Efficiency Act (ISTEA), the Transportation Equity Act for the 21st Century (TEA-21), the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), presidential directives, and interagency agreements established new directions for transportation within national parks and other federal lands during the 1990s and 2000s.

This paper examines the innovative partnerships among national parks, gateway communities, and other groups to introduce new transit services. Case studies are presented, highlighting new transit services in and around Acadia, Zion, Rocky Mountain, and Glacier national parks. The information presented in this paper should benefit staff and policy makers with the national parks, transportation agencies, gateway communities, and other groups interested in developing and operating transit services in, and adjacent to, national park and other federal lands.

The remainder of this paper is divided into three sections. The case studies are presented next, focusing on the innovative institutional arrangements, service delivery methods, and experience to date with the transit partnerships. The common themes emerging from the case studies are highlighted in the third section. The paper concludes with a discussion of areas for additional research.

Case studies

Acadia National Park. Acadia National Park comprises some 40,000 acres along the coast of Maine, Mount Desert Island, and other islands. Established initially as a National Monument in 1916, and given park status in 1929, Acadia represents one of the older parks in the system. Bar Harbor is the primary gateway community for Acadia, although there are smaller communities located throughout the park, and Ellsworth serves as the main entrance point on the mainland.

Private individuals and groups built much of the infrastructure in the area, including 44 miles of carriage roads constructed under the direction of John D. Rockefeller. Concerns arose in the 1980s about the ability of these roads, small parking lots, and other facilities to accommodate the ever-increasing number of visitors and vehicles.

In response to these concerns, a coordinated approach involving the Acadia National Park, the Maine Department of Transportation, regional organizations, local communities, local businesses, Friends of Acadia, and other groups was undertaken. A general management planning process for the park, initiated in 1987, resulted in agreement to pursue an area-wide transportation system.

The Island Explorer transit system was implemented in the summer of 1999, with eight propane buses operating on six routes, linking hotels and businesses with key destinations in the park. The system has been expanded over the years, with service currently provided on eight routes. Operating from late June to early September, Island Explorer provides free service daily from 7:30 a.m. to 11:00 p.m. Downeast Transportation, a non-profit organization located in the Ellsworth area, operates the service. Real-time information on the status of buses is provided to riders at key locations through an Intelligent Transportation System field operational test, funded by the U.S. Department of Transportation.

Ridership on the Island Explorer has grown from 142,000 passengers during the first year of operation in 1999 to approximately 405,000 riders in 2008. The system averages some 4,980 passengers per day during the peak season. The highest one-day total in 2008 was 8,440 riders.[1]

The results from the on-board surveys, conducted every year, show strong support for the service and high levels of satisfaction among riders. Driver friendliness and helpfulness, clean buses, and free fares all generate high levels of satisfaction. The vast majority of riders indicate that the Island Explorer improves the quality of their visit to the Acadia region. While park visitors represent the majority of riders, local residents also use Island Explorer, including going to and from work.[2]

The 1999 agreement establishing the system included 22 signatories, representing the cooperative efforts of Acadia National Park, the Maine Department of Transportation, Mount Desert Island towns, Friends of Acadia, regional organizations, local businesses, and other groups. Funding for capital and operating expenses has come from a wide range of sources, including traditional and new National Park Service programs, Federal Highways Administration (FHWA), and Federal Transit Administration (FTA) programs and funds from the state, Friends of Acadia, local communities, and other groups and businesses.

The Island Explorer gained a new sponsor in 2002, when L. L. Bean became the single corporate underwriter. With close to 3 million annual visitors to its store in Freeport, L. L. Bean and Acadia share honors as the most popular destinations in the state. Announced as its 90th anniversary gift to the state, the sponsorship reflects the company's values to promote recreation, sound stewardship of the nation's natural resources, and their corporate consciousness to help address local issues. The contribution, which has totaled $2 million since 2002, was made to Friends of Acadia, which in turn provides the funds to support the Island Explorer. The funding from L. L. Bean has been used to extend service later in the fall, to introduce a bicycle express service, and to match federal funds.

Planning activities and service enhancements continue, using the same partnership approach employed to develop and implement the Island Explorer. A short-range transit plan was prepared for the Island Explorer in 2007. The planning process involved the partner agencies and groups. A number of the recommendations from the plan, including development of the Acadia Gateway Center intermodal facility on the mainland, are being pursued.[3]

Zion National Park. Zion National Park encompasses 229 square miles of cliff-and-canyon landscape in southwestern Utah. The drive through the canyon is the main highlight of the park for most visitors. Springdale is the gateway community for the park. Traffic congestion on the six-mile dead-end road in the main canyon and lack of parking lead to the consideration of transit options.

A free shuttle bus system has been the only means of transportation for summer visitors to Zion Canyon since 2000. Buses traverse the roadway from 6:30 a.m. to 9:30 p.m., providing access to hiking trails, scenic view points, and Zion Lodge. Overnight guests at Zion Lodge are the only visitors allowed to drive private vehicles on the roadway.

A second shuttle bus route serves the gateway community of Springdale. The Springdale loop includes stops at hotels and activity centers. The two routes connect at the Zion Canyon visitor center allowing passengers to transfer between the two loops. Additional parking spaces were constructed at the center as part of the shuttle bus system. Frequent service, averaging six minutes or less during peak times, is provided on both loops using propane-powered buses and trailers.

Ridership on the shuttles has increased since 2000. In 2001, some 2.13 million trips were made on the shuttles. In 2008, 3 million trips were taken on the shuttle buses.[4] It is estimated that visitors on the Canyon Loop average 3 to 4 trips a day on the shuttle. Informal feedback from visitors has been positive. The results from an on-board ridership survey, conducted in 2008, should be available soon.

Planning, funding, and implementing the shuttle system in the park and Springdale represent the coordinated efforts of Zion National Park, the National Park Service Denver Service Center, Springdale, the Utah Department of Transportation (UDOT), FHWA, Zion National History Association, local businesses, and other groups. Zion National Park purchased the shuttle buses with McDonald Transit Associates, Inc., to operate the service. Funding options for both vehicle replacement and ongoing operations continue to be explored.

Springdale obtained federal Transportation Enhancement program funds through UDOT for the bus shuttle stops and related streetscape improvements, which were matched by city and Zion National Historical Association funds. The shuttle stops were designed to compliment the communities' road and streetscape elements, which had been constructed by the Works Project Administration in the late 1930s.

Rocky Mountain National Park. Established in 1915, Rocky Mountain National Park is located in north central Colorado. The park encompasses 416 square miles of the Rocky Mountains. Hiking, camping, and wildlife viewing are major visitor activities in the park. Estes Park is the gateway community for the park.

A limited shuttle bus system was implemented in the park in 1978. An expanded free shuttle bus service was initiated in 2001 to help address the shortage of parking spaces at trailheads and to ease traffic congestion on the park roadways. The shuttle service operates from May to September. The Bear Lake Shuttle operates between Park and Ride and Bear Lake every 10–15 minutes from 7:00 a.m. to 7:00 p.m. The Moraine Park Shuttle provides service between Park and Ride and Fern Lake every 30 minutes from 7:00 a.m. to 7:00 p.m. The Estes Park Hiker Shuttle provides service between the Estes Park Visitor Center and Park and Ride each hour from 6:30 a.m. to 7:30 p.m. An Estes Park Shopper Shuttle also operates from July to September, linking major destinations in the town.

Response to the shuttle bus system has been very positive. Total 2008 ridership for the three routes operating in the park was approximately 337,300.[5] The system appears to be popular with hikers, and other visitors wishing to view the park without driving.

Planning, implementing, and operating the shuttle bus service represent the coordinated efforts of Rocky Mountain National Park, the Colorado Department of Transportation, the town of Estes Park, and the U.S. Department of Transportation. McDonald Transit Associates, Inc. operates the shuttle service under contract to the park. The partners have worked together to share resources. For example, the park provided three vehicles to the town to initiate the Shopper Shuttle. The town is leasing additional vehicles this year for the Shopper Shuttle. Additional service enhancements and routes are being explored.

Glacier National Park. Established as a National Park in 1910, Glacier includes 1 million acres of glaciated landscape, lakes, forests, and alpine meadows. Gateway communities include Kalispell, Whitefish, Columbia Falls, Browning, and St. Mary.

The Going-to-the-Sun-Road traversing the park opened in 1932, after 11 years of construction. Traveling the road by automobile or the restored historic red buses is a focal point for park visitors. Planning for needed rehabilitation of the historic alpine road began in the 1990s. The planning process involved representatives from Glacier National Park, the Montana Department of Transportation, and FHWA. A Citizens Advisory Committee was actively involved to ensure the perspective of local communities, businesses, Tribal governments, and other groups were considered. To help reduce traffic on the Sun Road during the 8-to-10 year rehabilitation period, the implementation of a shuttle bus system was recommended.

A unique aspect of implementing the shuttle system was the signing of a cooperative interagency agreement among Glacier National Park, the Montana Department of Transportation, and Flathead County. The agreement provided for the purchase and shared use of 22 12-passenger and eight 23-passenger buses. The buses are used on the Sun Road Shuttle service in the summer, and by Flathead County's Eagle Transit and other service providers in the state during the remainder of the year. A combination of Sun Road mitigation funds, FTA funds to the state, and Montana Department of Transportation funds were used to purchase the vehicles.

Approximately 132,100 passengers rode the shuttle buses in the first summer of operation in 2007. Ridership levels declined slightly to 105,640 during the summer of 2008. Reactions from riders and visitors to the park have been positive.[6] Planning activities for service enhancements and ongoing funding for the shuttle continue.

Common themes

A number of common themes emerge from the four case studies. First, all the projects focus on the characteristics, needs, and unique aspects of each park and local area. There is no one best approach to transit service design, funding, operation, and management.

Second, the case studies highlight the importance of partnerships. These partnerships involve the parks, federal, state, and local governments, and local foundations, organizations, businesses, and corporations. It takes time to establish trust and build strong working relationships among these diverse groups. This time is well spent, however, and is critical to the ongoing success of transit services in the parks.

Although not all parks have an L. L. Bean in their backyard, involving the business community is important to obtaining support, and possibly funding, for transit projects. Local park foundations and other groups also play key roles in providing funding, managing funds from other sources, and providing expertise.

Finally, the case studies highlight the importance of leveraging resources and expertise. Given budget constraints at all levels of government and the sluggish economy, innovative financing and maximizing funding from multiple sources is critical. Leveraging staff resources and expertise among agencies and groups is also important.

Additional research

The four case studies presented in this paper also highlight areas for further research. First, examining the experience with transit systems in other national parks and federal lands would be beneficial to further explore the common themes identified in these case studies, as well as identifying additional themes.

Second, additional research on visitor capacity is needed. The park transit systems accommodate more visitors in fewer vehicles, increasing the number of people at key park locations. The potential for visitor overcrowding due to lifting the previous capacity controls imposed by limited parking should be explored in more detail. Although easing traffic congestion, reducing noise and air pollution levels, and improving wildlife-viewing opportunities all enhance the experience of visitors at national parks and federal lands, overcrowding concerns need to be considered.

Additional research examining the effects of new park transit systems on the economy of gateway communities is also needed. Finally, initial assessments of bus services in Zion and other parks indicate positive environmental impacts, including reducing vehicle emissions and noise levels. Additional research is needed to better understand the full impact of transit system on reducing vehicle emissions, improving air quality, reducing noise levels, and enhancing animal habitats.

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The Regional Integration of Protected Areas: A Study of Canada's National Parks

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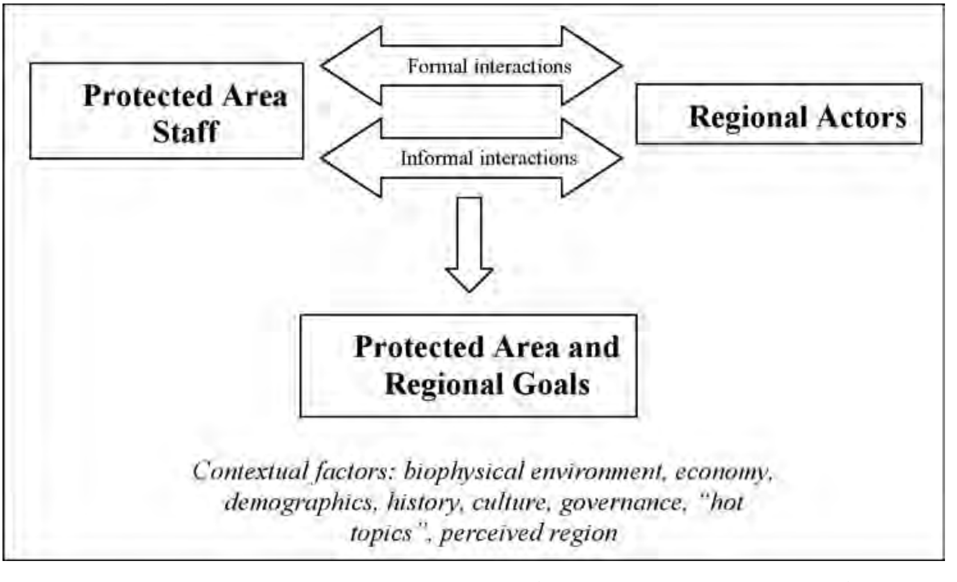
Protected areas are connected to their regions through relationships: ecological relationships, such as the movement of air, water, wildlife, and fire across boundaries; social relationships, such as human interactions between protected area agency staff and local people (Zube 1995); and economic relationships, such as the development of on-site and off-site goods and services for protected area visitors (Lockwood 2006). Because of these interactions, protected areas cannot be managed as "islands," in isolation of their surrounding regions.

The concept of regional integration emphasizes an approach to protected area management and planning that is regional in scope (Saunier and Meganck 1995) and acknowledges that building regional support for protected areas is crucial for their sustainability (McNeely, Lockwood, and Chapman 2006).The premise of regional integration is that protected area staff and regional actors engage in informal and formal interactions in order to fulfill short and long-term goals that are directly or indirectly related to the protected area (Figure 1). Formal mechanisms can include meetings, information sharing, open houses, or joint projects. Informal mechanisms can include phone calls, casual gatherings, or park staff getting involved in non-park related community activities. Regional integration is influenced by a number of contextual factors including the region's biophysical environment and economy, the history of park establishment, and "hot topics" in the region. Regional actors and park staff have varied goals for engaging in regional integration; for example, they may want to

Figure 1. Protected area interactions with regional actors.



address specific management problems, improve or restore ecological integrity, or move toward economic or ecological sustainability in the protected area region.

Research method

The goal of this research was to develop the theory and improve the practice of the regional integration of protected areas (for details, see McCleave 2008). This research aimed to answer the following four primary research questions:

- What are the critical interactions between national parks and their surrounding regions, and what management challenges do they raise?
- How have the interactions between national parks and their surrounding regions been addressed by protected area managers and other actors?
- How is the concept of regional integration currently defined and practiced within the context of national parks in Canada?
- How can the regional integration of Canada's national parks be improved?

Five national parks and their regions were used as case studies: Kejimkujik National Park and National Historic Site, Nova Scotia; Gros Morne National Park, Newfoundland; Waterton Lakes National Park, Alberta; Mount Revelstoke National Park, British Columbia; and Glacier National Park, British Columbia. Data to construct the case studies were collected through in-depth and semi-structured interviews, the collection of relevant documents, and field observations. A broad spectrum of people participated, including park staff, provincial government employees, First Nations, industry representatives, and local residents.

What is regional integration?

A revised definition of regional integration can be produced by incorporating the broad definition that was used to shape the study, participants' conceptualizations of regional integration (see McCleave 2008), and policies and documents that refer to regional integration at the national and park level. The following characteristics of the process of protected area regional integration have emerged:

- Regional integration is a process, not a goal. Regional integration is never fully reached per se, but a protected area may exhibit strong regional integration.
- Regional integration can be carried out both formally and informally.
- Regional integration is a complex process. There are multiple, constant interactions occurring between park staff and regional actors. Interactions can occur between park staff and one regional actor or between park staff and multiple regional actors.
- Regional integration is affected by contextual factors such as the economy, demographics, history, and culture.
- Regional integration occurs at the initiative of both park staff and regional actors.
- Regional integration focuses on human interactions and relationships, as opposed to biophysical interactions.

- Regional integration occurs at the regional scale but there is not a strictly defined physical boundary.
- Different regional actors have different goals for regional integration, although there are often some goals shared by all regional actors, such as sustainability.
- Regional actors can be individuals, organizations, businesses, or governments.

Based on the above characteristics, the following is offered as a slightly narrower definition of regional integration:

> Regional integration is a complex process by which protected area staff and regional actors engage in formal and informal social interactions in order to reach independent and shared goals related to the protected area. Regional integration is strongly influenced by contextual factors such as the region's economy, biophysical environment, governance, and history, as well as the culture of park staff and regional actors.

Characteristics of strong regional integration

Study participants recognized that regional integration for a particular park can range from weak to strong, and that the relative strength of regional integration can change over time. Table 1 lists some characteristics of strong regional integration. The characteristics of strong

Table 1. Characteristics of strong regional integration.

Awareness, understanding, and perceptions	• The goals, mandate, and interests of the park are understood and accepted by regional actors • Park staff are aware of the park's effects on the park region • Regional actors understand the tangible and intangible benefits that the park brings to the community • Regional actors perceive that they are adequately involved in park management and planning • Regional actors perceive that they can communicate effectively with park staff • Park staff perceive that they can communicate effectively with regional actors • Park staff are perceived as important contributors to the community
Direction and policy	• There are principles in place for park involvement in regional issues • Park staff have the flexibility to adjust national policies that may not be appropriate within the regional context • There are some common priorities and objectives established between the park and regional actors
Actions	• Park staff are represented on and play an active role in community boards and other regional processes • There are staff within the park dedicated to working on regional issues, but other park staff understand that regional issues are not solely the responsibility of these staff members • Personal relationships are developed between key park staff and regional actors • There are regular informal interactions occurring between park staff and regional actors • There are regular formal mechanisms in place for interactions between park staff and regional actors

regional integration are divided into three categories: (1) awareness, understanding, and perceptions, (2) direction and policy, and (3) actions.

Challenges to regional integration

Certain general challenges to effective regional integration emerged from the case studies. First, engaging in mechanisms for interacting with regional actors is time-consuming and laborious. Many park staff are very busy and, in most cases, engaging with regional actors is not a specific part of their job description. Furthermore, informal interactions with regional actors may be discouraged as "unproductive" depending on the culture of the park office.

Second, effective regional integration is not possible unless there is a willingness to engage on the part of both the park staff and regional actors. In some cases, a difficult historical context may lead to an unwillingness of some actors to engage with park staff for an extended period of time.

Third, some park staff may not feel comfortable with a high level of regional integration, even though the concept of regional integration can be connected to Parks Canada's mandate and future direction. Mechanisms that require local people to be intimately involved in the resource management of the park can be threatening to some park staff because they mean relinquishing some control in order to gain the trust and support of regional actors.

Finally, improving regional integration means accepting that regional actors often have goals and objectives that differ from those of park staff. This may be difficult for some park staff to accept and understand, as it is a different way of thinking than concepts, such as a "greater ecosystem approach," that often emphasizes a singular goal of protecting and enhancing the ecological integrity of the protected area.

Assessment of the case studies' regional integration

A general assessment of the strength of regional integration of the four case studies can be made based on the results of this study. It should be noted again that this study has not measured regional integration per se, and that the conclusions should not be interpreted without examining the regional context of the case studies (see McCleave 2008).

Gros Morne National Park seems to have the strongest regional integration of the case studies. This assessment is based on the overwhelmingly positive tone of the interviews for this case study, the articulation from staff of the importance of regional integration, and the number of informal and formal mechanisms in place for interaction with regional actors.

Both Waterton Lakes National Park and Kejimkujik National Park and National Historic Site have strong regional integration in certain areas. For example, Kejimkujik has very strong integration with academics as well as regional actors connected with several regional associations and networks. There is a medium level of integration with other government agencies and perceived weak links with local communities. Kejimkujik National Park and National Historic Site is the only case study with formal mechanisms in place for interaction with First Nations, and this is a hopeful sign that this relationship will strengthen over time.

The regional integration of Waterton Lakes National Park is highly influenced by its regional context. There is strong integration with some regional actors, particularly Glacier National Park, USA, and the Province of Alberta. Several regional networks, regular events, and formal mechanisms provide opportunities for interaction between park staff and regional actors. However, participants perceived weaker integration with First Nations, some Waterton townsite residents, and some ranchers.

Generally speaking, the regional integration of Mount Revelstoke and Glacier National Parks was perceived by some participants as strong and others as weak. The parks seem to be more disconnected from their region than the other case studies, particularly in terms of the overall visibility of the parks and park activities in the region. While some participants were very positive about the parks and the interaction between park staff and regional actors, other participants perceived the regional integration of the parks to be weak.

Improving regional integration

This section provides recommendations for how national parks in Canada could improve their regional integration. The following suggestions are not specific to any one case study and may be generalizable to other national parks with similar contextual factors and regional issues.

The implementation of park entrance fees in the mid 1990's was a "sticking point" for many regional actors in the four case studies, and had a significant effect on the parks' relationships with local communities. The implementation of entrance fees made some local people not feel welcome in "their parks." A tangible and effective way to move toward improving relationships with local residents would be to offer a reduced rate or no charge for local residents to use the parks. This would send a clear message to local people that they are indeed welcome in the parks, and would have an immediate impact on local peoples' perception of how the parks are integrated into their regions.

The next suggestion involves modifying the park culture and policies with regard to park staff interactions with regional actors by accommodating requests from regional actors as much as possible. The case study of Gros Morne National Park showed that this approach can go a long way toward building regional support and trust.

Another tangible way to improve regional integration would be to ensure that the turnover of park superintendents and other key staff is decreased. Staff continuity is important; some regional actors in this study noted that they did not attempt to interact with superintendents and other senior managers who were not perceived to be at the park "for the long haul."

A high number of participants articulated that they did not know what the mandate or policies of Parks Canada were. Therefore, to improve regional integration, park policies and the park mandate should be communicated more effectively so that regional actors can better understand Parks Canada's perspective.

Improving regional integration would mean improving the relationship between parks and First Nations. This is a complex and long-term endeavor that was found to be at the beginning stages, if at any stage at all, in the four case studies. Specific suggestions for starting this effort include: hiring more First Nations staff, officially recognizing and interpreting First Nations cultural heritage, formally incorporating the federal government's "duty to consult" First Nations, "being nimble" and ready to interact when First Nations are ready, and providing free entrance to national parks for First Nations people.

Political and managerial "buy in" of regional integration is important. This buy in can lead to increased funding for regional integration initiatives, the recognition that these initiatives are a vital component of work activities, and the promotion of the importance of improving regional integration to all park staff. Another important way to obtain buy in of regional integration would be to create specific strategies and policies for park staff's interaction with regional actors, such as Gros Morne National Park's "Engaging with Communities" strategy (Parks Canada).

National parks could improve their regional integration by increasing the frequency of informal and social interactions with regional actors. Informal interactions help to build trust, improve understanding of regional actors' goals and viewpoints, and create the personal relationships that are fundamental to continuity and organizational communication. In this study, the one park that made a point of engaging in social mechanisms with regional actors, Gros Morne National Park, also enjoyed the highest degree of support.

Finally, more information sharing among parks about regional integration is needed. There appears to be little communication among parks about regional integration, particularly between the eastern and western national parks. It would be very beneficial for national parks to share approaches to regional integration, details about mechanisms for regional integration, and experiences of regional integration.

Conclusion

The relationship between protected areas and their regions is complex, dynamic, and based on social interactions. This study has emphasized the inextricable link between people and protected areas. The ultimate goal of this research was to improve the understanding of the way that protected areas staff interact with regional actors, so that the goals of regional actors and protected area staff, whether they are building trust and awareness or protecting ecological integrity, can be realized.

The conceptual framework for regional integration offered here provides a broader perspective for examining the relationship between parks and people, and can hopefully be used as a model to gain insight from real parks and people in order to develop ways to improve interactions. It is grounded in multiple bodies of knowledge, and the move toward a new paradigm of protected areas management and planning. The true value of this study will only be realized if it informs future research and if lessons are applied in order to improve the regional integration of protected areas, and ultimately the sustainability of protected areas themselves.

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The National Historic Trail System

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This paper presents a discussion of U.S. national historic trails—and that means we'll be talking about trail ruts, historic sites along the trail, and interpretive sites that get the word out regarding the trails' importance.

By now, you may be wondering, "Why the concern with trails?" It's because Congress asked us to. In October 1968, Congress passed the National Trails System Act, which stated that "trails should be established" both in urban areas and "within established scenic areas more remotely located." The act that Congress passed in October 1968 established just two long-distance trails: the Appalachian Trail and the Pacific Crest Trail, both of which were designated as scenic trails. But the legislation also called for the studies of 14 additional routes as potential scenic trails, most of which have since been added to the system. The Bureau of Outdoor Recreation, in the Department of the Interior, was asked to complete the required studies. But the agency, as it pursued those studies, soon ran into difficulties because it was asked to evaluate several *historic* trails according to *scenic* trail criteria. As a result, the studies that were written in the wake of the act's passage recommended against designating any historic trails, and in fact between 1968 and 1978 Congress established no new trails of any kind. To get around the bureaucratic loophole pointed out in the Bureau of Outdoor Recreation studies, Congress in November 1978 passed a key provision in an omnibus park bill creating a third trails category: national historic trails. Given that new provision, Congress approved four new trails that had previously been bottled up in the bureaucracy. And in the years since that time, Congress—regardless of the party in power—has continued to approve new national historic trails: four during the 1980s, four more in the 1990s, and six since the year 2000, which has resulted in the system that we Americans enjoy today. Congress has now designated more than 30,000 miles of national historic trails. And this trend toward new trails seems likely to continue, because currently in the 111th Congress, a bill has already passed the Senate (S. 22) that would create one new national historic trail, expand another, provide for a special resource study for yet another, and mandate studies for additional routes for 6 existing trails.

So, given all this trail mileage that Congress has entrusted to the various federal agencies, how should they be managed? Once again, the 1978 amendment to the National Trails System Act provides us a clear guide, and more specifically, Congress has asked us to take on the identification and protection of trail resources in three distinct ways – by protecting trail segments, by preserving trailside historical sites, and by providing for trail interpretation.

As many of you may have gathered by now, the National Park Service and other agencies have been asked to take on a far different role than many of you in the various parks and monuments may be familiar with. For one thing, the various national trails are not national park units; instead, they collectively constitute a program that both benefits from and is hindered by their lack of status as park units. But unlike the various national scenic trails, which attract thousands of long-distance hikers each year, the idea behind the national historic trails was to preserve and interpret as much as possible of their existing rights-of-way and the adjacent historical resources. And because they are trails, not parks, the best way to look at these trails is to conceive of them as linear landscapes. And underscoring the fragility of our management scope is the fact that very little of the land in the various trail rights-of-way belongs to the Park Service or any other federal agency. And because so much of the historic trails are on private land, it's not at all surprising that slightly less than ten percent of their mileage is now open to the public.

Because only a small percentage of the historic trails' rights-of-way are on federal lands, one might wonder how Federal agencies are able to manage these trails at all. Well, the answer to that question is through partnerships. Fortunately, there are tens of thousands of Americans who are interested in these trails (we call them "rut nuts"), and many of these volunteers are members of groups that serve as our primary trail partners. To give you a few examples, the Santa Fe Trail Association, formed in 1987, has hundreds of members and 12 chapters that are spread across the five states where the trail is located. There is also a Trail of Tears Association, formed in 1993, which has an international membership and nine chapters, one for each state with a Trail of Tears route. There's the Oregon-California Trails Association (Figure 1), a National Pony Express Association, and a number of similar groups, one for each of the national trails. All of these groups have a board of directors, a newsletter, an annual convention, and other activities that provide chances for people to explore the trails, share new research findings, and swap stories about the history and adventure of these trails.

One may also wonder where the Park Service fits into the management picture. First and foremost, the NPS doesn't run much of anything on our own, but we do play an important part in assisting our various trail partners. To some extent, the NPS helped fund the start-up and operating costs for our cooperating associations. And, in many other ways, we do what we can to identify and protect trail segments and historic sites, and we also help interpret the trail by funding the creation and installation of museum displays and interpretive waysides. In the process, we work with local partners to ensure that the museum displays and waysides have accurate information, that they're pleasant to look at, and that they'll last a long time.

A key way in which we work with our partners is through the Challenge Cost Share Program. This program gives the Park Service the chance to financially help partners with their trail-related projects, particularly if the projects have been well planned and will help tell the story of

Figure 1. Guernsey State Park, in southeastern Wyoming, offers some of the most well-defined ruts along the Oregon National Historic Trail. Photo courtesy of the National Park Service.

the trail more effectively. In the past, for example, we have assisted researchers who wanted to dig out historical materials from the National Archives, we have helped scan research collections to make them available to others, we have funded some bricks-and-mortar rehabilitation projects, and we have assisted with archeological digs at old taverns and cemeteries that were located along these trails.

Another way that we work with our partners is through the Certified Sites Program. A clause in the National Trails System Act encourages non-Federal partners to take an active role in trail and site preservation and interpretation, and the Certified Sites Program provides an official mechanism for that participation. To join the program, owners of qualified sites along the trails simply fill out a short partnership form—which is revocable at any time. Being part of this program provides another way in which partners can obtain signs, interpretive waysides, and various other forms of technical assistance from the Park Service. Currently there are more than 70 certified partners along the Santa Fe Trail (Figure 2, 3), about 40 along the Trail of Tears, and a number of others from the seven remaining historic trails administered through the NPS National Trails System Office, Intermountain Region.

To finish up this discussion, I'd like to present a couple of examples in which the Park Service worked with our partners on projects that served our mutual interests.

For one project, a Trail of Tears Association member from Missouri let us know that she was concerned about where two of the lesser-known Cherokee detachments went as they traveled west through her state. To give you a bit of a background, there were 17 different detachments of Cherokee Indians that made the difficult trek west from the southern

Figure 2. The former Havana Stage Station, located in east-central Kansas, is a Santa Fe National Historic Trail historic site. Photo courtesy of the National Park Service.

Figure 3. Ross Marshall, an active member of the Santa Fe Trail Association (which cooperates with the NPS on trail management) is shown uncovering a century-old Daughters of the American Revolution historical marker. Photo courtesy of the National Park Service.

Appalachians to Indian Territory (present-day Oklahoma) during 1838 and 1839. Eleven of those detachments followed the main route, or northern route, that began in the vicinity of Chattanooga, Tennessee, headed northwest through Kentucky to the southern tip of Illinois, went west into central Missouri, then southwest through northwestern Arkansas to the Cherokee country near present-day Tahlequah, Oklahoma. Historians have a fairly good idea of the route that these 11 detachments took. But two other land detachments, led by John Benge and Peter Hildebrand, broke away from the main group. Neither Benge nor Hildebrand had any scribes, diary writers, or military personnel with them, and very few newspaper notices about their travels have come to light.

So to help fill the information gap, Park Service personnel contacted a number of trail to learn what they knew about those routes. All of these people had some strong hunches about where these detachments must have gone, so in September of last year several of those experts—a Missouri Department of Transportation historian, a state park interpreter, a forest service archeologist, pioneer family members, and several local historical society enthusiasts—gathered together. We spent the day together, talked about the trail's history, and drove over the most likely routes that these two detachments would have taken. With the Benge Route, one of the group members was able to obtain a series of maps and surveys for roads that had been built during Missouri's late territorial period and early statehood period. And after our day together, we had collectively concluded that this detachment went in a far different direction than we had previously thought, primarily because the 1812 New

Madrid earthquake had turned much of extreme southeastern Missouri into a roadless swamp. Additional portions of the old route, in the Greenville area, are now under a reservoir, but they had once been part of a military road built from Cape Girardeau, Missouri, to Natchitoches, Louisiana.

As a result of our combined efforts, none of us, of course, can be absolutely certain of the route they followed, because the data just aren't there. However, there *is* a relatively broad consensus that the route we picked is the most plausible route that John Benge and his detachment must have taken, and we have prepared a report that patiently explains why we selected the route that we did. Similarly, the route that the Peter Hildebrand detachment took was largely unknown between Jackson and Springfield, Missouri. However, the group did know that the detachment camped near Pilot Knob, in the Arcadia Valley; we also knew where they crossed the Gasconade River (about 60 miles west of Pilot Knob), and—based on the recollections of pioneer family members—we're fairly certain that the detachment would have taken a known ridge route rather than one that went up and down between ridge tops and river crossings. Of course, we'll eagerly await the day in which some future researcher can gather new and more certain information that was not available to the group that we had assembled. Until that day, however, we feel that our group made real progress in ascertaining a new, previously unknown route where the Hildebrand detachment went.

Another major project had to do with the Santa Fe Trail. Because this trail, from central Missouri to Santa Fe, covers a lot of dry, untilled land, and because people traveled over the Santa Fe Trail for almost 60 years—as opposed to just a few months for the Trail of Tears—the right-of-way of the Santa Fe Trail is fairly well known. But the key personnel in the Santa Fe Trail Association knew the trail in a substantially different way than Park Service personnel did. So to "share in the experience," so to speak, a five-person team from both the Santa Fe Trail Association and the National Park Service undertook the "Santa Fe Trail Rediscovery" during the summer of 2006. Over the course of several weeks, the group stopped at scores of sites and had the chance to compile a major electronic database about the trail. The outcome of all of this work has helped point out which sites and segments offer the best interpretive possibilities, which sites are potential candidates for nomination to the National Register of Historic Places, and which sites are most in danger of losing their historical significance through deterioration or development. By all accounts, the rediscovery trip seems to have succeeded in its mission, and the database promises to guide trail planning efforts for years to come.

Public Use, Private Meaning: A Case Study of Two New England Summer Communities

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The mission of the National Park Service (NPS) is to preserve "unimpaired the natural and cultural resources and values of the national park system for the enjoyment, education, and inspiration of this and future generations" (NPS 2009). Thus, it is an organization dedicated to preserving and using, two values which constantly require balancing in the operation and development of our national parks.

Inherent in this proclaimed philosophy is the idea that the preservation of a cultural landscape will provide generations of public users with the opportunity to gain knowledge and inspiration from it, while the responsible stewardship of particular physical resources will continue to cultivate certain intangibles, like appreciation and enlightenment. However, the acquisition of meaning and understanding is a strictly individual process. The question therefore arises: How can the management of a public landscape impact its personal meaning? What dangers or opportunities does this process hold for a publically-oriented organization like the NPS?

The following two New England case studies provide useful insight into these questions. More specifically, these sites bring out important lessons about the private meaning of landscapes throughout America, and how they might be most effectively managed for public use, enjoyment, and education.

The dune shacks of the Peaked Hill Bars

The dunes of Provincetown are a stark, isolated expanse of sand stretching up the outer shore of the tip of Cape Cod, in Massachusetts. Stepping into this landscape is like entering another world—a world of sand, sun, sky and sea. Here and there grow patches of beach plum and bayberry, on hillsides cloaked in pale green beach grasses that blow in the salty wind. In a setting almost entirely devoid of trees, only a few scrawny pitch pines cling to the occasional sheltered hollow. Over the crest of the last dune, the Atlantic Ocean lies flat in a bold, blue contrast to the rolling mounds of sand. Close by, the nesting sites of terns and the endangered piping plover can be found.

The wild, wind-swept coastal beauty of this area is the heart of a national treasure whose preservation is the primary goal of the Cape Cod National Seashore (CCNS). Roughly 1,500 acres of dune landscape located east of Provincetown are today known as the Peaked Hill Bars Historic District. Owned, managed, and maintained by the NPS since the creation of CCNS in 1960, the district also includes a total of nineteen rugged, wind-worn structures, or dune shacks.

Trudging heavily through the sloping dunes from Provincetown, it can be a surprise to come upon a wind-battered shack. The actual distance between these outposts and the bustle of Provincetown is only a matter of one or two miles; yet the looming size and emptiness of the dunes makes the shacks seem like tiny gems hidden in a remote desert. In truth, however, most of these buildings have been here for quite some time.

The original dune dwellers lived in shacks associated with one of the earliest coast guard facilities in the country. Built in 1872, the Life Saving Station of the Peaked Hill Bars was named after a treacherous line of sandbars that faced a stretch of coastline marked by a giant barrier sand dune, or the Peaked Hill. In the decades that followed, the station became a destination for family members and friends of the early life savers. When, in 1918, the Cape Cod Life Savers were replaced by the United States Coast Guard, their stations went out of service and the old structures were either abandoned or sold (Donaldson, Hilyard, and Brown, forthcoming).

From then on, the dune shacks became a regular retreat for a select few. With the social and artistic awakening of Provincetown during World War I and afterwards, many visitors were painters, actors, and writers driven by the spirit of creativity. When the old Life Saving Station and most of its associated buildings were swept into the sea by a severe storm in 1931, a new generation of shacks sprang up to replace them. Most of today's shacks belong to this group, and were built in the 1930s and 1940s.

Dune dwellers came to an agreement with the local land owners and built the shacks themselves, in some cases using salvaged materials from the ruins of other shacks, or wood washed up on the beach. Carefully crafted to sustain the harsh yet fragile dune environment, each simple shack was unique. Over decades of ongoing maintenance and seasonal use, the links forged between the families and the structures they created grew in strength and meaning, and an enduring shack user community was born.

The NPS acquired the Peaked Hill Bars area in 1966. At the time, the dunes were suffering from a high level of both human use and abuse, and becoming dangerously destabilized by swarms of beach buggies that ripped up the fragile beach grass and other sparse vegetation. Following the philosophy of the 1964 American Wilderness Act, the new park launched its pursuit of an untamed, nature-oriented dune environment devoid of any evidence of humanity (16 USC 1131–1136). Public use of the Peaked Hill Bars area was severely curtailed, and a policy of restricted vehicle access and dune preservation was established (Donaldson, Hilyard, and Brown, forthcoming).

As for the shacks, when most of the dune dwellers were unable to prove their legal right to the land in court, the NPS offered term lease and use agreement alternatives to allow families' use of the buildings to continue. Most of the shack users ultimately signed an agreement of this kind, and as a result were able to maintain their seasonal visits or permanent residency in the dunes without interruption.

Still, the meaning of the shacks themselves, and their place in the landscape, became more tenuous under NPS ownership. Over several winters, some of the buildings were vandalized or even burnt down, prompting many dune dwellers to post signs (e.g., "Keep Out") or repeatedly undertake repairs. In 1984, one of the shacks was destroyed as part of the park's effort to return the dunes to a more ideal wilderness landscape.

In an almost immediate response, local support for preservation of the shacks sprang to life. Several local non-profit organizations were soon formed, and together began working toward preserving the dunes' special meaning for shack users. The first was the Peaked Hill

Trust, which was founded in 1986 to protect the remaining dune structures. Most dune dwellers have traditionally been members of this group, whose periodic meetings have helped perpetuate an understanding of the values and concerns shared by regular shack users. Two similar organizations, the Provincetown Community Compact (PCC) and the Outer Cape Artist and Residence Consortium (OCARC), were formed in 1993 and 1995. Today, each of these bodies maintains and manages the use of one or more shacks through lottery, general application, or artist-in-residence programs. Many lottery winner and artist visitors, as well as the more regular dune dwellers and their friends, often paint and compose while staying in the shacks (Figure 1). Others just eat, sleep and enjoy the pure simplicity and peaceful quality of life in the dunes. Thus, the combination of artistic and long-term family use of the shacks today has come to echo their historic use.

In part through the efforts of the Peaked Hill Trust, the Dune Shacks of the Peaked Hill Bars are today recognized as a Historic District, and were determined eligible for listing on the National Register of Historic Places in 1989. This determination helps to protect the shacks that were threatened less than thirty years ago. Although the dune dwellers now lease the structures from the NPS, their ability to voice concerns about the shacks has been further reinforced by the Trust, PCC, and OCARC. Since the early 1990s, shack users have also been able to contribute to district management through the Dune Shack Subcommittee of the Cape Cod National Seashore Advisory Commission. Two individuals are elected to this subcommittee, which then represents dune dweller interests to the park in periodic meetings. In recent years, this subcommittee has not met consistently or regularly. However, its recognition of dune dweller interests and concerns is an important step toward cultivating a stronger partnership with the park.

Figure 1. View of one of the dune shacks, taken by the author in 2007.

Despite the ongoing anxiety on both sides about the management, use, and significance of the dune shacks over the years, the relationships that have emerged out of this process teach some crucial lessons about how to preserve not only the physical elements of cultural landscapes, but their more personal meaning.

Point Lookout

Studying the cultural landscape of the Dune Shacks of the Peaked Hill Bars is particularly powerful for me because I, too, am a summer escapee. For three generations, my extended family has paid seasonal visits to a house bought by my grandfather on Isle au Haut, in the Gulf of Maine, in 1952 (Figure 2). Our house stands on land owned by the Point Lookout Association (PLA), a group established by a collection of Boston families in the early nineteenth century. Today the PLA continues to manage the small, isolated Point Lookout community on the northeastern side of the island, just outside of Acadia National Park.

Relative to the rest of the roughly 7,680-acre island, the landscape of Point Lookout is not particularly distinctive. Roughly ten acres of old coniferous forest blanket a series of rolling hills as they tumble down to the waters' edge, where the cold, salty fingers of the Atlantic Ocean swirl around multicolored boulders. Deer flourish in these woods along with fox, rabbit, and turkey. Down among the clumps of seaweed at low tide, countless sea creatures scurry and hide from the sea gulls circling overhead.

Like the sandy hike out to the dune shacks, the process of reaching Isle au Haut is itself an isolating experience. A thick fog frequently hangs over the half-hour ferry ride on the island mail boat, which threads the needle through lobster buoys and a spread of tiny islands.

Figure 2. View of Point Lookout on Isle au Haut, in the Penobscot Bay, Maine, taken by the author in 2007. More than half of the island forms a part of Acadia National Park.

Visible on the approach are a few of the Point Lookout buildings, which were constructed as summer homes during the 1880s and 1890s. Linked by a network of creaky wooden boardwalks, the thirteen Victorian roofs nestle here and there in the thick Maine evergreens. These homes' impressive size contrasts boldly with the tiny dune shacks, yet their function throughout the decades has in many ways been the same. They are a familiar, seasonal withdrawal from the world; a simple yet comfortable place without phones, television, or computers, and only a few cars.

Most Point families rent out these homes for the summer weeks when they are not able to use them. Like the application program for the dune shacks, this is a way to share this special place with friends and other interested parties. Over the years, island activities have come to form the bedrock of my identity: ocean and lake swimming, hiking, games, clam digging, sailing and adventuring. Still more poignantly, the values fostered by this place have become essential to how I define myself and my goals. These include patience, courage, respect for nature, and education through reading and first-hand experience. Thus, although myriad events, relationships and memories exert a deep influence on the meaning of the places we inhabit, the opportunities offered us by specific physical locations can serve as a strong driver for how we behave and develop (Figure 3).

The possibilities of partnership

The strength of these ties to place are shared by many families throughout America, who similarly retreat to a familiar place each summer season. These escapes are important not only for their contribution to the nation's general quality of life, but for their frequent role in connecting Americans to place and, in many cases, nature. Understanding that connection is crucial for the future of the NPS, as concerns about interest in our national parks continue to escalate.

The recent inactivity of the Dune Shacks Subcommittee demonstrates that the Peaked Hill Bars model is not perfect; it nonetheless offers some useful ways for parks to address private meaning. Through the creation of organizations like the Peaked Hill Trust, communities strongly vested in landscapes can share in their care, and work toward a stronger partnership with governing bodies like the NPS (Figure 4). In turn, this relationship relieves parks from the often laborious task of maintaining and managing aged or deteriorating structures.

Partnerships of this kind acknowledge both the "tangible and intangible" aspects of a landscape in helping to preserve cultural heritage; an important tool according to the International Council on Monuments and Sites (ICOMOS

Figure 3. A simplified chart helps to illustrate how familiar landscapes can shape who we are.

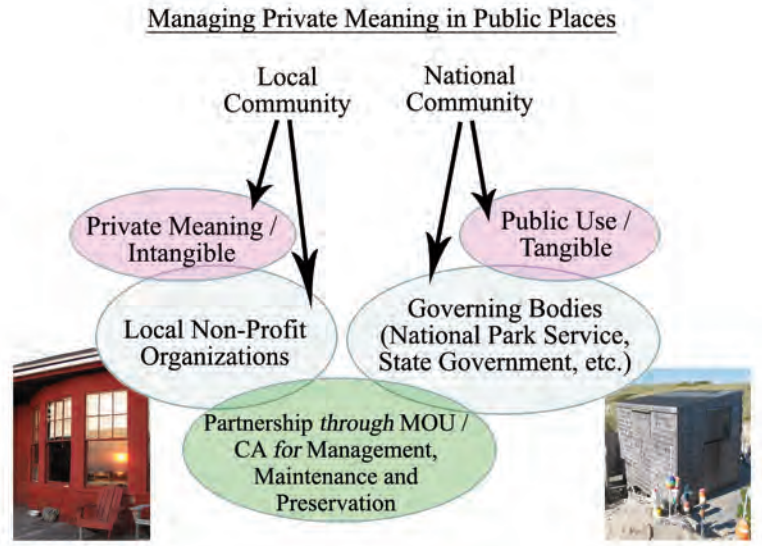

Figure 4. Chart illustrating the potential of partnership in the management of meaning in cultural landscapes.

2005). Similarly, in a recent article, Australian National University humanities professor Ken Taylor points out that "it is the places, traditions, and activities of ordinary people that create a rich cultural tapestry of life, particularly through recognition of the values people attach to their everyday places and concomitant sense of place and identity" (Taylor 2009, 12).

By recognizing and integrating the values of the ordinary public into the management of its cultural landscapes, the NPS could reinforce and grow from that personal connection to place. An excellent example is being set by Olympic National Park, whose Memorandum of Understanding (MOU) with the eight treaty Indian tribes of the Olympic Peninsula has substantially increased the level of mutual trust and understanding. Through this partnership, both parties have gained valuable insight into the management, use, and interpretation of their common landscape. Furthermore, the stability offered by an MOU that requires regular, superintendant-attended meetings, is instrumental for maintaining strong, healthy ties to indigenous communities (Wray 2009).

The management of cultural landscapes can be greatly enhanced through this type of collaboration between parks and local communities. The survival and continuing use of the dune shacks, for example, would not have been possible without partnership. Periodic meetings between local non-profit partners and the park can also bring new perspectives to the interpretation of park sites, guide the maintenance of trails, viewsheds, and other features, and improve treatment recommendations through the use of local knowledge. Perhaps most importantly, the parks' embrace of private meaning in the public places it manages promises to increase both interest and use among local communities.

In pursuit of this goal, it is important for parks to reach out and inform the general public of how to become involved in the management of their local public lands. Formalizing this relationship through mechanisms like MOUs, cooperative agreements, and regular meetings and communication, is crucial, as it gives parks the opportunity to address concerns about the meaning of cultural landscapes in local communities. Most importantly, a standardized partnership would provide a more sustainable level of involvement for local community members with long-standing connections to landscapes, and thus transcend turnover in both park and non-profit organization staff and leadership. Like a friendship, this relationship must be cultivated carefully over time to help ensure the survival of these landscapes for future generations.

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The Montana-Yellowstone Archeological Field School Project: Results of 2007–2008 Archeological Survey and Testing in the Boundary Lands, Gardiner, Montana

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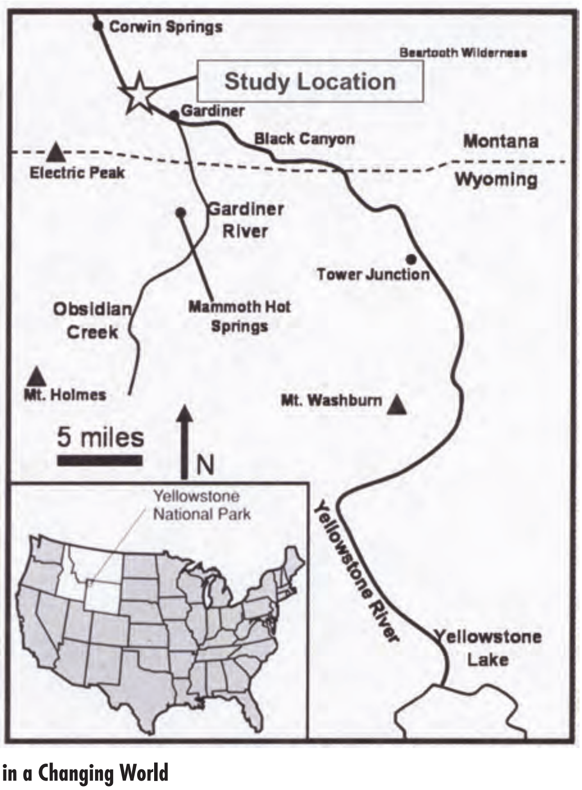
Introduction

The Montana-Yellowstone Archeological Project (MYAP) is a cooperative archeological field school developed by Yellowstone National Park (YNP) and the University of Montana (UM) Department of Anthropology. The 2007–2008 MYAP entailed a comprehensive survey and evaluation of archeological resources in the boundary lands of Yellowstone National Park. Sponsored by the Rocky Mountain Cooperative Ecosystem Study Unit (RM-CESU), the project also serves as a field school in archeological field methods from a cultural resource management perspective. Overall, the field school has trained twenty-three undergraduate and graduate students in its two years in existence.

The initial two years of the project entailed the survey and testing of archeological sites in the Boundary Lands, a roughly 3,000-acre tract along the upper Yellowstone River, bounded by Yellowstone's north entrance station on the south, and on the north by the YNP

Figure 1. Location of the Montana-Yellowstone Archeological Field School Project.



boundary at Reese Creek, north of Gardiner, Montana (Figure 1). The 2007 project area was approximately 700 acres, measuring approximately 3.61 miles northwest-southeast along the river, and between 1,000 and 2,000 feet southwest-northeast between the river and adjacent mountain slopes. MYAP surveyed 2,057 acres in 2008, largely west of the Old Yellowstone Road which marked the limits of the 2007 study area.

In two years, the MYAP surveyed 2,757 acres within Boundary Lands, resulting in the study of 47 archeological sites. Full results of archeological work are available in technical reports submitted to Yellowstone National Park (MacDonald 2007; Maas and MacDonald 2008). The remainder of this paper provides a summary of the key findings of the MYAP in the 2007 and 2008 field seasons, including an overview of results of excavations at 24YE355—Cinnabar and the Yellowstone Bank Cache site—and 24YE357—the Airport Rings site.

Summary of 2007 archeological results

During the 2007 field season, the University of Montana archeological team surveyed 700 acres of the boundary lands east of the Old Yellowstone Road, and west of the Yellowstone River, approximately between the new Heritage and Research Center in Gardiner, and Reese Creek. The MYAP team identified 14 archeological sites, including 8 with historic site components and 11 with prehistoric site components. Five of the sites contained evidence of both historic and prehistoric occupations.

After survey, excavations were conducted at Site 24YE355 to evaluate its eligibility for listing on the National Register of Historic Places. Excavations in the prehistoric portion of the site—Area A, or the Yellowstone Bank Cache Site—yielded evidence of five prehistoric fire pits, including two radiocarbon dated to 1600 and 1670 B.P. (years before present, "present" defined as 1950), respectively. The test excavations recovered abundant faunal remains and lithic artifacts, including Late Archaic Pelican Lake projectile points (MacDonald, Maas, and Hardes, forthcoming). In the historic portion of the site—Area B, or Cinnabar (Figure 2)—excavations identified nine depressions associated with the former location of the original Northern Pacific railroad depot, occupied between 1883–1903. Abundant artifacts were recovered that substantiate this period of site use, while the MYAP team also excavated a 5-ft.-deep river cobble and mortar foundation to a large building, perhaps the Cinnabar hotel.

Summary of 2008 results

The 2008 field season included a full inventory of prehistoric and historic archeological resources within the remaining 2,057 acres of the boundary lands not studied in 2007. The focus of the 2008 field school was on the portion of the boundary lands that lies west of the Old Yellowstone Trail road, up to the base of the foothills, with the North Entrance Ranger Station being the southern boundary and Reese Creek the northern. The MYAP crew investigated a total of 37 sites, including 24 with prehistoric components and 23 with historic components. Of the 37 investigated sites, the MYAP team identified 29 previously-unknown sites, while eight were previously recorded by YNP.

After survey, test excavations were conducted at four sites: 24YE0355 (Cinnabar, Area B), 24YE0357 (Airport Rings), 24YE0185 (99YP66) and 24YE0190 (RJP1). Additional

Figure 2. Northern Pacific train leaving Cinnabar Station in the late 19th century. Cinnabar is in the right rear. View is to southeast. Courtesy of the University of Montana Archives and Special Collections.

information obtained from 24YE0190 and 24YE0357 helped expand our knowledge and understanding of the use of upland camping and hunting sites by prehistoric peoples, while additional understanding of the complexities and placement of historic towns in the upper Yellowstone Valley were investigated at 24YE0355 and 24YE0185. Site 24YE0190 yielded 199 sub-surface artifacts predominately of obsidian that helped understand tool production and use on the landscape. Site 24YE0357 yielded a total of 687 lithic artifacts and three excavated hearths dating between the Middle Archaic and the Late Prehistoric. In total, the 2008 MYAP crew recovered 1,017 lithics and 795 historic artifacts from the 37 sites.

Research results

Based on results of archeological work conducted by MYAP in 2007 and 2008, it is clear that Native Americans have utilized this region since the Paleoindian Period, or approximately 11,000 years ago. Overall, the Late Plains Archaic (ca. 3,000–1,500 years ago) accounts for more than 50% (n = 48) of the projectile points recovered from both excavated and surface contexts (Figure 3). Of the 93 total projectile points collected in 2007-2008, Late Prehistoric points (ca. 1,500-300 years ago) account for 25% (n = 24), compared to 12% (n = 12) for the Middle Plains Archaic (ca. 5,000-3,000 years ago), and two for the Paleoindian period (>8,000 years ago). One of the Paleoindian projectile points is a red porcellanite Clovis point fragment that was likely recycled as a cutting tool during subsequent occupations. No Early Plains Archaic projectile points were recovered in either 2007 or 2008. Overall, these point data show a substantial and strong occupation of the Upper Yellowstone River during the Late Plains Archaic period, as well as during the preceding Middle Plains Archaic period, and subsequent Late Prehistoric periods.

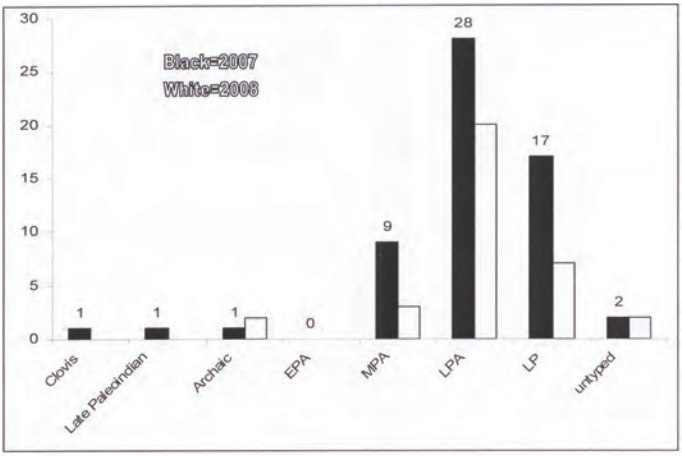


Figure 3. 2007–2008 Projectile points by period (n=93 total).

Excavations also focused on deciphering how lithic raw materials were utilized by prehistoric Native Americans in the Yellowstone Valley. In so doing, the team was able to better understand settlement patterns and tool-use practices. In particular, research focused on the comparative use of locally-available cherts (e.g., chert from the Crescent Hill chert source east of Mammoth, Wyoming) with use of locally-available obsidian from Obsidian Cliff and other nearby sources. Other lithic raw materials were recovered include dacite, orthoquartzite, porcellanite, and quartz, each of which was used differentially by prehistoric Native Americans. MYAP studied the procurement, use, and discard patterns of tools produced from all of these various lithic raw materials to better understand trade, settlement patterns, and tool production and use by Native Americans in the Yellowstone Valley.

Obsidian accounts for 67% of the 93 projectile points recovered at sites between 2007–2008 (Figure 4). In the 2007 sample, obsidian accounts for 66.1% of the points, while it accounts for 67.6% in 2008. Crescent Hill chert is the second most common material at the sites, accounting for 20% of the total collected projectile points. In 2007, Crescent Hill chert accounts for 22%, compared to 17.6% in 2008. Other lithic raw materials are poorly represented in the site assemblages, with dacite (n = 2), orthoquartzite (n = 3), porcellanite (n = 1), quartz (n = 2), and other untyped cherts (n = 4) accounting for the remainder of the site assemblages.

As reflected in Figure 3, the projectile point data from 2007 and 2008 support a gradual increase over time in the percentage of obsidian use compared to other material types. While only two Paleoindian points were recovered (both in 2007), both were produced from non-obsidian materials (chert and porcellanite). During all sub-periods of the Archaic, there is a relatively consistent use of obsidian (about 55–60%) compared to other materials (35–40%). However, these percentages increase substantially during the Late Prehistoric period, with obsidian accounting for nearly 80% of the point assemblages, compared to only around 20% for other materials. As reflected in Figure 4, these trends over time display a strong and significant correlation ($r^2 = 0.74$; $p < .05$). Clearly, obsidian use increased during

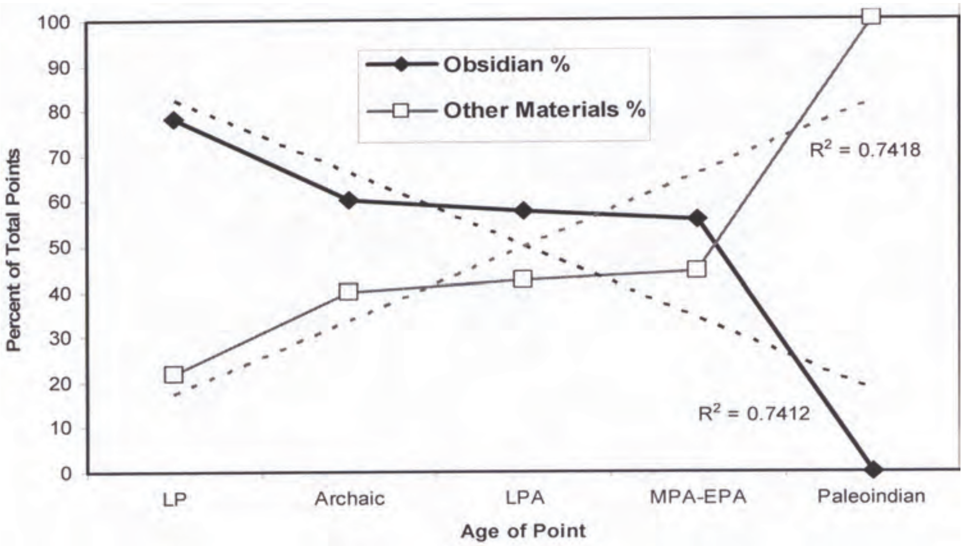


Figure 4. Summary of 2007–2008 MYAP projectile points by material and age.

the Late Prehistoric compared to the preceding periods.

Generally, Obsidian Cliff was the main source for lithic material during all time periods (Hughes 2008), followed by Crescent Hill chert. The 2007–2008 data indicate increasing use over time for obsidian, especially that procured from Obsidian Cliff in Yellowstone National Park. Lithic sourcing indicates that obsidian debitage (debris from stone tool manufacture) from dated Late Prehistoric features (from Airport Rings, 24YE357) is 100 percent from Obsidian Cliff, as is the obsidian debitage from dated Late Archaic Pelican Lake features (from Yellowstone Bank Cache, 24YE355). In other words, while other types of volcanic rocks from Bear Gulch in Montana and Big Southern Butte in Idaho were utilized and traded as projectile points, stone tool manufacture in the Upper Yellowstone Valley appears to have been primarily restricted to obsidian from Obsidian Cliff and chert from the Crescent Hill source (ca. 20 miles east of Mammoth Hot Springs, Wyo.).

Future research by the Principal Investigator and graduate students will compare these data with those from other investigated sites to better understand the organization of lithic technology of Native Americans living in the Upper Yellowstone River Valley during prehistory.

The 2007–2008 survey also identified a total of 32 stone circles at five sites in the Boundary Lands. The setting of the five sites varies from upper terraces overlooking the Yellowstone River (Stephens Creek [24YE356] and Airport Rings [24YE357]) to upland flats and high benches adjacent to springs and low-order feeder streams (all three sites in 2008). All of the sites are in well-protected settings, generally with water and a good view on one side, and a hill or enclosed valley on the other.

Overall, the chronological trend supports long-term use of stone circles in the Boundary Lands, with sites dating to the Late Archaic—GMS-1 (24YE182)—and Late Prehistoric—Airport Rings (24YE357). The latter site also yielded a Middle Archaic hearth within one of the stone circles, leaving open the possibility that it may be the earliest dated stone circle in the Northern Plains. However, it is possible that the Late Prehistoric stone circles simply overlay an early Middle Archaic occupation of the site. Livers and MacDonald (2009) provide a full technical report of excavations at Airport Rings.

Historic use of this area was frequent during the last 150 years. In addition to excavations at Cinnabar, the MYAP team identified several homestead remains, irrigation canals, and trash dumps associated with the historic use of the area. At Cinnabar, excavations identified nine depressions associated with the former location of the original Northern Pacific railroad depot, occupied between 1883-1903 (Figure 3). Abundant artifacts were recovered that substantiate this period of site use. In 2007, the MYAP team also excavated a 5-ft.-deep river cobble and mortar foundation to a large building, likely the Cinnabar Hotel. In 2008, excavations revealed the wooden floor of a blacksmith shop, as well as a privy, several outbuildings and a store. In addition, magnetometry studies indicated the presence of a buried foundation south of the main Cinnabar area. Excavations confirmed that a structure probably stood at that location (Sheriff and MacDonald, forthcoming). Dick and MacDonald (2009) provide a full technical report of the historic archeological investigations at Cinnabar.

Conclusion

Between the 2007 and 2008 MYAP field seasons in the Boundary Lands, the University of Montana field teams surveyed a total of 2,757 acres, including 2,057 in 2008, and 700 in 2007. MYAP worked at a total of 47 sites and collected 9,979 total lithic and historic artifacts, including 2,725 lithics and 7,254 historic artifacts. Even more importantly, with funding from the Rocky Mountain CESU, Yellowstone National Park, and the University of Montana, the Montana-Yellowstone Archeological field school project trained 23 undergraduate and graduate students in archeological field methods from a cultural resource management perspective.

The project has also provided ample research opportunities for several graduate students as well as the project principal investigator. Several papers on MYAP have already been presented at national and regional conferences. Graduate students Lester Maas, David Dick, and Michael Livers are using project data for graduate projects, while several more are in the planning stages for additional research. The 2009 version of the MYAP is slated for Yellowstone Lake and Swan Lake Flats, with the intention of collecting data by which to compare upland versus lowland sites within the Yellowstone Ecosystem.

Acknowledgments

The MYAP benefitted from numerous individuals and organizations who contributed time, funds, and resources towards the project's success. Christine Whitacre and the Rocky Mountain Cooperative Ecosystem Study of the National Park Service provided funding towards the project's completion, as did Yellowstone National Park (Mary Hektner) and the University of Montana (Department of Anthropology and the Office of the Vice President). Ann Johnson and Elaine Hale of Yellowstone helped to coordinate the project. Sub-consult-

ants included Richard Hughes (obsidian sourcing), Paleoresearch Inc. (botanicals), Jonathan Hardes (faunal remains), Ed Burke (wood identification), and Beta Analytic (radiocarbon dating). Brenda Covington, Mike Livers, Robert Peltier, and David Dick were teaching assistants during the 2007–2008 field seasons. Field school students on the project included Emily Darrell, Wilena Old Person, Meg Tracy, Jason Plainfeather, Seth Bates, Nathaniel Scherr, Penny Tollefson, Gerad Smith, Amber French, Raymond Ford, Chris Kirkpatrick, Sherry Nugent, Justin Ferryman, Katrina Johnson, and Jordan McIntyre from University of Montana. Students from other universities included Robert Hairston-Porter and Travis Wardell (College of Charleston, South Carolina), C.J. Truesdale (University of Wyoming), Michael Livers (University of North Dakota), Leia Hays (Western Carolina University), and River Lovec and Jacob Adams (Montana State University).

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Legal Protection of the Archeological Cultural Heritage in Mexico

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Abstract (Español; English)

En México el estatus legal de áreas protegidas se define por las leyes nacionales y los compromisos operacionales de dependencias federales. A diferencia de EE.UU, México divide la responsibilidad de proteger recursos culturales a un departamento mientras los recursos naturales se quedan en las manos de otro departamento. También la responsibilidad de protección puede estar en manos federales mientras posesión de la tierra se queda al nivel de la comunidad. Esta fregmentación require un proceso constante de negociación al nivel local entre dependencias y también entre depedencias y comunidades, algo que no contempla la ley. Tomando el proceso actual de extender el estatus del área protegida a recursos culturales tanto como naturales en un solo valle, esta ponencia da énfasis a los dilemas de trabajar dentro del marco legal existente cuando el proceso de negociar require marcos diferentes.

In Mexico the legal status of protected areas is defined by national laws and the operational commitments of federal agencies. Unlike the United States, Mexico divides responsibility for protection of cultural resources to one department while natural resources are in the hands of another department. In addition protection responsibility may lie in federal hands but actual land ownership remains at the community level. This fragmentation requires continuing local-level negotiation among agencies and between agencies and communities, something the legal arrangements do not contemplate. Using current efforts to extend protected area status for both cultural and natural resources in a single valley as a case study, this presentation underscores the dilemmas of working within formal legal structures when negotiations require other frameworks.

Introduction

The subject of this work is the legal protection of archeological heritage in Mexico, the objectives being to make known, roughly, the principal precepts of the legislation that in Mexico has been promulgated for the legal defense of this heritage, and how it is suitably applied.

The legal protection of archeological heritage is a subject that is not well studied in Mexico; attorneys specializing in this area are scarce, which is paradoxical, since Mexico is a country rich in historic and archeological monuments and monument zones. For example, Oaxaca is a state where tourism is the source of its economy, and therefore the conservation of cultural heritage is unavoidably influenced by the need for sufficient infrastructure to provide quality service to its visitors.

This paper will first focus on the historical background of the promulgation of the law that protects the nation's assets; on legal protection and its concept, which involves legal protection on the part of authorized institutions and bodies contributing to INAH (Instituto Nacional de Antropología e Historia/National Institute of Anthropology and History); the importance of its precise application; the legal basis, and some current forms of protection; and the concepts of transmission of property rights. Of course, we will review the consequences of breaking the law, as sanctioned by the corresponding legislation.

This work is the result of experience gained over more than 25 years as a legal assessor for INAH in Oaxaca. We have encountered exceedingly interesting challenges that, in addition to enriching our knowledge, motivate us to continue this work in spite of the fact that on many occasions we are swimming upstream, institutionally.

Historical background

Stemming from an appreciation of the historical value of cultural works of the pre-Hispanic era from 1827 to 1896, authority was established for the Federal Executive Power to regulate excavation and exportation of archeological assets, both transportable and real property.

The laws of 1930 and 1934, the jurisprudence that the Mexican Supreme Court established in this era, and an addition to Article 73 of the Political Constitution, created in 1966, clearly defined federal authority in matters of historical, artistic, and archeological monuments in a manner congruent with the legal tradition (Negret 2004).

The law's impact was important because since then, the possession, exploration, destination, use, etc., of archeological, artistic, and historical assets would be regulated; and the law would address national assets in the public domain. In this way, the nation's assets remain under state protection.

The term protection, in common language, means to safeguard, to care for a thing's integrity, be it material or immaterial. Legal protection consists of alloting cultural heritage, most beneficially as corollary elements together, best referred to as determined classes of assets, or, more effectively, as concrete assets, a special legal position with the aim of guaranteeing their integrity in any circumstance that could affect them, given the value and social function that they hold.

Protection shall be understood as the legal action initiated by one or more parties acting on behalf of the heritage, especially the administration, under the auspices of an institutional structure. From this perspective, the laws of the applied administrative procedure are the instruments of protection (Bermúdez, Juan, and Adelina 2004).

For Bolfy Cottom, cultural inheritance constitutes a cultural heritage, as a set of material or immaterial assets which, having relevant significance due to their historic or artistic value, must be protected by law in a precise manner and be the object of actions by the state, through suitable means (2004).

Fundamentally, assets—portable and non-portable, tangible or intangible—deserve legal protection, which from the moment the Mexican Political Constitution established the importance of these national assets, regulatory laws would be expanded to either directly or indirectly determine their protection by means of competent institutions.

For this reason, in Mexico, a series of legal norms (laws, agreements, decrees, etc.) are promulgated, that are to establish lineaments, conditions or restrictions on occupation or use of the nation's portable or non-portable assets, regulating what can or cannot be done with or to said assets, or in any case certain procedures, authorizations or requirements that shall be respected.

From there, are the legal norms with distinct hierarchy that are issued by the legislative power safeguard cultural property. Some laws refer in an indirect manner. Others are specialized because their objectives are related exactly to the protection of cultural heritage (Álvarez 1995).

Legal basis of protection by a hierarchy of laws

Political Constitution of the United Mexican States. The access to and benefit of cultural assets and services has its legal basis in the Political Constitition of the United Mexican States of 1917, whose Article 3 in Section V indicates: "In addition to providing the preschool, primary and secondary education indicated in the first paragraph, the State shall promote and fulfill all educational types and modalitites—including early education and higher education—that are necessary for the development of the nation; shall support technological and scientific research; and shall encourage the strengthening and dissemination of our culture."

The same fundamental legislation refers in its Article 73 of Section XXV, the Congressional faculty on other aspects of education: "and additional institutions concerned with the general culture of the nation's inhabitants and to legislate all that relates to said institutions; to legislate over fossil remains and archeological, artistic and historical monuments, whose conservation may be of national interest. . . . "

From this regulatory text stem "regulatory laws," which are elaborated by the Legislative Power, and should be executed and applied by the Judicial and Executive Powers.

General law of national assets. Addressing the nation's assets, the General Law of National Assets was promulgated, which in its Article 1 points out that National Heritage is composed of the following: (I) Public domain assets of the Federation, and (II) private domain assets of the Federation.

Section I notes that public domain assets are, among others, (VI) Artistic and historical monuments, portable and non-portable, that are federal property; (VII) Archeological monuments, portable and non-portable. The same law subjects public domain assets exclusively to the jurisdiction of federal powers (Article 5), which means that federal public administration entities shall be authorized, and will have the responsibility, to apply legislation promoting their conservation and protection.

The bases of Federal, Centralized, and Parastate Public Administration Organization are found in the Law of Federal Public Administration, which notes that to carry out administrative business entrusted to the Executive Power, the Centralized Public Administration will be relied upon, such as the Secretary of Public Education, the body that will deal with affairs concerning the following: creation of the inventory registry of national historical heritage; creation of the inventory of national monuments; organization, maintainence and management of historical, archeological and artistic museums and galleries, in order to safeguard the integrity, maintenance and conservation of historical and artistic treasures of the country's cultural heritage; conservation, protection and maintainence of archeological, historical and artistic monuments that make up the nation's cultural heritage, in compliance with legal regulations (Article 38, Sections XVIII–XXI).

By including cultural heritage among public domain assets of the Federation, the General Law of National Assets prohibits any transmission of rights, be it through purchase, sale, possession resulting from statutes of limitations, or any other legal action regarding these assets, when it states quite clearly: "Article 13—The assets subject to the regulations regarding the public domain of the Federation are inalienable, imprescribable and unseizable and shall not be subject to claims nor provisional or definitive possession, nor any other action by third parties."

Federal Law for Archeological, Artistic and Historical Zones and Monuments. After serious discussions in the Mexican Congress, on April 20, 1972, the Federal Law for Archeological, Artistic and Historical Zones and Monuments (FLAAHZM) was enacted, the importance of which was the legal regulation of movable archeological objects, omitting them from commerce, and of movable and immovable assets, making them no longer subject to claims or statutes of limitations. According to Article 1, the object of this law is the national and social interest, and its regulation and enforcement.

This legislation emphasizes the importance of registry of archeological pieces, and granting concessions to private parties for the possession—not ownership—of movable archeological pieces.

Authorized institutions regarding cultural heritage matters. By decree of President Carlos Salinas de Gortari, dated December 6, 1988, the National Council for Culture and the Arts (CONACULTA) was created as a body decentralized from the Secretary of Public Education and to which was specifically assigned the coordination of public institutions involved in the promotion and dissemination of culture and the arts.

INAH (a branch of CONACULTA) is concerned with preservation, conservation, and dissemination of the nation's paleontological, archeological and historical heritage.

Conservation of archeological heritage is also the responsibility of the state and municipal authorities, as presented in Article 4 of the FLAAHZM. Upon establishing that the state and municipal authorities shall be entitled, in the application of this law, to intervene as the law indicates, the Federation, in close coordination with the state government, shall combine efforts to implement the mechanisms of protection, conservation, and dissemination of the state's cultural heritage within the scope of their faculties.

Supplementary legislation. The application of supplemental legislation arises when the FLAAHZM does not have a regulation permitting effective legal defense of cultural heritage, and therefore international treaties and federal laws shall be applied, as well as civil and penal codes.

Outside of this legal framework, there is other applicable legislation, for example, decrees and resolutions. Decrees are a decision by a state body, created on a case-by-case basis, and require certain formalities (publicity) so that the decrees are known by those at whom they are directed. Resolutions, by contrast, are decisions of a higher body, authorized in these matters, which generally provides only written notice.

Means of protection of archeological heritage

Article 5 of the FLAAHZM establishes two forms of protection: "those archeological, artistic and historical monuments and monument zones expressly determined in this law" which leads us to Article 28, which says precisely: "archeological monuments are movable and immovable assets, product of cultures existing previous to establishment of the Hispanic culture in the national territory, as well as human remains, and flora and fauna remains pertaining to those cultures."

Also, the law grants extensive protection of "fossil vestiges or remains of organic beings that inhabited the national territory in past eras and whose research, conservation, restoration, recuperation or utilization are of paleontological interest, a circumstance which shall be allocated in the respective declaration which the President of the Republic shall issue."

By declaration, Article 5 states that archeological, artistic, and historical monuments and monument zones are those that are declared as such, either by official letter or petition, which means that the President of the Republic, or the Secretary of Public Education will issue or revoke the corresponding declaration, which will be published in the "Official Diary" of the Federation.

In this manner of protecting archeological heritage, the fact is that decrees issued by the Federal Executive are controversial, since they are finalized upon merely "declaring" the zone as one of archeological monuments. This brings with it conflict on the part of the landowners and possessors, who are then only able to use or enjoy their land within the limitations of said decree, subject FLAAHZM restrictions. Some communities, where an archeological site has been declared, have even filed appeals against the decrees, requiring work to fulfill additional requirements, including presenting proof in District Courts.

INAH must regulate land use in areas where the decree applies, coordinating with the local municipalities. This regulation involves issuing feasibility reports, work supervision, and, as necessary, suspension of any work not authorized by INAH.

Sanctions

The sanctions chapter in the FLAAHZM indicates the penalties that judicial authorities can impose on anyone who damages either archeological monuments or monumental archeological zones, or both, in any of the following forms:

- For carrying out actual physical archeological exploration through excavation, removal or any other means, the prison sentence will be from one to ten years and the fine from one hundred to ten thousand pesos.
- For the use of a monument, be it for his own benefit or for that of another party, on the part of personnel from the INAH commissioned in the execution of archeological works if the fault is committed by a functionary in charge of the application of a norm he will then be sanctioned in accordance with the Law of Responsibilities of Public Functionaries and Employees. At present, there is an organism called the Body of Internal Control which recognizes the disorder or the not carrying out of functions that arise among the functionaries of the institution and the handing over of the matter to the Department of Public Function to then be turned over to the instance that takes care of the sanctions related to the case.
- For the transferring of dominion of a monument or trafficking with it, as well as its trans-

port, exhibition or reproduction without the permission and the correspondent inscription, the prison sentence will be from one to ten years and a fine of fifteen thousand pesos.

- For the illegal possession of an archeological monument or a movable historical monument.
- For the appropriation of a movable archeological, historical or artistic monument without the consent of the one who has the right to dispose of it according to the law, the prison sentence will be from two to ten years and a fine from three thousand to fifteen thousand pesos.
- For anyone who by means of fire, flood or explosion damages or destroys an archeological, artistic or historical monument they will impose a prison sentence of two to ten years and a fine of three thousand to fifteen thousand pesos.
- For those who through any means pretend to remove or remove an archeological, artistic or historical monument from the country without the permission of the authorized institution, the prison sentence will be from two to twelve years and the fine from one hundred to fifty thousand pesos.

To prosecute crimes against archeological heritage, INAH presents a formal complaint of heritage damages to the Federal Public Ministry Agency, relying upon the Attorney General of the Republic's Office. This organization is charged with investigating crimes and collecting all the evidence or elements that INAH provides to, when perfectly integrated, result in an order to apprehend; it falls to the District Court to follow the process until a sentence for the case is issued.

It is important to note that to date, no revisions have been made to the FLAAHZM's economic sanctions (i.e., fines).

Also important is the other part of archeologists' activity, who in penal processes become official INAH expert witnesses. They must appear before the Federal Public Ministry Agency to present technical reports and to ratify them, to inspect areas along with Public Ministry agents, or in the case of archeological pieces, to determine the authenticity of these pieces, and to contribute additional information that ends in a judge sentencing the acused.

Independent of sanctions of a penal nature, INAH, through the Legal Jurisdiction of Monte Albán, administratively sanctions offenders of the FLAAHZM and its regulations. These administrative sanctions are:

- Suspension of work (Articles 12 and 32);
- Demolition;
- Fine; and
- Revocation of authorizations.

The INAH can make use of the necessary legal means, including the help of public force, to execute sanctions.

Starting from this point, in some cases the conflict becomes litigious, due to the fact that the resolution given, in the majority of these instances, is motive for legal recourse in a second instance: recourse of revision, a trial of protection, or a contentious administrative trial that will prolong the objective programmed for the plaintiff. Even so, the proper measures must be taken in anticipation of any other reaction on the part of the interested parties, especially if it deals with groups represented legally by leaders that will try to invade and block the activities in the archeological zones that are open to the public, put spots on the radio, block roads, etc.

In this manner the legal protection of the archeological sites and zones becomes a focus of attention. A careful watch over the developments should be kept so that proper and opportune measures may be taken.

Conclusions

Legal protection is a decisive factor in the legal defense of archeological heritage. This work has gathered a series of legal instruments, which have been published for their exact application. However, in some instances it is not sufficient to have the intention to do it, but rather, it is necessary to carry out the process to its ultimate consequences, with the political decision and will of the exact application of the law.

Currently, INAH has a body of laws sufficient for effective and opportune legal defense of archeological heritage. It is important to fully employ the laws in the state and municipal scope that will expand the criterion of interpretation and opportune defense. Modifications become necessary in some cases, such as levying fines, which should be adjusted to the prevailing minimum wages. The same holds true for modifications with a previous, exhaustive review of the land's tenancy. In international documents to which Mexico is party, recommendations are found that countries should follow in order to safeguard their cultural wealth. Even when the application of the law brings as a consequence the interjection of other means of defense, it is essential to comply with the requirements, to provide greater proof for conviction, in order to obtain a sentence or resolution favorable to the interests of INAH.

With regard to the reaction of social groups on claims of their "property rights," particularly in areas that have been protected by law and decree due to their archeological evidence and characteristics, INAH makes dialogue and reconciliation a priority in an effort to avoid greater conflicts, and certainly, to consider the presentation of a justifiable legal means.

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Caves, Cacti and Cucurbits: Realities of the Management of Protected Areas

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Abstract (Español; English)

Acuerdos internacionales y marcos legales nacionales definen los límites de la gestión del patrimonio, pero funcionarios tienen que trabajar de manera cotidiana en relación a las realidades sociales y del medioambiente del sitio. En el caso del corridor Mitla-Yagul en Oaxaca esto quiere decir la protección de restos frágiles de diez mil años de habitación humana en más de cuarenta cuevas, atender a paisajes botánicos delicados bajo mucha presión de usarios humanos, y avanzando con la investigación científica que nos permite entender mejor el recurso que intentamos proteger. Al mismo tiempo otros intereses quieren aprovechar del mismo corredor como ruta de construcción de caminos, para pastoreo, y para desarrollo turístico extensivo. Y comunidades locales tienen interéses pragmáticos tanto como simbólicos. ¿Como podemos atender a todos estos intereses sin perder la vista de las consideraciones nacionales y internacionales?

International agreements and national legal frameworks define the outer boundaries of heritage management, but practitioners must function on a day-to-day basis in relation to the environmental and social realities of the site. In the case of the Mitla-Yagul corridor in Oaxaca this means the protection of fragile remains from ten thousand years of human habitation in more than forty caves, dealing with delicate botanical landscapes under heavy pressure from human users, and moving forward with scientific research which betters our understanding of what we seek to protect. Yet other stakeholders prize the corridor for road construction, grazing, and extensive tourism development. And local communities have both symbolic and pragmatic interests. How do we manage these without losing sight of those national and international considerations?

The prehistoric caves of Yagul and Mitla

The prehistoric caves of Yagul and Mitla contain the earliest evidence of the domestication of plants and the beginning of incipient agriculture in North America which represents the first step in the conformation of the high civilizations that would develop in this area. The archeological evidence that has been located goes back to the end of the Pleistocene (10,000 B.C., identified in level E of Cueva Blanca [White Cave]) and shows the continuous process that leads to the establishment of sedentary farming societies.

The site is located in southeastern Mexico in the highlands of the State of Oaxaca (specifically in the sub-valley of Tlacolula, part of the Valles Centrales [Central Valleys]), where continuous archeological research has shown the development of a long cultural tradition, with sites such as Mitla, Yagul, Lamytieco, Dainzú, and above all, Monte Albán.

The site is defined by the concentration of the principal elements that shape the virtues of the site: the continuity of the cultural landscape, the caves and shelters that mark the transition from nomadism to sedentarism, the principal sites with cave paintings and the development of agriculture from prehistory to today. The site is composed principally of three parts: in the far west, the Monumental Archeological Zone of the Yagul is found; to the southeast of this site, Caballito Blanco (Little White Horse) is found, which contains three well-defined pre-Hispanic buildings with vertical stone walls, as well as a great quantity of caves, many of them with evidence of occupation and cave paintings; the zone of prehistoric caves occupies principally the east part of this site, these are located on an ample mesa (plateau) that ranges in elevation from two to three hundred meters above the floor of the valley, with long cliffs along the north part of the mesa formed by the volcanic tuff that shapes the area—the greater part of the shelters and caves are located here, among them are the ones investigated, from which we obtained what knowledge we have about the local incipient agricultural development.

It is in this place that the "Prehistoric Caves of Yagul and Mitla" project is being created as a protected area, which is being developed through an effort of construction, and management of a cultural landscape. The landscape here is understood not as a territory, but rather as the cultural value that the societies give to a territory. It is a point of meeting where in a portion of space a series of social values of different types intercalate, generating behaviors, which in some cases are incompatible among themselves.

Landscapes are diachronic spaces in which human activity goes along, leaving its footprint. The social modifications in the environment are evidence of the distinct values that have been given to determined spaces over time, but to be truly integrated into the landscape, the social modifications necessarily have to be consciously acknowledged by the actors involved in said landscape. It is because of this that the first step in the attempt at constructing this landscape is the identification of the values that are implicated in it, as well as the territorial characteristics that are its foundation.

The physical characteristics of the environment are those that constitute the foundation of our landscape. The area originated in the Quartenary period and is of igneous (volcanic) origin, whose greater part is of pyroclastic origin (was formed principally by volcanic ash), even though other types of igneous rocks are found at the site. The area comprises a microbasin that originates in the Sierra Juárez (Juárez Mountain Range) and discharges into the Mitla River. The vegetation comprises principally "low deciduous jungle"—this means that the vegetation loses its foliage during the dry season and presents great exuberance during the rains. As far as local fauna, it is conserved, thanks to the fact that the vegetation itself is well conserved. Among the principal species are lizards and other reptiles, and different types of birds, such as the hummingbird, sparrow, falcon, and bearded vulture, among others. Mammals of the region are in general crepuscular or nocturnal, and therefore are not easily sighted, but their presence is made known by their tracks and scat; most notably among these are the ring-tail, fox, skunk, opossum, rabbit, and field mouse.

In this territory, a series of values are formed. By "values," we mean a series of virtues that the distinct social actors find in the space in which they develop; these values exhibit a diversity of distinct forms that are not necessarily compatible among themselves, generating contradictions that shape the landscape over time. For the purposes of this work, three principal aspects have been identified: the economic, the identity-giving, and the scientific, with their distinct components, which shape the values of the area of the prehistoric caves of Yagul and Mitla.

In terms of the landscape, the economy can be seen starting equally from the interactions between nature and society, expressed principally in interchanges of material and energy, with which it is possible for us to distinguish three types of environments. The first is the natural environment, in which the work process does not seriously alter or negatively impact the ecosystems as do hunting, fishing, and harvesting. The second type is when the environment is negatively impacted by the introduction of an ecological artifice, formed by previously domesticated species, or those in the process of being domesticated, such as in agriculture, animal husbandry, etc., as well as production-related modifications to the soil, involving the landscape. In these cases the environment depends on the continuation of human work, since if it is abandoned, it will be recovered by the original local (native) populations. Therefore, we can consider three types of environments: the natural environment, which mans exploits directly, the transformed environment, that man exploits in a mediated form and which already constitutes a landscape, and the social environment, in which men exchange the products of their work.

The majority of the site, in which evidence of prehistoric occupation is concentrated, is made up of land too rocky for agricultural use, where we can observe the natural environment in the terms that have been expressed. These areas are used for gathering diverse species that are found in their wild state, as well as hunting (principally small mammals), through which we can observe a continuity in its uses from prehistoric times through the present.

In contrast, in the lower parts of the site, almost at the level of the valley, more fertile lands are found in the western part surrounding Yagul and Caballito Blanco, and in the eastern part surrounding the Mitla fortress. On these lands corn, beans, alfalfa, and marigolds (the traditional flower for the festivities for The Day of the Dead) are grown, among others. In dealing with lands that have traditionally been used for cultivation, it is not surprising that the principal economic value given by the population should be agricultural production.

Another area used for agriculture and animal husbandry is the upper part of the Caballito Blanco mesa, where cultivation of agave "espadín," used for mezcal production, is carried out. This crop differs from those above in that its growth is much more prolonged, taking between eight and nine years to yield harvest, which results in less disturbance of the sediments, thereby conserving archeological evidence that may exist in the area.

Some spots in the area of Los Compadres are used for grazing livestock, which, though not massive, has indeed resulted in modifying the conditions where the plant species exhibit a greater dispersion in comparison with the eastern section, where the minimal presence of livestock has resulted in the land being recovered by native plant species.

Recently, the economic value of the area, originally based on its agricultural productivity, has been modified by realty speculation, and the lands that correspond to the southwestern part of the polygon have become indentified as those most threatened by urban expansion. In the Tres Piedras Colony and the Duvil-Yasip spot, there have necessarily been constant inspections and work stoppages, to contain the urban growth of Tlacolula to the interior of the polygon. Likewise, the south part of the polygon, which is affected by the Panamerican Highway, is a focus of attention in protection efforts, due to the particular vulnerability that this roadway creates.

Transcending the economic values, which even if they are the immediate ones are not the only ones, we can also identify certain identity values in the landscape. The values of identity refer to the emotional links of the society to objects and specific sites. They can be traditional or commemorative, or have spiritual and religious ties, as well as patriotic-nationalistic ones (Feilden and Jokilehto 1998, 28). Peoples tend to create symbolic relationships with the spaces they inhabit; it is the relationship between country and nation—"country" as geographic space and "nation" as a feeling of community.

The indigenous peoples of Mexico have created ancestral ties with the territory that they occupy, designating some places over time as profane, and others as sacred. In this sense, the caves are an element of great relevance in the indigenous cosmology, an element strongly associated with the infraworld and its deities. Such is the case of the Cueva del Diablo (Devil's Cave), located to the east of Mitla, where even today diverse rituals of pre-Hispanic origin are performed, such as "cleanings" (*limpias*) and "petitions" (*pedimentos*).

The lands on which the prehistoric caves of Yagul and Mitla are found have also been shaped by indigenous, traditional community relationships in contemporary times, such as is the case of the Unión Zapata ejido (ejidos are areas of commonly held/worked land given to groups of peasants at the conclusion of the Mexican Revolution), which was created from the agrarian distribution of the 1930s. This historical period for Mexico is characterized by agrarian redistribution as one of the promised objectives of the Mexican Revolution, which modified in diverse scope the relationships between the land and those who work it. Subsequently, inhabitants of different communities, such as Mitla, Díaz Ordaz, and Santa Catarina Albarradas came to settle in Loma Larga, "all those who united to create the Unión Zapata ejido shared the experience of lacking land; the majority were extremely poor people who worked like peons on the different surrounding *haciendas*" (Stephen 2002, 270; in Mexico a hacienda encompasses the land as well as the compound—it is essentially equivalent to a plantation). This resulted in the lands becoming the integration and cohesion element of this community, which represents another important identity-giving element of our landscape.

A third group of values is made up of what we have called scientific values. They are recognized, starting from specialized studies in different branches of knowledge, and through them the importance of the property is identified in relation to its own time, or in reference to the present which, in the case of the prehistoric caves of Yagula and Mitla, is of both a natural and cultural nature.

The botanical wealth of the area was registered by Enrique Martínez y Ojeda (1996), who created an illustrated guide of the plants of Yagul, among which he distinguished that at least 90% of these have some use for man, be it as food, raw material for the manufacture of textiles, soaps, or many others. This study was conducted in only a fraction of the area, thus new works could augment the catalog of plants and our knowledge of the biological wealth of the region. Likewise, a series of studies are planned, with different institutions, of the local fauna for a more complete understanding of local ecological systems. In addition, recent botanical studies of the area have registered a series of endemic plants that are found only in this area. Therefore, proper management of the natural resources of the site is of the utmost importance.

The area has great biological importance, as the ecosystem that it supports has not suffered drastic changes during the last 10,000 years, conserving the same plant and animal species since the Archaic period (Flannery and Wheeler 1986; Flannery 1986), which represents a significant characteristic given that the greater part of the Central Valleys of Oaxaca, except perhaps in this small area, the native vegetation has been strongly altered by thousands of years of agricultural practices.

Nevertheless the principal academic value of the site is the one identified in the research by Flannery in the 1960s, with which he managed to document the earliest evidence of human presence in the area, around 12,000 years ago, as well as the process by which incipient agriculture developed.

Without doubt, the principal archeological value of the area is having been identified as one of the points where the area's incipient agriculture developed, thanks to the excavations conducted in the rock shelter of Guilá Naquitz, where the dry conditions of the interior allowed recovery of the earliest evidence of a series of plants in the process of domestication, most notably among these the jícara (a member of the gourd family, which is commonly hollowed out and used as a bowl or cup, sometimes ornately decorated), squash (*Cucurbita pepo*), beans, and corn.

The corn found in the rock shelter of Guilá Naquitz, thanks to recent studies with an accelerator mass spectrometer (AMS), turned out to be 730 years older than those located by McNeish in the Valley of Tehuacan (Benz 2001). This means that as of today, it is the oldest recovered in the world.

Nevertheless, the archeological wealth of the area is not restricted to this highly important event, but rather it also contains significant evidence of the different technologies developed in prehistoric times. Most notable are those of the lithic (stone/masonry) industry, as much during the prehistoric era with the development of stone tools such as arrowheads, as in the Postclassic Mesoamerican, during which very elaborate, monumental architectural structures were constructed, whose most outstanding example in the area is the archeological zone of Mitla, with its stone mosaics and monolithic lintels, the quarry of one of which is found in the area of the prehistoric caves.

Another archeological aspect of the area is the presence of distinct manifestations of cave paintings. In a great quantity of caves and rock shelters, small vestiges of paintings have been found, usually in the color red; the majority of these are abstract designs, principally composed of a series of dots or lines. Likewise, it is also possible to find anthropomorphic and zoomorphic designs which, due to their characteristics, could correspond to early phases of this practice. However, the most relevant examples of cave paintings appear to correspond to later phases, due to the characteristics they present. In the "Cave of the Machines," which is the component with the greatest quantity of cave paintings, the designs appear to correspond to the Postclassic period, in particular the representation of Yahui, a mythological figure related to the caves, amply represented in the Mixtec codices (manuscripts) of this period.

Likewise, the most representative example of stone engraving, located in the Caballito Blanco area, consists of a floor that contains an impressive quantity of petroglyphs, as well as a sculptural representation that appears to correspond to the bat god.

The great complexity that the carvings present, and their association with the archeological zone, gives us an indication that they originate from the epoch of Yagul's splendor during the Postclassic period, even though a complete study and registry of them is necessary, which presents a series of difficulties, given the physical characteristics of the element. Nonetheless, it is considered of vital importance for the understanding of the complicated Zapotec writing system, of which these carvings represent an incomparable example.

Based on all these particular characteristics of the site, the strategies for its management are posed, for the sake of reconciling all these recognized values. The first relevant aspect is the fragility that the site presents, as much in its natural as in its archeological aspects. It is because of this that if it were opened to tourists, it must be carefully planned, always in controlled groups, based on the carrying capacity of the place, and with site committee members to safeguard the different elements the site is composed of.

A fundamental aspect of management planning is the active participation of the communities involved, and by this means it is hoped that the identity-giving aspect of the site will be strengthened, just as it will be considered to be the best means to ensure their protection, since the onus of safeguarding the site is principally on the inhabitants. This, of course, with support and training from competent institutions.

Upon identifying the site's greatest risk factor as the change in soil uses due to urban expansion, and at the same time, agricultural development being of fundamental value, one of the means of protection has to be the promotion of agricultural activities for the sake of maintaining this economic value, this in order to contain the changes that threaten this site.

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Carrots and Sticks: Reconciling Stakeholder Interests in Cultural Landscapes

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Over the past two decades, the concept of "cultural landscape" has become increasingly accepted in the international conservation field as designating spaces where interaction between man and nature is the attribute or characteristic worthy of protection. It reflects a movement away from an earlier duality of man/nature which directed attention to either the built or natural environment, leaving in limbo places where the use, even reshaping, of the natural environment has been a critical element in human history. Since the 1992 decision by UNESCO to include cultural landscapes as eligible for World Heritage status, more than fifty such sites have gained recognition. It was not until 2006, with the designation of the Agave Fields and Ancient Industrial Facilities of Tequila, along the Tequila River in Jalisco, that Mexico gained its first cultural landscape designation. At a global and national level, therefore, there is far less experience managing cultural landscapes than the traditional designations for nature, or for the built environment. This lack of experience in what is arguably a more complex management arena than human or natural sites makes efforts to advance cultural landscape status as particularly worthy of attention.

In Mexico thinking about the specific array of management issues presented by cultural landscapes is still very much in its infancy. *Patrimonio y Paisajes Culturales* (Thiebaut, Sanchez, and Jimenez 2008), a product of Mexico's first organized symposium on the subject, captures a wide-ranging debate as scholars and practitioners, particularly archeologists, duel over lines of responsibility and authority. In this respect, the very notion of a "cultural landscape" highlights a larger tension between two agencies superimposed on an institutional framework which seeks to resolve jurisdictional matters by assigning exclusivity rather than promoting collaboration. To the extent effective management requires cross-disciplinary and inter-agency practice there is little organization history to guide collaboration among the social sciences, hard sciences, and humanities.

The Yagul-Mitla corridor

Approximately twenty-five miles east of the World Heritage site of Monte Alban and the city of Oaxaca de Juarez, a narrow valley paralleling the Tlacolula Valley is flanked by caves showing signs of continuing human habitation dating from 10,000 BC. In the 1960s research by archeologist Kent Flannery (1986) and others documented the extensive use early hunter-gathers made of the region's resources, and the gradual transition from passive appropriation of what could be found there to active manipulation of the resource base to support an increasingly sedentary population. In time significant human settlements emerged at Yagul and Mitla, at opposite ends of the valley, and for this reason current research and protection projects refer to it as the Yagul-Mitla corridor to differentiate its space from the neighboring and far larger Tlacolula Valley. While the archeological sites marked by material remains are quite small and generally in, or associated with caves, the entire corridor covers more than 10,000 acres and spreads across four municipalities. Its size and accessibility makes it important for grazing, resource extraction, and significant tourism at Yagul and Mitla. Legal ownership of the land rests with the municipalities or with ejidos, collective land-holding units created by the national government after the Mexican Revolution and important entities supporting local agriculture.

Jurisdictional matters

In this setting the concept of cultural landscape provokes persistent and seemingly intractable debates because of the way in which Mexican law and historic practice assigns responsibility. The Secretary of Environment and Natural Resources (SEMARNAT) has responsibility for the protection of natural resources, with the National Commission on Protected Natural Areas (CONANP) being the operational arm addressing protected areas, including potentially the Yagul-Mitla Corridor. SEMARNAT and CONANP are staffed heavily by biologists and physical scientists, and their frame of reference is defined both by disciplinary training and by critical pieces of legislation addressing protection of the natural environment. Archeological resources, defined as material remains, are under the jurisdiction of the National Commission on Culture (CONACULTA), with operational responsibility assigned to the National Institute of Anthropology and History (INAH) under the Federal Law for Archeological, Historical, and Artistic Monuments (1972). INAH's staff is heavily archeologists, anthropologists, and architects. Thus one federal department has jurisdiction over landscapes, while a second has jurisdiction over culture, unlike the fused responsibility of the National Park Service.

While these agencies have jurisdiction and responsibility legally, lands in the corridor are owned and under the control of the municipalities and ejidos. This is common in Mexico, where national parks and archeological zones are established via presidential proclamation, but ownership continues to be local. In effect the federal agencies have the obligation to protect resources, but in practice must depend on local governments to enforce the law. Despite their status, professionalism, and theoretically superior resource base, the federal agencies commonly find themselves with few incentives (carrots) or sanctions (sticks) to achieve cooperation from local governing bodies, which are experienced in resisting pressures from outsiders seeking compliance with laws created far away, on the basis of priorities rarely reflecting community interests. In Oaxaca, municipal and ejido officials frequently cut off discussion with outsiders by shifting from Spanish to local indigenous languages, such as Zapotec or Mixtec, effectively terminating communication (Robles 1998, 72).

Although this would seem to place a premium on fostering negotiating skills, and a collaborative orientation among federal employees charged with managing the relationship with local actors, a long tradition of top-down control centered in Mexico City continues to discourage this. For example, INAH runs its own university, the National School of Anthropology and History (ENAH), located in Mexico City, and generally staffed by faculty drawn from INAH's central office. While this arrangement builds staff identification with the agency, it does not encourage empathy for community-level governance. Personnel from

SEMARNAT also find efforts to assert control over local resources foundering from lack of communication and cooperation. Federal agencies have their principal offices in the state capital, meaning local officials called for meetings may never appear, while staff who drive out to communities discover the people they seek are exceedingly difficult to find, or who argue that while they personally would be happy to help, community sentiment does not permit it.

Other governmental actors also claim space in the jurisdictional arena. At the federal level the Secretary of Communications and Transportation (SCT) has been pushing the construction of a new highway which would pass within yards of some caves, threatening to damage them with blasting, or bury them with construction debris. While sympathetic to the arguments for landscape protection, the agency's mission is to build roads on time and within budget, making detours and delay difficult arguments to sell. Political parties courting voters become advocates for communities and groups wishing to promote some policies or oppose others. A call from a representative in the Chamber of Deputies to the head of CONANP or INAH quickly prompts a follow-up to local agency heads, and these may become risk-adverse in the face of pressures to avoid possible political controversy.

Land use and tourism potential

Two issue areas increasing the number of stakeholders in the corridor have to do with land use, and with the potential for tourism development. While their formal landholdings are limited, INAH and CONANP have significant legislative authority to regulate land use within the formal boundaries of areas they have been designated to protect, and these can have important consequences for local populations. They may determine whether one can cut trees for firewood or other uses, build a house, extract stone, or engage in other activities putting archeological artifacts at risk, or disturbing the environment. In turn the ability to make maximum use of every available resource becomes critical to household survival in semi-arid climates; taking goats out to graze may seem quaintly pastoral to agency managers in Mexico City, but a critical component of family economies in Villa Diaz Ordaz or in Union Zapata. Biologists may seek limits on grazing to reduce damage to endangered plants, while archaeologists may worry about site vulnerability to erosion, but their ability to control such uses will rest less on what the law says than on their capacity to explain and convince. Thus cultural landscape protection reaches beyond local governments to an array of formal and informal actors with highly-specific sets of interests.

If concerns over land use bring forth some sets of stakeholders focused on traditional matters of agriculture and resource extraction, other stakeholders appear when there is even a breath of opportunity to take advantage of potential tourist income. Over the past generation, the Oaxaca Valley has become increasingly dependent on tourist spending as a source of economic growth and employment. As one of the anchors in the Yagul-Mitla corridor, the community of Mitla has experienced a spectacular transformation over the past fifty years as an increasing flow of visitors to its well-known archeological zone promotes the expansion of services and commerce, a more urban lifestyle, and a transformation of work life. Fifty years ago, fifteen percent of the population worked in the service sector, while almost everyone else worked in agriculture; today those percentages are reversed. And the prosperity of nearby Teotitlan del Valle, where weavers with international reputations and client lists to match, drive late-model SUVs and send their children to universities, is well known throughout the valley.

If local farmers hope tourism will generate employment as taxi drivers for their sons and store clerks for their daughters, the close alignment of the Oaxaca Secretary of Tourism Development (SEDETUR) with the hotel, restaurant, and tour industry in the city of Oaxaca boosts expectations among its client groups. Only a small fraction of the visitors to Mitla, and almost none of the visitors to Teotitlan, stay in those places. Their service center is the city of Oaxaca, and service providers there wish to see that continue. The push, therefore, is to make the Yagul-Mitla corridor as visitor accessible and friendly as possible, although doing so may overwhelm the fragile ecology of the place. Parking lots, paved roads and trails, and carefully-groomed visitor services would support a major tourist flow. From a visitor standpoint there are no pyramids, churches, or craft shops as obvious points of interest, so without investment in interpretive services and comfort, it is not clear the corridor will be a major tourist attraction. At the Monte Alban Archeological Zone, the push to increase visitor through-put means INAH must invest an increasing percentage of its zone budget in visitor services, e.g., trucking in water for the sanitary facilities, even though tourist income flows primarily to the service providers rather than INAH (Jiménez 2006, 152).

Management challenges

There are several serious management planning challenges emerging from efforts to protect the cultural landscape of the Yagul-Mitla corridor. The first of these is to resolve the issue of jurisdiction. Should the corridor be managed as a protected landscape, where space and scale promote the priorities of SEMARNAT and CONANP, or is it really a place where the cultural dimensions of human agency should be given primacy, an argument favoring INAH? Is there a need for a new kind of managerial structure, and who will provide that, under what authority? While both SEMARNAT and CONACULTA have resource protection responsibilities, they may interpret them differently. INAH may see cacti growing on ancient walls as a threat to their integrity which must be removed, while CONAPO regulations see the walls as part of a physical context for a biological resource, and it is the resource which merits priority, not the physical context.

A related managerial challenge is the rather narrow preparation of most Mexican resource professionals. Archeologists receive outstanding training in archeological subject matter and techniques, but little in cultural resources management. Biologists or foresters have much the same experience. In arenas such as cultural landscape protection they have little preparation to work across disciplinary boundaries, and lack training enabling them to draw on data from a variety of sources. More training in plant cell structure does not prepare a botanist to work with tourism planners, nor does advanced training in lithics help archeologists negotiate with local community leaders. To the extent that one of the dominant characteristics of the Yagul-Mitla corridor is its institutional and organizational complexity, effective management will require breaking out of traditional "silos" which constrain action.

Still a third managerial challenge is the development of a more productive arsenal of carrots and sticks. The regulatory sticks currently available are difficult to use because in the end they depend very much on the willingness of local governments to act as enforcers for federal agencies, something which holds little appeal for locals. And not only are there few carrots, but even these are disappearing. At the Monte Alban Archeological Zone, one carrot encouraging productive relationships with local governments was the prospect of hiring people from the communities owning the land to do maintenance, janitorial work, and offer other services (Robles and Corbett, forthcoming). But national government efforts to promote uniformity and reduce possible corruption now requires such services to be issued via competitive bidding in Mexico City. From a community standpoint, a carrot has been ripped from its hands and awarded to outsiders. More centralized management, in the end, can work against, not for, resource protection.

Finally, promoting cultural landscape protection will require more systematic attention to working with those interests and communities who see themselves as the ultimate owners and stewards of the landscape. The Pueblos Mancomunados, a group of communities in the mountains adjacent to the Yagul-Mitla corridor, manage their land base as a common unit to gain the advantage of economies of scale and otherwise capture the resource flow. They charge visitors an access fee to hike or mountain bike in their communities, have their own guide service, and offer a network of cabins where visitors can stay. The goals are to protect the resource base and to generate employment as an alternative to emigration. To date, federal agencies have resisted payments or supplemental fees to local communities where an overt federal presence is involved, but it will be difficult to deprive communities with lands in the corridor of access to the resources on them. Failure to create such a system at the Monte Alban Archeological Zone may be one reason why there are recurring skirmishes between INAH and local groups over land use and access to opportunities.

Final thoughts

Cultural landscape protection opens some new challenges for Mexico. In the case of the Tequila region of Jalisco, the high-value product which gives the area its fame provides an incentive for colloboration among stakeholders. It is easy to see the outcome as more than the sum of its parts. That kind of outcome is far more difficult to imagine in the Yagul-Mitla corridor, reducing the motivation to overcome traditional obstacles to joint action. Yet it is difficult to imagine long-term collaboration being effective without a specific, consensus-based strategy which brings all the stakeholders to a common table, providing them with a process and an outcome acceptable across the board.

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A Wetland Inventory and Connectivity Assessment for Harpers Ferry National Historical Park

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Wetlands are a valuable natural resource in national parks, providing, among other services, valuable foraging habitat for species threatened by regional habitat loss. Most wetlands are considered in isolation without consideration of the broader landscape connections. We hypothesized that the network configuration of wetlands within park landscapes may be important for the conservation of mobile species that depend on wetland resources during at least part of their life cycle. We inventoried wetland habitat within and adjacent to Harpers Ferry National Historical Park. Our initial wetland inventory used a combination of aerial photography with ancillary GIS data and field surveys to delineate wetlands within park boundaries. We supplemented this information with data from the National Wetlands Inventory (NWI) and compared the abundance of wetlands within Harpers Ferry to the abundance in the landscape adjacent to the park, and in four neighboring parks. We used this information in a graph theoretic framework to construct network models of potential landscape connectivity for common bat species of the Mid-Atlantic. Harpers Ferry has some of the highest density of wetlands in the region. Consideration of how this network may best be managed to promote connectivity would benefit bats and other water-loving species in this mixed-use setting.

Introduction

Wetlands are considered transitional areas between terrestrial and aquatic ecosystems that support unique plant life adapted to inundated and anaerobic conditions for at least part of the growing season. Wetlands provide important ecosystem services such as excess nutrient removal, flood regulation, primary production and carbon storage, and are thus a primary conservation target (Keddy 2000). Despite the recognized need to manage wetlands effectively (e.g., Zedler and Kercher 2005), many protected areas lack even a basic map of the distribution and composition of wetlands within their boundaries. Further, most wetlands are considered in isolation, without consideration of the broader landscape connections (wetland–wetland, land–water) that many mobile species depend on to complete their life cycle (Roshier et al. 2001).

Effective landscape and habitat conservation planning depends critically on the spatial arrangement and connections among habitats. Graph networks have been increasingly and successfully used to describe habitat networks for conservation and restoration (Rothley and Rae 2005; Lookingbill et al. 2008) and to assess connectivity among landscape elements for individual species (Bunn, Urban, and Keitt 2000; Neel 2008). For example, Roshier and colleagues (2001) used graph-theory based network analysis to demonstrate how the configuration of wetland habitats can explain the extraordinary numbers of waterbirds present on the arid Australian continent. Rhodes et al. (2006) used graph theory to demonstrate the high connectivity of bat roosting sites in Brisbane, Australia.

The primary purpose of our wetland inventory was to document, characterize, and delineate wetlands of Harpers Ferry National Historical Park. By extending the analysis to lands adjacent to the park and to four neighboring parks, and by considering the individual wetlands within larger wetland networks, we provide context to the inventory that should be important to both wetland and species-based park management.

Study area

Harpers Ferry National Historical Park was designated a National Monument in 1944, and a National Historical Park in 1963. The park is located at the confluence of the Potomac and Shenandoah Rivers across the West Virginia, Virginia, and Maryland State boundaries, approximately fifty miles northwest of Washington, D.C. (Figure 1). Located in the foothills of the Blue Ridge Mountains, in the water gap between Maryland and Loudoun Heights, the terrain is very steep, and dominated by well-drained, shaly silt loams. Wetland habitats within the Blue Ridge and neighboring physiographic provinces are limited in extent, and are known to harbor numerous rare, threatened, and endangered species not found elsewhere. The park requires an accurate and detailed inventory of these sites to ensure proper management and protection of wetland resources, and to comply with existing federal laws that regulate activities in or near these habitats (e.g., National Environmental Policy Act, Clean Water Act, and the Rivers and Harbors Act).

For context, we considered the distribution of wetlands within Harpers Ferry relative to the wetland distributions within four nearby parks of the National Capital Region (Figure 1) that are similar in size, support significant wetland habitats, and cover a gradient of decreasing urbanization of surrounding land cover. The four additional parks, in decreasing proximity from Washington, D.C., are Rock Creek Park, Monocacy National Battlefield, Antietam National Battlefield, and Catoctin Mountain Park. All five parks are located in either or both of the Piedmont and Blue Ridge physiographic provinces of the eastern United States.

Parks do not exist in isolation, and effects of surrounding lands on nature reserves have been well documented (Hansen and DeFries 2007). For our network analyses, we therefore extended each park landscape to fifty times the foraging range size used to build the graph networks (see below) to avoid missing important wetlands at the edges of parks (greater park landscape = 5-km-radius circle). This circle, centered on the centroid of each park, was large enough to contain each park, except for some small outlying parcels of Rock Creek Park and Harpers Ferry. The circles standardized area so that landscapes could be compared across parks.

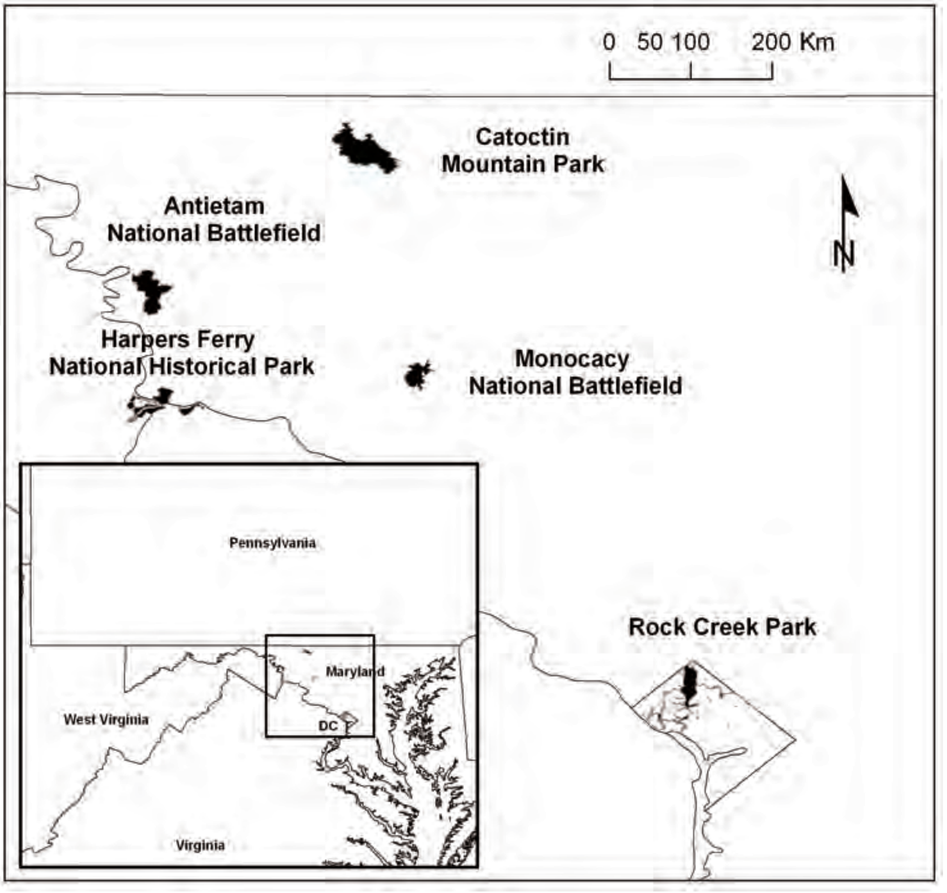


Figure 1. Study sites. An enhanced wetland inventory was conducted at Harpers Ferry National Historical Park and the results compared to wetland networks for other national parks in the region.

Methods

Possible wetlands were identified within Harpers Ferry based on aerial photography, GIS layers of park boundaries and water bodies, and prior knowledge of NPS natural resource personnel. All sites listed by the U.S. Fish and Wildlife Service's NWI were also considered as part of an initial assessment of wetland area. Following this geospatial assessment, groundtruthing and field mapping of wetland habitats were conducted using methods outlined by the Army Corps of Engineers Wetland Delineation Manual (USACE 1987). Wetlands encountered in the field were classified according to Cowardin's Classification of Wetlands as forested, emergent, aquatic bed, unconsolidated bottom, scrub-shrub, or rock bottom (Cowardin et al. 1987).

Mapping of wetlands from aerial photographs was done by searching for wetland features at a scale of 1:1200, and then digitizing them at a scale of 1:700. Digitizing was accomplished using ArcMap 9.2 software from Environmental Systems Research Institute, Inc. (ESRI), Redlands, California. GPS data collected in the field were used to guide the delineations, using a Trimble ProXR-1 GPS unit, since the GPS provides better accuracy in terms of seeing below the canopy when the photo is obscured. We used the following datasets for wetland identification:

- Six-inch resolution TIF format images acquired by the park from April 13, 2001.
- SPOT imagery from November 20, 2005.
- Digital orthophoto quarter quads (DOQQs) from March 24, 2004.
- USFWS NWI data.
- USGS NHD hydrography and drainage features.

During late spring and early summer of 2007, we visited all sites in Harpers Ferry, and searched for evidence of wetland hydrology. We recorded all dominant plant species at each possible wetland, and documented whether hydrophytic vegetation was present. For sites with more than 50% cover of hydrophytic plant species, we also checked for indicators of hydric soils by digging soil pits 12-inches deep and looking for evidence of reducing conditions. Thus, wetlands within Harpers Ferry were mapped and described using a combination of digital information and extensive ground truthing based on three criteria: hydrophytic vegetation, wetland hydrology, and hydric soils (USACE 1987). For other parks and for lands outside park boundaries, we relied solely on digital information to create wetland maps.

Landscape graphs are built from a combination of landscape structural information (here, the wetland maps) and information on organism traits (i.e., dispersal distances). We used bats to define connections for wetland networks. In addition to being a group of species of conservation concern globally and locally (Johnson, Gates, and Ford 2008), we selected bats as our model organism as they are potentially affected by not just the total area of wetlands but also the spatial distribution of wetlands (e.g., Ford et al. 2006). We assume that bat activity should be higher for more connected wetlands than for unconnected wetlands, as has been shown for waterbirds and other water-dependent species (Roshier et al. 2001). Based on the high levels of bat activity observed within 100 m of wetlands in the region (Lookingbill et al., forthcoming), we drew lines connecting all wetlands separated by less than 100 m.

A large number of well-developed indices are available for quantifying landscape attributes, based on properties of the landscape network (e.g., see Minor and Urban 2008). We chose two of these indices that emphasize different aspects of the graph: (1) graph diameter (G_{diam}), a measure of length of the largest component in the wetland network, where a component is defined as a collection of connected wetlands; (2) area of the largest component (A_{LC}), a measure of the amount of connected habitat. Ferrari, Lookingbill, and Neel (2007) provide a detailed description of the two metrics.

Results

Eleven wetlands were field characterized and delineated within Harpers Ferry, with an additional 10 potential sites identified by the desktop geospatial analysis as having some level of wetland characteristics (Figure 2, and see Tessel et al. 2007). In addition, considerable stream and river resources are included in the park, and are identified in Figure 2. Four of

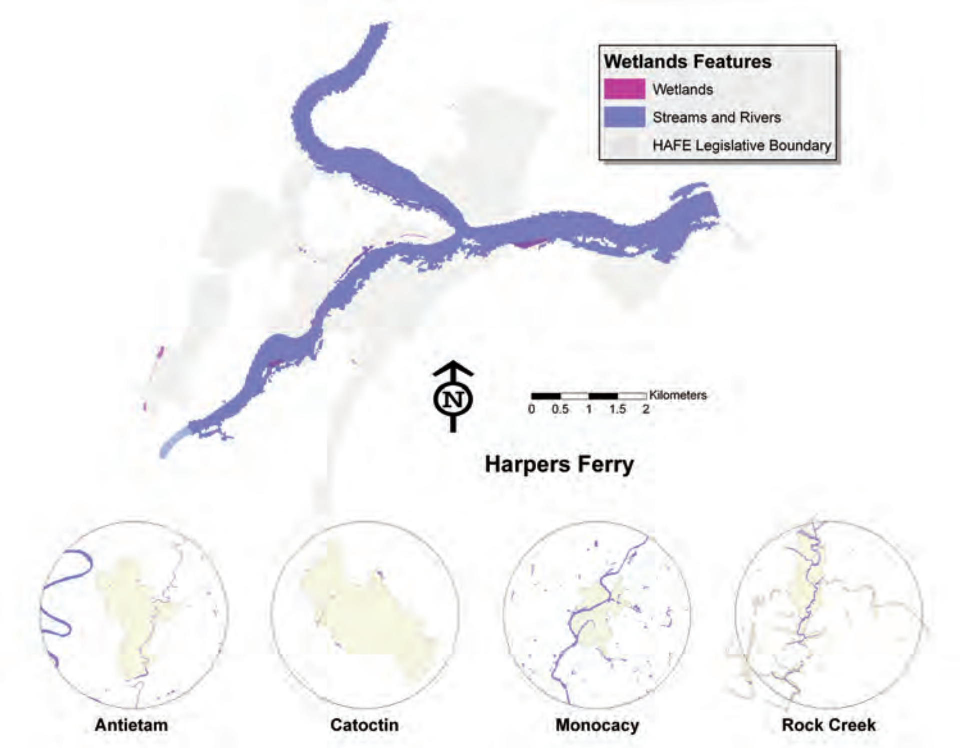


Figure 2. Wetland maps. The enhanced wetland map for Harpers Ferry combines information from digital geospatial data and field surveys. Also shown are wetland maps for 4 other parks in the region using a 5-km radius circle to define greater park landscapes.

the wetlands were characterized as forested, one was emergent, one was aquatic bed, two were palustrine, forested, and emergent at different parts, one was emergent and scrub-shrub at different parts, and two were emergent and aquatic bed at different parts. These wetlands were delineated at a broad scale to capture gradation in class type, and to be robust to inter-annual fluctuation in wetland location on floodplains. Three areas were floodplains or low areas, with many moist depressions dominated by the obligate wetland species, *Saururus cernuus* (lizard's tail). Hydric soils were generally found only within these depressions, but wetlands were delineated at a broader scale to avoid delineating around one species, and because every flood may change topography of the area, and the specific locations of each depression. Many of the wetlands had human-altered hydrology resulting from dams or wetland construction.

Two additional pond sites were recognized by the NWI as wetlands, and were readily delineated using aerial photos. The ponds were not visited owing to accessibility issues, and the certainty of the wetland designation and delineation. Several islands patches in the Shenandoah and the Potomac Rivers also could not be field characterized, but were recognized as wetlands. Three potential wetland sites identified by the NWI were not included in our final inventory due to the lack of hydric soils and wetland hydrology.

In total, 16% of the park area was mapped as wetland habitat. This is nearly double the amount of wetlands in the 5-km greater park landscape (Table 1). It is also substantially more than in any of the other park landscapes in the region (Figure 2, Table 1). By considering connectivity in addition to amount of wetland, the network metrics provided an independent measure of habitat quality. Graph diameter (G_{diam}), in particular, was strongly affected by the presence or absence of small stepping stone wetlands, and was uncorrelated to wetland amount ($R^2 = 0.24$, $p = 0.40$), though Harpers Ferry was exceptionally high in both amount and connectivity of wetlands (Figure 3). Over 90% of the wetland area at Harpers Ferry was connected, as indicated by the area of the largest component (A_{LC}) graph measure (Table 1). Rock Creek and Antietam also had relatively high proportions of their total wetlands contained within a single connected graph component; however, the lengths of the networks for these two parks as measured by G_{diam} were the shortest observed (Table 1).

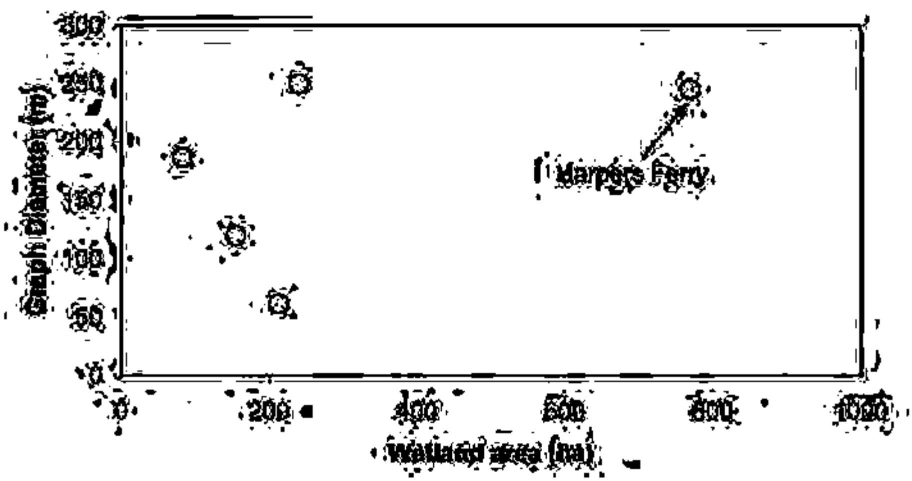
Discussion

By all measures, Harpers Ferry National Historical Park contains extraordinary wetland resources for the region. In addition to two major rivers, the park supports a diverse group

Table 1. Wetland area and graph metrics for 5 park landscapes (each landscape = 7854 ha). Graph networks built using a connectivity threshold distance of 100m as defined in Lookingbill et al. (in prep) for bats in the region.

Park	Wetland area - (ha)	Graph diameter - G_{diam} (m)	Area of the largest component - A_{LC} (ha)
Harpers Ferry	769	245	710
Antietam	213	62	172
Catoctin	83	187	20
Monocacy	240	250	158
Rock Creek	155	120	136

Figure 3. Wetland area vs. connectivity for 5 parks. Connectivity is defined using graph diameter, a measure of the length of the wetland network.



of wetlands on shallow slopes, mainly found on the floodplains of the Shenandoah and Potomac Rivers, and along streams and seeps throughout the park. The total amount and connectivity of these resources are exceptionally high relative to other parks in the National Capital Region. None of the other four parks or greater park landscapes contained as much as half the wetland area as found in Harpers Ferry—Monocacy was the park with the next greatest wetland cover as a percent of total park area (7.3%, compared to 16.4% for Harpers Ferry). The two other parks that had most of their wetland area connected via large streams (Antietam and Rock Creek) did not have networks that extended much beyond these stream corridors, as represented by their relatively low graph diameters. Thus, in addition to their important roles in water purification, shoreline stabilization, and flood mitigation, the wetland habitats within Harpers Ferry likely provide valuable foraging networks for the region's bats and other species with a proclivity for feeding over water.

Wetland management and restoration goals that do not consider the broader landscape may fall short of their target and waste limited funds. We have shown here how park wetlands can be considered not just individually, but within the context of neighboring wetlands within the greater park landscape. We argue that both the overall amount and configuration of critical resources such as wetlands are important in assessing whether a landscape is suitable for highly mobile species such as bats. Graph theory-based network analysis provides a valuable tool for quantifying landscape connectivity on a species-specific basis.

The importance of regional management efforts is increasingly recognized by the National Park Service, but the implementation of effective habitat conservation at this scale is often limited by the lack of coherent, cross-boundary management strategies. Landscape-level analyses of wetland networks provide the type of spatial information needed to work with neighbors and other local conservation agencies to inform regional management plans.

Acknowledgments

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Collaboration on the Vertical Frontier: AAC Mountaineers Assist with Yosemite National Park Lichen ATBI

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> In the end we will conserve only what we love. We love only what we understand. We will understand only what we are taught.
>
> — *Baba Dioum, Senegalese Poet-Conservationist*

Yosemite's imposing cliff faces are so prominently colored that they appear to have been streaked with paint. The nature of these streaks has been debated: are they mineral stains, or are they alive? Far beyond the reach of most NPS biologists, it has been difficult to investigate.

Yosemite launched its lichen all taxa biological inventory (ATBI) with support from the Yosemite Fund, and the NPS Centennial Challenge Initiative in 2007. For two consecutive years, the American Alpine Club (AAC) assisted by supplying more than 25 skilled climbers. Carrying forward the vision of John Muir, who was also an AAC member, these climbers relished the chance to actively participate as "citizen-scientists." Their skills allowed NPS botanists to safely explore Yosemite's spectacular cliffs (Figure 1).

Lichen communities are uniquely tuned to their environment and can be useful biomonitoring tools. Yosemite receives high levels of nitrogen deposition from California's Central Valley sources which is likely altering lichen communities. Lichens may also be good early indicators of climate change. Air pollution, particularly nitrogen deposition originating from California's Central Valley agricultural, industrial, and urban centers, is affecting Yosemite's naturally nitrogen-poor ecosystems. In some areas of Yosemite, the nitrogen deposition levels are up to ten times higher than natural background levels, and lichens indicative of high nitrogen levels are already common.

Similarly, climate change is thought to already have altered the forest structure and vegetation patterns in Yosemite. It is also likely that the ongoing warming trend will cause cold-adapted species, presently at the southern extent of their ranges, to retract northward. Species that are more heat and drought-tolerant may remain and perhaps expand their ranges northward. Such trends have been documented in lichen communities in Europe, and appear to be going on in Yosemite as well.

Although ATBIs, such as this project, are extremely valuable, they are often challenging to fund and staff. By using the AAC citizen scientist volunteers, we are able to minimize costs and staffing while establishing a monitoring baseline which can play a critical role in the preservation of Yosemite's native organisms and natural processes. At the same time, using citizen scientists allows us to fulfill our roles to engage and educate the public and increase

Figure 1. An AAC climber and NPS scientist Martin Hutten rappel down a seasonally dry section of Vernal Fall in Yosemite Valley to gather lichen samples.

its sense of stewardship toward our national parks. Our success in creating this powerful connection to parks and the natural environment is eloquently described by one of the project's citizen scientists, world-renowned mountaineer and AAC member, Carlos Buhler:

> This world of lichen is something that climbers see up close every day without knowing very much about it, so it's a chance for me to learn more about the world in which I live. I doubt I'll ever look at lichen the same way again. We cannot see accurately into our environmental future. Yet the natural environment we have grown to love, nurture, and believe in, is changing at amazing speed. Our minds are challenged to interpret what we see occurring on a macro level, let alone a microscopic one. But it is clear that identifying and mapping these micro level shifts in the natural balance of our wild areas will help us to interpret the impacts, and give an indication of the direction these changes will have on the ecosystems that sustain us.

Methodology

Our project methodology consists of three basic phases:

1. Compile baseline list from herbaria and literature to understand what species are known to occur and which species are expected to occur.

2. Determine under-sampled, lichen-rich habitats in Yosemite:

    - Collect voucher specimens of lichens suspected to be new to Yosemite, and solicit help from the AAC to reach lichens in difficult-to-access vertical areas.
    - Identify a large proportion of the Yosemite flora in difficult lichen groups, and, toward that end, establish a partnership with the McCune lab at OSU through the Cooperative Ecosystem Studies Unit (CESU).
    - Refine our search through the "Yosemite Lichen Blitz 2009," during which we will bring in lichen taxonomists whose expertise will likely complement the current lichen list.
    - Publish findings—the central Sierra Nevada flora is not well documented.

3. Installation of permanent sampling plots to document changes in lichen community composition due to nitrogen deposition and climate change (presently unfunded).

Project results to date

Only about 100 lichen species were previously known from Yosemite, whereas about 500 species are expected. The present list has grown to about 250, but many specimens still need to be identified. The AAC climbers collected almost 400 specimens from difficult-to-access micro-habitats on Yosemite's great walls, and on other cliff faces. Significant finds included *Solorina spongiosa*, which is the second record for California (Figure 2), and multiple species apparently new to the Sierra Nevada.

Figure 2. *Solorina spongiosa.* Crista-Lee Mitchel, AP photo.

In the next several years, we hope to be able to document as many as 500 different lichen species in Yosemite as additional, unexpected species will also inevitably be discovered. Unexpected finds include occurrences well beyond the known boundary of a species' range. Such occurrences are particularly important for conservation, because it is in these presumably isolated populations where the process of speciation, the refinement and development of a species' characters, runs its course. Our work is especially timely for those species that are presently at the southern extent of their range because they could, otherwise, be locally extirpated in a rapidly warming climate before scientists have a chance to document their presence in the park.

After the 2009 efforts, the majority of Yosemite's common lichens will be known, and park resource managers will have the baseline information needed to begin to design future monitoring projects to document the effects of air quality and climate change on Yosemite's lichen communities.

Acknowledgments

Funding for this project was provided by the Yosemite Fund. Brent Johnson, Lisa Acree, Meryl Rose, and Suzanne Thomas initiated this project. James Walton and Alison Colwell provided valuable assistance in the field and office. Without the help of more than 25 AAC mountaineers, we could not have sampled some interesting habitats. Jack Hoeflich and Lorna Illingworth of Yosemite Search and Rescue assisted with equipment, logistics, and staff time. Thanks to Heather Root, Bruce McCune, and Daphne Stone for assistance with difficult lichen identifications.

The Central Alaska Network Flowing Waters Program: A Multi-tiered Approach to Ecological Monitoring in Alaskan National Parks

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This study is part of the National Park Service Inventory and Monitoring (Vital Signs) Program for the Central Alaska Network (CAKN). Climate change and other anthropogenic impacts can be expected to have a dramatic effect on CAKN freshwater ecosystems; the streams and rivers portion of the Vital Signs program is designed to detect trends in the status of important components of lotic (moving water) ecosystems. These include hydrologic regime, geomorphology, water quality, and the distribution and abundance of freshwater fish, benthic macroinvertebrate, and diatom species. Fundamentally, the goal is to develop a logistically feasible, repeatable, and scientifically robust monitoring program. To the extent possible, we intend to incorporate indicators, data and methods developed as part of the Denali Long Term Ecological Monitoring (LTEM) program.

The Central Alaska Network consists of 3 park units—Denali National Park and Preserve (DNPP), Wrangell-St. Elias National Park and Preserve (WSENPP) and Yukon-Charley Rivers National Preserve (YCRNP). Together these parks cover approximately 21.7 million acres (34,000 square miles) of land, which is about the size of the state of Indiana. In fact, if the CAKN were a state, it would be the 39th largest state in terms of area. This network constitutes 26% of land in the National Park Service (NPS) system, and is nearly 80% as large as all NPS land in the lower 48 states combined. Nearly 12 million acres of the network is designated wilderness, and a substantial portion of the rest is wilderness quality. There are an estimated 28,000 miles of streams and rivers flowing through the network. A lack of high-quality hydrologic data makes it difficult to obtain accurate numbers at this time. However, based on these estimates, the CAKN contains nearly one-third of all stream miles in the national park system. Based on an average sampling reach of 250 meters and a sampling frequency of 40 reaches per year, it would take approximately 4600 years to sample the entire system.

These inherent challenges are exacerbated by the remoteness of most of the network, and a paucity of data. There are fewer than 200 miles of roads in the network, meaning that the vast majority of sites can only be reached by helicopter. Currently, there are no active stream gages in the network, and almost no historical flow data. With some limited exceptions, there are few other extant data, either biological or physicochemical. For example, prior to the start of the CAKN Flowing Waters program, there were no data on the distribution of benthic diatoms, a key component of stream and river ecosystems.

Like streams everywhere, the characteristics and dynamics of stream ecosystems in the CAKN are influenced at a variety of spatial and temporal scales by physical, chemical, meteorological, and biological phenomena. Factors such as basin geology, topography, climate, and terrestrial vegetation community composition are nearly universal drivers of stream ecosystem structure and dynamics. Other determinants include flow regime (hydrology), habitat structure (geomorphology), temperature regime, and water chemistry. These in turn constrain ecosystem characteristics such as nutrient dynamics, primary productivity, organic matter decomposition, and ultimately biodiversity.

Due to the extreme climate that characterizes arctic and subarctic regions, the streams of the CAKN are substantially affected by extreme winters, glaciation, and permafrost. These differences present unique challenges, and an important opportunity to document the expected dramatic alterations in these systems in response to climate change. Melting permafrost can be expected to have a substantial effect on nutrient concentrations and transport, as well as on hydrologic regime, and connectivity between lakes and streams within catchments. The extent of glaciation within stream and river basins has a profound influence on all aspects of lotic ecosystems. Glacially-dominated streams tend to be highly dynamic and extensively braided, with a hydrograph that is characterized by extreme diurnal fluctuations in the summer months. Ongoing climate warming can be expected to alter these systems dramatically as glacial melting accelerates, the melting season increases in length, and glaciers continue to retreat. Another potentially damaging effect of climate warming is invasion by exotic species. To date, exotic species are not thought to be a problem for aquatic ecosystems in most of Alaska. However, we can expect northward migration of exotics to increase in the near future. Examples include whirling disease, and New Zealand mud snails. Furthermore, there is some evidence that nuisance blooms of the native diatom *Didymosphenia geminata* are increasing in scope and frequency already, a phenomenon that has been attributed (in other areas) to climate warming.

In addition to ecosystem perturbations related to climate change, other anthropogenic stressors are also expected to impact stream ecosystems in the CAKN. For example, atmospheric deposition of contaminants originating outside the parks is likely to become more important in coming years. Two airborne contaminants of special concern are nitrate, which can have substantial effects on stream nutrient dynamics, and mercury, which after methylation can bioaccumulate to very high levels in aquatic food webs.

Although they are currently less of an issue for Alaskan wilderness parks, local-scale stressors such as increased visitation, infrastructure development, resource extraction, and the accidental or purposeful introduction of exotic species (for example, Atlantic salmon). The CAKN flowing water monitoring program is designed to capture the effects of these and other potential changes on important aspects of stream ecosystem structure and function. More specifically, the overall goals of the program are to describe the current status of stream ecosystems in the CAKN and to detect decadal-scale trends in ecosystem condition, landscape context, instream biodiversity, hydrology (flow regime), channel characteristics (geomorphology), water chemistry, and temperature regime. A related goal is to provide a robust methodology for park management to use to evaluate water quality at specific sites of management concern.

A major focus of the program will be on the use of biological indicators to estimate ecosystem condition, and to detect changes in that condition over time. Biological indicators of ecosystem condition generally consist of various metrics that singly or together describe important aspects of biological communities. Biological indicators for streams typically are derived from metrics that describe either aquatic macroinvertebrate, benthic diatom, or freshwater fish communities, either singly or in combination. For example, indicator metrics may describe overall species composition, trophic structure, physiological condition, or the presence of sensitive taxa. The primary advantage of biological indicators is that they integrate the effects of ecosystem stressors over both space and time. Stream ecosystems typically exhibit a great deal of spatial and temporal variability, making them difficult to describe accurately based on physical or chemical data collected in a single visit. The biota, however, respond to and integrate the effects of these changes because resident organisms are exposed to them continuously over the course of their lifetimes. Moreover, different communities respond at different spatial and temporal scales. For example, benthic diatoms turn over rapidly and hence tend to respond to relatively short-term effects, whereas aquatic macroinvertebrate larvae may live for months to years and hence respond over longer time scales. In recent years, biological indicators have become commonly as tools for water quality assessment. Such biological assessment methods are thought to more accurately reflect overall water quality than traditional approaches that rely on water chemistry. A major goal of the CAKN streams program, therefore, will be to use biological indicators not only to assess overall status and trends in stream ecosystem condition, but also to develop robust bioassessment tools that park managers can use to address specific water quality issues.

Currently, we are evaluating a variety of physical, chemical, and biological metrics to detect ecosystem change in CAKN streams. These include the following: remotely sensed imagery; instantaneous discharge measurements; spherical panoramic photography; detailed habitat surveys; water chemistry sampling (field and lab); fish presence, physiological condition, and tissue contamination; macroinvertebrate species composition and abundance; and benthic diatom species composition, chlorophyll content, and abundance. In addition, we hope to institute a program of continuous data collection of stage height, temperature, and water chemistry at a subset of sampled sites.

Perhaps the most critical aspect of the program is determining where and when we will sample. In order to detect "real" trends, we need to account for natural variability of what we are measuring. This variability may be spatial, temporal, or more commonly, both. This is particularly the case for streams, which are exceptionally variable and dynamic ecosystems in both space and time. Survey design can help to account for some of this variation. For example, the use of a small number of sentinel sites (that are sampled frequently) can eliminate the effects of spatial variability, and result in increased power to detect trends. However, this approach sacrifices inference to unsampled sites, both because of the small number of sites sampled and, more importantly, because sentinel sites are typically chosen for accessibility (i.e., they constitute a judgment sample). Conversely, we obtain maximal spatial inference with a probabilistic survey of many sites. However, given the cost of accessing remote locations, there will typically be a relatively small number of sites sampled each year, and hence a long return interval for each site. This results in a greatly reduced ability to quantify temporal variability and hence to detect trends. In an area the size of the CAKN, it might easily take many decades to begin to detect trends with any degree of confidence.

To address these challenges, the CAKN program is combining these approaches into a multi-tiered survey design. The survey design consists of three types of sites. We will sample a moderate number of sentinel sites. These will be selected by accessibility (a judgment sample), and will be sampled annually for an increased sensitivity to trends. We will also sample a large number of "synoptic" sites. These will be sampled on a long return interval (a relatively small number will be sampled each year). The synoptic sites will be selected using a probabilistic approach (using the generalized random tessellation stratified, or GRTS, algorithm) to increase inference to unsampled sites. The GRTS algorithm generates a probabilistic sample of potential study sites that is spatially balanced. In addition, any consecutive subset of sites on the resulting list is also a spatially balanced sample. This has obvious advantages when the costs of site access are high. The GRTS sample can also be stratified and weighted by relevant criteria. For the CAKN program, the GRTS sample was stratified by accessibility (based on a GIS layer representing cost of access), and unequally weighted by stream size to maximize the proportion of streams in the final sample that would be wadeable.

Finally, we will designate a very small number of intensively monitored sites. These sites, a subset of the sentinel sites, will be sampled multiple times each year. At these sites we will collect many types of data continuously (e.g., temperature, discharge, precipitation, water chemistry) to provide more insight into diel (daily) and seasonal dynamics. We will also collect more types of data at these sites (e.g., permafrost active layer depth, precipitation) to provide a more robust platform for the development of both explanatory and predictive ecosystem models. These models will facilitate the interpretation of data collected at the synoptic and sentinel sites and provide a basis for the development of predictive hypotheses that may allow more focused data collection. The data collected at the synoptic and sentinel sites will, in turn, allow us to both calibrate and evaluate the models that we construct.

We are currently in the early stages of implementing this approach. To date we have established 19 sentinel sites in 2 park units (DNPP and WSENPP). We have also generated a GRTS sample for WSENPP that is in the process of being evaluated. The initial GRTS sample consisted of 400 potential study sites, 200 in each of the 2 accessibility strata. Although the goal was a final list of 100 sites, we selected 300 oversample sites to account for the likelihood that many sites would not be sampleable. Accessibility was defined largely by the probability that a helicopter would be required to access the site. Each sample was weighted to ensure overrepresentation of second- and third-order streams; stream order is an imperfect surrogate for stream size, but is much more easily extracted from spatial data for large numbers of sites than better surrogates, such as upstream contributing area. Of these 400 sites, 23% were eliminated as unsampleable using remotely sensed data. 115 of the remaining 307 sites were evaluated by helicopter overflights in 2008. Of these 115 sites, 66% were determined to be unsampleable or probably unsampleable, leaving a maximum of 34% that we expect to be able to sampleable. Based on these numbers, we should be able to generate a final list of 100 sites. In 2009, we will be attempting to formally implement the GRTS survey in WSENPP. We hope to expand the program to include a GRTS sample of DNPP in 2010 and YCRNP in 2011.

Foundations of Marine Reserves in the California Channel Islands

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Channel Islands National Park, off the coast of Southern California, includes the waters one nautical mile around each of the five islands. Overlapping designations for these waters include Channel Islands National Marine Sanctuary, International Biosphere Reserve, and Areas of Special Biological Significance (ASBS). Many people see these layers of special names (park, sanctuary, reserve) and assume that the marine life is fully protected. In fact the National Park has no management authority over the marine life, the National Marine Sanctuary protects the habitat with prohibitions to mining and hydrocarbon development, the Biosphere Reserve goals are "to promote and demonstrate a balanced relationship between humans and the biosphere," and ASBS regulations protect water quality. Until 2003, with the creation of State Marine Reserves and Conservation Areas that prohibit or limit exploitation of marine life in about 20% of those waters, only one small area, the Anacapa Ecological Reserve, fully protected the fish and invertebrates in the area.

The islands lie at an area of mixing cold and warm water currents, which creates a strong regional temperature gradient, representing the environmental conditions of a large portion of the California coast within an area of less than 100 km. This environmental gradient results in a highly diverse and productive marine ecosystem. California Department of Fish and Game (CDFG) landings data show that nearly 20% of the state's overall fish landings come from the park and sanctuary waters. However, the park islands only constitute about 5% of the total California coastline. The marine resources are owned and managed by the state.

When the park was created in 1980, Congress mandated that the National Park Service report on the condition of the resources of the new park. Gary Davis and others established a long-term marine monitoring program, including the monitoring of kelp forest, rocky intertidal, and sand beach communities. Since the state owns and manages the marine resources, CDFG scientists were brought in early to collaborate in the design of the marine monitoring program. Their experience and local area knowledge were especially valuable in the early phases. We also worked closely with research and monitoring programs from other partners, such as Minerals Management Service, National Marine Fisheries Service, various universities, and local governments.

So why monitor park resources, and spend money and time to determine the condition of these resources? They are already 'protected' in many people's minds. As mentioned above, people often make the assumptions about protections and are surprised to learn that the National Park and National Marine Sanctuary only play an advisory role for management of marine life. Unfortunately, habitat and population fragmentation, unsustainable exploitation, invasion by alien species, and pollution threaten the integrity of park ecosystems across the nation. Marine ecosystems are no different. Park managers must convince others to protect and preserve parks, and the required collaboration requires factual information about ecosystem health. The NPS understands that knowledge is necessary for proper management.

An example of the importance of long term monitoring information is provided by the example of the Anacapa Ecological Reserve. What we learned about this reserve laid the foundations of the network of Marine Protected Areas that is now in place at the islands.

Soon after beginning the kelp forest monitoring, Southern California was affected by largest El Niño on record, in 1983. Warm water events such as this cause great disruption in the marine environment. As much as 80% of the region's kelp beds disappeared. Beyond the immediate effects of the storms and warm water, this El Niño event brought to light many of the issues that had been brewing for years. Decades of unsustainable fishing, the dumping of pollutants, and the spread of alien species and disease had destabilized the Southern California marine ecosystem.

By the 1980s, after becoming one of the most popular seafood items in the area, rockfish were recognized as being severely depleted. Boccacio and cow cod populations declined to about 5% of the un-fished population. Large closures for cow cod were established in Southern California in 2001, restricting both commercial and sport fishing.

All abalone take in Southern California was banned in 1997 as most species were severely depleted by fishing and disease. Two abalone species are now listed as endangered, and other species were viewed with concern.

Giant seabass are large groupers that can reach a size of two meters, and over 200 kg. Nearly wiped out by over-fishing, the species has been recovering since being protected in 1978. Recovery was given an additional boost with the ban on gillnets in nearshore waters. As word of their recovery spread, divers started going to the islands just to observe and photograph these giant fish. This was significant, because fish were finally being seen as having value as a non-consumptive commodity.

At the same time, other resource conflicts were appearing faster than management could deal with them. New fisheries began impacting species once thought undesirable, such as hagfish or sea cucumbers. Often fisheries were already in collapse before any management actions were taken. Ecological conflicts arose, such as the potential impacts on seabird populations caused by squid fishing. Several boats will work together in this fishery to attract squid to the surface with up to 50,000 watts of light. We became concerned that the fleet fishing immediately below colonies of nocturnal nesting seabirds at Santa Barbara and Anacapa Islands could cause disorientation, and expose the birds to predation.

These are examples of events that changed public and agency views of marine management. By the 1990s, environmental groups and the ocean-going public, dissatisfied with ocean management, began to demand action. In 1992, the gill-net issue was taken to a public vote. Policy makers and scientists were pushed aside by emotions and advertising campaigns. This act also set up the creation of several highly contested marine reserves along the coast that resulted in poorly planned sites. These situations were a wake up call for many managers.

In 1998, a group of recreational fishermen, unhappy with the declines in catches that they had observed over the years, proposed that marine reserves be established at the islands to protect 20% of the islands. The Channel Islands National Marine Sanctuary, with the California Department of Fish and Game, spearheaded a community-based plan to design a network of marine reserves at the islands. Thus the Marine Reserve Working Group (MRWG) was formed, consisting of 22 stakeholder groups from involved members of the public, government agencies, fisheries representatives, and conservation groups. Science and socio-economic panels provided information and professional review (Davis 2005). Even with a few irreconcilable objections, in the end it was a collaborative effort which would not have been possible without the local knowledge of biologists and fishermen, the determination of local citizens, and the combined resources of different agencies.

Support for the reserve proposal was spawned from monitoring data that showed the benefits of a small no-take marine reserve that had been established at East Anacapa Island in 1978. The Anacapa Ecological Reserve was only 15 hectares, but showed remarkable differences in diversity and abundance when compared to nearby kelp forest sites. Two of the kelp forest monitoring sites are within the reserve area, and kelp forest monitoring data made it possible to convince managers and the public that the reserve had a positive effect on the marine environment. Divers could see the value, but anecdotal descriptions do not carry as much weight as factual data.

Fishing industry lobbyists often identify pollution, not fishing, as the cause of declines in abalone and urchin populations. Southern California coastal waters are not pristine. Pesticides, including DDT, were dumped off the coast of Southern California for decades. Storm drains, agricultural runoff, and over a billion gallons of sewage enter the southern California Bight daily. Nevertheless, the waters of the Anacapa Reserve are equally polluted, if not more polluted, than other parts of the park more distant from mainland sources of contamination. We were able to demonstrate that abalone and urchin populations in the Anacapa Reserve remained at healthy levels, while adjacent fished populations declined (Figure 1). Scientists and managers could see that having an un-fished area available as a control allows detection and measurement of the combined effects of pollution, climate change, and fishing.

The effects of fishing may seem obvious, but the cascade of indirect effects from resource exploitation may not be so noticeable. When purple sea urchins were released from competition with abalone and red sea urchins in the fished parts of the park, their densities jumped from a few thousand per hectare to hundreds of thousands per hectare (Figure 2). Disease now appears to be the major limiting factor on purple sea urchins in these areas (Behrens and Lafferty 2004). These high densities of purple urchins graze virtually all kelps, and physically exclude other species, creating vast areas known by divers as 'urchin barrens.'The beneficial effects of reserves seem clear. Inside the reserve, where competition and predation keep the population in check, purple sea urchin densities remained consistently lower, showing only minor, temporary increases following El Niño events. Here, giant kelp recovers quickly (1–2 years) after El Niño events, providing primary production of food and shelter among its fronds. The physical structure of kelp slows currents, creates eddies that entrain passing larvae, and enhances local recruitment of other organisms.

We know from past studies that predator-prey interactions can lead to changes at many levels of the food web. In kelp forests, one of the key dynamics is between kelp, urchins, and

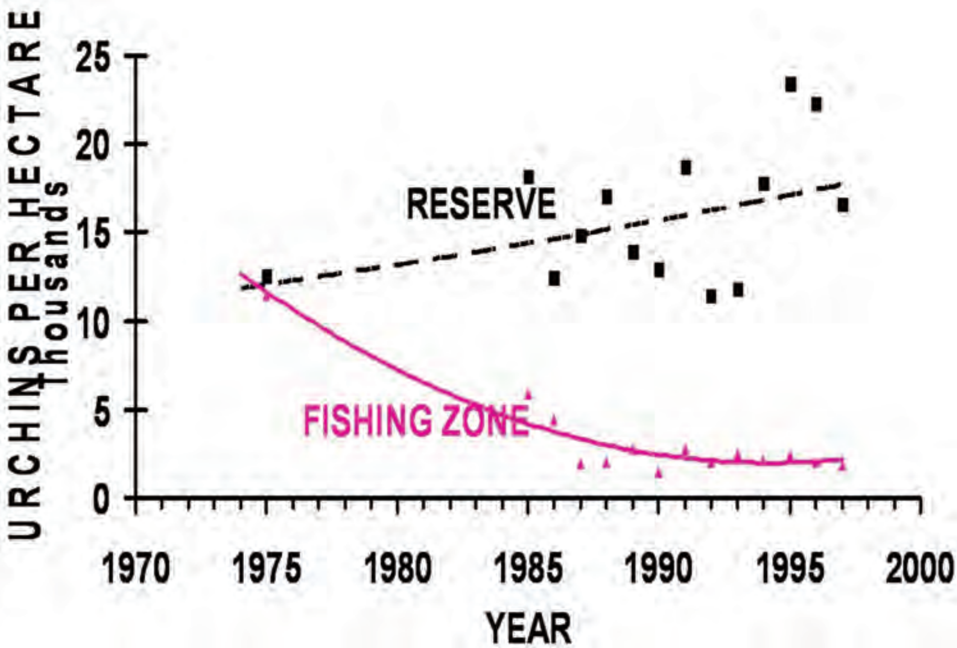

Figure 1. Large red sea urchins (>83 mm), *Strongylocentrotus franciscanus,* declined in fished areas, but the population remained stable inside the Anacapa reserve (relative to 1974 data from NSF study of feasibility of red sea urchin fishery, number of urchins >105 mm).

urchin predators. In places where sea urchin predators are rare, sea urchins, when starved of drift algae, will leave the safety of their crevices and denude whole kelp forests, holding them in that state until some disturbance reduces the urchin population. However, in places where urchin predators like lobsters are common, such as the Anacapa Ecological Reserve, urchin densities are maintained at normal levels and kelp can flourish (Lafferty 2004). Sheephead have a similar impact on sea urchin numbers. They were found to feed on purple urchins, not the commercially valuable red urchins.

Our kelp forest monitoring data was the only fishery-independent data available for evaluation of reserve effects. In the Anacapa Reserve, we could demonstrate that the problems in the kelp forest community of Southern California were moderated within the reserve compared with fished areas. Because of the monitoring program, we could demonstrate the value of no harvest areas. When the Marine Reserve Working Group was formed, evidence from previous monitoring was important in convincing fishermen to set aside nearly 20% of the island waters for protection. Having a monitoring program in place was also important in convincing fishermen that management attention would continue, and that results would be tested and evaluated. One of the biggest fears of fishermen was that the reserves would be set aside, simply locked up and forgotten. Fishermen feared they would lose valuable fishing grounds with no way to prove or disprove the value of reserves.

After three years, a plan was developed by the Marine Reserve Working Group that everyone could live with (though enthusiasm varied among groups). The California Fish and

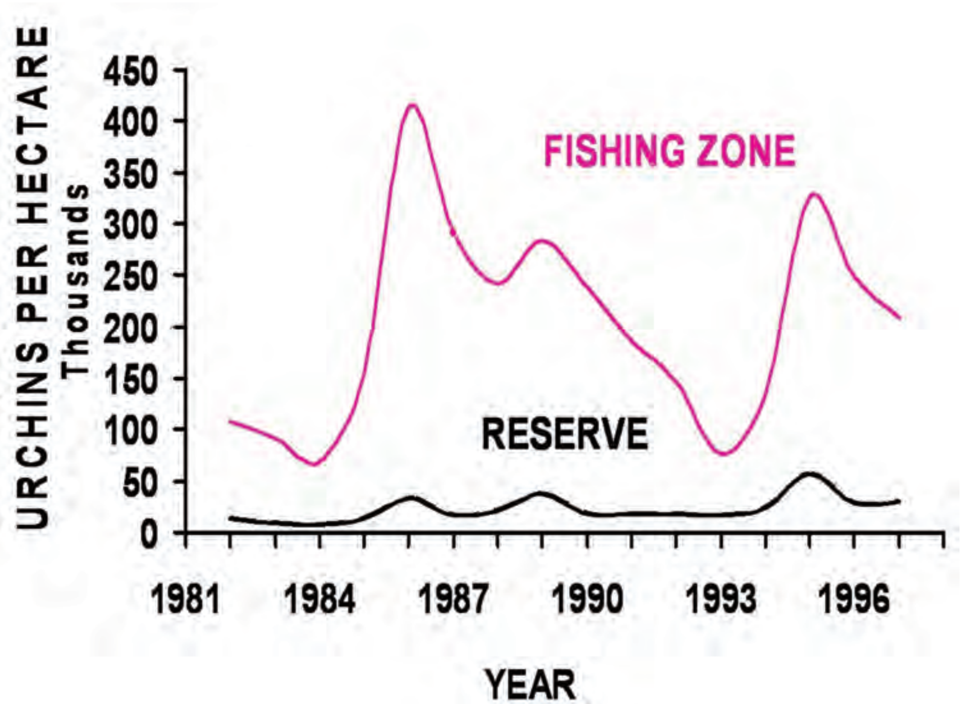

Figure 2. Purple sea urchins, *Strongylocentrotus purpuratus,* underwent dramatic population fluctuations in fished areas. Inside the Anacapa reserve, purple sea urchin numbers remained stable in the presence of predator and competitor populations.

Game Commission adopted the plan, and the reserve network went into effect in April, 2003, placing approximately 20% of the park waters into Marine Protected Areas. The reserves were extended into federal waters in the summer of 2007. The network now encompasses 318 square miles, making it the largest reserve network in the continental United States. The Anacapa Ecological Reserve is incorproated into the much larger Anacapa Island State Marine Reserve. Currently the Marine Life Protection Act initiative is underway to try to establish a network of reserves throughout Southern California. There are about 70 stakeholders involved, and the issues are very complex.

Five years after the establishment of the reserves, a review conducted by the National Center for Ecological Analysis and Synthesis analyzed data from the kelp forest monitoring and other programs (Aireme and Ugoretz 2008). No one expected to see much from the first five years, but surprisingly there were strong positive trends supporting predicted changes in the reserves. Analysis showed that there are strong differences in community structure within the parts of the Anacapa Reserve protected since 1978. It also appears that the new reserve is starting to resemble the old reserve.

Results show there are more and bigger fish in reserves. Older reserves had twice the biomass of new reserves. Reserves are characterized by high abundances of lobsters, turban snails, and sponges. Non-reserves tend to have high abundances of purple urchins, sunflower stars (which are purple urchin predators), and Kellet's whelk. Targeted fishery species tend to be larger in reserves. This is important because larger fish produce more eggs.

In summary, through a well designed and consistent monitoring program with a lot of collaboration, we were able to show the value of a small protected area, and change the way we look at and manage marine resources in California.

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Unauthorized Fossil Collecting from National Park Service Shorelines: Servicewide Policy and Perspectives

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Background: Scale of unauthorized fossil collection

Since 2002, the NPS has been developing baseline paleontological resource inventory reports for each of the 32 NPS inventory and monitoring networks (ecosystem-based clusters of park units). These reports are literature-based, assessing past and present research, museum collections inventories, and evaluation of park resource management issues and needs. The reports address all contexts in which fossils are found in each park in each network. Through this endeavor, the NPS has ascertained that at least 211 park units have fossils either *in situ* or in museum collections. Thirty additional parks contain geologic formations that potentially contain fossils, although no fossils have yet been documented in those particular parks. All 32 reports should be completed by 2010.

The servicewide perspective provided by these reports enables the NPS to detect resource management trends, contexts, and issues that are shared by multiple parks or issues that are unique to a particular network or region. One issue revealed during the research for these reports is the unauthorized collection (collection without an NPS-approved permit) of fossils from at least 12 coastal parks along the Atlantic and Gulf coasts, and the Great Lakes. Such collection contravenes NPS regulations, which specify that fossils may be collected in parks only for scientific or educational purposes pursuant to an NPS-approved research and collection permit.[1] Without such a permit, the collection, removing, digging, or injuring of partial or entire non-fossilized and fossilized paleontological specimens from their natural state is prohibited Servicewide.[2]

The types of fossils known to have been collected in parks without authorization from NPS park managers, based on written documentation or photographs by the park or Geologic Resources Division staff, include 400-million-year-old Petoskey stones (ancient corals), Miocene shark teeth and marine mammal bones, Pliocene marine invertebrates and vertebrates, Pleistocene invertebrates and shark teeth, and ammonites. Some of these fossils have been physically chiseled out of the bluffs along the parks' shoreline, while others have been picked up from the beaches where they had washed up.

Approximately 60 park units which preserve coastal or shoreline resources are now known to also preserve fossils. Most likely, unauthorized collection in these parks is more widespread than the 12 parks in which it has been documented.

Why unauthorized fossil collection in parks is a problem

There are six reasons why the NPS should address the issue of unauthorized fossil collection in parks:

1. *Inconsistent with the NPS Organic Act.* Fossils are not renewable resources. Allowing fossils to be collected from park lands without NPS authorization is contrary to the Act's intent and mandate to conserve park resources unimpaired for the enjoyment of current and future generations.
2. *Prohibited by NPS regulations.* As stated above, the collection of fossils in parks without a permit is clearly prohibited by NPS regulations. These regulations apply (a) on federally owned lands and waters, (b) on lands and waters that are administered by the NPS pursuant to a written instrument or over which the NPS holds a less-than-fee interest, and (c) in waters subject to the jurisdiction of the U.S. up to the mean high water line, regardless of the ownership of the submerged lands.
3. *Contrary to NPS management policies.* The policy of the NPS is to protect geologic features from the unacceptable impacts of human activity, while allowing natural processes to continue. Geologic features are defined as including paleontological and paleo-ecological resources, such as fossilized plants or animals, or their traces. It is also the policy of the NPS to take appropriate action to prevent unauthorized fossil collection.[3] Failing to effectively address unauthorized fossil collection is inconsistent with these policies.
4. *Undermines NPS law enforcement.* Visitors who collect fossils in a park without NPS permission may develop the mistaken belief that it is permissible to collect fossils, or other park resources, in other park units. They may convey this misapprehension to their friends and families, creating a negative, cascading effect that complicates the management of multiple parks, and the ability of NPS law enforcement staff to protect park resources. It is inconsistent for the NPS to enforce the regulatory prohibitions on the unauthorized collection of some resources such as archeological specimens, but not enforce the prohibitions on the unauthorized collection of fossils. This inconsistency may also complicate the ability of federal magistrates to impose effective penalties for the unauthorized collection of NPS resources.
5. *Diminishes the value of the resources.* The collection of these fossils from NPS shorelines may contribute to the loss of scientifically significant or interesting fossils from the public domain. Scientifically significant fossils have been found along the shorelines of several parks, including a well-preserved walrus skull at Cape Hatteras National Seashore, and another mammal skull at George Washington Birthplace National Monument. Shark teeth at George Washington Birthplace National Monument have been found in association with Native American shell middens, indicating the shark teeth were used as tools. Fortunately, these specimens were collected by researchers or knowledgeable volunteers, and now reside in museums. Had these fossils been collected and removed from the park without authorization, their scientific and educational value would have been greatly diminished.
6. *Adversely impacts future visitor experience opportunities to discover fossils in a natu-*

ral context. One visitor recently told NPS staff at George Washington Birthplace National Monument, "We don't find the big shark teeth like we used to!" She indicated that she had collected shark teeth with her family from the time she was a young girl, and that her family could regularly find large shark teeth in the past. Although it is possible that the lack of large shark teeth stems from a sudden reduction in the numbers of shark teeth contained in the park's eroding bluffs, the more likely explanation is that today's large number of collectors reduces a visitor's chances of finding the large shark teeth, resulting in lost visitor experiences and educational opportunities.

Why it is difficult to stop unauthorized fossil collection

For at least four reasons, it is very difficult for the NPS to stop the illegal collection of fossils from NPS shorelines.

1. *Regulatory confusion.* Although the NPS regulations cited above clearly prohibit the collection of fossils in parks without an NPS-approved permit, another NPS regulation potentially undermines those prohibitions by allowing superintendents to permit the casual collection of unoccupied seashells.[4] It is very difficult for most park visitors to distinguish between fossilized and modern seashells.
2. *Jurisdictional confusion.* It can be difficult for the NPS to determine and reasonably prove that a fossil was actually collected within park boundaries. Many coastal parks' boundaries follow the mean high or mean low water line, or sometimes both. Fossils collected from the water beyond these boundaries are not within NPS jurisdiction. As park shorelines erode or accrete, the location of the exact boundary line can become unclear. Therefore, fossils collected from beaches may or may not be within NPS jurisdiction.
3. *Enforcement difficulty.* Given the millions of park visitors who spend time on park beaches every year, and the ease of picking up fossils from exposed beaches and bluffs, it is very difficult for NPS law enforcement rangers to be at the right spot at the right time. However, the March 2009 enactment of the Paleontological Resources Preservation Act, P.L. 111-11, which directs federal land management agencies, such as the NPS, to take certain measures to increase the protection of fossils, may strengthen the ability of law enforcement staff to predict, detect, and promptly respond to unauthorized fossil collection.
4. *Public perception.* Parks may experience public pressure to allow the continued collection of fossils from park shorelines. In some park areas, fossil collecting is a family tradition. Fossils are very popular with the public, and their removal from the park is viewed by many as a harmless activity. The continuous erosion of park shorelines and the fossils therein creates the impression that these fossils are in plentiful supply, or will be lost anyway, so collecting them would not be harmful.

Potential NPS management strategies

Currently, park managers address unauthorized fossil collection differently. Staff at George Washington Birthplace National Monument have put up signs along the beach explaining that the collection of all objects from the park is prohibited. Yet a recent park photo revealed a woman collecting fossils from the beach right behind the sign! George Washington Birthplace National Monument staff have also made personal contacts with park visitors to explain the NPS rules, and have issued citations in some cases.

Another approach, utilized by staff at Sleeping Bear Dunes National Lakeshore, is the differentiation between casual and directed (or even commercial) collecting. Education, outreach, and warnings are used in the former situation, while citations and confiscation are used in the latter situation.

Five additional strategies might include the following:

1. *More outreach, education, and interpretation.* The NPS should continue or increase visitor education efforts to highlight that the NPS resource conservation and stewardship mandate includes fossils. Outreach, education, and interpretation should show that the appearance of previously-unseen fossils, and the erosion or weathering of known specimens, is a natural process, and that leaving the fossils in place allows the next visitor to personally experience that process as well.
2. *Explicit servicewide survey and guidance.* It may be helpful for the NPS to assess the full scale of unauthorized fossil collection and to develop guidance on successful methods of reducing this problem.
3. *Consider and incorporate social science data.* It might be helpful for NPS natural resources and law enforcement staff to work with the NPS social science program to develop signs, brochures, and other forms of communication that are most effective at reducing visitor theft of NPS resources and increasing the willingness of the public to bring new discoveries to the attention of the NPS.
4. *Encourage and support more fossil monitoring and data collection by scientists, amateur collectors, local fossil clubs, and students.* These volunteers might serve as the park's eyes and ears by monitoring park shorelines for the appearance of newly-exposed fossils, alerting park staff about unauthorized collectors, and helping park staff collect exposed fossils and related data for scientific study, and park museum collections. Several park museums contain specimens collected by park staff and visitors along the park shoreline.
5. *Revise NPS regulations.* Revising or expanding NPS regulations to implement the Paleontological Resources Preservation Act, and to address problems such as the confusion caused by the collection of unoccupied seashells, might help the NPS better protect fossils.

Conclusion

As our knowledge of the fossil record, that is protected by the national park system, continues to grow, so too does the knowledge of the fossil management issues shared servicewide. Through increased documentation efforts and a servicewide management perspective, the fossil resource management techniques learned and applied at one park may be valuable and adaptable for other parks. Thus, the unauthorized collection of fossils from NPS shoreline parks is not solely a coastal issue. It is an issue that should be addressed by the entire NPS resource management community.

Endnotes

1. 36 CFR [Code of Federal Regulations] sec. 2.5(a).
2. 36 CFR sec. 2.1(a)(1)(iii); 36 CFR sec. 13.20(e)(1).
3. NPS Management Policies sec. 4.8.2 (2006).
4. 36 CFR sec. 2.1(c)(1).

Runaway Dinosaur Tracks: Cooperative Efforts to Preserve Fossil Resources at Two National Natural Landmark Sites

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Long-term preservation of fossil resources has unique challenges, given that the natural preservation state for these resources is to be buried. Intentional or non-intentional excavation are the means by which we are made aware of paleontological resources. Once exposed, they become available for scientific discovery, study, and interpretation; however, they also become susceptible to weathering, erosion, and collection. Thus landowners of lands containing fossil resources, who are either charged with conservation by law, policy or organizational mission, or voluntarily elect to conserve fossil resources, face a variety of challenges and key decision points. This paper explores the methods undertaken and partnerships employed for long-term preservation of dinosaur track resources at two National Natural Landmark (NNL) sites. The Morrison Fossil Area in Colorado and Dinosaur Valley in Texas are designated NNL sites in recognition of their significant paleontological resources and both are actively addressing the issues associated with long-term preservation of such heritage resources.

The National Natural Landmarks Program was established by the Secretary of the Interior in 1962, under authority of the Historic Sites Act. Administered by the National Park Service (NPS), the primary program objectives are to identify, recognize and encourage the preservation of sites containing the best remaining examples of biological and geological features that illustrate our nation's natural heritage. With designation occurring on lands of any ownership, the NNL Program is the only natural areas program of national scope that recognizes outstanding examples of biological and geological features in both public and private ownership. To date, 586 sites in 48 states, 3 territories, and the Commonwealth of Puerto Rico have been designated as NNLs.

Landmark designation is not a land withdrawal, does not change ownership of the site, does not require public access, and does not dictate use nor impose any land use activities. It is a recognition program highlighting and raising public awareness of significant natural resources. Landmark designation also creates a partnership between the National Park Service and the landowner, such that the NPS can be an advocate for and assist in the conservation of significant natural resources.

Based on NNL significance criteria of illustrative character, present condition, rarity, diversity and value for science and education, NNL resources are considered to be some of the best examples of those biological or geological features within a bio-physiographic province. Potential NNL sites go through an in-depth evaluation by a qualified scientist(s) to determine the fit of the potential site as it relates to these national significance criteria and in comparison to other sites with similar resources. Evaluation reports go through internal and external review and designation is ultimately conferred by the Secretary of the Interior, with owner consent. More information on the NNL Program can be found at www.nature.-nps.gov/nnl.

The Morrison Fossil Area (locally known as Dinosaur Ridge, see www.dinoridge.org), located approximately 35 miles west of Denver, Colorado, was designated a NNL in 1973. The site is significant as the site of the first major discovery of giant dinosaur fossil bones in North America. In the late 1800's, fossils from nine different species of dinosaur were recovered, seven of which were newly discovered species. The site also contains a dinosaur trackway with over 300 dinosaur tracks that were made by three types of dinosaurs and one crocodile.

The tracksite is located in the South Platte Formation, which is composed primarily of thin to massive sandstone units with thin shale interbeds, and has a slope of 37–38 degrees (77%). The site is also open and exposed to the outdoors and thus is susceptible to weathering (Figure 1).

Natural erosional processes have taken a toll on the tracksite over the years resulting in the loss of tracks. This has typically occurred in the form of small rocks slides. The interbedded shale begins to crumble after being compromised by water seepage and freeze-thaw cycles. This in turn results in the overlying track-bearing sandstone layer breaking up, and sliding down the face of the tracksite.

In April 2006, a sandstone slab containing several tracks sloughed off the main trackway and slid to the bottom of the hill. As previously discussed, this has been the natural progression of erosion at the site. Piecemeal solutions, including wire-mesh and shotcrete, a concrete diversion structure, rebar pins and metal strapping, have been implemented over the years in an attempt to arrest the erosion. However, these are typically short-term, band-aid repairs, versus substantial protection measures.

The Friends of Dinosaur Ridge (FODR), the non-profit managing entity at the site, was founded in 1989 to preserve the fossils on the ridge and to educate the public. Approximately 100,000 visitors, including 10,000 school children visit the site each year. In addition to its national significance and scientific value, the site's proximity to a large metropolitan area and

Figure 1. Main tracksite at Morrison Fossil Area National Natural Landmark (Dinosaur Ridge) in Lakewood, Colorado. Dinosaur tracks located in sandstone along the Dakota Hogback, tilted at a 37–38 degree slope. Photo by S. Hutchison.

easy access to viewing such dramatic evidence of life from millions of years ago, makes this site a favorite among locals. Given the site's significance, the mission of the FODR, and the continued loss of the resource from erosion, investigations into longer-term preservation options became imperative.

Using the partnership in place through the NNL designation, the expertise of two National Park Service Geologists were employed to provide an overall assessment of the condition of the tracksite and to offer short- and long-term management recommendations. They determined that if no action was taken, more tracks would continue to be lost and that over time, perhaps over several decades to a century, the entire tracksite is in jeopardy of being lost completely to a progression of slides. The FODR have also sought consultation and input from the State Historical Society, paleontologists, architects, and engineers, and have since determined that a structure over the tracksite is the alternative that would best provide for the long-term preservation of the track resources, thereby ensuring its continued presence for future generations.

The past couple of years have been spent designing a structure for the tracksite that will meet long-term resource preservation needs, provide viewing and educational opportunities, as well as meet aesthetic requirements. Situated on the side of a wide valley, the main tracksite at the Morrison Fossil Area can be seen for quite some distance. Thus in addition to the challenges associated with the steep setting of the tracksite, the view of Dinosaur Ridge has also been an important consideration in the structure's design. After much research, many versions, and passionate discussion, final renderings have recently been completed (Figure 2).

The proposed structure, which will include a solid foundation wall and perimeter drain at the top to divert water away, will protect the tracksite from the erosional effects of freeze-thaw cycles. Additionally, it will include a translucent roof to produce the flat natural lighting for best viewing, new interpretive exhibits on the second floor, and elevated walkways up either side of the trackway to provide for more public educational opportunities and new ways to view and experience the resources. A major fundraising campaign has recently been undertaken to help raise the money needed for construction (tracksite cover, $2 million dollars; a child in awe over dinosaur tracks for generations to come, priceless).

The second NNL site experiencing runaway dinosaur tracks is Dinosaur Valley. This NNL is located within Dinosaur Valley State Park just outside Glen Rose in the central hills of Texas (see www.tpwd.state.tx.us/spdest/findadest/parks/dinosaur_valley). Dinosaur Valley was designated a National Natural Landmark in 1968 in recognition of the series of trackways that contain some of the best preserved Sauropod and Theropod footprints. The site contains the first discovered and identified Sauropod trackways, and they are designated

Figure 2. Computer generated rendering of proposed tracksite cover for main tracksite at Morrison Fossil Area National Natural Landmark.

as the type specimen for that species. Additionally, one of the park's Theropod tracks was designated as the type specimen for Acrocanthosaurus. The tracks also provide evidence related to the herding, habits and locomotion methods of Sauropods and their interaction with Theropod carnosaurs. The Theropod tracks are a good source of information regarding the maximum speed of bipedal Theropods.

The dinosaur tracks at Dinosaur Valley are preserved primarily in limestone within the bed of the Paluxy River and tributary creeks (Figure 3). Therefore, as with the fossil resources at Morrison Fossil Area, the track resources at Dinosaur Valley are also susceptible to the natural effects of weathering. However, given the extent of the resources and their riverine location, building a structure to cover the track sites is not a viable management action; continued erosion and loss of tracks at this site are inevitable. Therefore, an important aspect of managing and preserving these important resources is having a thorough inventory of the track resources and ideally having those data digitally stored for easy retrieval and long-term, archival storage.

Figure 3. Theropod tracks preserved in the limestone bed of the Paluxy River at Dinosaur Valley National Natural Landmark, which is located within Dinosaur Valley State Park, near Glen Rose, Texas. Photo by M. O'Brien.

It was estimated that about 80% of the known track sites have been mapped at the park. The first maps were made in the late 1930's and mapping continued through the 1990's. However, these maps were recorded on paper using measuring tape, triangulation and a compass. These maps have not been gathered into a single geo-referenced map using modern GIS technology, thus the risk remains that the maps, which represent the park's primary documentation, are subject to loss. Additionally, as most of the tracks are located within the bed of the river, many of the tracks documented over the past 70 years are gone or are disappearing due to natural streambed erosion. Thus, there was a critical need for complete and digital documentation of the park's track resources.

The NNL status at the site made it eligible for funding through the NPS Challenge Cost Share Program (CCSP). CCSP funding was applied for to help address this need, and funding was awarded for 2008–2009. Project partners include the National Park Service, Texas Parks and Wildlife Department, Indiana-Purdue University, a volunteer paleontologist who has been involved with mapping at the park for the past 28 years, and the Friends of Dinosaur Valley. The overall goal for the project was to bring together the work of the past 70 years of track documentation into a long-term, geo-referenced digital format using GIS, to make the data accessible for future study and to guide in management decisions and preservation efforts, and to create a fully interactive map of the park's track sites to serve as an educational resource for park visitors.

A major effort to collect data took place during the summer and fall of 2008. Data were collected at most of the known track sites with one new site discovered along the way. Some of the park's trackways, at any given time are either above or below water. Dry track sites were gridded with chalk in one meter cells and oriented to magnetic north. These track sites were hand drawn, and where available, compared with earlier maps. In several instances tracks were visible today that were not visible when the maps were drawn 10 or 30 years earlier and vice versa; tracks appearing in older maps are no longer visible at the track sites today. Thus, the value of previous map documentation can not be overstated. Moreover, using earlier maps in conjunction with existing maps provides a more complete picture of the tracksites. Another technique employed at some of the sites where dry tracks were accessible, was to hand-trace individual tracks onto large sheets of Mylar. These data are used for later refinement of the digital data.

The second step in the field involved digital documentation through the collection of photographs and GPS data. A 17-foot metal deer stand was used as the platform from which to take close range aerial photographs. Digital photographs were taken at the four cardinal directions and the center of each deer stand location, which was moved along the grid until the entire track site was photographed. This resulted in several hundred individual photographs that are now in the process of being painstakingly merged to create a photo mosaic of the entire site (Figure 4).

Sub-foot accuracy GPS points were also collected at the center point of each deer stand location and on individual tracks, data that continue to be collected. These data, when combined with digitized versions of the hand-drawn maps, result in fully geo-referenced versions of each track site.

After all the post-field data processing has occurred, Dinosaur Valley will have a fully geo-referenced digital record, in a long-term, archival format, of all known tracks within the park. Data have been captured down to the individual track level such that single tracks can be measured for length and width, and distances between tracks can be measured. Digital databases will be created to provide for easy access to information for park managers and for future scientific study and education. And finally, an interactive map will be created that will aid park visitors with identification and location of tracks.

While each fossil resource conservation situation has its own unique set of challenges, as can be seen with the two examples in this paper, some commonalities exist. First, it is important to explore and understand the range of alternatives available to best meet the preservation needs at hand. Whether its collecting data to capture the history or whether its capturing the resource itself, look at the variety of options available, explore what has been done in similar situations elsewhere, and look for new methods and technologies. What is available today is certainly different than what was available 20–30 years ago.

Second, utilize partners. Solicit the involvement of a variety of partners to provide different perspectives, expertise, and experience. This often assists in identification of alternatives, adds credibility, promotes collaboration, and enhances opportunities for cost-sharing.

Figure 4. Photo mosaic of a dinosaur trackway at Dinosaur Valley National Natural Landmark.

Finally, engage the public. People are fascinated by dinosaurs and fossil resources. Get the public involved at whatever stages are appropriate. Find new ways to show them the resources and opportunities to learn and gain appreciation. Long-term preservation of all resources depends on a people who understand the value of their natural heritage.

Identifying National Park Visitors in National Household Surveys, 2000 and 2008

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The National Park Service (NPS) uses public surveys in many forms to assess visitors' experiences in the national park system. Since 1979, these surveys have included the Visitor Survey Card Project, which uses a mail-back card given to park visitors as they leave a site. Additionally, surveys may be administered on request for a particular park, as budgets and time permit. These are generally intercept surveys, tailored to the needs of a particular park, and may target specific groups of visitors. Other researchers (academic, private, and individual) may also access the parks for their own research, often in conjunction with park administration.

In 2000, the NPS, in association with Northern Arizona University's Social Research Laboratory, conducted its first Comprehensive Survey of the American Public. The 2000 survey sought a representative sample of all U.S. adults, including non-visitors to NPS units, as well as visitors. More than 3,500 households nationwide were interviewed by telephone on subjects covering, among others, frequency of visiting national park units, reasons for not visiting, cost of traveling to a park, and attitudes toward various park management policies.

In 2008, the second Comprehensive Survey was undertaken by NPS in cooperation with the Wyoming Survey and Analysis Center (WYSAC) at the University of Wyoming. The aim of this survey was to provide updated information on issues covered in the 2000 survey and to address new questions.

Space limitations prevent an extensive discussion of sampling and interviewing methods; a detailed statement is available on request. Below we present a sketch of the methods, and comparisons on a set of questions asked both in the 2000 and 2008 surveys. We focus on a key methodological issue: accurate identification of recent visitors to NPS units.

Methods

Both the 2000 and 2008 surveys were conducted by random digit dial telephone interviews using computer aided telephone interviewing. Both samples were stratified by the seven NPS administrative regions, and both used the "birthday method" for selecting a particular, quasi-random respondent within each household (see Grandjean et al. 2004).

However, the 2008 survey differed in method from the 2000 survey in some notable ways. First, a cell phone sample was intentionally included in 2008, because by then at least

10 percent of all households had only cellular telephone service (Keeter et al. 2007). These households tend to be younger, less affluent, more mobile geographically, and more likely to be Hispanic than households with landline telephones. Second, we provided a Spanish translation of the questionnaire, with call-backs by bilingual interviewers to households where the telephone was initially answered in Spanish. Both of these adjustments in the sampling plan addressed problems of under-coverage in traditional landline-only and English-only telephone surveys, problems that have increased (and have increasingly come to be recognized) since the 2000 survey was conducted.

Another methodological difference in the two studies is that the 2000 survey (n = 3,506) was completed in three months during the spring of the year. In contrast, calling for the 2008 survey took place over a full year, from spring 2008 through winter 2009. This allowed a comparison with the 2000 results, as well as across seasons for the 2008/2009 results. In addition, calling over four seasons should have reduced bias in the type of visit recalled (e.g., peak season, off-season) when respondents were asked to provide details of their most recent visit to a park. The results presented here are for the spring wave of 2008 (n = 1,025) compared to results from the 2000 survey.

Attempts to identify the park unit visited by the respondent were assisted in the 2008 survey by a more complete list of unit names, including some common aliases that differ from official names, and by a cross-reference list of national park system units arranged by state. As described below, this list was augmented by standardized interviewer probes, and by an interviewer prompt to facilitate respondents' recall.

Who is a park visitor? While the identification of park visitors may seem self-evident, in the survey context, determining who is a park visitor is a multi-layered task. After visiting a park (six months ago, a year earlier, etc.) visitors may forget its name, or may confuse the unit with state parks or national forests. In other cases, visitors may not realize they were in a unit of the NPS. Several techniques were developed for the 2008 survey to address this problem.

In both the 2000 and 2008 surveys, respondents were asked the following question: "The national park system consists of all the units managed by the National Park Service, including national parks, historic and cultural sites, and national monuments. How many times in the past two years have you visited a unit of the national park system?" Respondents who said they had visited a national park unit at least once in the past two years were then asked to name the last NPS unit they visited. Only those respondents who identified a valid NPS unit were defined as "visitors." In the 2000 survey, this determination was finalized during each individual interview, and the interviewer's decision dictated whether or not a particular respondent was asked the questions intended for visitors, or only those relevant to non-visitors.

Through pre-testing of the 2008 questionnaire, a process that included focus groups, cognitive interviews (Willis 2005) conducted by telephone, and national calling on the final draft of the instrument, we learned that respondents often recalled the NPS unit they visited not by its official name, but by its location, a colloquial alias, or some key geographic or natural feature. Therefore, in the full-scale 2008 calling, when a telephone interviewer could not find the named park on a list of the 391 park units, three "primary probes" were introduced into the telephone script: "Do you know what state that park is in?"; "Is there another name for that park?"; and finally, "Can you spell that name for me?" Responses to these questions allowed the interviewer to double-check the list of park unit names (alphabetically by name or alias, by state, or both, as needed). The list was available to interviewers as an on-screen spreadsheet and in hardcopy, allowing them to search whichever format they found more convenient.

If the telephone interviewer still could not find the named park unit on the list, or if the respondent said he or she had not visited any unit in the past two years, a "secondary prompt" was provided. The respondent's state of residence (as determined in a previous question) was used by the interviewing software to identify two nearby national park units. The telephone script then provided the following statement for the interviewers to read: "A lot of people don't realize that the national park system includes not only the big units like Yellowstone, but also national battlefields, national seashores, national recreation areas, and small urban sites. In your area, __________ and _________ are both national park system units. With this in mind, can you give me the name of any place you've visited in the past two years that you think is part of the national park System?" If the respondent could name or describe any place visited, the telephone interviewer took down the response verbatim, and the respondent was treated tentatively as a park visitor for purposes of the interview. After completion of the interview, these open-ended responses were reviewed, and only then was a final determination made as to whether any persons were indeed park visitors. Those who were determined to be non-visitors were moved to the non-visitor respondents.

For example, a respondent might report going to a national park beach in Corpus Christi, Texas, without being able to name the unit. Similarly, another respondent might say the family visited the "Arch" in St. Louis. Responses such as these were subsequently coded as indicating a park visitor (i.e., to Padre Island National Seashore and the Jefferson National Expansion Memorial, respectively). Approximately 87 respondents in the spring 2008 calling were retained as "visitors" based on the open-ended responses. These respondents would not have been counted as visitors in the 2000 survey, because probing to identify park units was not as systematic.

Some respondents initially said they had not visited a national park unit within the past two years, but volunteered on a subsequent question that their most recent visit had been within the past two years. Seven such respondents who were then able to identify a valid NPS unit for that visit were reclassified as "visitors" in the spring 2008 wave.

Comparison of 2000 and 2008 results

Table 1 presents the results of the two surveys as regards defining recent "visitors." Both sets of data have been weighted to adjust for the stratified sampling and to generate comparable national estimates.

Asked whether they had "ever visited a National Park System unit," 87% in the 2000 survey said they had visited a park unit sometime during their lives. In 2008, the percentage was slightly higher, at 91%. In 2000, 53% reported that they had visited a park unit within the past two years, while in 2008, that figure was noticeably higher, at almost 63%. Both of these questions elicited unprompted, unverified self-reports, and hence should be largely unaffected by the methodological differences just discussed. The differences in results sug-

	2000 (n=3506)	2008 (n=1088)
Says ever visited NPS unit	86.9%	91.0%
Says visited in past 2 years	53.4%	62.5%
Says visited in past 2 years and names a valid unit	32.1%	49.1%
Says visited in past 2 years, names unit after a prompt	—	62.9%

Table 1. Visitor percentages to a National Park Service unit by year, sample survey data for 2000 and 2008.

gest either somewhat higher visitation recently, or somewhat greater self-selection of recent visitors among those reached and willing to respond to the 2008 survey. The NPS visitation counts have not shown any increase this decade (if anything, a slight decline), while response rates to telephone surveys have been dropping. We therefore are inclined to attribute the modest increase in the percent of households reporting unverified visitation between 2000 and 2008 mainly to the greater willingness of recent visitors to participate in a survey about national parks. Those who were less interested in national parks, and who were not recent visitors, may also have been more likely to refuse to be interviewed.

The effect of the more systematic probing used in 2008, as well as the additional time for respondent reflection, became evident when self-reported visitation was verified against a list of valid NPS units. In 2000, the interviewer verifications identified only 32% of respondents as "visitors," while in 2008, 49% were so identified. Or, to view the figures from a different perspective, in 2000, only 60% of those who said they had visited in the past two years could name a unit that the interviewers found on their list, whereas in 2008, almost 79% of the self-reported recent visitors could provide a unit name, an alias, or a state that led the interviewers to find the unit in their more comprehensive list. The use of a complete, cross-referenced list of NPS units (in two formats) in 2008, along with a standardized set of probes, seems to have substantially reduced the number of "false negatives" in the verification process. Because it lacked these design features, the 2000 survey's estimate of the proportion of recent visitors probably was conservative.

Indeed, when the interviewers moved beyond the primary probes to the secondary prompt, nearly all of those who said they visited a national park unit in the past two years were able to describe or identify a location that was subsequently coded as a valid NPS unit. This would suggest that as many as 63% of respondents in 2008 had in fact visited a park unit in the past two years. However, we view this figure as a high-side estimate, because the prompting may have generated some false positives. Having initially claimed a recent visit, some respondents might react to the prompting by identifying any valid NPS unit, even if they had not visited it recently. Therefore, it's possible that the 2008 estimate of the proportion of recent visitors is somewhat liberal because of the tendency toward "yea-saying" in surveys in which respondents interact directly with interviewers (see Dillman 2007).

Why do such methodological details matter? The details of method are often lost in the march toward substantive comparisons. However, these details are important in a number of respects. The NPS often is called upon to describe the nature and extent of park visitation. Counts of visitation compiled by the NPS Public Use Statistics Office are estimates of the number of visits to the national park system, not the number of different visitors. The NPS estimates do not identify repeat visitors to the same park during the year, nor do they identify those who visit more than one park. A single person may generate multiple visits, but this is not captured in official statistics. By knowing what proportion of households has visited in the past two years, or has ever visited a national park unit, the NPS obtains a complementary and valuable perspective on the connection between the U.S. population and the national park system. Results from the spring wave of the 2008/2009 NPS survey indicate that respondents in more than 90% of households in the sample reported that they had visited a national park unit at some time in their lives. In that sense, the NPS directly serves nearly the entire population of households in the United States.

The NPS visitor counts at park unit entrances also make no distinction between U.S. and international visitors, so that counts of visitors from the United States cannot be extracted from NPS gate counts. For example, Grand Canyon National Park and Death Valley National Park report that nearly half of their visitors during the summer months are international in origin (Myers 2008; Shochaki 2009). The Comprehensive Survey of the American Public yields visitation figures that are specific to the U.S. population, since the survey includes information on residency.

Finally, some groups may be more likely than others to under-report their visitation. Probes included in the 2008 survey should help to reduce those differences. For example, individuals or families who did not make trips for the express purpose of visiting national park sites, but who "stopped on the way" to another location, may not quickly recall their park visit. Or casual (but regular) users of sites in urban areas such as Washington, D.C., San Francisco, Boston, New York, or Philadelphia may not realize they are in units of the national park system. Only by probing or prompting the respondents will a better picture emerge of the visitation rates by the population.

Conclusion

The wide support enjoyed by the NPS is demonstrated by this survey. That more than 90% of respondents in the spring wave reported visiting an NPS site during their lifetime, and up to 63% said they had visited a site in the past two years that they could name, suggests a strong connection between the American public and those exemplars of natural and cultural heritage protected by the NPS. Additional analyses of the 2008/2009 data are in progress; more complete information will be available regarding the attitudes of Americans toward their national parks, and will further illuminate the connection between the national park system, established in 1916 by the Organic Act, and the U.S. population. This information is vital to the NPS as it approaches its centennial in 2016, and as the national park system prepares for a new generation of visitors.

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Rethinking Protected Areas in a Changing World

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An Assessment of the Efficacy of the Theory of Planned Behavior to Predict Intentions to Visit State Parks

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Problem statement

The individual and social benefits of outdoor recreation participation have been well documented by various authors and researchers (Driver, Brown, and Peterson 1991). U.S. state park systems are one of the most important public outdoor recreation resources in the nation. The state park systems play a vital role in providing recreation benefits to the American population by offering tremendous varieties of outdoor recreation opportunities. The state parks in Oregon are especially well known in this regard. The unique natural and historical resources of Oregon state parks provide a wide range of recreation opportunities to the in-state as well as out-of-state visitors. However, in order to participate in outdoor recreation activities, people must first pay visits to the state parks. As such, encouragement to people to visit parks has been one of the major foci of recreation area managers and planners. Growing efforts to identify the determinants of recreation participation, including visits to state parks and recreation areas. To date, many theories and models have been applied to describe recreation participation; however a comprehensive model applicable in a wider variety of activities and situations is still lacking (Henderson, Presley and Bialeschki 2004, Iso-Ahola 1988). In this context, it would be a useful exercise to examine whether the theory of planned behavior (TPB) model, a model successfully applied in many disciplines can be used to describe peoples' state park visit behavior, while generating some other basic management information.

Objectives

The specific objectives of the study were the following:

- Identify the characteristics of the state park visitors in Oregon and the their purpose of visiting these state parks.
- To assess the role of TPB model in describing the state park visit behavior of the visitors in the Oregon state parks.

Theoretical background of the study

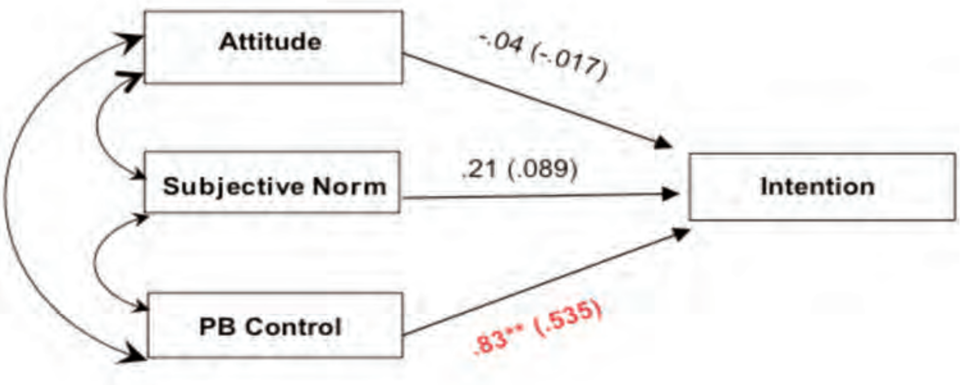
In light of the lack of a conclusive knowledge base explaining leisure and recreation behavior, a better theoretical foundation is essential in leisure research (Henderson, Presley and Bialeschki 2004; Iso-Ahola 1988). In this regard, the theory of planned behavior (TPB), which has been applied to a variety of behavior studies and has received widespread support for its predictive ability, may provide an alternative approach to understand the predictors of the recreation participation.

The theory of planned behavior in its present form is an extension of the theory of reasoned action (TRA), which was proposed by Fishbein and Ajzen (1975). Later, Ajzen (1985) extended the TRA into TPB by adding a non-volition predictor, perceived behavioral control (PBC). According to this theory, a human *behavior* is a function of an individual's *intention* to perform a behavior in question. This makes *intention*, a central construct in the theory, which can be reliably predicted by a combination of three predictors, namely *attitude, subjective norms,* and *perceived behavioral control* related to a specific behavior (Figure 1).

A meta-review of research by Armitage and Conner (1999), and Conner and Armitage (1998) provided a strong support for the predictive validity of the TPB in terms of percentage of variance explained. They found that *intention,* which represents a person's motivation in the sense of her or his conscious plan or decision to exert effort to enact a behavior, is a reliable predictor of a behavior. They also noted that *PBC,* which represents an individual's perception of the extent to which participation in a given behavior is easy or difficult, was a reliable predictor of both *intention* and *behavior*. *PBC* was found more influential in describing intentions and behaviors. *PBC* also lowered the role of subjective norms and attitude especially in the cases where non-volitional forces were more active. On the other hand, *subjective norms and attitude* played significant roles in describing intentions and behavior and reduced the effect of *PBC* where volitional forces were more important.

Some recent recreation behavior studies have made attempt to use the TPB to understand the antecedents of selected recreation behaviors (e.g., Kouthouris and Spontis 2008; Alexandris, Barkoukis and Tsormpatzoudis 2007; Hrubers and Ajzen 2001; Ajzen and Driver 1992) with mixed results. None of the studies had however addressed how effectively the predictors of TPB model could describe the state park visit behavior of the people.

Figure 1. Theory of planned behavior Model (adopted from Ajzen and Driver 1992).



Methodology

On-site survey. On-site interviews of Oregon State Park Department (OPRD) visitors were conducted from July 24 to Aug 4, 2008, in six state parks (Rooster Rock, Vista House, Bridal Veil, Lewis and Clark, Women's Forum, and Starvation Creek) located near Portland, Oregon. Two interviewers spent two hours in each site on each alternate day from 10 a.m. to 6 p.m. Altogether 179 visitors were interviewed, out of which 172 were usable. The questionnaire consisted of questions related to demography, past visit, purpose of visit, and items related to TPB model variables, self esteem, and interpersonal and structural constraints. The instrument (questionnaire) was pretested, and necessary revisions were made twice, first among the WVU students, and second with park visitors on first day of the survey.

Constructs and measurement. The TPB model constructs (attitude, subjective norms, PBC and intentions) were measured using items and scales burrowed from Ajzen and Driver (1992). The dependent construct, intention, was measured with three items. The independent construct, attitude, was measured with three items, subjective norms with five items, and PBC with three items (Table 1). In all cases, the seven-point Likert-type scale was used where a score of one stood for strong disagreement with the statement and seven stood for strong agreement. Table 1 shows the number of items for each construct and the reliability of the scales and items used.

Data analysis. Data analysis included both descriptive and inferential statistics using SPSS, Version 16. Construct validity and reliability were assessed using factor analysis and *Chronbach's alpha*. *Model fit* was assessed using *Structural Equation Modeling (SEM)* with the help of Analysis of Moment Structures (AMOS) software. SEM is an extension of *GLM* (regression modeling) which performs two steps simultaneously in AMOS (Arbuckle 2006). These include *measurement modeling*, which performs validating the measurement model

Table 1. Items used to measure the dependent and independent variables and their reliability.

Constructs	Items	Mean	S.D.	Reliability
Attitude: For me visiting a SP in 3 months period would be:	Unpleasant or Pleasant	6.6	0.7	Chronbach's Alpha 924
	Boring or Interesting	6.4	1.0	
	Unenjoyable or Enjoyable	6.6	0.9	
	Harmful or Beneficial	6.4	1.1	
	Bad or Good	6.5	1.0.	
	Useless or Useful	6.3.	1.1	
	Overall Mean	**6.5**	**.79**	
Subjective Norm: People important to me:	Think that I should visit a SP in next 3 months	6.1	1.2	Cronbach's alpha .859
	Would approve my SP visit in next 3 months	6.4	0.9	
	Would support my SP Visit in next 3 months	6.4	1.0	
	Want me to visit to visit a SP in next 3 months	6.0	1.2	
	Would visit a SP in next 3 months	5.4	1.6	
	Overall Mean	**6.1**	**.98**	
Perceived Behavioral Control	How confident are you that you can visit a SP?	5.6	1.9	Chronbach's alpha .874
	How true is that you would visit a SP?	6.1	1.5	
	How true is that the decision making factors to visit a SP are under your control?	5.8	1.7	
	Overall Mean	**5.9**	**1.5**	
Intention	I have intention to visit a SP	5.2	2.3	Chronback's alpha .959
	I will try to visit a SP	5.3	2.2	
	I am planning to visit a SP	4.7	2.4	
	Overall Mean	**5.1**	**2.21**	

using confirmatory factor analysis (CFA), and *structural modeling*, involving model fit testing using chi-square goodness-of- fit. The chi-square value should not be significant if there is a good model, however chi-square model testing is regarded as a conservative approach, and it is very common to obtain a significant chi-square when the sample size is larger. Because of this, Kline (1998) and Jaccard and Wan (1996) have recommended to use at least three or four other fit-tests for a more reliable assessment of the model.

Path coefficients (regression weights) were calculated using *maximum likelihood estimates*. The model testing hypothesis was: "*how likely it is (the odds) that observed values of the dependent variable may be predicted from the observed values of the independent variables.*" In other words, how well does the data fit with the model.

Findings

Characteristics of the respondents. The sample included about 58% male and 42% female respondents. Interestingly there were more out-of-state respondents (58%) than the in-state respondents (42%). The sample was dominated by white (85%), married (67%), educated (63% with graduate or higher degrees), mature (80% above 30 years old), and repeat visitors (79%). Majority of the respondents came in small to medium size groups, ranging from 2-10 persons with families or friends, or both. Some visitors also came in large groups for some cultural, educational, or religious purposes (e.g., religious and ethnic-society conventions and meetings; Table 2). Among the ten purposes asked, *spending time with family and friends*, *enjoying nature,* and *enjoying nature/open space* were the three most important reasons people visited Oregon state parks, near Portland.

Visitors' attitude, subjective norms, PBC, and intentions to visit state parks. Table 1 shows that, in general the respondents' had a positive intention to visit the state park in next three months time (overall mean 5.1) and they possessed very positive attitudes towards visiting the state parks in Oregon within next three months time (mean 6.5). Likewise, they perceived that most people who were important to them supported their behavior of state park

Table 2. Percentage of respondents by different demographic features.

Sex	Male 58%		Female 42%		
Race/Ethnicity	White 79%		Others 21%		
Visit Origin	Oregon 43%		Other states 2%		Foreigner 5%
Age	Mean Age: 43 yr.	Std. Deviation: 13.1			
Visited before?	Yes 70%		No 30%		
Number of visits in past 1 year	No Visit 5.7%	1-5 times 65.0%	6-10 times 15.4%	11-20 times 3.3%	> 20 times 10.6%
Visit Type	Alone 6.4%		Group 93.6%		
Group Size (number of persons)	Mean Gr. Size: 5.3	Std. Dev. 6.5			
	Single 6.5%	Small Gr. (2-5) 70.6%	Med. Gr. (6-10) 10.0%	Large Gr. (>10) 13%	
Three Most Important Purposes	Purposes	1st Important purpose	2nd Important purpose	2nd Important purpose	
	Enjoy nature	39%	21%	10%	
	Enjoy nature/open space	32%	16%	10%	
	Escape from normal life	19%	36%	6%	

visit and liked to see them visiting state park (6.1). The respondents also expressed that all the factors that affected their decision to visit a state park in Oregon within next three months period were to a large extent under their control (mean 5.9).

Model fit. The R^2 value (.322) of the TPB model in Table 3 shows that attitude, subjective norms and PBC together can explain about 32% variance in the intentions to visit the state parks. The model testing chi-square statistics for the original model (χ^2 =319.4) is significant which indicate that the data poorly fits with the model. Considering the earlier discussed limitations of the chi-square test, CMIN/DF ratio, CFI, IFI and RMSEA were used for a more reliable assessment of the model fit.

Generally, a CMIN/DF ratio (chi-square divided by degree of freedom) smaller than 2 is regarded as good fit and smaller than 3 is acceptable (Kline 1998). The CFI, which compares the researcher's model with a default model, ranges from 0 to 1. The CFI close to 1 indicates a very good fit and conventionally the CFI should be greater than .9 to accept a model-fit. Likewise, IFI requires being close to .9 to accept a model. Conventionally, there is good model fit if RMSEA is less than or equal to .05 and adequate fit if RMSEA is close to .08.

The RMSEA vale of .10 indicates that the model cannot be very well described with the data (Table 3). However, all other fit tests show that that people's intention to visit state parks can be adequately described with this model. For example, the CMIN/DF ratio (2.8) indicates that the data moderately fits with the model in comparison to a saturated model. Likewise, the CFI (.92) and IFI (.92) both also indicate that the model is adequately acceptable in comparison to a default model.

Examination of the standardized path coefficients in Figure 1 shows that only PBC has a strong significant effect on visitors' intention (.535) to visit state parks in Oregon within next three months. Attitude and subjective norms were found to play no significant role in describing intention. This finding is consistent with the findings of Ajzen and Driver (1992) in their study of the participation in five recreation behaviors. Among the five recreation activities, they found that PBC was more powerful and significant predictor of *intention* to spend time in beach while subjective norm and instrumental attitude had no significant role. Additionally, the role of the affective attitude lowered as PBC was added to the analysis. Similar results were found by Blanchard et al., (2008) in their study of physical activity behavior. These authors discovered a strong role of PBC in determining the intention to participate in physical activity among the African-American while subjective norms and instrumental attitudes were again non-significant. Likewise, Kouthouris and Spontis (2008) reported that PBC played a more crucial role in describing intention to participate in outdoor recreation

Table 3. Model fit statistics and path coefficients.

Model Fit Statistics	Original
R^2 (variance explained)	.322
χ^2 (CMIN)	319.410
CMIN/DF	2.827
CFI	.92
IFI	.92
RMSEA	.103

Note: * significant at .05 alpha level and ** significant at .01 alpha level than the subjective norms and attitude. One likely explanation for this result might be that state park visit is a non-volitional behavior which is under influence of some non-volitional forces like availability of resources, perceived constraints, and information to visit the state park because of which PBC has a very strong influence on this behavior while subjective norms and attitude have no significant roles to play.

Conclusions and recommendations

The Oregon state parks are equally popular among in-state and out of state visitors. A majority of the visitors are married and visit in social groups. The three most important purposes of visits to the Oregon state parks are, spend time with families and/or friends, enjoy nature and enjoy open space. The visitors had a very positive attitude towards Oregon state parks and had intention to visit state parks in Oregon within next three months time. For the Oregon state park visitors felt more structural constraints than the inter-personal constraints.

The state park visit appears to be a non-volitional behavior. About 32% of the variation in the state park visit behavior can be described using the theory of planned behavior model. The larger role of the PBC indicates that something more than just attitude and subjective norms, various forces such as the availability of resources, perceived and realized constraints, availability of information, knowledge, health condition and information and skills play big role the formation of intention to visit a state park.

From the management perspective, the findings of the study indicate that the facilities and services in the states parks in Oregon, near urban centers should be designed to meet the requirement of social groups than individual needs.

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Fire and Water: Environmental History at Pinnacles National Monument

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As anybody who works in the National Park Service (NPS) soon discovers, the objectives of cultural and natural resource managers are often at cross-purposes, or seem to share no common ground at all. However, I would like to discuss an example where these two divisions of the NPS have been able to work together, and where the prospects for future cooperation seem especially bright. I am thinking of the environmental history program, which was initiated within the Park Service's Pacific West Region only a few years ago.

Environmental history is a relatively new discipline in American academia, emerging only just after the Second World War.[1] Its purpose, put as succinctly as possible, is to ground history in place. Environmental historians investigate how the physical environment affects human culture over time, and how our actions in turn affect our environments. An environmental history describes the reciprocal relationship between nature and culture. You can see, then, why this might be an appropriate method for the NPS, where we are concerned with both natural and cultural resources but often fail to appreciate or understand their connection to one another.

Pinnacles National Monument became interested in an environmental history several years ago, when natural resource managers there were confronted with questions they were not able to answer on the basis of scientific data alone. Pinnacles lies within the arid Gabilan Mountains in the central coast range of California, about 120 miles south of San Francisco. The environment is mostly rugged hills dominated by chaparral but the monument also includes valley bottoms where oak woodland and grassland occur. The entire monument lies within the upper reaches of the Chalone Creek Watershed, a mostly seasonal stream which flows south and west to the Salinas River. In the bottomlands of the monument and adjacent Bear Valley, this stream meanders through broad floodplains in braided channels of gravel or cobble with relatively sparse, shrubby vegetation. During summer months, when stream flow diminishes or ceases altogether, standing pools often persist late into the season, creating ideal habitat for breeding populations of many amphibians. During the early 1990s, park resource managers proposed reintroducing to this habitat the foothill yellow-legged frog (*Rana boylii*, a California Department of Fish and Game Species of Special Concern) after finding evidence that this species had been present here as recently as 1940, although it is now no longer found. Nobody knew why it had disappeared. Although the present habitat seemed appropriate for the foothill yellow-legged frog, the likeliest explanation for its demise was environmental change. If the original population had been extirpated as a result of degrading habitat conditions, any efforts to reintroduce the species were likely to fail, because the conditions which limited its success probably still prevailed.

But if the foothill yellow-legged frog's habitat had degraded as a result of human activities, park staff might also be obligated to reverse these changes whether they reintroduced the frog or not, since NPS management policies state that "biological or physical processes altered in the past by human activities may need to be actively managed to restore them to a natural condition. . . ."[2] If nothing else, the foothill yellow-legged frog was an indicator of changes in the environment which park staff needed to understand in order to guide their management practices. But reliable scientific data on natural processes within the Upper Chalone Creek Watershed only dated back a few decades—to the 1950s at the earliest. This was long after the putative changes affecting foothill yellow-legged frog populations would have occurred. There were no baseline data against which to measure anthropogenic impacts which may have initiated these changes. But park staff had become aware of anecdotal evidence suggesting that such change had occurred, and describing—albeit rather vaguely—conditions which existed in the watershed prior to the frog's disappearance.

For example, local ranching families are almost unanimous in believing that the valley was wetter and greener when the first American settlers—their ancestors—arrived during the middle of the nineteenth century. "In the early days," writes one resident, Bear Valley was "covered with luscious grass and green the year round." Others say the valley used to be swampy in places, with springs rising to the surface. Nowadays, the valley is green only during the winter rainy season. The annual forbs and grasses which constitute its dominant vegetation have usually turned brown by late March or early April when the soil dries up and the creek stops flowing. Although the water table remains relatively high, no springs reach the surface within the valley itself.

Park staff wondered what to make of these local stories. On the one hand, they could dismiss them as idle romanticizations. Or they could take them seriously and investigate the possibilities which might account for such changes. The monument's physical scientist chose the latter alternative and proposed researching the historical record to see if further information could be found. A project request was made to the history division, and eventually I was given the task of researching and writing an environmental history of the Upper Chalone Creek Watershed.

The challenge, as I saw it, was to see whether the environmental changes which local residents claimed had occurred were possible, not whether they had actually happened. What I proposed was a comprehensive account of all past land use practices associated with the study area which might have affected the central question of changing water availability. I began by assuming that the settlers' accounts could be trusted and that conditions within the Upper Chalone Creek Watershed had become drier over the course of the historic period. My objective was to describe a plausible scenario based on known historic events which might have produced the hydrologic changes responsible for the foothill yellow-legged frog's disappearance. Only if the historical evidence would not support such a scenario, could we entirely dismiss the possibility that these changes had occurred as a result of human actions. Since human influence was the single greatest factor affecting change in the natural environment during the historic period, the absence of any anthropogenic cause for hydrologic change would probably mean that such change had not occurred.

In order to test what I considered the most likely scenario, I adopted a methodology combining two very different types of evidence. One, the historical record, is mostly anecdotal in character. It includes everything which has been documented about human activities. Very little of this record directly addresses the natural environment, and practically none of it contains systematic or scientifically verifiable observation, but it does tell us a great deal about what people were doing at various times and places. Extrapolating from this information, we can deduce how early settlers might have altered their environment. The other body of evidence is analytical. It represents the knowledge which natural scientists have accumulated about the ecology of the local region—its vegetation, wildlife, fire regimes etc. This scientific knowledge provides the principles from which we can interpret the ecological significance of historical events and activities and allows us to infer how these actions might have affected natural habitats within the study area.

The history of land use within the Upper Chalone Creek Watershed predates the period commonly known as "historical" (1769 to present), although most anthropogenic impacts are typically—and mistakenly—associated only with the historic period. This part of California has been occupied by humans for at least 10,000 years, possibly longer. Sometime between 2,000 and 3,000 years ago, the ancestors of the present Ohlone Indians migrated into California's central coast region, bringing with them new technologies which included the processing and storage of durable grains and nuts, especially acorns, which became a staple of their civilization. These innovation allowed them to evolve a complex social structure which was capable of supporting a relatively large population. It also resulted in a more intensive management of the landscape. A subgroup of the Ohloneans, known as the Chalon, occupied the region which now includes Pinnacles National Monument and the Upper Chalone Creek Watershed.

Recent research has shown what nineteenth century American homesteaders could never have known, that the Chalon Indians, like most of their Native California cousins, had actively manipulated the land through a variety of management techniques to create a landscape which uniquely supported their interests.[3] The Chalons' most effective tool was fire, which they had learned to use with considerable skill. Numerous testimonies from early explorers, naturalists, and Spanish colonialists provide evidence of the widespread use of fire in aboriginal California and suggest how and where it was applied. Above all, fire was used to maintain grassland and oak woodland in valley bottoms. It was also used to manage woody vegetation in riparian corridors and kept these otherwise overgrown communities relatively open. Fire was used far more sparingly on the chaparral in surrounding hills and mountains, where the Indians spent less time. The attractive, grassy prairies of Bear Valley in the Upper Chalone Creek Watershed, which the Americans first saw around 1865, were a product of these management practices, but the people who had created and managed them were largely absent by this time. Most of the Chalon had either been inducted into Spanish missions or had died of European diseases by about 1810. Those who survived the mission period were absorbed into European society as ranch hands or mine laborers, with very few returning to their ancestral homelands. When American homesteaders arrived several decades later, they understandably mistook the landscape of the Chalons' homeland for pristine wilderness.

The Americans' own land use practices, learned in more humid environments in the eastern United States and in Europe, would not have preserved the same ecological regime. For instance, the Americans needed to maintain leafy vegetation as late as possible each summer to provide pasturage for their livestock and therefore would not have burned valley grasslands. Since the Indians were interested in seed rather than leaf (having no livestock to pasture), they burned as soon as they had finished harvesting seeds in late spring. This did no harm to the native bunchgrasses which once probably dominated these environments, since bunchgrasses concentrate their resources in a dense underground root structure safely insulated from the heat of most fires. Fire would have actually stimulated the following year's seed growth by burning off unnecessary chaff and scarifying the grass tussocks' crown tissue. The Americans, however, probably extirpated these perennial grasslands by suppressing the Indian fire regime, by increasing grazing pressure through the introduction of livestock, and by introducing agriculture, which mechanically replaced native grasses with exotic annuals like wheat, barley, and rye.

The American impact on the landscape was markedly different than that of the Chalon. For example, fire was applied relatively frequently within the chaparral by American livestock drovers, who hoped to convert the brush to grassland in order to increase the area of forageable habitat for their animals. But fire was applied far less commonly within the riparian corridors and bottomland valleys, where the Chalon had once practiced their most intense landscape management. Although American homesteaders continued to burn within these bottomlands, they did so in a much more restricted manner, using fire only to burn off post-harvest chaff and slash piles. This was also typically done late in the season. In short, the American pattern of fire use was an inversion of Indian burning practices, both in timing and distribution.

How would this inversion of the fire regime have affected the ecology of the watershed? Might it have reduced water availability to streams and bottomlands? Experiments conducted in the San Gabriel Mountains of southern California within a similar chaparral-dominated habitat during the early twentieth century demonstrated that changes in the vegetational pattern can result in substantial variations in water availability. In one study, after all woody vegetation was removed through fire, average streamflow within the watershed was found to increase by close to 500 percent. Some streams, which had previously flowed only seasonally, now flowed perennially for several years after the burn and did not diminish until native vegetation began to grow back. Later experiments showed that the principal cause of the increased streamflow was the reduction in riparian vegetation, not hillside brush.[4]

Applied to the history of the study area, these findings were significant, because they *did* suggest that the contrasting land use practices of the Chalon and the early American settlers might have accounted for at least some of the hydrologic changes observed by later ranchers. Increased burning within the chaparral probably had a negligible effect, but suppression of burning within the valley bottomlands, and the abandonment of riparian corridors along the mid- to upper-reaches of Chalone Creek and its tributaries, would have had substantial consequences. After the disappearance of the Chalon, the latter region was allowed to revert to wilderness, possibly for the first time in millennia, and remained in this state even after the arrival of American homesteaders in the 1860s. Since these tributary canyons contain substantial amounts of riparian woodland growing upstream of the principal valley bottoms, their re-vegetation might well have contributed to the decline of downstream water availability during the historic period.

This is only one among several changes in land use practice associated with the transition from Native American to Euro-American dominance. Other examples support the same conclusion. The historical documentation of these changes demonstrates that the proposed scenario of diminishing water availability in the Upper Chalone Creek Watershed during the latter half of the nineteenth century is plausible, even if it does not provide a definitive answer to the questions asked by modern physical scientists. This methodology makes it possible for us to work backward through time, reconstructing past environmental conditions based on an ecological interpretation of known historical activities, which the historian can elucidate.

Apart from the implications for greater collaboration between natural and cultural resource managers, environmental history also suggests some provocative conclusions. The history of the Upper Chalone Creek Watershed reveals that the supposedly natural conditions for which the park has been managing are, in fact, cultural artifacts. Up until very recently, most natural resource managers have assumed that the California landscape prior to European settlement in the late eighteenth century was pristine wilderness and could be used as a baseline for determining natural conditions as the object for restoration projects. But historical research suggests that natural conditions may not have existed more recently than 10,000 years before present (and possibly earlier). Climate and other macro-environmental conditions were so markedly different at that time that restoration to this period is essentially impossible. But as the present study indicates, restoration to the conditions prevailing just prior to European contact requires managing for a cultural, rather than a natural, environment, and the implications of this conclusion have not yet been adequately explored.[5]

Endnotes

1. Thomas R. Cox, "A Tale of Two Journals: Fifty Years of *Environmental History*—and Its Predecessors," *Environmental History* 13:1 (2008), 9–40.
2. National Park Service, *Management Policies 2006*, Sec. 4.1.
3. M. Kat Anderson, *Tending the Wild: Native American Knowledge and the Management of California's Natural Resources* (Berkeley: University of California Press, 2005); Jon Keeley, "Native American Impacts on Fire Regimes of the California Coastal Ranges," *Journal of Biogeography* 29 (2002), 303–320.
4. W.G. Hoyt and H.C. Troxell, "Forests and Stream Flow," *Proceedings of the American Society of Civil Engineers* 99 (1934), 1–111; Lawrence Hill and Raymond M. Rice, "Converting from Brush to Grass Increases Water Yield in Southern California," *Journal of Range Management* 16:6 (1963), 300–305.
5. The full study by the author, *Fire and Water: An Environmental History of the Upper Chalone Creek Watershed*, is pending publication by the National Park Service, Pacific West Regional Office, Oakland, Calif.

Improving Emergency Response for Natural and Cultural Resources: Applying the CESU Cooperative Agreement for All-Hazards Emergencies

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The National Park Service (NPS) and the Piedmont-South Atlantic Coast Cooperative Ecosystem Studies Unit (CESU) have undertaken a pilot project to enhance federal emergency response capability for natural and cultural resources, and improve coordination with non-federal responders. CESU partners (universities, tribes, museums, science centers, botanical gardens, conservation organizations, and more) adopting this approach nationwide would improve the national response capability for emergencies involving natural and cultural heritage by increasing the availability of archeologists, biologists, coastal experts, conservators, curators, historical architects, wetlands scientists, and others ready to respond in every region of the country. This paper describes how the CESU cooperative agreement can facilitate rapidly deploying experts required to address emergency response when federal agencies lack sufficient responders or technical expertise.

Federal emergency response needs

Following the 2005 hurricane season (including Hurricanes Katrina, Rita, and Wilma), federal and non-federal responders and managers reviewed lessons learned, and identified emergency response needs related to natural and cultural resources and historic properties. Three major needs can potentially be addressed, at least in part, through a CESU cooperative agreement:

1. **Expand the federal capacity for response**. The federal capacity to respond to these major events was limited. Federal coordinators need to expand the roster of available responders to include both federal and non-federal responders with natural and cultural resources skills.
2. **Integrate governmental and non-governmental organization (NGO) response.** Responders from NGOs were generally not well integrated with state and federal responses. Available and skilled individual, non-federal responders often could not find a means to get into the response structure. Responders recognized the need for a structure to ensure informed, coordinated, and expedient responses.
3. **Ensure that responders function under the National Response Framework.** Responders must be trained in emergency response, and be familiar with the National Re-

sponse Framework (NRF) and the National Incident Management System (NIMS). Some federal and most NGO responders were not adequately conversant with the NRF or NIMS.

NPS conceived of a pilot project to apply the CESU cooperative agreement to address these needs.

The concept of applying the CESU cooperative agreement to federal emergency response

The CESU cooperative agreement can be an especially useful tool to address federal emergency response responsibilities related to natural and cultural heritage. The agreement can facilitate rapid deployment of experts needed when federal agencies lack sufficient responders or technical expertise for response on federal lands, or to FEMA-coordinated responses in states under presidentially-declared disasters.

Simply described, a CESU is a group of university, museum, NGO, and some non-profit entities that collectively have a cooperative agreement with several federal agencies to achieve mutual goals in natural and cultural resources research, technical assistance, and education. There are seventeen such groups, or CESUs, forming a national CESU Network that covers the entire United States. When a member federal agency has a need for experts in emergency response for natural and cultural resources to supplement federal responders, it can acquire these experts through a task order under a CESU cooperative agreement.

Application of the CESU cooperative agreement to assist emergency response must occur within the context of the federal role in the NRF and NIMS. The federal response may be on federal lands, or to assist a state upon request of the governor. For example, NPS responds to emergencies in parks. NPS may also respond to emergencies for other federal agencies on a reimbursable basis. In addition, NPS may respond when states request federal assistance and FEMA coordinates the federal response.

The National Response Framework is a guide to how the USA conducts all-hazards responses. When a governor asks for federal assistance, the secretary of the Department of Homeland Security (DHS) coordinates the response through FEMA. Response related to natural and cultural resources and historic properties (referred to as NCH) falls under Emergency Support Function (ESF) 11, of the National Response Framework. The Department of the Interior is the coordinating agency for NCH under ESF 11. NPS generally coordinates the cultural resources response under ESF 11.

Coordination of the NCH response under ESF 11 involves recruiting and deploying natural and cultural resource specialists to the impacted area in response to FEMA mission assignments. The first such recruits are federal employees. However, federal employees may be in short supply during major or multiple emergencies. The CESU pilot project is expected to expand the number of experts available by incorporating non-federal expert deployment, ensuring that responders are trained, and integrating federal and non-federal responders by deploying them together under the NRF and NIMS. The pilot project involves NPS, the University of Georgia, and other partners in the Piedmont-South Atlantic Coast CESU.

The CESU model for all-hazards incident response

The Piedmont South-Atlantic Coast CESU was selected for the pilot project in August 2007. This particular CESU encompasses the states of North Carolina, South Carolina, Georgia and the eastern coast of Florida. The University of Georgia (Athens) is the host entity for the CESU and joins eleven other partner universities within the CESU. The capacity and expertise within this cadre of universities offers an excellent resource for the pilot project.

The standard model for processing an NPS project through the CESU cooperative agreement is a fairly linear process, much like boxes moving on a conveyer belt. Typically, a project originates with an NPS unit (such as a park or office). The NPS unit seeks and confirms collaboration with a faculty member from a CESU partner university and drafts a sub-agreement or task agreement (under the CESU cooperative agreement), which passes though an NPS CESU coordinator and an NPS contracting officer. The NPS unit must provide a statement of work and purchase request. The university must provide a series of government-wide grant-related forms, called the SF-424 Form Families, which include grant application coversheets, forms, form data analysis templates, and form schemas. The university also provides a signed proposal and the NPS CESU coordinator provides approval memos. Several federal laws and related mandates require this paperwork. The process generally takes three to six weeks.

Clearly, this standard CESU model would not meet the needs for a rapid response to an all-hazards incident; however, an expedited process, that the NPS CESU coordinator crafted specifically for emergency response, received concurrence from the contracting officer and the university, and formed the foundation on which to build the pilot project. The expedited process includes use of pre-scripted documents that can be modified rapidly and adopted for a specific incident.

The all-hazards incident CESU model works in two phases. The first phase is the creation of a roster of experts at CESU partner universities who would be interested in assisting a federal response. The starting point is a university-appointed contact, who is responsible for broadcasting recruitment announcements throughout the university, calling for faculty experts to add their names to the roster. Interested faculty then take required Incident Command System (ICS) training from a free on-line service, and fill out a short informational form. Once training and supervisory approvals are secured, the university submits the names to the federal roster of stand-by personnel, which the NPS Emergency Incident Coordination Center (EICC) maintains. This roster-building phase may take several months to initiate and will require a continual effort to maintain an up-to-date database of faculty experts.

The model's second phase begins once an all-hazards incident occurs and the federal Incident Command Team (ICT) acknowledges the need for resource experts to supplement federal responders in supporting the emergency effort. The federal natural and cultural resources coordinator (ESF #11 NCH national coordinator or designee) consults the EICC database and selects appropriately skilled faculty members.

At this point, the standard CESU model comes into operation, but at an accelerated rate. The CESU coordinator, university contact, and the NPS contracting officer work quickly to assemble the required paperwork. The result is that a faculty member can be deployed to an all-hazards incident within 24 to 48 hours of being contracted by the ICT.

The university perspective on the CESU model for all-hazards incidents

The CESU model for the all-hazards incident presents benefits and challenges for the university faculty and administration. Trained responders are one of the benefits. Universities have adopted the ICS for responding to on-campus emergencies and the prospect of having faculty members trained in basic ICS meets a goal for the university. Having a faculty member respond to a stricken area brings positive publicity to the university as well as the faculty member. Less measurable, but probably the most important benefit, is the personal satisfaction gained by the faculty member from contributing during an emergency and applying his or her professional skills to the critical needs of others. This benefit is the primary incentive for faculty to enroll on the EICC roster since all-hazards incidents offer no opportunity for typical advancement towards academic tenure. An important university benefit is financial. The CESU cooperative agreement specifies that the federal agency will cover expenses and reimburse the university for the responder's salary, including a 17.5 percent overhead rate.

The challenges of the CESU model for the all-hazards incident are mainly logistical, although some are of a personal nature. A number of administrative offices oversee faculty in a university. These offices typically are the department office, the college office, the sponsored programs office, the human resource office, the public affairs office, and, at times, the attorney's office. These offices all need notification when a faculty member is deployed to an all-hazards incident. Also, issues related to overtime policies, travel authorities, and appointment terms (such as nine month or twelve month) must be considered.

Faculty members need to arrange for substitutes to cover classroom and research responsibilities during incidents. In addition, the faculty member must be willing and ready to respond within hours; be absent from the university and family for several days; live in a devastated area under hardship and stressful circumstances, including high risks, no electricity, and limited amenities; and work extended hours on a daily basis.

The university's final challenge is the amount of work the university point of contact will do before, during, and after incidents, without additional compensation, other than the 17.5 percent overhead that accrues to the university based on the pay of deployed faculty. Besides sending recruitment announcements, the point of contact will oversee the assembly and maintenance of the roster for the university, forward roster information to the EICC, and respond quickly to facilitate the deployment of university faculty.

The PSAC CESU web site (http://psaccesu.uga.edu/h/nps-emergency-response.html) provides a complete description of the pilot project and instructions for universities and other CESU partners, and their faculty and staff who want to participate. The web site describes the following:

- The intent and purpose of the emergency response roster:
  - Background information;
  - How the concept works; and

  - The contractual side of the roster.
- University administrative approval and responsibilities:
  - Statement of interest;
  - The university's step-by-step process; and
  - The university contact person.
- The qualifications and process for a university expert to enroll on the roster:
  - The qualifications, how to enroll and prepare for deployment;
  - Emergency Response Priority Skills List;
  - Natural and cultural resources and historic properties resource list data form; and
  - NPS Emergency Response Checklist.
- NPS point of contact and support documents.

Summary

The CESU network of universities, bound together with NPS through a cooperative agreement, offers an ideal setting for amassing the skills and capabilities of university faculty to support the agency during all-hazards incidents. NPS may then use this increased capacity to respond to the needs of parks, and to meet its responsibilities in responding to the needs of other federal agencies, including FEMA (which coordinates the federal response to states, when states formally request federal assistance). The CESU cooperative agreement is an excellent tool to expand the federal response capacity, integrate federal and non-federal responders, and ensure that non-federal responders have appropriate training through online courses and emergency exercises. The pilot project with the Piedmont South-Atlantic Coast CESU illustrates several benefits and challenges. The test of real application will refine and improve the process.

If the pilot is successful, the concept could be expanded nationwide to the sixteen other CESUs, greatly increasing the federal capacity to respond during emergencies to impacted natural and cultural resources, and historic properties. The model ensures that non-federal responders are trained in emergency response, and familiar with the National Response Framework. In addition, adoption of the model has the potential to strengthen the natural and cultural resources emergency response experience and capability for the more than two hundred CESU partners nationwide, which would, in turn, enhance state and local emergency response.