rethinking protected areas in a changing world

proceedings of the 2007

george wright society biennial conference

on parks, protected areas, and cultural sites

edited by samantha weber & david harmon

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Introduction and Acknowledgments

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The theme of the 2007 George Wright Society Conference on Parks, Protected Areas, and Cultural Sites, "Rethinking Protected Areas in a Changing World," was 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 by seven plenary sessions, over 130 concurrent sessions, and a week-long poster session. In addition, an immense 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 St. Paul, Minnesota, April 16–20, and was the 14th in a series of conferences that date back to 1976.

A record crowd of 916 attendees made the week a most vibrant one. There were many highlights during the meeting, but a particularly outstanding addition was the inaugural Native Participant Travel Grant (NPTG) Program. The interface between Native interests and protected areas is a realm of great ferment, both in terms of policy and philosophy. To have genuine and critically enriching dialogue, there must be face-to-face engagement between Native and non-Native people. This dialogue can lead to multi-directional learning, improved relationships, new conservation strategies, and expanded vision. Launched in partnership with the National Park Service, the NPTG is intended to foster this dialogue. Applications were invited from non-student indigenous people from Canada, Mexico, or the USA who were involved in the protection, management, or study of Native lands, their biological and cultural systems and features, or Native land rights. Out of a strong applicant pool, the NPTG was able to support the participation of 12 Native people at the GWS2007 conference. We hope to make the NPTG a permanent feature of our biennial conferences.

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 CD-ROM editions, and individual papers may be downloaded from the GWS website. In lieu of appearing here, a number of other papers that originated at the conference were published in our journal, *The George Wright Forum.* In addition, a cluster of wilderness-related papers from the conference appeared in the December 2007 issue of the *International Journal of Wilderness.*

The GWS is grateful to the many people who made GWS2007 possible. At the heart of the effort is the Conference Committee. Chaired by Abigail Miller, the 2007 Conference Committee members were Gillian Bowser, Rolf Diamant, David J. Parsons, William H. Walker, and Stephen Woodley. Equally important are our organizational sponsors and supporters, all of whom have worked with us for many years: the National Park Service, the U.S. Geological Survey, and Eastern National.

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 Sue Haseltine of the U.S. Geological Survey; Mike Soukup, John Dennis, Jon Jarvis, and Marcia Blaszak of the National Park Service; and Chesley Moroz of Eastern National. 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. Others who provided invaluable assistance include Dorothy Anderson, John Anfinson, Otis Halfmoon, Bonnie Halda, Melia Lane-Kamahele, Corliss Outley, Michael Schuett, Jerrilyn Thompson, and Robyn Thorson.

The next conference will be held March 2–6, 2009, in Portland, Oregon.

Remarks of the Director, U.S. National Park Service, at the Plenary Session on North American Park Directors and Global Change

Mary A. Bomar, U.S. National Park Service, 1849 C Street NW, Washington, DC 20240; mary_bomar@nps.gov

Thank you, Ernie [Ortega] for your kind introduction. I am honored to be here this evening and to share the microphone with my colleagues, Ernesto Enkerlin and Alan Latourelle.

Global change is expansive, inescapable, and all encompassing—and central to the challenges and opportunities the three of us share with everyone in this room.

It is our shared privilege to have this chance to address the George Wright Society, which collectively represents the thoughtful analysis of what we manage and where we are headed.

Management of protected areas is impossible unless we recognize the need for anticipation of and reaction to the inevitability of change.

I view global change in three broad classes—natural, cultural, and technological. I'm not sure those categories matter except as a way to discuss what we face.

The technological changes of recent times have occurred at a breath-taking pace. Many here today began our careers with no notion we would use computers professionally. Now we cannot imagine working without them!

The exponential growth in communication speed and access to information has been a joy—even if that joy is sometimes overwhelming. But it comes with a price—or many prices. Even the brightest among us cannot begin to assimilate all that our computers can access. Add in cell phone and Blackberries and we are losing much of what is personal in our lives—the personal connection with colleagues and the personal distinction between work and home life.

To me, the most insidious effect, however, is on our youth. In his book, *Last Child in the Woods,* Richard Louv, a San Diego newspaper columnist, warns that the video-game generation is losing its connection with the natural world. I fear that he is right—and we may be to blame!

Where do we draw on the electronic mastery of the young by providing useful versions of familiar electronic tools—iPod-based interpretive tours, for example? When do we insist that our central asset—reality—should be undiluted, requiring the laptops, cell phones, gameboys, and iPods all be put aside so that eyes can focus, hands can touch, and ears can listen?

Can we bridge the gap between seamless virtual experiences and uneven truths of nature and history where—and as—they occur? How do we encourage the kids of "Geeks in the Woods" (www.geeksinthewoods.org)? Our own Junior Ranger and Web Ranger programs (www.nps.gov/webrangers/) are good. Can we make them better?

It is our job as educators—and all of us who gather and share information are educators—to compete effectively for the minds and hearts of the next generation. We proudly and rightly claim to be the keepers of a heritage —responsible for places and things that our society values. If that is so, we must teach the next generation how to share those values and to appreciate their symbols.

That leads us to the cultural challenges we face. Another aspect of global change is global migration. Every nation is witnessing shifting demographics. There is an accelerating worldwide population growth—by itself assuring urbanization even without migration. And there is the relentless movement that drives people to seek economic, political, or social opportunities unavailable where their lives began.

Accompanying all of this movement of peoples is the cultural baggage that travels with them. Languages, eating habits, clothing styles, religious persuasions, and more intersect along with the people who carry them.

Years ago, we recognized that the influx of German and Japanese visitors to Grand Canyon National Park made it imperative we provide visitor information in their languages. How can we do less for the Laotian-speaking neighbors and visitors of Lowell National Historical Park in Massachusetts or the Somali communities now found in the Upper Midwest?

All the things we do to feed, clothe, house, protect, and employ people have their own impacts. Power from coal-fired plants affects air quality, from dam impoundments impacts water and all that depends on those waters, nuclear has notable risks, even wind and solar affect landscapes, wildlife, even soundscapes. Each choice requires incisive decision-making about which costs are acceptable and which unmanageable.

Our farms, roads, and buildings not only consume space, they disrupt or displace resources of all kinds—anthropological, geological, historical, and biological.

Climate change is very real and directly impacts many of the other changes we have identified. Our responsibility for landscapes, built and natural, requires that we understand how climate change affects the resources entrusted to us.

Air pollutants are eroding buildings and monuments as surely as they are killing trees in the forests.

Recurrent storms force us to re-examine the propriety of rebuilding roads we once built in good faith in vulnerable places, like the barrier-island formations of Gulf islands National Seashore.

Everywhere, historic structures fight self-concealing damage to bricks, mortar, window frames, and more caused by that wall-crawling interloper, English ivy, or kudzu, or honeysuckle, or Formosan termites, or . . . the list is unending.

The presence of non-native plants, animals, and other organisms poses a major and nearly universal threat. Global change in nature rides on melaleucas in the swamps and mollusks in the lakes. Misplaced species drive out those that were not only native, but essential parts of dynamic, interactive systems. Displaced species cost predators their prey—and foster the spread of prey that no longer have predators!

And through it all we have the measures of what is. Another of our global changes is the rapidly growing global record. Last week [April 9] the Smithsonian's National Museum of Natural History announced that the worldwide scientific effort to catalogue every living species has surpassed one million. I should note, too, that the U.S. Geological Survey's

National Biological Information Infrastructure program has provided essential support for access to this burgeoning body of knowledge.

In the U.S. National Park System, of course, we've had a decade of experience with the All-Taxa Inventory at Great Smoky Mountains National Park and its spawn—from serious, traditional scientific study to the "BioBlitz" programs that engage our young in the hands-on discovery and identification of the biological diversity of a given park. Part fun and games, part serious science; part learning, part teaching—and all valuable.

Seeing change is not enough. At the beginning, I noted that management of protected areas imposes on us a need to anticipate and react to the inevitability of change.

Our three agencies have to look at what North Americans can do to help protected areas withstand or adapt to global change. We already know some of the answers. We can continue to develop non-consumptive uses of protected areas and reduce consumptive conduct, too. We can guide management and visitor behavior in ways that provide for use without degrading the features of the protected areas. We can actively resist change where possible by removing exotic species, restoring natural systems, and creating corridors to facilitate the natural dynamics of plant and animal communities.

Ultimately, the greatest challenge and the greatest obligation of our response to global change is cooperative action.

We have long known that individual parks cannot function as nature's islands in a sea of human endeavor. Drawing a line on a map will not make nature whole within those boundaries. The winds will carry seeds far from the wilderness; the animals will wander in and out and the people, in ever-growing numbers, will come to share the shrinking space of protected lands.

Just as surely, we cannot halt global change at our national boundaries. The great North American continent needs a great North American partnership. This forum is a reflection of our shared commitment to working together. And, as we work together, we must also work with the global community to address the meaning and response to global change.

Thank you.

The National Park Service, Education, and Civic Reflection

Daniel L. Ritchie, Chancellor Emeritus, University of Denver, Denver, CO

Good morning. It's awfully nice to be with you and to have the opportunity to talk about such important subjects. I don't plan to talk long but to offer some observations that I hope will invite your thought and response. I hope that you will not only just ask questions but make contributions to our common understanding and purpose. I would like to talk this morning about two recent, unprecedented opportunities where the U.S. National Park Service engaged some of the best minds in the country in perhaps its most critical enterprise—education.

The National Park System Advisory Board accomplishes its work by providing diverse outside input and by advocating for the NPS within a broader community. In doing this, over the years the Advisory Board has contributed in significant ways to shaping the national park system and the policies and programs of the Park Service. A key function of the Board is to assemble expertise for developing ideas and policy recommendations.

A year ago in January, the Advisory Board's Education Committee convened a forum of distinguished historians and sociologists to talk with National Park Service leaders about civic engagement and the place of national parks in our nation's educational system. The Board was anxious to know how an NPS commitment to young people and education could strengthen civic awareness and stewardship in America. Present at the forum were members of the Advisory Board, National Leadership Council, representatives of the Education Council, and other NPS leaders.

The Advisory Board feels strongly that we as a people are not as well informed as we should be about our history as a nation, nor are we as involved individually or collectively in community life as we once were and some believe we ought to be. If you don't think we have a problem, let me give you a few facts. In a recent, large survey of our citizens 18–24 years of age, 29% couldn't find the Pacific Ocean on a world map. One-third thinks that the population of the U.S. is between one and two billion. Of schoolchildren, fewer than 15% are proficient at grade level in history. Only 54% know why the Bill of Rights is in the Constitution. There's more, but you get the idea. You can see why the Advisory Board has concentrated on education for the past several years, beginning with the release of its 2001 report, *Rethinking the National Parks for the 21st Century.* We have come to believe strongly that the NPS should—and must—play a larger role in the education of all Americans.

Following the model established by the Scholars' Forum, the Advisory Board last October convened an Evaluation Summit at the University of Denver. The summit's goal was to create a culture of evaluative thinking throughout the interpretation and education staff of the NPS, characterized by continuous inquiry and learning, and to plan for and practice decision-making based on outcome data. Similarly to the Scholars' Forum, we reached outside the agency to bring respected experts, in this case in the field of evaluation, together with NPS leaders at all levels of the organization, and with many of the Park Service's key education partners.

So first, I would like to briefly report on the Scholars' Forum. A summary report on the forum is available at this conference as well as the current copy of *Common Ground: Preserving Our Nation's Heritage* that includes a special feature on the Forum.

Placing their discussion in the context of our nation's educational needs, our invited scholars cited disturbing evidence of eroding participation in civic and community organizations and declining knowledge of history and current events that have potentially serious consequences for the nation. As greater numbers of Americans appear to be, in the words of author Robert Putnam, "bowling alone," our experts argued that the national park system is uniquely positioned to contribute to the public life of the nation, helping to rebuild the social capital of citizenship and community.

The panelists praised national parks as ideal places to train teachers and to advance place-based learning, where natural and cultural history can be encountered firsthand, in fresh, sometimes quite unexpected, ways. Young people can have transformative experiences in national parks through various service learning and stewardship opportunities—gaining confidence, knowledge, and citizenship skills that they can apply in their schools and in their communities.

In addressing contemporary challenges facing the national park system, the scholars declared that parks and park programs are vital components of a diverse and democratic society, contributing to what Frederick Law Olmsted once described as "a refinement of the republic." Furthermore, they emphasized, this high purpose can only be secured into the future by finding new and meaningful ways to engage historically underserved communities and especially youth. For example, Professor Charlene Mires described the experience of an inner-city teacher reacting to an interpretive presentation on the controversy surrounding the slave quarters at the President's House at Independence National Historical Park: "So here's someone responding as a citizen, as a teacher, as a parent to an experience that was made more powerful because it acknowledged the controversy, because it engaged with issues that had been subordinated for a long time and have only recently come very powerfully back to life."

The panelists talked about the role of civic engagement and the importance of building bridges to local communities and stakeholders. They also discussed, using the example of Gettysburg, how civic engagement can open the door to more contemporary scholarship and provide a broader context for park interpretation.

In the view of University of Wisconsin environmental historian William Cronon, civic engagement in national parks provides multiple opportunities to "re-enact" experiences and stories uniquely associated with places that can reconnect people to their most deeply held values and aspirations: "… if we act as if this nation had full liberty, had full freedom, had full justice, we kill those things; they die because they in fact have to be re-enacted, re-embraced, re-empowered and struggled over yet again in each new generation that encounters the burdens of taking on those values. And that's why civic engagement is the core of the project."

For everyone in our audience it was both humbling and energizing to hear the panelists speak of their deep affection for the national park system and their high expectations for its future.

Turning to the Evaluation Summit, I would like to take a moment to talk about the role of evaluation in educational programs. What you would call evaluation, I would call continual assessment. All the great organizations do it rigorously. It is not just a fad. Every great organization has a culture of continual assessment. It's how we get better. Above all it is not a compliance tool. It is a learning tool and a self-improvement tool. An organization collectively needs to decide what is really important to measure and to understand. It is satisfying and necessary to be able to track progress, to constantly get feedback and to respond to it.

To be effective, assessment must be widely embraced as a way to measure success so that it is owned by everyone, and people who succeed are rewarded. Assessment is even more important when budgets are tight. It encourages transparency and accountability and is essential to program efficiency and effectiveness. Essentially it's a form of adaptive management. It also helps to see our work in a larger context, so we can better understand and respond to changes in the world around us.

It is critical that the NPS Interpretation and Education Program be strong, vital, flexible, effective, and fun. To that end, it is exciting that the NPS is in the midst of an "Interpretation and Education Renaissance" championed by NPS Director Mary Bomar and Interior Secretary Dirk Kempthorne and supported through the president's National Park Centennial Initiative. The National Park Service must continue to marshal the resources and intellectual discipline needed to create this culture of inquiry and ongoing learning and improvement.

The National Interpretation and Education Evaluation Summit was a historic step forward. It was clear to me that Summit participants found the experience to be fulfilling and quite thought provoking. The contributions of our panelists and 14 outside experts provided fresh and useful insights, and the responsive discussion from NPS staff and partners demonstrated the depth, creativity, and commitment that can be brought to this challenge.

All this, however, is not something that can be accomplished overnight. It will be a long journey, but ultimately the effort will be fulfilling, worthwhile, and should be enjoyable. Creating a culture of evaluation will be a key piece of taking the NPS from "good" to "great."

In summary, I believe that education is not something that is tangential or supplemental to the mission of the NPS. Since the National Park Service was established almost a century ago, education has been at the core of its mission. It is through education that we pass on our civilization, the knowledge and understanding that we have gained over hundreds and thousands of years. If we don't do it well, in the long run, our prospects as a people, a nation, and a species will be diminished. Abraham Lincoln said it about as well as anybody ever did and I'd like to quote him: "A child is a person who is going to carry on what you have started. He is going to sit where you are sitting, and when you are gone attend to those things which you think are important. You may adopt all the policies you please, but how they are carried out depends on him. He will assume control of your cities, states and nation. He is going to move in and take over your churches, schools, universities and corporations. All your books will be judged, praised or condemned by him. The fate of humanity is in his hands."

In its 2001 report, the Advisory Board recommended that the NPS "develop and expand" its educational capacity. The Board believed that there is a distinct and critical national purpose embedded in this mission: "to build a citizenry that is committed to conserving its heritage and its home on earth." As never before, young people—and people of all ages—need to embrace and participate in the public life of the nation. The fundamental well-being of our society and the strength of our democratic system of government depend on the stewardship and citizenship of the next generation. As we look to our future I would suggest four positive outcomes:

- That people have a powerful understanding and connection to the American land, its history, its biodiversity, and its stories.
- That people broadly share an ethic of stewardship for the earth's natural and cultural heritage and are willing to work collaboratively and respectfully for conservation.
- That they are empowered to deal with the tremendous environment challenges we face, particularly global climate change, with a sense of optimism, resourcefulness and a commitment to one another, inspired by all we have accomplished throughout our history, often in the face of adversity and conflict.
- That people practice civic engagement in many different aspects of their lives with a commitment to responsible citizenship empowered and encouraged by their educational experiences in parks.

National parks are places where people experience and learn about their country first-hand—its history, cultures, geography and ecology—and what it means to be a responsible steward and citizen of this republic. When parks conduct their business in ways that value transparency and public discourse, they can become places where people can engage in learning, dialogue, and problem-solving —sharpening essential civic skills of a democracy.

National parks are places where all citizens can come together to rediscover the common purposes and values that have shaped the American experience; places which animate a shared sense of national optimism, places where we can get it right. As Wallace Stegner wrote, national parks can "reflect us at our best. . . ."

In looking to its centennial in 2016, the National Park Service should take immense pride in reflecting on its accomplishments, on the profound good it has brought to the nation and indeed to the entire world. By developing and expanding your capacity and reach as an educational institution, you will dramatically grow the parks' influence in your second century and play yet a more vital and meaningful role in our society.

Dbaajmoowin: Dialogue with the Elders

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I have a story. It is about relationship, shared experience, the role of story, and the importance of traditional language in dialogue, *Dbaajmoowin*, with Native American elders. My story features the Algonquin Dome, the region of Ontario between the Ottawa River and Georgian Bay of Lake Huron, land which was occupied in pre-European contact times by Algonquian-speaking people. Just two hours drive south of the Algonquin Dome, over eight million people live in Ontario's Golden Horseshoe, a metropolitan area centered on the city of Toronto. Fully one-quarter of Canada's total population lives in the Golden Horseshoe. This demographic has required rethinking the protection plan for significant portions of the Algonquin Dome.

At the beginning of the 17th century the Great Lakes region was unknown to Europeans. As the century proceeded the French moved further inland, almost always with native guides. The main canoe route westward toward Lake Superior from Montreal was up the Ottawa River, through Lake Nipissing and down the river that came to be known as the French River. That section of the route forms the northern boundary of the Algonquin Dome. The dome, shaped like a huge turtle shell in the middle of central Ontario, has short rivers running to the north and long rivers running eastwardly to the Ottawa. Several short rivers flow southward across "The Land Between" rock barrens and limestone alvars and on to Lake Ontario. To the west the Algonquin Dome is drained by the French, Magnetawan, and Muskoka rivers flowing to Georgian Bay. The height of land from which the rivers flow to the four directions is in Algonquin Park, a rugged natural environment park sprawling across 7,630 square kilometers. The park has over 300 archeological sites and many aboriginal sacred sites, such as Manitou Mountain and the famous Kitchi Mikinak Assin, a perched erratic first photographed in 1897 by a Buffalo railway executive who was shown the location by his Mnjikaning guides. With over 1,900 lakes, the park's beauty extends to the horizon. It has inspired more than 40 books, 1,800 scientific papers, a dozen films, a symphony, and the art of some of Canada's best-known artists (Ontario Parks 1998:1). Meandering rivers flow through wildlife habitat that includes over 1,000 vascular plants and a cornucopia of aboriginal medicines. Many modern island campsites have evidence of ancient occupation. The breakup regime of ice in late April and early May shows areas of ancient *bibon kana*, winter trails of the Anishinaabeg people. Trails skirt places of rugged wilderness. In Algonquin Park forestry, recreation and cultural landscapes are managed simultaneously. The entire park is designated as a national historic site.

At the eastern lip of the Algonquin Dome is *Asinabka*, at Chaudière Falls on the Ottawa River (Allen 2006). This aboriginal sacred gathering place and fishing site was shared with Champlain on his first trip westward in 1613, seven years before the Mayflower arrived at Plymouth Rock (Champlain 1925:2–302). Champlain witnessed and documented the sacred tobacco ceremony carried out by his guides, an event depicted much later by the well-known Canadian artist Charles W. Jefferys. Champlain called the falls the "Chaudière" because of the round kettle shape of the plunge pool and the boiling water below the falls. Asinabka describes the rocky area surrounding the falls, washed to a shiny glare by the rising mist. Before the kettle was artificially flattened by water lot development, the turbulence was increased by the restricted outlet shown in an 1836 map (Wright and Crawley 1836). We can see why ancient people saw the area as a Great Pipe Bowl with sacred smoke rising from it. Canada's capital city of Ottawa sprang up around the site.

The Chaudière Falls area now is the international focal point for the plight of the American eel (OMNR 2007), a fish which migrates from the Atlantic to inland waters via this route, wiggling out of the water across the rocks of Asinabka to reach the river above the falls. The American eel is now under consideration as a species at risk under Canadian legislation and is the subject of transboundary eel management planning. In February 2007, a U.S. Fish and Wildlife Service finding stated that although the species has been extirpated from some portions of its historical freshwater habitat over the last 100 years or so, the species remains distributed over the majority of its historical range (Bell 2007:4995). Canadian records indicate extirpation of the species in large portions of the upper Ottawa River (Haxton and Chubbuck 2002). In the history of aboriginal people, the eel is one of the most important species for sustenance, ceremony, medicine, teaching, and functional uses. Eel was a trade item in current-day Ontario as early as 1770 (Schmalz 1991:96). Now the eel stands as a symbolic warning of the health of all Great Lakes fish species. The dramatic decline in Great Lakes and Ottawa River eel populations is about to become much more widely understood and is being compared with declines in the Mississippi Basin between 1894 and 1922 (Coker 1929:173). The history of the eel is embedded in many native languages, such as the *nannisainti* or *yasinti* of the Choctaw of Louisiana (Read 1940:547). The declaration by Elder Dr. William Commanda that eel spirit is in the 600-year-old Seven Fires Prophecy Belt, which he carries, is rippling through the Americas as the eel, hardy metabolic miracle that it is, now is considered formally under Canadian Species at Risk legislation (Commanda 2007). We ignore at our peril the warning about the health of this species and its significance—yet another inconvenient truth of our time.

At the western lip of the Algonquin Dome the land slopes to the Georgian Bay coast where, in 2004, the Georgian Bay Littoral was designated as a World Biosphere Reserve by the United Nations Educational, Scientific, and Cultural Organization. Central to the designation was collaboration with aboriginal groups. Here lives the Great Sacred Turtle, symbol of an ancient aboriginal sacred site where aboriginal ceremony is still held, where traditional knowledge circles are led by elders and where Anishinaabeg can contemplate the ancient navigational and astronomical skills of ancestors who prayed here for calm water before making an evening and night-time crossing of the wide expanse of Georgian Bay out of sight of any land. The site now is protected in a conservation reserve under Ontario's Living Legacy legislation. At the southern end of Georgian Bay, Beausoleil Island is not only the traditional homeland of Beausoleil First Nation, it is the center of Georgian Bay Islands National Park, Canada's smallest national park and the site of stunning archeological discoveries.

Across the Algonquin Dome the need for planning to incorporate the wisdom of aboriginal elders has been widely acknowledged. This wisdom is beginning to be embedded into cultural heritage research objectives for specific programs and into cultural landscape

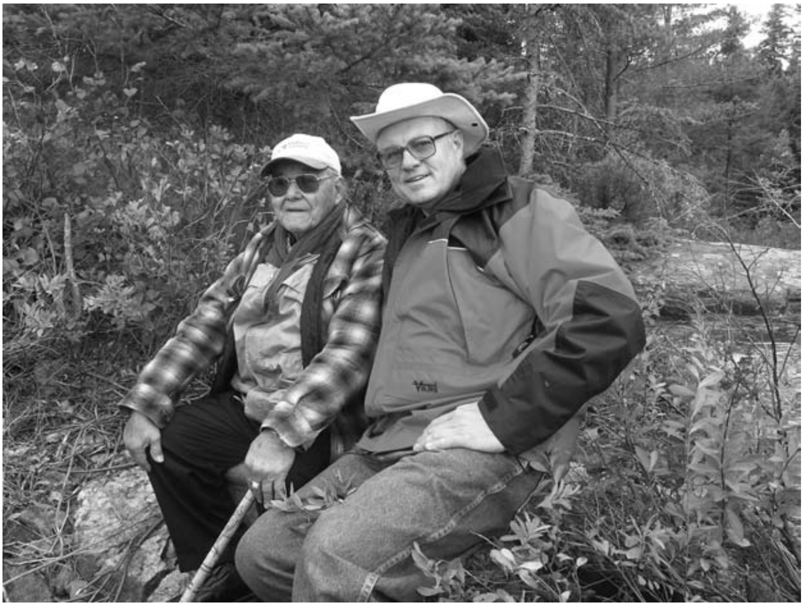

Figure 1. Elder Dr. William Commanda at age 91 with the author at Ajidimo Beach, Algonquin Park, on October 7, 2005, the 242nd anniversary date of the 1763 signing of the Royal Proclamation. Photo by the author.

interpretation. Pikwàknagàn First Nation has devised its own "protocol" based largely on the Canadian Archaeological Association's *Statement of Principles for Ethical Conduct Pertaining to Aboriginal Peoples* (CAA 1996; Swayze and Badgley 2004). Ontario government policy, entitled *Ontario's New Approach to Aboriginal Affairs,* facilitates respectful relationships with First Nations, Métis, and aboriginal service providers. Parks Canada Agency undertakes regular roundtable consultations, such as the one in April 2007 that drew aboriginal leaders from across the country to discuss building better relationships between aboriginal partners and Parks Canada and to identify ways of ensuring that traditional knowledge is incorporated into management planning. The Ottawa hotel chosen for the dialogue is directly across the street from Canada's Aboriginal War Veterans Memorial.

The richest elder dialogue proceeds in a certain way. It begins with an understanding by all involved of the aboriginal perspective of land, fire, water, and air as sacred. The dialogue is preceded by purification ceremony and prayer. That process gets people connected and centered, much as a communion service does for Christians or a time of intense contemplation does for a downhill skier about to make a run. Speaking, *Giigidowin*, is necessary. Listening, *Bzindmoowin*, is more necessary (CAC 2007:2). Silence has a particularly significant role. Reflecting on what has been said helps concentration and remembering. The silence is not a void. It is a time of active reflection on what the speaker is saying. The speaker, likewise, uses pauses before the *Giigidowin* proceeds. It is respectful to wait until the speaker finally indicates that he or she has finished. It is wise to think of the "spect" of looking and to understand that "*re*spect" means looking again and again. Sometime the speaker holds an eagle feather while speaking and only the speaker decides when to pass the feather.

Breaking the silence before a speaker is finished robs the listeners of the last part of the speaking. For aboriginal people one of the historical settings where dialogue with those of European ancestry has been practiced is the dialogue during treaty-making, a sometimes painful process (Long 2006). From this history we have learned that it is important to speak truthfully and to listen honestly, including allowing long periods of silence to just *be* with one another.

Dbaajmoowin is most meaningful when those in the dialogue already have a personal relationship. Dialogue nurtures the relationship more than achieving an agenda objective. Relationship is key. When relationship is strong, true caring is evident and disagreement about particulars is not a threat. Judgment and moralizing are suspended. Calmness and gentleness show on the faces. In my experience such dialogue is characterized by much healthy laughter.

Relationship is enriched through shared experiences. A shared helicopter inspection leads to subsequent reminiscences. A pow-wow becomes a touchstone in later dialogue. Hiking together to a medicine gathering site is bonding. Attending a planning circle for a new facility makes one part of a team. Attending an important speech or special ceremony means membership in a community's history. Teaching a skill at an outdoor education Aboriginal Youth Week becomes a learning experience for the volunteer teacher. No shared experience is more bonding than fulfilling the dream of an old elder to visit a remote sacred site. When Elder William Commanda of Kitigan Zibi, Quebec, was age 91, he boarded a float plane for a special trip on the anniversary of the 1763 Royal Proclamation. At the destination the pilot and park official built a stone bridge from the back of the pontoon to the shore, helped Grandfather out of the plane onto the pontoon, then watched him step—independently and with great glee—onto the beach named after his clan before he gave a prayer of thanks and rested.

Shared experience leads to dialogue in the form of story. A question about the days of fish spearing may result in a visit to the attic. A long-lost stone pipe brought to an elder along with a gift of tobacco may lead to reminiscences of a pipe story and a teaching about peace and the time the same story was shared with others. In time our own shared experiences show up in stories relayed to others, often over and over again. Frequently the story revisits one of the seven Grandfather teachings, since those principles are reinforced repeatedly.

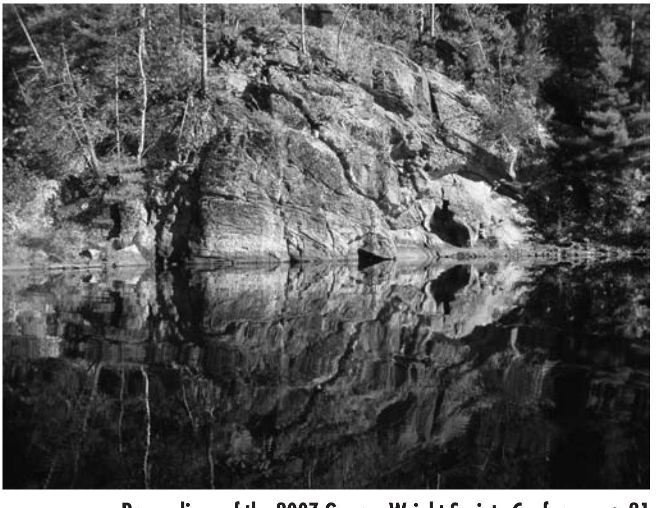

Figure 2. Aboriginal people view the land as sacred and reflect about that sacredness at special places on the land. Photo by the author.

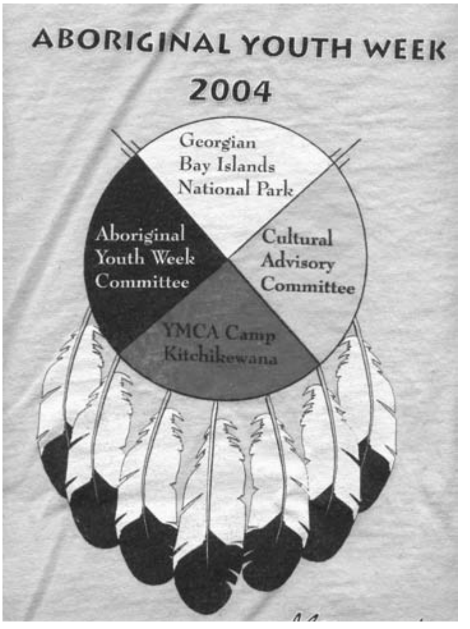

Figure 3. The seven feathers in the logo on an Aboriginal Youth Week tee-shirt provide reminders about the seven Grandfather teachings: wisdom, truth, humility, bravery, honesty, love, and respect. The seven Grandfather teachings are characteristic of dialogue with elders since they lie at the heart of aboriginal emotional, spiritual, physical, and intellectual development. Photo by the author.

As story proceeds, an elder often slips into traditional language to get the right nuance of meaning. The listener may be invited to repeat the word and gradually come to understand more of the language. Laughter is a common feature in dialogue, and may be prompted by something as simple as the differences in fur hats. These discussions are not just translations, but explanations of the efficiency and metaphors of the language which, in a few syllables, can portray complex notions. When *Ajidimo* runs headfirst down a tree trunk, the observer recalls myriad connections in an instant and pauses to reflect in gratitude about the principle of courage represented in the spirit of the squirrel.

After undertaking study and dialogue of their own, sometimes over many months, the elders have been naming newly found archeological sites on the Algonquin Dome. *Ojigkwanong* Island, in one word, carries an entire history of observation of the morning star, of ancient canoe navigation reference points, of a specific observation location to view a sacred site on the shore across the lake, and of the spirit name of a revered elder. A check of mainland shorelines adjacent to Ojigkwanong Island led to discovery of one of the highest concentrations of archeological sites in the region. As a follow-up, these sites get additional protection in a park plan. At one property, a new park facility was due to be constructed. "Misho's Clearing," a long-forgotten entry on a 19th-century surveyor's map, was central to the naming of the Misho Stone on the property. In Anishinaabemowin (the Ojibwe language), *Mishomis* means "Grandfather." Such stones are thought of as living and are called "Grandfathers." Discovery of the Misho Stone led to authorization of an archeological assessment during which ancient pottery sherds were discovered and recovered before the new park building project was allowed to proceed at an adjusted location. Another case in a different park centered on a nuanced message in a letter written in 1868 by an Anishinaabe chief and filed with government authorities at the time. An explanation of one term was freely offered to an archeologist who had previously developed a relationship and some shared experiences with the current-day chief of the community. The outcome was the locating of an important archeological site that was about to be logged over. With knowledge of the fresh archeological discovery, the foresters, showing outstanding sensitivity, quickly aborted their harvesting plan. A photograph of their inspection of the site with the archeologist became the image on the cover of the province-wide *Forest Management Guide for Cultural Heritage Values 2007*. A potential grievance turned into a good news story.

Aboriginal naming of archeological sites is serious business and is undertaken with a keen sense of responsibility. Language is part of the identity of any people. For aboriginal people who have endured loss of language through residential school policies, the resuscitation of the language of the ancestors at locations occupied long ago by those ancestors is a resurrection experience.

I have told a story. The story is about relationship, shared experience, the role of story, and the importance of traditional language in dialogue with Native American elders. In a changing world the story has application for one way of helping to protect special places. The Algonquin Dome is not the only place where dialogue with the elders can enrich the protection of the land. Those who engage the elders in sincere and thoughtful dialogue, listening carefully, respecting silence, and contemplating the sacredness of the land, are sure of a rich and rewarding journey.

Acknowledgments

Thanks are extended to the Grandmothers and Grandfathers, those ancient ones who, in times past, cared for the traditional lands of the Algonquin Dome. Thanks also go to Dakota Elder Dave Larson, Elders William Commanda and Peter Decontie, Merv Sarazin, and members of the Cultural Advisory Committee of Georgian Bay Islands National Park.

References

Allen, William A. 2006. Asinabka on the Kichisippi: An early history. Presentation to the Water Life Workshop, Ottawa, November 4, 2006. On-line at www.icenetwork.ca.

Bell, Heather. 2007. Endangered and threatened wildlife and plants: 12-Month finding on a petition to list the American Eel as threatened or endangered, 50 CFR Part 17, Department of the Interior, Fish and Wildlife Service. *Federal Register* 72:22, 4967–4997, February 2, 2007. On-line at www.fws.gov/policy/library/07-429.pdf.

CAA [Canadian Archaeological Association]. 1996. *Statement of Principles for Ethical Conduct Pertaining to Aboriginal Peoples*. On-line at www.canadianarchaeology.com/ethical.lasso.

CAC [Georgian Bay Islands National Park Cultural Advisory Committee]. 2007. Minutes, Georgian Bay Islands National Park Cultural Advisory Committee, Wednesday, March 28, 2007. On file, Georgian Bay Islands National Park Office, Midland, Ontario.

de Champlain, Samuel. 1925. *The Works of Samuel de Champlain in Six Volumes: Reprinted, Translated and Annotated by Six Canadian Scholars under the General Editorship of H.P. Biggar*. Toronto: Champlain Society.

Coker, Robert E. 1929. Studies of common fishes of the Mississippi River at Keokuk. In Bureau of Fisheries Document no. 1072. *Bulletin of the Bureau of Fisheries* 45, 141–219.

Commanda, William. 2007. Correspondence from William Commanda, Algonquin elder, to Pooi-Leng Wong, Fisheries and Oceans Canada, March 31, 2007.

Haxton, Tim, and Don Chubbuck. 2002. *Review of the Historical and Existing Natural*

Environment and Resource Uses on the Ottawa River. Southcentral Science and Information Section Technical Report no. 119. North Bay, Ont.: Ontario Ministry of Natural Resources, Science and Information Branch.

Long, John S. 2006. How the commissioners explained Treaty Number Nine to the Ojibway and Cree in 1905. *Ontario History* 98:1, 1–51.

OMNR [Ontario Ministry of Natural Resources]. 2007 *American Eel in Ontario*: *Status of Resource Report.* On-line at www.mnr.gov.on.ca/MNR/sorr/pdf/SORR_American-Eel.pdf

Ontario Parks. 1998. *Algonquin Provincial Park Management Plan.* MNR no. 5016. Toronto: Queen's Printer for Ontario.

Read, William A. 1940. Notes on an Opelousas manuscript of 1862. *American Anthropologist* (new series) 42:3 (July–September), 546–548.

Schmalz, Peter S. 1991. *The Ojibwa of Southern Ontario*. Toronto: University of Toronto Press.

Swayze, Ken, and Ian Badgley. 2004. *Umbrella Protocol of the Algonquins of Pikwàkanagàn for the Management of Archaeological Resources in Unceded Algonquin Territory*. Cobden, Ont.: Kinickinick Heritage Consultants.

Wright, J.R., and H.O. Crawley. 1836. *Sketch of the Channels of the Ottawa at the Chaudiere Falls*. Map no. NMC 3980. Library and Archives Canada, Ottawa, Ont.

Finding Identity with Cultural Protected Areas: The Vevé of Afá Palma Soriano, Cuba

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> Migration, economic dislocation, and a sense of generational discontinuity are a few stimuli that provoke intense feelings of loss, absence, and yearning, conditions that heritage projects attempt to assuage by recovering memories and traditions presumed emblematic of a group's desired continuity. —*James Abrams*

The migration of people from Haiti to the easternmost region of Cuba, mostly from the time of the Haitian Revolution (1791–1803), and namely to the provinces of Guantanamo and Santiago de Cuba, has to be understood not just from the social and economic point of view, but also from the contribution of a distinct culture that practices a religion long misunderstood in the Americas and other parts of the world.

Voodoo, a religion practiced in the old kingdom of Dahomey (today, southern Benin) in western Africa, is an animistic religion with a pantheon of gods and divinities that serve the believers with an oracle and a set of organized rituals and celebrations—all part of a practice that is complex in its theology. This religion was brought to the New World with the slave trade at the time of the colonization of the Americas. It is widely practiced in Haiti, and came to Cuba with the migration of rich sugar planters. At the time of the Haitian abolitionist fight for independence, these planters migrated to other parts of the Americas and brought their workers, who practiced Voodoo as a link to their ancestral homeland. In Cuban Voodoo, the use of the spectacle of fire, the blade and point of a weapon, and use of violent animals like the *jabalí* or wild boar, complements what was already established in African Voodoo, such as the dances around a bonfire, levitation, the play of machetes, and use of daggers (James et al. 1999). The act of the trance is probably the most misunderstood aspect about this religion, arousing many misconceptions. The interdictions that are part of this religion also play an important part in how believers conduct themselves in their natural and social environment.

The Voodoo practiced in Cuba has gone through an evolution or change due to certain events in the history of the Haitian presence, and the political environment in Cuba during the Republican period.

It was during the 1930s and 1940s, a period which saw the end of the Machado dictatorship, and which encompassed the first dictatorship of Batista, that an alliance between this president and the Communist party produced a law passed for the sugar-growing sector in which a case was made for the repatriation of Haitians, many of whom had been on the island for a long period of time. This led to a situation where many Haitians went into hiding since there were those that wanted to stay due to their familiarity with their adopted place, and who would get protection from the landowner, who benefited from paying low wages while exploiting a migrant population. The government used its army, and, with the help of Haitian government functionaries and shipping magnates, captured Haitians, and with a bounty paid for each one (James et al. 1999).

Subsequently, Haitians went into hiding in the mountains, and the landowners used them to clear vast areas for cultivation later on. This state of instability allowed Haitians to build, while hiding, their own villages where they would practice Voodoo after working (and not receiving pay in currency, but by a token system). These villages turned into settlements later on, with names like Barrancas, Thompson, Pilón del Cauto, La Palmita, and La Cidra, among others (James et al. 1999).

After the period of repatriation ended, the government recognized Haitian settlements and landowners sought to keep the Haitian population in the area. (It was not until the 1959 Cuban revolution that the Cuban government recognized the migrant population in the island as persons eligible for citizenship). Some landowners granted *conucos*, small pieces of land with a dwelling, to induce some to stay (Figure 1; James et al. 1999).

With the passing of time, the Haitian community made its way side by side with mainstream society, although not without problems of discrimination and lack of empowerment, along with other new issues regarding minority populations—ills facing a young Cuban society transforming itself from a colony into nationhood. It is in this context that the Haitian community slowly began to grow and manifest itself as a cultural entity in that region of the island.

The present need for a communal place that serves the population of Haitian descendants is what gave rise to the ecocultural project of the Vevé of Afá. This ecocultural project in the city of Palma Soriano, in the province of Santiago de Cuba (Figure 2), deals with the restoration of a site at the confluence of the Cauto and Yarayabo rivers (Figure 3). To the practitioners of the Voodoo religion in eastern Cuba, this site is sacred since the confluence symbolizes the male and female counterparts of nature in the consummation of the act of creation.

The project at this site has been designated as a protected area under the Ministry of Culture in Cuba, and the lessons acquired from this endeavor will benefit other parts of the island suffering from acute development problems due to lack of economic incentives and alternatives for sustainable growth. It also clearly points out the connection between social justice and ecological wholeness under a new worldview whose ethico-religious traditions are becoming more important in an ever-changing world influenced by rapid social changes and limited resources (Engel 1985).

Figure 1. A *conuco*. Courtesy of Taller Experimental ENNEGRO.

The project consist of two elements, one functional and one symbolic. The func-

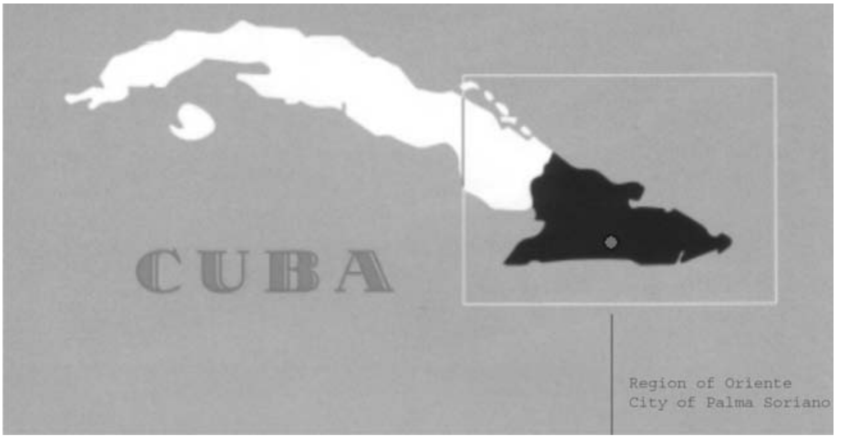

Figure 2. Map of Cuba showing the location of the city of Palma Soriano. Courtesy of Oriente de Cuba–Andalucia, 2002.

Figure 3. Russian aerial photograph, ca. 1970, showing Palma Soriano and the confluence of the Yarayabo and El Cauto rivers. Courtesy of University of Oriente, Santiago de Cuba.

tional element consists of communal living, with housing and public facilities for visitation and gathering, and a community garden. The symbolic one is the restoration of the site at the confluence of the two rivers, Yarayabo and El Cauto. The latter is the longest river in Cuba (87 mi, or 140 km) and crosses five provinces.

The project originated from a group of artists called Taller Experimental ENNEGRO, which is part of the Hermanos Saiz Organization, whose mission is to promote vanguard movements in the arts in the island. The initial concept of the Vevé of Afá, which means "signature of nature" or "imprint," was to develop a mosaic with plant material over approximately two-thirds of the site that will look like a design when viewed from above. In the practice of Voodoo, the *vevés* are drawings done on the ground to attract a divinity to the place of worship in a ceremonial ritual (Figure 4). They are usually made with flour, coffee grounds, or some other available loose material.

The site appears to be a former pastureland for the grazing of cattle that has been fallow for a long period of time; natural succession has been slow and difficult due to drought conditions in the island. It needs to be pointed out that deforestation since the beginning of the colonization of the island has changed patterns of rainfall and regional climate in general. The total acreage given to the project is 90 hectares (approximately 223 acres).

Figure 4. Camilo Fis showing a rendering of the *vevé*. Courtesy of J.M. Menendez.

Due to the difficulty and limitations in realizing the "planted mosaic" concept on the site, the work for my thesis, on which this paper is based, focuses on how to "translate" the initial design proposed by Taller Experimental ENNEGRO, who are practitioners of Voodoo, into something that is more viable for them to develop physically. The original rendering or design was used as a mandala or graphic representation to extract elements that are important to the Voodoo religion, thereby establishing associations of the graphic with actual landscape elements.

It was proposed in the thesis project to restore the *entire* area with the process of natural succession by introducing a nurse crop, in this case the guava tree, *Psidium guajava*, to encourage succession. This tree is able to grow easily in grasslands and facilitates the growth of native species of plants to the area. The most economical way of establishing this nurse crop is through the grazing of cattle on the site, and providing them with guavas to consume. Seed dispersal will be attained through the cattle fecal matter. Supervision on the site for the containment of the guava tree species and eradication of exotic species is extremely important for achieving a balanced restoration (Fourth Annual Puerto Rico Forestry Conference 1999).

In addition to the goal of achieving a climax plant community for most of the site, other aspects were considered, like the public areas for rituals and ceremonies, and the premises for the priest, or *hougan*. These had to be designed adhering to their religious sensibilities and customs.

For these areas, some universal landscape elements and concepts were considered for the design to appeal not just to the religious practitioners of Voodoo, but to the visiting public as well. For example, an element like a water well, at the center of the site, was proposed to celebrate the cleansing rituals. The ceremonial places were assigned particular areas for their symbolic reference, and a shrine using wattle as a construction technique was used to illustrate traditional methods of construction. Motifs for inspiration were taken from traditional priest tunics, musical instruments, and representations of deities.

Overall, the main goal of the thesis project was to propose a simpler solution achievable in an environment of great economic limitations, while emphasizing the cyclical process of nature recovering from a former agricultural land use. The city of Palma Soriano (population 126,000) lacks spaces for green areas and parks, and this project will serve as a place for reflection upon the natural environment for residents and visitors alike.

The importance of the project proposed by Taller Experimental ENNEGRO relies on the proper handling of aspects of religious significance that exalt the animistic and pantheistic qualities of the Voodoo religion for the public to understand. This will clear up erroneous ideas and misconceptions that only serve to isolate and debase beliefs while demeaning cultural and religious understanding.

References

Abrams, James, 1994. Lost frames of reference: Sightings of history and memory in Pennsylvania's documentary landscape. In *Conserving Culture: A New Discourse on Heritage*, Mary Hufford, ed. Urbana: University of Illinois Press, 78–93.

Engel, J. Ronald. 1985. Promoting the development and adoption of environmental ethics. *The George Wright Forum* 4:2, 13–35. On-line www.georgewright.org/042engel.html.

Fourth Annual Puerto Rico Forestry Conference. 1999. San Juan, Puerto Rico. On-line at http://members.aol.com/tropbosq/conf_toc.htm.

James, Joel, José Millet, and Alexis Alarcon. 1992. *El Vodú En Cuba*. Santo Domingo: CEDEE.

Hmong Americans and Public Lands in Minnesota and Wisconsin

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Introduction

Natural resource managers and policy-makers need to understand the cultures and perspectives of ethnic minority communities in order to serve them effectively. In this exploratory study, we focus on Hmong Americans, perhaps the least-studied and -understood Asian ethnic group in the United States. The Hmong, who lived in the mountains of Laos, were relatively isolated until they were secretly recruited and armed by the United States Central Intelligence Agency in the early 1960s to fight the communist Pathet Lao and their North Vietnamese allies (Warner 1998). When the Americans abruptly withdrew from Vietnam and Laos and the pro-American Royal Laotian government collapsed in 1975, the Hmong fled persecution and annihilation from the new communist regime.

Laotian Hmong refugees came to the United States in the years following the war in Vietnam and Laos. The number of Hmong refugees grew rapidly in the late 1970s and reached a peak of about 27,000 admitted to the United States in 1980. The Hmong are now the third-largest Southeast Asian group in the U.S. after Vietnamese and Cambodian, with the largest Hmong populations in California (65,095), Minnesota (41,800) and Wisconsin (33,791) (HNDI and HCRC 2004). All other states have a combined total of only 28,742 Hmong.

Yang (2001) documents the significant accomplishments in education, political participation, business, and government that Hmong Americans have achieved in a short amount of time. But overall, it is impossible to avoid the conclusion that Hmong Americans lag significantly behind the general population in many social and economic indicators. Fennelly and Palasz (2003:103) note the "acute disadvantage of Hmong residents" compared with other immigrant groups in Minneapolis and St. Paul.

Natural resource-related activities such as hunting, fishing, and gathering edible plants are important cultural and economic activities for a relatively high percentage of Hmong. But a lack of knowledge about hunting and fishing regulations among a minority of Hmong hunters and anglers, language barriers, and traditional Hmong hunting practices, such as hunting in large groups, have resulted in occasional clashes with hunters, property owners, and conservation officers (Price 1995).

These long-standing tensions have become more intense recently as a result of a tragic hunting incident in Wisconsin on November 21, 2004 (see Hmong Today 2005; Associated Press 2005). Chai Soua Vang was found sitting in a deer stand on private land and was confronted by a group of white hunters. The chain of events that caused this confrontation to become violent are under dispute, but the result was the fatal shooting of six of the white hunters and wounding of two others by Chai Soua Vang. This incident sparked racially charged harassment of the Hmong communities in Wisconsin and Minnesota (Asian Week 2005).

The objective of this study was to listen to the Hmong American community and learn about their experiences, perspectives, needs, and concerns related to public lands. The ultimate goal is to help land managers, planners, and policy-makers be more responsive to the needs of Hmong and to better serve the Hmong community. We conducted a series of five focus groups with Hmong Americans in late 2005 through early 2006, one in St. Paul, Minnesota, two in La Crosse, Wisconsin, and two in Eau Claire, Wisconsin. All of these communities have significant Hmong populations. Separate groups were held for men and women in La Crosse and Eau Claire (the St. Paul group had one woman participant), because of gender roles in Hmong culture. The focus groups were moderated by male and female Hmong public health professionals who had past experience and training in focus group methods, and they were held in familiar, comfortable locations. See Bengston et al. (2007) for details about the focus groups and data analysis.

Activities

Focus group participants described a wide range of activities they enjoy on public lands. These included most of the activities that would likely be mentioned by any group, except that some of the women mentioned gathering edible plants and there was a strong emphasis on extended family and community gatherings, such as the Hmong New Year celebration. The most frequently mentioned activities, in order of frequency of mention, were "family fun" (i.e., our label for non-specific family activities), fishing, hunting, hiking/walking, and picnicking/barbecuing.

What's special about favorite public lands?

When asked what was special about their favorite public lands, participants talked about places that were relaxing and peaceful, allowed you to be close to nature, were close to home, reminded them of Laos, and where they receive less harassment and discrimination. A woman described the way in which visiting public lands relieves the stress of everyday life: "No wonder why men like to go hunting, because they say when they are outdoors they forget about everything. When you get there, it is like they say. You don't remember about the stress at home." When discussing lands that remind them of their homeland in Laos, the memories were often bittersweet because these places also reminded them of loved ones who died during the war or fleeing the communists, or were left behind. Several participants mentioned that they prefer public lands where the managers or others are welcoming and treat them with respect and kindness.

Positive and negative experiences

Positive experiences described by our participants were universal in character, similar to the good times that many people experience on public lands, e.g., enjoyable times with one's family, teaching little brothers how to fish, and seeing the northern lights for the first time. A number of women described good experiences on public lands as being with their children and families.

Although participants described good times on public lands, conversations about these experiences were scant compared to discussion of negative experiences. Negative experiences revolved around incidents of racism, discrimination, and harassment from public land managers, recreationists, and private landowners. The following quote illustrates the types of comments expressed about discrimination from public land managers: "I like fishing and it is like that with fishing too. They discriminate against us Asians also. They check our licenses, but they do not ask as frequently with the white people."

Harassment from other recreationists was also frequently mentioned and included the use of racial slurs and other verbal harassment, attempts to bully or intimidate and, as shown in the following quotation, attempts to steal fish and game from Hmong anglers and hunters: "The third time we went hunting at 72 and we shot another buck and they tried to come again to steal the deer just like before. He said, 'You Hmong do not know the rules of hunting. This deer was mine and you shot it.'"

Women in our focus groups often described harassment from private landowners related to gathering special forest products. Encounters with private landowners near public land were described as tense and often involved verbal harassment and angry confrontations. Many women mentioned being yelled at by landowners, and two women described landowners sending out their dogs to scare them away.

Needs and concerns

In addition to widespread concern about racism and harassment, focus group participants expressed a variety of other concerns and needs. Low literacy rates were often mentioned as a problem for Hmong using public lands because many elders and new refugees are unable to read signs or books of rules and regulations. The Minnesota Department of Natural Resources offers special classes for Hmong in hunting education and firearms safety classes through its Southeast Asian Outreach Program, but there is a need for more classes and more teachers (Hmong Times Online 2005). Similar classes are offered by the Wisconsin Department of Natural Resources.

Problems with signage were also frequently discussed, beyond the inability of some Hmong to read them. Signs explaining the entrance fees and rules of public lands were considered confusing and too small to notice for those unfamiliar with such signs. There was confusion about the boundaries separating public and private lands due to inadequate signage, as well as confusion about the rules and laws governing each type of land. Fear of the possible consequences of accidentally trespassing on private lands was high among our participants. The problem of user fees being too high for some families, especially new refugees, was also brought up. Inadequate parking and unsanitary restrooms were mentioned by a few, but these concerns were at the bottom of the list for our focus group participants.

Suggestions for improvement

Many suggestions were offered for better meeting the needs of the Hmong community and improving their experiences on public lands. A high priority was cultural training for public land managers about the Hmong and other minority groups. This suggestion was made many times. Participants expressed the belief that cultural training would help land managers and others be more open minded and reduce bias.

Another frequent suggestion was for land management agencies to hire more ethnic and minority employees, including Hmong. For example, one participant suggested hiring minorities to meet and greet people at state parks, to make minority visitors feel welcome and solicit suggestions from them. Someone else stressed the importance of Hmong park employees to help ensure that Hmong elders and others who are not fluent in English know the rules and know how to use the parks appropriately.

Many participants suggested a variety of types of training for Hmong, including classes on hunting safety and rule changes for hunting and fishing. Many of our participants were either unaware of such classes or expressed the need for wider availability. Women also brought up the need for separate classes for women because of the different ways in which they use public lands: "There needs to be specific training. For the women who are gathering greens, how do you go and gather? ... If there is training for hunters that only targets men. But women do not know about private lands."

Participants recognized that public land management agencies would likely be unable to meet all the needs for training and that Hmong must also train themselves. Some suggested that Hmong leadership must take a more active role in promoting responsible use of public lands, which is consistent with the importance of community and clan leaders in Hmong culture.

Other suggestions included the need for improved and more signs to explain the rules, including signs with pictures or symbols for those who cannot read. Several people volunteered to help translate for Hmong who don't speak English if there is a communication problem with land managers. A solution offered for the problem of unaffordable fees was to have occasional free days for low-income visitors.

Finally, two suggestions that were repeatedly made by our participants were that people (1) not assume that all Hmong are guilty of breaking the rules because of the actions of a small minority, and (2) speak kindly to the Hmong rather than getting angry and yelling. Many of our participants felt that the Hmong were unfairly stereotyped as rule breakers and they were saddened or frustrated by this characterization.

Special needs of new refugees

About 15,000 Hmong have come to the United States in recent years from Wat Tham Krabok in Thailand, with more than half of the new refugees coming to Minnesota and Wisconsin. Almost half of the adult Hmong immigrants are expected to start hunting (Hmong Times Online 2005). Our participants had great concern for these new refugees and wanted us to understand their special needs. They told us that new refugees often lack basic knowledge about public lands and how to use them. Common themes were the absence of hunting and fishing regulations in their homeland in Laos and different attitudes toward acceptable use of land in refugee camps in Thailand. Participants frequently mentioned the need for special and intensive training for new refugees, especially about the rules of hunting and fishing, hunting safety, and distinguishing between public and private lands. Many of the new refugees were worried about accidentally breaking the rules and long-time residents were concerned about conflict that could arise from new refugees' lack of knowledge. Several participants also suggested pairing up new refugees with experienced and trained mentors, or "buddies," to teach them the rules and regulations. Others stressed the importance of communicating with new refugees about the use of public lands through the local Hmong community association. These organizations were viewed as vital communication links for new refugees.

The low income of new refugees was seen as a potential barrier to their participation in some activities on public lands, unless the Hmong long-time residents who invite them to go are able to pay for licenses, fees, and other expenses. Finally, participants emphasized the importance of treating new refugees with kindness and patience.

Fallout from the Chai Soua Vang case

The Chai Soua Vang case was the "elephant in the room" throughout our focus group discussions. Although we did not ask about this case, participants were eager to discuss its repercussions on their use of public lands. Several participants mentioned the need to be more cautious and walk away from potential conflict. Many people expressed the view that harassment of Hmong had increased. A surprising finding was that, at least in some situations, white hunters were fearful of Hmong and therefore more respectful after the Chai Soua Vang incident. Several long-time residents expressed deep concern about the potential for "another Chai Vang incident" involving new refugees.

Conclusions and implications

Our participants revealed deep cultural and personal connections with nature and public lands. Favorite public lands evoked both pleasant and painful memories of their homeland in Laos and were valued in many ways. Hunting, fishing, and gathering activities have high subsistence value to many. But perhaps of deeper significance is the role of public lands in maintaining Hmong culture. Participating in traditional activities on public lands gives Hmong a sense that they are preserving their culture by connecting with aspects of their time-honored way of life and the beliefs and values associated with it (Koltyk 1998).

We also heard about profound problems and concerns. Harassment directed at Hmong on public lands is common. These problems have existed since the Hmong first arrived in the U.S. but have intensified after the Chai Soua Vang incident. Tensions are high and the public lands that Hmong have sought out to relieve stress are now stressful places. Several people mentioned that they have quit hunting or fishing because of harassment or the potential for conflict.

The experiences of Hmong on public lands appear to be part of a larger pattern of intercultural and interracial tension experienced by many other minority groups (see Gramann 1996 and Schelhas 2002 for reviews of race, ethnicity, and natural resources). Solutions to these problems will take much time and effort on the part of public land managers in partnership with Hmong leaders and the Hmong community.

References

Asian Week. 2005. Hmong hunters are up for new season. *Asian Week* (11 November). On-line at http://news.asianweek.com/news/view_article.html?article_id= c8c02c2f6d25d-141395df877c19682a9.

Associated Press. 2005. As deer season opens in Wisconsin, tensions remain a year after the killing of 6 hunters. *The New York Times* (20 November), sec. 1, 33.

Bengston, D.N., M. Schermann, M. Moua, and T. Lee. 2007. Listening to neglected voices: Hmong and public lands in Minnesota and Wisconsin. *Society and Natural Resources* (in review).

Fennelly, K. and N. Palasz. 2003. English language proficiency of immigrants and refugees in the Twin Cities metropolitan area. *International Migration* 41:5, 93–125.

Gramann, J.H. 1996. *Ethnicity, Race, and Outdoor Recreation: A Review of Trends, Policy, and Research.* Miscellaneous Paper R-96-1. Washington, D.C.: Natural Resources Research Program, U.S. Army Corps of Engineers.

Hmong Times Online. 2005. Aiming for acceptance: Southeast Asian program helps hunters find common ground. *Hmong Times Online* (October 1). On-line at www.hmongtimes.com/main.asp?Search=1&ArticleID=244&SectionID=36&SubSectionID=182&S=1.

Hmong Today. 2005. Chai Vang: The last chapter. *Hmong Today* (17 November). On-line at www.hmongtoday.com/displaynews.asp?ID=2076.

HNDI and HCRC [Hmong National Development, Inc., and Hmong Cultural and Resource Center]. 2004. *Hmong 2000 Census Publication: Data & Analysis.* Washington, D.C.: HNDI.

Koltyk, J. 1998. *New Pioneers in the Heartland: Hmong Life in Wisconsin.* New Immigrants Series, N. Foner, series editor. Boston: Allyn and Bacon.

Price, D. 1995. Hunting and fishing in a new land. *The Minnesota Volunteer* (Minnesota Department of Natural Resources) 58:341 (July–August), 8–17.

Schelhas, J. 2002. Race, ethnicity, and natural resources in the United States: A review. *Natural Resources Journal* 42:4, 723–763.

Warner, R. 1998. *Shooting at the Moon: The Story of America's Clandestine War in Laos.* South Royalton, Vt.: Steerforth Press.

Yang, K. 2001. The Hmong in America: Twenty-five years after the U.S. secret war in Laos. *Journal of Asian American Studies* 4:2, 165–174.

La Vida Verde: Hispanic Engagement in Natural Resource Conservation and Education (panel discussion summary)

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Tulia Defex (panelist), Texas A&M University
Manuel Piña, Jr. (panelist), Texas A&M University
Maria R. Gutierrez (panelist), Texas A&M University

Session overview

Hispanic populations represent one of the fastest growing demographics in the United States, and yet there is little representation apparent in the "green" jobs—or those of natural resource conservation in the United States. Participation by Hispanics in conservation may have much less to do with appreciation for nature and conservation, and much more to do with socioeconomic and political mechanisms inherent in the dominant culture that may complicate, deter, or inhibit participation by other groups. Integration of this fast-growing demographic group into conservation practices is essential to successfully promote natural resource conservation and healthy, sustainable ecosystems. The panel presented points of view from community leaders, university professors, professionals from federal agencies, and university students on what factors have promoted their successes in conservation, and how we might go about in promoting changes that will more closely integrate this demographic group into the conservation arena.

Session introduction by Pedro Chavarria

Good morning and welcome to the George Melendez Wright panel session "La Vida Verde: Hispanic engagement in natural resource conservation and education." My name is Pedro Chavarria and I am blessed with the opportunity to be the chair of this panel this morning.

This morning we have four outstanding speakers that will address the main topic of this session. Dr. Roel Lopez, Dr. Manuel Piña, Maria Gutierrez, and Tulia Defex, all of Texas A&M University. (A fifth speaker, Roger Rivera of the National Hispanic Environmental Council—was unfortunately not able to make it because of a rescheduled flight due to bad weather.)

But before I introduce our speakers further, I'd like to consider an overview of the theme we'll be discussing this morning. As we've heard in this morning's plenary session, we live in a world that is increasingly imperiled by global climate change. The detrimental effects of global warming are becoming more apparent with increased temperatures in the polar latitudes and other unusual patterns of weather observed worldwide.

A solution to this problem is not one that a single nation nor a single group of people can achieve on their own. The welfare of the environment is the responsibility of every citizen of our planet. The United States prides itself on being on the forefront of ecological awareness and environmental protection, but, unfortunately, we are also one of the major contributors to environmental degradation. Socioeconomic and political disparities are drivers that inhibit the full participation of all of our citizens on many grounds—including those things which may serve to enhance awareness or garner the full participation of all of our citizens to protect the environment.

A report produced by *Newsweek* some years back reported that in 1900 only 500,000 Latinos lived in the United States. Today there are more than 40 million. With the continued on-going gain in population, by 2100, one in three Americans will be Latino.

The political consequences of these statistics are evident in light of environmentalism—a large body of a voting population that has the potential to either contribute to or detract from policies that serve to protect the environment. This begs the questions: How informed and educated are Hispanics in regard to issues of the environment? How involved are they?

When I came up with the title for this panel—"La Vide Verde," which translates, roughly, to "The Green Life"—I meant it as a paradox, in contrast with "La Vida Loca." Not "Living La Vida Loca," like the bad Ricky Martin song—"Living the Vida Loca" like that place from which I came: the gang-infested, traffic-congested, paved-over place I call Echo Park.

I stand before you today, however, not as an apparent paradox or token statistic, but as a representative of a somewhat hidden truth: "We [Hispanics] do care."

When I think of the "green life," I think about the green thumbs that the hundreds and thousands of immigrant farm workers have, from laboring tirelessly over the green fields—to put those vegetables on our tables that we simply gather effortlessly from the local grocery store.

When I think of the "green life," I think about the green-stained pants my father would bring home after mowing lawns or trimming hedges—one of the first jobs he took as a necessity, being a newly arrived immigrant with an education from his home country, but with an language barrier difficult to overcome.

When I think of the "green life," however, I also think of those that have been blessed to work for the Forest Service or, in my case, the Green and Grey—as in the uniform that I've proudly worn in service to the National Park Service for close to six years.

But when I think of the "green life," I think about where we can all be in improving environmental awareness. I think about the Paradise that once was, and where it could be.

Perhaps the trail to Paradise is the folly of an optimist, but as Gandhi once said, "We must be the change we want to see in this world."

So, before us this morning, are four speakers who will talk about and represent this change we want to see in this world. They will speak to us about what things in life have made them successful in their fields, where they are at the present moment, and what we can do to improve Hispanic engagement in natural resource conservation and education.

Roel Lopez presentation (summary)

Lopez discussed his role in academia and how to actively recruit prospective students in the sciences from the undergraduate to graduate level. He talked about a program called "Abriendo Puertas" which seeks to involve parents of prospective students, from the high-school level or beyond, so as to facilitate making educated decisions about seeking a college education and diminish myths or cultural hurdles that might prevent success of their children in pursuing degrees in the sciences or a college education in general. Lopez talked about being actively engaged in mentorship with the students and facilitating success through diversified funding opportunities. His major point of emphasis was mentorship for students and encouragement of pursuit of higher education.

Tulia Defex presentation (summary)

Defex provided her perspective as an international student from Colombia who is pursuing her Ph.D. although already having a Doctor of Veterinary Medicine from her native country. She talked about economic hurdles and cultural barriers encountered. She also talked about cultural differences in environmentalism between U.S. and Latin-American countries—emphasizing that protection of the environment is something that is culturally ingrained in the native philosophy of Latin-American people because of the environment they live in and the socioeconomic conditions they must cope with. She suggested debunking myths and cultural stereotypes about how Hispanics don't care about the environment or how they might be seen as "backwards" in ecological awareness. Her major point of emphasis was facilitating involvement of international students by providing avenues of cooperation through enhanced communication and addressing issues of cultural stereotypes.

Roger Rivera presentation (summary)

Chavarria presented Rivera's talk on his behalf. He talked about Rivera's program with the National Hispanic Environmental Council and the National Park Service recently at New York and its relation to expanding the Minority Youth Environmental Training Institutes (MYETIs). He next spoke about Rivera's progress with the MYETI concept and his incorporation of "role models" to promote awareness for minority youth in pursuing careers in science and the environment. Finally, he talked about the field trips at the MYETI, the coursework students are exposed to (environmental testing of soils and waters, environmental justice, general ecology, geology, astronomy, wildlife science), and the benefits of the internship experience to recruitment into agencies involved in conservation. The major point was to facilitate involvement of minority youth in conservation education.

Manuel Piña presentation (summary)

Piña discussed his role on the faculty of Texas A&M and his role as co-program director for the Hispanic Leadership Program in Agriculture and Natural Resources (HLPANR) at Texas A&M and the University of Texas at San Antonio. He discussed the importance of the program in facilitating graduate studies for students with proven academic merit and great potential for leadership in agriculture and natural resource management. He gave examples of HLPANR successes but also pointed out that the program's funding has been cut off, and how graduates from the program are not always assured of positions with the Department of Agriculture in general or Forest Service in particular, despite the fact that that is the principal reason for funding the program. The major point he discussed was the tenuous situation of lack of funding, asking members in the audience for solutions to resolving this impending problem in the near future.

Maria Gutierrez (summary)

Gutierrez represented an example of a success story from the HLPANR program, but directed her attention to the role of Hispanic women in natural resource conservation and education. She talked about issues Hispanic women have faced in the past and face in their culture today—citing examples from her own life and how she was once discouraged to pursue a career in science or academia. The major point of her talk was to address the role of gender in Hispanic families and how to improve greater participation of women in science.

Session conclusion by Pedro Chavarria

Many of you in the audience may already be aware of and have heard of the Spanish expression "Mi casa, es tu casa." In the case of the welfare of our planet, it is everybody's casa, so we must seek to get every citizen involved in its protection.

As we've heard from our speakers today, there's quite a bit of change that needs to be implemented in regards to improving Hispanic engagement in environmentalism. If we want to avoid the effects of unusual El Niños or La Niñas in the future from global climate change, we must step forward to make sure and better educate *all* of *our* niños and niñas today. With that, I want to thank all of you for coming today to our panel.

Hispanic Leadership Program in Agriculture and Natural Resources—Lessons Learned

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The purpose of the Hispanic Leadership Program in Agriculture and Natural Resources (HLPANR) is to improve participation of Hispanic Americans in assessment, design, delivery, and evaluation of programs related to food, agriculture, and natural resources. It is a collaborative effort between Texas A&M University (TAMU) and the University of Texas at San Antonio (UTSA). The HLPANR was founded in 2002 through a joint venture agreement with the U.S. Forest Service and a special research grant (earmark) through the Cooperative State Research, Education, and Extension Service (CSREES).

Program activities include: graduate research fellowships, research with Hispanic communities, policy development, professional improvement for employers, and leadership development (Figure 1).

Key accomplishments

HLPANR has sponsored 46 graduate students (5 cohorts) at TAMU and UTSA; 17 have graduated. Of the 46 students, 28 have enrolled at TAMU (14 M.S. and 14 Ph.D.) and 18 have enrolled at UTSA (11 M.S. and 7 Ph.D.) At TAMU:

- Twenty-three students are Hispanic, 4 are white, and 1 is African American;
- Thirteen are female and 15 are male;

Figure 1. Program activities of HLPANR.

- Twelve have graduated (3 employed by the U.S. Forest Service, 5 by universities, 2 by state natural resource agencies, and 2 by private industry); and
- Monthly stipends of the students are cost-shared equally by respective academic departments.

At UTSA:

- Fourteen students are Hispanic and 4 are white;
- Eleven are female and 7 are male; and
- Five have graduated (2 employed by the U.S. Forest Service, 1 by a university, 1 by a state natural resource agency, and 1 by private industry)

All students have conducted or are conducting research on topics of importance to the U.S. Hispanic community, have participated in field trips to south Texas and northeastern Mexico to understand the land tenure and natural resources of the border region, and have participated in workshops on policy, professional and leadership development.

Funding for the HLPANR has come from the U.S. Forest Service and CSREES to UTSA, then to TAMU. At TAMU, additional funds are contributed by the College of Agriculture and Life Sciences, Office of Graduate Studies, and the participating academic departments.

Ten lessons learned

1. **Develop a sound concept and highlight its distinctiveness**. It is important that we develop a concept that is pedagogically and sequentially sound, and with the input from as many stakeholders as possible, e.g., potential employers, academics, students, ultimate recipients of services, political leaders, and leaders from possible funding agencies. It is equally important that we develop programs that are distinguishable from others with similar sounding names, i.e., to highlight that our program is much more than a fellowship-managing enterprise, where graduates will be prepared well in their academic disciplines but also be able to exercise effective leadership as professionals in their careers.
2. **Select partners carefully**. It is important to select institutional partners carefully. In doing this, we must recognize differences in size; infrastructural support, management style, leadership history and capacity for programs of this type; academic and research programs and facilities; overall culture; and previous history of collaboration.
3. **Engage with the long term in mind**. It is important to enter into this kind of program and related process with the long term in mind. We cannot expect to have the impact that we need in a three- to five-year period. As such, programmatically and financially, from the onset, we must be thinking ahead for a longer period of time. In doing this, we must be able to continually evaluate our progress and process, make necessary adjustments, and, most importantly, expand our funding support base, always anticipating that current funding sources may disappear.
4. **Get faculty involvement**. It is important to recognize those faculties who teach and conduct research in academic departments are key to the success of a project of this

type. They are the ones who advise, teach, mentor, and conduct research. But, they are also volunteers; they don't have to do this. Our job as project directors is to enable them to do their jobs by providing them with funds to support students and, sometimes, suggesting to them students that we would like to see in the programs. We must also invite and involve the faculty in all project activities and recognize them for their participation and support of programs of this type.

5. **Be prepared to defend the program**. It is important to know that not all faculty and administrators will automatically be supportive of efforts of this type. We must be prepared to not only defend why we are concentrating on increasing the number of minority or under-represented students but also, and more importantly, continually gain support for these programs. We must have data and a process for defending and have lucrative and innovative opportunities for engaging, e.g., support for research.
6. **Mainstream the effort**. It is important to accept that most institutions will allow us to do anything that is legal, that we want to do, and that we find the funding to do from external sources. However, it is too often the case that when external funding ends, our projects also end. Therefore, from the onset, every effort should be made to make programs of this type a part of the core activities of the institution in such a way that when external funding ends, chances of the project continuing are increased. One way of doing this is for the receiving academic departments to cost-share the monthly stipends of students in their departments. Another is to get complementary institutional funding support from the onset.
7. **Showcase the students**. It is important to showcase the students at every opportunity. Let the students sell programs of this type, e.g., presentations to donors, paper and panel presentations at professional association meetings, receptions with policy-makers, interactions with potential employers, etc.
8. **Maintain communication with donors, supporters, and partners**. It is important to establish and maintain communication with all stakeholders, especially donors, supporters, and partners. This can be done through personal contact with the students or periodic newsletters, updated websites, special and annual reports, and office courtesy visits, always highlighting the progress and successes of the students.
9. **Monitor progress**. It is important to establish systematic ways for monitoring the progress of the students. Students and faculty must be held accountable for progress. Periodic progress reports are essential not only to monitor progress but also for external reporting purposes. Students should also be encouraged to submit interim reports that include successes they may have had, e.g., awards, internships, additional funding for their research, submission of proposals for additional funding, etc.
10. **Diversify the funding base**. It is of paramount importance to diversify your funding base as soon as possible after receiving any amount of funding for programs of this type. Most funding sources are not perpetual and programs of this type must be sustainable for longer periods of time than most grants allow.

Insight to the future

Our vision is to continue adding cohorts of students each year, secure sustained funding, expand our funding base to include other sources, and share this model with other universities that may have similar interests.

Deconstructing Myths Influencing Protected Area Policies and Partnering with Indigenous Peoples in Protected Area Co-Management

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Myths are powerful drivers of individual and national behavior. Quantitative Western science is not immune to myths, either. Science is, at bottom, about measurement in the process of hypotheses testing with replicable experiments. It is a powerful methodological tool. But unconscious and unarticulated cultural myths still determine what kinds of questions science does or does not ask; what its powerful lens focuses on or does not. Moreover, Western science is not the only valid epistemology. Native science, or traditional ecological knowledge (TEK), is far more inclusive and includes multi-generational observations of environmental changes and plant and animal knowledge. Both epistemologies—qualitative Native science and quantitative Western science—are now needed to better address unprecedented environmental degradation and change. But deconstruction of two prevailing myths will need to happen before Western science sees the value of the contributions indigenous cultures can make to ecological restoration and conservation for the protection of biodiversity, and before true co-equal partnering in the stewardship of protected areas can take place.

The first myth is the separation of human cultures with a history of good stewardship from what is considered "natural." This myth is really not very old in the West—about 150 years old. It has replaced an earlier myth of indigenous peoples considered so much a part of nature that European colonials viewed them as incapable of being objective enough to manage nature or even themselves. Before the middle of the 19th century in the United States, Catlin, Thoreau, Audubon, and other environmental leaders were calling for national parks for both Indians and animals. But since Yellowstone was established as the world's first national park in 1872, a gradual shift has taken place which has increasingly viewed indigenous peoples as either of no beneficial consequence to natural systems or as actually harmful to them. Today, with the exportation of the Yellowstone model to every continent on earth, indigenous peoples are being evicted from their homelands to protect wildlife and so scientists can do "pure" scientific research. Both myths—first, indigenous peoples as part of nature, and then as separate from nature—promote the idea that indigenous peoples are ecologically incompetent or inappropriate.

The characterization of native peoples as ecologically harmful or incompetent has had disastrous consequences for both ecosystems and cultures. So has the second myth: Nature is entirely autogenic or self-regulating and in a perpetual state of balance or homeostasis, always returning to its optimal pre-disturbance state. Therefore nature is best studied or understood without humans. Even though a new ecological paradigm has been emerging over the last quarter-century that views nature as non-linear, asymmetrical, stochastic, chaotic, and with the potential, following disturbance, of not one but several possible pathways to recovery different from its pre-disturbance state (and not necessarily with the most optimum result), government protected area policy-makers and managers are still living in the older, discredited intellectual world of homeostasis.

The consequences of these two myths to indigenous cultures have been catastrophic:

- Forced removal from homelands;
- Exclusion from livelihoods, resources, sacred sites, traditional cultural landcare practices, and knowledge;
- Loss of access to resources and equity in management in ancestral lands now designated as protected areas;
- Lack of secure land tenure;
- Landlessness;
- Joblessness;
- Homelessness;
- Political and economic marginalization;
- Identity loss;
- Psychological and social pathology, drug and alcohol addiction, abuse of spouses or children;
- Food insecurity and poor nutrition;
- Increased morbidity and mortality (coronary disease, diabetes, obesity, high infant mortality, short life spans);
- Disruption of social and economic institutions (traditional land tenure regulatory structure, i.e. self-governance of herding, hunting, fishing, gathering);
- Loss of native languages; and
- Loss of confidence in spiritual beliefs and medicine people.

Consequences to ecosystems occupied until eviction by indigenous communities have also been dire. These vacated homelands can be described as cultural landscapes—environments cared for over enough time (hundreds to thousands of years) to have helped shape, along with non-human processes and species, ecosystem structure and composition in some of the most productive, biodiverse, and unique plant communities. These include, in North America, oak–pine savannas and woodlands, prairie, wetlands, high-elevation montane meadows and woodlands, riparian areas, Great Basin pinyon–juniper savannas, Southwest U.S. desert grasslands, *Sequoia gigantia* forests, and whitebark pine communities. Frequent low-intensity burning by aboriginal peoples not only enhanced the productivity of the communities just described, but improved the productivity and diversity of resource-poor ecosystems such as redwood forests, boreal forests and wetlands, and other conifer forests by creating and maintaining various-sized gaps and openings, thus increasing structural and compositional heterogeneity and species richness. Ecological productivity translated into cultural plant and animal productivity. Even in regions of high lightning-fire frequency, such as the U.S. Southwest and Southeast, Indians couldn't always rely on lightning to strike and burn a particular patch or habitat when it was needed. Global examples of indigenous-enhanced resource-poor environments include Mediterranean mulga scrub, Australian eucalyptus forest, and sedgelands.

These time-tested and ecologically appropriate cultural landcare practices were as "natural" as any other non-human dynamic by a species, element, or process. Aboriginal people were in fact a keystone species and top carnivore in their far-reaching ecological effects. And like any other keystone species, when they are removed from their roles in ecosystems, unintended negative cascading effects occur.

The homeostasis myth has been the most persistent and has had the most negative consequences for natural systems in protected areas. A well-known example is Yellowstone National Park's management of elk. Tourists adore elk and come expecting to see them in large numbers. So the park encouraged elk by eliminating predators such as cougars and wolves (and a number of lesser predators as well). Elk multiplied, and as herds grew (artificially fed with hay in winter), they eliminated aspen, willows, and other riparian vegetation. Deprived of a major food source, beavers soon disappeared. Ranges were severely overgrazed, eliminating native species and encouraging exotic grasses and forbs.

Unbelievably, managers expected that elk birthrates would automatically drop and death rates would rise when elk exceeded the carrying capacity of the land. What they did not understand, or chose not to examine, was the long history of aboriginal involvement with Yellowstone as carnivores even more effective than wolves in reducing game numbers: the all-year "Sheepeater" Bannock residents, and the Kicked-in-the-Belly Band of Crow, Shoshone, Utes, and Blackfoot who hunted there in the summer. Removal of Indians and wolves was devastating to Yellowstone's ecosystem.

But that was yesterday. Today, wolves (but not Indians) have been re-introduced. Yet, while wolves are beginning to take a toll on elk, elk numbers still far exceed the carrying capacity of the range. Beavers are still not anywhere near historical numbers. And wolves, to survive in the *long term* in an artificially small ecosystem which is now a park surrounded by hostile ranchers, need beaver as a winter supplemental food source in order to stay in the park.

Another example of ecological problems resulting from an uncritical acceptance of the myth of homeostasis is that natural lightning-fire regimes, *not supplemented by Indian burning*, are sufficient to maintain healthy ecosystems in the northern Rockies. The Yellowstone fires of 1988 were catastrophic for some, but for park managers, many fire ecologists, and most environmentalists, it was nature's way of rejuvenating the land—despite the relatively high percentage of places where the soil was sterilized by the extreme heat of stand-replacing fires. It was viewed as "natural" even though a number of fire cycles of lesser severity had been missed, and fuel loads were unhistorically high, and was therefore far outside of the natural or historical range of variability.

Lodgepole pine regeneration—millions of new seedlings growing out of the ashes—was viewed as a successful natural event. Apparently, few realized that whitebark pine, an endangered keystone community of critical importance to the life cycles of grizzly bears, red squirrels, and Clark's nutcrackers, had extended historically downslope to the lodgepole pine belt, where historic periodic light Indian burns reduced fuel loads and took out enough lodgepole regeneration that smaller, non-contiguous stands burned up after 80 to 100 years or longer *without a major, region-wide conflagration*. But, in 1988, crowded, senescent lodgepole stands were ready to go up in a very unnatural way.

Indian burning at elevations below and into the lodgepole belt protected the whitebark pine community by regularly reducing fuel loads and thinning lodgepole saplings and poles. Moreover, lodgepole seedling establishment is faster than that of whitebark pine. Whitebark pine seedling establishment did not occur until 1990 and 1991—too late to compete successfully with lodgepole pine. And that was only from the few whitebarks that did not burn up in 1988.

Of course, a half-century of effective fire suppression played an important role. But with the removal of Indians from Yellowstone and surrounding areas after 1872, that many more low-intensity fire cycles were lost. This monumental oversight by park managers was encouraged by a phenomenon known as "shifting baselines." Lightning-ignited fires have always played an important role in the northern Rockies, with fires in the higher elevations kept in check by a colder, wetter environment—but only when fuel loads at lower elevations were kept in check by lightning *and* Indian fires. Leaving Indian burning and lower-elevation whitebark pine stands out of historical baselines in this case masked the true damage done by the Yellowstone fire. (White pine blister rust and infestations of mountain pine beetle of course are other factors in whitebark pine mortality, yet studies show the benefits of smoke from regular low-intensity fires in reducing pathogens such as blister rust as well as the benefits of light prescription fires—the historical fire regime which includes Indian burning—in enhancing tree vigor and resistance to beetles.)

Examples like these abound throughout the world where indigenous peoples have been removed from their homelands. The most egregious cases involve environmental BINGOs (big international nongovernmental organizations) such as the World Wide Fund for Nature, Conservation International, and The Nature Conservancy. BINGOs have bought into the myth that nature works best without humans—even humans who have a proven track record in ecologically sustainable landcare practices. They in turn influence the eviction policies of third-world governments. They just look the other way when evictions occur.

Today, Indians still remember with a mixture of sadness and anger how they were forced out of their homes; homelands; hunting, fishing, and gathering places; and livelihoods. Trust can only be restored by granting access to and co-management of their ancestral lands in protected areas. In a changing world, the time has come for real, co-equal partnering between dispossessed tribes and governments. Access, equity, and the legal right to sustainable stewardship of resources with traditional practices such as intentional fire are the touchstones of restored trust. Reciprocity is now in order. But restitution has to come before reconciliation and restoration. Government policy-makers need to consider the following concrete steps:

- Reserved treaty rights law, traditional resource rights, and intellectual property rights need to be enforced and facilitated.
- Remove the distinction between "historic" and "nature." For example, amend the U.S. National Historic Preservation Act by expanding the definition of "cultural resources" to include culturally important biological species (e.g., protect the plants used, not just the artifacts that processed the plants and their seeds).
- Expand the definition of "ecological integrity" to include competent and time-tested traditional cultural landcare practices.

- Encourage the recognition by Western science of the *ecological* importance of Native landcare systems. Instead of a hard and fast line between "historical–cultural" and "natural," there is a continuum which runs from self-organizing, autogenic nature at one end to purely historic sites (e.g., buildings, places where artifacts occur) or ecologically inappropriate landscapes at the other end. Between these two extremes is where culture overlaps with nature (cultural landscapes)—indeed where culture *is* nature.
- Let dispossessed tribal peoples tell the true story of how national parks were created. Educational material for parks should be co-authored by both protected area managers and indigenous elders who have lived through the nightmare of dispossession and loss of identity with place.
- Assign as much weight to culture impact statements as to environmental impact statements.

We have seen changes recently in government policy-makers toward indigenous reserved treaty rights and access to and co-management of protected areas. Associative cultural landscapes are now increasingly seen not just in terms of material evidence of *past* cultural activities, but in terms of present spiritual significance of place and the importance of the continuation of past practices into the present and beyond, as well as the indivisibility of cultural and natural values in the aboriginal landscape. Examples are Tongariro National Park in New Zealand; Uluru-Kata Tjuta National Park in Australia (and the Australian Natural Heritage and Burra Charters); the Laponian Area in Sweden; IUCN's category V (protected landscapes); changes in Parks Canada policies where 50% of Canada's aboriginal peoples now have access to traditional sacred and natural/cultural resource areas; and the blending of cultural and economic activities with nature conservation in Mexican parks.

The U.S. lags far behind in accommodating indigenous peoples. Only Death Valley National Park has allowed some small measure of co-management to the Timbishe Shoshone. Even here, their legal tenure as co-managers hangs by the thin thread of an executive order by President Clinton. If U.S. national parks really believe in diversity—i.e., in biocultural diversity in the case of co-management—they need to follow the example of other countries and embrace the future in a changing world.

References

Adams, J.S., and T.O. McShane. 1992. *The Myth of Wild Africa: Conservation without Illusion*. Berkeley and Los Angeles: University of California Press.

Brockington, D., and J. Igoe. 2006. Eviction for conservation: A global overview. *Conservation and Society* 4:3, 424–470.

Buggey, S. 1999. *An Approach to Aboriginal Cultural Landscapes*. Ottawa: Historic Sites and Monuments Board of Canada.

Chase, A. 1987. *Playing God in Yellowstone: The Destruction of America's First National Park*. San Diego: Harcourt Brace Jovanovich.

Cram, F. *Maori and Science: Three Case Studies*. Auckland, New Zealand: University of Auckland, International Institute for Maori and Indigenous Education.

Dowie, M. In prep. (Global survey of evictions from protected areas.)

Keenleyside, K. 2006. *Draft Standards and Guidelines for Ecological Restoration in Canada's Protected Natural Areas*. Gatineau, Quebec: Ecological Integrity Branch, Parks Canada Agency.

Keller, R.H., and M.F. Turek. 1998. *American Indians and National Parks*. Tucson: University of Arizona Press, Tucson, Arizona.

Lanner, R.M. 1996. *Made for Each Other: A Symbiosis of Birds and Pines*. New York: Oxford University Press.

Martinez, D. 2006. *Ecocultural Restoration Standards and Policies for Parks Canada Restoration*. Sydney, B.C., and Ottawa: N.p.

Martinez, D., and E. Higgs. 2004. Cultural Landscape policy sections, Society for Ecological Restoration International, Science and Policy Working Group. *The SER Primer on Ecological Restoration,* ver. 2. Tucson: Society for Ecological Restoration.

Nabakov, P., and L. Lawrence. 2004. *Restoring a Preserve: A Documentary Overview of Native America and Yellowstone National Park*. Norman: University of Oklahoma Press.

Smith, L.T. 1999. *Decolonizing Methodologies: Research and Indigenous Peoples*. London and Dunedin, New Zealand: Zed Books and University of Otaga Press.

Spence, M.D. 1997. *Dispossessing the Wilderness*. New York and Oxford: Oxford University Press.

Tomback, D.F., S.F. Arno, and R.E. Keane, eds. 2001. *Whitebark Pine Communities: Ecology and Restoration*. Covelo, Calif.: Island Press.

Worster, D. 1994. *Nature's Economy: A History of Ecological Ideas.* 2nd ed. Cambridge, U.K.: University of Cambridge Press.

Bears, Fish, Archeology, and Deferred Maintenance at Brooks Camp, Katmai National Park and Preserve

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Katmai National Park and Preserve includes 4,600,000 acres on the Alaska Peninsula that encompasses the Pacific Coast; the Aleutian Range, currently glaciated and punctuated by active volcanoes; and lakes filling glacial troughs that extend from the mountains to the terminal moraines in the Bristol Bay tundra lowland.

In the 1950s, Ray Petersen established five lodges in what is now Katmai National Park and Preserve. Four of the lodges are near short rivers connecting large lakes because Peterson recognized that the large sockeye salmon runs on these streams produced world-class rainbow trout fishing. Brooks Camp, now the most visited area of Katmai National Park and Preserve, occupies the downstream end of the mile-long Brooks River which flows from Brooks Lake to Naknek Lake (Figure 1). The salmon runs on Brooks River also attracted many other species, including brown bears and people (Figure 2).

In 1950, archeologists noted the presence of three archeological sites in the Brooks Camp vicinity. The fish camp by the river mouth started as a group of World War II surplus tents, but soon new facilities were built on XMK-044, an important archeological site on the terrace next to the fish camp. The National Park Service (NPS) began to establish a presence, building a cabin and a boat house a little way down the shore of Naknek Lake.

Researchers from the University of Oregon, directed by Don Dumond, conducted archeological research at Brooks Camp from 1960 to 1970, identifying 20 sites that showed that people had lived along Brooks River for at least 4,500 years (Dumond 1981). The Brooks River archeological record begins with camps of early nomadic hunters related to the Northern Archaic tradition, around 4500 BP, and continues to end of the Brooks River Bluffs phase of the Koniag tradition, around AD 1820. This research demonstrated that people occupied and re-occupied Brooks River despite frequent disruptive or catastrophic volcanic eruptions. Today, hundreds of large and small surface depressions arranged along terraces and beach ridges mark Brooks River archeological sites. Archeologists estimate that only one-third of the houses are visible as surface features.

NPS interpreters sometimes ask why the archeological sites at Brooks Camp are worth preserving after having undergone such exten-

Figure 1. Geographic setting of Brooks Camp in Katmai National Park and Preserve.

Figure 2. Sport fishermen and brown bear sharing Brooks River in autumn.

sive research. Dumond constructed a 4,500-year cultural chronology that demonstrates that the Brooks Camp archeological record has links with archeological traditions from both the Bering Sea and the North Pacific regions. We know less about the lives of the people who occupied the many houses, and how the groups of houses and pit features along the river and lake terraces functioned as communities. Why, after centuries of occupation, were year-round settlements abandoned at Brooks River, and why have archeologists not found evidence of use there during the Russian period? These are important questions for understanding the history of the region. The Brooks River sites were listed as an archeological district on the National Register of Historic Places, and later the district was designated a national historic landmark (NHL) in recognition of its national significance. Protecting the Brooks River NHL from the constant pressure to develop and upgrade facilities for guests and park staff is a continual challenge for NPS archeologists.

Archeological compliance

As the lodge developed and added guest cabins, numerous impacts to archeological site occurred, including construction of two cellars and installation of water, electric, and sewer utilities between the lodge and guest cabins. In 1969, archeologists were called to Brooks Lodge to evaluate a large pit filled with ash, charcoal, and burned bone found in a sewer trench being dug for a new guest cabin. At least four graves were disturbed by construction in the vicinity of Brooks Lodge before 1974. In 1974, lodge construction uncovered six graves that were observed by an archeologist, but not investigated. At least 13 graves have been encountered in archeological excavations or naturally eroding contexts.

As both the lodge and the NPS operations at Brooks Camp developed during the 1980s, many small archeological investigations occurred due to installing and maintaining electric, water, and sewer systems. These small excavations were by and large limited to the footprint of planned disturbances, but were never expanded to fully investigate archeological features encountered. These incremental impacts continued into the 1990s; however, the results of these small investigations have never been integrated into a study guided by research questions. As a result, we know very little about the large settlement under Brooks Lodge. By 1990, NPS archeologists began to avoid further impacts to archeological resources and promoted a "no new ground disturbance" policy aided by the protection provided by a 9- to 18-inch 1912 tephra layer.

Alaska Native interests in Brooks Camp

Alaska Native people occupied much of Katmai National Monument and Preserve until the 1912 Novarupta Eruption that formed the Valley of Ten Thousand Smokes. At that time, people lived in villages at the upper end of Naknek Lake along the lower Savonoski River, which is fed by glaciers on the western slopes of the Aleutian Range. The people fled downstream and founded New Savonoski on the lower Naknek River across from the Yupik village of Paugvik. Probably by the 1930s people began to return to the mouth of Brooks River in the fall to net red salmon. When Petersen established his fish camp in 1950, there were at least three cabins in the area of the river mouth, permanent log fish-drying racks, and wall tent sites.

In the early 1990s two things happened. First, the family of Pelegia Melgenak, who had lived at Old Savonoski, claimed 160 acres at the mouth of Brooks River as a native allotment. After a long court case the heirs prevailed and gained title to land on the south side of the river. This family organized as the Heirs of Pelegia Melgenak and sold some of the land back to the NPS 1998. They retained a 10-acre parcel of land and established a conservation easement on the south bank of the river mouth in cooperation with the NPS.

Second, in 1989 shoreline investigations related to the *Exxon Valdez* oil spill focused attention on the Katmai Coast where archeologists found human remains eroding from archeological sites. In 1990, the NPS became aware that fuel leaks from numerous fuel tanks, fuel lines, and underground fuel storage tanks threatened to contaminate Brooks River, Naknek Lake, and Brooks Lake. Efforts to clean up the fuel were complicated by the presence of archeological deposits, including human graves. Due to concerns about the treatment of the remains of their ancestors, a group of Alaska Native people from South Naknek formed the Council of Katmai Descendants (CKD), which represents all Alaska Natives with cultural ties to Katmai National Monument and Preserve. The CKD is recognized by the NPS and is endorsed by the Bristol Bay Native Association as the official Alaska Native representatives in cultural matters in Katmai and Brooks Camp. In matters concerning protocols and treatment of the remains of Alaska Natives in Katmai National Park and Preserve, the park consults primarily with the CKD.

Brooks River development concept plan

Beginning in 1989, the NPS began planning to determine how to protect Brooks Camp resources, including brown bear habitat and nationally significant archeological sites. This became the Brooks Area development concept plan. The steadily increasing numbers of bear viewers at Brooks Camp was far beyond the capacity of existing lodging and bear viewing facilities. To provide infrastructure to meet visitor needs meant additional impacts on archeological resources. Increasing numbers of brown bears fishing on Brooks River emphasized its importance as bear habitat and increased the need for the NPS to manage visitors to avoid injury and the habituation of bears. Recognizing that limiting visitors was not an option, the NPS reached a decision in 1996 to create a "people-free zone" on the north side of Brooks River and relocate all NPS and lodge facilities south of the river to the Beaver Pond terrace.

An archeological survey in 1999 tested and cleared a 40-acre parcel on the Beaver Pond Terrace with access roads to visitor arrival areas on Brooks Lake and Naknek Lake. But funding was lost and the plan was put on hold. The NPS did implement part of the development concept plan in 1999 by constructing an elevated boardwalk to replace the last part of the trail to the Brooks Falls bear viewing platform. The trail was eroding a major archeological site where bears liked to sleep in house depressions covered in high grass next to the trail.

Deteriorating infrastructure in the 21st century

Since 2000 NPS archeologists continue to avoid major impacts to archeological resources with the "no new ground disturbance" policy. However, the need to replace or install new infrastructure in terms of housing, electrical utilities, maintenance facilities, visitor facilities, and wastewater disposal has become critical. Upgrades in housing and the electrical systems were planned and funded. The park struggles with the issue of providing access across the Brooks River Bridge without displacing bears from prime habitat.

In November 2005, NPS engineers proposed to construct a reserve leach field at Brooks Camp in response to signs of failure of the existing leach field. They originally proposed to build the 25x40-meter facility contiguous with the south edge of the existing leach field, which would have put it within archeological site XMK-043, where previous research showed that houses and occupation surfaces as well as graves existed (Figure 3). Project managers rejected implementing an archeological data recovery program to clear the area due to the costs and need to replace the leach field without delay.

NPS archeologists proposed constructing the new leach field well north of Brooks River, reasoning that distance from the river would decrease the chance of encountering archeological sites (Figure 4). Consultation with the CKD and the Heirs of Pelegia Melgenak showed that they supported constructing the leach field away from areas of known archeological sites. People specifically mentioned that they did not support building a leach field over the graves of their ancestors.

Archeological testing at the northern alternative surprisingly located a hearth and lithic scatter dated 2,479 ± 50 BP (BETA 220451), or 520 BC. This date places the occupation of the new site between the Smelt Creek Phase of the Norton tradition and earlier Gravels phase of the Arctic Small Tool tradition. Torrential rains disclosed that the water table at the northern location was too high for a leach field to function correctly.

Katmai National Monument and Preserve managers directed archeologists to investigate a linear landscape feature just southeast of the existing leach field that seemed to be the best

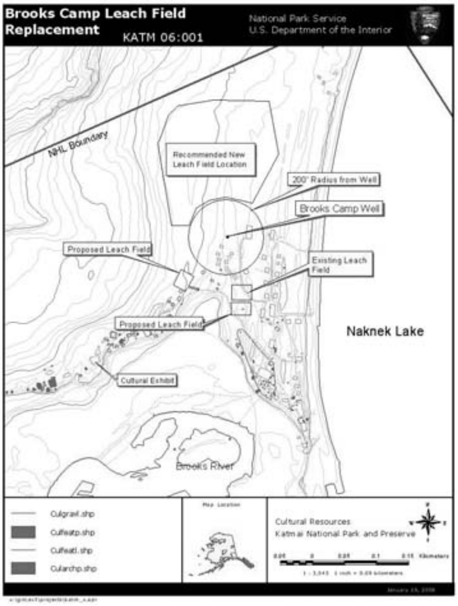

Figure 3. Location of Brooks Camp leach field and adjacent archeological features and graves.

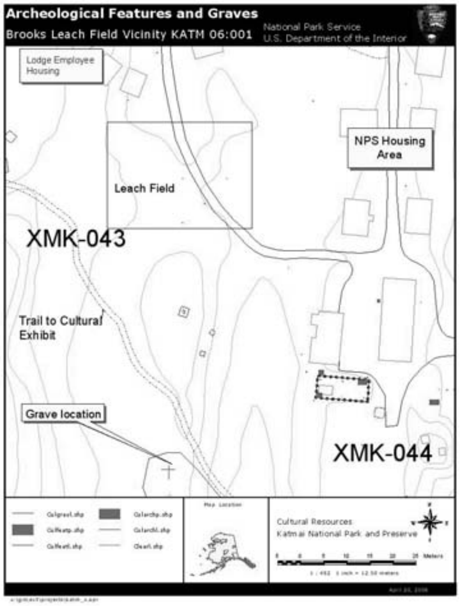

Figure 4. Brooks Camp showing archeological features, the current leach field, and proposed leach field locations.

chance for installing a leach field without impacting archeological resources. Systematic investigation of this area disclosed the presence of at least two occupation surfaces that were probably within houses. This alternative was dropped when archeologists discovered a grave within the area proposed for the leach field.

With the discovery of the grave, Katmai National Park and Preserve realized that protecting archeological resources required a different approach. A plan was made to rebuild the leach field in the existing excavation at its current location. In order to prolong the life of the reconstructed leach field, the park is taking action to reduce the number of people using facilities on the north side of Brooks River. Planned new replacement housing for deteriorating wall tents was shifted from Brooks Camp to a five-acre site for a new maintenance yard on the south side of the river (Figure 5), thus reducing the number of NPS staff using Brooks Camp utilities by eight.

There are currently three laws for protecting archeological sites on

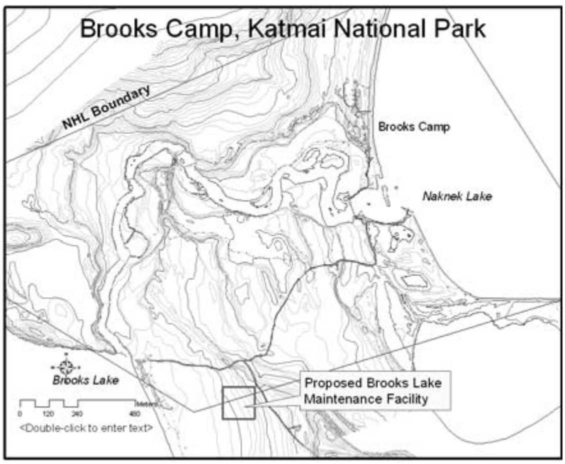

Figure 5. Brooks Camp area with proposed new maintenance facility south of Brooks River.

federal land. The Archeological Resources Protection Act (ARPA) protects sites from illegal digging—not an issue at Brooks Camp. The National Historic Preservation Act, which requires federal managers to take into account the effect of federal undertakings on archeological resources, involved archeologists in project planning. However, at Brooks Camp adequate funding to mitigate the impacts of projects beyond their actual footprint was never available. Thus, the Native American Graves Protection and Repatriation act (NAGPRA) has become the ultimate protector of Brooks Camp's archeological resources by giving the power to the lineal descendants and culturally affiliated people to protect the remains of their ancestors.

Reference

Dumond, D.E. 1981. *Archaeology on the Alaska Peninsula: The Naknek Region, 1960–1975*. University of Oregon Anthropological Papers no. 21. Eugene: University of Oregon.

Monitoring Resources in the Fremont-Winema National Forest and Yosemite National Park Using Satellite Imagery

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Introduction

The DEVELOP program is a student run and led internship program that creates pilot demonstration projects, with supervision from NASA scientists, under the Earth Science Division at NASA Ames Research Center. During an intensive 10-week program DEVELOP students use NASA facilities, techniques, computers, and technology for research primarily directed toward environmental issues, community development, management, and/or local policy.

The objective of this paper is to illustrate to resource managers how NASA Earth science data and imagery can be used as decision support tools for forest management. The use of NASA Earth science data and technology in environmental management applications is demonstrated by three projects completed by students in the NASA Ames DEVELOP program over the last three years. Each of the three following projects incorporated NASA Earth science data and technology, computer analysis, and field work. The U.S. Forest Service or the National Park Service were collaborators for these studies.

Fire behavior modeling and carbon budget in the Fremont-Winema National Forest, Oregon

The state of Oregon is a significant area to study carbon sequestration in forests because it is the leading provider of lumber in the United States. Within the 2.3 million acres of the Fremont-Winema National Forest (Figure 1), approximately 12 million cubic feet of timber is harvested annually for sale and to reduce fuel loads (N. Michaels, pers. comm.). Forest managers were interested in how timber harvesting and forest fires affect the carbon budget within the forest. In order to address these issues, the project contained two main components: fire behavior characteristic modeling and carbon simulation modeling. Both of these components used a combination of satellite imagery and field data.

Fire modeling

Due to the selective timber cutting that occurs throughout the Fremont-Winema forest, re-plantings of tree species such as mono-aged, thin-bark lodgepole pine (*Pinus contortus*) have replaced diverse-aged and more fire resistant communities of ponderosa pine (*Pinus* *ponderosa*) and Douglas fir (*Pseudotsuga* sp.) which has resulted in increased fire risk. Fremont-Winema forest managers were interested in fire behavior modeling to identify locations in the forest that might require prescribed burns or selective cutting due to accumulated fuel load.

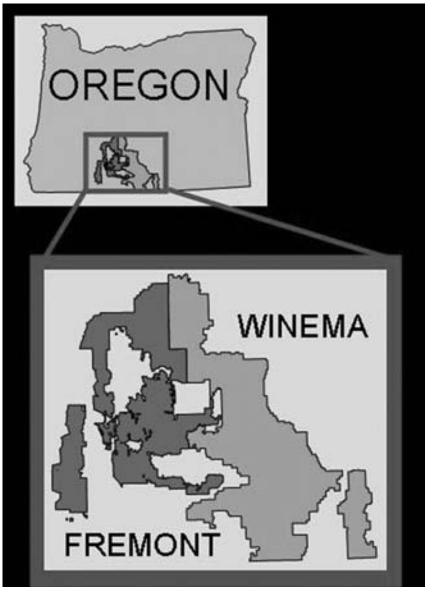


Figure 1. Location of Fremont-Winema National Forest.

The fire model used for this project is a software program entitled FlamMap, produced by the Fire Sciences Lab in Missoula, Montana, which computes potential fire behavior characteristics for constant weather and fuel moisture conditions. The inputs used for FlamMap included geographic data layers such as elevation, slope and aspect, remotely sensed data, and weather data. The outputs of the fire behavior model are rate-of-spread, which indicates how quickly a fire moves across a landscape, and flame length, which is an indication of fire intensity. Combined, these two maps can be used as a decision support tool to estimate fire risk and identify target areas for fuel-load reduction treatments. Fuel-load reduction treatments such as clearing slash and fallen trees to prevent large fires could also act as management tools to preserve the forest's carbon budget.

Carbon budget modeling

The forest's carbon budget was analyzed using the NASA Carnegie-Ames-Stanford-Approach (CASA) model. The NASA-CASA model is an internationally recognized carbon simulation model that estimates Net Primary Productivity (NPP) and soil heterotrophic respiration at regional to global scales. The model was set to simulate Net Ecosystem Productivity (NEP) over a 100-year re-growth period for two different harvest scenarios consisting of high and low slash values, in three climate regions throughout the forest. Other inputs to the model include vegetation, elevation, Fraction of Photosynthetically Active Radiation (FPAR), and soil texture.

According to results of the CASA model, wood harvest scenarios deplete the forest of several years of non-recoverable NPP carbon inputs. The results show that NPP will begin to decrease after 50-years of re-growth. Even after 100 years, drier climate areas still retain negative NEP flux. Ecosystems of this type do not contain enough productivity to recover completely from harvest losses of carbon and the slash and natural soil pool decompositions that follow.

An important and unanticipated finding of this project is based on our inputs to the NASA-CASA model, NEP will continue to decrease every time timber is harvested regardless of how long a forest is left to regenerate after selective-cuts. This finding should alert forest managers to the carbon sequestration effects of excessive timber harvesting. All of the data, maps and findings were turned over the Fremont-Winema National Forest for possible use in their 2005 management plan as decision support tools (Cleve et al. 2005).

Vegetation recovery in fire scars in Yosemite National Park, California

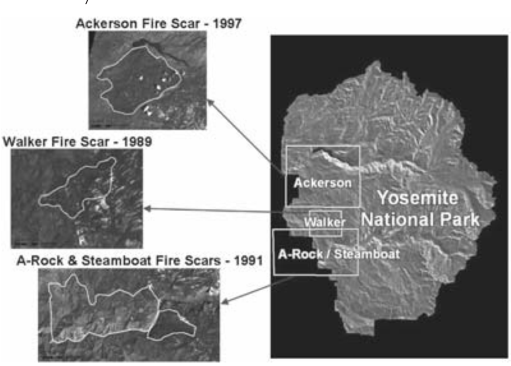
Remotely sensed data utilized for projects addressing landcover changes traditionally concentrate on detecting deforestation; however, studies have also successfully detected forest regeneration and succession with remotely sensed data (Foody et al. 1996; Fiorella and Ripple 1993). A thorough fire management plan includes long-term considerations such as assessing forest regeneration, which creates important, but not always obvious, forest changes. The objective of this project was to study subtle long-term post-fire regeneration changes in order to aid natural resource managers in long-term fire management decisions.

A total of four fire sites were assessed for this project within Yosemite National Park: A-Rock, which burned in 1990; Steamboat, 1990; Walker, 1988; and Ackerson, 1996. The sites were selected based on the criterion of resource management interest, accessibility, and availability of cloud free imagery. All four fires were naturally started by lightening and burned various vegetation zones.

Landsat imagery from the Thematic Mapper (TM) and Enhanced Thematic Mapper (ETM+) sensors were analyzed for the years between 1988 and 2004 and vegetation indices were selected to enhance interpretability of change patterns (Figure 2). Specifically, the normalized differenced vegetation index (NDVI) and normalized difference moisture index (NDMI) were computed for each Landsat image from 1989 to 2004. NDVI is used extensively to monitor vegetation (Jenson 1996), but NDMI has been proven useful for detecting forest changes (Jin and Sader 2005; Wilson and Sader 2002).

The older-date NDVI and NDMI images were subtracted from the newer date images on a pixel-by-pixel basis from the first year of the fire scar through 2004, in two-year intervals, in order to display a time-series of change patterns. This method is a means to broadly quantify the amount of moisture and vegetation change. In order to validate the imagery analysis, field data were collected in 65 plots for dominant species, percent cover, diameter at breast height, and tree height.

Figure 2. Landsat TM false color composites of study sites in Yosemite National Park, CA (grayscaled here). The outlines of the fire scars from the imagery are one year after the fire.



All of the fire scars were dominated by shrubs such as ceanothus (*Ceanothus* sp.) and manzanita (*Arctostaphylos* sp.). Trees had not re-colonized the fire scars and these areas were still in the shrub-seedling-sapling stage of the second defined stage of successional recovery (Allen 2003). The analysis showed that all four sites consistently had the greatest change occur within the first six years of recovery and remained steady throughout the second stage of succession. The vegetation growth patterns identified in this project are useful to NPS resource managers in understanding long term effects of fires on regeneration (Syfert et al. 2006).

Identifying vegetative anomalies in Yosemite National Park

Monitoring ecological disturbances such as fire and insect infestation within Yosemite National Park's 1,158 square miles is a challenging endeavor for the National Park Service. Lightning fires consume approximately 16,000 acres of Yosemite National Park per year, destroying an average of 2.4 percent of the park's combustible vegetation annually. The National Park Service could effectively augment their use of remote sensing technology to rapidly identify potential regions of concern, as well as monitor the recovery of already disturbed areas.

The purpose of this project was to demonstrate the effectiveness of the Moderate Resolution Imaging Spectroradiometer (MODIS) instrument to park resource managers. Located on two of NASA's Earth Observing satellites, Terra and Aqua, MODIS sensors provide repeat coverage at 250-m, 500-m, and 1,000-m spatial resolutions every one to two days. Such high temporal resolution enables resource managers to monitor rapid changes on the earth's surface at both regional and global scales. By utilizing MODIS data, Yosemite Park resource managers could be more cost and time efficient in detecting and identifying threats to the park.

Methods

The leaf area index (LAI) is the ratio of total leaf area to ground area. LAI data for this project were processed by NASA's Terrestrial Observation and Prediction System (TOPS). TOPS is a data and modeling software system designed to seamlessly integrate data from satellite, aircraft, ground sensors, and weather/climate models to quickly and reliably produce operational nowcasts (descriptions of current conditions) and forecasts of ecological conditions. The use of TOPS outputs is advantageous for ecological monitoring as they are rapidly processed and made available to the user (Nemani et al. 2007).

LAI data for Yosemite National Park from 2000 through 2005 were averaged for the month of July on a pixel by pixel basis. This average was then contrasted with the average LAI for July 2005. Low, average and high LAI ranges were classified for the July 2005 average relative to the five year average, resulting in an LAI-anomaly map. Landsat data and field data were collected and analyzed during the summer of 2006 to verify the accuracy of the MODIS instrument to detect vegetative anomalies in Yosemite National Park's coniferous forests. Analysis of vegetation maps, Landsat imagery, fire data, and insect infestation data revealed the likely causes for these anomalies.

Four sites were chosen for field investigation: one site was identified as having an *unknown* cause for a low LAI anomaly, one site was identified as having a *known* cause for a low LAI anomaly, and two sites represented the highest LAI value and average LAI value. Three utilities were used to verify MODIS LAI values: the LAI-2000 handheld instrument, allometric measurements (diameter at breast height, total tree height, and height above first branch), and Landsat 7 images. LAI was computed for the allometric data and the Landsat 7 images and these values were compared to MODIS LAI values using statistical analysis.

Results

The LAI-2000 data were found to be poorly correlated to the MODIS LAI values. This could be due to the fact that all trees studied were coniferous and the LAI-2000 is known to underestimate LAI values for conifers by as much as 52% (Malone et al. 2002; Jonckheere et al. 2005). Because of the inconsistency of the LAI-2000 in collecting leaf area indices for coniferous trees, the LAI-2000 data were found to be inconclusive in verifying MODIS.

There was a strong correlation between the allometric data-derived LAI values and the MODIS-derived LAI values. The strong correlation supports the accuracy of MODIS LAI, and also allows for MODIS to be used to calculate allometric data. There was also a strong correlation found between the Landsat LAI image and the MODIS LAI image, which further supports the accuracy of MODIS LAI.

Low LAI anomalies composed 48.1 percent of the entire park. Of that 48.1 percent, 10.4 percent was attributable to 2001-2005 fires; 2.2 percent to 2001 and 2002 beetle infestations; 3.6 percent to late snow fall; and 10.2 percent to rock. The remaining 73.6 percent of the low LAI anomalies need further investigation to determine the reasons for the vegetation disturbance. A map with the coordinates of these areas was given to park resource managers as a decision support tool (Figure 3).

Discussion

This project has laid out the method by which Yosemite National Park's resource managers can monitor vegetative disturbances and identify sites to investigate further. Due to strong correlations between allometric data and MODIS LAI, as well as Landsat LAI and MODIS LAI, an automated change detection model which will not only output the coordinates of sites for further investigation, but also reveal the cause and severity of future disturbances, could act as a powerful tool for forest management. Officials could use this information to preview sites before beginning control burns, monitor the shifts in the tree line, and have access to a historic record of MODIS LAI data. By observing changes in LAI values at higher elevations, Yosemite National Park resource managers could study how vegetation responds to the corresponding fluctuations in temperature and snowfall. If such trends in anomalous LAI persist, the LAI data have the potential to aid NPS resource managers in identifying the possibility that plant communities and ecosystems are shifting elevations. The accumulation of MODIS LAI will create a database of additional information that could act as an important point of reference for future studies (Voss et al. 2007).

Figure 3. Sites for further investigation in Yosemite National Park, CA.

References

Allen, B.H. 2003. Sierran mixed conifer. California Wildlife Habitat Relationships System, Department of Fish and Game, Interagency Wildlife Task Group. On-line at www.dfg.ca.gov/whdab/cwhr/pdfs/SMC.pdf. Accessed 2 June 2006.

Cleve, C., C. Huybrechts, K. Hsu, and M. Jin. 2005. Effects of fuel load reduction treatments on carbon sinks and forest fire risk in Fremont-Winema National Forest, Oregon. In *American Society for Photogrammetry and Remote Sensing Conference Proceedings.* March 7–11, 2005, Baltimore, Md.

Fiorella, M., and W.J. Ripple 1993. Determining successional stage of temperate coniferous forests with Landsat data. *Photogrammetric Engineering and Remote Sensing* 59:2, 239–246.

Foody, G.M., G. Palubinskas, R.M. Lucas, P.J. Curran, and M. Honzak. 1996. Identifying terrestrial carbon sinks: Classification of successional stages in regenerating tropical forest from Landsat TM data. *Remote Sensing of Environment* 55, 205–216.

Jenson, J.R. 1996. *Introductory Digital Image Processing: A Remote sensing Perspective.* 2nd ed. Englewood Cliffs, N.J.: Prentice-Hall.

Jin, S., and S.A. Sader. 2005. Comparison of time series tasseled cap wetness and the normalized difference moisture index in detecting forest disturbances. *Remote Sensing of Environment* 94, 364–372.

Jonckheere, I., B. Muysand, and P. Coppin. 2005. Allometry and evaluation of in situ optical LAI determination in Scots pine: A case study in Belgium. *Tree Physiology* 25, 723–732.

Malone, S., D.A. Herbert, and D.L. Holshouser. 2002. Evaluation of the LAI-2000 plant canopy analyzer to estimate leaf area in manually defoliated soybean. *Agronomy Journal* 94, 1012–1019.

Nemani, R., P. Votava, A. Michaelis, M. White, F. Melton, J. Coughlan, K. Golden, H. Hashimoto, K. Ichii, L. Johnson, M. Jolly, C. Milesi, R. Myneni, L. Pierce, S. Running, C. Tague, and W. Pang. 2007. Terrestrial Observation and Prediction System (TOPS): Developing ecological nowcasts and forecasts by integrating surface, satellite and climate data with simulation models. In *Research and Economic Applications of Remote Sensing Data Products.* U. Aswathanarayana and R. Balaii, eds.. American Geophysical Union Book Series (in press).

Syfert, M., J. Rudy, L. Anderson, C. Cleve, J. Jenkins, C. Schmidt, and J. Skiles. 2006. Post fire regeneration assessment in Yosemite National Park. In *American Society for Photogrammetry and Remote Sensing Conference Proceedings*, *May 1-5, Reno, Nev*.

Voss, M., I. Wilson, S. Oza, A. Suarez, A. Husby, C. Schmidt, and J. Skiles. 2007. Correlating vegetation growth anomalies with occurrences such as fire and insect infestation in Yosemite National Park using MODIS FPAR data. In *American Society for Photogrammetry and Remote Sensing Conference Proceedings*, *May 7-11, Tampa, Fla*. (in press).

Wilson, E.H., and S.A. Sader. 2002. Detection of forest harvest type using multiple dates of Landsat imagery. *Remote Sensing of Environment* 80, 385–396.

Developing Integrated Assessments for National Capital Region Network Parks: An Example from Rock Creek Park

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Rock Creek Park in context

The National Capital Region Network (NCRN) contains 11 parks within the District of Columbia, Maryland, Virginia, and West Virginia (Figure 1a): Antietam National Battlefield (ANTI), Catoctin Mountain Park (CATO), Chesapeake and Ohio Canal National Historical Park (CHOH), George Washington Memorial Parkway (GWMP), Harpers Ferry National Historical Park (HAFE), Manassas National Battlefield Park (MANA), Monocacy National Battlefield (MONO), National Capital Parks–East (NACE), Prince William Forest Park (PRWI), Rock Creek Park (ROCR), and Wolf Trap National Park for the Performing Arts (WOTR). These parks are some of the most visited in the National Park Service (NPS) system due to the urban context in which many of the parks are located, as well as the proximity to the major population centers of the District of Columbia and Baltimore (Carter et al. 2006). The integrated assessment focuses on Rock Creek Park, one the most urban of the NCRN parks.

Rock Creek Park (Figure 1b) is located in the heart of the District of Columbia and is one of the largest forested, urban parks in the United States. It contains a unique combination of natural, historical and recreational features. The mixed deciduous forests, streams, and sensitive floodplain communities of the park represent a largely natural system surrounded by high-density urban development. A land use analysis of Rock Creek Park shows that the park is 80% forested and 12% developed; the surrounding area is 21% forested and 71% developed (Townsend et al. 2006). Because of this dramatic difference in land use, Rock Creek Park has been described as "an island of forest in a sea of development." This dense urban development impacts park resources through traffic, flooding, chemical and

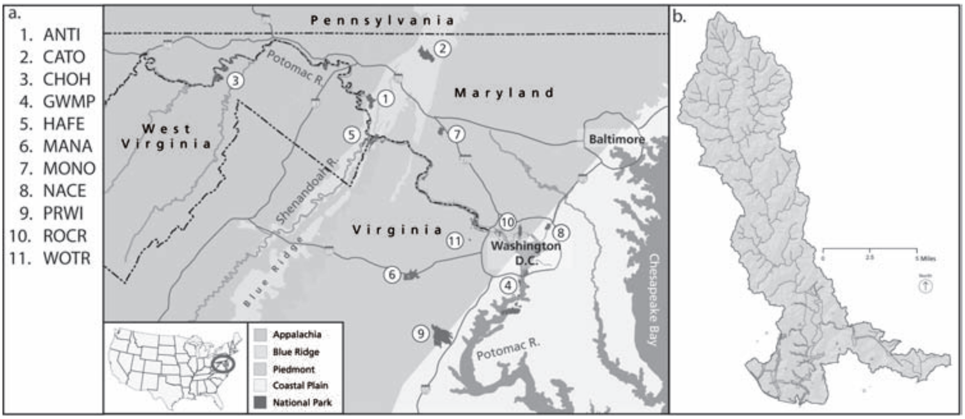


Figure 1. Rock Creek Park in a (a) regional and (b) watershed context (NPS 2006).

biological pollution of park streams, introductions of invasive species, recreational demand, dumping, collecting, creation of unauthorized trails, and boundary encroachments (Carter et al. 2006).

Developing thresholds for diverse vital signs

The integrated assessment of Rock Creek Park is based upon Inventory & Monitoring (I&M) data collected in the 2005-2006 field seasons. Within Rock Creek Park, the I&M Program is collecting data on 21 vital signs (62 metrics) in four categories:

- Air quality and climate: ozone, wet deposition, visibility and particulate matter, mercury deposition, weather (11 metrics);
- Water quality and hydrology: surface water dynamics, water chemistry, nutrient dynamics, aquatic macroinvertebrates, physical habitat index (18 metrics);
- Biodiversity: invasive/exotic plants, forest insect pests, forest vegetation, fishes, amphibians, land birds, white-tailed deer, rare/threatened/endangered species and communities (23 metrics); and,
- Ecosystem pattern and process: land cover/land use, and landscape condition (10 metrics).

Linking management objectives to thresholds

Each of the vital signs listed above is associated with one or more management objectives (Figure 2). These objectives are laid out in the protocols written by the networks. In order to use the I&M data to determine whether management objectives are met (Mehaffey et al. 2005), it is necessary to evaluate the data relative to pre-determined threshold values or assessment points. These values can be set by scientific journals, regulations, or can be based on expert opinion (Bertollo 1998; Shear et al. 2003; Pantus and Dennison 2005). Our goal for threshold development is to use ecologically relevant thresholds. However, until these thresholds can be developed, regulatory values are used as a substitute to measure park health. According to Biggs (2004), thresholds serve as research hypotheses, connections to

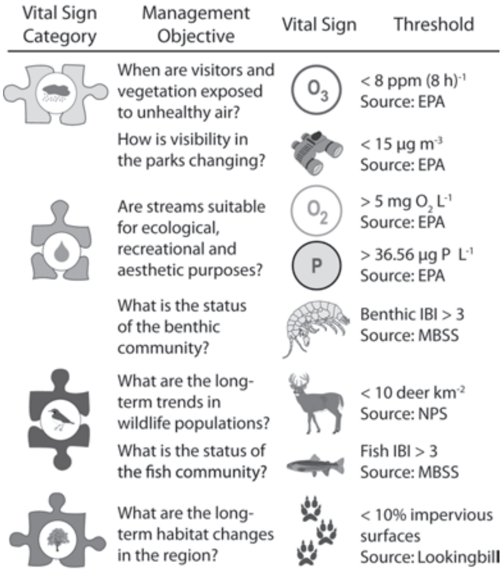


Figure 2. The link between management objectives and thresholds. Example management objectives are listed for each vital sign category. A vital sign that pertains to the management objective is listed. The threshold that has been developed for one of the metrics within that vital sign has been listed in the final column.

system drivers that influence ecosystems, and tangible, realistic environmental goals. It is important to note that these threshold values do not have to be permanent. If management goals change or new research is published, the threshold can be modified accordingly (Jensen et al. 2000; Pantus and Dennison 2005). These flexible environmental thresholds are a key part of the adaptive management cycle. Adaptive management requires approaching management as an experiment that relies on sound, responsive monitoring to inform future management decisions (Boesch 2000).

Threshold development is currently an on-going process for the NCRN. At this point, threshold values have been determined for eight of the 21 vital signs that pertain to Rock Creek Park. In order to develop these thresholds, we began by looking at regulatory values for the "air quality and climate" and "water quality and hydrology" categories. Regulatory values are readily available for these two vital sign categories because the quality of these natural resources is federally regulated for human health reasons. At Rock Creek Park, the two thresholds that have been developed for the ozone and "visibility and particulate matter" vital signs are Environmental Protection Agency (EPA) National Ambient Air Quality Standards (NAAQS) (EPA 1990). Those vital signs that do not have thresholds are either being used to explain variation in other vital signs (e.g., weather) or there has yet to be a link between ecological effect and the metrics (e.g., mercury deposition).

For the water quality and hydrology category, 10 thresholds have been developed. Seven of the thresholds are regulatory: five are District of Columbia Municipal Regulations (DC 2006) and two are EPA National Recommended Water Quality Criteria. The remaining three thresholds are ecologically relevant thresholds. One was developed by Hilderbrand et al. (2006), one was developed by the Maryland Department of Natural Resources (MDDNR) Maryland Biological Stream Survey (MBSS), and the third is an EPA Nutrient Criteria that is suggested to prevent eutrophication. Ultimately, developing these ecologically relevant thresholds is the goal for all of the thresholds used in the integrated assessment.

Thresholds for the Biodiversity category are difficult to develop. In many cases the monitoring data that is being collected is species assemblage information. What needs to be determined is what species assemblages are considered "healthy" or whether "keystone" species are present. To develop these thresholds, scientific research projects may need to be conducted or many years of monitoring data may need to be collected to determine what assemblages are present. Currently, two thresholds have been developed; one is from the MBSS and the second has been developed by NCRN staff.

For the ecosystem pattern and process category, four thresholds have been developed from expert opinion. The remaining metrics require trend information to develop thresholds. Because the vital signs in this category are measured on a five-year basis, it will require at least five more years of monitoring data in order to develop these thresholds.

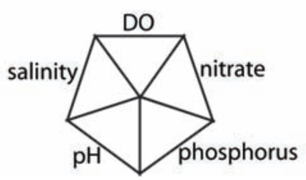
Using the thresholds that are currently available it is possible to assess Rock Creek Park with the caveat that more indicators and thresholds could be incorporated at a later date. The assessment framework that has been developed is easy to adjust to add more vital sign metrics as thresholds become available. According to Pantus and Dennison (2005), indices of ecosystem health which are based upon more indicators generally incorporate more information. Therefore, as the remaining thresholds are developed, more vital sign metrics will be added to the integrated assessment.

Assessing threshold attainment in space and time

The next step in the assessment is to determine whether the resource, as measured by the monitoring data, meets the management goal, as quantified by the threshold value. To do this, monitoring data is directly compared to the threshold value. For example, monthly water quality measurements are made at the Pinehurst Branch monitoring location (Figure 3). Information is collected at this site for both the water chemistry and nutrient dynamics vital signs. Thresholds and monitoring data are listed for five vital sign metrics, and the monitoring data that do not meet the threshold value are colored gray (Figure 3).

Figure 3. Monitoring data and thresholds from Rock Creek Park. Example data set is from the Pinehurst Branch monitoring location. Data colored gray do not meet the threshold value.

	Dissolved O_2 mg L^{-1}	NO_3 mg L^{-1}	PO_4 mg L^{-1}	pH	Salinity
Threshold	> 5.00	< 2.00	< 0.037	6.00 - 8.50	< 0.25
10/4/2005	7.80	0.40	0.69	7.50	Not Reported
11/3/2005	6.56	1.20	1.23	7.58	Not Reported
12/8/2005	9.01	0.30	0.41	7.47	1.10
1/3/2006	5.58	2.50	0.44	7.67	0.20
2/14/2006	11.88	3.00	0.48	7.67	0.70
3/8/2006	7.64	3.10	0.15	8.30	0.30
4/4/2006	5.98	0.70	Absent	8.01	0.20
5/4/2006	3.94	2.80	0.61	7.75	0.20
	0.88	**0.50**	**0.00**	**1.00**	**0.50**



Excellent A ≤ 1.00
Good B ≤ 0.80
Poor C ≤ 0.60
Degraded D ≤ 0.40
Very Degraded F ≤ 0.20

To compare sites within Rock Creek Park, the percentage of time a site meets the thresholds is calculated. Pinehurst Branch receives a score of 0.50 for nitrate concentration, where a score of one means that the site always meets the threshold (Figure 3). Normalizing the data by the percentage of time the threshold is met also allows vital sign metrics to be compared that have different units and different sampling frequency. In this way we can compare nutrient dynamics (mg L^{-1}), which are sampled monthly, with white-tailed deer (deer/ha), which are sampled annually. Another method of measuring attainment of thresholds would be to assign the vital sign metric a zero if any sampling periods exceeded the threshold value and a one only if the metric was always within the threshold, as would be used if any of the metrics used in the assessment indicated a system collapse after one instance of exceedance. Because of the intense urban pressures the NCRN parks experience, it is unlikely that all metrics will meet the threshold at all sampling periods. By using the percentage of time assessment criteria, it is possible to create a continuum of site conditions to determine where management should focus restoration or protection efforts. Using a binary (one or zero) scale only would not provide the same amount of information as the percentage scale.

Calculation of park ecosystem health

There are different methods for combining the vital sign metric scores into a condition assessment. One method is to combine scores across vital signs into a site condition score. As discussed previously, this assessment score allows management to determine where within a park resources are needed for restoration and protection. A second method of combining metric scores is within vital signs. In this method, the mean of metric scores for the entire park can be calculated to create a park-level vital sign score. This score potentially can be compared with the vital sign score other parks receive to place a particular park along a gradient of park health. The vital sign score can be compared not only within a Network, but also between Networks.

The next step in the integrated assessment for Rock Creek Park is to combine vital sign scores into a park health score (Figure 4). To calculate this score, all the vital signs within a category are combined to create a vital sign category score. In Rock Creek Park, the vital sign metrics for which thresholds are available are averaged into vital sign scores. These vital sign scores are then averaged to calculate a vital sign category score. For example, the water chemistry score is 0.92, the nutrient dynamics score is 0.04, and the aquatic macroinvertebrates score is 0.52. These scores are then averaged to calcu-

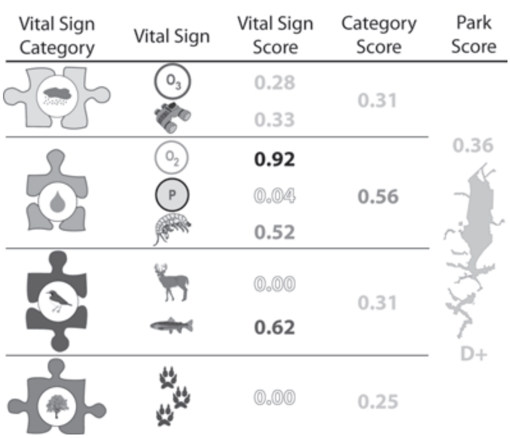


Figure 4. Representation of integrated assessment approach. Vital sign scores are calculated by averaging vital sign metric scores (not shown). These vital sign scores are averaged to create a category score. The category scores are then averaged to create a park health score.

late the Water Quality and Hydrology score of 0.56. A similar method is used to calculate the scores for the three remaining vital sign categories. These category scores are then averaged together to calculate the final score for Rock Creek Park. This numeric score is not useful if management and the public cannot easily relate to it. The numeric score can be translated into a letter grade using the same scale as the recent Chesapeake Bay Report Card (Ecocheck 2007). Using that scale, Rock Creek receives a D+ for this preliminary assessment of ecosystem health.

Application to other parks and networks

The method for calculating the park score was chosen to facilitate comparison between I&M Networks. Due to the wide range of geomorphologic structures, habitats, fauna and flora throughout the nation, individual networks are measuring different metrics and vital signs. Regional comparisons within networks will be most efficient at the vital sign level (e.g. aquatic macroinvertebrates) as this will provide the most detailed information about the relative status of the local resources within a network. Broad scale comparisons, however, will best be carried out at the vital sign category level (e.g. "water quality and hydrology") as there will always be some metrics at all parks within these generic classes. For these reasons, this hierarchical approach to an integrated assessment for vital signs monitoring can provide local detail as well as regional or national-level synthesis.

References

Bertollo, P. 1998. Assessing ecosystem health in governed landscapes: A framework for developing core indicators. *Ecosystem Health* 4:1, 33–51.

Biggs, H.C. 2004. Promoting ecological research in national parks—A South African perspective. *Ecological Applications* 14:1, 21–24.

Boesch, D.F. 2000. Measuring the health of the Chesapeake Bay: Toward integration and prediction. *Environmental Research* 82:2, 134–142.

Carter, S., T. Lookingbill, J. Hawkey, T. Carruthers, and W.C. Dennison. 2006. *A Conceptual Basis for Natural Resource Monitoring.* Washington, D.C.: Inventory & Monitoring Program, Center for Urban Ecology, National Park Service.

Dennison, W.C., T. Lookingbill, T. Carruthers, J. Hawkey, and S. Carter. In press. An eye-opening approach to developing and communicating integrated environmental assessments. *Frontiers in Ecology.*

DC [District of Columbia]. 2006. Water Quality Standards. 21 District of Columbia Municipal Regulations Ch. 11. On-line at www.epa.gov/waterscience/standards/wqslibrary/dc/.

Ecocheck. 2007. *Chesapeake Bay Habitat Health Report Card: 2006.* Integration and Application Network, University of Maryland Center for Environmental Science, Ecocheck (NOAA-UMCES Partnership). On-line at www.eco-check.org/reportcard/chesapeake/.

EPA [Environmental Protection Agency]. 1990. *Clean Air Act.* 40 CFR part 50. On-line at www.epa.gov/air/criteria.html.

Hilderbrand, R.H., R.L. Raesly, and D.M. Boward. 2006. *National Capital Region Network Biological Stream Survey Protocols.* Washington, D.C.: National Capital Region Network, National Park Service.

Jensen, M.E., K. Reynolds, J. Andreasen, and I.A. Goodman. 2000. A knowledge-based approach to the assessment of watershed condition. *Environmental Monitoring and Assessment* 64:1, 271–283.

Mehaffey, M.H., M.S. Nash, T.G. Wade, D.W. Ebert, K.B. Jones, and A. Ranger. 2005. Linking land cover and water quality in New York City's water supply watersheds. *Environmental Monitoring and Assessment* 107:1/3, 29–44.

Pantus, F.J., and W.C. Dennison. 2005. Quantifying and evaluating ecosystem health: A case study from Moreton Bay, Australia. *Environmental Management* 36:5, 757–771.

Shear, H., N. Stadler-Salt, P. Bertram, and P. Hovatin. 2003. The development and implementation of indicators of ecosystem health in the Great Lakes basin. *Environmental Monitoring and Assessment* 88:1/3, 119–152.

Townsend, P.A., R.H. Gardner, T.R. Lookingbill, and C.C. Kingdon. 2006. *National Capital Region Network Remote Sensing and Landscape Pattern Protocol for Long-term Monitoring of Parks.* Washington, D.C.: National Capital Region Network, National Park Service.

Wazniak, C., M. Hall, C. Cain, D. Wilson, R. Jesein, J. Thomas, T. Carruthers, and W. Dennison. 2004. *State of the Maryland Coastal Bays.* Maryland Department of Natural Resources, Maryland Coastal Bays Program and University of Maryland Center for Environmental Science.

Evaluation of Watershed Imperviousness Models Using Stream Assessment Techniques in the Cuyahoga Valley, Ohio

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Introduction

National parks are designated to preserve and protect significant natural, cultural and historic resources. Unfortunately, many of the resources park managers seek to preserve extend far beyond jurisdictional boundaries. For river-based parks at the bottom of large watersheds, this challenge is particularly daunting—land use changes outside the park can quickly degrade the rivers, streams, and watersheds these parks are charged with protecting.

Changes in land use in areas surrounding parks, particularly suburbanization, impact hydrology through the loss of wetlands, headwater streams, and increased imperviousness (e.g., roads, buildings, parking lots, etc.). As wetlands and headwaters are lost and watershed imperviousness escalates, surface water run-off increases and stream channel erosion and sedimentation occur. These physical changes result in increased flood frequency and adverse effects on water quality, habitat structure, and biodiversity (Schueler 1994).

These impacts have materialized in Cuyahoga Valley National Park, Ohio, a 33,000-acre (13,365-ha) island of green between the cities of Cleveland and Akron, Ohio, managed by the National Park Service (NPS). It is home to 35 km of the Cuyahoga River and more than 300 km of tributaries (most with watersheds extending out beyond park boundaries). At an ever-increasing rate, the communities surrounding the park have experienced considerable residential and commercial development.

Between 2003–2006, the park experienced three major floods, which caused more than $6 million in damages to park infrastructure, recreational facilities, and historical and cultural resources. Many of the park's communities also experienced severe economic impacts from the floods. Although these floods were due to unusually heavy rains, even typical storms are now causing flooding problems in smaller park tributaries as sedimentation blocks channels and stream flows outpace culvert capacities. Park managers embraced flooding issues as a unifying theme to engage and educate local communities on the importance of watershed-focused planning, protection of water resources through set-backs, and the importance of greenspace (Skerl et al. 2006).

To more easily communicate this issue, watershed imperviousness was identified as an overall indicator of watershed health to help communities understand their watershed context, identify upstream partnerships, and focus discussion towards priority areas for conservation and restoration. Research has shown that imperviousness reliably tracks changes in important stream characteristics, has apparent thresholds for impacts, and is one of the few variables that can be quantified and managed during development (Schueler 1994, Arnold and Gibbons 1996). Additional research to clarify the reliability of these thresholds is needed (Brabec et al. 2002) and the application of locally-derived data strengthens outreach efforts. We examined the accuracy of two impervious surface models and assessed their utility as indicators for local stream monitoring data at various scales in the Cuyahoga Valley watershed.

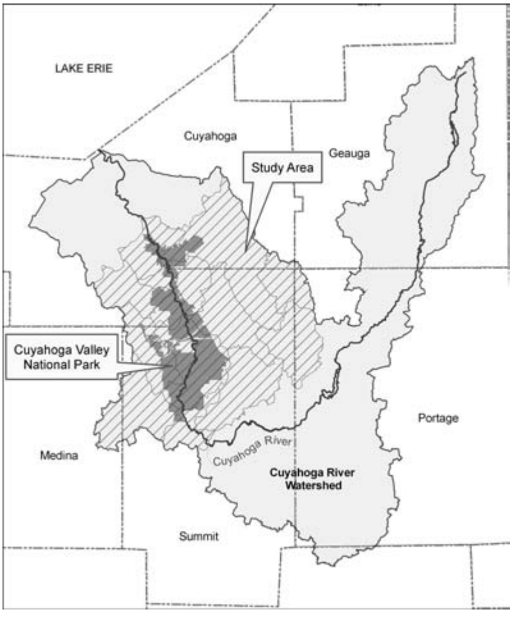
Methodology

Study area. The 800 km^2-study area includes the watersheds for all tributaries that drain through the park into the Cuyahoga River (U.S. Environmental Protection Agency Hydrological Unit Code [HUC] HUC 04110002) (Figure 1).

Watershed delineation. Watersheds were examined at three nested scales: large Cuyahoga River basin watersheds with fourteen-digit HUC codes, smaller subwatersheds, and headwaters. Cuyahoga River watershed boundaries were obtained from the Ohio Natural Resource Conservation Service. Other watershed delineations were performed using ESRI's ArcGIS Spatial Analyst 9.1. Subwatersheds were generated from a U.S. Geological Survey (USGS) 30-m digital elevation model (DEM) with a minimum basin size of 575 pixels (51.75 ha); these subwatershed units were iteratively aggregated to develop subwatershed boundaries for stream segments monitored by the Ohio Environmental Protection Agency (OEPA) or National Park Service (NPS). To further examine the effects of scale, watershed areas above headwater stream monitoring sites were generated from USGS 10-m DEM. Spatially independent headwater stream watersheds greater than 0.01 mi^2 (~0.03 km^2) were selected for this analysis.

Land use/land cover data. Land use/land cover (LULC) was characterized using a modified Anderson (Anderson et al. 1976) Level I and Level II classification developed for Ohio (Schall 1988). On-screen digitizing (ArcGIS 8.3 and ArcInfo Workstation) was performed (minimum mapping unit was 0.4 ha, scale was 1:5,000) utilizing 2000 Summit County (color) and 2002 Cuyahoga County (black and white) digital orthophotography (leaves off, 1:100 scale). LULC was classified based on dominant (greater than 75%) land cover for a delineated area. The road class was generated buffering county road line data (1:1,200 scale) at 25-feet (7.6 m) buffer. Data were converted to 10 m grid format for analysis. Previous studies indicate that residential imperviousness estimates using parcel size information are more accurate, as percent impervious generally decreases as residential parcel size increases (e.g., Sleavin et al. 2000). County parcel datasets (1:1,200 scale) were used to clip the general residential

Figure 1. The project study area (hatched) is within the Cuyahoga River watershed and includes Cuyahoga Valley National Park (shaded).



LULC class into residential units of varying size. A total of 24 classes, including 11 residential, were identified.

Actual imperviousness. We measured actual imperviousness in a representative portion of the project area to compare to predicted values. We focused our accuracy assessment on the Brandywine Creek watershed as it is one of the largest park watersheds (70 km^2) and includes a good representation of the variety of suburban/rural land uses surrounding the park. A 100 m-by-100 m (1-ha) polygon grid was generated over the extent of the project area. Grid areas (plots) that intersected the Brandywine Creek watershed were identified and a random selection of approximately 5% of the grids was made (n = 385). The 1-ha plots were converted into a 1-m resolution raster data layer. Grid generation and random selection were performed using Hawth's Analysis Tools (v. 3.26) for ArcGIS.

Binary values (impervious/pervious) were assigned for each 1-m^2 pixel. A Summit County planimetric data layer (2000) depicting building extents at 1:1200 was used to characterize impervious areas. Additional impervious surfaces (e.g., roads, sidewalks, other buildings, parking lots) within all plots were then digitized at approximately 1:1000 scale from the orthophotography using ARIS Grid Editor 1.1.1.1 extension for ArcGIS.

LULC model. Approximately half (n=193) of the sample plots (Subset 1) were randomly selected for training the LULC model. The remaining plots (Subset 2, n=192) were reserved for accuracy assessment. Mean imperviousness values for LULC classes within the subset were calculated and used in the imperviousness model.

NLCD imperviousness. The imperviousness layer from the USGS 2001 National Land Cover Database (NLCD) was used for analysis (Yang et al. 2002; Homer et al. 2004). This 30-m resolution pixel dataset contains imperviousness values ranging from 0 to 100%.

Imperviousness analysis. Imperviousness for all analysis units was calculated using the Zonal Statistics function in Spatial Analyst 9.1. All statistical analyses were performed in SPSS 10.1. NLCD and LULC model predictions of imperviousness were compared to actual imperviousness in Subset 2 using linear regression. Mean NLCD imperviousness in all watershed units was calculated.

Stream monitoring. Stream monitoring data collected by the OEPA and the NPS were compiled. Sites (n = 30) in the watersheds and subwatersheds were visited three to six times in May through October, 2000, and measurements were averaged. Primary headwater stream evaluations (one visit, May through August) following a protocol developed by the OEPA (2002) were completed during 2004–2006.

Variables that may be associated with changes in imperviousness were measured and analyzed, including several OEPA indices of stream and habitat quality: the Qualitative Habitat Evaluation Index (Rankin 1989), Index of Biotic Integrity (IBI) (OEPA 1987), Headwater Habitat Evaluation Index (HHEI) (OEPA 2002), and Headwater Macroinvertebrate Field Evaluation Index (HMFEI) (Table 1). Attainment of OEPA Warm Water Habitat (WWH) designated use standards (OEPA 1987) in tributaries and final Primary Headwaters Aquatic Life Classes were also examined.

Data were analyzed with Pearson correlation (r) or Spearman rank correlation (r_S), linear regression, two-independent sample t-tests and Kruskal Wallis (K-W) tests. We reported results significant at $p < .10$ levels.

Results

Actual mean imperviousness for Subset 2 was 15.9 ± 1.3 % (mean ± SE). The imperviousness models differed in their ability to predict actual imperviousness ($t(191) = 4.82$, $p < .001$). The NLCD model underestimated actual imperviousness (13.8 ± 1.1%) while the LUCL model overestimated (17.8 ± 1.25%). Linear regression analyses indicate that the NLCD is a better overall predictor ($R^2 = 0.70$; RMSE = 10.0) than the LULC model ($R^2 = 0.60$; RMSE=11.5). NLCD imperviousness was therefore further assessed as an indicator.

Significant results of correlation analyses of stream monitoring measures with NLCD imperviousness at each watershed scale are shown in Table 2.

Stream and Watershed Variables
Watershed Size (km^2)
Dissolved Oxygen (mg/L)
pH
Specific Conductance (mS/cm)
Temperature (C)
Turbidity (NTU)
Total Dissolved Solids (mg/L)
Total Suspended Solids (mg/L)
Chloride (mg/L)
Total Phosphorus (mg/L)
E. coli concentration (cfu/100ml)
Qualitative Habitat Evaluation Index
Index of Biotic Integrity
Attainment of OEPA Warm Water Habitat standards
Primary Headwater Habitat Evaluation Variables
Stream Order
Pool Depth (cm)
Large Substrate Score
Headwater Habitat Evaluation Index
Headwater Macroinvertebrate Field Evaluation Index
Final Primary Headwater Habitat Aquatic Life Class
Presence/Absence of cold water salamander young

Table 1. Stream and watershed variables assessed.

Mean watershed size was 78.1 ± 14.1 km^2 (n=6). Mean watershed imperviousness was 12.9 ± 2.7% (n = 6) ranging from 5.6 to 23.3%. Imperviousness was positively correlated with temperature, turbidity, total suspended solids (TSS), and *Escherichia coli* (*E. coli*) concentrations and negatively correlated with IBI (Table 2).

Mean subwatershed size was 9.35 ± 1.6 km^2 (n = 24). Mean subwatershed imperviousness was 8.9 ± 2.1% (n = 24,) ranging from 1.7 to 37.9%. Imperviousness was positively correlated with temperature, chloride, *E. coli* concentrations, and watershed size, and negatively correlated with pH and IBI (Table 2). Watershed size was not correlated with IBI ($r = 0.13$, $p = .63$), or *E. coli* ($r_s = 0.38$, $p = .06$), but was correlated with pH ($r = 0.59$, $p = 0.009$), temperature ($r = 0.47$, $p = .027$) and total phosphorus ($r = 0.38$, $p = .066$). Step-wise regression analyses using imperviousness and watershed size indicate that imperviousness explained more variability in temperature while size accounted for more pH variability. Mean watershed imperviousness was found to differ ($t(15) = 4.4$, $p < .001$) between watersheds in full or partial attainment of OEPA warm water habitat standards (5.8 ± 1.7%, n = 13) compared to non-attainment (25.6 ± 6.1%, n = 4).

Mean primary headwater stream watershed size was 0.21 ± .02 km^2 (n = 118). Mean watershed imperviousness was 2.8 ± 0.3% (n = 118) ranging from 0 to 16.0%. Imperviousness was positively correlated with watershed size, HHEI score, HMFEI score and pool depth (Table 2). Imperviousness differed (K-W test :$F(2) = 5.21$, $p = .07$) across final headwater class categories. The significant difference was between Class I (5.7 ± 1.8%, n = 8) and Class III (2.1 ± .04%, n = 68) headwaters (K-W test: $F(1) = 3.44$, $p = .064$).

Variable	Watersheds		Subwatersheds[a]		Headwaters	
	r	n	r	n	r	n
pH	ns		–0.64***	18	ns	
Temperature	0.98***	5	0.87***	18	0.16*	118
Turbidity	0.83*	5	ns		ns	
Total Suspended Solids	0.92**	6	ns		ns	
Chloride	ns		0.44**	24	ns	
Total Phosphorus	ns		0.51***(s)	22	ns	
E. coli	0.771* (s)	6	0.63***(s)		ns	
Index of Biotic Integrity (IBI)	–0.82*	5	–0.50**(s)	17	ns	
Pool Depth	NA		NA		0.15* (s)	118
Headwater Habitat Evaluation Index (HHEI)	NA		NA		0.16* (s)	118
Headwater Macroinvertebrate Field Evaluation Index (HMFEI)	NA		NA		–0.27*** (s)	118
Watershed Size	ns		0.54***(s)	24	0.35***(s)	118

***p<.01,** p<.05, * p<.10; a = log-transformed mean imperviousness; (s) = Spearman rank correlation; ns= not significant; NA = not applicable at watershed scale

Table 2. Significant correlations of stream and watershed variables with mean NLCD imperviousness.

Discussion

We found that the NLCD imperviousness data set more adequately represents actual watershed imperviousness when compared to an aerial photo-interpreted LULC model, even when that model is modified to capture variability in residential parcel size and is trained with actual imperviousness data. The data layer is not without weaknesses, as it consistently underestimated imperviousness and had sizable error margins. However, much of this apparent error may be due to its 30 m pixel resolution, which can result in significant error specifically at the edges of sample areas, becoming increasingly apparent at small scales (e.g., our 1 ha plots). Accuracy may presumably improve at larger watershed scales. This follows the findings of other researchers that document high overall NLCD imperviousness accuracy (Homer et al. 2004) and the greater reliability of satellite-derived imperviousness values over photo-interpreted LULC models (Dougherty et al. 2004).

The NLCD data are freely available nationwide, increasing its utility for other watershed assessment efforts. In contrast, the LULC model took nearly six months of staff time to digitize and develop. Additionally, we found that the NLCD imperviousness data reliably tracked trends in some important stream characteristics at the large watershed (despite small sample size) and subwatershed scale.

For the larger watersheds, several turbidity measures increased as imperviousness increased. Turbidity is a measure of suspended particles in water and is evidence of erosion. High turbidity levels can inhibit photosynthesis for aquatic plants and contribute to stream temperature increases. Mean total suspended solids was found to exceed the level of a typical rain event (15–20 mg/L) once watershed imperviousness exceeded 15%. Such high turbidity levels also result in increased sedimentation on downstream park lands, flooding, and pressure from local communities to dredge streams and wetlands.

E. coli concentrations increased with increased imperviousness in both watersheds and subwatershed scales. *E. coli* bacteria are indicators of fecal contamination caused by humans or non-human animals. Fecal contaminates may lead to water-associated communicable diseases. Sources of fecal contamination include poorly functioning septic systems, inadequately treated municipal wastewater, farm runoff, contaminated soils, and urban storm runoff. The trend observed in subwatersheds demonstrates that *E. coli* concentrations generally remain low and near the OEPA 126 colonies/100 ml monthly mean standard (with the exceptions of a few outliers) until imperviousness exceeds 15% (Figure 2a).

All park streams (as of 2000) were designated by OEPA as Warm Water Habitat (WWH) (waters capable of supporting warm water species) and all large watersheds are in at least partial attainment of WWH standards. However, non-attainment of WWH standards in subwatersheds was clearly associated with higher imperviousness levels.

Temperature was found to increase with imperviousness at both scales (Figure 2b). In the subwatersheds, a 10^{O}C change was observed as imperviousness increased from zero to nearly 40%. Increased imperviousness, and associated stream forest cover losses, warm surface waters. Changes in temperature affect the chemical and biological characteristics of surface water, including dissolved oxygen levels, metabolism in aquatic organisms, and photosynthesis in aquatic plants. Recently (April 2007), OEPA designated seven park watersheds as Cold Water Habitat (streams that support cold water vertebrate and invertebrate organisms). Increases in temperature from development in headwaters outside the park could degrade these special resources.

IBI was found to decrease as watershed imperviousness increased, at both scales. IBI measures the structural and functional characteristics of fish communities and is based on trophic composition, diversity, presence of pollution-tolerant species, abundance of biomass, and the presence of abnormal organisms (OEPA 1987). IBI ranges from 12 to 60 with the following categories: exceptional 60 to 50, very good 49 to 42, good 41 to 34, fair 33 to 27, poor 26 to 17, and very poor 17 to 12. In the larger watersheds, IBI decreases from a very good (at ~5% imperviousness) to fair as imperviousness exceeds 24%. In subwatersheds, IBI ranges from nearly exceptional (at ~2% imperviousness) to very poor as imperviousness approaches 35% (Figure 2c).

The condition of the benthic macroinvertebrate community in headwater watersheds (as measured by the HMFEI) clearly decreased as imperviousness increased. The HMFEI score is highest in headwaters with higher diversity and species richness associated with high quality streams. While there was wide variability in HMFEI scores at lower levels of imperviousness, maximum HMFEI scores sharply decline as imperviousness levels increased beyond 10%. Headwater watershed imperviousness also differed for final Aquatic Life Classes, particularly for Class I and Class III headwaters. Class I headwaters lack any obligate vertebrate aquatic life and have a high probability of being ephemeral, Class II headwaters represent a moderately diverse assemblage of warm water fauna, whereas Class III headwaters represent a very unique assemblage of cool-cold water adapted species that require flowing water (OEPA 2002). Increased imperviousness may therefore contribute to headwater stream community degradation or limitation. We might expect this pattern to strengthen with additional sampling in headwaters with higher levels of imperviousness.

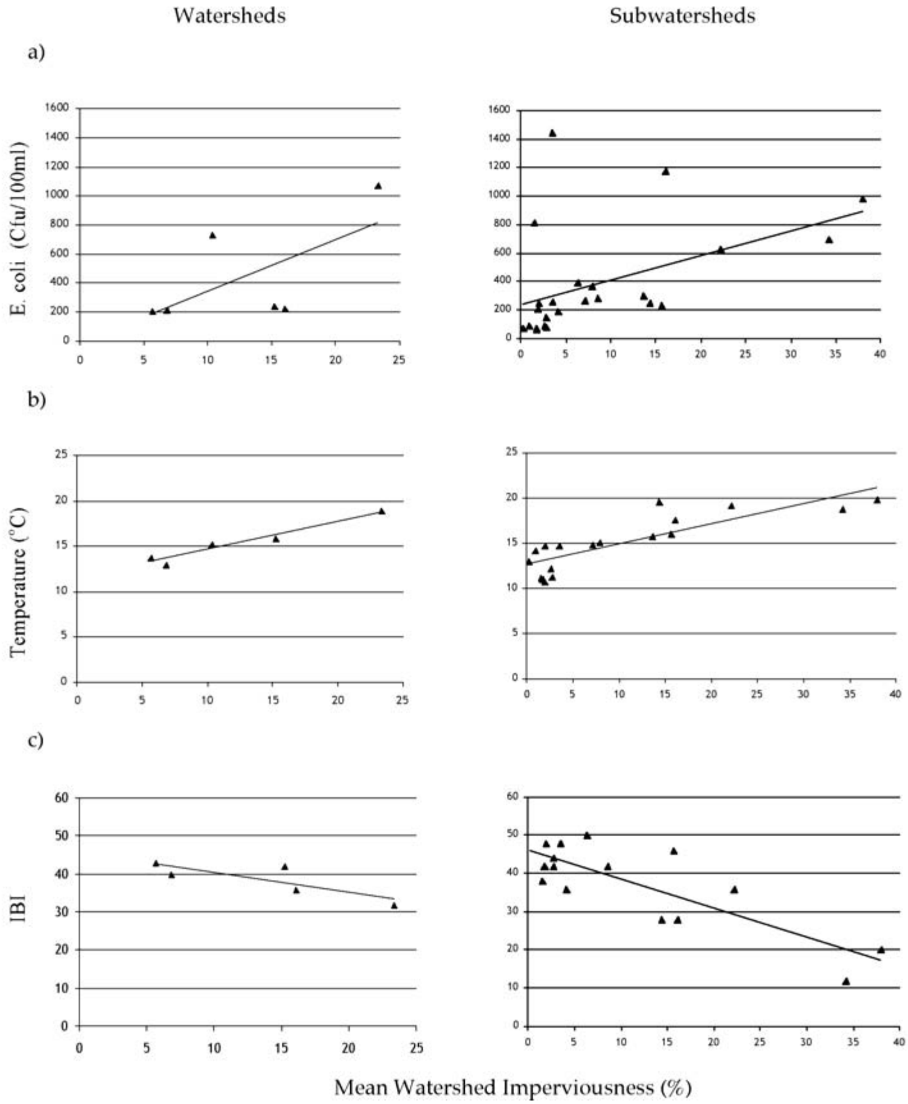


Figure 2. Scatterplots of mean watershed imperviousness and (a) *E. coli* concentrations, (b) temperature, and (c) Index of Biotic Integrity (IBI) at the watershed and subwatershed scales.

Few other patterns were identified in primary headwater watersheds. This is likely an artifact of sampling as all headwater stream watersheds we examined were clustered under 16% imperviousness, near the threshold (10 to 15%) where impacts are expected to manifest (Schueler 1994). Nevertheless some weak relationships to physical habitat features were noted (i.e., HHEI, pool depth).

Overall, we are encouraged that watershed imperviousness can be reliably presented as an indicator of stream and watershed health in the Cuyahoga Valley, particularly for ecological values. Efforts to promote watershed management are strengthened by the relevance of locally-derived information to the model.

Future work to strengthen these conclusions will include the collection of information from headwater streams in more developed areas of the watersheds and integration of data collected by Cleveland Metroparks to further clarify trends. We have also initiated and are continuing an examination of the microbial communities in headwater streams with researchers at Case Western Reserve University.

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References

Anderson, J.R., E.E. Hardy, J.T. Roach, and R.E. Witmer. 1976. *Land Use and Land Cover Classification system for Use with Remote Sensor Data.* U.S. Geological Survey Professional Paper no. 964. Washington, D.C.: U.S. Geological Survey.

Arnold, C.L., and C.J. Gibbons. 1996. Impervious surface coverage: The emergence of a key environmental indicator. *Journal of the American Planning Association* 62:2, 243–258.

Brabec, E., S. Schulte, and P.L. Richards. 2002. Impervious surfaces and water quality: A review of current literature and its implications for watershed planning. *Journal of Planning Literature* 16:4, 499–514.

Dougherty M., R.L. Dymond, S.J. Goetz, C.A. Jantz, and N. Goule. 2004. Evaluation of impervious surface estimates in a rapidly urbanizing watershed. *Photogrammetric Engineering and Remote Sensing* 70:11, 1275–1284.

Homer C., C. Huang, L. Yang, B. Wylie, and M. Coan. 2004 Development of a 2001 National Land-cover Database for the United States. *Photogrammetric Engineering and Remote Sensing* 70:7, 829–840.

OEPA [Ohio Environmental Protection Agency]. 1987. *Biological Criteria for the Protection of Aquatic Life, Volume II: User's Manual for Biological Field Assessment of Ohio Surface Waters.* Columbus, Oh.: Division of Water Quality Monitoring and Assessment, Surface Water Section.

———. 2002. *Field Evaluation Manual for Ohio's Primary Headwater Habitat Streams.* (Final Version 1.0.) Columbus, Oh.: Division of Water Quality Monitoring and Assessment, Surface Water Section.

Rankin, E. 1989. *The Qualitative Habitat Evaluation Index (QHEI): Rationale, Methods, and Application.* Columbus, Oh.: OEPA.

Schaal, G.M. 1988. *Ohio Land Use / Land Cover Classification.* 5th ed. Miscellaneous Report no. 17. Columbus, Oh.: Ohio Department of Natural Resources.

Schueler, T. 1994. The importance of imperviousness. *Watershed Protection Techniques* 1:3, 100–111.

Skerl, K.L., J. Winstel, and T.E. Ross. 2006. Development pressures prompt integration of science and planning to enhance stormwater management in Cuyahoga Valley. In

Natural Resource Year in Review 2005. J. Selleck, ed. Denver and Washington, D.C.: National Park Service, 53–54.

Sleavin, W., S. Prisloe, L. Giannotti, J. Stocker, and D.L. Civco. 2000. Measuring impervious surfaces for non-point source pollution modeling. In *Proceedings of 2000 ASPRS Annual Convention*. Washington, D.C.

Yang, L., C. Huang, C. Homer, B. Wylie, and M. Coan. 2002. An approach for mapping large-area impervious surfaces: Synergistic use of Landsat 7 ETM+ and high spatial resolution imagery. *Canadian Journal of Remote Sensing* 29:2, 230–240.

Rethinking Evaluation of Terrestrial Biodiversity Conservation in Protected Areas Systems of Tropical Islands

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The essence of terrestrial biodiversity conservation is the regulation of human land use in order to protect the natural variety of ecosystems, their plant and animal species and associated genes. Protected areas systems have been a key land use strategy for protecting the naturally high concentrations of species diversity and unique biological communities in the continental and insular tropics (Kramer et al. 1997). While the continental tropics have the highest overall species richness, it is the islands that feature the highest levels of species endemism. These general distribution patterns have been reported for mammals, birds, reptiles, amphibians and flowering plants (Brooks et al. 2001). From a global perspective, it is the disproportionate contribution of endemic species relative to island size and not the low total species richness of tropical islands that has contributed to their high conservation value (Spellerberg and Sawyer 1999). However, biodiversity conservation interests are not the only motivators for protected areas establishment in tropical islands. Conservation literature shows that where high priority has been placed on *in situ* conservation of tropical biodiversity, differing conservation goals and strategies across protected sites has generated much interest in assessing management effectiveness of protected areas systems.

Yet, conservation of terrestrial island biodiversity has been under-represented in scientific discourse and international efforts on the management effectiveness of protected areas systems. Academic literature in tropical biodiversity (e.g., Kramer and van Schaik 1997; Brandon et al. 1998; Terborgh et al. 2002) tends to be oriented towards the Amazon Basin, Central America and the African island Madagascar. There are few studies on protected areas management in oceanic islands worldwide. Recently in 2006, the U.N. Convention on Biological Diversity (CBD) added a new Programme of Work (PoW), namely Island Biodiversity, which is expected to advance the goal of significantly reducing terrestrial biodiversity loss by the year 2010 (UNEP 2006). One of the targets of this PoW is to prioritize ecological representation in comprehensive, effectively managed national and regional protected areas networks. Implicit in this target is the desired outcome of ecological representation and the need to assess how well protected areas systems are conserving terrestrial biodiversity.

What do we know about ecological representation in tropical islands? Keeping in mind Margules and Pressey's (2000) definition of representation (sampling of the full variety of ecosystems, species and genes for the long-term survival of biodiversity), I did a brief overview of the history of protected areas management in tropical islands. Records for protected watersheds in the Caribbean go back to the 18th century and there is probably an early history also associated with traditional sacred grounds on Pacific islands (Solahuddin and Dahuri 1998; European Union/IUCN 1999). Protected areas were valued for their provision of natural resources (e.g. timber, game birds) and ecological services (e.g. sources of freshwater), and to a lesser extent, for protection of natural heritage. It is in the latter part of the 20th century that biodiversity conservation became a priority for protected areas on tropical islands through the influence of international conservation efforts. One consequence of the international agenda for biodiversity conservation was the adoption of the World Conservation Union (IUCN) categories for protected areas (Table 1).

The 2003 UN List of Protected Areas provided summary statistics for 953 Caribbean and 321 Pacific protected areas (Table 2). The nearly 40% uncategorized sites in the Caribbean and Pacific regions may indicate that these sites were not established for biodiversity conservation and so their management objectives do not coincide with those of the IUCN categories, or simply that the designation of the IUCN categories is incomplete. The tendency is for establishment of several small and few large sites. Both insular regions focus on select species and their habitats within the smaller sites. However, there seems to be a dichotomy of interests in the larger sites with the Caribbean focused on minimal exploitation compatible with non-consumptive values (national parks) and the Pacific focused on sustainable use being integrated with biodiversity conservation (managed resource protected areas).

In spite of the dominance of habitat/species management areas, a global gap analysis report by Rodrigues et al. (2004) flagged many of the tropical African, Asian, Caribbean and Pacific islands as urgent priorities for the establishment of new protected areas for vertebrate diversity. Several mammals, birds, turtles/tortoises and amphibians were not included or

Table 1. Summary of IUCN protected area management categories and their objectives. Source: http://www.unep-wcmc.org/protected_areas/categories/~main.

Category	Objective
Ia. Strict Nature Reserve	primarily for scientific research and/or environmental monitoring
Ib. Wilderness Area	protected and managed so as to preserve its natural condition
II. National Park	provide a foundation for spiritual, scientific, educational, recreational and visitor opportunities, all of which must be environmentally and culturally compatible
III. Natural Monument	mainly for conservation of specific natural features (these may be rare or outstanding natural or cultural features)
IV. Habitat/Species Management Area	mainly for conservation through management intervention (includes maintenance of habitats and meeting specific species needs)
V. Protected Landscape/ Seascape	mainly for landscape/ seascape conservation and recreation (where interaction of people and nature over time has produced areas of distinct character)
VI. Managed Resource Protected Area	mainly for the sustainable use of natural ecosystems

Island region	Dominant IUCN Category	
	Percentage of total number	Area (km^2)
Caribbean	• 36.5% Uncategorized • 26.6% Habitat/Species Management Area	• 39% National Park • 29.1% Managed Resource Protected Area
Pacific	• 42.4% Uncategorized • 21.2% Habitat/Species Management Area	• 52.6% Managed Resource Protected Area • 27% National Park

Table 2. Summary statistics for Caribbean and Pacific protected areas. Source: Chape et al. 2003.

adequately conserved within protected area systems. Interestingly, both the authors of the U.N. List and Gap Analysis noted a need for assessments of management effectiveness. In other words, ecological representation as a conservation outcome is not guaranteed by just adequate site establishment and protected area design. Appropriate management inputs and implementation of conservation strategies are also critical components of effective protected areas management for biodiversity conservation.

The commonly adopted ecoregional approach provides a biogeographic basis for assessing conservation priorities for protected area establishment and design (Olson and Dinerstein 1998). However, the scale of ecoregions while convenient for global conservation planning is problematic for national conservation planning on islands. A single ecoregion may encompass several island nations with differently structured governance and institutional environments for the management of national protected areas systems (Table 3). Since implementation of management activities happens within the boundaries of an island, assessments of protected area management need to be sensitive to (a) the biogeographic scale used in protected area planning and design and (b) the scale at which institutional resources and governance are implemented.

Assessments of ecological representation and its impacts on biodiversity can be based on the unique biogeographical features of oceanic islands. In addition to high levels of endemism, the insularity and smallness of oceanic islands have contributed to the unusually high occurrences of co-adapted flora and fauna, and co-evolved species interactions (Cronk 1997; Spellerberg and Sawyer 1999). Another significant feature of tropical oceanic islands is that their small size means relatively narrow species ranges compared to continental biota, with several co-evolved endemic species occurring in the same habitat (Cronk 1997). Overlaps or congruence between distribution ranges for co-adapted and co-evolved species should be factored in to decisions on protected area size. Not only do threats arising from

Table 3. Examples of Global 200 Ecoregions that include several tropical islands.

Ecoregion	Island regions
Greater Antillean Moist Forest	Haiti, Cuba, Dominican Republic, Jamaica, Puerto Rico
New Guinea Montane Forests	Papua New Guinea, Indonesia
Seychelles and Mascarene Island Forests	Mauritius, Seychelles, Comoros, Reunion, Rodrigues

human exploitation need to be curtailed but island vulnerability to introductions of invasive species makes invasive species a priority issue for island biodiversity conservation. An island biogeographic element has been missing from existing evaluation schemes that are designed to assist managers and policy-makers improve conservation programs and address management outcomes and their impact on biodiversity.

Most existing evaluation schemes for biodiversity conservation in protected areas (i.e., *in situ* biodiversity conservation) are based on the IUCN World Commission on Protected Areas framework for assessing protected areas management (Hockings 2003; Hockings et al. 2006). The strength of the framework lies in its capacity to facilitate the development of methodologies that (a) prioritize biological conservation targets and resource allocation, (b) identify under-resourced and vulnerable protected areas, (c) identify weaknesses and strengths in protected areas governance and institutions (d) identify major pressures and threats to biodiversity and (e) comparatively assess sites distributed throughout a system or assess single sites (Hockings et al. 2006). However, the outcome aspect of the evaluation framework tends to be vague, and associated outcome evaluations tend to emphasize the reduction of threats, lack clear links between management objectives and conservation outcomes, and between national system and site levels of protected areas management (Hockings et al. 2006).

With the prevalence of sustainable use in some protected areas systems, evaluations also need to assess its compatibility or competitiveness with biodiversity conservation. The appeal of the sustainable use approach for protected areas management lies in the advocacy of a "win-win" outcome for both the protectors and consumers of biodiversity (Redford and Richter 1999). However, little attention has been paid to any biases towards socioeconomic aspects of the sustainable use paradigm in outcome evaluations.

My Ph.D. research is attempting to address these limitations in outcome evaluations through the development of an island-specific framework for outcome evaluations (Table 4). The conceptual framework is goal-based, linking management goals and objectives with management outcomes, inputs, and actions. Outcomes, inputs, and actions are represented by theoretically derived evaluation criteria that cover both ecological and socioeconomic aspects of protected areas management. Criteria are actually selected environmental conditions or aspects of protected area management. Two advantages of considering a system-site relationship in the evaluation of *in situ* biodiversity conservation are:

1. Insight into how the objectives of a protected areas system are achieved through site operations and reflected in site outcomes for biodiversity conservation; and
2. Minimizing the risk at the system level of implementing financial and legal institutions and organizational structures that unwittingly compromise site operations.

The socioeconomic component allows assessment of sustainable use approaches. The research process will include further development of the framework criteria and the generation of indicators for the criteria through the participation of protected area experts and community stakeholders. The methodology involves two case studies which include literature reviews, data and information extraction, a Delphi process, community workshops and interviews. The case study locations are Jamaica and the Dominican Republic. The idea of the

	Biodiversity		Socioeconomic	
	PA System	PA Site	PA System	PA Site
Goals/ objectives	**System plan goals & objectives**	**Management plan goals & objectives**	**System plan goals & objectives**	**Management plan goals & objectives**
Biophysical	* Representation * Congruence of species indices	* Choice of conservation strategy * Species indices: endemism, rich-ness, threat status, co-adaptation	* Proposed biological targets for direct & indirect consumption	* Actual biological targets for direct & indirect consumption
Management institutions	* Funding sources/ partners	* Staff numbers * Salaries	* Expected stakeholder/ actor participation	* Actual stakeholder/ actor participation
Governance	* Presence of NPAS policy * Implementation of PA laws	* Presence of park rangers * PA demarcation	* National land use policies	* Land tenure and use arrangements

Explanatory notes: Choice of conservation strategy refers to whether the focus is coarse filter-fine filter, species or ecosystems. PA means protected areas, NPAS means national protected areas system. N.B. Only a sample of the criteria are provided in Table 4. This framework is currently undergoing further development.

Table 4. Theoretical framework for evaluating the effectiveness of biodiversity conservation in terrestrial protected areas of tropical islands.

case study approach is to field test the utility of the evaluation criteria and indicators.

Fieldwork was initiated recently and so only a few findings about governance structure are shared in this paper. The protected areas systems for both Jamaica and the Dominican Republic are managed through state authorities and their designated representatives. Jamaica is currently addressing a lack of coordination between four government agencies that administer protected areas legislation through the preparation of a master plan for its system of protected areas. Management responsibilities are shared with non-government organizations (NGOs) who are responsible for developing management plans, for daily operations and implementation of site programs. In the Dominican Republic, a single government agency is responsible for the entire protected areas system. Devolution of management responsibilities to NGOs is very new and there is strong government involvement in site operations through co-authoring of management plans and hiring of staff. An important implication for development of framework is that indicators for governance criteria will have to be carefully selected in order to address variations in the centralized governance structure across Caribbean islands. It is anticipated that the final evaluation framework will be sensitive to the biogeographical scale and socioeconomic contexts of tropical islands.

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References

Brandon, K., K.H. Redford, and S.E. Sanderson. 1998. *Parks in Peril: People, Politics and Protected Areas.* Washington, D.C.: Island Press.

Brooks, T.M., R.A. Mittermeier, C.G. Mittermeier, G.A.B. da Fonseca, A.B. Rylands, W.R. Konstant, P. Flick, J. Pilgrim, S. Oldfield, G. Magin, and C. Hilton-Taylor. 2001. Habitat loss and extinction in the hotspots of biodiversity. *Conservation Biology* 16:4, 909–923.

Chape, S., S. Blyth, L. Fish, P. Fox, and M. Spalding, comps. 2003. *2003 United Nations List of Protected Areas*. Gland, Switzerland, and Cambridge, U.K.: IUCN and UNEP-WCMC.

Cronk, Q.C.B. 1997. Islands: stability, diversity, conservation. *Biodiversity and Conservation* 6, 477–493.

European Commission/IUCN. 1999 *Parks for Biodiversity: Policy Guidance Based on Experience in ACP Countries.* Cambridge, U.K.: European Commission/IUCN.

Hockings, M. 2003. Systems for assessing the effectiveness of management in protected areas. *BioScience* 53:9, 823–832.

Hockings, M., S. Stolton, F. Leverington, N. Dudley, and J. Courrau. 2006. *Evaluating Effectiveness: A Framework for Assessing the Management of Protected Areas*. 2nd ed. Gland, Switzerland, and Cambridge, U.K.: IUCN.

Kramer, R., C. van Schaik, and J. Johnson, eds. 1997. *Last Stand: Protected Areas and the Defense of Tropical Biodiversity*. New York and Oxford, U.K.: Oxford University Press.

Margules, C.R., and R.L. Pressey. 2000. Systematic conservation planning. *Nature* 405:6783, 243–253.

Olson, D.M., and E. Dinerstein. 1998. The Global 200: A representation approach to conserving the Earth's most biologically valuable ecoregions. *Conservation Biology* 12:3, 502–515.

Redford, K.H., and B.D. Richter. 1999. Conservation of biodiversity in a world of use. *Conservation Biology* 13:6, 1246–1256.

Rodrigues, A.S.L., H.R. Akqakaya, S.J. Andelman, M.I. Bakarr, L. Boitani, T.M. Brooks, J.S. Chanson, L.D.C. Fishpool, G.A.B. da Fonseca, K.J. Gaston, M. Hoffmann, P.A. Marquet, J.D. Pilgrim, R.L. Pressey, J. Schipper, W. Sechrest, S.N. Stuart, L.G. Underhill, R.W. Waller, M.E.J. Watts, and Y. Xie. 2004. Global Gap Analysis: Priority regions for expanding the global protected area network. *BioScience* 54:12, 1092–1100.

Sadler, J.P. 1999. Biodiversity on oceanic islands: a palaeoecological assessment. *Journal of Biogeography* 26:1, 75–87.

Solahuddin, S., and R. Dahuri. 1998. Sustainable use of natural resources and biodiversity conservation in Indonesia. In *Biodiversity Conservation in ASEAN: Emerging Issues and Regional Needs*. G. Ismail and M. Mohammed, eds. London: ASEAN Academic Press.

Spellerberg, I.F., and J.W.D. Sawyer. 1999. *An Introduction to Applied Biogeography*. Cambridge, U.K.: Cambridge University Press.

Terborgh, J., L.C. Davenport, and C. van Schaik. 2002. *Making Parks Work: Identifying Key Factors to Implementing Parks in the Tropics*. Covelo, Calif.: Island Press.

UNEP/Secretariat of Convention on Biological Diversity. 2006. Decisions Adopted by the Conference of the Parties to the Convention on Biological Diversity. Annex: Programme of Work on Island Biodiversity. On-line at www.biodiv.org/doc/decisions/COP-08-dec-en.pdf.

The Natural Resource Challenge: A Retrospective and View to the Future

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About 10 years ago, I was invited to speak to a graduate class at the University of Wisconsin, Madison, by an old friend, Professor Don Field.

After class, Field said, "Do you want to go to the shack?" *"The shack?"* I said. Aldo Leopold's Sand County shack?

So we drove down to the river and parked along a country road, and wound our way through the forest now grown from the over-used and cutover lands that were inspiration to Leopold's "A Sand County Almanac." And there it stood, the old Chicken Coop, now turned shrine to all of us who grew up with Leopold, Muir, and Eiseley.

The door was not locked, and inside the furniture and furnishings were the same as when Leopold developed the core principles of the conservation ethic of America for the next century. On the mantel over the fireplace, I opened a box of carefully prepared specimens, each tagged with the handwritten notes by Leopold himself.

For me, a trip to the shack was akin to a Muslim pilgrimage to Mecca. This was a place where civic engagement worked to change the course of the American land ethic and stewardship. Leopold envisioned a better world and challenged us to make it so.

In his classic essay on the conservation ethic, Leopold wrote of his disappointment with the slow progress in conservation education, and that the "usual answer to this dilemma is 'more conservation education.'"

In turn, Leopold argues that such education will continue to fail until we help people develop a "love, respect, and admiration for land, and a high regard for its value." "No important change in ethics was ever accomplished without an internal change in our intellectual emphasis, loyalties, affections, and convictions."

I want to talk about the Natural Resource Challenge as a turning point for the National Park Service (NPS), in many ways the culmination of several decades of a paradigm shift in the organization that has affected, as Leopold put it, our "intellectual emphasis, loyalties, affections, and convictions."

Essentially, the culture of the NPS has changed from one in which it focused primarily on the visitor, to one that prides itself in managing, protecting, and understanding the complex natural and cultural resources for which it has stewardship responsibilities. I do not mean to imply that the visitor now takes a second seat to the resource, but that visitors are provided high-quality experiences within the context of a far more sophisticated resource management program than we did twenty years ago. Those doubting that we have changed need look no further than the Natural Resource Challenge, a bold, $75–100 million budgetary initiative that transitioned smoothly between two presidents and has been well received by the field, the Congress, and the Office of Management and Budget.

Some would characterize the NPS as hide-bound, or, derisively, "mulch ridden." I think a better analogy is the battleship, slow to turn, but deliberate in its mission, which is to preserve and protect parks for the enjoyment of future generations. Our resistance to change is a double-edged sword. Resistance keeps us from blowing with the particular political wind of any given administration or Congress, but when a good idea comes along, we also resist, or at least take a long time to incorporate it into our ideology.

In 1993, I authored an article for *Park Science* about the litany of reports written and published by highly respected organizations that admonished the NPS for its lack of attention to resources, particularly natural resources. Our record on this front was, frankly, embarrassing, particularly for me at the time, as one of those young whippersnappers who wanted the NPS to be the premier resource management agency in the U.S., if not the world. Those reports, while important to the recognition of the issue, were relatively ineffective in changing the agency.

The following are the essential items I would identify that have were key to the paradigm shift. Of course there were things going on outside the agency within the American society and the world that affected the parks and the National Park Service, which pushed us to have a more resource focus, but for the purposes of this talk, I will focus mostly on the internal items, as follows.

An articulate and effective champion in Washington. In my tenure, I would place now-retired Ro Wauer in this slot. The former associate director for natural resources, Wauer was a tireless champion within the organization for a stronger focus on natural resources. Far from a complainer, Wauer was a doer, and the creation of the Natural Resource Trainee Program, his brainchild, was one of the most important acts that changed the organization. Few programs ever succeed without good leadership in Washington. For the Challenge success, I would put that same mantle on Mike Soukup.

A peer group fed into the lower level in the organization. Wauer created the two-year long Natural Resource Trainee Program, and over a period of about 10 years more than a hundred bright, young, motivated natural resource professionals were fed into the organization at the relatively lower grades. I was in the first class. At our first meeting in Fort Collins in 1982, Wauer was clear in his goals, expecting us to infiltrate the agency and rise to the top as new superintendents, regional chiefs, and top leaders. From those humble roots to leadership positions, we have been able to shift policy, hiring, funding, planning, and even the dialogue towards an agency with a resource focus. As the Pacific West Region regional director, I have now hired 33 superintendents, and the majority is coming from the resource management ranks.

External pressure. Call them our friends or our critics, the National Parks Conservation Association and other organizations have consistently pushed us to live up to our potential by challenging our resource stewardship through the media, through their membership, and through periodic reporting. The "threats to the park" reports focused attention not only on our stewardship but our lack of investment in understanding of the resources within our responsibility.

Visionaries who serve as role models. While the NPS is a decentralized organization, there are always as few senior leaders who are looked to for wise counsel and emulation. During this period, two rise in my mind. One is Bob Barbee, the Golden Buffalo and superintendent of Yellowstone who faced large resource issues such as brucellosis-carrying, migratory bison and large natural fires with not only characteristic humor and resolve, but with good, old-fashioned hard science. And he won, and we all like winners. The other was Boyd Evison, former superintendent in many parks and regional director for Alaska. An eloquent spokesperson for the environment, Evison saw and acted on the opportunity presented by the vast parks of Alaska, and invested in a strong science and resource management program with a focus on inventory and monitoring. Other regional directors and superintendents around the country took notice of these exceptional leaders and emulated their attention to these issues.

Lead parks. As there are a few lead individuals, there are always a few lead parks in each region that establish new directions that lay the groundwork for other parks to follow. Parks that invested in long-term monitoring grew in respect because that had a better grip on their stewardship. Yellowstone's large science center, Olympic's GIS program, Isle Royale's wolf–moose study, Denali's predator–prey work, and Everglades water, Shenandoah's air quality, and Yosemite's fire programs come easily to mind, among others. Their investment, notoriety and success inspired other to emulate.

Professionals who walk in both worlds. At this time too, the NPS still had its small but highly qualified core of park-based or Cooperative Park Studies Unit-based scientists. Practicing scientists with the ability to serve on major university faculty and supervise students, but with field-level practicality that allowed them to chew the fat with superintendents and their staff, these unique men and women were the emissaries of research, mentors for budding new resource managers, and unofficial counselors to park decision-makers faced with increasingly complex resource issues. They were, through both word and deed, champions of the notion that good science guides good management.

Training in the subject matter. As the parks' issues became more complex, as the trainee program became more recognized, there was a cry from the field for more technical resource training, and an investment in resource training for managers. A plethora of classes emerged in what is often called our "cradle-to-the-grave training program." For some managers, particularly those who came up through the ranks in non-resource fields, this was their first real exposure to formal training in the application of science, in the world of National Environmental Policy Act compliance, or the protection of endangered species.

Communications tools. Emulation requires that you know what someone else is doing. Two small publications come to mind: *The George Wright Forum* and *Park Science. Park Science* was started in the old Pacific Northwest Region by Jean Matthews, and the *Forum* by Bob Linn and Dave Harmon. These became the communication tools for fledgling programs to learn about each other. Remember, this was before email and the internet.

Policy without money is just talk. That infamous quote from the former director, George Hartzog, is as true today as it was then. The first real money set aside just for resources came as NRPP: the Natural Resources Preservation Program. It was a competitive fund source managed out of Washington but designed to fund the best resource management projects in the system for three years running. The total fund was small, but it was a start and from that came increasing fund sources, so that today there are dozens of sources just for natural resources and for cultural resources. This does not count all the park base funds that are now supporting basic resource management activities in most parks.

Technology that works and is cool. The last twenty years have seen an explosion of technology that can be applied to science in the field. Some of it, like the great maps coming from GIS, is "eye candy" that helps convince upper management and the public that science is not boring and can provide powerful insights into complex issues. The public interest in the results of good science, incorporated into interpretive and education programs, has been essential to public support for the parks and the emergence of a higher level of stewardship.

Legal challenges. Periodically, it takes some litigation to snap us to attention. The Sierra Club Legal Defense and North Cascades Conservation Council lawsuit on the North Cascades National Park Complex was a great case in point. The NPS had not invested in the gathering and quantitative analysis of the information it really needed to make the kind of land use decisions within the draft general management plan and environmental assessment. The settlement agreement set a new standard for environmental impact statements in the NPS for all general management plans.

Focused conferences. For decades the George Wright Society's biennial conferences have been a vital forum for the discussion between scientists, resource managers, and park managers. Because of frequency, consistency, and continuity, the dialogue created in these conferences has built over the years to the point that they have become one of the most important gatherings of NPS and other protected area resource professionals.

A critical book. Richard Sellars' bold and well-researched book, *Preserving Nature in the National Parks,* came at a perfect moment, and presented a clarion call to action. Fortunately, this time, we were ready. While I believe it will stand the test of time as a wise treatise on the history of the NPS, coming at a different time, without all the other actions outlined above, I doubt there would have made a significant difference in the agency. Instead, it caused top leadership to recognize the opportunity and declare, finally, the agency was making resources a priority not only for policy but also for budget. From that grew the Natural Resource Challenge, the best budget initiative we have seen in some years.

The units of the national park system represent some of the best places in America to study and understand the complex natural and cultural heritage of North America. Over the last 20 years, we have exponentially increased our capacity to invest in that understanding and to pass along what we are learning to the public. I believe out organizational culture has changed for the better. Yet, I still do not believe the NPS has reached its full potential in American society—that will take another culture change, but hopefully not take as long.

At the conference of the National Park Service and our many partners known as Discovery 2000, one of the plenary speakers made a bold challenge to the National Park Service: it was our job "to make this great experiment in American democracy succeed." He said we have the places and the passion, and the people and the audience, to engage the public in such as way as to ensure that our democratic principles stand.

In Yosemite National Park, there was a recent resurvey of the work pioneered by biologist Joseph Grinnell and his colleagues in 1915. This time, armed with live traps instead of snap traps, the team resurveyed the small mammals of Lyell Canyon. They found significant changes in the populations of ground squirrels, pikas, piñon mouse, and the alpine chipmunk. Some of them had moved up in elevation by 2,000 feet since surveyed by Grinnell 100 years ago. These are indicators of global climate change. We all know too that these little creatures can only go so far up, until they are popped right off the top mountain into extinction.

You and your fellow scientists and resource managers are the Joseph Grinnells of this generation, laying down a foundation to understanding of parks that will be a platform for management action and public awareness.

So what lies before us as stewards of these great places? What *will* we do, what *should* we do with this newfound knowledge borne of the Natural Resource Challenge, in year 2020, 2040, 2050 and beyond? I have my ideas, but frankly, I would rather hear from you.

Whitebark Pines at Rim Village in Crater Lake National Park, Oregon

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Introduction

Whitebark pine (*Pinus albicaulis*) is a high-elevation conifer that, over the last one hundred years, has increasingly been affected by the introduction of white pine blister rust (*Cronartium ribicola;* Figure 1). As the spread of blister rust increases, concern for the fate of whitebark pines also increases. Both private and public land managers predict that without comprehensive management intervention, whitebark pines face "continuous decline, functional extinction, and local extirpation" (Kendall and Keane 2001:237). Because whitebark pines are considered keystone species for subalpine ecosystems, the loss of these important trees may also cause population declines for Clark's nutcrackers (*Nucifraga columbiana*), grizzly bears (*Ursus arctos*), red squirrels (*Tamiasciurus vulgaris*), and other subalpine species.

Whitebark pines at Crater Lake National Park in Oregon have been impacted by the combined effects of fire suppression, mountain pine beetles (*Dendroctonus pondersae*), dwarf mistletoe (*Arceuthobium cyanocarpum*), and white pine blister rust. The whitebark pines at the historic Rim Village in the park commonly frame visitors' photos and are an important part of both the scenic and historic value of the area (Figure 2). The whitebark pines along the promenade at Rim Village were surveyed in July of 2006. The results demonstrated that the whitebark pines at Rim Village had similar infection rates to those found in park-wide surveys. Blister rust has infected approximately 20% of all whitebark pines in the park (Murray and Rasmussen 2000) while 19.4% of the trees at Rim Village were infected. Of the 124 trees surveyed on the promenade, 88 were alive.

Continued monitoring of the health of these trees will be an important aspect of park management and will hopefully contribute to the longevity of the whitebark pine species both in Crater Lake National Park and elsewhere.

Whitebark pines

Upper subalpine ecosystems are characterized by short growing seasons, rocky and low-nutrient soil conditions, exposure to extreme winds and low temperatures, pummeling by heavy ice and snow, and high-elevation locations. Whitebark pines not only survive under these conditions but are the symbol of tenacity in the face

Figure 1. Whitepine blister rust on a whitebark pine. Photo by Carrie Wittmer.

Figure 2. Whitebark pines frame Crater Lake at Crater Lake National Park, Oregon. Photo by Carrie Wittmer.

of such adversities. "Tenacious" is defined as having the ability to cling to or hold on to something. "Tenacious" aptly describes whitebark pines that are perched on the edge of deep precipices, clinging to rocky outcrops, and thriving despite conditions that discourage other types of growth or life. In fact, whitebark pines often exhibit "Krummholz," which is the name given to crooked, wind-beaten timber (Murray and Rasmussen 2000), and their bent forms are common in high-elevation forests from British Colombia through Wyoming, down into California and up to Washington.

Whitebark pines are part of the white pine family, which all have needles in bundles of five. Whitebark pines can reach heights of up to 70 feet (Peattie 1981), but in extreme environments, even old trees may never grow higher than five feet. Adaptations that allow the species to cope with subalpine conditions include flexible branches, short stems, solidly anchored root systems (Murray 2005), thick bark, and seedlings that are able to tolerate full-sun conditions.

Keystone species

Whitebark pines' tenacity and ability to colonize harsh environments have made it a keystone species of subalpine and alpine ecosystems. The services it provides to these ecosystems include:

- Symbiotic collaboration with Clark's nutcracker: the nutcrackers harvest and cache whitebark pine seeds. The nutcrackers benefit from the large, nutritious seeds and the whitebark pines benefit from regular and discriminating seed dissemination.
- Several other species also depend on whitebark pine seeds including red squirrels, flickers, blue birds, and grizzly bears who seek out squirrel middens for stored seeds (Zeglen 2002).
- Nurseries for shade-dependent and wind-sensitive species such as subalpine fir, Englemann spruce, and mountain hemlock (Zeglen 2002).
- Stabilization of rocky soils, allowing for establishment of other species. Soil stabilization also allows for better seepage of snowmelt, regulating spring run-off and erosion (Tomback and Kendall 2001).
- Provides substrates for mycorrhizae, fungi, bacterial communities, and lichens (Kendall and Keane 2001).

The future of whitebark pines

Is tenacity, however, enough to save this species? Whitebark pines survive where other trees cannot: they sit patiently through brutal wind storms, extreme temperatures, and heavy snowpack. They often have a ragged, scarred, wind-blown appearance and lack a full crown of branches or have broken tops. Bark is often picked at by bears, squirrels, and hares (Zeglen 2002). Their tenacity and patience, thick bark, and flexible branches are proving insufficient to resist the combined onslaught of several factors: fire suppression, mountain pine beetles, dwarf mistletoe, and white pine blister rust. According to Kendall and Keane in "Whitebark Pine Decline: Infection, Mortality, and Population Trends" (2001:221), "throughout major parts of their range, whitebark pine communities have declined dramatically over the past fifty years from the combined effects of disease, insects, and successional replacement."

The last 100 years of fire suppression have had a severe impact on whitebark pine regeneration. Clark's nutcrackers favor open caching areas and whitebark pine seedlings are typically the first growth in fire-scarred landscapes at high altitudes. The lack of fires has benefited more shade-tolerant species such as mountain hemlocks and subalpine firs while also contributing to fuel-buildup, leading to stand-replacement fires.

Mountain pine beetles appear in periodic outbreaks and usually attack trees that have been weakened by other factors. Male and female beetles tunnel into live tree bark, mate, produce eggs which produce larvae. The larvae eventually create characteristic "J" tunnels under the tree's bark (Leatherman 2005). Trees usually die from the infestation if they are not capable of resisting the attack.

Limber pine dwarf mistletoe is a parasitic plant that threatens whitebark pines by penetrating tree bark and taking water and nutrients from the host. Infections can persist for years and eventually kill the host tree (Jacobi and Swift 2005). (Dwarf mistletoe is a particular problem for whitebark pines on Wizard Island at Crater Lake.)

Finally, white pine blister rust weakens and kills whitebark and other white pines. Blister rust is an Asian fungus that was accidentally introduced in Vancouver in 1910, and since that time, has made steady progress through stands of white pines throughout the Pacific Northwest and the southwestern United States. Whitebark pine is the most susceptible of the white pines to blister rust (Maloy 1997) and, despite millions of dollars spent on blister rust control programs, whitebark pine deaths attributed to the fungus are expected to rise considerably over the next 30 years. In fact, Baskin (1998, 52) reports that "from Glacier National Park west across northwest Montana, Idaho, Washington, and up into Southern Alberta and British Colombia, 40–100% of whitebark pines are dead. Most of the rest are infected, and many of these have stopped producing cones." Kendall and Keane (2001) predict severe declines in whitebark pine survival and possible extirpation unless there is widespread management intervention.

Whitebark pines at Crater Lake National Park

As elsewhere in the Cascade Mountain Range, whitebark pines at Crater Lake National Park are being adversely affected by white pine blister rust. A survey from 2000, where 1,200 trees in the park were inventoried, showed 20% infection rates (Murray and Rasmussen 2000). In 50 years at projected rates of loss, there will be half the original number of whitebark pines in the park (Murray and Rasmussen 2000). Park ecologist Michael Murray writes (2005:28), "Unless actions are taken, whitebark pine will continue to decline. With resistance levels estimated to be less than 5%, we can anticipate 95–99% mortality without management intervention."

Scarcity of mature, cone-producing trees may impact populations of Clark's nutcrackers which in turn, will limit the nutcracker's ability to cache and disseminate tree seeds. As a result, smaller populations of trees will trigger an "extinction vortex," caused by combinations of reduced population sizes, fragmentation of tree distributions, inbreeding, and finally loss of genetic variation (Tomback and Kendall 2001), ultimately leading to extirpation. As an ecosystem "keystone species," the loss of even half of the park's whitebark pines may ultimately affect bird and squirrel populations and soil stabilization. The loss will not only change the composition of subalpine ecosystems in the park, but will also negatively affect the historic and aesthetic values of the park.

Whitebark pines at Rim Village: A survey

Project scope. Visitors from around the world congregate year-round at Rim Village in order to gaze in wonder at the stunning beauty of Crater Lake. During the summer months, they stroll along the promenade from West Rim Drive up to the historic Crater Lake Lodge. Thousands of photographs of the lake are framed by the crooked, bent, and wind-whipped boughs of the 5-needled whitebark pines. These trees cling to the northern aspect of the stone wall built by the Civilian Conservation Corps in the 1930s and some hang precipitously out over the caldera rim. Clark's nutcrackers croak and cry overhead to each other as they pick at cones high in the trees for seeds. Whether visitors recognize the trees as whitebark pines or not, the trees (and the birds) are an integral part of both the historic and aesthetic beauty of the visitor's experience. As outlined in the "Status of Whitebark Pine in Crater Lake National Park" by Murray and Rasmussen (2000), one of the key components of managing and mitigating whitebark pine loss, both at Rim Village and in the entire park, is mapping and monitoring the park's trees. Toward this end, a survey was conducted in July of 2006 to assess and map both the live and dead whitebark pines at Rim Village.

Methods. Over three days of surveying, each whitebark pine along the promenade at Rim Village was assessed as either alive or dead; its location was noted using a global positioning system (GPS) device; its height (feet), diameter at breast height (inches), maximum crown width (feet), minimum crown width (feet), live crown ratio (%), height to live crown (feet), and number of cone clusters were measured and recorded; a photo was taken; inactive and active blister rust cankers were observed; and any other damage to the tree was recorded. This information was collected in a spread sheet, and each tree location was mapped from the promenade's intersection with West Rim Drive to approximately 300 feet past the lodge. It should be noted that numerous whitebark pines were observed below the rim, but because of the dangers involved in scrambling down the side of the caldera, they were not inventoried. Also, many of the surveyed individuals were difficult to identify as either one tree with several main branches or a cluster of genetically different trees cached in the same hole by Clark's nutcrackers. In order to provide clarity for future monitoring, trees in clusters were given the same number but different letters so that they could be differentiated by their characteristics and measurements.

Results. One hundred twenty-four whitebark pines were found along the promenade at Rim Village. Of the trees surveyed, 36 (29%) were dead and 88 (71%) were alive. Of the live trees, 64 had no observable blister rust infections and 24 had either inactive or active cankers. Of the total number of whitebark pines along the promenade, 19.4% of the trees were infected by white pine blister rust, indicated by either active cankers, indicated by stem swelling and orange football-shaped aecia, or by blistering caused by old cankers. This infection rate closely reflects the 20% infection rates found in the park-wide survey of whitebark pines in 2000 (Murray and Rasmussen 2000).

The future of whitebark pines at Crater Lake National Park

Monitoring and mapping the whitebark pines at Crater Lake is only part of an overall management plan to mitigate the impacts of fire suppression, dwarf mistletoe, mountain pine beetles, and, of course, white pine blister rust. It is a critical feature of being able to monitor both long-term successes and failures of management practices in the park. In addition, two other essential components to preserving whitebark pine's long term viability are fire use (Figure 3) and propagating rust-resistant trees.

Because of its clear mission "to conserve the scenery and the natural and historic objects and the wildlife therein 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" (National Park Service Organic Act, 16 U.S.C. 1), the National Park Service is in a good position to use fire to preserve and restore whitebark pine ecosystems. Fires not only clear out competing species of trees but also provide preferred caching areas for Clark's nutcrackers. Crater Lake National Park is currently experimenting with fire use to restore the park's ecosystems which are evolutionarily adapted to periodic burning from lightening strikes.

Additionally, methods of mitigating the impacts of white pine blister rust must be found. In 2003, whitebark pines at Rim Village were assessed for resistance to blister rust. Ten trees with few or no blister rust cankers were identified and their cones were harvested in late

Figure 3. Fire use at Crater Lake National Park. Photo by Michael Murray.

September. These seeds are being germinated at the U.S. Forest Service's Dorena Tree Improvement Center near Cottage Grove, Oregon (Murray 2005). The seedlings will be tested for resistance to blister rust and, hopefully, resistant seedlings can be transplanted back into the park, or seeds from resistant trees can be provided for Clark's nutcrackers to cache.

It is uncertain in this case whether human efforts can stop an introduced epidemic; the one thing that is certain is if nothing is done, whitebark pines, both at Crater Lake National Park and in North America, face eventual extinction. As with numerous other examples of extraordinary effort, species can be brought back to healthy populations. Hopefully, through persistent, thoughtful, and well-researched management efforts, whitebark pines can continue to frame photos of Crater Lake and perhaps even conservation efforts of other species in other places.

References

Baskin, Y. 1998. Trouble at timberline. *Natural History* 107:9, 50–57.

Jacobi, W.R., and C.E. Swift. 2005. Dwarf mistletoe management. Colorado State University Extension. On-line at ext.colostate.edu/pubs/garden/0295.html. Accessed 26 July 2006.

Kendall, K., and R. Keane. 2001. Whitebark pine decline: Infection, mortality, and population trends. In *Whitebark Pine Communities: Ecology and Restoration*. D. Tomback, S. Arno, and R. Keane, eds. Washington, D.C.: Island Press, 221–242.

Leatherman, D. 2005. Mountain pine beetle quick facts. Colorado State University Extension. On-line at ext.colostate.edu/pubs/insect/05528.html. Accessed 26 July 2006.

Maloy, O. 1997. White pine blister rust control in North America: A case history. *Annual Review of Phytopathology* 35, 87–109.

Murray, M. 2005. Our threatened timberlines: The plight of the whitebark pine ecosystems. *Kalmiopsis* 12, 25–29.

Murray, M., and M. Rasmussen. 2000. Status of whitebark pine in Crater Lake National Park. On file at Crater Lake National Park, Crater Lake, Ore.

Peattie, D. 1981. *A Natural History of Western Trees.* Boston, Mass.: Houghton Mifflin.

Tomback, D., and K. Kendall. 2001. Biodiversity losses: The downward spiral. In *Whitebark Pine Communities: Ecology and Restoration*. D. Tomback, S. Arno, and R. Keane, eds. Washington, D.C.: Island Press, 243–262.

Zeglen, S. 2002. Whitebark pine and white pine blister rust in British Colombia, Canada. *Canadian Journal of Forestry Research* 32, 1265–1274.

Determining the Disturbance Effect on Forest Development for Use in Park Management Plans

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Introduction

On San Juan Island, Washington, forests are an important component not only of the landscape of the island but also of San Juan Island National Historical Park. Although the forests of the island were manipulated during the historic military time period (1853 to 1871), significant and widespread alterations occurred during the post historic period of 1872 to 1966 (Agee 1984). During that time, patches of forest were cleared for agriculture in both the American and English Camps. Following the park's establishment in 1966, many of these fields were abandoned and dense Douglas fir (*Pseudotsuga menziesii*) and lodgepole pine (*Pinus contorta*) stands became established. In addition, the island has a history of fires and windstorms that impact the forest stand development.

Objectives

An important part of any monitoring plan is proper stratification of the area. Earlier work on San Juan divided the forests into nine community types (Peterson 2002). Our early analysis showed that there was great variation within type, at least in the Douglas fir types which included approximately 80% of the stands in the park. In order to develop management and monitoring plans in an efficient and cost effective manner the stand types must be stratified in order to reduce the coefficient of variation among measurement plots.

Our objective of this study was to determine if "forensic silviculture" techniques could be used to better understand the history and development of the forest stands in order to better stratify the forest stand types. "Forensic silviculture" is the term used for a variety of tools that can be used to quantify the role of disturbance on forest stand development. Past patterns of tree growth and mortality are related to disturbance history and competitive interaction between trees.

Three stands were selected that represented different disturbance regimes that had affected the park.

Research objectives by stand. One stand (EC-SL) was chosen because it presents signs of past selective logging. The objective here was to study and analyze the effect past selective logging had on the present diameter distribution and to determine the nature of the cutting.

A second stand (EO-WD) was chosen because we hypothesized that the major disturbance regime was windstorms. We wanted to analyse the impact of wind damage on the structure (vertical arrangement and spatial distribution of individuals) of the stand, and to determine whether the fallen trees were the consequence of a single event.

The third stand at American Camp (AC-ND) was chosen because during the initial reconnaissance because there was no evidence of recent major disturbances. The objective here was to reconstruct the stand development patterns and to compare the age distribution with the other two stands at English Camp which have been impacted by disturbances after stand initiation.

Methods

Basic techniques in stand reconstruction were used. The purpose of reconstruction is to determine what the stand looked like in past times. Quantitative measure are used, such as diameter distribution and number of stems per hectare. After the reconstruction is complete, patterns such as how the diameter distribution has changed in time are used to better understand the stand development trajectories. This information can then be used to better understand the future and incorporated into management and monitoring plans.

The goal of reconstruction is to understand the impact of certain disturbances. Evidence of disturbance (such as stumps or windthrown trees) is used to separate the stands into groups that have different disturbance regimes. Then the most efficient methodology can be used in each group to reconstruct the development patterns. For this reason different techniques were used in different stands.

EC-SL. A 10m x 14m grid was laid out in the stand into which a total of 26 circular plots (0.02 ha each) were fit. Plot size was determined after a preliminary survey where stand and stump density were assessed in order to determine the variability within the stand. Since the objective was to study the effect of a considerable selective logging, we decided to define two populations: uncut and cut. For the "cut population" the baseline were all plots that included at least two stumps while the "uncut population" included plots with no stumps.

In each plot, diameter at breast height (DBH), species, and crown class were determined for all trees. Tree cores for age determination were taken at breast height, and three of the cored trees were randomly chosen to measure total height and height of the live crown (no trees with broken tops were measured).

EC-WD. In order to have a better understanding of the vertical and spatial arrangement of trees and the nature of the wind damage (different wind events, trees affected and wind direction) we stem mapped all individuals contained in a representative area of the stand representing severe wind damage. We laid out a 0.25 ha-square plot (50m x 50m) and stem mapped the individual location of each standing and fallen tree. For this, horizontal distances and bearings for each tree were taken from a reference point. For the fallen trees, the direction (bearing) of the tree on the ground was also recorded. Other measurements in the plot included: species, diameter at breast height and crown class for all trees; total height and height to live crown were recorded and cores for age determination were taken on a subsample of trees (one-fifth and one-third of the trees, respectively).

AC-ND. The sampling approach in this stand consisted of two transects run along the stand where plots were laid down systematically every 24 meters. The first transect was initially located following (parallel) the ridge line, and the second one 24 meters downhill from this one. Plots were circular and 0.02 ha each (7.98 m radius). Measurements in all plots included species, diameter at breast height and crown class for all trees; total height and height to live crown were recorded and cores for age determination were taken on a subsample of trees (one-quarter and one-third of the trees, respectively).

For the three stands, a total of 795 trees were measured and 250 tree cores taken.

Analysis

In this paper we demonstrate examples of the types of analyses that were conducted as part of the stand reconstruction. The total analyses were much more complete than what is presented here. These examples will demonstrate the usefulness of reconstruction to stratify stands into groups following similar patters of development.

The EC-SL stand had an average age at breast height of 84 years with a range of tree ages varying between 53 and 94 years. Most trees were in the 85- and 95-year age classes. On average it took 2.8 years (differences varied between 1 and 5 years) for trees to reach the age at breast height determined from the cores taken at ground level.

The diameter distribution for the stand as a whole ranged between 6 and 66 cm and presented a mean diameter value of 29 cm. While comparing both "cut" and "uncut" populations, diameter distributions exhibited different patterns as well as mean values. The uncut population had an arithmetic mean of 31.9 and its diameter distribution can be described as a bell-shaped curve. The cut population, on the other hand, had an arithmetic mean of 33.8 cm and seems to present a bimodal diameter distribution. Although different by almost 2 cm, differences were not statistically significant.

Diameter distributions were compared by fitting two-parametric Weibull curves to assess whether both follow a sigmoidal (bell-shaped) distribution. The results showed that uncut population could be assumed to follow a single-peaked distribution. Different from the cut population, plots with stumps were more widely distributed (lower γ value) and seemed to have a second peak in the 55–60 cm class. However, tests showed that although two peaks were noticeable, it could not be considered non single peaked; furthermore, the second peak resulted insignificant. CHI-square tests between both distributions showed significant difference at an α-level of 0.05 (p-value 0.03).

The EC-WD stand tree ages were between 51 and 90 years with an average of 78 years. Most tree ages ranged between 70 and 90 years. The age distribution is normal but is skewed to the left (skewness coefficient of –1.96).

The diameter distribution of the EC-WD stand exhibited a wide range of diameters ranging from 12 and 74 cm, and a mean diameter of 37 cm. The distribution seems to be skewed to the right, but it is important to note that the distribution is only represented by living trees, windthrown trees were not included and this might have resulted in some missing trees in the intermediate-high diameter classes.

In order to reconstruct the storm history of the stand, the direction (bearing) of the fallen trees was mapped. A combined detailed analysis of the direction, tree condition and relation to other fallen trees (whether a stem was above or below its neighbor) suggested patterns of different winds events. Based on the direction in which the trees fell and the diameter of the trees, we assume that the two major clumps fell during the same wind storm event. Most of these trees had diameters greater than 45 cm, and where the diameter was smaller, the trees were below them (probably due to the impact of the previous ones). This type of analysis was used throughout the plot and it was hypothesized that three separate wind events influenced the development of this stand.

Tree ages ranged from 23 and 105 years. However, it is important to note that the youngest age classes (30 and 35) were only represented by three trees, and two of them corresponded to suppressed trees that have recently died.

Discussion

The age distribution of both stands at English Camp suggests that these stands were established after a major or stand-replacing disturbance. The majority of trees at both stands varied by less than 20 years of age. This narrow age pattern is typical for stand establishment after stand-replacing disturbances such as fires or clearcuts (Oliver and Larson 1996). Considering the time the trees needed to grow to breast height (around four years on average), we deduced that the establishment of the stands occurred between 1907 and 1920 for the EC-SL stand, and 1915 and 1920 for the EC-WD stand. The presence of large old stumps covered with charcoal in some areas of these stands indicates that there was logging activity in the site before the current stand got established. Remaining older trees in the proximity of these stands had charcoal on the bark as well, while this could not be observed in any of the living trees in the stands. This strongly suggests that a fire had gone through the area before the stand was established. The age class distributions of both stands, as well as the previously mentioned observations on the site lead to the conclusion that the stands established after an intensive harvesting and subsequent fire in the beginning of the 20th century (around 1905). This coincides with observations made by Agee (1984), reporting that in the period from 1905 to 1915 most of the forest in English Camp was cut and often burned shortly after.

The EC-SL stand exhibits signs of past logging activity evidenced by the presence of stumps. Based on the radial growth of the trees growing close to the stumps and the age of stumps, Hetsch (2005) indicates that this partial cutting took place around 1960. Based on the reconstruction of the DBH of the cut trees, we could say that the cutting did not follow the common logging practice known as high grading where usually large diameter and high quality timber are harvested (Smith et al. 1997). A detailed reconstruction of the event done by Hetsch (2005) indicates the cutting was done at a low intensity where 86 intermediate size trees per hectare (20 cm diameter) were removed. Since this event, there seems to be no other disturbances but the fall of few intermediate and suppressed trees. This may have been a combined event of trees weakened by competition that probably fell by the action of wind events.

The EC-WD stand, on the other hand, showed evidence of past wind storm events. Based on the analyses we hypothesize that more than one wind storm took place. The first wind storm, where almost all trees fell down, may have been of important intensity since most of the windthrown trees were large in diameter. Some of the remaining fallen trees may have fallen down later as a consequence of a less intense wind event. Although the exact date of these events was not determined, we hypothesize that these events took place not long ago. The overall condition of the fallen trees was good (no indication of external rot).

There is no evidence of any other partial disturbances of importance since the time of the past described disturbances. Both the windthrow damage and the partial cutting have resulted in the development of variable-size gaps and the release of growing space (sensu Oliver and Larson 1996). However, due to the poor establishment of new individuals in most of the situations, we assumed that most of it was re-occupied by the remaining overstory trees.

The age distribution of the stand studied at the English Camp follows also that one of stands initiated after stand-replacing disturbances. The majority of the trees in this case established in a period of between 30 and 40 years. This wider age distribution could be explained by the drier site conditions where the stand grew, thus delaying the establishment. Additionally, and according to the variability found in age across the sampled trees, we could also hypothesize that part of another stand established earlier may have been sampled. Considering the time the trees needed to grow to breast height, we can predict for this stand a time of establishment around 1905 and 1940. The presence of old stumps in almost all sampled plots indicates the existence of logging activity preceding the establishment of the stand. Neither these sumps nor the older trees in the proximity of the stand presented signs of past intense fires (scars, charcoal). In summary, the currently stand got established after the previous stand was harvested at the beginning of the 20th century (around 1905). Whether fire was used after logging or naturally occurred remains unknown.

Conclusion

This study represents a collaborative work between the National Park Service and the University of British Columbia. Three stands at the English and American Camps at San Juan Nation Historic Park were selected for study. Different field techniques and sampling approaches were used in the three stands in order to determine stand development patterns through the reconstruction of present and past stand structures. These studies showed that although the average tree age and average diameter of stands may be similar, very different distributions of these statistics may have resulted from different disturbance regimes. In order to reduce the coefficient of variation between plots in the creation of a monitoring plan stands should be stratified by disturbance regime. Reduction of the variation through stratification will increase the efficiency and effectiveness of the plan.

References

Agee, J.K. 1984. *Historical Landscapes of San Juan Island National Historic Park.* Seattle, Wash.: University of Washington.

Hetsch, S. 2005. Reconstruction of stand development—A case study on San Juan Island, Washington, USA. Diploma Thesis, Albert-Ludwigs-Universität, Freiburg, Germany.

Oliver, C.D., and B.C. Larson. 1996. *Forest Stand Dynamics*. 2nd ed. New York: John Wiley & Sons.

Peterson, D.L. 2002. *Developing a Vegetation and Fuels Data Base for San Juan Island National Historical Park.* Seattle: U.S. Geological Survey Forest and Rangeland Ecosystem Science Center, Cascadia Field Station.

Smith, D.M., B.C. Larson, M.J. Kelty, and P.M.S. Ashton. 1997. *The Practice of Silviculture*. 9th ed. New York: John Wiley & Sons.

How Do You Manage Your Resources if They are being Stolen and Sold at the Swap Meet?

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Most of us began our park careers hoping to work outdoors and, in the process, do something positive for the environment. As we progressed from seasonal to permanent employees, and from trainees to supervisors, we were given more administrative duties. Now, the everyday tasks making up the majority of our jobs, like staff meetings, report writing, and budgeting, leave us little time to actually protect resources.

While we balance budgets and attend meetings, fossils, insects, mining equipment, Native American artifacts, and reptiles located on the public lands are being plundered. Some of them are taken as "souvenirs," but a sizeable percentage is taken by people possessing specialized knowledge and seeking specific resources. Many park resources, thus, are being commercially exploited, as Operation Indian Rocks and Operation VIPER show.

Operation Indian Rocks, a multi-agency criminal investigation into the theft and trafficking of cultural resources, began in Death Valley National Park. Ultimately, the operation recovered over 11,000 artifacts and resulted in the criminal convictions of eight individuals and one corporation for looting sites managed by a minimum of five different agencies in at least five states.[1]

Operation VIPER, a covert investigation into the trafficking of bear parts and protected plants in the Appalachian Mountains, uncovered a thriving commercial trade in bear parts reaching as far away as Korea. The investigation succeeded in tying 103 defendants to nearly 700 criminal violations, almost 300 of them felonies.[2]

The commercial depredation of resources crosses land management boundaries. The Bureau of Land Management, U.S. Forest Service ,and National Park Service[3] each regularly document the commercial theft of "crooked wood," galax, beargrass, burls, cacti, salal, mushrooms, and other resources in their weekly enforcement reports.

To stem the removal and degradation of park resources, land management agency personnel must use an interdisciplinary, consultative approach—they must act as a team. Otherwise, the law enforcement officer might apprehend an archeological looter but, without the archeologist, not be able to determine the "archeological value" of the resources involved in the offense, and thus hold the looter truly accountable for the violation. Similarly, the botanists might notice a certain plant species disappearing but, without the law enforcement officer, not be able to link the population reduction to commercial trafficking. Further, the maintenance employee might notice a car parked in the same area of the park each day but, without the biologist, not realize that an endangered species is living nearby.

A critical element of an interdisciplinary approach is information-sharing. Today, there are parks where resource staffs refuse to provide rangers with the locations of threatened resources. This practice must end if we are to effectively protect those resources. Archeological or endangered species locations need not be broadcast for all to hear in order that rangers, who typically are the eyes and ears of the park, have an awareness of these resources' locations and the risk of their injury or loss. In turn, when rangers discover damage to park resources, they need to report it to resources management staff so that the damage may be assessed and quantified.

Public information officers (PIOs) and interpretive rangers are factors in the information-sharing matrix, too. They need to regularly brief the public about the special nature and quality of parklands. Also, as resource protection is an important message, we get the "biggest bang for our buck" when a looter or resource thief is successfully prosecuted and the PIO publicizes the case. Hopefully, in making the public aware of our protection efforts, press releases will deter others from engaging in similar illegal activities.

Effective resources protection requires proactive effort. One example of that effort is the program at Lake Mead National Recreation Area, in Nevada and Arizona, to mark cacti with microchips. This marking and monitoring program has been widely publicized in an effort to deter the theft of desert plants for landscaping or other purposes.[4] A second example is the marking of ginseng plants in park areas along the Appalachians with dye, to identify the plants' provenance if they are poached. Innovations such as these need to be encouraged and applauded.

Operation Indian Rocks and Operation VIPER have demonstrated the value of different agency personnel working together in identifying violators and holding them accountable for their conduct. Consequently, it is incumbent upon all park staff that they work closely with employees in other disciplines. Our job in the national park system is to protect park resources for future generations. We must do it as efficiently as possible—the public is counting on us.

Endnotes

1. Joseph Johns, presentation at 2007 George Wright Society Conference, April 20, 2007, and Tim Canaday and Todd Swain, "Operation Indian Rocks: Conducting Interagency ARPA Investigations," *The SAA Archaeological Record* 5:4, 26–32 (2005).
2. Timothy Alley, presentation at 2007 George Wright Society Conference, April 20, 2007.
3. Each agency distributes a summary of significant events. The National Park Service issues a daily "Morning Report"; the other agencies issue a report on a weekly basis.
4. Alice C. Newton, presentation at 2007 George Wright Society Conference, April 20, 2007.

Responding to Shrinking Budgets: How to Keep Controlling Invasive Plants with Reduced Program Funding

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Introduction

Land managers face challenges from two sides. On the one hand, outside threats to natural and cultural resources continue and increase in their intensity and menace. On the other, programmatic support to manage those threats is steadily eroding. In the case of the national park system, there is now less available project funding to preserve and protect our precious resources than during the previous five years.

When it comes to the threat posed by invasive nonnative plants, Pimentel et al. (2005) estimates there are at least 25,000 exotic plant species in North America. An eastern park example illustrates the challenge. Shenandoah National Park, Virginia, has documented fully 25 percent of its known terrestrial plant species as not native to its region (NPSpecies 2007).

Programmatic funding trends are not encouraging. It is an economic case of guns or butter. The United States' war on terrorism is suppressing most domestic budgets to flat or decreasing levels. Program funding for the nationally funded National Park Service (NPS) Mid-Atlantic Exotic Plant Management Team has steadily eroded as indicated by the Consumer Price Index. Though ostensibly a flat budget during the fiscal years 2003–2007, the CPI indicates their purchasing power has decreased 13 percent during the period (Figure 1). That equates to 13 percent fewer hours of labor or available supplies that they can purchase relative to 2003.

If your programmatic funding is drying up as well, you will need to consider how to get things done in different, cheaper ways. Åkerson and Forder (2006) described ways to improve programmatical output by use of contracts, cooperation, and collaboration to capture the available expertise and staff time of outside organizations. Building a program of volunteerism is another powerful way to accomplish work and grow a citizen base of support and advocacy.

Volunteers in the Parks

Working with volunteers in the parks (VIPs) is not new to the National Park Service. The VIP program, established in 1970 under Public Law 91-357, garners millions of hours

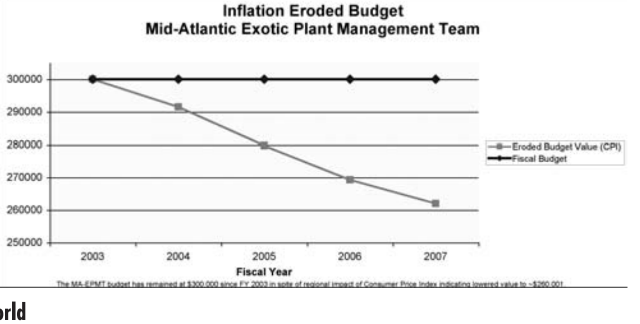

Figure 1. Chart illustrating the seriously eroded federal budget devoted to invasive plant control for the Mid-Atlantic Exotic Plant Management Team as calculated by the consumer price index for the region.

of assistance each year for the NPS. "In fiscal year 2005, 137,000 volunteers donated 5.2 million hours to your national parks" (NPS 2007). The types of services that volunteers cover includes a broad range of activities such as interpretation, reenactment, science and practical resource management, maintenance, and clerical duties, among others. Most common are volunteers that contribute more than 25 hours per year. A recent emphasis is to encourage volunteers that may only be able to contribute fewer than 10 hours per year.

Short-term volunteers

The NPS Mid-Atlantic Exotic Plant Management Team and Shenandoah National Park, with the support of the National Parks Foundation and Tauck Foundation, have formed a short-term volunteer program that focuses on a public that may only be available for a few hours. Called the Shenandoah National Park Short-term Volunteer Program, the effort is proving to be a great boon to resource management.

In fiscal year 2006, as part of the Short-term Volunteer Program, the park conducted 21 field events involving 392 volunteers who contributed 772 volunteer hours in the field. There were also ten volunteers and student interns who contributed 868 hours as part of the invasive plant management program. All told, there were 402 short-term volunteers who contributed 1,640 volunteer hours to manage invasive plants (Figure 2). FY 2006 was the first field season for the program. We anticipate even more volunteer hours in the years to follow.

The program is more than a way to generate volunteer work accomplishment in the park. It is a vehicle for educating the public about the dangers of invasive species and helping them learn ways of combating invasive plants at the park and back at their home areas. They are also briefed on how they might avoid future invasive species introductions by their awareness and advocacy. Finally, it generates interest in parks and the protection of our precious natural and cultural resources.

Organization

The Short-term Volunteer Program is overseen by the Mid-Atlantic Exotic Plant Management Team liaison. A Student Conservation Association intern (SCA volunteer leader) leads the day-to-day activities of contacting volunteers and potential volunteer groups, setting up field events, overseeing the field activity, and documenting those activities. Public outreach is vigorously pursued. The first year of field activity helped to fine-tune the program for future years.

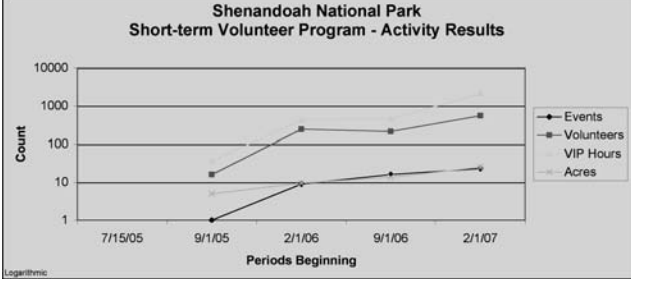

Figure 2. Chart illustrating the assistance provided by short-term volunteers at Shenandoah National Park. Volunteers come from schools, universities, special-interest groups, clubs, and the general public.

Four types of field events emerged as a natural outflow of the program. The first are special events. Two special events have been developed to date, including a May event known as *Save the Meadow!* and a September event linked with National Public Lands Day (Figure 3). These serve as high profile opportunities for the park to attract and work with many volunteers at one time. In the first year, those events attracted 30 and 70 people, respectively. We anticipate much stronger turn-out as the event reputation and publicity increases.

The second type of event focuses on groups by appointment. In the first year, group sizes varied from 10 to 120 people. The SCA volunteer leader made initial contacts and set up the time and place for gathering and field work. Groups included civic organizations, professional societies, church youth groups, university classes and clubs, middle school and high school groups, home school families, and youth organizations. Many of the school and university-affiliated groups hoped to fulfill service learning requirements of their schools. The program became a way for them to fulfill their need. Group events generated the greatest number of volunteers and volunteer hours within the program.

A third type of event is akin to "pick-up basketball." The SCA volunteer leader went to one of the park visitor centers and led the interested public in invasive plant control for one-to-three hours. Posters were set up at several locations to attract the public in an opportunistic fashion. People that responded came to the park and enjoyed their stay but may not have known what to do next or wanted to "give back" to the park in some way. This approach, frankly, was the least successful in generating volunteers. It was informative to the park, however, by suggesting a public activity that the park's interpretation program could cut, in light of their shrinking budget.

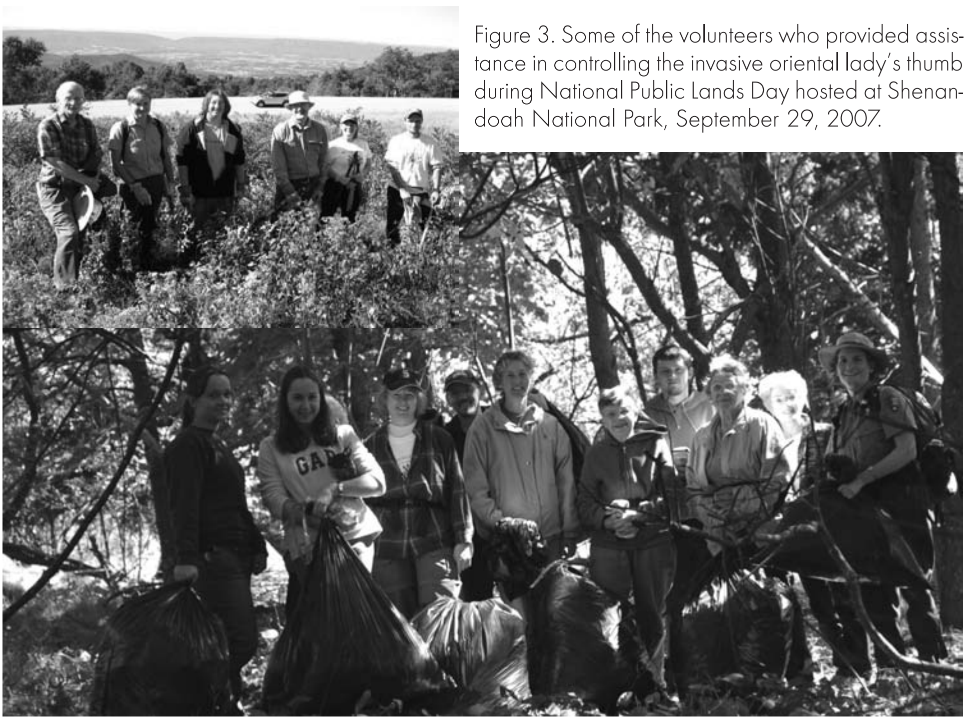

Figure 3. Some of the volunteers who provided assistance in controlling the invasive oriental lady's thumb during National Public Lands Day hosted at Shenandoah National Park, September 29, 2007.

Finally, as a spin-off from the other short-term volunteer activities, interest by some of the original volunteers developed into their willingness to participate in longer-term relationships. Several became volunteer leaders that were willing to serve when large groups or special events were scheduled. These relationships were very encouraging and helpful to the program.

Strategic planning

In the first year of operations, planning and preparations took place that allowed for smooth operations in the first field season. A strategic plan was created that describes the various volunteer types, provides protocols for preparing for and administering field events, and provides forms for documenting field activity. Maps of potential work areas were created with descriptions of the likely exotic plant species and optimal control methods. A safety plan was made part of the overall strategic document that helps organize the thinking of the volunteer leader to keep safety uppermost in their planning and administration.

As part of the first year of planning, a database of potential volunteers and volunteer groups was created and populated. At time of this writing, 240 groups and individuals are part of the database—made possible by countless telephone calls in that first year of planning. It is used extensively now for contacting groups to set up field events and notify volunteers of future special events.

Continuous improvement

Volunteers are asked to provide feedback subsequent to their field experience. Using an approved questionnaire, the information helps inform park staff of the need for program improvements. The National Park Foundation handles the tallying and analysis of the questionnaire responses.

Conclusion

The Shenandoah National Park Short-term Volunteer Program has proved highly beneficial to the park in several ways. It is a boon to resource management. It generates public goodwill and long-term advocacy among the participants—for parks and against invasive exotic species that harm park resources. Finally, it increases the number of visitors to the park in these days of changing tastes in recreation.

References

Åkerson, J., and N. Forder. 2006. Tackling exotic plants as a team: Cooperate, collaborate, and contract. In *People, Places, and Parks: Proceedings of the 2005 George Wright Society Conference on Parks, Protected Areas, and Cultural Sites.* D. Harmon, ed. Hancock, Mich.: The George Wright Society, 54–61.

Pimentel, D., R. Zuniga, and D. Morrison. 2005. Update on the environmental and economic costs associated with alien-invasive species in the United States. *Ecological Economics* 52:3, 273–288.

NPS [National Park Service]. 2007. Getting involved: Volunteer. On-line at www.nps.gov/volunteer/. Accessed 30 April 2007.

NPSpecies. 2007. The National Park Service Biodiversity Database. On-line at https://science1.nature.nps.gov/npspecies/web/main/start. Accessed 1 February 2007.

"Rats and Weeds and Lizards—Oh My!" Eradication of *Rattus rattus* and Control of Invasive Exotic Plants on Buck Island, U.S. Virgin Islands

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Introduction

Once introduced to an island, non-native rodents can cause considerable damage to the native flora and fauna, including the endangerment of endemic species (Campbell 1989; Witmer et al. 1998). As a result, there have been numerous efforts in recent years to eradicate introduced rats (*Rattus* spp.) and house mice (*Mus musculus*) from islands around the world (e.g., Buckle and Fenn 1992; Howald et al. 1999; Billing and Harden 2000; Key and Hudson 2000). Problems caused by introduced roof rats (*Rattus rattus*) at Buck Island Reef National Monument, St. Croix, U.S. Virgin Islands, have been documented by the U.S. National Park Service (NPS) for many years (see Witmer et al. 1998). Of particular concern have been the impacts on endangered and threatened species, such as the hawksbill turtle (*Eretmochelys imbricata*), the ground-nesting least tern (*Sterna antillarum*), and the brown pelican (*Pelecanus occidentalis*). Efforts to protect and restore native vegetation, such as the lignum vitae (*Guaiacum officinale*), were hampered by rat foraging. Additionally, the NPS and the U.S. Fish and Wildlife Service (USFWS) have planned to reintroduce the endangered St. Croix ground lizard (*Ameiva polops*) to Buck Island as part of a recovery plan for that species (USFWS 1984). Rat predation poses a serious threat to lizards (Philobosin and Ruibel 1971; Meier et al. 1990) and *A. polops* reintroduction plans. The rats also posed a human health threat to visitors to Buck Island because since they harbor many diseases such as the tick-borne relapsing fever (caused by a *Borrelia spirochete* bacterium) that has been found to occur on Buck Island (Flanigan et al. 1991). Efforts to control the introduced rats on Buck Island have also increased public and territorial conservation agencies' awareness to threats from exotic pest species.

Buck Island is primarily a tropical dry forest rising to 100 meters in elevation and is comprised of four distinct plant community types including scrub thicket, semi-deciduous dry woodland, mangroves, and a beach forest (Ray 2002). Historic documentation states the island was originally covered by the tropical hard wood species lignum vitae (*Guaiacum officinale*), which was harvested in the late 1700s. During the nineteenth and twentieth centuries, several non-native plants and trees used for domestic purposes were introduced, including African Guinea grass *(U. maximum)*, tan-tan *(Leucaena leucocephala)*, tamarind *(Tamarindus indica)*, aloe *(Aloe vera)*, and wild pineapple or penguin (*Bromelia penguin*); the island was grazed by goats and burned to improve forage; and severe changes in annual rainfall coupled with exotic animal pest predation on fruits and seeds have all impacted native plant survival.

Nineteen out of the 228 plant species are not native to Buck Island Reef NM (Woodbury and Little 1976; Ray 2002). Six invasive non-native species (*Urochloa maxima, Leucaena leucocephala, Tecoma stans, Bromelia penguin, Boerhavia erecta,* and *Aloe vera*) on Buck Island were of immediate concern, and three additional invasive exotic plant species (*Melicoccus bijugatus, Thespesia populnea,* and *Morinda citrifolia*) on Buck Island are known to exhibit invasive characteristics in the region. One non-native plant species with historical consideration expanding its population on the island was *Tamarindus indica*.

Methods

A strategy to eliminate rats from Buck Island was formulated and proposed in early1998 and a budget for the project was approved in August 1998. The NPS and the U.S. Department of Agriculture Animal and Plant Health Inspection Service Wildlife Services (WS) completed a study plan for the eradication of rats on Buck Island in April 1999. Under a 1999 interagency agreement, WS conducted an island-wide rat eradication project on Buck Island. In compliance with the National Environmental Policy Act, the NPS prepared an environmental assessment on the proposed rat eradication on Buck Island and a finding of no significant impact was issued on October 19, 1999.

Rat baiting using the anticoagulant rodenticide J. T. Eaton Bait Block (EPA reg. no. 56-42) containing 0.005% diphacinone was proposed. An island-wide 40 by 40 m grid pattern was mapped, and at each grid intersection point a bait station was established in the field. Baiting began on the island's shore in October 1999. Forty-four black plastic bait-stations—"Rodent Baiter" (Bell Laboratories, Inc., Madison, Wis.) measuring 23 by 18 by 10 cm (with a 6.5 by 6.5 cm opening in each end) were placed on the ground. Four bait blocks (peanut butter/molasses flavored) were placed in each station and maintained by checking the stations every day for two weeks and every three days thereafter. Hermit crabs (*Coenobita clypeata*) were observed feeding at the stations after the first three days of baiting and were possibly preventing rat access. All bait stations were subsequently moved to elevated locations by being stapled or cable-tied to tree trunks and tree limbs approximately two meters off the ground. No rats were captured in snap traps after two weeks of baiting, suggesting rat control along the shoreline areas.

Prior to establishing bait stations island-wide, a new station mount was created to deter crabs. The plastic bait stations were elevated to about 20 cm off the ground using a wire platform. The first island-wide baiting was conducted April 11–21, 2000, by distributing bait to all 428 stations. Bait was checked in every station every day for ten days. The first dead rat was observed on April 16, and by day seven the smell of decaying carcasses was apparent throughout the island. Snap traps were established at every other bait station (210 snap-traps) during non-baiting times and operated for three consecutive nights with only one rat captured.

The second island-wide baiting operation was conducted from May 2–14, 2000. Rat sign was observed early in the baiting operation, but by the second week, evidence of rats was gone. During this baiting session hermit crabs and birds took the majority of the bait. On May 11, a pearly-eyed thrasher (*Margarops fuscatus*) was observed taking bait out of a bait station. During this baiting session, least terns returned to the island and established a nesting colony on the open sand beach with over 40 adults, 17 nests and 28 eggs. No rat predation of tern adults, chicks, or eggs was observed.

The bait station mount was again modified to reduce access by hermit crabs and birds. The final configuration allowed rats to jump up to the bait station and access the bait while making it very difficult for birds landing on the bait station to get into the box. Tests with captive rats revealed that the rats could readily access the bait in the modified bait station containing bird and hermit crab excluder devices.

The final island-wide baiting was conducted from June 9–22, 2000, using these newly modified station mounts. Seventy-seven stations were fitted with bird excluder devices. The only bait that was consumed occurred when a bait station lid detached and the bait fell onto the ground–crabs were suspected of consuming that bait. On July 10–13, 2000, all bait was removed from the stations. On August 16–20, 2000, no rats were captured on the three original rat snap-trap lines and two new additional lines (north and east lines).

In 2003, the NPS Florida Partnership Exotic Plant Management Team (EPMT) was expanded to include the Caribbean park units, in line with the geographic boundaries of the NPS South Florida and Caribbean Inventory and Monitoring Network. The Caribbean extension of the team operates from the same organization and budget as the original Florida team, which was founded in 1999. An NPS staff liaison in Florida and one in the U.S. Virgin Islands coordinated with staff of area national parks and expert local citizenry to organize and prioritize invasive exotic plant removal projects in the parks. Contracted labor is utilized to conduct the work on the ground. The liaison supervises the contractor as a contracting officer representative in the field, providing technical expertise and tracking contractor performance.

In the spring of 2003, Buck Island Reef National Monument's Division of Resource Management attained funding to begin an invasive non-native plant control and management program on Buck Island. Coordination among monument staff and staff of the Florida/Caribbean EPMT (which brought additional funding to the project) led to the formulation of the project in August 2003. Utilizing the existing island-wide grid system (40 by 40 m) established by the park for the tree rat eradication project, and the existing trail system, the island was systematically treated. The ten target species were controlled by basal and foliar application of herbicide as described below. The method of treatment varied according to targeted species. Every effort was made to minimize non-target species damage during herbicide application and crew transit over the island. All herbicides and rates of usage had prior approval from the NPS Florida/Caribbean EPMT and Buck Island Reef National Monument Division of Resource Management.

- Grasses *(Urochloa maxima)* and Boerhavia *(Boerhavia erecta):* Foliarly spray to wet using compression or backpack sprayer with Glyphosate in water solution at a concentration of 4%.
- Woody vegetation *(Leucaena leucocephala, Tecoma stans, Melicoccus bijugatus, Thes-*

pesia populnea, Tamarindus indica and *Morinda citrifolia):* Basally apply Triclopyr (in vegetable oil carrier) to entire stem(s) circumference above ground (between where the foliage starts and ground) at a concentration of 30% (using compression or backpack sprayer).
- Aloe and wild pineapple (*Aloe vera and Bromelia penguin):* Apply Triclopyr (in vegetable oil carrier) at a concentration of 30% to apical growth of each plant (using compression or backpack sprayer).

Results

The five rat snap-trap lines described above were operated again during December 15–18, 2000. No rats were captured, suggesting that the rat population on Buck Island had been eliminated. However, part of the project strategy was to continue monitoring the island for the presence of rats, by use of the standardized rat snap-trap lines, because a small group of rats on some part of the island may have been missed or because they could, again, be accidentally introduced. Annual post-project monitoring sessions using this method have yielded no rats captured to date. Island vegetation appears very robust with much new growth and a profusion of flowers and fruits. Fruits and seeds have even been observed, undisturbed, on the ground. There appeared to be more bird and lizard activity. Observations of this nature were very rare prior to rat eradication. NPS personnel reported more bird nesting activity by ground doves (*Columbaigalina passerina*), white-crowned pigeons (*Columba leucophala*), and Bahama ducks (*Anas bahamensis*) than in the past on Buck Island. No rat predation on sea turtle nests has been observed since 2000.

Since 2004, annual contractor visits to treat invasive exotic plant species on Buck Island have reduced the coverage of six of the targeted species (*Melicoccus bijugatus, Thespesia populnea, Morinda citrifolia, Aloe vera, Tamarindus indica* and *Bromelia penguin*) to fewer than 10 individual plants detected per species, per visit, island-wide. During the annual visits, any individuals of these species encountered are removed. The remaining four species (*Urochloa maxima, Boerhavia erecta, Leucaena leucocephala,* and *Tecoma stans*) were initially present in greater abundance, and have proven more persistent. However, the coverage of these species has been reduced island-wide by 95% through repeated treatments. African Guinea grass (*Urochloa maxima*) remains as the most persistent invasive species found in most island habitat types, occurring in 63 of the 176 total acres. Tan tan (*Leucaena leucocephala*), the second most persistent species, was found on 20 of the 176 acres. Removal costs to date have cumulatively totaled approximately US$250 per acre, including labor, materials (including herbicide) and logistics (including crew travel).

Discussion

In response to floral and faunal ecological impacts, a sustained effort to eradicate the rats from Buck Island from 1998–2000 was undertaken. The island-wide grid of elevated bait stations using an anticoagulant rodenticide bait block was effective in eradicating the rats. The bait stations were modified several times to assure ready access by rats while minimizing access by non-target animals. Post-project snap-trapping has resulted in no rat captures, further suggesting that rats have been eradicated. Field personnel observed no non-target losses as a result of the baiting program and a rapid recovery of many of the island's floral and faunal resources. The rat eradication project has also heightened local awareness of threats posed by exotic, introduced species in the Caribbean.

The mosaic of native flora on Buck Island continues to provide recruitment for areas where invasive exotic plants have been treated and removed. Persistence in the treatment program (in perpetuity) will continue to reduce coverage of targeted species while providing suitable sites for native plant recruitment. Herbicide treatment requirements decrease as targeted species decline in coverage, while treatment of and non-target damage to native plant species has been well below acceptable levels.

The combination of the eradication of *Rattus rattus* and the control of invasive exotic plant species on Buck Island demonstrates that an integrated pest management strategy is both fiscally and ecologically effective at restoring floral and faunal communities in a Caribbean island. Perpetual monitoring and maintenance will be required to ensure current positive results are not lost, and Buck Island remains a suitable location for the translocation of the federally endangered St. Croix ground lizard (*Ameiva polops*).

References

Billing, J., and B. Harden. 2000. Control of introduced *Rattus rattus* on Lord Howe Island: The response of mouse populations to warfarin bait used to control rats. *Wildlife Research* 27, 655–658.

Buckle, A., and M. Fenn. 1992. Rodent control in the conservation of endangered species. *Proceedings of the Vertebrate Pest Conference* 15, 36–41.

Campbell, E. 1989. The effects of introduced roof rats on the vertebrate fauna of Antillean cays. M.S. Thesis, Bowling Green State University, Bowling Green, Ohio.

Flanigan, T., T. Schwan, C. Armstrong, L. Van Voris, and R. Salata. 1991. Relapsing fever in the U.S. Virgin Islands. *Journal of Infectious Diseases* 163, 1391–1392.

Howald, G., P. Mineau, J. Elliott, and K. Cheng. 1999. Brodifacoum poisoning of avian scavengers during rat control at a seabird colony. *Ecotoxicology* 8, 431–447.

Key, G., and R. Hudson. 2000. The rat control program on the island of St. Helena. *Proceedings of the Vertebrate Pest Conference* 19, 133–138.

Meier, A., R. Noble, and P. Zwank. 1990. Criteria for the introduction of the St. Croix ground lizard. *New York State Museum Bulletin* 471, 154–156.

Philobosin, R., and R. Ruibel. 1971. Conservation of the lizard *Ameiva polops* in the Virgin Islands. *Herpetologica* 27, 450–454.

Ray, G.F. 2002. *Vascular Plant Inventory and Mapping of Buck Island Reef National Monument.* On-line at http://science.nature.nps.gov/im/units/sfcn/docs/BUIS%20Veg-%20Final%20Report.pdf.

USFWS [U.S. Fish and Wildlife Service]. 1984. *Recovery Plan for the St. Croix Ground Lizard, Ameiva polops.* Atlanta: U.S. Fish and Wildlife Service.

Witmer, G., E. Campbell, and F. Boyd. 1998. Rat management for endangered species protection in the U.S. Virgin Islands. *Proceedings of the Vertebrate Pest Conference* 18, 281–286.

Woodbury, R.O., and E.L. Little, Jr. 1976. *Flora of Buck Island Reef National Monument (U.S. Virgin Islands).* U.S. Forest Service Research Paper ITF-19. Rio Piedras, Puerto Rico: U.S. Forest Service.

The Threat of the Non-native Neotropical Rust *Puccinia psidii* to Hawaiian Biodiversity and Native Ecosystems: A Case Example of the Need for Prevention

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Introduction

The threat of invasive species to natural areas presents enormous challenges, but there are opportunities for working toward solutions, often in conjunction with agricultural and forestry perspectives. There is a growing awareness of the danger to botanical biodiversity and conservation from "emerging infectious diseases" that have increased in incidence, geographical distribution, or host range/pathogenicity; have newly evolved characteristics; and/or have been newly discovered (Anderson et al. 2004). There is a heightened concern for forest health due to accelerating worldwide movement of plant pathogens (e.g., with ineffective quarantine measures) that negatively affect both biodiversity and commercial forestry (Wingfield 2003). An important related concept is that of the ability of fungi to jump to new hosts following anthropogenic introduction. Native hosts are exposed to pathogens with no coevolved recognition or defense mechanism, and microevolution toward increased virulence of introduced pathogens can result (Wingfield 2003; Slippers et al. 2005). The rust fungus *Puccinia psidii* (Basidiomycota, Uredinales: Pucciniaceae), a species first documented to have jumped from native guava *(Psidium guajava*, Myrtaceae) to introduced *Eucalyptus* spp. (Myrtaceae) in Brazil in 1912 (Coutinho et al. 1998) is an extremely important example of this phenomenon (Wingfield 2003; Slippers et al. 2005). Such threats have typically been underestimated by quarantine authorities worldwide, largely due to a lack of understanding of the taxonomy and ecology of the fungi involved (Wingfield 2003). For example, Coutinho et al. (1998) stated: "A detailed taxonomic study is needed to determine the host range and geographical distribution of *P. psidii*. It is still not certain whether more than one species of *Puccinia* is capable of infecting members of the Myrtaceae. Comparisons at the molecular level would be particularly useful in this regard."

To protect a dominant Hawaiian tree species (*Metrosideros polymorpha*, Myrtaceae) and an associated large segment of Hawaii's terrestrial biodiversity, we must work closely with the Hawaii Department of Agriculture to block entry pathways for new strains of the rust pathogen, *Puccinia psidii,* from entering the state. This is a clear need and can serve as an important example of ecosystem protection by preventative measures.

Overview of the issue

Introduction of additional strains of the rust *Puccinia psidii* could pose a major threat to *'ohi'a (Metrosideros polymorpha)* forests, watershed health, and Hawaii's unique plants and animals. Potential damage from the introduction of a strain of rust that kills or significantly damages *'ohi'a,* a tree species that dominates 80% of Hawaii's remaining forests, cannot be overstated. In April 2005, the rust was found in Hawaii, the first time it had been found to occur outside the Neotropics, and within a few months had spread throughout the main Hawaiian Islands. Effects have been highly dramatic on the endangered endemic plant *Eugenia koolauensis* and introduced rose apple *(Syzygium jambos).* The rust strain currently established in Hawaii damages leaves of *'ohi'a* in some instances, mostly on potted plants and in wet environments, but currently appears to cause minor though not yet fully defined damage to *'ohi'a* populations and ecosystems.

The rust is believed to have reached Hawaii through the live plant or foliage trade (Darcy Oishi, Hawaii Department of Agriculture, pers. comm., 2006). Well-known potential sources of infected Myrtaceae are in South and Central America, the Caribbean, and Florida. Plants from all infected areas would likely pass through the continental U.S. and arrive in Hawaii as domestic shipments (Dorothy Alontaga, U.S. Department of Agriculture, Animal and Plant Health Inspection Service, pers. comm., 2006). The rust was recently discovered on myrtle in California (Mellano 2006), a state that exports a significant amount of Myrtaceae plant and foliage material to Hawaii (Darcy Oishi, pers. comm., 2006).

Background

The rust *Puccinia psidii* is a pathogen with a very broad host range in the myrtle family (Myrtaceae). It was first described from common guava *(Psidium guajava)* in Brazil in the 1880s, and it causes severe damage to introduced *Eucalyptus* plantations in Brazil. *Puccinia psidii* is "regarded as the most significant quarantine risk to the cultivation of *Eucalyptus* spp. as well as to related plants. In Brazil it is severely limiting to the growth of highly susceptible species and provenances" (Ciesla et al. 1996). Pathogens such as the guava rust, which has developed strong pathogenicity in Brazil on introduced eucalyptus, will be devastating if these new strains are introduced back into the geographic areas where eucalyptus evolved without the rust (Glen et al. 2007).

The Neotropical species in the Myrtaceae recorded by Simpson et al. (2006) as having been attacked by the pathogen *P. psidii* are in the genera *Acca* (1), *Campomanesia* (2), *Eugenia* (10), *Marlierea* (1), *Myrcia* (3), *Myrcianthes* (2), *Myrciaria* (3), *Pimenta* (2), and *Psidium* (4). The other-than-Neotropical species exposed through cultivation/naturalization and attacked are in the genera *Angophora* (1), *Callistemon* (3), *Corymbia* (3), *Eucalyptus* (20), *Eugenia* (2), *Heteropyxis* (1), *Kunzea* (1), *Melaleuca* (6), *Metrosideros* (1), *Myrtus* (1), *Syncarpia* (1), and *Syzygium* (5) (Simpson et al. 2006). The large genus *Eugenia* (ca. 1,000 spp.) is the only genus that occurs both within and outside the Neotropics. The 26 species recorded as attacked comprise 2.3% of the 1,131 Neotropical species in the myrtle family. The 45 non-Neotropical species documented as susceptible comprise a small percentage of the ca. 3,400 (naïve) species in the myrtle family that grow outside the Neotropics, although most of the latter have never been exposed to *P. psidii*. Susceptibility to *P. psidii* seems to be low among species of Myrtaceae from the Americas but more common among taxa from Asia, Australia, and the Pacific (Simpson et al. 2006). Glen et al. (2007) cite a collaborative Australian–Brazilian study in 1996 in which 58 Australian Myrtaceae species were exposed to *P. psidii* in Brazil; 52 of those had some degree of susceptibility.

Lesions on susceptible hosts are produced by *P. psidii* on young, actively growing leaves and shoots, as well as on fruits and sepals. Lesions are brown to gray with masses of bright yellow or orange yellow (asexual) urediniospores. It is considered an autoecious rust species, with all stages produced on the same myrtaceous host; and aecia with aeciospores are morphologically identical to uredinia and urediniospores (Glen et al. 2007).

Conditions optimal for growth and development of *P. psidii* have not been precisely defined, perhaps because of differences among strains, but most active spore production and germination occurs during periods of high humidity/leaf wetness and temperatures in the range of 15–24°C (Glen et al. 2007). Such conditions are normal in windward Hawaii along an elevational gradient for much of the year.

Hawaii's current situation

Although the rust was first discovered on Oahu on potted *'ohi'a* in April 2005 (Killgore and Heu 2007), it has been found to be primarily attacking non-native rose apple *(Syzygium jambos)*. Damage to rose apple has occurred at a landscape scale with very significant partial dieback of large rose apple stands (L. Loope and others, pers. obs.). In spite of large numbers of spores produced on rose apple, adjacent *'ohi'a*, bombarded by millions of wind-dispersed spores, have appeared relatively disease-free to date.

Three native and about a dozen non-native species have been observed as hosts of *P. psidii* in Hawaii, with the introduced rose apple *(Syzygium jambos)* being the most severely affected. The rust has been found statewide, attacking local Myrtaceae from sea level to about 1,200 m elevation in areas with mean annual rainfall ranging from 750–3,000 mm (Robert Anderson, U.S. Geological Survey, pers. comm.). The host distribution and DNA profile suggest that only one genotype is established in Hawaii (Zhong and Yang 2007).

Eugenia koolauensis, listed federally as an endangered plant species endemic to Hawaii, is significantly affected by the rust (Kapua Kawelo and Jane Beachy, U.S. Army Garrison, Hawaii, pers. comm., 2006).

According to the generally accepted taxonomic treatment, Hawaii has seven endemic species in the Myrtaceae: *Eugenia koolauensis*, *Eugenia* (*Syzygium*) *sandwicensis, Metrosideros macropus, Metrosideros polymorpha*, *Metrosideros rugosa, Metrosideros tremuloides,* and *Metrosideros waialealae*. There is a single indigenous species, *Eugenia reinwardtiana*, that is a host for *P. psidii*. Of special concern for damage by additional rust strains is *'ohi'a, Metrosideros polymorpha*, a major component of the native forest on all main islands of the Hawaiian archipelago. This single species overwhelmingly dominates approximately 80% of Hawaii's remaining native forest—about 965,000 acres (1,500 square miles). Significant damage to Hawaii's *'ohi'a* forests would have major impacts on Hawaiian birds, plants, and invertebrates.

Eighteen of 19 extant Hawaiian honeycreepers in the main Hawaiian islands, including 12 species listed as endangered by the U.S. Fish and Wildlife Service (as well as six not listed as endangered) inhabit *'ohi'a* or *'ohi'a/koa* forests. Significant degradation of Hawaii's *Metrosideros polymorpha* forest by *P. psidii* will negatively affect populations of endangered honeycreepers as well as populations of at least some of the non-endangered birds *(aniani-*

au, Kauai creeper, Maui creeper, and *i'iwi*), increasing the likelihood for these species to become endangered.

In addition to direct impacts on Hawaiian Myrtaceae, dozens of endemic Hawaiian plant and invertebrate species are also dependent upon *'ohi'a* or *'ohi'a/koa* forests. As with the birds, the loss of *'ohi'a* could have significant negative affects on these taxa as well.

Rust strains

There is strong evidence of host specialization in this pathogen, with isolates from one host unable to infect certain other hosts. A rust population that consistently causes disease on a host species is termed a "strain" (= race or biotype). Each species of rust can have several or many strains.

Glen et al. (2007) summarize some of the findings to date on strains of *P. psidii*: "Several races or biotypes of *P. psidii* are known to exist; although in comparison with other rusts such as those of cereal crops, very little is known of these specialized forms." For example, two strains in Jamaica infected allspice (*Pimenta* spp.) and rose apple, respectively, but neither strain infected guava. The allspice strain was able to infect rose apple but did not sporulate. In Florida, the *Pimenta* (allspice) strain sporulated in rose apple, even though it took twice as long for maturation of urediniospores in rose apple than in allspice. In later tests, rose apple was considered immune to rust strains from *Melaleuca quinquenervia* (paperbark) and allspice (Rayachhetry et al. 2001).

In Florida, there seems to be good evidence that this rust has increased its host range since an outbreak on allspice *(Pimienta dioica)* was first detected 30 years ago, presumably through the importation of additional rust strains or development of new pathogenicities. The host range of *P. psidii* in Florida now includes about 20 species, most of which are introduced species. It has received special attention since an epiphytotic on invasive *Melaleuca quinquenervia* stands in South Florida in 1997 demonstrated explosive virulence (Rayachhetry et al. 2001), with the rust defoliating thousands of trees.

Although the rust in Hawaii was originally found on *'ohi'a*, the primary species damaged thus far is rose apple. To date, the *'ohi'a* forests have been minimally affected. Species such as the common guava, eucalyptus, and allspice are not affected by the strain currently in Hawaii, although they are substantially damaged by *P. psidii* elsewhere in the world.

The latest (though preliminary) information from DNA analysis is that there might exist only one strain or genotype of *P. psidii* in Hawaii (Zhong and Yang 2007), and the complete life cycle has not been found (Uchida 2007). In its first two years in Hawaii, the host preference behavior of *P. psidii* has been consistent among islands and locations on islands, and may indicate that only a single strain is present at this point (L. Loope and others, pers. obs.). This is in contrast to a substantial amount of variation found in the same rust species in Florida (Rayachhetry 2001; Zhong and Yang 2007).

Importance of excluding a sexual strain or strains of *P. psidii*

The apparent lack of the complete life cycle in the *P. psidii* strain already in Hawaii has enormous implications. Populations that undergo regular sexual reproduction are able to recombine genes in the population into new combinations, whereas populations with strict-ly asexual reproduction possess a more limited number of different gene combinations (McDonald and McDermott 1993). Whereas an asexual strain may have less potential for evolution, a sexual strain would have enormous potential for increased virulence for *'ohi'a* and increased environmental tolerance (Janice Uchida, University of Hawaii, pers. comm., 2006). Introduction events present a window of evolutionary opportunity for a pathogen, with potential for novel or episodic selection in a new environment, leading to rapid evolution (Brasier 2001; Wingfield 2003; Slippers et al. 2003). Few, if any, other environments on earth have a single plant species dominant over such a broad environmental range as *'ohi'a* in Hawaii (Vitousek 2004). *'Ohi'a* has been in place in Hawaii for over 1 million years and has a great amount of genetic variation, but is nevertheless constrained in its genetic variation by within-species gene flow (Vitousek 2004). Given Hawaii's generally highly favorable environmental conditions for *P. psidii* and an abundant potential host in *'ohi'a*, the stage is set for rapid pathogen evolution. There are few, if any, more important achievable priorities for biodiversity conservation in Hawaii than exclusion of new strains of *P. psidii*.

Recommendations

Rapid establishment and spread of the rust *Puccinia psidii* in Hawaii demonstrates how quickly this organism can affect multiple species on multiple islands. Establishment of a strain damaging or lethal to *'ohi'a* would be catastrophic to Hawaiian ecosystems. Management and research organizations should work together to:

- Prevent the introduction of additional strains of eucalyptus rust *(Puccinia psidii)* into Hawaii. Because it is not possible to predict which strains might affect *'ohi'a* and other Hawaiian Myrtaceae, and because of the potential for adaptation and evolution once a new strain arrives in Hawaii, effective efforts should be undertaken to prevent all additional strains of this rust from reaching Hawaii.
- Monitor nursery stock and cut-vegetation products that are freshly imported from the U.S. mainland into Hawaii to determine whether stocks are infected.
- Complete baseline documentation of current conditions through a thorough host/effects assessment and DNA analysis for the *P. psidii* that is in Hawaii already, and periodically monitor for changes in the status quo.
- Monitor native Hawaiian Myrtaceae to continually assess the impact of the existing or future rust strain(s).
- Develop a management plan to mitigate the effects of the existing rust strain on native Myrtaceae species, especially *Eugenia koolauensis,* an endangered species.
- Work with Pacific Island/Asian countries to develop procedures aimed at minimizing the spread of the rust from Hawaii.

References

Anderson, P.K., A.A. Cunningham, N.G. Patel, F.J. Morales, P.R. Epstein, and P. Daszak. 2004. Emerging infectious diseases of plants: Pathogen pollution, climate change and agrotechnology drivers. *Trends in Ecology and Evolution* 19, 535–544.

Brasier, C.M. 2001. Rapid evolution of introduced plant pathogens via interspecific hybridization. *BioScience* 51, 123–133.

Ciesla, W.M., M. Diekmann, and C.A.J. Putter.1996. *FAO/IPGRI Technical Guidelines for the Safe Movement of Germplasm, no. 17: Eucalyptus spp.* United Nations Food and Agriculture Organization and International Plant Genetic Resources Institute. On-line at www.bioversityinternational.org/publications/pubfile.asp?ID_PUB=406.

Coutinho, T.A., M.J. Wingfield, A.C. Alfenas, and P.W. Crous. 1998. Eucalyptus rust: A disease with the potential for serious international implications. *Plant Disease* 82, 819–825.

Glen, M., A.C. Alfenas, E.A.V. Zauza, M.J. Wingfield, and C. Mohammed. 2007. *Puccinia psidii*: a threat to the Australian environment and economy—A review. *Australasian Plant Pathology* 36, 1–16.

Killgore, E.M., and R.A. Heu. 2007. 'Ohi'a rust: *Puccinia psidii* Winter. *New Pest Advisory*, no. 05-04. Honolulu: Hawaii Department of Agriculture. (Originally published 2005; updated March 2007.)

McDonald, B.A., and J.M. McDermott. 1993. Population genetics of plant pathogenic fungi. *BioScience* 43, 311–319.

Mellano, V. 2006. Rust on myrtle found in San Diego County. *Healthy Garden—Healthy Home: University of California Cooperative Extension, Retail Nursery Newsletter* 1:6, 3.

Rayachhetry, M.B., T.K. Van, T.D. Center, and M.L. Elliott. 2001. Host range of *Puccinia psidii*, a potential biological control agent of *Melaleuca quinquinervia* in Florida. *Biological Control* 22, 38–45.

Simpson, J.A., K. Thomas, and C.A. Grgurinovic. 2006. Uredinales species pathogenic on species of Myrtaceae. *Australasian Plant Pathology* 35, 546–562.

Slippers, B., J. Stenlid, and M.J. Wingfield. 2005. Emerging pathogens: Fungal host jumps following anthropogenic introduction. *Trends in Ecology and Evolution* 20, 420–421.

Uchida, J.Y. 2007. Pathogenicity and biology of *Puccinia psidii* in Hawai'i. Abstract for 2007 Hawaii Conservation Conference, 25–27 July 2007.

Vitousek, P. 2004. *Nutrient Cycling and Limitation: Hawai'i as a Model System*. Princeton, N.J.: Princeton University Press.

Wingfield, M.J. 2003. 2003 Daniel McAlpine Memorial Lecture. Increasing threat of diseases to exotic plantation forests in the Southern Hemisphere: Lessons from *Cryphonectria* canker. *Australasian Plant Pathology* 32, 133–139.

Zhong, S., and B. Yang. 2007. Use of microsatellite DNA markers for characterization of *Puccinia psidii*, a rust fungus attacking 'ohi'a *(Metrosideros polymorpha)* and other Myrtaceae in Hawaii. Abstract for 2007 Hawaii Conservation Conference, 25–27 July.

Cost-Effective Mapping of Invasive Plants Using Systematic Reconnaissance Flights (SRFs)

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Why SRFs?

The quarantine strategy is recognized as one of the most effective strategies for controlling invasive plant populations. The quarantine strategy as described by Woodall 1981 is where the least-infested areas (outliers) are addressed first in order to stop the progression of the existing population.

Detection of individual trees and scattered small clusters is imperative for the success of the quarantine strategy. Attempts to map individual trees and small clusters of invasive plants in south Florida such as *Melaleuca quinquenervia* through remote sensing have not been successful. For example, in 1988 efforts to detect Melaleuca from false color infrared (1:10,000) in Everglades National Park showed that Melaleuca had a distinctive signature and could be identified on the imagery; however, imagery was not successful at locating individual trees and small clusters (Rose and Doren 1988).

Systematic aerial surveys or systematic reconnaissance flights (SRFs) have been widely used to estimate species abundance and distribution of biological populations. SRFs have shown to be particularly practical when a study area is large or remote (Quang and Lanctot 1991). In Florida, SRFs have been shown to be the most practical and cost effective method to map individual populations of invasive plants.

History of SRFs in Florida

In 1980, the U.S. Forest Service (Cost and Craver1980) conducted the initial SRFs for invasive plant mapping in south Florida, covering over seven million acres. The goal of the survey was to map the distribution of Melaleuca in south Florida. The survey used east–west transect lines spaced at five mile intervals across southern Florida to sample Melaleuca distribution. The survey used a Cessna Sky Master flying at 500 ft above ground level (agl). Two observers on either side of the aircraft classified the vegetation on one acre plots using an aiming device at five second intervals. A navigator was used, in addition to the observers and the pilot.

In 1990, Big Cypress National Preserve (BCNP) started an SRF program to document the spatial distribution of invasive plants with an emphasis on Melaleuca. The distribution maps could be used for treatment prioritization and to provide exact locations for control crews. Due to the prolific nature of the tree and the limited budget to control the trees, the SRF program had to ensure 100% coverage of BCNP, with a maximized tree recovery rate. Additionally the program would need to be set up so that the work could easily be reproduced to document control success.

All previous SRFs that had been conducted relied on statistical extrapolation of the results from a limited number of transects. BCNP wanted 100% coverage in order to accurately determine the extent of Melaleuca and other exotic plant species that could be detected from the air. The survey used east–west transects spaced at 1,000-m intervals to assure 100% coverage (census). Two observers on either side of the aircraft recorded invasive plants detected within a half-kilometer of the aircraft. When an invasive plant was sighted by one of the observers, the pilot is directed to deviate from the transect, in order to directly fly over each target. Once over the target the position is entered into the GPS and the species/density recorded. The pilot then re-establishes the aircraft on the flight line. The annual SRFs revealed that Melaleuca reached the height of its infestation in 1992. Melaleuca at varying densities occupied 186 square miles (482 sq km) (Snyder et al. 2003). In 2003, the Melaleuca control program at BCNP completed the initial treatment of all detected Melaleuca. The success of the program can be attributed to accurate distribution maps produced by SRF. In 1999, Everglades National Park and Loxahatchee National Wildlife Refuge (NWR) also began to utilize 1-km-transect SRFs to map invasive plant species.

In 1993, the SFWMD began conducting biannual SRF in order to document the status, distribution, rates of expansion, and habitat preferences of all targeted invasive plants in southern Florida (eight million acres). The SRFs used east–west transects spaced at 2.5-mile intervals across southern Florida to sample invasive plant distribution. Two observers flying at 500 ft agl classified the vegetation on one acre plots using an aiming device at eight second intervals. Species and density information were recorded on a GPS.

In 1999, the South Florida Water Management District (SFWMD), NPS, and Loxahatchee NWR, at the recommendation of the South Florida Ecosystem Restoration Task Force's Nuisance Exotic Weed Task Team (NEWTT), began to conduct the biannual surveys collaboratively by nesting the surveys. The SFWMD began using 4-km transects, and the NPS and Loxahatchee NWR continued using 1-km transects with the transects overlapping over federal lands (Ferriter and Pernas 2005). By combining resources, the NPS, Loxahatchee NWR, and the SFWMD can maximize efficiency and ensure compatible data sources.

By 2005, the scope of the SFWMD SRFs had expanded to include almost the entire state of Florida (20 million acres) with funding assistance from the U.S. Department of Agriculture's Areawide Management and Evaluation of Melaleuca program (TAME). TAME is an area-wide pest management program designed to promote long-term, biologically based management for the invasive Melaleuca problem in southern Florida.

Due to its large geographical extent, and the fact that the survey is only flown in the winter months to optimize plant detection, the SRFs have been compartmentalized. Portions of the state are flown each year in an alternating regional design to allow for complete coverage of the study area. Past survey results (1993–2005) are available for viewing and download at http://tame.ifas.ufl.edu/ (Ferriter and Pernas 2005).

Conclusions

SRFs are a fast, accurate, and cost-effective method for mapping selected invasive plant species over large areas. SRFs can either provide land managers with detailed maps of invasive plant distribution, or provide land managers with broad-scale species distribution information. Average costs for SFWMD surveys, including initial equipment purchases, have been $0.005 per acre.

References

Cost, N.D. and G.C. Craver. 1981. Distribution of Melaleuca in South Florida measured from the air. In *Procceedings of the Melaleuca Symposium, September 23–24, 1980.* R.K. Geiger, ed. Tallahassee, Fla.: Division of Forestry, Florida Department of Agricultural and Consumer Services.

Ferriter, A.P., and A.J. Pernas. 2005. *Systematic Reconnaissance Flight Data*. South Florida Water Management District, West Palm Beach, Fla. On-line at http://tame.ifas.ufl.edu.

Quang, P.X., and R.B. Lanctot. 1991. A line transect model for aerial surveys. *Biometrics* 47, 1089–1102.

Rose, M., and R.F. Doren. 1988. Distribution of Melaleuca (*Melaleuca quinquenervia*), Brazilian pepper (*Schinus terebinthifolius*), Australian pine, (*Casuarina* spp.) and latherleaf (*Colubrina asiatica*) in Everglades National Park. On file at Everglades National Park, Homestead, Fla.

Snyder, W.A., A.J. Pernas, and J.N. Burch. 2003. Exotic plant management: Non-native Melaleuca under control at Big Cypress National Preserve. In *Natural Resource Year in Review 2003*. J. Selleck, ed. Publication D-1533. Denver and Washington D.C.: National Park Service, 15.

Woodall, S.L. 1981. Site requirements for Melaleuca seedling establishment. In *Proceedings of the Melaleuca Symposium, September 23–24, 1980.* R.K. Geiger, ed. Tallahassee, Fla.: Division of Forestry, Florida Department of Agricultural and Consumer Services.

Understanding Oversnow Vehicle Noise Impacts

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Introduction

The 2006 National Park Service *Management Policies* (NPS 2006) state that natural soundscapes are to be preserved or restored as is practicable because the unimpaired sounds of nature (natural soundscapes) are a valued resource at national parks. Historical numbers of oversnow vehicle usage in Yellowstone and Grand Teton National Parks and the John D. Rockefeller, Jr. Memorial Parkway created unacceptable adverse impacts on natural soundscapes (NPS 2000; NPS 2003). The 2004 temporary winter use plans environmental assessment reaffirmed these conclusions and established acoustical indicators and standards to mitigate the impact of noise from oversnow vehicles on the natural soundscape (NPS 2004).

The winter soundscape at Yellowstone and Grand Teton National Parks consists of natural and non-natural sounds, although extreme quiet also can be experienced in both parks. Natural soundscapes are often important for wildlife survival due to the use of acoustic communication during breeding and predator/prey interactions. Common natural sounds include bird calls, mammal vocalizations, flowing water, wind, and thermal activity. Non-natural sounds include wheeled vehicles, aircraft, and the sounds associated with other human activity and facility utilities in visitor and employee developed areas. The subject of this paper, however, is the sound of oversnow vehicles (snowmobiles, snowcoaches, and snowgroomers).

Extensive information on the impacts of oversnow vehicles on the natural soundscapes of Yellowstone and Grand Teton National Parks has been gathered through intensive acoustical monitoring, modeling, and targeted research the past four years. Direct measurements of oversnow vehicle pass-bys, continuous acoustic monitoring throughout the winter, and sophisticated computer modeling all estimate the sound levels and percent of time that snowmobiles and snowcoaches are audible. A few details of these different approaches follow.

Monitoring

Extensive acoustic data were collected at 29 locations during the winter season in Yellowstone and Grand Teton. These automated acoustic monitors, following the protocol of Ambrose and Burson (2004), collected continuous one-second sound levels, digital recordings using a systematic sampling scheme, and recordings triggered by loud sounds. Monitoring was conducted at both the most heavily visited frontcountry sites and remote backcountry areas (Burson 2006). Monitoring data provided information on the sound levels of oversnow vehicles and the percent time they were audible and was useful to assess how actual oversnow vehicle noise related to the acoustic standards set in the winter use planning documents. Monitoring data also was used to partially validate the computer acoustic modeling.

Targeted research

Sound levels of oversnow vehicles were directly measured using standardized controlled pass-by test procedures. These measurements provided information on the relative sound levels of several snowmobile and snowcoach models and how the levels varied by speed. These data were then used as input variables for computer modeling.

Additional information was gathered in person with many hours of oversnow vehicle classification and audibility logging. These data provided information on the composition of oversnow vehicle use (visitors versus employee usage) and numbers, timing, distribution, and the interval between audible oversnow vehicles (the noise-free interval). This observational information was also used to validate the monitoring data.

Modeling

Computer modeling was used during winter use planning in Yellowstone and Grand Teton to estimate the impact of oversnow vehicle noise (HMMH 2002; Hastings et al. 2006). The most recent modeling calculated the expected sound levels and percent time oversnow vehicles would be audible for a number of hypothetical oversnow vehicle traffic patterns. The main advantage of using computer modeling to estimate oversnow vehicle noise impacts is that modeling can provide internally consistent estimates using hypothetical oversnow vehicle use patterns. This is particularly useful during management planning processes.

Results

The complexity of the oversnow vehicle noise impact topic is illustrated in the answers to the following basic questions. How loud are oversnow vehicles? Generally, oversnow vehicles sound levels range from a roar at 50 feet (up to 85 dBA for the loudest snowcoaches and 75 dBA for four-stroke snowmobiles) to a distant hum at several miles away (below the ambient sound level) (Burson 2006). Oversnow vehicle sound levels also depend on how fast they are going, the type of oversnow vehicle, topography, the speed and direction of wind and other atmospheric and ground cover conditions, and how far they are from the listener. See Table 1 for reference sound levels of common sources of sound.

How often can you hear oversnow vehicles? In most of Grand Teton and the backcountry of Yellowstone, oversnow vehicles are rarely heard, but in developed areas and along busy travel corridors oversnow vehicles can be continuously audible during some hours. Snowmobiles on Jackson Lake in Grand Teton are audible for an average of less than 5% of the day. At Flagg Ranch, in the John D. Rockefeller, Jr. Memorial Parkway, a staging area for Yellowstone, oversnow vehicles are audible an average of 28% of the day. In Yellowstone at Old Faithful, oversnow vehicles are audible about 70% of the day (Burson 2006). How often oversnow vehicles are heard depends on where the listener is, how many oversnow vehicles are operating in the area, how quiet the natural ambient sound level is, and other nearby natural and non-natural sounds.

Why conduct both modeling and monitoring? Modeling allows the National Park Service to compare various hypothetical oversnow vehicle use pattern management schemes; monitoring measures current conditions and can partially validate modeling results. Both are useful means of exploring the impacts of oversnow vehicle sounds. When used in combina-

dBA	Perception	Outdoor Sounds	Indoor Sounds
130	Painful		
120	Intolerable	Jet aircraft at 50 ft	Oxygen torch
110	Uncomfortable	Turbo-prop at 200 ft	Rock Band
100		Jet flyover at 1,000 ft	Blood-curdling scream
90	Very noisy	Lawn mower	Hair dryer
		Straight pipe motorcycle at 100 ft	
80		Diesel truck 50 mph at 50 ft	Food blender
70	Noisy	2-stroke snowmobile 30 mph at 50 ft	Vacuum cleaner
60		4-stroke snowmobile 30 mph at 50 ft	Conversation
50	Moderate	Raven croaking flyover at 200 ft	Office
40		Quiet urban nightime	Average living room
30	Quiet	Snake River at 300 ft	Quiet bedroom
20	Very quiet	Quiet rural nightime	Recording studio
			"Sound-proof chamber"
10	Just audible		Faint whisper
0	Limit of Human Hearing	Winter wilderness	

Table 1. Reference levels for common sources of sound.

tion, managers can better understand the impacts of oversnow vehicles on the natural soundscape.

Is there too much oversnow vehicle noise? Science, monitoring, modeling and targeted studies can only describe acoustical conditions; setting desired and acceptable conditions are value-based management decisions (Figure 1).

Conclusions

Several general conclusions can be made from the information collected over the past several years.

- Fewer oversnow vehicles as a whole, and fewer traveling in groups, reduces the noise impact on the natural soundscape.
- The unmodified Bombardier technology snowcoaches, employee two-stroke snowmobiles, and snow-groomers are the loudest oversnow vehicles being used in the parks.

Figure 1. Snowmobiles lined up at Old Faithful, Yellowstone National Park.

- Employee oversnow vehicle use is a sizeable component of the oversnow vehicle noise impact on natural soundscapes.
- Environmental conditions, such as weather, topography, and natural sound sources make a big difference in how oversnow vehicles affect the natural soundscapes.
- Noise impacts from current oversnow vehicle use exceed some of the soundscape thresholds set by park management, suggesting the need for further mitigation.

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References

Ambrose, S., and S. Burson. 2004. Soundscape studies in national parks. *The George Wright Forum* 21:1, 29–38.

Burson, S. 2006. Natural soundscape monitoring at Yellowstone National Park, December 2005–March 2006. Unpublished Grand Teton National Park Soundscape Program Report no. 200601. Moose, Wyo.: Grand Teton National Park.

HMMH [Harris Miller Miller and Hanson, Inc.] 2002. Draft supplemental technical report on noise: Winter Use Plan final supplemental environmental impact statement for the Yellowstone and Grand Teton National Parks and John D. Rockefeller, Jr. Memorial Parkway. Report no. 295860.360. October 2002. On file at Grant Teton National Park, Moose, Wyo.

Hastings, A.L., G.G. Fleming, and C.S.Y. Lee. 2006. *Modeling Sound Due to Over-snow Vehicles in Yellowstone and Grand Teton National Parks.* Cambridge, Mass: U.S. Department of Transportation, Volpe National Transportation Systems Center, Acoustics Facility.

NPS [National Park Service]. 2000. Winter use plans final environmental impact statement for Yellowstone and Grand Teton National Parks and John D. Rockefeller, Jr. Memorial Parkway. Mont., Idaho, Wyo.: U. S. Department of the Interior.

———. 2003. Winter use plans final supplemental environmental impact statement for Yellowstone and Grand Teton National Parks and John D. Rockefeller, Jr. Memorial Parkway. Mont., Idaho, Wyo.: U. S. Department of the Interior.

———. 2004. Temporary winter use plans environmental assessment for Yellowstone and Grand Teton National Parks and John D. Rockefeller, Jr. Memorial Parkway. Mont., Idaho, Wyo.: U.S. Department of the Interior.

———. 2006. *Management Policies 2006.* U. S. Department of the Interior. Washington, D.C.: U.S. Government Printing Office.

The "Adaptable Human" Phenomenon: Implications for Recreation Management in High-Use Wilderness

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Introduction

Wilderness managers must balance providing access for wilderness recreation with protecting the special experiences wilderness provides. This balancing act is particularly challenging at popular destinations close to large metropolitan areas. Such destinations provide substantial societal benefits by allowing respite from city life and immersion in natural environments for thousands; however, the thousands that throng to these places detract from the wildness and sense of solitude that wilderness should provide. Managers are left wondering what sorts of experiences are appropriate in such places or, more precisely, what experiences are so inappropriate that restrictive actions should be taken to avoid them. Particularly contentious are decisions about whether or not to deny access to people who want to visit—limiting use in order to protect experiences.

This is not a new issue. But it is an issue that is increasingly pervasive, particularly in regions such as the United States' Pacific Northwest where large populations of outdoor-oriented people live immediately adjacent to spectacular wilderness areas. Consequently, we conducted studies of visitors to Forest Service wilderness areas of Oregon and Washington. From previous research, we have learned lots about people's evaluations of experiences (for example, Manning 1999). How crowded does this place feel? How satisfied were you with your experience? Is this or that a problem? And we have learned lots about peoples' management preferences. Do you support use limits? Should dogs be prohibited? But in exploring such questions, apparent inconsistencies have emerged. Despite apparent social impacts, experience evaluations usually remain positive and behavioral responses to impacts suggest that they are considered trivial. This suggests the need to better understand what people actually experience.

The primary thrust of our research, then, was to understand what people were actually experiencing, their evaluations of those experiences, and their management preferences. We contrasted experiences, evaluations, and management preferences in situations where there were lots of other people around with situations where few other people were around.

Study methods

We conducted nine different interrelated studies (reports are being posted at http://leopold.wilderness.net/research/fprojects/F007_B.htm as they are completed). One study, conducted at three popular destinations inside wilderness, involved in-depth interviews with people about their immediate experience. Both day and overnight visitors were interviewed on days when these places were lightly and heavily used (Hall et al. 2007).

We conducted several questionnaire-based studies—again designed to differentiate between day and overnight visitors, as well as between visitors to high- and low-use places. We surveyed visitors entering as well as exiting at trailheads, so we could compare motivations (the types of experiences people hoped to have) to the types of experiences people actually had (Cole and Hall 2005). To survey visitors at low-use trailheads, we got names and addresses from wilderness permits and sent out mailback questionnaires (Cole and Hall 2006). We also used the database of permits to draw a regional sample of wilderness users in order to study displacement. We were particularly interested in displacement caused by crowding, but we also explored other causes of displacement, types and frequency of displacement, as well as other coping behaviors (Hall and Cole 2007).

At Snow Lake in the Alpine Lakes Wilderness, a beautiful, very heavily used lake that is a one-hour drive and one-hour hike from downtown Seattle, we combined observation, interviews, and questionnaires. We observed the behaviors people employ trying to find a place to do whatever they want to at the lake—as well as their interactions with other groups at the lake. Interviews and questionnaires focused on perceptions of the situation and coping behaviors (Cole and Hall 2007).

And finally, in an effort to learn from a somewhat different population, we conducted a series of stakeholder meetings at which we explored people's opinions about how several high-use destinations in the Three Sisters Wilderness should be managed. We invited participants in earlier wilderness public involvement processes, as well as members of recreation and wilderness organizations to participate. We exposed these people to information and gave them time to explore their values—and those of other participants—and work through complex issues and trade-offs (Seekamp et al. 2006).

Results and discussion

One of the emergent themes from the studies was that while the conditions people experience at high- and low-use places are very different, differences between high- and low-use places diminished when we explored peoples' evaluations of those conditions and their management preferences. In the trailhead study, for example, the mean number of groups seen was 14 at the very high-use trailheads and 6 at the less-popular trailheads (Table 1). At Snow Lake, on weekends when use was very high, 38% of the groups we observed intruded on the space of other groups—stopping and staying at places that were already occupied. On weekdays when use levels were more moderate, only 7% of the groups we observed selected already-occupied sites (Table 2). Verbal interchanges between groups were five times more frequent on weekends than they were on weekdays. These are large differences.

Visitor evaluations of these divergent conditions did not differ so dramatically, however. In the trailhead survey, we asked people about the effect of the number of people seen on their "sense that I was in wilderness." On a 7-point response scale, from "added a lot" (assigned a value of +3) to "detracted a lot" (assigned a value of –3) the mean response was –0.2 at very high-use trailheads and –0.1 at less-popular trailheads (Table 1). While this difference was statistically significant, a difference of 0.1 units on a 7-point scale is negligible. At Snow Lake, we asked people how much they were bothered by there being too many peo-

	Very High Use	Moderate Use	p [a]
Mean reported number of groups encountered/day	14	6	<0.01
Effect of number of people seen on the "sense that I was in wilderness" [b]	-0.2	-0.1	0.02
Percent of groups that support limiting use now	18	16	0.82

[a] t-tests and chi-square test, respectively

[b] 7-point scale from "added a lot" (+3) to "detracted a lot" (-3)

Table 1. Differences in conditions, evaluations and management preferences at wilderness trailheads where use levels are very high and moderate.

	Weekend Visitors	Weekday Visitors	p [a]
Percent of groups that selected an already occupied site	38	7	<0.01
Mean number of verbal encounters [b]	0.5	0.1	<0.01
Degree visitors were bothered by "too many people near the lake" [c]	1.0	0.5	<0.01
Agreement with statement "I thoroughly enjoyed this trip" [d]	2.4	2.5	0.12
Percent of groups that support limiting use now	16	14	0.64

[a] Mann-Whitney tests and chi-square test, respectively

[b] Verbal exchanges (number of different groups) during a 30-minute (or less) observation period

[c] 7-point scale from "not bothered at all " (0) to "bothered me a great deal" (6)

[d] 7-point scale from "strongly agree" (+3) to "strongly disagree" (-3)

Table 2. Differences in conditions, evaluations and management preferences at Snow Lake between very high use times (weekends) and less heavily used times (weekdays)..

ple near the lake. On a 7-point scale, from 0 to 6, the mean response on weekends was 1.0 and the mean response on weekdays was 0.5—again a statistically significant but negligible difference (Table 2).

All differences disappear when we move to opinions about how the Forest Service *ought* to manage these places. In our trailhead surveys, we asked people if they would support use limits now or in the future. At very-high-use trailheads, 18% of people supported use limits now, compared with 16% at moderate-use trailheads (Table 1). At Snow Lake, 16% of weekend users supported limits now compared with 14% of weekday users (Table 2). Neither of these differences is statistically significant.

Why do people who are experiencing very different situations respond to them in such similar ways? And why are most people not supportive of use limits, regardless of how heavily used a place is?

Several competing hypotheses have been suggested. One hypothesis is that the people who are bothered by crowded conditions—and the difficulty of finding solitude—have been displaced elsewhere (Dustin and McAvoy 1982). If this is common, then managers definitely should give careful consideration to use limitation—otherwise quality experiences for many will become increasingly hard to find.

Another hypothesis is that encountering lots of other people simply doesn't matter much to people—the number of people encountered is simply not salient (Stankey and McCool 1984). If this is the case, it's no wonder that use limitation is so unpopular.

A final hypothesis—and this is the "adaptable human hypothesis"—is that people do care about how many other people they encounter. However, they learn; they plan; they adjust their expectations; they cope; they rationalize; they view things in relative terms—rather than in absolutes—they say "this place provides more solitude than Seattle" rather than "this place provides no solitude"; they make trade-offs. They adapt.

We believe that all of these phenomena are going on. So we are going to try to use data from our studies to estimate the relative prevalence of three types of people in wilderness: the displaced people, the people who do not care how many other people are around, and the adaptable humans. We'll do this in the context of concern about crowding and solitude—the social experience in wilderness. Also, we recognize that the lines between these categories are somewhat fuzzy and, indeed, any person may be displaced one day and adaptable on another day.

From our region-wide study of displacement, only 3% of wilderness users reported that there was a place in wilderness that they never go back to because it is too crowded. Twelve percent said that they usually or always go to less-crowded wildernesses. In our trailhead surveys, only 5% of users favored the implementation of use limits that would reduce use. When we asked people about solitude on their trip, only 5% said "solitude was important to me and I did not find it." Collectively, these results suggest that the population of displaced users is quite small—perhaps on the order of 5–15% of the population.

What about those who do not care how many people they encounter? They are fine if they are alone and fine if they are surrounded by people. In our trailhead surveys, we asked people their preferences for encounter rates—30% said that the number of encounters does not matter to them. When we asked them about solitude, 27% reported that solitude was not important to me on this visit. People who do not care about encounters are obviously more prevalent in the population than displaced users, constituting somewhere around one-quarter or one-third of the population.

This means that the majority of wilderness users fall into the adaptable camp. Although two-thirds of our trailhead sample encountered more groups than they prefer, only 23% of these people—the ones who encountered more than they prefer—felt that this was even a slight problem. Only 5% felt it was a moderate problem. In our studies of displacement in popular wildernesses, more than 50% told us that these places felt less like wilderness than in the past. But only about 20% reported not being as satisfied with their experience as in the past and large majorities agreed with such statements as "the area is so beautiful I come in spite of high numbers of people," "impacts could be worse considering the amount of use," and "everyone should have a right to visit, even if it means high use."

These rationalization processes—and the adaptability of people—were most evident in the interviews we conducted. A common response when we asked if people had experienced a sense of solitude was "Yes. I mean there was a lot of people coming down … solitude may not be the word—if you wanted to get out, you could find a place." Another person said "Not really. Well, it is a popular trail. It is close to Seattle so people just come here, but I am willing to deal with the people that are here because it is beautiful. . . ."

So, what we found is that very different experiential settings (within the range of settings found in wilderness) do not lead to very different evaluations of the quality of those experiences or to different management preferences. The primary reason for this appears to be that most wilderness visitors are highly adaptable. They prefer to use coping behaviors and to be allowed to decide for themselves whether or not to visit a crowded wilderness. Most people do not want the Forest Service to make this decision for them. So, they do not support use limits even in very heavily used places.

One final result we would like to talk about is that despite there being little difference in *mean opinions* about how to manage very different situations, *individual opinions* in each setting were highly divergent. In our stakeholder meetings, after four hours of information (about the Wilderness Act, current trends in visitor use and management, and results from visitor surveys) and exploration of values, we asked people how they felt about limiting use at two highly used destination areas in the Three Sisters Wilderness. The mean response on a 7-point scale from highly positive to highly negative was essentially neutral (0.4). But only 6% of participants actually had a neutral opinion. Large and equal proportions strongly supported and strongly opposed use limits.

Conclusions and implications

This work clarifies the difficult decisions that Forest Service managers must make. The data from the stakeholder meeting, particularly, makes it crystal clear that whatever the Forest Service does in any particular place will be strongly supported by only a minority. The Forest Service will be damned by some if they limit use and damned by others if they do not implement limits. However, our research suggests little about which minority to choose. It suggests little about whether or not limits are appropriate. Our research can be used to justify whatever the Forest Service decides, but it does not make those decisions easier or better.

Conversely, our research suggests that whatever decision is made—within reason—most people will adapt to it and accept it. Our trailhead surveys also suggest that visitors are much more supportive of use limits if the rationale for limits is protection of the environment rather than protection of experiences (Cole and Hall 2005). Although our research suggests that most people are adaptable, there is a small minority of people who have strict standards that are resistant to change. These wilderness "purists" will be displaced and marginalized if managers attend only to the wishes of the adaptable majority. Again, our research clarifies this situation but does little to suggest the degree to which managers should listen to the majority or to the "purists."

Given the divergent opinions within these populations of users, it would seem to make sense to provide and protect a diversity of setting conditions. Still, managers are left to decide how much land and which places to allocate to each type of setting, as well as what the standards should be for each setting. Visitor opinions, norms, and preferences will not help them make these decisions if—as we found—the majority of users are highly adaptable, and opinions are homogeneous across settings but highly divergent within settings.

Science is usually more useful in clarifying and describing phenomena than in helping managers decide what they should do, and our research is no exception (Stewart and Cole 2003). Our research will contribute to prescriptive decision-making by making decisions more informed, particularly regarding consequences of alternative choices. Insights into the situation were greatly enhanced by our exploration of varied stakeholders and our use of multiple methods, applied on multiple sites.

References

Cole, D., and T. Hall. 2005. Wilderness visitors and experiences in Oregon and Washington: Trailhead surveys in thirteen Forest Service wildernesses. Unpublished report available at http://leopold.wilderness.net/research/fprojects/F007_B.htm.

———. 2006. Visitors to low use wilderness trailheads in Oregon and Washington: Do they differ from most wilderness visitors? Unpublished report available at http://leopold.wilderness.net/research/fprojects/F007_B.htm.

———. 2007. Conditions, experiences, coping behaviors, visitor evaluations and management preferences at a heavily-used wilderness destination: Snow Lake in the Alpine Lakes Wilderness, Washington. Unpublished report available at http://leopold.wilderness.net/research/fprojects/F007_B.htm.

Dustin, D., and L. McAvoy. 1982. The decline and fall of quality recreation opportunities and environments. *Environmental Ethics* 4, 49–57.

Hall, T., and D. Cole. 2007. *Changes in the Motivations, Perceptions, and Behaviors of Recreation Users: Displacement and Coping in Wilderness.* RMRS-RP-63. Fort Collins, Colo.: U.S. Department of Agriculture–Forest Service Rocky Mountain Research Station.

Hall, T., B. Johnson, and D. Cole. 2007. Dimensions of wilderness experience: A qualitative investigation. Unpublished report available at http://leopold.wilderness.net/research/fprojects/F007_B.htm.

Manning, R. 1999. *Studies in Outdoor Recreation: Search and Research for Satisfaction*. 2nd ed. Corvallis: Oregon State University Press.

Seekamp, E., T. Hall, C. Harris, and D. Cole. 2006. Attitudes and changes in attitudes about visitor management at the Green Lakes/ South Sister area of the Three Sisters Wilderness: A study of four stakeholder involvement meetings in Oregon. Unpublished report available at http://leopold.wilderness.net/research/fprojects/F007_B.htm.

Stankey, G., and S. McCool. 1984. Carrying capacity in recreational settings: Evolution, appraisal, and application. *Leisure Sciences* 6, 453–473.

Stewart, W., and D. Cole. 2003. On the prescriptive utility of visitor survey research: A rejoinder to Manning. *Journal of Leisure Research* 35, 119–127.

Dragonology 101: Understanding Dragon-Hunters and Odonata Interactions in Protected Areas

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Introduction

Upper-level predators such as Odonata/Odanates (dragonflies—Anisoptera; damselflies—Zygoptera) are used as bio-indicators for wetland quality in Europe, Japan, the USA, and Australia, and are a flagship species for certain tourism attractions (Clausnitzer and Jödicke 2004). Understanding the socioeconomic values of insects while also convincing management agencies and decision-makers to increase conservation procedures and policies, are just some of the challenges facing entomologists and conservationists. Others include taxonomic limitations, lack of research funding, and social misconceptions (i.e., insects being perceived as pests). This article presents how some of these barriers have been overcome through experiential learning and applied field experiences.

Historiography, literature reviews, on-site observations (i.e., attending dragonfly symposiums), and interviews with dragon-hunters were used to acquire a greater understanding of the human dimensions of Odonata-human interactions. A sociocultural, historical overview of the role of dragonflies is provided first, followed by an examination of emerging recreation and tourism trends. The findings highlight protected area management strategies, legislation, and education. The article concludes by examining current management challenges and proposing future research recommendations.

Objectives

Raising public awareness concerning insects and Odonata is an essential feature of effective conservation practices in protected areas. By focusing on the human dimensions of "dragonflying" (viewing, collecting, and participating in dragonfly counts) and by discussing participants' experiences in attending various dragonfly symposia, we may be able to translate these findings into practical tools that will enhance the recognition that experiential activities and awareness are essential cornerstones of conservation, and protected area management strategies.

Literature Review

For most Europeans and Euro-North Americans, invertebrates such as Odonata remain largely unfathomable and alien. However, Odonates have inspired artists, scientists and engineers (Thakoor et al. 2002). Indeed, some researchers have asserted that Odonates are humanity's best friend of the insect world, while some special interest groups (i.e., the British Dragonfly Society) have established sanctuaries dedicated solely for the protection of these insects.

Dragonfly gatherings (e.g., festivals, specimen counts, educational outings) have been increasing in popularity in North America. Some of the most popular events in North America include the Dragonflies in Our Wetlands hosted by the West Eugene Wetlands

Education in Oregon, and the Valley Nature Centre's Annual Dragonfly Days, in Weslaco, Texas. Some symposiums, like the Great Lakes Odonata Meeting (GLOM), or the Volunteer for Nature programs (e.g., in the Boundary Waters, and the Carden Alvar butterfly and dragonfly counts), are often held near or in protected areas (e.g., provincial, state, and national parks). Those unfamiliar with "dragon-hunting" might be surprised to learn that regional, national (or, more precisely, continental), and international organizations exist which share a common interest in Odonates. Conservative estimates place the number of individuals belonging to Odonate associations at over 4,500 worldwide. The largest of these national organizations are located in Japan and Britain. This number increases dramatically if participation in dragonfly symposiums, volunteer insect counts, and festivals are included.

Method

A number of dragonfly outings held in northern Ontario were attended by the researcher during a two-year period (2005–2007). Throughout each outing, extensive observations and field notes were taken. These notes were supplemented with in-depth interviews with twenty participants (recruited from these outings) and other noted enthusiasts (referred by the participants), lasting approximately 20 to 30 minutes each. More males (15) than females (5), ranging in age from their early twenties to their mid-seventies, and representing a wide range of socioeconomic, educational and sociocultural groups, participated in the interviews. A large proportion of these interviewees, ranging from beginners and hobbyists to biologists, were from two Canadian provinces (Ontario and Manitoba), although some were also from two Midwestern states (Minnesota and Wisconsin). Complementing the process were electronic conversations with Odonata enthusiasts. In total, over 25 individuals from across the world provided additional information and reflections on Odonata and Odonata-related activities. It is important to note that I did not interview or conduct any electronic interviews with professional collectors. Although I do mention this group in the findings, my ethnographic focus is on amateurs, hobbyists, and biologists.

Semi-structured interviews were conducted on an agreed-upon date and time. Some interviews were conducted over the telephone, while others were face-to-face. All interviews were recorded and journal notes taken. Interviews were then transcribed and coded. A myriad of complex and emerging concepts and themes from the interviews were coded, compared, and winnowed down. A number of salient themes emerged from the analysis, including conservation and protection, education, attraction (colors, beauty), physical prowess, collecting specimens, and the role of technology. In order to facilitate this analysis, only themes pertaining to anthropogenic impacts, conservation and protection (e.g., protected areas, legislation), and education are discussed next. To preserve the anonymity of the participants, interviewees are referred to in general.

Findings

A number of interviewees noted that current anthropogenic activities such as forestry, increased agricultural activities, pest control schemes involving insecticides (e.g., for hydro lines), hydroelectric developments, and suburban sprawl have destroyed habitats and greatly reduced Odonata populations (Moore 1997). Compounding these factors are recreational activities (motorized water vehicles) and associated developments (cottages, resorts) along shorelines, coastlines and riparian zones.

Since dragonflies can spend as much of two-thirds of their life in aquatic environments and require these areas for reproduction, a number of protected areas have been established with the specific purpose of protecting Odonata and their environments (e.g., Great Britain's sites of special scientific interest). In other locations, Ramsar sites and protected areas (e.g., Ba Be National Park, Vietnam) are essential biodiversity reservoirs. Some participants more familiar with international (Ramsar sites), national, and regional policies (Ramsar Sites, the Canadian Federal Wetlands Policy, and the Ontario Wetlands Policy Statement) in Canada stated that these policies provide additional protection to wildlife and their environments, including Odonates. Yet, research into wetlands management indicate that while great advances have been made in the public's understanding of these areas, the most notable feature of wetlands management in the province of Ontario and Canada is that there is still no specific or comprehensive national wetland law. Rather, as one participant explained, federal statutes regulating or otherwise protecting wetlands habitats in Canada have evolved piecemeal over the years. As a result, jurisdiction for wetland protection in Canada is a mixed of regional, provincial, and federal policies.

As two interviewees familiar with Odonata protection indicated, protected areas are not always synonymous with Odonata preservation. For example, some management approaches favoring tourism (i.e., the construction of visitor facilities, clearing undergrowth from stream banks) in the Khao Phanom Bench and Doi Suthep National Parks in Thailand, have been found to be detrimental to insect populations, especially Odonates (Hämäläinen 2004). Compounding these issues are the limited success that protected areas strategies have had in minimizing direct and indirect anthropogenic disturbances such as invasive species and climate change (Hoyle and James 2005). These limitations are further aggravated by our lack of knowledge surrounding dragonflies and their migratory patterns, e.g., the North American Dragonfly Migration Project (Wikelski et al. 2006).

While most participants understood the need to collect and preserve individual specimens for scientific purposes, a large majority opposed "recreational collections" and also questioned the need to collect and kill Odonates in the name of conservation. These perspectives however, were often dismissed by biologists and entomologists, who were quick to point out that potential impacts from collecting (personal, research) are minimal when one considers the various impacts on wildlife through human activities (e.g., industrial waste, suburban sprawl). They also noted that various legislation strategies designed to control the harvesting and collecting of specimens on endangered species lists (e.g., CITES, the Convention on International Trade in Endangered Species of Wild Fauna and Flora) and the Convention of Biological Diversity) have been implemented. None of the participants addressed the limitations of these legislative approaches to protected area management.

Last, while nearly all participants supported experiential approaches with insects and Odonata (e.g., guided interpretations in protected areas), and although a number of participants discussed the importance of early childhood exposure (e.g., outdoor recreation, environmental education) to nature and wildlife in fostering their environmental awareness, only in a few cases did this curiosity result in career pursuits. Thus, interest in dragonflies appears to be a later-life manifestation, often occurring after several other activities have been experienced and mastered (e.g., birding).

Conclusion

From a parks and protected area management perspective, insects are rarely addressed in interpretation strategies, and when they are, they are often labeled as pests, living in disagreeable environments. Yet, as one study conducted on wildlife tourists visiting South African protected areas highlighted, managers were often "fairly surprised to learn that tourists had indicated an interest in being shown the invertebrate fauna" (Kerley et al. 2003:18). Repercussions from these information lapses are numerous, including people who may influence conservation procedures and priorities, such as politicians and land managers, who "commonly take the lack of definitive species lists of invertebrates as symptomatic of disinterests by biologists, or lack of importance, rather than reflecting major ecological complexity. It means also that with some exceptions, we cannot state categorically whether or not a particular invertebrate species is rare or otherwise worthy of conservation, because we do not know where else it occurs and what detailed environmental needs may be" (New 1997:6).

A far more effective translation of the diverse values (biological, social) of invertebrates and their environments will be needed to reverse the current trend toward increasing impoverishment of the planet's species diversity. This will require public recognition and education as essential elements of policy changes regarding invertebrate conservation (Rykken 2007). Examples of such strategies already exist in various protected areas in Canada and the USA, including various interpretation programs in protected areas (e.g., Bruce Peninsula and Point Pelee National Parks in Canada, Rondeau and Sleeping Giant Provincial Parks in Ontario), experiential approaches promoted by such organizations as the Invertebrate Conservation Trust (also known as Buglife), the Boston Harbor Islands National Recreation Area All Taxa Biodiversity Inventory (Rykken 2007), and Odonata symposiums (e.g., Great Lakes Odonata Meeting). All of these methods are raising public, professional, and conservationist awareness of the diversity of invertebrates, their functions, and conservation needs.

On a more optimistic note, this research indicates that large, conspicuous, colorful, diurnal and aerial insects such as Odonata are excellent subjects for nature interpretation programs and public education. Indeed, participants noted that codes of conduct, greater information exchange, applied field experiences, interpretation, and new technologies (i.e., digital cameras, portable scanners, on-line verification) can increase our understanding of Odonates by producing species inventories, while minimizing our ecological effect on these creatures and their environments. In order to increase awareness of Odonates and provide a better understanding of their habitats, Odonata counts and symposiums should be open and marketed to individuals of various backgrounds and ages, and they should also seek to lessen, whenever possible, ecological impacts of these activities on Odonata habitat. Last, the findings from these interviews indicate that further interpretation strategies pertaining to this charismatic macrofauna of various stakeholders including biologists, managers, members of environmental not-for-profits groups, and various other social actors is still required.

Acknowledgments

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References

Clausnitzer, V., and R. Jödicke. 2004. Guardians of the watershed. *International Journal of Odonatology* 7:2, 111–112.

Hämäläinen, M. 2004. Critical species of Odonata in Thailand and Indochina. *International Journal of Odonatology* 7:2, 295–304.

Kerley, G.I.H., B.G.S. Geach, and C. Vial. 2003. Jumbo or bust: Do tourists' perceptions lead to an under-appreciation of biodiversity? *South African Journal of Wildlife Research* 33:1, 13–21.

Moore, N.W. 1997, *Status Survey and Conservation Action Plan: Dragonflies*. Cambridge, U.K.: IUCN Species Survival Commission Odonata Specialist Group.

New, T.R. 1997. *Butterfly Conservation*. 2nd ed. New York: Oxford University Press.

Rykken, J. 2007. Boston Harbor Islands All Taxa Biodiversity Inventory. Presentation at the George Wright Society Biennial Conference on Parks, Protected Areas, and Cultural Sites. St. Paul, Minnesota, April 16–20.

Thakoor S., J. Chahl, M.V. Srinivasan, L. Young, F. Werblin, B. Hine, and S. Zornetzer. 2002. Bioinspired engineering of exploration systems for NASA and DoD. *Artificial Life* 8, 357–369.

Wikelski, M., D. Moskowitz, J.S. Adelman, J. Cochran, D.S. Wilcove, and M.L. May. 2006. Simple rules guide dragonfly migration. *Biology Letters* 1-5 (on-line article).

Keeping the Wild in Wilderness: Minimizing Non-Conforming Uses in the National Wilderness Preservation System

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Introduction

Forty-three years after passage of the 1964 Wilderness Act, it is increasingly clear that, despite the best intentions of the law, the lands within the national wilderness preservation system (NWPS) are degrading. One of the greatest emerging challenges to protecting the wild character of these lands is the preponderance of *special provisions* or *non-conforming uses* in subsequent wilderness bills. These provisions not only allow activities within wilderness that are inappropriate and degrade individual areas, but the cumulative impact of these provisions threatens to diminish the core values that distinguish wilderness from other public lands.

Wilderness has its own meaning and character

The statutory definition of wilderness is found in Section 2(c) of the Wilderness Act. The framers of the act intended the first sentence of this section to establish the meaning of wilderness:[1]

> A wilderness, *in contrast* with those areas where man and his own works dominate the landscape, is hereby recognized as an area where the earth and its community of life are *untrammeled* by man, where man himself is a visitor who does not remain (emphases added).[2]

By law, wilderness is to remain *in contrast* to modern civilization, its technologies, conventions, and contrivances. Incompatible activities are prohibited because allowing their intrusion blurs the distinction between wilderness and modern civilization, diminishing wilderness character and the unique values that set it apart.

Congress also specified that wilderness would be *untrammeled*, meaning free of the human intent to manipulate, alter, control, or subjugate nature. In wilderness, the forces of nature should shape the landscape without intentional human interference.

The overarching statutory mandate in the Wilderness Act is to preserve the wilderness character of each wilderness within the NWPS.[3] Though the law did not itself define wilderness character, perhaps the best attempt to do so came from the U.S. Fish and Wildlife Service. This policy stated in part:

> Preserving wilderness character requires that we maintain the wilderness condition: the natural, scenic condition of the land, biological diversity, biological integrity, environmental health, and ecological and evolutionary processes. But the character of wilderness embodies more than a physical condition.

> The character of wilderness refocuses our perception of nature and our relationship to it. It embodies an attitude of humility and restraint that lifts our connection to a landscape from the utilitarian, commodity orientation that often dominates our relationship with nature to the symbolic realm serving other human needs. We preserve wilderness character by our compliance with wilderness legislation and regulation, but also by imposing limits upon ourselves.[4]

How non-conforming uses degrade wilderness

The unique values that characterize lands within the National Wilderness Preservation System are being steadily degraded. The culprits can be broadly categorized as (1) increased motorized use, (2) commercialization, (3) manipulation of natural processes, and (4) changing types and levels of recreational use. These problems are exacerbated by special exceptions written into wilderness bills. Indeed, special provisions are becoming paramount in the overall threats to Wilderness nationwide.

Non-conforming uses diminish an area's wilderness character and the opportunity for present and future generations to experience the unique benefits of authentic wilderness. Section 4(d) of the Wilderness Act is titled "special provisions." These so-called *non-conforming* uses are compromises that diminish wilderness character, but were nonetheless written into the original law. These special exceptions are qualified to various degrees so as to provide federal wilderness managers with the ability to regulate these uses to minimize their impacts on wilderness.

With the exception of honoring private existing rights and for fire management, where Congress gave the secretary of agriculture broad discretion, the Wilderness Act requires that the other activities be administered to protect wilderness character. For instance, the exception for commercial services allows for commercial outfitting and guiding, but those activities must be done in a manner that protects the wilderness character of the areas. Unfortunately, the good intentions of the law are not always being realized on the ground.

The responsibility for regulating the uses allowed by special provisions falls to federal agencies that have often *not* been supportive of good wilderness stewardship. All four agencies with wilderness responsibilities are falling woefully short in meeting their stewardship obligations, and these shortcomings transcend the past several administrations.[5] Given the lack of commitment to or understanding of good stewardship on the part of some managers, exceptions in wilderness bills often result in far more damage to wilderness character than the supporters of these exceptions anticipated.

The Central Idaho Wilderness Act (CIWA), which designated the River of No Return Wilderness, is a case in point. When that law was passed in 1980, eight airplane landing strips existed in the wilderness for public use on national forest land. Under the Wilderness Act, the Forest Service had the authority to close any or all of the landing strips and was moving in that direction on at least two. A special provision in CIWA prohibited the Forest Service from closing any landing strip "in regular use on national forest lands" at the time of designation without the express approval of the state of Idaho.[6] This provision effectively precluded closing any of the existing strips and in fact has resulted in a far worse condition. Under pressure from pilots and the state, the Forest Service recently recognized four more meadows as additional historic landing strips, increasing the total number to 12. Furthermore, the landing of airplanes in the wilderness has exploded to more than 5,500 annually, much of it for practicing touch-and-go landings and for "bagging" airstrips—activities that have nothing to do with accessing the area for wilderness purposes.

Similarly, another provision of CIWA that allowed some jet boat use on the main Salmon River has been used to dramatically increase both commercial and private use of jet boats. In short, special provisions in the CIWA have allowed the largest contiguous wilderness in the lower 48 states (2.5 million acres), an area that should provide the ultimate wilderness experience, to instead be riddled with unlimited airplane and jet boat use.

Significantly, much of the motorized use occurs in order to facilitate *commercial services* (outfitting and guiding), a Wilderness Act exception that itself is limited to the degree that the activity is both *necessary* and *proper* in a wilderness context.

One of the most widespread examples of the unanticipated consequences of special provisions is the Congressional Grazing Guidelines (CGG) that Congress first adopted in a Colorado national forest wilderness bill in 1980. The guidelines authorized ranchers to use motor vehicles to develop new "improvements" for certain livestock activities provided there were no "practical alternatives" and where such activities cannot "reasonably and practically be accomplished on horseback or foot."[7] Again, these guidelines have been expanded over time.

Many of the wildernesses added to the system in the past two decades, particularly those in the Intermountain West and the desert Southwest, are extensively grazed by livestock. Ranchers have become increasingly accustomed to using off-road vehicles, including all-terrain vehicles, in these areas. In particular, the Bureau of Land Management (BLM), which now administers about one-quarter of all wildernesses, has proven woefully lenient in allowing ranchers to drive off-road vehicles in wilderness. For example, in administering the Steens Mountain Wilderness in eastern Oregon, BLM allows ranchers unrestricted use of motor vehicles for tending cattle.[8]

Further damage to wilderness can be traced to the guidelines. In 2002 a federal court, relying on the grazing guidelines, ruled that the Department of Agriculture was justified in killing a large number of mountain lions in the Santa Teresa Wilderness in Arizona in order to protect domestic livestock.[9]

These examples represent just a few of the threats presented by special provisions in wilderness bills, and they also highlight the *unintended consequences* from such exceptions. Most managers have been unable or unwilling to regulate or limit these non-conforming uses. Thus, even when discretionary safeguards have been included in legislation, they have proven ineffective for protecting wilderness character from the harm resulting from special provisions.

This array of non-conforming uses decreases the recognizable core qualities that define wilderness across the system. It brings about a gradual decline in the overall wilderness standards that govern the NWPS. Some non-conforming uses in wilderness may seem small, or of little impact in a system that encompasses more than 700 areas and 107 million acres. But each non-conforming use violates the ideal and integrity of wilderness and diminishes the wilderness character and symbolic value of all wilderness areas in the system. The cumulative impact of hundreds of non-conforming uses is significant.

Non-conforming uses allowed in one wilderness bill are replicated—and often expanded—in subsequent wilderness bills. Once an exception is made in one bill, it becomes harder to exclude similar exceptions in future wilderness bills. Three noteworthy examples of provisions that have become troublesome precedents for other bills include the CGG, discussed above; motorized access for state fish and wildlife agencies; and access to inholdings (non-federal lands).

Special language allowing motorized access for fish and wildlife management shows how a narrow exception in one bill evolves into highly destructive exceptions in future bills. The first specific exception allowing for vehicle use for wildlife management appeared in the 1984 Wyoming Wilderness Act. The provision allowed motorized access to a specific location in the Fitzpatrick Wilderness for capturing bighorn sheep.[10] Six years later, Congress allowed for greatly expanded motorized access and other wilderness-damaging activities under the guise of wildlife management in 39 new wildernesses designated in the Arizona Desert Wilderness Act.[11] As a result there are now permanent roads in some wildernesses used for constructing, operating, and maintaining artificial water developments, called "guzzlers," to artificially inflate the numbers of bighorn sheep and other game species. In various forms, this exception for motorized uses for fish and wildlife management has been continued in subsequent wilderness designations, including the Los Padres Condor Range and River Protection Act (1992), the California Desert Protection Act of 1994, the Clark County Conservation of Public Land and Natural Resources Act of 2002, and the Lincoln County Conservation, Recreation, and Development Act of 2004.

Access to private lands ("inholdings") surrounded by wilderness provides a third example of how precedents are unexpectedly set with damaging provisions in a wilderness bill. The framers of the Wilderness Act anticipated the potential conflict between wilderness protection and the desires of private landowners wanting access to their lands. In those cases where the desired access is incompatible with wilderness protection, the 1964 act offers the inholder "adequate access" or an "exchange for federally owned land in the same state of approximately equal value" (Section 5[a]). An opinion from the United States Attorney General in 1980 concluded that wilderness managers retained the right to deny access that would be harmful to wilderness and could offer an exchange instead:

> The language of 5(a) indicates that a landowner has a right to access or exchange. If he is offered either, he has been accorded all the rights granted by the statute. If you offer land exchange, the landowner has no right of access under 5(a).[12]

It was an excellent solution to a problem with dangerous potential to degrade wilderness. Yet, here again, special provisions in new bills have begun to erode the protections ensured by the Wilderness Act.

A provision in the Alaska National Interest Lands Conservation Act (ANILCA) in 1980 dealt the first blow to the protections afforded in Section 5(a). That provision states that the secretary of agriculture "shall provide such access to nonfederally owned land within ... the National Forest System ... adequate to secure the reasonable use and enjoyment thereof. ..." While every other provision in ANILCA applies only to Alaska, the reference to "National Forest System" led the Forest Service to conclude that the provision applies to all national forest lands, including wilderness, in the lower 48 states. Whether or not the agencies have correctly interpreted this special provision in ANILCA, it has effectively eliminated the option of protecting wilderness by offering a land exchange in lieu of allowing potentially harmful access.[13]

As with other special provisions, the "access" exception in ANILCA is being repeated in subsequent bills. In 1994, the California Desert Protection Act (CDPA) included access language nearly identical to ANILCA, thereby ensuring that this weakening provision would apply to the 69 areas and millions of acres of wilderness it designated. Subsequent laws designating wilderness in Oregon and Nevada have included variations of the language used in the CDPA.

As a result of access provisions included in the above-mentioned laws, BLM and the Forest Service have begun approving motorized access (and related road development and improvements) to inholdings for a variety of inappropriate uses in wilderness.[14]

Suggestions for ensuring that new wilderness bills protect wilderness character

It is imperative that wilderness advocates oppose the use of special provisions in new wilderness bills. Forty-plus years of experience in implementing the Wilderness Act have shown that the special provisions in various wilderness bills are leading to serious degradation to both the wilderness *ideal* and to the wilderness condition.

1. Avoid non-conforming uses in new wilderness designations. Wilderness advocates should keep proposals for designating new wildernesses clean of non-conforming uses, while working to remove such provisions from bills introduced in Congress.

2. Keep wilderness bills brief and free of special management language, even if the intent of the language is simply to reiterate the provisions of the Wilderness Act. The simplest and most straightforward way to address this problem is to eschew special language and instead include a statement saying the area is to be managed in accordance with the Wilderness Act.

3. Minimize the impacts of any new non-conforming uses in wilderness legislation. First, *phase out the non-conforming uses over time.* Congress included motorboat phase-outs for specific lakes at specific dates in the 1978 Boundary Waters Canoe Area Wilderness Act. Second, *limit the impacts from non-conforming uses allowed in the Wilderness Act that might not be phased out over time.* Require, for example, the Wilderness Act to regulate grazing, rather than the more liberal CCG. Third, *place the non-conforming uses outside of the wilderness boundary if possible.*

4. Consider alternative designations if special provisions compromise the ability to manage the area *as wilderness* and if protection is needed from threats such as logging or off-road vehicles. In the 60,000-acre Rattlesnake area that borders Missoula, Montana, Congress designated the lower half of the area, which is popular for day-hiking, mountain biking, and horseback riding, as the Rattlesnake National Recreation Area and the upper half as the Rattlesnake Wilderness.

Conclusion

Wilderness advocates must ensure that special provisions in new wilderness bills and incompatible uses in existing wildernesses are not allowed to further degrade the wilderness character of NWPS units. We must seize opportunities to stem the erosion of wilderness standards and the gradual degradation of the system due to special provisions in wilderness legislation. By taking an aggressive stance against new non-conforming uses we can ensure that we pass on to future generations the "enduring resource of wilderness" that the framers of the Wilderness Act sought to preserve and that future generations deserve to inherit.

Ed. note: A more detailed version of this paper can be found at www.wildernesswatch.org.

Endnotes

1. In testimony before the final Senate hearing on the wilderness bill in 1963, the bill's chief author, Howard Zahniser, testified that: "The first sentence defines the character of wilderness. . . . In this definition the first sentence is definitive of the meaning of the concept of wilderness, its essence, its essential nature—a definition that makes plain the character of lands with which the bill deals, the ideal."
2. 1964 Wilderness Act, Sec. 2(c).
3. Numerous courts have found that preserving wilderness character is the purpose of the Wilderness Act. See, for example, *Wilderness Watch v. Mainella*, 2004 (11th Circuit Court of Appeals) and *High Sierra Hikers Assn. v. Blackwell*, 2004 (9th Circuit Court of Appeals).
4. U.S. Fish & Wildlife Service, "Draft Wilderness Stewardship Policy," *Federal Register* 66:10 (January 16, 2001), 3714.
5. See, for example, Pinchot Institute for Conservation, *Ensuring the Stewardship of the National Wilderness Preservation System*: *A Report to the USDA Forest Service, Bureau of Land Management, US Fish and Wildlife Service, National Park Service, US Geological Survey*. September 2001. On-line at www.pinchot.org/pubs/?catid=32.
6. The name of this wilderness was later changed to the Frank Church–River of No Return Wilderness. Beyond the on-the-ground impacts to the wilderness, this provision has the dubious distinction of being the first so-called Sagebrush Rebellion provision in a wilderness bill in that it granted the state decision-making authority over parcels of federal land.
7. The Congressional Grazing Guidelines have been incorporated in the Forest Service Manual at FSM 2323.22 and can be found at www.fs.fed.us/im/directives/fsm/2300/2320.doc.
8. The Congressional Grazing Guidelines are *more* restrictive than BLM's implementation of them on Steens Mountain. However, environmentalists have thus far been unsuccessful in trying to prevent unlimited driving, while local congressmen have consistently pressured BLM to interpret the guidelines in the most lenient fashion. BLM relies on ambiguous language in the Steens Act to justify its actions.
9. *Forest Guardians v. Animal & Plant Health Inspection Service,* no. 01-15239, United States Court of Appeals for the Ninth Circuit, 309 F.3d 1141, 2002.
10. The provision applied only to a 6,000-acre addition to the Fitzpatrick Wilderness in order to allow occasional motorized access for capturing and transporting bighorn sheep. The trapping program had been conducted for many years to transplant bighorns from

the Wind River Mountains to other mountain ranges throughout the West where Rocky Mountain bighorns had been extirpated.

11. The Arizona Desert Wilderness Act of 1990 referred to a memorandum of understanding (MOU) between BLM, the Forest Service, and the International Association of Fish and Wildlife Agencies (IAFWA) as guidance for the types of activities that should be allowed in wilderness. The MOU allows for predator control, constructing artificial water sources, poisoning streams, stocking non-native fishes, and, in many cases, the use of motor vehicles and motorized equipment in carrying out these activities. While the federal land managers retain authority to regulate or limit any activity under the MOU, they are often unable or unwilling to do so. MOUs are not legally enforceable unless they are incorporated into statutes, as is the case in a growing number of wilderness bills.
12. 43 Op. Att'y Gen. 243, 269 (1980).
13. The U.S. Department of Agriculture has codified this interpretation in its regulations applying to all national forest wildernesses. For its part, BLM has also applied the access language of ANILCA to all lands under its jurisdiction. It is important to note, however, that the courts have not yet ruled on the question of whether this section (1323[a]) of ANILCA effectively amended the Wilderness Act.
14. These include weekend camping and star-gazing (Palen–McCoy Wilderness, California), building and operating a horse breeding and dude ranch (Mt. Tipton Wilderness, Arizona), campground development (Kalmiopsis Wilderness, Oregon), and commercial outfitting and guiding (Steens Mountain Wilderness, Oregon).

Agency-Sponsored Treasure Hunts: Providing Alternatives to Traditional Geocaching

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Introduction

Geocaching, a sort of modern-day treasure hunt using Global Positioning System (GPS) units, has been prohibited in most national parks largely due to federal regulations prohibiting disturbance or damage of natural features and leaving behind unattended property. National parks, including Acadia National Park in Bar Harbor, Maine, are continually challenged by unauthorized geocache sites within their borders. The National Park Service (NPS) must take enforcement action when necessary to prevent resource damage and ensure visitor safety. However, it has become clear that geocaching is a well-established, popular pastime that is more than just a trend, and some parks perceive positive benefits in constructively managing the use.

Acadia National Park's pilot, NPS-sponsored EarthCache program is an example of how the agency's responsibility to preserve resources and provide for appropriate visitor enjoyment can be achieved while fulfilling some of the desires of the geocaching community.

Background

On March 3, 2000, the United States government removed the selective availability programmed into satellite systems designed to make GPS location less accurate. The result was that, under the right conditions, over-the-counter GPS units became accurate to within 20 feet, a great improvement over accuracies averaging hundreds of feet using the same GPS units just one day before.

Geocaching was reportedly born the next day. An Oregon computer consultant placed a bucket filled with various items, including videos, books, software, and a slingshot, in the woods. He also included a logbook and pencil to record visits to the site. He called the idea the "Great American GPS Stash Hunt" and posted the coordinates in an Internet GPS users' group. The rules were "Take some stuff, leave some stuff."[1]

Since that time, geocaching has become a wildly popular pastime, due in part to the thrill of achievement and the pursuant recognition for that achievement,[2] the pervasiveness of the Internet, and affordable GPS technology. The activity's explosive popularity has led to the development of more than 389,000 geocache sites worldwide, as listed on the www.geocaching.com website as of this writing.[3]

Geocaching: Definition, evolution, and variations

Geocaching is like a game of hide-and-seek for both children and adults, where the searcher seeks a hidden object instead of a person. Participants download coordinates from a website, follow the coordinates to a location using a GPS unit, and then search that location for a hidden container (cache). In traditional geocaching, caches contain assorted trinkets left behind by other participants. Participants often exchange items they brought with them for another item in the container. Traditional geocaches also typically contain a logbook in which geocachers can make journal entries. Once the location is visited, participants record their visits on the Internet, adding to a list of lifetime geocache visits.

Since its inception in 2000, traditional geocaching has evolved into many forms. Acadia's program combines components of several of these variations, including virtual caches, EarthCaches, multi-caches (offset caches), and mystery or puzzle caches. Virtual caches rely on the techniques of traditional geocaches without including a physical cache. EarthCaches include educational messages about geoscience. Multi-caches (offset caches) involve two or more locations and include a physical container at the final location. Mystery or puzzle caches require solving a puzzle to obtain the coordinates.

Variations such as virtual caches were developed to address the concerns of landowners and managers who felt that traditional geocaches were inappropriate on their lands. These alternative forms of caches are more educational, environmentally friendly, and appropriate for such areas. Virtual caches were developed for areas where digging and placement of physical caches were inappropriate or unlawful. Virtual caches utilize the concept of traditional geocaches without the need for physical containers or the exchange of items. Participants prove a visit to the site by returning to the website to enter the answer to a question, such as "find the date on the memorial plaque" or "count the number of flagpoles."

EarthCaches are a type of virtual cache of particular interest to public land management agencies. EarthCaching was developed through the collaborative efforts of the National Park Service and the Geological Society of America to teach participants about the unique and interesting geological features and processes that help tell the story of the earth's development (Figure 1). By design, EarthCache submissions require approval from park managers prior to being placed on the Internet. Following Leave No Trace practices, sites are located along trails and other durable, sustainable sites. As of this writing, the official EarthCache website (www.earthcache.org) listed 907 EarthCaches worldwide, 51 of which are located within NPS units.[4]

Caching activities on National Park Service lands

The National Park Service manages recreational activities according to the criteria listed in sections 8.1 and 8.2 (and 6.4 for wilderness areas) of the *Management Policies 2006*. While these policies include EarthCaching as a possibly appropriate activity in certain areas, they do not explicitly preclude traditional geocaching activities. Instead, these activities would normally be ruled out either by sections 1.4.7.1 and 8.2 because they cause unacceptable impacts, or by other general management policies aimed at protecting each park's natural and cultural resources. Moreover, disturbing or damaging natural features, abandoning property and, in some areas, hiking off trails—actions associated with traditional geocaching—are listed as violations in Title 36 of the Code of Federal Regulations. The development of "social paths"—unintended trails that result in soil compaction and damage to vegetation—is one of the greatest potential problems. In addition to the concerns of resource damage, traditional geocaching has been widely considered undesirable due to the anonymous nature of the Internet postings; the lack of advance permission, control over placement or content (Figure 2), and accountability; and public safety concerns (including the potential for sexual predation).

Within the parks that allow caching activities, managers generally require special use permits prior to placement. Without special use permits in place, many parks prohibit geocaching altogether. Whether or not parks allow any or all caching activities is determined at the park level through park planning. One outcome of park-by-park decision-making is that the geocaching community perceives inconsistencies; this, in turn, creates a challenge for NPS employees who must explain their rationale for allowing or not allowing the activities.

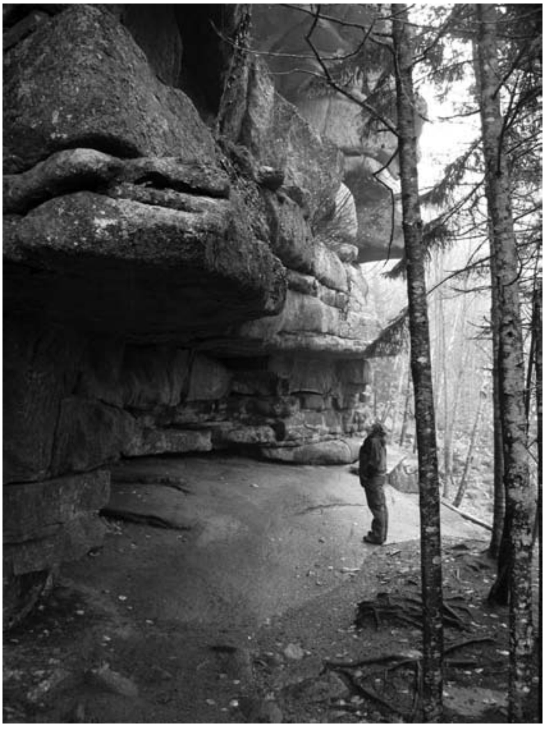

Figure 1. Each stop in Acadia's EarthCache Program highlights the park's significant geological resources. Here, volunteer Mollie Behn, co-creator of Acadia's program, studies a sea cave that is used to demonstrate ancient sea levels. National Park Service photo by Stuart West.

Although there is no specific servicewide policy or regulatory prohibition against geocaching, the need to prevent unacceptable impacts requires that NPS personnel take enforcement action against unauthorized sites within NPS boundaries. Acadia National Park is no exception: on average, the park removes three unauthorized geocaches and their respective Internet listings per year. The park currently contains seven virtual caches, and more than 330 caches are located within the area encompassed by the zip code of park headquarters.

Acadia National Park's approach

While the staff at Acadia National Park fully supports all efforts to prevent or reduce resource damage, it believes that parks should not continue to indiscriminately reject caching activities or ignore their potential educational value. Providing opportunities for appropriate public enjoyment is an important part of the NPS mission, and NPS leaders are especially intent on finding ways to appeal to the younger generation of potential park users. Therefore, park staff, led by Stuart West and Mollie Behn, designed and developed a carefully considered pilot program utilizing EarthCaches as a platform (Figure 3). As of this writing, it appears Acadia is the first national park unit to actually develop a caching activity.

Despite obvious concerns about the potential impacts of caching in the park, West rec-

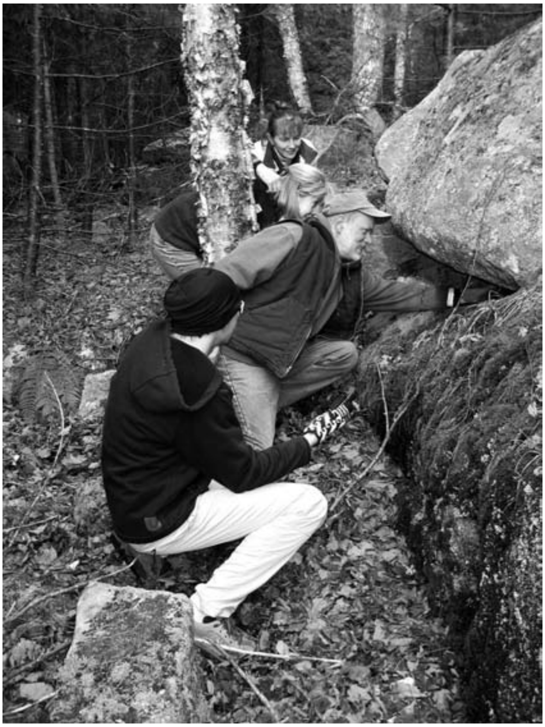

Figure 2. The placement of traditional caches in unsuitable locations may require participants to leave established trails, which damages vegetation and can harm other natural or cultural resources. National Park Service photo by Stuart West.

ognized the many untapped benefits of caching activities, including the opportunity to provide an appropriate form of outdoor recreation to new groups of visitors. The intent of the program was to engage an otherwise uninvolved, unsupportive segment of the population in a self-paced program that would not only enhance understanding and appreciation of the resources protected by Acadia National Park, but also garner broader support for public lands that protect unique features of national significance. Recognizing that the National Park Service is often criticized for being hostile to potential user groups, another goal was to find a positive way to manage the use, instead of simply saying "no" to geocaching. The park mission of resource protection and interpretation guided the program's development.

Acadia's EarthCache program uses carefully scripted clues to lead participants to a series of predetermined field locations within the park's frontcountry. The program requires puzzle-solving at each of the five field locations. Participants who follow the adventure through to the end receive proof of completion in the form of an Internet-generated certificate of completion or through access to a NPS letterbox stamp and logbook.

This pilot program aims to develop insight for the National Park Service about methods of addressing geocaching in the national parks. The program is designed in a manner that makes it compatible for most parks and can, therefore, become a model for future GPS-based programs servicewide.

Considerations for adopting or creating a caching program

Even a park-developed EarthCache program requires the completion of many formalities before being approved by the Geological Society of America. The designers of Acadia's program highly recommend, therefore, that parks take an active role in reviewing and managing caches allowed in their parks.

The process encompasses several steps. First, analysis of a park's enabling legislation will ascertain if a GPS program is even feasible. Second, the proposed program must be compatible with established interpretive themes and goals. Third, park management must

Figure 3. By carefully selecting the location of EarthCache sites, park staff are able to keep participants on established trails, reducing the creation of social trails and subsequent impacts on natural and cultural resources. National Park Service photo by Stuart West.

approve the program. Every division has a stake in a GPS program. Resource management should consider site durability and compliance issues; protection should consider implications for archeological theft, safety, and patrols; and interpretation should consider time requirements to develop or validate the program and make it available to participants (e.g., post it on the park website).

Communication with the geocaching community

Effective management of geocaching in national parks begins with an honest effort to communicate with the geocaching community. Park rangers sometimes make the mistake of removing caches without following up with the geocacher or asking the www.geocaching.com webmasters to remove the cache information from the website. These half-completed enforcement activities can result in anti-park sentiments from a community that has the potential to become a strong park supporter.

Park efforts should be directed at working *with* geocachers to permit only appropriate, authorized caching activity. The first step in doing this is to make contact with geocachers before their caches are removed. Unless geocachers feel they can trust park managers, they will not likely assist with the development of park-sponsored caches. Because geocachers value their anonymity, they will not give up their true identities without a trusting relationship.

Involving geocachers in the development of authorized caching activities, such as Acadia's EarthCache program, is essential for the success of the program. They can provide valuable insights into the logistics and feasibility of a program.

Potential benefits of developing an NPS-sponsored caching activity

Caching activities such as EarthCache programs provide parks an avenue through which to connect with other parks and to develop partnerships with outside agencies. They may also be used to provide the public with the opportunity to learn about the park's natural and cultural history and the challenges facing public land managers. Imagine, for example, teaching the public about the negative impacts of invasive species by guiding them to areas overcome by non-native plants.

Such activities also provide an opportunity for a wide array of interpretive programs designed to address park themes. They offer the opportunity to encourage protection of resources through understanding, without the structure and requirements of formal ranger-led programs. Visitors can participate in an interactive program on their own schedules. The cost of maintaining an EarthCache program can be substantially less than traditional forms of non-personal interpretation like self-guided hikes and wayside exhibits; text on the Internet can be changed immediately and with minimal cost (e.g., staff time). In addition, because there is no need for high-profile structures, GPS-led interpretation offers preservation of landscapes and scenic vistas in a manner that traditional wayside exhibits do not.

The future of caching activities in national parks

The advent of new technologies like GPS programs couldn't come at a better time for the National Park Service. Despite a rising population in the United States, visitation to national parks has been declining since 1987. This decline can be attributed to several things, but social scientists generally agree that increased time spent on the Internet, watching movies, and video gaming takes away from time spent outdoors. A recent study by the Kaiser Family Foundation reveals that children today spend more time watching and interacting with media than most adults spend at work.[5]

Caching activities such as EarthCaches reach individuals who may not have an outdoor mindset, an interest in hiking, or an appreciation for national parks, but *do* have interest in technology, problem-solving, exploration, and game-playing—components of EarthCaching. The introduction of EarthCache programs to NPS sites could, therefore, serve multiple purposes and address the needs of several audiences. These programs invite and encourage visitors who may not otherwise be interested in national parks, provide a resource-friendly form of geocaching in the park, and distribute park messages and knowledge about park resources. EarthCache programs can build relationships between federal agencies and the geocaching community that support the mutual interests of resource protection, exploration, and learning.

In the end, the National Park Service will surely benefit from sponsoring caching activities.

Endnotes

1. Groundspeak, Inc. "The history of geocaching." On-line at www.geocaching.com/about/history.aspx. Accessed April 26, 2007.
2. Margot Anne Kelley, *Local Treasures: Geocaching Across America* (Chicago: Center for American Places/University of Chicago Press, 2005).
3. Groundspeak, Inc., "Geocaching: The official global GPS cache hunt site." On-line at www.geocaching.com/about/history.aspx. Accessed April 26, 2007.
4. Geological Society of America, "EarthCache listings." On-line at www.earthcache.org/. Accessed April 26, 2007. (EarthCache is a registered trademark.)
5. Kaiser Family Foundation, "Issue Brief: The Role of Media in Childhood Obesity." On-line at www.kff.org/entmedia/upload/The-Role-Of-Media-in-Childhood-Obesity.pdf (2004). Accessed April 26, 2007.

Recreation Opportunity Classification and Challenges in Maintaining Recreation Diversity in Thailand's National Parks

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Introduction

Recreation Opportunity Spectrum (ROS) is a planning framework that has emerged in recreation systems of North America since late 1970s (Clark and Stankey 1979). It first appeared in Thailand's literature in 1998 when Tanakanjana et al. (1998) used the concept to classify ecotourism sites and developed a manual for facility development for those sites. There were some other studies in Thailand which utilized the ROS concept in the past few years. These included Ampolchan (2001), Suriyachay (2003), Ratchano (2004), and Emphandhu et. al. (2004). This paper presents the most recent findings on ROS classification of nature-based recreation sites within Thailand's national parks. This work was part of a large-scale research and development project entitled "Decision Support System for Sustainable Management Planning of Nature-based Recreation Areas" funded by the Thailand Research Fund (Tanakanjana et al. 2006).

There are 103 national parks in Thailand, covering 52,782.20 square kilometers, or 10.29% of the country's area (Department of National Parks, Plant and Wildlife Conservation 2006). This study included 91 individual recreation sites from 47 national parks around the country. While this study used recreation setting indicators similar to other ROS studies in Thailand, there were two major differences from the other studies, including quantitative measurement of setting indices and the statistical equation used to classify the ROS. It also took another step further in verifying the classification result by collecting user data to determine a consistency between normative recreation experiences and actual experiences obtained from each opportunity class.

Methods

Nature-based recreation areas in this study were classified into nine types based on ecosystem differences. The nine types of recreation areas were waterfalls, rivers and lakes, caves, hot springs, geomorphological sites, scenic areas, nature trails, islands, and beaches. A recent database of nature-based recreation areas in Thailand recorded that the total number of individual recreation sites was 1,504 sites, about 80% of them situated within the boundaries of protected areas, national parks in particular (Tanakanjana et. al. 2006). Purposive cluster sampling was used to select the sample sites based on their distribution and diversity in size and usage patterns. A total of 91 sites were chosen, including 24 waterfalls, 7 rivers and lakes, 9 caves, 6 hot springs, 8 geomorphological sites, 7 scenic areas, 11 nature trails, 10 islands, and 9 beaches.

Recreation setting indicators were developed primarily based on literature and previous in-country study (Clark and Stankey 1979; Tanakanjana et al. 1998). A focus group meeting of academics and practitioners was conducted to obtain opinions on those indicators and their measurement. The final set of recreation setting indicators was composed of seven groups, including access, remoteness, naturalness, opportunity for social encounter, evidence of human impact, site management, and user management. Each indicator had multiple indices. The total number of indices was 16. A list of all indicators, indices, and their measurement is presented in Table 1.

At each site, inventories on basic characteristics of recreation resources were conducted using GPS and associated tools. The size of the recreation area, the area remaining natural, access conditions, and distance between each site were measured. Site boundaries were identified to cover the location of key resources such as water body for waterfalls, trail body for nature trails, coral reef area for islands, etc., as well as to cover development area, and 100 meters of natural buffering from the key resources. A user survey was also conducted at each site. A total of 1,550 visitors completed the study questionnaires. Descriptions of each setting indicator were provided in the survey questionnaire. The survey participants were asked to subjectively evaluate recreation settings. Descriptive statistics, discriminant analysis, principal component analysis, and logistic regression analysis were used in the analysis. Opinions on recreation setting of visitors with post-graduate education were put together with the opinions of the research teams (Tanakanjana et al. 2006) and used to develop initial equations to classify the ROS for the sites.

Results

Site characteristics. The study found that the majority of the recreation sites were moderate-to-small in size. The average size of waterfalls was 6,375.57 square meters; rivers and lakes, 7,694,298.77 square meters; caves, 4,262.40 square meters; hot springs, 2,021.25 square meters; geomorphological sites, 94,401.30 square meters; scenic areas, 8,988.60 square meters; nature trails, 531,052.30 square meters; islands, 3,282,310.80 square meters; and beaches, 95,266.02 square meters. Most sites were preserved in their natural state; the average percentage for all types of recreation areas of areas without vegetative alteration and physical development was 85.59%. However, it was noticeable that changes in natural areas to accommodate recreational uses have been continued in many parks.

The access to most recreation sites is by dirt road, making the sites moderately easy to get to, particularly during the dry season (between November and April). The majority of the sites had a low level of remoteness and had a moderate-to-high level of opportunity for social encounters. The evidence of human impact found in most recreation sites was moderate, and litter was the most prominent impact. Though the natural basic characteristics of recreation resources within each type of recreation area were diverse, site management of most recreation areas was uniform and consistent. Basic facilities such as parking areas, walkways, interpretive signs, trash cans, toilets, etc., were provided to visitors at almost all sites. Most sites had visitor surveillance and control, and indirect control by interpretive programs, to moderate degree. However, there was no use limit at almost all sites surveyed. The similarity of site and user management caused challenges in maintaining recreation diversity to some degree.

Use characteristics. Results from the visitor survey found that the proportion of male and female users was almost equal. Their average age was 30 years and most of them completed a university degree program. Over 50% of them had prior experience in visiting the

Setting indicators	Indices and measurement
1. Access	Land-based site: 1) Road and trail access conditions, measured by air-photo interpretation and ground checked by GPS, focusing on the last 1,500 meters before getting to a key resource; then converting to 5-point rating scale: e.g., 5 = very rough hiking trail with >1,500 meters in length; 1 = very convenient road access all year round with <500 meters' walk to key resource Water-based site: 2) Distance from mainland to the site, e.g. 5 = >70 kilometers; 1 = <10 kilometers 3) Number of months per year that the site is accessible, e.g., 5 = <3 months; 1 = 12 months
2. Remoteness	4) Distance of the site from motorized area, measured by GPS, e.g., 5 = >10 kilometers; 1 < 1 kilometer 5) Visitors' perception of the remoteness of the site, using average rating score obtained from questionnaire; e.g., 5 = very remote and peaceful (score between 4.21–5.00); 1 = very noisy (score between 1.00–1.80)
3. Naturalness	6) Percentage of areas left in their natural state, measured by air-photo interpretation and ground checked with GPS, e.g., 5 = >95%; 1 = <80%
4. Opportunity for social encounters	7) Number of other visiting parties encountered within the site, obtained from questionnaire, e.g., 5 = <5 parties; 1 > 20 parties
5. Evidence of human impacts	8) Amount of litter found in activity area (piece per 10 square meters), e.g., 5 = < 2.0; 1 = >5.0 9) Amount of broken tree branches along the trail (point per 100 meters of trail length), e.g., 5 = <1; 1 = >6 10) Percentage of area covered with broken stalagmites and stalactites (as compared with the total area covered with stalagmites and stalactites), e.g., 5 = <5; 1 = >20 11) Amount of scars on trees (point per 100 meters of trail length), e.g., 5 = <1; 1 = >6 12) Visibility of soil erosion on trails (percentage per trail length in meters), e.g., 5 = <5; 1 = >20 13) Length of trail with exposed tree roots (percentage per trail length in meters), e.g., 5 = <5; 1 = >20 All indices were measured by direct observation.
6. Site management	14) Quantity and size of facilities within the site, measuring by direct observation at each site, e.g., 5 = only trial access provided; 1 = highly developed area with full facilities that can accommodate more than 100 people at a time
7. User management	15) Direct surveillance and control by staff, 3 = no control; 2 = sometimes or in some activity areas; 1 = all the time at all activity areas 16) Indirect control by interpretive programs, 3 = no interpretive program; 2 = interpretive program installed

Table 1. Recreation setting indicators, indices, and their measurement.

site in which they were surveyed. Most user groups were individual–mass tour groups with an average group size of ten people (mean = 10.49; SD = 12.83). Generally, the diversity in socio-demographic characteristics of visitors to national parks in Thailand was moderate-to-low. It was found that most park visitors engaged in more than one type of recreation activity. The average number of activities engaged in by each individual was 3.89. The top five activities in which visitors engaged were sight-seeing, relaxing, taking photos, picnicking, and playing in waterfalls. Most activities were general recreational activities that did not require the individual characteristics or the particular resources available at the particular site of recreation.

Recreation motivation or desired recreation experience was measured with a five-point rating scale on how important each motivational item is in visiting each site. It was found that the three motivating factors with the highest mean score were motivation for being with nature (mean = 4.31; SD = 0.71), motivation for escaping from crowds and noise (mean = 4.21; SD = 0.87), and motivation for experiencing the scenic beauty of the landscape (mean = 4.15; SD = 0.75). Discriminant analysis found that the mean scores of the 15 motivational items were significantly different among each type of recreation area. For only three items, including motivation in cultural learning, motivation in being independent, and motivation for safety was there no significant difference found. However, the overall correlation among each motivational item and type of recreation area was moderate (canonical correlation = .345; p-value <.001). There was not much difference in the motivation of people who visited each type of nature-base recreation area. Recreation motivation in this study accounted for 40.9% of variance in the users of each type of recreation area.

Principal component analysis was performed to group recreation motivation items into domains. It was found that the 15 items of motivation could be grouped into five domains. The first domain was motivation for physical development and self-reliance. The second domain was motivation for relaxing, escaping from crowds and noise, and finding solitude. The third domain was motivation for safety, comfort, and social bonding. The fourth domain was motivation for experiencing nature and learning. The last domain was motivation for escaping from one's daily routine, and cultural learning. The cumulative percent of variance for the five factors was 60.65%.

ROS classification. Logistic regression analysis was employed and result was taken to develop the ROS classification equation. The ROS equation was:

$$Y = 3.762 + 0.462X1 + 0.677X2 + 1.073X3 + 0.483X4 - 0.162X5 + 0.308X6 + 0.189X7 \quad (R^2 = 0.631)$$

Where Y = sum of recreation experiences to be gained from visiting recreation area in each ROS, and X1 = access, X2 = remoteness, X3 = naturalness, X4 = opportunity for social encounters, X5 = evidence of human impact, X6 = facilities and site management, and X7 = visitor management.

From the equation, factors that highly influenced the differences in opportunity class were naturalness, remoteness, and opportunity for social encounter, respectively. The ROS for recreation sites within Thailand's national parks in this study was classified into five classes primarily based on the results from recreation diversity analysis. The five ROS class-

Obtained recreation experience	MN	SPM	SPNM
Socializing, convenience, and comfort	71.95 (n=59)	54.66 (n=129)	31.96 (n=31)
Isolation, solitude, risk-taking, and self-reliance	28.05 (n=23)	45.34 (n=107)	68.04 (66)
Total	100.00 (n=82)	100.00 (n=236)	100.00 (n=97)

Chi-square = 30.053; df = 2; p-value <.001; n = 415
SPNM = semi-primitive non-motorized area; SPM = semi-primitive motorized area; MN = modified natural or rural area

Table 2. Relationship between recreation experiences and ROS of recreation areas.

es included primitive area (P); semi-primitive non-motorized area (SPNM); semi-primitive motorized area (SPM); modified natural or rural area (MN); and urban area (U). It was found that 35.17% of the recreation sites were SPM, 34.07% were SPNM, 18.68% were MN, 6.59% were U, and 5.49% were P. Finally, another user survey was conducted in order to test the consistency between normative recreation experience from visiting each opportunity class and the actual experience gained. Socializing, convenience, and comfort were specified as normative recreation experiences for more urbanized areas, while isolation, solitude, risk-taking, and self-reliance were specified as normative experiences for more primitive areas. A total of 415 recreation area users participated in the survey. The analysis found that 71.95% of people visiting MN sites obtained their normative experiences and 68.04% of those who visited SPNM did so, as presented in Table 2.

Conclusion

Findings from this study led to the conclusion that the ROS model moderately applies to Thailand's national parks. However, the study revealed that recreation diversity, the underlying concept of the ROS, has not been well maintained in the national park system. Most park managers did not pay enough attention to the diversity concept as previously discussed, causing the site management of most areas to be overly consistent and uniform. Another observation is that the majority of recreation sites were motorized, with control over uses and impacts generally less strict than in non-motorized areas. Maintaining resource quality thus becomes another challenge. Lastly, continuous change in natural areas to accommodate users and no use limits are the other challenges for recreation management in Thailand's national parks.

References

Ampolchan, J. 2001. Application of recreation opportunity spectrum in national parks: A case study of Krang Krachan National Park, Petchaburi and Prachuab Khiri Khan provinces. Master's thesis, Kasetsart University, Bangkok. (In Thai.)

Clark, R.M., and G.H. Stankey. 1979. *The Recreation Opportunity Spectrum: A Framework for Planning, Management and Research*. General Technical Report PNW-98. Portland, Ore.: U.S. Department of Agriculture–Forest Service Northwest Forest Experiment Station.

Emphandhu, D., S. Wannalert, and R. Ratchano. 2004. *Manual for ROS classification of Ecotourism Sites*. Bangkok: Tourism Authority of Thailand. (In Thai.)

Rachano, R. 2004. Application of GIS in classifying ecotourism opportunity classes in Obkhan watershed tourism network, Chiang Mai province. Master's thesis, Kasetsart University, Bangkok. (In Thai.)

Suriyachay, P. 2003. Analysis of users' desired experiences and preferences to classify recreation opportunity classes. Master's thesis, Kasetsart University, Bangkok. (In Thai.)

Tanakanjana, N., W. Arunpraparut, N. Pongpattananurak, R. Nuampukdee, and T. Chumsangsri. 2006. *A Final Report of the Project "Decision Support System for Sustainable Management Planning of Nature-Based Recreation Areas."* Bangkok: Kasetsart University. (In Thai.)

Tanakanjana, N., S. Chettamart, D. Emphandhu, N. Pitchakum, S. Singhavorawut, L. Termtrakul, and S. Rachkiri. 1998. *Manual for Ecotourism Facility Design and Development.* Bangkok: Aksorn Siam Publishing.

Multistage Research to Assist with Pricing the New Recreation Pass

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When Public Law 108-447 was signed on December 8, 2004, the U.S. Departments of Agriculture and the Interior were tasked with setting the price of a new annual pass for federal recreation lands. Effective January 2007, the new pass would offer entrance to recreational users on federal lands that charge an access fee, including but not limited to national forests, parks, monuments, wildlife refuges, etc.

In May 2005, the federal agencies issued a national call for scholarly assistance in examining possible prices for the new pass. In June, the University of Wyoming, through its Wyoming Survey & Analysis Center, submitted a project proposal. In July, the Wyoming research team was selected to provide the assistance, through a cooperative task agreement (no. H-200040001) under the Rocky Mountain Cooperative Ecosystems Studies Unit.

Designed to assist policy-makers in setting the price of the pass, the research consisted of five interrelated tasks: producing a working "road map" that was mutually negotiated among all parties; conducting a "benchmarking" study to compare federal recreation passes with passes for state parks and Parks Canada; conducting a study of the theoretical and methodological issues in the economics of non-market valuation; convening a series of focus groups across the country; and collecting and analyzing data from a nationwide telephone survey. Below we describe the tasks and summarize the major conclusions of each. Then we provide an overall view of the multistage research process, outlining how each task informed the others. Finally, major policy conclusions from the research process are presented.

The five tasks

Task 1 was to produce a "road map" detailing the steps for completing the remaining tasks. This document drew on the initial proposal and on communications with federal agency personnel, including a kick-off meeting in Washington, D.C. in August 2005. Members of the Wyoming research team also participated in a stakeholders' listening session in D.C. in September. The draft road map was reviewed by two external consultants internationally known in the field of environmental economics. The final road map provided the basis for a submission to the Office of Management and Budget (OMB) laying out the plan for the survey. Authorization to proceed with the survey was granted in February 2006.

Task 2 was a "benchmarking" study to compare existing federal passes with those for state park systems throughout the nation and for Parks Canada. Information obtained from the Internet and from published sources was supplemented by interviews conducted with representatives from selected state park systems, as well as Parks Canada. The states selected for intensive study were California, Florida, Massachusetts, Oregon, Texas, Utah, Virginia, and Wisconsin. For all of these states except Texas, interviews were conducted face-to-face. For Texas, we were able to interview a park representative by telephone. The benchmarking study reached the following findings:

- Adjusted for inflation, both the $65 Golden Eagle Passport and the $50 National Parks Pass were more than 10% cheaper in 2006 than they were when the latter was introduced in the year 2000.
- With pass purchasers averaging three or more entrances per year, these two existing passes provide a cost savings to multi-visit households and a revenue loss to federal land management agencies, relative to the typical gate fees for entrance that are forgone as a result of the passes.
- Parks Canada offers fewer recreational sites than the U.S. national park system, and far fewer than all federal land management agencies combined. Nevertheless, at about $140 per year in U.S. dollars, the Canadian pass costs more than double the price of the cheaper of the two existing U.S. annual passes.
- No state park system in the U.S. offers the number or variety of outdoor recreational venues available on federal lands, but eighteen states have annual passes priced equal to or greater than $50. California's state parks pass is the highest priced, at $125 per year.

Task 3 examined theoretical and methodological issues in the economics of non-market valuation. That effort informed both the road map document and a subsequent econometric examination of survey data. Both the theoretical and the empirical analyses received detailed external review by two internationally known environmental economists.

The theoretical analysis developed an economic model of willingness-to-pay to guide the use of standard non-market valuation methods, with the goal that a price for the new pass should be consistent with revenue-neutrality (relative to gate receipts in the absence of a pass program). Key points included:

- The price of the pass will affect not only revenues and visitation, but also educational goals as well as costs such as visitor congestion, air and water pollution, and damage to trails and roads.
- Setting a high price for the pass is more likely to maintain revenue neutrality; setting a low pass price may reduce gate revenues but could be desirable to increase visitation to federal recreation sites.
- The pass price can be adjusted upward to account in advance for future cost-of-living increases in gate fees, or for the anticipated costs of marketing and distribution.

A fundamental concern of any contingent valuation study is "hypothetical bias," since respondents tend to state willingness to pay values that are greater than those revealed in real-market interactions.

This project had a built-in opportunity to calibrate hypothetical willingness to pay with real choices, by taking advantage of the fact that the new pass is similar to the existing Golden Eagle Passport as already sold in the marketplace.

The focus groups **(Task 4)** served to identify themes and issues to be addressed quantitatively in the other phases of the study, and to pre-test the survey questionnaire. These discussions were held between September 11 and September 29, 2005 (under OMB approval no. 1024-0224) in Boston, Massachusetts; Richmond, Virginia; Portland, Oregon; Fresno, California; Madison, Wisconsin; and Salt Lake City, Utah. A preliminary group discussion had previously been held in Laramie, Wyoming. The focus groups also provided suggestive qualitative information on the following topics:

- Focus group participants valued federal lands as part of the American national identity.
- Focus group participants expressed concern over the fee structure for access to federal lands.
- Participants offered suggestions for improved marketing efforts, including better advertising, more places at which to purchase the pass, and more attractive pass options and benefits, such as a "fast-pass" lane for quick park access.

Their opinions about pricing the new pass varied widely, with some participants favoring a price no higher than the current passes, and others willing to pay a substantially higher amount if assured that the revenues would be used for "stewardship," to protect and enhance the nation's lands.

Throughout the discussions, focus group members' comments about forest service and park service personnel expressed high regard for the work done to preserve our public lands.

Task 5 was a national telephone survey conducted from February through April, 2006 (under OMB approval no. 1024-0248). A total of 3,773 households in two distinct sub-samples provided data. An internationally known expert on sampling was consulted on the design and analysis of the dual-frame sample. Of the households surveyed, 2,080 met the screening criteria for the main analysis, as determined by the sponsoring agencies (which limited the target population to households that had visited federal lands in the past two years and that would not qualify for either a Golden Age or a Golden Access Passport). Eligible households included 556 in a nationally representative sample (random digit dialing) and another 1,524 households in a probability sample from a list of telephone numbers of recent pass purchasers provided by the National Parks Foundation.

Development of the survey instrument incorporated input from the kick-off meeting in August, the stakeholders meeting in September, the benchmarking research, the theoretical and methodological issues identified in the economic analysis, and feedback from the focus groups. Once drafted, the questionnaire was thoroughly reviewed by the agencies, by the two external consultants, and by the Office of Management and Budget. Just before the full-scale survey interviewing began, another meeting with agency representatives was held at a National Park Service office in Fort Collins, Colorado, in February 2006. Results from a few days of pre-test interviewing were discussed, and the survey instrument was finalized.

Findings from the survey include:

- Households in the National Parks Foundation sample of recent pass purchasers tend to have higher socioeconomic status, travel farther and more often to visit federal lands, know more about existing passes, and express a higher willingness to pay for the pass than households in the random digit dialing sample.
- Households in the two samples engage in generally similar activities on federal lands.
- Reports of expected visitation and future pass purchasing from the National Parks Foundation households are more in line with their actual previous behaviors than is the case for the random digit dialing households.
- Both groups report being influenced by a combination of factors in their decisions about purchasing an annual pass, including economics, convenience, and stewardship.

Following the multistage research process

The use of several forms of research allowed each task to inform the others. For example, the sponsoring agencies specified that the survey (Task 5) should include current pass holders as well as non-pass holders. However, the benchmarking (Task 2) revealed a low rate of pass sales nationally, suggesting that a broadly representative sample would yield relatively few pass-holding households. The random digit dialing sample was therefore augmented by a sample drawn randomly from a list of U.S. telephone numbers recorded by the National Parks Foundation as having purchased a National Parks Pass between April 2004 and March 2005 (i.e., one to two years prior to the survey).

During focus group conversations (Task 4), a number of participants who expressed life-time interest in public lands were not pass-holders at the time, and some had not visited federal lands in the preceding twelve months. Therefore, it was decided that the target population for the survey (Task 5) would consist of households that had visited federal recreational lands in the past two years, a time frame longer than in some other surveys of public land users.

In Task 3 (on theoretical and methodological issues), the research team studied the relevant issues in the economics of environmental valuation. Analysis of the literature, along with input from outside consultants, suggested what questions needed to be included in the survey to support a contingent valuation analysis of the price of the new recreation pass (Task 5).

The benchmarking (Task 2) and the focus groups (Task 4) examined the pricing of passes to state parks, as well as what individuals said they thought a recreational pass for federal public lands would be worth. In the focus groups, the prices mentioned ranged from participants who thought the pass would be a bargain at $300 to those who thought it should be a free benefit of paying taxes. This type of information augmented other methodological considerations to provide the upper and lower boundaries on the contingent valuation questions for the questionnaire (Task 5). The entire bid vector addressed in the survey contained twenty separate bid prices, beginning with $0 and ranging up to $325.

Respondents were asked an initial bid price and a follow-up bid price, the amount of which depended upon a “yes” or “no” to the first bid. Respondents who said “no” to both the initial bid price and the second, lower bid amount were then asked whether they would be interested in the pass for free. Doing so identified potential "protest" bidders who may have an objection in principle to the pass, to the current management practices on federal lands, or the like. Those who would reject the pass even if it were free were asked why, to determine the nature of their objection. The focus group (Task 4) discussions as well as the relevant literature (Task 3) had revealed this possibility and therefore follow-up questions were prepared for the questionnaire (Task 4) so that protest bidders could be analyzed separately. Protest bidders defined themselves out of the potential market for the pass, and needed to be identified so that their refusal to take the pass at any bid price, even zero, did not distort the estimated demand curve for the final analysis.

Major policy conclusions

Econometric analyses of the survey data yielded the following conclusions:

- Willingness to pay for the new pass was significantly related to factors such as a desire that pass revenues be used for maintenance and services on federal recreation sites, number of typical visits, household income, race, gender, and region.
- Statistically, the predictive power of the econometric model was modest; therefore, revenue projections were generated from the raw data as well as from the model.
- Calibrated for hypothetical bias, pass revenues could be maximized at a price in the range of $35 to $60, but such a pass price would likely result in substantial forgone gate revenues.

Assuming that gate entrance fees were to remain at their current level and that households primarily purchase the pass to save money at the gate, the calibrated raw data from either sample indicate that a pass price of $100 to $125 (or higher) should come close to revenue neutrality.

Balancing the considerations of revenue-neutrality and high visitation, federal policymakers have set the initial price of the new pass at $80.

Additional details about the new pass, including our full reports on the various components of the research, are available on the website of the U.S. Department of the Interior, at www.doi.gov/initiatives/recreation_feeprogram.html.

Sensing the Parks: The Importance of Sound, Smell, and Touch to Visitor Experience at Rocky Mountain National Park

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Background

The Wyoming Survey and Analysis Center (WYSAC) recently conducted a study of visitor satisfaction along the eastern boundary of Rocky Mountain National Park (RMNP or "Rocky"). This area is known as the Highway 7 corridor, because Colorado Highway 7 travels from Denver (only two hours southeast) up to the park's several entrances. With a population of 2.5 million in the Denver metropolitan area, the human impact on the eastern side of the park is considerable. Douglas and Weld counties, two of Denver's metropolitan counties, grew by 50.0% and 31.9%, respectively, from 2000 to 2006 (U.S. Census Bureau 2007). Moreover, Longs Peak, the only 14,000 foot peak in the park (and a non-technical climb), is primarily accessed from Highway 7. The number of hikers, as well as climbers, visiting this peak is increasing, causing congestion along the trail, and possibly degrading the visitor experience.

To explore the various aspects of the visitor experience in the park, a questionnaire was developed, with review by Park Service personnel. In addition to questions on satisfaction with visitor resources, questions were also asked regarding what visitors expected to experience via their senses while at RMNP, the number and length of visits to the park, and demographic information such as age, education, and ethnicity (WYSAC 2006).

Experiencing the senses

The National Park Service (NPS) operates under a continuing dilemma. It must both "conserve the scenery and the natural and historic objects and the wild life" within the national parks and at the same time "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" (National Park Service Act of 1916; see also Winks 1997). This dilemma is highlighted by at least three factors. First, the increasing U.S. population, especially in areas neighboring on park service land, means that open space is becoming scarce. Indeed when the Park Service was created in 1916, the U.S. population was only 101 million. In 2006, the U.S. population has grown to 298 million. Can a park that was visited by 52,000 people in 1915 (e.g., Yellowstone) provide the same experience as when visited by three million people in 2007? (See Manning and More 2002.)

Second, as we move further in time from our own historical experience of the "frontier," the desire to retain as much of the natural settings within the parks may also increase (Stegner 1960). Many of the western parks especially provide an experience for their visitors of the western landscape before European settlement and transformation. The idea of westward expansion and the icon of the frontiersman are important in the mythology and ideology of the American experience, especially as it contributes to our modern identities.

Finally, increasing demands for services and access, such as river boat tours and alpine trails, may degrade the wildlife and the space they occupy, as well as infringe on natural and archeological sites. As the NPS provides more access and services, some "taken for granted" resources are noticed just as they seem to be missing. These resources include the sound of the wilderness, the smell of the land, the dark night sky, and the sight of wildlife moving in forests The recognition that the sights, smells, and sounds of the land are changing has led the Park Service to consider whether the sights, smells and sounds of nature are as much a part of the parks' resources as artifacts, geological formations, and the flora and fauna.

Administering the questionnaire

Along the eastern border of RMNP and the Highway 7 corridor are three major entry points to the park. From north to south they are Lily Lake, Longs Peak, and Wild Basin. Lily Lake is directly on the highway and has a lake with trails on its western side; on the eastern side of the highway it has a visitor center open only seasonally; and a trail to Twin Sisters Peak (11,288 ft). The Longs Peak trailhead and campground are approximately one mile off the highway, and access is by a narrow steep road which passes a residential area and a music camp. Finally, Wild Basin entry is by dirt road from the highway, and has a ranger hut and kiosk about one and one-half miles into the area.

From October 2004 to October 2005, both volunteer and paid interviewers were stationed at either the parking lots or the trailheads into the areas. At Wild Basin during the winter, interviewers were encouraged to station themselves at the warming hut approximately one-half mile from the parking lot. The interviewers followed a schedule constructed by random drawing of times and days for each week, and were given instructions as to how to vary interviewee selection by gender, ethnicity and age, and the spacing of the visitors as they finished their hike or were returning to the parking lot. The interviewing took place face-to-face 2–3 times per week, in one of three time slots: 7–11 AM, 11–3 PM, and 3–7 PM. These times were compressed for the winter months, from 8 AM to 5 PM, but the interviewing continued for twelve full months. One interviewer even completed three interviews at Longs Peak on New Year's Day. Approximately 1,371 visitors to RMNP were contacted for interviews, and 1,283 visitors completed the face-to-face interviews, yielding a completion rate of 93%.

The visitors to Rocky were asked a series of questions that focused on their satisfaction with park resources, including: roads into the areas, information about the park, parking, water, toilets, campgrounds, safety, and availability of personnel. There were 21 such questions total. Visitors were asked to rate their satisfaction with these resource items from "very dissatisfied" (scored 1) to "very satisfied" (scored 5). These items were then factor analyzed using SPSS software to determine the underlying dimensions of satisfaction with park resources. The reliability analyses suggested three dimensions to the resource variables. These included: satisfaction with park information, satisfaction with frontcountry park resources, and satisfaction with backcountry resources. The park information factor tapped those items regarding information about the park and activities within the park including: information kiosks, availability of park personnel, and park programs. The frontcountry satisfaction factor was composed of questions regarding resources visitors used for short day trips: satisfaction with the roads into the area, parking, pedestrian safety in parking lots, picnic areas and facilities, restrooms, facilities for the disabled. Finally, the backcountry factor captured those items which were connected to longer hikes in the backcountry, either as starting points or as items dealing with the trails themselves and include: scenic road pull-offs, trail signs, developed trails, backcountry toilets, and water availability for hikers.

The items for each of these three scales were subjected to a statistical test known as Cronbach's alpha. This measure, which varies from 0 to 1.0, assesses the extent to which the items are enough like each other to be used together in a scale. For the three scales, park information, frontcountry, and backcountry, the alpha level was .60, .64, and .62, respectively. These measures are considerably above the .5 mark which is generally recognized as a minimum alpha measure.

Investigating the importance of the senses

We report here the results of three questions on measuring the sense of smell, touch, and, especially, sound. The questions were stated as follows: "When you came to the park today, did you come with the expectation that you would notice the (smells, sounds, touch) of nature?" As further explanation, interviewers could prompt the respondents with comments such as: "that you could smell the trees or flowers"; "that you could hear birds or elk"; "that you could dip your feet into a stream or feel the snow crunch." The answers on the expectation questions ranged from "Yes, I had hoped to" (scored 5 for analysis) to "No, and it doesn't interest me even now" (scored 1).

First we provide an examination of the univariate distribution of expectations for smell, sound, and touch in Table 1.

Not surprisingly, most of the respondents had expected to smell and hear the life in the park. However, with respect to touch, visitors apparently had not anticipated the feel of nature. In casual conversations with respondents and other visitors, two comments prevailed regarding water and tree moss. Visitors reported that the stream water was colder than they had expected; and that the moss was "spongy" or rubbery.

A higher percentage of visitors expected to hear the park than to smell or touch the park. This is consistent with studies which report that smell has become an underutilized sense

Table 1. Distributions of responses to "When you came to the park today, did you come with the expectation that you would notice the (sounds, smells, touch) of nature?"

Responses (N=1264)	% Responding for each value of: Smell	Sound	Touch
Yes, I was looking forward to it	75.6	86.0	39.2
Yes, and I was still surprised by it	3.7	3.8	4.0
Had not really thought about it	17.1	7.9	28.5
No, and I was completely surprised by it	2.1	1.7	21.8
No, and I don't find it interesting even now	1.5	0.6	6.5

for humans in comparison to sight and sound (Porter et al. 2006). Moreover, when we computed a difference of means tests we found that the percent who responded that they were expecting to experience the park through sound was significantly different from the percent who expected to experience the park through smell or touch. The percent who expected to experience the park through touch was significantly different from the percent who expected to experience the park through smell or sound. And finally, the percent who expected to experience the park through smell was significantly different than the percent who expected to experience the park through sound or touch. This means that the percentages are tapping different expectations on the part of the park visitors.

That hearing the sounds of the park was expected by 86% of the visitors suggests how important the soundscape is to park visitors, and supports the initiative of the NPS to retain natural soundscapes wherever possible. Nearly 90% of the visitors expected to hear the sounds of the park. Comments on specific sounds mentioned included the wind in the trees (77.9%), the sound of streams (75.4%), the bird songs (74.1%), bugling elk (44.5%), coyote calls (34.7%), rain against the sides of a tent (26.7%), silence (23.9%), and the sounds of horses on the trails (15.7%).

As a further exploration of the role of sound in the visitor experience, we regressed the expectation of hearing the sounds of the park onto a number of predictor variables which could have an effect of one's desire to hear the park. These predictor variables include demographic characteristics: gender, education, ethnicity, and age. Also included were variables related to the other senses: the smell of the park, touch the park, and how crowded their experience of the park. Finally, we included whether the visitor had paid some type of access fee, and how many times the visitor had been to the park in the past year. The results are presented below in Table 2.

The regression analysis suggests that the typical variables important in social science research have no discernable effect on expectation to hear the park. Gender, education, eth-

Table 2. Regression of "hearing the sounds of the park," with predictor variables.

Predictor Variables	Unstandardized Coefficient (B)	Significance Level
Gender	.015	.769
Education	.007	.566
Ethnicity	–.070	.494
Age	.001	.509
Notice the smell	.232***	.000
Touch	.051*	.039
Number of trips	.012**	.010
Paid entrance fee	.157**	
R	.359	

* Statistically significant at the p<.05 level
** Statistically significant at the p<.01 level
*** Statistically significant at the p<.001 level

nicity, and age were not significantly related to the expectation of hearing the sounds of the park. This suggests that sounds in the park are equally important across age, gender, and ethnic groups. The two sets of variables which were statistically related to hearing the sounds were the other sense variables and the measures of importance of the park to the visitor.

Those who expect to hear the sounds of the park may be more likely to equally expect to experience other senses in visiting the parks. The significance levels of .001 and .05 indicate that we would find the relationship of smell and sound in 999 of 1,000 times we measured. For touch, we would find this relationship in 19 times of 20 in which we measured.

Finally, the number of trips to the park in the past year, and whether the visitor had paid some type of entrance fee, were both significantly related to the expectation of hearing the sounds of the park. The more trips a visitor had made to the park in the past year, the more likely that individual was expecting to hear the sounds of the park. And the payment of an entrance fee was also positively related to the expectation of hearing the sounds of the park ($p<.003$). This may suggest that for those visitors for whom the park is worth paying the entrance fee, even though they were at sites which were seldom monitored for entrance fee payment, part of the reason to come to the park was to hear the sounds of nature.

References

Manning, R., and T. More. 2002. Recreational values of public parks. *The George Wright Forum* 19:2, 21–30.

Porter, J., B. Craven, R.M. Khan, S.J. Chang, I. Kang, B. Judkewicz, J. Volpe, G. Settles, and N. Sobel. 2006. Mechanisms of scent tracking in humans. *Nature Neuroscience* 10, 27–29.

Stegner, W. 1960. "Wilderness letter," written to the Outdoor Recreation Resources Review Commission. Reprinted as "Wilderness idea," in *The Sound of Mountain Water*. New York: Doubleday (1969).

U.S. Census Bureau. 2007. Table 8: Population estimates for the 100 fastest growing U.S. Counties with 10,000 or more population in 2006: April 1, 2000 to July 1, 2006 (CO-EST2006-08) Population Division. (Release date: March 20, 2007.)

Winks, R.W. 1997. The National Park Service Act of 1916: "A contradictory mandate"? *Denver University Law Review* 74, 575–623. On-line at nature.nps.gov.winks/index.htm.

WYSAC [Wyoming Survey and Analysis Center]. 2006. *Visitor Satisfaction along the Highway 7 Corridor to Rocky Mountain National Park: Final Report to Rocky Mountain National Park*. Technical Report no. SRC-607. Laramie, Wyo.: WYSAC.

Drawing a Line in the Tundra: Conservationists and the Mount McKinley Park Road

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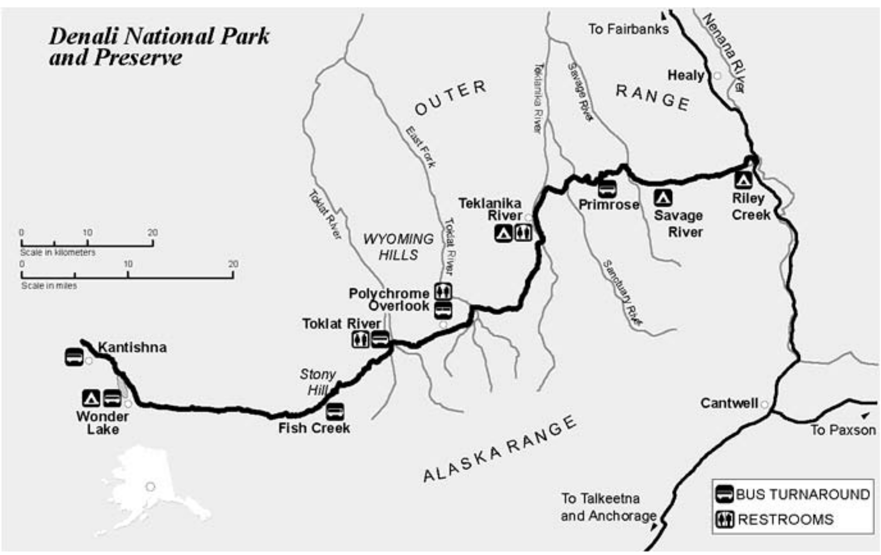
Today, Denali National Park and Preserve is one of the largest units in the national park system. The entire unit encompasses about 6.1 million acres, of which a little over three-quarters (4.7 million acres) are national park, with the remainder being a national preserve, where sport hunting is allowed. About 425,000 people visited Denali in 2006. Most of them arrived at the park's eastern entrance and boarded either a tour bus or shuttle bus and headed down the park road in search of one of the "big five" wildlife species that inhabit the area (mountain sheep, caribou, grizzly bear, moose, and wolf), along with great views of Mount McKinley (Figure 1) and the chance to enjoy a series of remarkable wilderness landscapes. Many others, however, enjoy the park's backcountry on hiking and backcountry trips; more than a thousand people every year try climbing Mount McKinley or one of the other high Alaska Range peaks; and a number of local residents take advantage of the park's subsistence hunting opportunities.

Figure 1. Mount McKinley (elevation 20,320 feet) is North America's highest peak. Charles Ott photo, DENA 3557, Denali National Park and Preserve Museum Collection.

As many of you know, large mammal species don't mix well with large numbers of people, and a major management theme that has concerned Park Service officials over the past 40 years has been, "How can we provide interpretive opportunities to the visiting public without jeopardizing the remarkable wildlife resources that brought about the establishment of the national park in the first place?" A short answer to that question has been the establishment of a road management philosophy and incorporates a three-part, telescoping degree of access and use. Briefly stated, park officials allow unlimited use of the park road from the Parks Highway junction 15 miles west to the Savage River Bridge; restricted use, and some private camping vehicles, for the next 16 miles west to the Teklanika River Bridge; and restricted use, with almost no private vehicles allowed, for the remaining 59 miles of the park road (Figure 2). The condition of the park road, moreover, reflects the usage allowances: its first 15 miles of the park is paved, 24 feet wide, and in full conformity to federal primary road standards; the next 16 miles is graded dirt, still 24 feet wide, and less conforming to federal standards; and the last 59 miles is graded dirt, just 20 feet wide and even less conforming to federal highway standards. Today, both Park Service officials and visitors recognize the necessity for this telescoping road system, because biologists, through repeated studies, have long known that rationalizing private vehicle traffic is a key to maintaining healthy wildlife populations. Creating this three-part road system hearkens back to a series of events from the 1950s and 1960s that pitted conservationists against road builders, with Park Service officials caught in the middle.

To understand why today's road looks the way it does, we need to go all the way back to 1916, when various bills were being proposed for a Mount McKinley National Park. Charles Sheldon, a gentleman hunter who had made two extended trips to the high valleys

Figure 2. The status of the park road—90 miles long between the McKinley Park railroad depot to Kantishna—was the subject of lively debate during the 1950s and 1960s. National Park Service, Denali National Park and Preserve Collection.



just north of the Alaska Range, recognized that the area held some of the best mountain sheep habitat in North America; that habitat, however, was under attack because of the government railroad that was then under construction between Anchorage and Fairbanks. Sheldon did everything he could to protect the area, and the bill that finally passed Congress called for the "preservation of animals, birds, and fish."[1] Sheldon, however, was just as interested in attracting visitors, and in his mind, a key to the park was "a comfortable lodge at the foot of Peters Glacier." This site was very close to Mount McKinley, but to reach it by road, it was more than 90 miles from the Alaska Railroad.[2]

As soon as Congress began providing operating funds for the park, National Park Service officials recognized the need for a park road and began working with Alaska Road Commission (ARC) officials on the best route. The park's first superintendent, Harry Karstens, agreed with Sheldon's ideas and pushed for a road that would connect the park headquarters with the foot of Peters Glacier. But ARC officials were far more interested in building the road farther north, with the final destination being the Kantishna mining camp, 90 miles away from park headquarters and just north of the park boundary. The Park Service, which was paying for the road, knew that it needed the ARC's cooperation in the matter—road commission employees, after all, would actually be building the road—so NPS officials agreed on Kantishna as a destination *if* they could design the road according to NPS standards.[3]

So in 1923, the ARC began constructing the road. The commission built it in stages—3 miles one year, 8 miles the next—and the road didn't reach Kantishna until 1938.[4] I hasten to add that throughout the 1920s and 1930s virtually everyone—Alaska officials, the NPS bureaucracy, and Kantishna miners—supported the construction of the road. The road was broadly supported because the NPS knew that a road was necessary to make the park accessible to visitors, and also because *no one* saw the road as a real or potential ecological threat. Alaska Territory, attracted fewer than 30,000 outside tourists each summer.[5] And Mount McKinley National Park, located 250 miles away from the nearest steamship port and accessible only by train, saw only a few hundred visitors each year. This scarcity of tourists was due, in part, to the fact that the only available park accommodation was a small, rustic concessioner's camp at Savage River. To raise the level of amenities, federal authorities in 1939 opened the 98-room McKinley Park Hotel near the railroad station. But even in the first few years after it opened, park visitation did not exceed 2,500 people per year.[6]

In the 1940s, however, the park's popularity began to multiply, and by the early 1950s the park was attracting up to 8,000 visitors per year. And key to future growth was the Alaska Road Commission's decision to construct a 150-mile-long-highway that would tie the park road to the Territory's road network. That road, called the Denali Highway, was completed in August 1957—and by 1959, more than 25,000 visitors per year were coming to Mount McKinley National Park, many of whom arrived in their station wagons and stayed over at one of the park's seven campgrounds. The era of "rubber-tired tourism" was in full swing (Figure 3).

Throughout the 1940s and 1950s, the 90-mile-long park road continued to be the same, 20-foot-wide gravel road that the Alaska Road Commission had completed in 1938. But the park's Mission 66 program, proposed in 1956 and approved in 1957, called for the

Figure 3. During the "rubber-tired tourism" era (1957 to 1971), thousands of tourists drove out the park road and overnighted in one of the park's seven campgrounds. Bob and Ira Spring photo, courtesy of Wallace A. Cole Collection, Camp Denali.

road to be widened and paved, and for guard rails and striping to be added. So the NPS authorized the Bureau of Public Roads (BPR), which was the successor to the Alaska Road Commission, to start a program to widen and reconstruct the park road. Construction began in 1958 near the park hotel, and by August of 1962 the agency had worked its way to Mile 26 of the park road, about 5 miles shy of the Teklanika River.[7]

Not everyone who witnessed the road construction was pleased by its progress. In 1956, for example, park biologist Adolph Murie railed against any developments that might downgrade the prevailing "purity of wilderness atmosphere" in the park.[8] Two years later, Murie and other conservationists loudly protested against Eielson Visitor Center at Mile 66, which was then under construction, because it did not blend into the tundra landscape; they derided it as a "monstrosity" and a "Dairy Queen." In the fall of 1959, Adolph's brother Olaus Murie, who was a National Parks Association board member, spoke out against the road; he warned that "the national park will not serve its purpose if we encourage the visitor to hurry as fast as possible for a mere glimpse of scenery from a car, and a few snapshots." But the Park Service's regional director concluded that "the road must be widened to minimum safety standards" as far as Eielson Visitor Center. And in Washington, Assistant Director A. Clark Stratton agreed with the regional director; he stated that "we have been forced … by increased use to improve the substandard existing Park road to make it safe for today's travel needs."[9]

Murie and his fellow conservationists were not pleased by the Park Service's response, so in the spring of 1963 *National Parks Magazine* published an entire issue devoted to Mount McKinley. In several short articles, they criticized the new "speedway" that encouraged visitors to "get in and get out fast," and they further stated that they were violating the park's Mission 66 planning guidelines, which called on visitors to "savor their park and get full enjoyment and inspiration." These criticisms apparently made an impression because Stratton, in June 1963, wrote to Director Conrad Wirth and suggested that the agency adopt "telescoping standards" for the road: 26 miles of a 20-foot roadway with 3-foot shoulders, 40 additional miles of a 20-foot roadway with "minimum shoulders" that would be anywhere from nothing to three feet wide; and the final 18 miles with no new improvements. That letter, however, never got beyond the concept stage, because in August 1965 the NPS contracted with a Fairbanks firm to widen five more miles of road, from Mile 26 to the Teklanika River Bridge. This work was to be carried out in the spring and summer of 1966. Meanwhile, the Bureau of Public Roads was pressuring the NPS to take on even more construction; it stated that the next 12 miles of road was currently "unsafe for general public use," and it recommended a $1.2 million construction job. NPS officials agreed, stating that the job was a Priority 1 request.[10]

Conservationists, however, refused to give up. In the July 1965 issue of *National Parks Magazine*, Adolph Murie, who had just retired from federal service, wrote a pointed article about the controversy. Given his 20-plus years of experience at the park, he stated that most visitors liked the "charm" of the old road and that many observers—including even a few BPR officials—felt that overzealous engineering standards were being applied. He urged readers to register their protests with NPS officials; otherwise, road widening would continue almost all the way to Kantishna.[11]

Murie's article hit home. Conservationists *did* send in protest letters, and in response, NPS officials at both the regional and Washington levels engaged in a flurry of intra-agency correspondence. By the end of September 1965, a new policy had emerged. Assistant Director Johannes Jensen, speaking for the agency, defended the NPS's past actions; he stated that it had long been the agency's goal to provide road access "with as little impact on the natural scene as possible," and that "conditions of permafrost" had demanded improvements to portions of the old right-of-way. For the future, however, he stated that "it is our intention to use progressively lower standards the farther the road penetrates into the wilderness. Beyond [the Teklanika River Bridge], the remainder of the road is to receive only minor repairs."[12]

Conservationists had clearly won a victory. It remained to be seen, however, if it would last, because by late 1965, another threat had emerged on the horizon. A new, direct highway was being built between Anchorage and Fairbanks, and given its easier access to the park, conservationists were worried that a new wave of park visitation would completely upset the status quo. Knowing that the new highway would be completed in 1970 or 1971, conservationists were not pleased by the NPS's public statements on the subject, because all that the agency could promise was that it would hold back on new park road construction projects only until the Anchorage–Fairbanks highway had been completed.[13]

The NPS, in fact, issued no further statements on the issue until the road was completed in October 1971. Then, just three months later, Park Service Director George Hartzog

(Figure 4) clearly made the agency's position known in an interview for the magazine *U.S. News and World Report*. The road, he stated, would not be improved; instead, he planned to manage the new waves of visitors by limiting private vehicle traffic west of the Savage River Campground and by instituting a free shuttle bus system—similar to the one recently begun at Yosemite—that would take visitors down the park road. The new system proved controversial, particularly to Alaska residents. The system, however, was implemented as scheduled on June 1, 1972, and the various shuttle buses, along with the concessioner's tour buses, became the primary ways in which visitors saw the wonders of Mount McKinley National Park.[14]

Figure 4. NPS Director George Hartzog played a major role in the implementation of the park's shuttle system. National Park Service photo.

Eight years later, the passage of the Alaska National Interest Lands Conservation Act (ANILCA) brought forth Denali National Park and Preserve, which was three times the size of the "old park." Visitation patterns, however, didn't change much after the law was passed, and even today, most visitors arrive at the park's eastern entrance and take a bus down the park road. Park Service officials now recognize that providing public access via the road corridor will always be a management challenge. But today's management system provides a healthy balance between visitor access and ecological integrity, a balance that surely would have been threatened if conservationists during the 1960s, and George Hartzog in 1972, had not stepped forward and drawn a line in the tundra.

Endnotes

1. Section 5 of park act, signed by President Woodrow Wilson February 26, 1917, in *U.S. Statutes at Large* 39, 938.
2. Charles Sheldon, *The Wilderness of Denali: Explorations of a Hunter–Naturalist in Northern Alaska* (New York: Charles Scribner's Sons,1930), 272.
3. Frank Norris, *Crown Jewel of the North: An Administrative History of Denali National Park and Preserve,* Volume 1 (Anchorage: NPS, 2006), *33–35*.
4. Ibid., 293 (Appendix F).
5. Norris, "Touring Alaska," *Alaska History* 2 (Fall 1987), 276; Alaska Department of Labor, *Alaska Population Overview, 1990 Census and Estimates*, Table 1.3, 19.
6. Norris, *Crown Jewel of the North*, 283 (Appendix B).
7. Ibid., 169–170.
8. Adolph Murie, "Comments on Mission 66 Plans, and on Policies Pertaining to Mount

McKinley National Park" (November 8, 1956), 7, from "H14 Historical Notes, 1964–70" folder, Box 7, ARCC-00183, NPS Alaska Regional Office, Anchorage.
9. Norris, *Crown Jewel of the North*, 170.
10. Ibid., 170–171.
11. Ibid., 171.
12. Ibid., 172–173.
13. Ibid., 173.
14. Ibid., 219–221.

Cultivating a Community-Based Approach to Restoration of the Cache River Wetlands in Southern Illinois

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Natural resource conservation agencies and organizations are increasingly taking advantage of opportunities to build partnerships between the public, private, and community sectors. The benefits of collaborative natural resource management—increased social justice (Smith and McDonough 2001), better conflict resolution (Lachapelle and McCool 2005), and ecosystem-scale conservation (Grumbine 1994)—have been touted by researchers, practitioners, and citizens alike. While community-based partnerships are essential to effective and sustainable environmental management, clear direction for agencies on how to cultivate these partnerships is lacking. This study used a qualitative methodological approach to (1) develop a community stakeholder typology, (2) identify constraints to and opportunities for community-based partnerships in a watershed-scale restoration project, and (3) develop outreach recommendations tailored to each stakeholder group.

Large tracts in the Cache River watershed in southern Illinois were cleared and converted to agricultural production from the early 1900s through the 1970s (Kruse and Groninger 2003). The resulting deforestation, flooding and sedimentation of the Cache River, and decline in waterfowl migration to the area inspired local citizens to organize and advocate for wetlands protection and restoration. Grassroots conservation efforts propelled the establishment of the Cache River Joint Venture Partnership (JVP) in 1991, a restoration cooperative of the U.S. Fish and Wildlife Service, Illinois Department of Natural Resources (IDNR), The Nature Conservancy, Ducks Unlimited, and, later, the Natural Resources Conservation Service. The Cache River wetlands complex was identified as a Wetland of International Importance by the Ramsar Convention of the United Nations Educational, Scientific and Cultural Organization in 1994, largely because of the area's ecological significance for migratory waterfowl (Ramsar Secretariat 1994). The primary goal of the JVP is to protect and restore a 60,000-acre forest and wetland corridor along the Cache River, which encompasses both public and private lands.

Methods

In-depth personal interviews were conducted from September 2006 through February 2007 with 25 residents of the five counties encompassing the Cache River. A purposive and heterogeneity sampling strategy was employed to identify and gain access to different interest group representatives or information-rich "community gatekeepers" (Marshall and Rossman 1999). A variety of community members were interviewed, representing a wide range of interests, including local government officials, environmental advocacy group members, tourism operators, economic development agency staff, educators, and farm and agricultural advocates.

Once an initial set of key informants was identified, a snowball or chain-referral sampling technique was used to broaden the participant pool. Interviews were conducted following an interview guide and were audio-recorded and transcribed. Data analysis followed Strauss and Corbin's (1990) strategies for data reduction, organization, interpretation, and verification. To ensure credibility and confirmability (Marshall and Rossman 1999), an iterative analysis process, substantiated by a team of researchers, was adopted.

Results

Data analysis revealed that study participants attach a wide variety of meanings to the wetlands and hold diverse attitudes toward restoration and in particular, the JVP. Three stakeholder types: advocates, generalists, and skeptics emerged through the analysis of four characteristics: (1) awareness of the JVP and its restoration initiatives; (2) involvement with restoration; (3) meanings ascribed to the Cache River wetlands, and (4) attitudes toward restoration and the JVP.

Below, the stakeholder typology is presented first, followed by findings associated with barriers to and opportunities for community-based partnerships in restoration.

Advocates. Nine of the 25 participants were classified as "advocates." They represent three broad community interests: (1) environmental advocacy; (2) nature-based tourism; and (3) landowners and agriculture. Advocates described both high levels of awareness of and extensive past involvement in restoration initiatives, attributed primarily to public meetings, volunteer programs, and personal interaction with JVP staff. Participants in this group exhibited the most favorable attitudes toward restoration, often linked to the need to preserve and restore rare wetlands habitat: "The southern Illinois landscape, while it is very unique and very diverse, is incredibly fragmented on a forest aspect. And when you get to the wetlands all you have to do is look at the history of what was done to our wetlands."

These stakeholders expressed meanings for the Cache River Wetlands associated with the ecological and inspirational significance of the area. For instance, one participant compared the wetlands to "forest cathedrals." He continued, "I can't think of a place more like that than Heron Pond. It just has that very dramatic feel to it. It is really a unique place and it just draws me." Above all, however, this group emphasized ecological significance of the Cache River Wetlands:

> I have been to the Okefenokee, to the Cache River over in Arkansas. And everyone brags about their trees and their swamp. But the Cache, our Cache, the Cache River has as much to offer as any of those places. Maybe not as big … but it is a unique little spot on the planet.

Advocates expressed great trust in local natural resource managers and the JVP in particular. Their trust was attributed primarily to personal relationships with JVP staff. Participation in environmental planning efforts was both a source of information and medium for interaction with local managers.

Generalists. Ten of the 25 participants were classified as "generalists." They represented several community interests, including (1) regional, county, and municipal government; (2) tourism and economic development; (3) education, and (4) business. Generalists exhibited the least awareness of and past involvement in Cache River wetlands restoration initiatives. When asked how familiar she was with JVP's restoration initiatives, a participant responded, "Not familiar at all." Another participant described her familiarity with the JVP: "I know that they are here."

The meanings generalists ascribed to the Cache River wetlands were largely associated with economic development or as one participant put it, "economic revitalization." However, several participants also noted the impact of the wetlands on the quality of life in the area. Recreation opportunities and aesthetics were highlighted:

> It gives our citizens an opportunity that they don't have to travel so far for canoeing. People like canoeing; there is a place to go. People like bird watching; there is a place to go. They don't have to travel to do those sorts of things.

Generalists exhibited positive attitudes toward the restoration of the Cache River wetlands, yet little initiative for personal involvement in JVP programs. These stakeholders also described moderate levels of trust in local natural resource managers, despite being largely unaware of what managers were doing. When asked how much he trusts local natural resource managers, one local community member replied, "I am moderately trusting."

Skeptics. Six of the 25 participants were classified as "skeptics." They represented three primary community interests: (1) environmental advocacy; (2) regional, county, and municipal government; and (3) landowners and agriculture. Skeptics described extensive past involvement in Cache River wetlands restoration activities. Like the advocates, personal involvement in environmental planning processes was a primary source of information. However, civic science and the exchange of traditional knowledge throughout community organizations were additional sources of information that were generally perceived as more reliable.

Skeptics often expressed meanings for the Cache River wetlands linked to its ecosystem functions, primarily around water retention and associated agricultural drainage. Big hardwood trees have important meaning to some skeptics:

> I think of big cypress trees in real thin water, and seeing certain wildlife like maybe a cottonmouth or a rattlesnake or water birds. But now I see the dead and dying hardwood trees and the duckweed and I know. I have a general idea about what that means so it's not all good.

Skeptics were generally supportive of the idea of restoration, but were distrustful of the JVP, its restoration targets, and programs. One participant questioned current water levels and the impacts on public and private land:

> They are sticking to the pool stage being 328.4 … meaning that they are content to kill the rest of those trees, not only on private land but on public land. Hey, I have reported three separate times the oak trees in the Section 8 Woods is being impounded by water. The beavers have shut up all of the drainage ditches.… Nobody does nothing.

Several skeptics were concerned about the JVP's restoration targets and intimated they believed the JVP may intend to flood the entire Cache River Valley. This sentiment was summarized by one participant:

> Go down to the end of my road … you will see a sign that says reforested in 1997 with native hardwoods. Look and see what the majority of the trees is behind that sign. It's cypress trees. Why would they put cypress trees? They are going to be above that swamp. Right out here is the same thing. The trees in the field, does that look like maybe in the future, maybe a hundred years from now, that they expect this is going to be the swamp?… I really believe. A hundred years from now, they have already planned and are not telling the public. That is going to fill in.

Constraints and opportunities for community-based partnerships. Study participants were asked to describe existing constraints to and opportunities for community-based partnerships in the restoration of the Cache River wetlands. The findings presented here are based on those responses, as well as constraints and opportunities that emerged through further analysis of the interview discussions. Seven constraints were revealed:

- Regional economic depression;
- Unclear community benefits;
- Lack of community awareness and comprehension of restoration;
- Limited communication with the broader community;
- Limited opportunities for community involvement in decision-making;
- Distrust of outside decision-makers; and
- Uncertainty of restoration science and targets.

Regional economic depression, coupled with the unclear community benefits of restoration, has contributed to constrained community resources and general apathy around restoration. According to participants, many residents struggle to meet their basic needs and do not have free time to participate in programs. Moreover, the potential for the economic benefits of restoration, including nature-based tourism industries and other ecosystem services, have not been clearly articulated. The generalists acknowledged having little to no knowledge about the JVP and its restoration programs. Since the generalists of this study likely represent a large proportion of the broader community, this may be one of the most important and challenging constraints to overcome.

Several participants believed that the JVP's communication efforts could be improved, especially since the construction of the Cache River Wetlands Center in 2002. Several participants felt that better access to the center could help the community take ownership of restoration efforts:

> Wonderful facility. I think it's a great facility. Lot to learn. I have little kids and I haven't taken them there because every time you drive by it's closed. You can't get in. I understand that the state is broke, but they didn't ask us. We have a multi-million dollar facility that no one can see unless you have a tour scheduled.

Public involvement and decision-making authority was a hot topic, particularly among skeptics. One participant criticized the IDNR's public involvement policies and their failure to inform stakeholders during an environmental planning process. He said:

> There is less requirements at the state level for public [involvement] and that has been a frustration for me, because the state is supposed to be more local than the federal government. They don't have to do NEPA, they don't have to do environmental assessments, they don't even have to take public comment.... They put all of those weirs in and never told anybody.... The DNR did it and it was illegal. You could sue them, but it's a huge undertaking.

Distrust and uncertainty, once again expressed by the skeptics, has constrained the potential for partnerships. According to several participants, the lack of a firsthand knowledge of the area and appreciation for community values demonstrated by the agencies and organizations involved has made community members, especially landowners and agriculturalists, wary of the JVP's restoration science and targets. One stakeholder surmised, "I really believe that they have got a different interest than the people in general. They are managers. They don't have to live here. They don't know what we are dealing with."

Several opportunities for the development of community-based partnerships to restore the Cache River wetlands were identified by participants. Nature-based tourism was perceived as a potential growth area that would link ecological and economic values. A few participants called for more partnering with local tourism businesses. Participants emphasized the need for communication and marketing strategies that were more targeted to the communities, including programs at schools, meetings with civic organizations, and articles in newspapers.

Discussion and conclusions

This study offers a new stakeholder typology reflecting community member awareness, involvement, meanings, and attitudes (Table 1). The three stakeholder types—advocates, generalists, and skeptics—transcend traditional interest-group memberships and provide more clear guidance for developing outreach programs toward inspiring support and participation in restoration. Partnering with advocates will be the easiest first step for building a community-wide commitment to restoration. While the JVP has had great success in developing relationships with advocates, it has not tapped their potential as liaisons with the broader community. More intensive training, especially in environmental education and public relations, may help advocates play a stronger role in bridging the gap between the JVP and the community.

We speculate that the generalists make up the largest proportion of the Cache River wetlands community. The JVP needs to better articulate the community benefits of restoration to this group and reach beyond the Wetlands Center (e.g., programs at schools and presentations at civic organizations) to engage underserved residents. Finally, although the skeptics may appear to be the most oppositional group, in this study they expressed general support for restoration. Integrating traditional and agency knowledge will be important to gaining

	Advocates	Generalists	Skeptics
Meanings	• Unique ecosystem, ancient forests and swamps • Spiritual, educational, and inspirational	• Wildlife conservation • Economic development • Aesthetics • Local quality of life	• Water levels • Flooding • Agriculture
Awareness and involvement	• High awareness • Extensive past involvement	• Limited awareness • Little past involvement	• High awareness of restoration initiatives • Extensive past involvement
Attitudes and trust	• Strong support for restoration • High trust in local managers	• Moderate support for restoration • Moderate trust in local managers	• Strong support for restoration • Opposition to JVP • Distrust in local managers
Outreach recommendations	• Provide more structured volunteer opportunities • Develop expertise through orientation and training • Validate and acknowledge contributions	• Better market recreation opportunities • Better communicate restoration benefits • Instill a sense of pride and ownership	• Restore communication channels • Seek opportunities for relationship building • Offer meaningful participation opportunities

Table 1. Summary of Cache River wetlands stakeholder typology and recommendations.

their support. Furthermore, more clearly defining restoration targets and communicating outcomes through modeling should build trust.

This study uncovered great potential for protected area managers in the Cache River wetlands to cultivate meaningful community support for restoration. The insight provided by this study should help to develop outreach strategies that can more efficiently and effectively reach community stakeholders.

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References

Grumbine, R.E. 1994. What is ecosystem management? *Conservation Biology* 8, 27–38.

Kruse, B.S., and J.W. Groninger. 2003. Vegetative characteristics of recently reforested bottomlands in the Lower Cache River Watershed, Illinois, USA. *Restoration Ecology* 11, 273–280.

Lachapelle, P.E. and S.F. McCool. 2005. Exploring the concept of "ownership" in natural resource planning. *Society and Natural Resources* 18, 279–285.

Marshall, C., and G.B. Rossman. 1999. *Designing Qualitative Research*. Thousand Oaks, Calif.: Sage.

Ramsar Secretariat, the Ramsar Convention on Wetlands. 2005. *The Ramsar List of Wetlands of International Importance.* On-line at //www.ramsar.org (accessed 20 August 2005).

Smith, P., and M. McDonough. 2001. Beyond public participation: Fairness in natural resource decision making. *Society and Natural Resources* 14, 239–249.

Strauss A., and J. Corbin. 1994. Grounded theory methodology: An overview. In *Handbook of Qualitative Research*. N. Denzin and Y.S. Lincoln, eds. Thousand Oaks, Calif.: Sage, 273–285.

Effective Resource Advising and Suppression Rehabilitation, BAER Teams, Planning, and Assessments

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Wildland fire incidents can place a great deal of stress on park resources as well as resource managers. As time is of the essence in both fire management and post-fire response, preparedness is essential. This paper will outline the major roles of the resource manager from initial attack to burned area rehabilitation, with an emphasis on preparedness.

During fire management activities, whether that management is suppression or wildland fire use (where natural ignitions are allowed to burn under specific conditions for resource benefit), it is essential that resource concerns are communicated to the incident commander. The most common approach is to assign one or more people from the resource management staff to the incident, in the role of resource advisor(s). The resource advisor provides daily input to the incident commander or his/her designee, often the plans chief, in the development of fire suppression strategies and tactics to minimize or mitigate the expected impacts of fire and fire suppression actions upon natural and cultural resources (NWCG 2004). In this role, the resource advisor advises the incident commander of specific resource values at risk (e.g. threatened and endangered species, cultural sites, paleontological sites), communicates the mitigation measures established in the fire management plan and related documents (such as the finding of no significant impact for the environmental assessment and the biological opinion for endangered species), and may also provide critical geospatial data to the incident geographic information systems (GIS) operation to support the resource protection efforts of the incident. The resource advisor also provides input on behalf of the agency administrator (e.g., park superintendent) in the development of the wildland fire implementation plan and/or wildland fire situation analysis. In large or prolonged incidents, multiple resource advisors may be assigned either concurrently or consecutively to assure that both planning and operational requirements are met for the duration of the incident. In such cases, it may be advantageous to assign a lead resource advisor, who primarily participates in planning, and several additional resource advisors of appropriate disciplines to serve in fire operations (e.g., archaeologists assigned to crews constructing line through sensitive areas or wildlife biologists working with crews in critical habitat). To be most effective as fire incident resource advisors, resource management staff should prepare before fire season by obtaining the appropriate training and fire qualifications, establishing contact procedures either through the fire dispatch system or some other way to assure that the local fire management officer and/or incident commanders know how to reach a resource advisor outside of business hours, summarizing key mitigation requirements into short documents that can be handed to an incoming incident commander, and compiling geospatial data to support the resource information needs of the incident while providing for protection of sensitive datasets.

The incident commander is responsible for rehabilitation of suppression impacts according to local standards. It is generally incumbent upon the resource advisor to provide those standards and work with the incident to assure that rehabilitation is completed appropriately. In order to do this, it is imperative that the resource advisor work with the field observers and GIS unit to assure that all suppression impacts are mapped. Typical suppression rehabilitation tasks include: raking out firelines, grading roads, installing water bars, disguising cut stumps, scattering slash, removing all trash and flagging, and treating heavily used areas (such as incident command posts, staging areas, and base camp) to reduce soil compaction and/or re-establish vegetation. In any case, time is of the essence as the suppression rehabilitation is funded by the suppression account and suppression rehabilitation must be completed within 90 days from date of containment. If rehabilitation requires the use of hand crews, it is essential that the resource advisor work with the incident demobilization unit leader to assure that adequate personnel are available to complete the identified tasks, as it can be difficult to order additional hand crews post-containment for completion of suppression rehabilitation due to competing priorities in the fire ordering system. Resource management staff should prepare before fire season by extracting suppression rehabilitation standards from their fire management plans or establishing those standards if they do not otherwise exist, and assuring that adequate resource management personnel are trained in suppression rehabilitation techniques and available to work with the field crews on suppression rehabilitation treatments.

Emergency stabilization treatments are planned actions to stabilize and prevent unacceptable degradation to natural and cultural resources, to minimize threats to life or property resulting from the effects of a fire, or to repair/replace/construct physical improvements necessary to prevent degradation of resources. Emergency stabilization actions must be completed within one year following containment of a wildland fire and the agency administrator (e.g., park superintendent) is responsible for determining the need for and completing emergency stabilization treatments. The assessment of stabilization needs and proposed treatments is documented in a burned area emergency response (BAER) plan within seven days from date of containment. BAER plans are generally written by interdisciplinary BAER teams. There are two standing Department of the Interior national BAER teams and specific call out criteria that must be met for their assignment. In addition, there are some standing regional teams in various agencies, but many BAER plans, particularly for small or less complex incidents, are done by ad hoc teams composed of specialists from that unit and other nearby areas. The determination of how to complete the BAER planning process is generally a discussion between the agency administrator, the resource advisor, and the regional BAER coordinator. In any case, it is important that the local resource management staff be closely involved in the entire BAER planning process as their local knowledge is critical in designing treatments and it is often left to the local staff to implement the BAER treatments after they are approved.

Emergency stabilization treatments and activities must be compatible with approved land management plans for the local unit. In the Department of the Interior, the priorities for emergency stabilization are protection of human life and safety, and protection of property and unique or critical biological/cultural resources. There are specific requirements for what must be contained in the BAER plan and a discrete list of allowable actions found in the Departmental Policy 620 DM 3 (USDI 2004). Watershed assessment and subsequent watershed stabilization treatments are often the central focus of emergency stabilization efforts. Burned area reflectance classification maps, a remotely sensed product, provide a good starting point for mapping burn severity, but it is important that such products are ground-truthed and that treatments are designed by experts such as hydrologists, soil scientists, and geologists with knowledge about both local watershed conditions as well as post-fire watershed response. Other expertise usually needed to assess emergency stabilization needs and impacts from proposed treatments include cultural resource specialists/archaeologists, wildlife biologists, vegetation specialists, GIS specialists, environmental compliance specialists, and documentation specialists. To prepare for emergency stabilization needs, the fire management plan can be used to highlight specific values at risk and, in some cases, the associated biological opinion may address emergency stabilization treatments in critical habitat. Additionally, resource management staff may want to compile geospatial data sets for soils, geology, slope, and hydrology, as well as precipitation data, so that the primary information sources are readily available to the watershed experts should the need arise.

Non-emergency burned area rehabilitation (BAR) is also the responsibility of the agency administrator, and is focused on efforts undertaken within three years of containment of a wildland fire to repair or improve fire-damaged lands unlikely to recover naturally to management approved conditions, or to repair or replace minor facilities damaged by fire. The BAR plan is a document that specifies treatments required to implement post-fire rehabilitation policies. This plan may be programmatic and prepared in advance as part of the fire management plan and applicable to clearly defined types of incidents or situations, or prepared by an interdisciplinary team of specialists during or immediately following the containment of a wildland fire. Most typically, the BAR plan is prepared by local resource management staff with some outside help from contractors, regional offices, or staff from other parks. Like burned area emergency response plans, there are specific requirements for what must be contained in the BAR plan and a discrete list of allowable actions found in the Departmental Policy 620 DM 3 (USDI 2004). Typically, BAR plans are completed after BAER plans because they are non-emergency in nature. Additionally, funding for BAR plans is competitive and generally awarded early in the fiscal year based on fires that occurred during the previous fire season, although there is some variation from agency to agency and year to year. BAR treatments must be completed within three years from date of containment. There are also some opportunities to leverage BAR funding with other funding sources, such as joint fire sciences or fee demo, to accomplish treatments or studies that otherwise would not be possible.

In summary, the resource manager has critical responsibilities for fire incidents and their after effects. These specific tasks include: resource advising during the fire management incident, guiding suppression rehabilitation efforts, participating in the burned area emergency response planning effort, leading all or some of the implementation of BAER treatments, participating in the burned area rehabilitation planning effort, and leading all or some of the implementation of BAR treatments. These responsibilities can add a great deal to already full workloads but there are efficiencies to be gained in preparing in advance before a fire incident occurs. Some of the most important preparedness tasks include: getting resource management staff trained as resource advisors, compiling critical geospatial data and documents (preferably on handy external USB hard drives), establishing a relationship with the regional BAER coordinator, reviewing your fire management plan and participating in annual updates to address resource concerns, as well as working cooperatively with the local fire management officer and incident commanders regarding resource values and fire management concerns.

References

NWCG [National Wildfire Coordinating Group]. 2004. *Resource Advisor's Guide for Wildland Fire.* PMS 313/NFES 1831. On-line at www.nwcg.gov/pms/pubs/pubs.htm.

USDI [U.S. Department of the Interior]. 2004. *Wildland Fire Management Burned Area Emergency Stabilization and Rehabilitation.* Departmental Policy 620 DM 3 (release 3610). Washington, D.C.: USDI.

The Science of Large Dam Removal: Removing Dams on the Elwha River, Olympic National Park

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This paper centers on the development of a research consortium to study ecological effects of dam removal. Long-time public interest has centered on the National Park Service's plan to remove two hydropower dams from the Elwha River in Olympic National Park. The Elwha is not only the largest dam removal ever attempted but is also unique in that land above the dams is within Olympic National Park, removing the confounding anthropogenic factors in other dam removals nationwide. I will provide a general update on the project to set the scene for the science part, which is actually the story I want to tell.

Interest in damming the Elwha River for electric power generation began in the late 19th century. A Canadian entrepreneur named Thomas Aldwell gained financing from George Glines and constructed the Elwha Dam five miles from the river mouth in 1913. The dam is 100 feet high and 400 feet long at its top. Although dams such as this were legally required to provide for passage of migrating fish, the Elwha Dam was constructed without any fish ladder or other provision for fish passage. A hatchery was built at the dam to compensate, but it was unsuccessful and closed in 1922. A second dam, Glines Canyon Dam, was constructed for additional power generation 13 miles upriver from the mouth between 1925 and 1927. The Glines Canyon Dam also lacks any provision for fish passage. Ownership of the dam and associated land remained in private hands until recently, but most of the land under Lake Mills was incorporated into Olympic National Park in 1940.

Anadromous fish such as salmon and steelhead have been restricted to the lower five miles of the Elwha River and tributaries for over 90 years. The Elwha was legendary for its enormous runs of salmon and steelhead. Spawning runs this size would have carried vast amounts of marine-derived nutrients to the upper reaches of the watershed where they were distributed into riparian and aquatic habitats, in effect fertilizing those upstream food webs. The dams and reservoirs also have radically affected the size and distribution of sediments in the lower Elwha and in the near shore marine environment. The middle and lower reaches of the river have been starved of small size sediments which have been trapped in the reservoirs. Today, 17 million cubic yards of sediment are believed to be trapped behind the dams.

Built as they were without fish passage, both dams would face expensive and difficult modification in order to be relicensed given current requirements. Because power is now widely available through the grid and several of the paper mills in the nearby town of Port Angeles are closed, the dams' power gradually became less important. Although controversial, in the 1980s public sentiment began shifting towards supporting the removal of the two dams. To resolve the controversies, Congress enacted the Elwha River Ecosystem and Fisheries Restoration Act of 1992 (PL102-495). This law provides for "the full restoration of the Elwha River ecosystem and native anadromous fisheries...." The Department of the Interior determined in 1995 that removal of both dams was required for full restoration.

The dams have now been bought by the federal government. Planning is well underway for their removal, which will begin in 2009, and for various mitigation and restoration measures. Current plans call for removing both dams at approximately the same time and allowing trapped sediments to wash down the river as quickly as possible. Removal will extend over perhaps two years, with activities suspended for periods when spawning fish return to the lower river, in order to allow sediments to clear.

A total of about $185 million has been authorized to pay for acquisition and removal of the dams, protection of the drinking water for Port Angeles, and some vegetation and fisheries restoration. But what is little known, even within the National Park Service, is that scientific research and monitoring were *not* funded by the Restoration Act. Numerous scientists in many disciplines (geology, hydrology, ecology, and fisheries) have been anxious to study this model system and have been frustrated by the lack of funding. A series of four workshops were held in which 150 scientists weighed in to propose and prioritize research. The Park Service has done its own analysis of needed research. But funding for it remains problematic.

Finding funding for Elwha restoration research has proven a difficult challenge. Because so much is being spent on the overall project, the task of asking funds of foundations and donors is a conundrum. Although everyone agrees that the Elwha is tantalizing; it's like the famous Pogo cartoon where Pogo says, "We're surrounded by insurmountable opportunity." It's hard to explain to someone that $185 million is being spent, but that you want them to donate!

After many attempts and frustrations in approaching foundations, in 2005, a group of local and regional players received National Science Foundation (NSF) support in the form of two grants totaling $1 million. The grants provided the basis for the Elwha Research Consortium. The Consortium is intended to create a level playing field for any scientist wishing to do research on the Elwha restoration, to synergize the research across institutions and disciplines, and to provide data infrastructure coordination. The core grant participants were Western Washington University, Olympic National Park, the Elwha Tribe, U.S. Geological Survey (USGS) Biological Resources Discipline (BRD), National Oceanographic and Atmospheric Administration (NOAA) Fisheries, Olympic Park Institute, and Peninsula College (a two-year college in Port Angeles). Many other partners have since joined the group. The process of assembling these partners and the story of how the grants were won is of some interest, because of the model used and its possible application to other situations.

Creation of the Elwha Research Consortium originated within the Natural Resources Division at Olympic National Park. The idea was to create a core group that included strong *local* support together with *bona fide* research capability. It was further the intention to bring together federal, tribal, and academic partners to enhance success for all. We used the urgency of the Elwha timeline to our advantage, stressing that needed information must be collected *now* before the dams are removed. Finally, realizing that although federal agencies are not eligible to receive NSF funding, we made a strong case for the federal/private partnership and how the funds could benefit both sectors.

Our first fortunate break was an award of $13,000 from the NPS North Coast and Cascades Research Learning Network to Jim Allaway, a scientist at Western Washington University. Allaway wrote a white paper outlining the history of the Elwha restoration project, underlining the need for research. This report proved to be critical, in part because it was well written, but also because it made a compelling case. The language in the Allaway report became the basis for the two NSF grants.

The first of the two successful grants was to NSF's Research Coordination Networks (RCN) for $500,000 over five years. This is an NSF program specifically intended to provide support for large, multi-institutional research projects. The grant does not actually fund any research, but it permits the scientists to meet, to travel, to coordinate work, to establish a web presence, and to work on data compatibility. This grant in effect established the Elwha Research Consortium. The principal investigator is Brad Smith, dean of the Huxley College of the Environment at Western Washington University.

The second grant was for Research Experience for Undergraduates (REU), also for $500,000 over several years. These grants are most commonly awarded to universities that use it for student summer support. In our case, the REU grant is providing stipends for 16 students each academic year. These students become the assistants for agency and academic researchers, providing an invaluable field presence throughout the year. These stipends are shared between Western Washington University and Peninsula College with a number each year targeted at Elwha tribal members. The two colleges have embarked on a major educational program incorporating the Elwha restoration project into their curriculum. Courses are taught in which biostatistics, field biology, social science, English composition, and the humanities are all integrated with a focus on the Elwha and the greater meaning of the river's restoration. The principal investigator is Bill Eaton, vice president of Peninsula College.

The Elwha Research Consortium is now in its second year. A board of directors has been formed and by-laws generated. Annual meetings have been held at which the various researchers currently doing Elwha work could meet and coordinate logistics for the field season. Separate sub-groups have organized under the consortium umbrella focused on "nearshore resources" (off the river's mouth) and "education/outreach." A committee is considering whether to create an "Elwha Research Foundation," which would be a 501(c)(3) non-profit to serve as a membership-based, fundraising partner of the consortium.

The non-intuitive, creative part of this story was in accepting that Olympic Park staff would make a significant contribution to writing the grants but receive no *direct* funding from them. Remember that although federal agencies cannot receive NSF funds, there is nothing to prevent NPS scientists from writing grants submitted through non-federal partners. We found that the trick was to find well-placed academics interested in the project and willing to become partners so long as they did not have to do the heavy lifting of writing the grants. Another important revelation was understanding the role played by "Office of Research" support staff. These folks play vital, behind-the-scenes roles and are expert at grant writing, budget planning, administration, and FastLane (NSF's project tracking software). They can be invaluable friends and unexpected partners.

Although most Elwha research is still being conducted on small grants to individual researchers, the "pie" is now much larger than before creation of the consortium. The non-federal partners in this case got the money but the agencies got the vital work started and continue to receive many value-added benefits such as field assistants, data management, and increased public awareness. As word spreads of the growing consortium, more researchers are attracted to the project, writing their own grants, gradually filling in those scientific questions still needing answers.

The Elwha is a perfect test of whether removing dams can help restore a river. The lessons learned from restoring the Elwha will be in every ecology book for the next 50 years. The Elwha Research Consortium—based on teamwork, strategic partnerships, and scientific collaboration—will tell the tale.

Restoring Burned Area Fire Regimes at Zion National Park

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Introduction

The Kolob Fire is the largest wildfire in Zion National Park's recorded history (10,516 acres in Zion and 17,632 acres total; Figure 1). In June 2006, this human-caused fire altered the landscape in Zion on a scale that was unprecedented (Figure 2). A major concern of the fire's impact was the loss of native vegetation and its replacement by non-native invasive species. After the burned area emergency rehabilitation (BAER) assessment was completed, a focused effort by park staff was initiated to implement recommended BAER actions. In late October and early November 2006, an aerial herbicide and seed treatment using PLATEAU herbicide and native grass and forb species seed was applied by helicopter to the Kolob Fire area in Zion. The goal of these treatments is to encourage native perennial plant re-establishment and diversity in areas that are being threatened by cheatgrass invasion.

Methods

To combat the competitive strategies of cheatgrass, we chose a restoration approach that included the use of aerially sprayed PLATEAU herbicide over the entire extent of the 10,516 acres of the Kolob Fire (Figure 3). This product has been thoroughly tested and approved for use by the U.S. Environmental Protection Agency. PLATEAU is a highly selective herbicide that targets many of Zion's invasive, non-native species, including cheatgrass, ripgut brome, annual mustards, puncture vine, and field bindweed. Imazapic is the active ingredient in PLATEAU herbicide. It works by affecting proteins specific to plants which are not present in animals, and therefore they are not affected. Imazapic is essentially non-toxic to a wide range of non-target organisms including mammals, birds, fish, aquatic invertebrates, and insects. It does not bio-accumulate and has limited mobility in soil. After an application of Imazapic, there is little potential for

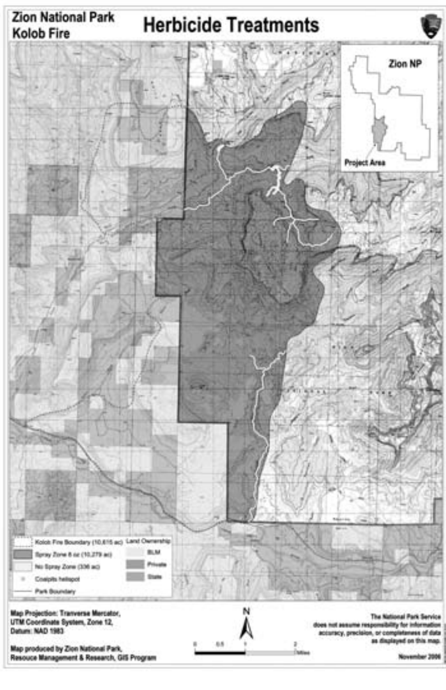

Figure 1. The human-caused Kolob Fire ignited along the Kolob Terrace Road in Zion National Park. Extreme fire behavior throughout the burn resulted in an intense, fast-moving fire that burned over 17,000 acres of NPS, BLM, and private lands in less than four days. The fire intensity and resulting fire severity influenced recommended restoration techniques by the BAER team to accommodate post-fire rehabilitation successes.

Figure 2. Terrain within Zion National Park and adjacent lands combined with strong wind and very dry conditions provided challenges to firefighting efforts during the Kolob Fire. It also facilitated extreme fire behavior over much of the fire and created challenges to suppression activities in canyons of Color Country. The majority of burned acres are part of an old-growth pinyon–juniper forest in Zion National Park. NPS photo.

Figure 3. The USGS and NPS began collaborating in 2004 on a project focused on the control of exotic/invasive cheatgrass *(Bromus techtorum)* using a combination of treatments in Zion Canyon. These treatments include a combination of mowing, burning, and herbicide application using PLATEAU herbicide. This information was used to plan restoration efforts on the large-scale restoration project after the Kolob Fire. NPS photo by C. Decker.

movement off of the treated area. It is also moderately persistent in soil which allows for full-season control of targeted species (Vollmer and Vollmer 2006).

In addition to the herbicide application, we used a mix of native grasses and forbs over 500 acres of the fire that, previous to the fire, were heavily infested with cheatgrass. This mix consisted of bottlebrush squirreltail (*Elymus elymoides*), sand dropseed (*Sporobolus cryptan-*

drus), scarlet globemallow (*Sphaeralcea coccinea*), and Palmer penstemon (*Penstemon palmeri*). These species are all native to Zion National Park and will not be impacted by the herbicide. Herbicide, in addition to seeding, was used on this portion of the fire to combat a heavy infestation of cheatgrass which ignited and fueled the Kolob Fire. The application rate of eight ounces of herbicide per acre was recommended to prevent damage to the seeding effort and promote a successful recovery of native plants over the entire fire.

Monitoring is a critical component of this ecosystem restoration project. Our ability to understand ecosystem processes through detecting trends is an essential part of making effective decisions and implementing management actions. The massive restoration efforts involved with the Kolob Fire are being followed up with an extensive monitoring regime. The National Park Service (NPS) and the Northern Arizona University School of Forestry have established a network of plots (Table 1) throughout the restoration area to track changes in vegetation community composition and determine the effectiveness of our chosen actions.

Results

Preliminary results from a collaborative U.S. Geological Survey (USGS)/NPS research project initiated in Zion Canyon in 2005, and funded by the Joint Fire Science Program, have shown that the use of PLATEAU herbicide to combat non-native annual grasses and forbs is most successful if applied during the fall season after a fire disturbance (Figure 4). This disturbance removes excess surface biomass and allows the herbicide to reach the soil surface directly. Direct contact with the soil surface provides more effective absorption and effectiveness of the herbicide.

Discussion

The post-Kolob fire restoration project was the perfect opportunity to expand upon the Zion Canyon research project and try the herbicide application on a larger scale, but we had less than two months to complete the compliance and contracting processes and apply the treatment to get the most effective results. The primary concern after the Kolob Fire was the

Table 1. A plot design and layout scheme was developed to monitor the effects of the herbicide and seeding treatments over a four-year period. This project was designed in conjunction with the restoration efforts to determine effectiveness of the treatments on the burned area and track the recovery process of the affected plant communities and ecosystems.

Study Area within Kolob Fire	Vegetation Type	Plot Design	Plot Size (m)	Number of Replicated Blocks
Kolob Terrace Road	pinyon / juniper	blocks of 4 plots; control, seeded. sprayed, seeded & sprayed	30 x 5	12
Lower Dalton Wash	grassland / shrubland	paired plots; control & spray	2 x 2	22
Upper Dalton Wash	pinyon / juniper	paired plots; control & spray	30 x 5	22

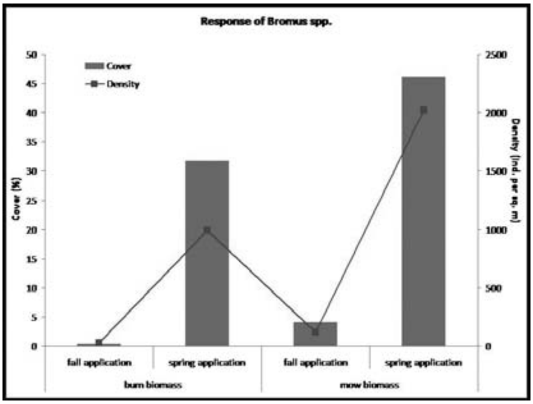

Figure 4. The Kolob Fire rehabilitation project incorporated aerial herbicide and seeding application by helicopter and is the largest such undertaking in National Park Service history. Contract crews (United Agri Products and Northstar Helicopters) worked on the project for two weeks to complete prescribed treatments on over 10,000 acres of NPS land. Herbicide application on the Kolob Fire was a detailed process. Terrain features provided a challenge to helicopter pilots. Effectiveness of the herbicide relies on the application rate of the spraying. The droplet size created by the helicopter spray boom nozzles was adjusted to provide even application of the herbicide over the entire area of the fire.

dominance of cheatgrass, which increases in abundance and density after fire, resulting in increased fuel loads. This, in turn, promotes a plant community prone to frequent fires. Cheatgrass displaces native grasses and herbaceous plants because, as a winter annual, it is able to establish earlier in the growing season and is very competitive for resources such as soil moisture (Billings 1994). Native plants are eventually crowded out because they cannot compete effectively for environmental resources such as space, water, and sunlight.

Monocultures of cheatgrass limit biodiversity, and significantly affect the structure and function of an ecosystem. As cheatgrass continues to increase after each fire, the time between fires becomes shorter (Young et al. 1987). Since native shrubs and trees are slower to re-establish after fire and cannot compete effectively for resources, the increased fire frequency fueled by cheatgrass eventually eliminates most of them from the landscape (Brooks 1999). With cheatgrass dominance, wildfires tend to occur earlier in the season when native perennials are more susceptible to injury by burning. The result is a conversion from native shrub and perennial grasslands to annual grasslands adapted to frequent fires. This adaptation to and promotion of frequent fires is what gives cheatgrass its greatest competitive advantage in ecosystems that evolved with less frequent fires. Cheatgrass expansion has dramatically changed fire cycles and plant and animal communities over vast areas of the West by creating an environment where fires are easily ignited, spread rapidly, cover large areas, occur frequently, and are more intense (Reid et al. 2006).

Conclusion

This landscape-scale restoration effort will be used to learn more about the potential of such actions and share our understanding with the larger agency and private land management community throughout the western United States. We are looking forward to the results from our first year of monitoring.

References

Billings, W.D. 1994. Ecological impacts of cheatgrass and resultant fire on ecosystems in the western Great Basin. In *Proceedings—Ecology and Management of Annual Rangelands,* *May 18–22, 1992, Boise, Idaho.* S.B. Monsen and S.G. Kitchen, eds. General Technical Report INT-GTR-313. Ogden, Utah: U.S. Forest Service, Intermountain Research Station, 22–30.

Brooks, M.L. 1999. Alien annual grasses and fire in the Mojave Desert. *Madrono* 46:1, 13–19.

Reid, C.R., S. Goodrich, and J.E. Bowns. 2006. The history and ecology of Cheatgrass (*Bromus techtorum*) and red brome (*Bromus madritensis* subs. *rubens*) in the western U.S. Paper presented at the Fourteenth Wildland Shrub Symposium, Shrublands Under Fire: A Disturbance and Recovery in a Changing World, Southern Utah University, Cedar City, Utah.

Vollmer, J.G, and J.L. Vollmer. 2006. Controlling cheatgrass in winter range to restore habitat and endemic fire. Paper presented at the Fourteenth Wildland Shrub Symposium, Shrublands Under Fire: A Disturbance and Recovery in a Changing World. Southern Utah University, Cedar City, Utah.

Young, J.A., R.A. Evans, R.E. Eckert, Jr., and B.L. Kay. 1987. Cheatgrass. *Rangelands* 9:6, 266–270.

Young, J.A., and R.A. Evans. 1978. Population dynamics after wildfires in sagebrush grasslands. *Journal of Range Management,*31:4, 283–289.

National Park Service CD Workbook for Planning, and Specifications for Ecological Restoration

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Introduction

This is an introduction to a new restoration workbook. It is a guide for writing specifications for ecological restoration in the National Park Service (NPS).The NPS has unique policies, guidelines, and procedures that govern ecological restoration of parklands. The policy guidance in this restoration workbook is taken from those management documents. Standards and specifications must be modified frequently.

The purpose of this workbook is to assist NPS staff in planning, designing, writing scopes of services and construction specifications for ecological restoration. It is based on engineering standards and specifications, and past experiences from actual park projects.

Many NPS restoration projects require that certain genetic and environmental protection standards be met. Standard specifications such as those published by the American Institute of Architects (AIA), the Construction Standards Institute (CSI), and the Federal Highway Administration (FHWA) are frequently modified for park projects.

Below is a summary of the eight sections included in the workbook. This document, which is over 550 pages, uses "object links" for ease of navigation and locating specific subjects. These examples will help improve the efficiency of specification writing and better ecological restoration. This workbook provides planning document outlines and organizes planning guidance processes. It will give sample scopes of services and construction specifications. NPS restoration manuals are also provided; the workbook includes two manuals which interpret restoration guidelines. The restoration manuals have been used previously in many different types of NPS revegetation and restoration projects.

Workbook contents

Section I, "Planning Process," summarizes the ecological restoration, planning, and design processes as described in the disturbed lands section of draft Reference Manual #77. The information is appropriate for projects focused on removal of exotic species, removal of contaminants and non-historic structures or facilities, restoration of abandoned mineral lands, abandoned or unauthorized roads, areas over-grazed by domestic animals, disrupted natural waterways and/or shoreline processes, restoration of areas disturbed by NPS administrative, management, or development activities (hazard tree removal, construction, or sand and gravel extraction) or by public use, restoration of natural sounds capes, and restoration of native plants and animals.

Section ll, "Construction Standards and Specifications," contains 26 specifications for land restoration. They include, but are not limited to, "Clearing and Grubbing," "Excavating and Embankment," "Topsoil," "Mulching," "Seeding," "Sodding," "Planting," "Landscaping," and "Mined Land Revegetation." These specifications were generally adapted from the AIA and CSI for NPS use. These specifications are written to direct the performance of particular tasks. A list of other references is also included at the end of each specification for additional information. Because a number of different materials can be used, the most common material specifications have been removed and placed in Section V, "Specifications for Materials."

Section III, "NPS Specifications Organized by Parks," contains 24 park packages with specifications associated with past land restoration projects. These projects have been organized according to format (NPS best management practices, CSI, and FHWA). Part I is entitled "Park Restoration/Revegetation Best Management Practices." Part II covers "NPS Specifications in CSI format." Part III describes "NPS Specifications in FHWA format." Part IV lists "Miscellaneous Scopes and Specifications."

The "National Park(s) Special Contract Requirements" (SCRs) is an informal guide. It is intended to help NPS staff in preparing specifications for SCRs by discussing issues frequently confronted and by providing examples of specifications that have been modified.

It also gives examples for inspection of materials imported into the park, crimping straw, mulching, erosion control materials, time, and rental equipment specifications. This allows for special finishing techniques, restoration of desert pavement, log and plant salvage, and installation. Section V also contains forms that have been useful in connection with planning, restoration and monitoring projects.

Section IV, "Federal Lands Highway Project," contains the guide entitled "Library of Commonly Used Supplemental Specifications for National Park Service Projects in the Pacific Northwest." This is the result of a cooperative effort of the FHWA Federal Lands Highway Western Division, the NPS Denver Service Center, and park staff. This is used for the development of a request for proposals (RFP) for the construction of roads and bridges in the Pacific Northwest.

Section V, "Specifications for Materials," provides specifications for commonly used materials (fertilizers, erosion control blankets, soil amendments, etc.) and notes NPS preferences.

Section VI, "Watershed Restoration, RFP Contract," is an example of an RFP for contracting for a watershed-scale restoration with heavy equipment. Redwood National and State Parks used this document to contract for removal of roads, skid roads, reduction of erosion, and restoration of natural landforms. It includes technical specifications for road outsloping and cost estimation guidance.

Section VII, "Watershed Restoration Manual, Redwood National Park, 1992," is a publication which provides information on establishing a restoration program that addresses erosion problems related to roads in steep forest terrain. Watershed restoration work involves a long-term commitment to improving the conditions of ecosystems. This publication goes through the thought processes and actions necessary to set program goals and identify and evaluate erosion problems. It prioritizes areas for treatment and investigates the causes of the problem through geomorphic mapping and design treatments.

Section VIII, "Internet References," discusses the Internet as another beneficial source for standards and specifications and technical information on ecological restoration.

Section VIII contains specific website descriptions, the steps required for accessing selected technical information, and examples. Websites described include the Natural Resources Conservation Service and Federal Highways project FP-96, plus miscellaneous references.

The workbook is a Microsoft Word file. Standard procedures for copying, saving, merging, etc., are used for standardization and convenience.

Each section of the workbook, I through VIII, is listed in the master table of contents (TOC). The TOC gives a brief description of the tasks and topics described in each section. Sections I, II, III, and V also have subtopic TOCs. Subtopic TOCs can be located by double clicking on the respective icons as described below.

Click on the icon in the TOC of the respective project or subtopic TOC you wish to locate. Repeat this operation from the subtopic TOC to open the respective project file you want to visit. To return to the beginning of the main TOC or a subtopic TOC, simply close the project file and/or subtopic TOC file you are presently using.

Using and modifying file contents

Individual files and examples contained within the workbook are Microsoft Word files. A specific document can be revised and saved. When you have a project file open, you can save it to a named target document by using the "save as" command. This target document can then be changed or modified to fit the specific situation or need. "Blocking" and "copying" to a new file can also extract portions of individual forms and documents.

This document brings together a large number of references and examples for writing restoration specifications. It is a helpful guide for writing specifications and accessing associated information for ecological restoration. For more information or a copy of the CD, contact Wendell Hassell at wghassell@msn.com or telephone 1-303-431-6405.

Formation of a Cooperative to Conduct Research on Native Plants and Restore Damaged Ecosystems

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A major challenge facing restorationists is preparing for restoration in local areas before an ecological disturbance. This is particularly true after land development and can be true after wildfires. After disturbances, invasive species can dominate, reducing native species diversity (Sheley and Petroff 1999). Ecological restoration is difficult if local ecotypes have been destroyed. The Confederated Tribes of the Umatilla Indian Reservation and Washington State University are building a cooperative to conduct research on native species propagation and restoration using highly diverse plant communities.

We are attempting to engage land managers and the public in valuing and restoring highly diverse ecosystems. This is not trivial. It requires restoring entire ecosystems and being prepared to do this before a disturbance. Restoration is often an afterthought done in an emergency stabilization mode after a disturbance. This behavior forces the use of a few species that may not be locally derived. If local genetic resources are not available, then remaining local ecotypes can become genetically polluted (Link 2006). Collecting seeds of local ecotypes would reduce the likelihood of genetic pollution. A local seed store can retain local genetic characters. When a restoration need arises, the local stock can be "increased" to produce adequate numbers of seed for the restoration area.

The goal of our efforts is to create a sustainable research cooperative to resolve issues in restoration ecology, focused first on Columbia Basin shrub-steppe and riparian species. Successful and sustainable restoration is integrally tied to the cultural values of the tribes. The very nature of natural areas is, in some part, a product of thousands of years of Native American manipulation environmental management (Senos et al. 2006). Thus, successful and sustainable ecological restoration depends on understanding the values Native Americans have for native plants and ecosystems. Our cooperative includes members of societypeople with an interest in native plant research including land management agencies, Native American groups, commercial greenhouses, ecological restoration contractors, and local homeowners among others.

Our cooperative serves a strong social need by being an example of how like-minded groups can address difficult ecological restoration questions. We decided toare creatinge our cooperative with funding contributions from many groups and individuals to overcome difficulties associated with funding long-term restoration efforts. We are modeling our cooperative after Oregon State University's Nursery Technology Cooperative (www.cof.orst.edu/coops/ntc). An element of the group can fall out without destroying the entire effort. In contrast, funding cuts from a single group or institutional funding can have devastating consequences.This lowers the risk of failure if a major funding source is interrupted.

A good strategy is to form a cooperative business model and encourages all elements of society to fund the cooperative similar to a government-funded natural resources group except the cooperative asks for financial support as opposed to taxing the public. Cooperatives can be formed in local areas or regions to address local or regional restoration problems. Local groups are knowledgeable about local flora and are able to collect local seed thereby conserving the genetic diversity of local areas. If local cooperatives collect sufficient local seed then the likelihood that areas subjected to disturbances such as severe fire can be restored with locally derived genetic material.

As climate changes, cooperatives can network to anticipate species change, understand requirements of new species, and assist in plant movement. Tribes can educate others on the proper cultural use of new species before they arrive, and can send their own information to the new hosts of species that migrate northward from their current locations. As the effects of climate change become better known, networks of native plant collaboratives can exchange seed and knowledge to mitigate some of the impacts.

Our initial research focuses on growing local species that are not available or have had little horticultural research. We collected seed from 80 of about 800 species in the Columbia Basin in the summer and fall of 2006, built a greenhouse, and are propagating the species. Seed were cleaned by hand and stored in glass vials at room temperature and humidity until germination and emergence trials were initiated. Germination trials were initiated in February 2007 and emergence recorded at the first sign of a radicle. Germination trials included placing seed on wetted filter paper in sterile Petri dishes. The same species were also planted just below the soil surface in pots in a greenhouse. Greenhouse temperature was not controlled. Pots were watered daily. At least 30 seeds were used to compute percent germination and emergence. Days to first germination and first emergence were noted as number of days after sowing until the first germinated or emerged seedling was observed.

Germination and emergence of the species is highly variable (Table 1). Greater than 90% of *Apocynum cannabinum* seed germinated or seedlings emerged which is much greater than the 44% observed by Mitchell (1926) under similar germination conditions. We noted only three days until first germination compared with six days in Mitchell (1926). Germination of *Asclepias speciosa* was the lowest at 27% and is less than about 70% germination under similar circumstances (Comes et al. 1978). There is little known of germination characteristics of the lithosolic species *Eriogonum thymoides, Sedum leibergii,* or *Talinum spinescens*, found at the Hanford National Monument in the Pacific Northwest. We are currently conducting seed stratification trials on species that have not germinated.

The next step is to determine how to increase the resource and plant highly diverse native plant communities. As a research effort, monitoring will occur without fail!

Cooperatives formed to conduct research on native plants and restoration of damaged ecosystems can be useful to improve our knowledge of restoration ecology. This strategy can be repeated in many regions where local expertise can be brought to bear on local ecological

Family Common Name Scientific Name	% Germination Petri Dish	Days to first Germination	% Emergence in soil	Days to First Emergence
Asclepiadaceae				
Showy milkweed				
Asclepias speciosa	27	30	48	21
Apocynaceae				
Common dogbane				
Apocynum cannabinum	93	3	98	6
Chenopodiaceae				
Spiny hopsage				
Grayia spinosa	57	10	43	21
Compositae				
Large-flowered agoseris				
Agoseris grandiflora	100	3	96	6
Coreopsis				
Coreopsis atkinsonia	70	7	0	0
Threadleaf fleabane				
Erigeron filifolius	53	5	15	8
Desert yellow daisy				
Erigeron linearis	53	5	49	11
Piper's daisy				
Erigeron piperianus	77	5	15	16
Shaggy fleabane				
Erigeron pumilus	60	5	12	18
Columbia River gumweed				
Grindelia columbiana	87	18	19	10
Sneezeweed				
Helenium autumnale	80	13	30	13
Hoary aster				
Machaeranthera canescens	77	3	58	5
False mountain dandelion				
Microseris troximoides	53	12	5	26
Crassulaceae				
Leiberg's sedum				
Sedum leibergii	60	5	45	11
Graminae				
Squirreltail				
Elymus elymoides	87	5	97	10
Sand dropseed				
Sporobolus cryptandrus	100	14	0	0
Grossulariaceae				
Wax currant				
Ribes cereum	100	5	0	0
Leguminosae				
Buckwheat milkvetch				
Astragalus caricinus	53	8	13	8
Crouching milkvetch				
Astragalus succumbens	60	23	5	25
Annual lupine				
Lupinus pusillus	63	3	5	25
Onagraceae				
Pale evening primrose				
Oenothera pallida	50	5	1	13
Polemoniaceae				
Longleaf phlox				
Phlox longifolia	87	3	81	9
Polygonaceae				
Thymeleaf buckwheat				
Eriogonum thymoides	73	10	21	8
Portulacaceae				
Spiny flameflower				
Talinum spinescens	60	3	12	11
Ranunculaceae				
Virgin's bower				
Clematis ligusticifolia	73	10	47	21
Scrophulariaceae				
Showy penstemon				
Penstemon speciosus	83	10	13	18

Table 1. Germination and emergence of a subset of species (Hitchcock and Cronquist 1973).

restoration problems. This strategy may also be useful in the National Park Service Cooperative Ecosystem Studies Units network.

References

Comes, R.D., V.F. Bruns, and A.D. Kelley. 1978. Longevity of certain weed and crop seeds in fresh water. *Weed Science* 26, 336–344.

Hitchcock, C.L., and A. Cronquist. 1973. *Flora of the Pacific Northwest*. Seattle: University of Washington Press.

Link, S.O. 2006. Ecological restoration in natural areas: Genetic issues. *Natural Areas Journal* 26, 328–329.

Mitchell, E. 1926. Germination of seeds of plants native to Dutchess County, New York. *Botanical Gazette* 81, 108–112.

Senos, R., F.K. Lake, N. Turner, and D. Martinez. 2006. Traditional ecological knowledge and restoration practice. In *Restoring the Pacific Northwest: The Art and Science of Ecological Restoration in Cascadia*. D. Apostol and M. Sinclair, eds. Washington, D.C.: Island Press, 393–426.

Sheley, R.L., and J.K. Petroff. 1999. *Biology and Management of Noxious Rangeland Weeds*. Corvallis: Oregon State University Press.

Sharing a World of Resources: Incorporating Science Content in Effective Interpretation

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Incorporating science content into the presentation of resource issues to the public is essential for effective interpretation. Science professionals are eager to share their work; interpreters are equally eager to learn about relevant science. Yet, interpreting science and resource issues remains a challenge. Professional development for interpreters is critical to effectively address this challenge. Here, we describe a proven model for integrating science into interpretation: the National Park Service (NPS)–NASA Earth to Sky Institutes. These institutes resulted in the creation of a variety of products using science in dynamic interpretation at many national parks. We highlight the methodology of the Earth to Sky Institutes, and share strategies—of successful training including authentic work time, opportunity for reflection, and the creation of a resource-rich learning environment.

The Earth to Sky NASA Explorer Institutes constituted one of several professional development projects funded in 2004 by NASA's Division of Informal Education. Earth to Sky Institutes were unique in forging an exciting new partnership between NASA's space and earth science disciplines, and(NPS interpretation. For the first time, NASA scientists and education specialists worked in true collaboration with NPS interpretation trainers. The team wove NASA's rich content with proven NPS interpretation professional development methodology and research-based adult education techniques to create effective professional development opportunities for rangers.

Participants explored cutting-edge science through interactive presentations by NASA scientists and education specialists, facilitated by experienced NPS interpreters. Five major themes–night sky, comparative planetology, astrobiology, sun-earth connection/space weather, and earth systems science–provided participants with stimulating and important information that they readily incorporated into new interpretive programs, slide shows, written material, Junior Ranger activities, and educational programming. The institutes were quite successful: over 50 NPS units were represented, and each participant developed an action plan to use the new information in their interpretive work. Through these creative and engaging efforts, NASA science is now being included in many compelling stories about our Nation's natural and cultural heritage.

The structure of these successful institutes can serve as a useful model for effective professional development in interpretation, especially with respect to incorporation of new science content (as occurs, for example, during seasonal training).

The goals of the institutes were two-fold: (1) design and implement workshops that respond to park interpreters' needs for professional development; and (2) more actively engage NPS in the use of NASA science content.

Our objectives were to provide opportunities for participants to:

- Broaden exposure to and heighten interest in NASA science;
- Develop further knowledge of and ability to apply the interpretive process model (IPM);
- Enhance NPS familiarity with NASA content (astrobiology, comparative planetology, earth systems science, the night sky, and the sun and space weather);
- Learn how to access NASA's people, programs, and products;
- Apply NASA content to a written product or an interpretive program—create an action plan;
- Network and learn with and from a community of colleagues; and
- Increase understanding and appreciation of interpretation among NASA science and education/outreach staff.

Institute design

To help ensure success, leaders from the intended audience, namely NPS interpreters, were fully involved, from the inception of the institutes' design through implementation, assessment, and strategic planning for sustainability.

The Earth to Sky Institutes began with a planning workshop held at Goddard Space Flight Center (GSFC). NPS interpreter facilitators and experienced interpreters, together with the entire project design team, principal investigators, and selected NASA education and science staff, refined content and structure for the institutes. During this planning workshop, project leadership and interpreter facilitators noted strong similarities in purpose between the two agencies, as exemplified by their respective mission statements:

NASA mission: To understand and *protect* our home planet, *inspire the next generation* of explorers, explore the Universe and search for life, and *engage the public* in shaping and sharing the experience of exploration and discovery.

NPS mission: *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.*

The knowledge that all involved had a commonality of purpose helped unify the team, and strengthened the planning and professional development effort.

Using information gathered at the planning workshop, two institutes were structured to include: (1) learning about and practicing multiple modes of collaboration, (2) science sessions, (3) tours of NASA, and (4) significant time to work in small groups led by NPS facilitators. Daily feedback and overall program evaluation were to be provided by an external evaluation team.

Prior to each of the institutes, NPS interpreter facilitators and NASA science presenters were briefed on the project with the to encourage pre-Institute communication between the two agencies. Our goal was for iterative discussions between presenters and experienced interpreters, so presenters could gauge the needs of their audience, and NPS facilitators could provide timely and useful feedback on Earth and space science presentations.

During the institutes, interpreters had numerous opportunities to connect with NASA scientists, engineers, and technologists. Participants met formally and informally with NASA personnel in a variety of settings, including large groups, small groups, and one-on-one. Formal sessions were designed for small audiences of eight to ten people with ample time for facilitated discussions. These were followed with large amounts of time for facilitated work on developing interpretive products. Several scientists and technologists (some of whom were presenters during the Institutes) also attended ranger presentations on the methodology of interpretation.

The methodology used by the Park Service to develop interpretive products (IPM) coincidentally parallels the professional development methodology used by Earth to Sky design team advisors, WestEd. WestEd's methodology, the authentic task approach (ATA), is based on extensive research in adult learning. Both methods first define the task to be accomplished, and through a series of activities, culminate in the execution of the task. Key features of the ATA include guided facilitation, protected work time, a resource-rich environment, and continuous reflection.

Best practices for effective professional development

The Earth to Sky Institutes used a training architecture that provided facilitated, authentic work time, and allowed participants to process and reflect upon new content, ultimately leading to the development of 50 action plans. In "Designing Professional Meetings and Conferences in Education: Planning, Implementation and Evaluation," Susan Mundry, and co-authors outline established principles that foster effective workshops. These principles, together with a strong evaluation component, formed the underpinning of the Earth to Sky workshops. Below is a list of those principles, illustrated with examples of how the principle was manifest during each institute. Commitment to these principles helps create workshops that promote change or growth, reach clear outcomes, and help people develop new relationships.

1. Establish and share clear outcomes.

- State goals and objectives of workshop up front.
- Give everyone an agenda that provides a sense of structure and rhythm for the experience.
- Provide opportunities for participants to know where they are within the process—recap activities, overview of next steps.

2. Design activities to engage all participants.

- Teach/use collaboration tools (e.g., norms of collaboration—Garmston and Wellman 1999).
- Recognize the importance of shared interest—allow opportunities to highlight shared values, and to share their motivation for being in the training.
- Provide a catalyst for participants to get to know one another (otherwise it may not happen on its own). This also encourages free exchanges of ideas during the training process.
- Create a balance between structured and unstructured time.

- Provide an opportunity for a little fun—silliness with a purpose (awards, icebreakers, etc).
- Provide ample opportunities for informal, unstructured interactions between participants and between participants and speakers.
- Provide for varied learning styles (lecture, facilitated interaction, group work, one on one conversations, "share-a-thon," dedicated individual work time, were all used in Earth to Sky).

3. Model effective learning processes and environments: Make sure participants are learning by being engaged in the process (model good interpretive technique if you are teaching interpretation).

- Try to build some consistency into the structure of each day (research supports this concept).
- Allow choice (do not always assign group memberships, allow learners to choose topics of greatest interest if at all possible).
- Give breaks!
- Move from the most familiar to the least familiar throughout course of workshop.
- Have groups build some cohesiveness and achieve some success (perhaps with somewhat familiar content) before attempting a big task or before learning and applying weighty content.
- Pay attention to the physical space. Setting is important (familiar locations or new, cramped room versus spaciousness, urban or rural, lighting, layout of space). Orient people to physical space and let them know their physical needs will be met: breaks; lunch; where is the bathroom, pencil sharpener, socket for laptop, coffee, etc.

4. Establish clear roles.

- Describe who is involved in the workshop/task (in Earth to Sky: education and outreach specialist, scientist, facilitator, evaluator, participants).
- Clarify the task (in Earth to Sky it was to learn and create a plan for an interpretation product using new knowledge).
- Remind participants of their responsibility for achieving the task as appropriate/needed.

5. Have participants take responsibility for reaching the stated outcomes.

- Earth to Sky facilitator/coaching structure (facilitators also were participants, and their coaching helped participants to stay focused and on task).
- Part of the requirement for acceptance to the course was a commitment to use materials and content presented during the workshop.
- Set realistic and honest expectations (e.g., do not surprise people at the end by suddenly collecting or reporting their work!).

6. Connect with participant's own work and thinking.

- Provide a context for the content to be delivered (for Earth to Sky, it was science context and interpretation context—provide participants with a contextual understanding of where the content fits).

- Ask yourself, how will the content apply to participants' jobs?
- In Earth to Sky we taught the IPM before the science, so people could begin to relate how the science would fit into the process of creating interpretive products.
- In Earth to Sky, facilitated discussions for each science presentation provided an opportunity for participants to make the connection between the content and their own work (creating interpretive products).

7. Provide opportunities for continued learning and maintaining relationships after the event.

- Through use of technology maintain contacts (follow up e-mails, calls, updates; website creation).
- Availability of leaders and scientists after event was emphasized in Earth to Sky.
- Make use of the mentoring/coaching/"auditing" processes at home park or site.

8. Encourage participants to share what they have learned with others outside the event.

- Participants were asked to do so as part of initial screening process.
- Participants created and conducted training for peers at their parks/regions.
- Action plans and follow-ups were posted on the workshop website.

9. Ensure adequate time for authentic work activity (as close as possible to the participants' "real world" task).

- Stick with the 40/60 rule (40% content, 60% to reflect upon and use the content to accomplish the task—challenging to do!).
- Ensure dedicated, structured time to work together on identified task.
- Provide a resource-rich environment (experts, in-print resources, electronic resources, example interpretive techniques, etc.).

10. Provide ample time for reflecting on the information and experiences.

- Include reflection time for participants throughout the workshop (use journals and pauses to write/think in sessions).
- End-of-day assessment/reflection time for participants (a chance to breathe! journal time).

11. Meaningful evaluation! (Note that providing reflection time increases likelihood of worthwhile responses during evaluation.)

- Use the application process as tool for pre-assessment; use e-mail or online access to administer pre-assessment tool.
- Use a pre-and post-assessment chart (create a simple scale for level of expertise in subject matter and have participants self-rate prior to and at end of sessions or workshop).
- Use focus groups to provide feedback at points during the workshop (this formative

evaluation helps catch items one might not otherwise, in order to make needed changes which help ensure success).
- End-of-day debrief for workshop organizer team (this provided insights we would not have otherwise received).

Results

As a result of the institutes, interpreters internalized new NASA science content and incorporated it into their own practice. Their plans show a high level of application of learning, as well as reaching the synthesis level of Bloom's (1956) taxonomy of learning. Participants learned about aspects of NASA's science that relate directly to their own parks and to the interests of the park visitors, greatly increased their ability to access NASA resources, and incorporated these resources into their own practice. Presenters made strong connections with interpreters, expressing interest in continuing the collaborative work with the NPS, and meaningful professional relationships between and among NASA and NPS staff were established and expanded. Finally, high interest was developed among NASA scientists, Education and outreach personnel, and management, to learn more about the NPS interpretive method for use in their own professional work.

NPS interpreters are now integrating NASA science at parks throughout the country. For example, "Never Summer, Ever Summer," an interpretive program at Rocky Mountain National Park, incorporating climate change, dynamics of our Sun, and changes in the landscape over time; "Night Watch/Sky Watch: The Universe through the Lens of Science and the Native American Perspective," an interpretive talk; "Hydrothermal Vents: Life in Extreme Environments on Earth and Beyond," an interpretive talk; development of a Junior Space Ranger activity booklet and accompanying badge at Delaware Water Gap National Recreation Area; and, from follow-up activities, a "Climate Change in Parks" brochure and display have been developed for use NPS-wide.

Conclusion

It is evident that the methodology used in the Earth to Sky Institutes made is possible for NPS interpreters to readily absorb and use the new material presented to them. NASA exploration and science programs offer substantial benefits to NPS interpreters who in turn, inform and inspire park visitors about our place in the natural world and the universe. NPS interpreters and NASA scientists are gaining new perspectives and creating products that use relevant science and imagery to support dynamic interpretation in the national park setting.

> Thank you! This was a tremendously successful course.... There is no question that my programs and the written material I create for students and teachers will be greatly enriched.
>
> — Earth to Sky participant

> ... a fantastic workshop. I am honored to have participated in such a well-organized and inspirational event. It has broadly expanded my interpretive mind.
>
> — Earth to Sky participant

References

Bloom, B.S. 1956. *Taxonomy of Educational Objectives, Handbook I: The Cognitive Domain*. New York: David McKay Co.

Garmston, R.J., and B.M. Wellman. 1999. *The Adaptive School: A Sourcebook for Developing Collaborative Groups.* Norwood, Mass.: Christopher Gordon.

Mundry, S., E. Britton, S.A. Raizen, and S. Loucks-Horsley. 2000. *Designing Professional Meetings and Conferences in Education: Planning, Implementation and Evaluation.* Thousand Oaks, Calif.: Corwin Press.

Breakfast at the Cockpit Café and Other Innovations in Protected Area Outreach

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Introduction

Fundamental changes in protected area outreach and education strategies are dissolving old boundaries and fostering innovative approaches to civic engagement. The practice of community-based ecosystem management as presented by Meffe et al. (2002) provides an organizing framework blending ecological, institutional and sociocultural perspectives. This framework flows from a definition of ecosystem management that considers sustaining ecosystem structure and processes across spatial and temporal scales in tandem with societal priorities. The decision-making authority in this system, envisioned as collaborative and participatory, can present challenges for traditionally trained protected area managers. This definition views ecosystem management as:

> … an approach to maintaining or restoring the composition, structure, and function of natural and modified ecosystems for the goal of long-term sustainability. *It is based on a collaboratively developed vision* of desired future conditions that integrates ecological, socioeconomic and institutional perspectives, applied within a geographic framework defined primarily by natural ecological boundaries (Meffe et al. 2002:70, emphasis added).

Roles for natural resource professionals within this integrated system include participation as stakeholders and pioneers in collaborative processes that transcend traditional concepts of *boundaries* inherent in the core definition of protected areas.

Critical examination of beliefs concerning *where* ecosystem management happens, *who* is responsible for implementing management practices, and *what* constitutes effective processes for identifying and prioritizing action can fuel the development of innovative strategies for accomplishing the mission of protected areas (Feurt 2007; Lyman 2006).

Strategic community-based ecosystem management, as exemplified by the two case studies presented here, links the management objectives of protected areas with local and regional place-based initiatives. In this model, protected area outreach and education serves a catalytic function, fostering the creation of what Meffe et al. (2002) refer to as "win-win-win partnerships." These partnerships draw strength from shared goals and repeated opportunities for analysis and deliberation about progress toward those goals (NRC 1996). Pragmatic considerations relevant to the social, economic, and cultural dimensions of natural resource issues are deliberated within the context of collaborative knowledge networks that evolve through on-going relationships. The concept of collaborative knowledge networks captures the relationship among protected areas managers, local communities, and organizations with shared missions for sustaining natural systems in locally valued places (Feurt 2007). These networks provide what Kai Lee (1993) calls the *gyroscope* guiding the course of adaptive management. Science, in the form of biodiversity assessments and watershed surveys, is the *compass* used for charting the course for management actions in these case studies.

The Rachel Carson National Wildlife Refuge (NWR) and Wells National Estuarine Research Reserve (NERR) share a physical land base and philosophical commitment to achieving biological diversity and habitat conservation goals through partnerships. Located along the southern coast of Maine in the Gulf of Maine watershed, the region is the most rapidly developing in the state. The Rachel Carson Refuge encompasses 10 units with a combined size of 5,200 acres spread along 50 miles of Maine's coast between Kittery and Cape Elizabeth (U.S. Fish and Wildlife Service 2006). The refuge holds the honor and concomitant responsibility of having more neighbors than any refuge in the system. The 2,000-acre Wells National Estuarine Research Reserve overlays a portion of the refuge, located primarily in the coastal portions of the watersheds of the Webhannet and Little rivers (Dionne et al. 2006).

Case study #1: The Mount Agamenticus to the Sea Conservation Initiative

The title of this paper alludes to a frequently unappreciated aspect of community-based ecosystem management. The genesis of ideas and complex conversations where people sift through priorities, debate conflicts, and strategize over challenges frequently occur over coffee, in local restaurants and in homes. What was to become the Mount Agamenticus to the Sea (MtA2C) Conservation Initiative began with the work of the York Rivers Association and grew to include additional partners at an informal potluck supper in 1999. The nexus of what was to become a ten-organization coalition has evolved over the past eight years. National and regional conservation organizations, three local land trusts, and state and federal agencies comprise the coalition including: U.S. Fish and Wildlife Service (USFWS) Rachel Carson NWR, Wells NERR, The Nature Conservancy, Maine Coast Heritage Trust, Trust for Public Land, Maine Department of Inland Fisheries and Wildlife, York Land Trust, Kittery Land Trust, Great Works Regional Land Trust, and York Rivers Association (Lyman 2006). This dedicated group of stakeholders continues to punctuate and celebrate success with gatherings at community potlucks.

Causes for celebration during the past eight years have been significant and varied. Key accomplishments include:

- Delineate the 48,000-acre conservation area based upon a collaboratively developed vision to protect ecological systems and community values.
- Develop and apply diverse processes for managing the initiative, including leadership, financing, staffing, and balancing priorities of participating organizations.
- Develop and implement a science-based conservation plan (Ward 2000; MtA2C 2005) based upon The Nature Conservancy's 5-S Framework (TNC 2000).
- Identify and protect 1,495 acres of high-priority conservation sites.
- Engage six towns in regional land conservation based upon the goals of the conservation plan.
- Complete a $10 million capital campaign.

These accomplishments resulted from the dedicated work of both volunteers and members of the coalition organizations, as well as technical support provided by professional staff, and outside consultants hired to bring specialized expertise to the group (Lyman 2006).

The managers of both the Rachel Carson NWR and Wells NERR participated as members of the MtA2C Conservation Initiative throughout this partnership. Wells NERR, as a state/federal entity, linked the project to Maine state government and National Oceanic and Atmospheric Association (NOAA) programs. Rachel Carson NWR provided science expertise, including wildlife habitat modeling results. Linking project objectives to the objectives of the Rachel Carson NWR comprehensive conservation plan and the mission of the Wells NERR elevated the work of the coalition to national significance. The project benefited from enhanced congressional awareness due to communication emanating from two trusted federal protected area managers.

Both NOAA and the USFWS provided links to funds, including Coastal and Estuaries Land Protection funds and North American Waterfowl Conservation Act grants. As experienced managers of established federally protected areas, the reserve and refuge managers regularly consider long-term consequences of acquisition and management decisions. This professional expertise and institutional capacity provided a stable foundation for the coalition's habitat prioritization and land conservation efforts.

The MtA2C Conservation Initiative influenced the focus of Rachel Carson NWR's habitat protection efforts. The coalition's land protection committees developed specific landowner contact information on parcels within the refuge acquisition boundary. The refuge benefited from this local knowledge and the community connections provided by local land trusts. The MtA2C's goals were not identical to the missions of the reserve or the refuge. Where goals overlapped the power of the coalition made collaboration mutually beneficial, financially attractive and efficient. What the coalition accomplished could not have been achieved by any single organization.

Case Study #2: Protecting Our Children's Water

> The whole system of science, society and nature is evolving in fundamental ways that cause us to rethink the way science is deployed to help people cope with a changing world. Scientists should be leading the dialogue on scientific priorities, new institutional arrangements, and improved methodologies to disseminate and utilize knowledge more quickly (Lubchenco 1998:496).

The Coastal Training Program (CTP) of the national estuarine research reserve system (NERRS) is a proving ground for new education and outreach methodologies with a fundamental goal of putting science to work. Each of the 27 research reserves choosing to implement this national program completes a market analysis and needs assessment to identify critical coastal management issues, science-based training needs, and gaps in the training and education provider network serving the region surrounding the reserve. Each regionally adapted CTP aims to enhance the capacity to use scientific information as a basis for decision-making and increase networking and collaboration among coastal decision-makers.

Municipal land use decision-making and the implications of those decisions for water quality and habitat are key focus areas for the Wells NERR CTR (Krum and Feurt 2002).

For the past six years, the Wells NERR CTP has experimented with an adaptation of community-based ecosystem management based upon an interdisciplinary blend of collaborative learning (Daniels and Walker 2001) and cultural models theory and methodology. The Protecting Our Children's Water project uses ethnographic knowledge of stakeholder and institutional barriers to science translation and progress on watershed management goals to create and maintain a collaborative knowledge network. A regional Watershed Council, formed experimentally in the summer of 2005, included planning, public works, and code enforcement staff from three municipalities, volunteers from community conservation groups, and staff of the local water district, Rachel Carson NWR, Maine Department of Environmental Protection, Maine Sea Grant, and Wells NERR.

Water quality monitoring and a non-point source watershed survey contributed to a watershed management plan, which the watershed council used as the basis for priority-setting and action during the experimental phase of the project. Like the MtA2C Coalition, the diverse members of the watershed council were united through shared goals: in this case, for clean water. Equally powerful were shared values about the importance of clean water and perceptions of the threats posed by development. These shared values provided some of the motivational force for participation on the watershed council, contributing to the overall collaborative potential of the project despite conflict associated with property rights and diverse professional orientations (Feurt 2007).

The collaborative learning approach developed by Daniels and Walker (2001) provided the procedural framework for collaborative development of priority actions and evaluation of progress or improvement in watershed conditions. Ethnographic knowledge of the complexity of municipal water management revealed a complex system where seven *ways of knowing* or types of knowledge interacted within a "kaleidoscope of expertise." Ways of knowing include: governance, educational practices, science, technological, land use, ecological, and local knowledge. The "kaleidoscope of expertise" includes eight distinct professional approaches to protecting water:

- Regulatory approaches, ordinance development, and enforcement;
- Land conservation;
- Planning and land use management;
- Engineering and public works;
- Drinking water provision and source water protection;
- Water research and monitoring;
- Education and community outreach; and
- Citizen and business watershed stewardship.

Practitioners draw from multiple knowledge domains in their work. Opportunities for addressing water management across disciplinary and institutional lines are rare. Indeed, a dominant barrier to collaboration and science translation has been the perception, on the part of protected area institutions such as the NERRS, that municipal officials are *receptacles* awaiting the *delivery* of science-based information. The Protecting Our Children's Water project recognized and cultivated the problem-solving potential inherent in the municipal water management system as a rich *resource.* The collaborative learning approach, systematically applied within the Protecting Our Children's Water project provided a template for collaboration and action. Evaluation by participants and elected officials in the member towns acknowledged both successes and failures during the experimental phase. This evaluation resulted in the decision to continue to use the watershed council approach to address watershed-scale efforts to protect and enhance water quality (Feurt 2007).

The Cockpit Café at the Sanford Regional Airport became a gathering place for the watershed council. The airport was the site of a successful field trip to learn more about the challenges of managing airport stormwater in the headwaters of a five-town drinking-water source. The same airport faces homeland security constraints out of proportion to its size because the current president and former presidents use it as a landing area during visits to nearby Kennebunkport, Maine.

On the one-year anniversary of the first meeting of the watershed council, delegates met for breakfast at the Cockpit Café. Over breakfast, surrounded by World War II aviation memorabilia, fifteen people talked about the potential for the new Super Wal-Mart to adopt low-impact development practices, the construction of a new interstate highway access through the watershed, all-terrain vehicle impacts, transfer of development rights, and the fact that a field trip in pouring rain was a great way to learn about non-point source pollution. Breakfast was an informal prelude to a field session designed to allow the group to observe and discuss three projects relevant to ecosystem management: restoration of a severely eroded rural riparian site; a bio-engineered wetland mitigation site; and characterization and restoration of an urban watershed. The ability to observe watershed-scale land use effects makes these social–ecological interactions powerful opportunities for learning. Interpreting ecosystem management at this scale begins with dialogue over coffee and ends with step-by-step progress toward agreed-upon goals.

Conclusion

Both breakfast at the Cockpit Café and the community celebrations honoring accomplishments of the MtA2C Conservation Initiative are components of innovative outreach strategies characteristic of community-based ecosystem management. These experiences of civic engagement are part of the gyroscope guiding the adaptive management cycle of ecosystem management. They bring people to the table for conversation and careful consideration of the learning and stewardship associated with progress toward desired environmental outcomes. Dialogue contributes to the recognition of new problems, collection of local knowledge about cause-and-effect relationships, identification of values and motivations associated with stewardship, and pulse-taking for sources of conflict and collaboration. The collaborative knowledge networks described in these case studies are manifestations of what sociologist Robert Putnam (2000) calls "social capital."

The science embedded in the conservation plan and watershed management plan becomes real for people when they can link actions aimed at protecting ecosystem integrity with actions designed to "make the places we live, work and play noticeably better today and in the future" (Meffe et al. 2002:67). Social capital played a critical role in both of these case studies. Social capital remains a largely untapped resource for facilitating science translation. Its value is difficult to imagine when protected areas are conceived of as pristine nature surrounded by boundaries excluding outside threats. *Seeing* ecosystem management in working landscapes, *recognizing* ecosystem management in stormwater treatment at the airport, and *hearing* ecosystem management when the developer talks about his vision for restoring a sediment-choked stream adjacent to his low-income housing project requires forays into the everyday world of people acting as stewards and managers of their local environments. The new outreach paradigm presented in these case studies bridges the institutional world of traditional protected area management to new constituencies in the communities that surround them as an antidote to *preaching to the choir*. The experience brings science out of the church altogether by recognizing the importance of linking the stories that science tells with places that people value to forge relationships invaluable for learning and stewardship.

References

Daniels, S., and G. Walker. 2001. *Working through Environmental Conflict: The Collaborative Learning Approach.* Westport, Conn.: Praeger.

Dionne, M., C. Dalton, and H. Wilheim, eds. 2006. *Site Profile of the Wells National Estuarine Research Reserve.* Wells, Maine: Wells National Estuarine Research Reserve.

Feurt, C. 2007. Protecting Our Children's Water—Using cultural models and collaborative learning to frame and implement ecosystem management. Doctoral dissertation, Antioch University–New England, Keene, New Hampshire.

Krum, C., and C. Feurt. 2002. *Wells National Estuarine Research Reserve, Coastal Training Program: Market Analysis and Needs Assessment*. Executive summary available on-line at www.wellsreserve.org/ctip/exec-mana.htm.

Lee, K. 1993. *Compass and Gyroscope: Integrating Science and Politics for the Environment.* Washington, D.C.: Island Press.

Lubchenco, J. 1998. Entering the century of the environment: A new social contract for science. *Science* 279, 491–497.

Lyman, M. 2006. *An Evaluation of the Mt. Agamenticus to the Sea Conservation Initiative: An Assessment of the Mt. Agamenticus to the Sea Conservation Initiative*, *October 2002–October 2006*. York, Maine: MtA2C Coalition.

Meffe, G., L. Nielsen, R. Knight, and D. Schenborn. 2002. *Ecosystem Management: Adaptive, Community-Based Conservation*. Washington, D.C.: Island Press.

MtA2C [Mt. Agamenticus to the Sea Conservation Initiative]. 2005. *A Conservation Plan for the Mt. Agamenticus to the Sea Conservation Initiative.* Available from www.mta2c.org/mta2c_ conservation_plan.pdf.

NRC [National Research Council]. 1996. *Understanding Risk: Informing Decisions in a Democratic Society.* Washington, D. C.: National Academy Press.

Putnam, R. 2000. *Bowling Alone: The Collapse and Revival of American Community*. New York: Simon & Schuster.

TNC [The Nature Conservancy]. 2000. *The Five-S Framework for Site Conservation*: *A Practitioner's Handbook for Site Conservation Planning and Measuring Conservation*

Success, Vol. 1. 2nd ed. Arlington, Va.: The Nature Conservancy.

U.S. Fish and Wildlife Service. 2006. *Draft Comprehensive Conservation Plan for Rachel Carson National Wildlife Refuge.* South Hadley, Mass.: USFWS, Region 5.

Ward, M. 2000. *Mt. Agamenticus to the Sea Conservation Plan*. York, Maine: MtA2C Oversight Committee.

Great Lakes Research and Education Center, Indiana Dunes National Lakeshore: Connecting Research, Education, and Outreach through Research Internships

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Introduction

The National Park Service (NPS) initiated the Natural Resources Challenge in 1999. The Challenge resulted in the development of research learning centers (RLCs) throughout the country. The RLCs increase the effectiveness and communication of scientific research in national parks by (1) facilitating use of parks for scientific inquiry; (2) supporting science-based decision-making; (3) communicating current research information; and (4) promoting resource stewardship through partnerships. RLCs initiate, support, and implement a wide variety of research projects and provide opportunities for university students to work with researchers and park managers. The Great Lakes Research and Education Center initiated a university student research internship program in 2005 to provide support for researchers and managers in the Great Lakes Network parks (Figure 1). Among the network parks, eight participated in the program.

Internship funding

The Great Lakes Research and Education Center allocated $25,000 of its FY2005–2006 budget for development of the internship program. Since eight parks participated, a total of $3,125 was earmarked for each park. Indiana Dunes National Lakeshore administered fund distribution to each park. In February 2006 an announcement was developed for

Figure 1. Great Lakes Research and Education Center Network parks.

summer student internships according to the research needs of the responses received from eight park managers. The schedule for the interns' duty time varied by park needs. The announcement was advertised in the Great Lakes–Northern Forest Cooperative Ecosystem Studies Unit (CESU), RLCs, and NPS websites. It was also placed in the jobs announcement section of the Society of Wetland Scientists. Applicants sent materials, including their resume, preferred primary and secondary park sites, and references, to the Great Lakes Research and Education Center research coordinator. The research coordinator sorted the applicant materials by applicants' preferred parks, and sent applicant materials to each park. The resource management staff at each park then selected the most qualified applicant for their park.

There were 49 applicants from several universities in the Midwest region. Apostle Islands National Lakeshore selected an applicant internally. The number received and reviewed for each of the other parks were: Indiana Dunes National Lakeshore (10), Isle Royale National Park (9), Keweenaw National Historical Park (3), Pictured Rocks National Lakeshore (5), St. Croix National Scenic Riverway (8), Sleeping Bear Dunes National Lakeshore (7), and Voyageurs National Park (9).

Products

Each park produced a report on the research and monitoring projects that interns were assigned. Products that interns produced included development of research equipment, reports, and oral presentations using PowerPoint to park staff and at conferences. Reports and PowerPoint presentations will be uploaded to NPS websites for managers and the public to view. Table 1 summarizes student background, projects, and products obtained through the internship.

Following project completion, a survey questionnaire was emailed to both the resource managers and the interns to evaluate the success of the program. The responses were summarized as follows:

Results of resource manager survey (8 parks)

- Rank according to: highest approval (5), OK (4), no opinion (3), somewhat dissatisfied (2), highly dissatisfied (1).
- Please comment on each question and make recommendations.

1. Ease of obtaining funding from the Great Lakes Research and Education Center (explain how you used the funding: biotechnician, Student Conservation Association, etc.). Average rating was 4.25. The ranking indicates that resource managers were satisfied with the funding procedures through the Great Lakes Research and Education program.

2. Timeliness (i.e., did you get the internship started in time for your field work assignments?). Average rating was 4.20. One park resource manager found much difficulty in getting the internship underway, due to funding transfer problems.

3. Experience and qualifications of the intern. Average rating was 5.0. Resource managers were very pleased with the interns' qualifications and results that they produced.

4. Recommendation for future internships. Average rating was 4.6. All parks highly recommended continuation of the program in the future, with recommended improvements

Degree Sought	Location	Fields of Research	Research Topics	Types of Products
Post-Master's	Sleeping Bear Dunes NL	Biology (Avian Ecology)	Piping Plover Recovery Efforts at Sleeping Bear Dunes National Lakeshore	2006 Year in Review Article, Presentation at Great Lakes Piping Plover Recovery Group Meeting
Master's	Pictured Rocks NL	Biology (Mammalogy)	Hair Sampling of Black Bear and White-tailed Deer for DNA Population Characterization	Data and report
Bachelor's capstone	VoyageursNP	Biology (Avian Ecology)	Synthesis of Great Blue Heron Monitoring Data: 1974-2006	Senior B.S. thesis
Bachelor's	Apostle Islands NL	Anthropology/Biology	Woody Debris Availability to Campers for Firewood	Report and park presentation
	Indiana Dunes NL	Chemistry, Biology	Methyl Mercury Sampling Methods, Endangered Butterfly	Methyl mercury probe, presentation
	Isle Royale NP	Biology (Mammalogy)	Mustelid Survey/Marten Tracking via Radio-collar	Data and report
	Keweenaw NHP	Cultural History	Timeline of Michigan Copper Mining	Brochure, poster
	St. Croix NSR	Biology	Grassland Butterfly and Bird Population Monitoring	Two reports, presentation

Table 1. Examples of student educational levels and products from participating parks.

in funding transfer and more participation of CESU researchers.

5. Recommend increase in number of internships? Most resource managers were satisfied with having one intern. One park suggested having two interns working together in the field for safety reasons. Basically, having one intern is good, two would be better.

Other comments: Resource managers highly recommended that the program be continued in the future.

Results of student intern survey

- Rank your experience with the internship program. Please respond objectively. Rating 1–5: 5= highest, 1= lowest.

1. How would you rate your research learning experience during the internship? Average ranking was 4.5. The interns gained new knowledge about natural resources in the Great Lakes national parks.

2. What suggestions would you recommend to improve the learning experience? Interns suggested that they receive more detailed background about their assigned projects, prior to starting their employment. They also suggested that work should focus on only one or two projects.

3. How would you rate the housing facilities? Average ranking was 4.25 for those interns who were provided park housing. One intern noted that the housing shared with other temporary staff was not always kept clean in a cooperative manner.

4. What suggestions do you have for the housing? No major suggestions were made.

5. Would you recommend this program to other students? Average ranking was 5.0. The interns thought the program provided a very good work experience to students.

6. Would you like more direction in a defined research project? In what way? See number 2 above. Interns valued the experience because it did provide them with a major project in most cases. The projects provided them opportunities to collaborate with resource managers, develop independent thinking, and develop field research skills.

7. Any other suggestions? Interns suggested that the paperwork and logistics be worked out in advance before their work assignments began.

Future planning for Great Lakes Research and Education research internships

The Great Lakes Research and Education Center played an important role in promoting student research opportunities in the Great Lakes Network parks. This effort benefited resource managers in providing needed field assistance, and provided students with a hands-on research and monitoring experience in the eight parks.

A RLC research internship program can provide a strategic link for conducting park science and meeting public education needs. The program can provide hands-on training for undergraduate and graduate students, toward future natural resource manager positions, in a real-world situation. Parks are "living laboratories" in which concepts can be tested in the field for improving park management. For example, a student could conduct experimental seed germination and propagation studies of various native plant species in order to develop better restoration techniques. Interns who are paid by the National Park Service can be trained by scientists and managers to help conduct research projects in the parks. Several of the projects focused on monitoring activities rather than actual research. Resource managers in the participating parks recommended continuation of the program; however, future efforts should be more focused on actual research projects by teaming the student intern with a university or U.S. Geological Survey researcher. The Great Lakes–Northern Forest CESU could be a point of contact to promote the research elements of the program.

References

Brewer, C. 2001. Cultivating conservation literacy: "Trickle-down" education is not enough. *Conservation Biology* 15:5, 1203–1205.

D'Avanzo, C. 2003. Research on learning: Potential for improving college education teaching. *Frontiers in Ecology and Environment* 1:10, 533–540.

Jacobson, S.K. 1990. Graduate education in conservation biology. *Conservation Biology* 4:4, 431–440.

Using Experiential Learning Opportunities in the National Parks to Inform Science Classroom Practice

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Theoretical program bases

Experiential learning is a process through which a learner constructs knowledge, skill, and value directly from an experience within the environment. Learning occurs when carefully chosen experiences are supported by reflection, critical analysis, and synthesis. Experiences are structured to require the learner to take initiative, make decisions, and be accountable for the results. The results of the learning are personal and self constructed, preparing for and leading to future experiences and learning. Relationships within the experience are developed and nurtured. Lave and Wenger (1991) suggest that individuals learn as they participate by interacting with a community, its history, assumptions and cultural values, rules, and patterns of relationship; the tools at hand, including objects, technology, language and images; the moment's activity, its purposes, norms, and the practical challenges. Shared knowledge emerges from the interaction of these elements. The interactions and shared experiences result in what Davis and Sumara (1997) refer to as a "commingling of consciousness." As each participates, the relational space among them all changes. This is "mutual specification" (Varela et al. 1991), the fundamental dynamic of systems engaging in mutual action and interaction. Activities that involve professionals in open and dynamic discussion, mutual problem solving and/or collaborative learning, draw the participants into a community of learners or professional cohort and contribute to a deeper shared understanding of an experience.

The use of a field site such as a national park considers this theoretical base in planning meaningful activities. The field experience is designed to meet all of following program objectives.

- Increased knowledge of science content.
- Holistic understandings of the connections and relationships within the selected environment.
- Skill development in doing science inquiry utilizing the field site resources.
- Support for implementation of critical thinking and problem solving skills.

For maximum impact, the learner must be actively engaged in the experience and the experience must be structured to require the learner to take action, draw conclusions and support their understandings. Another important component of the experience is the nature of interactions among participants. The more positive the interaction, the more likely the experience will be viewed favorably. In any group experience, when relationships are developed and nurtured, the group has the potential to evolve into a community or cohort. The key to group learning is not so much the destination, but rather the chance to participate in a true learning experience within the context of a cohort in a rich environment.

What does an inquiry-based national park visit look like?

In designing an inquiry-based approach for the participants, the experience is something that they do, not something that is done to them. As a result they must actively construct knowledge by making connections with and building on prior knowledge, and working with and using science ideas and concepts. As such, scientific ways of communicating, thinking, evaluating evidence, constructing arguments, and problem solving become central aspects of the experience. The visit must be well planned, the participants well prepared for the content to be explored and there needs to be an over arching theme to the investigation.

General planning approach: Developing an overarching theme

The first step in any field experience is to identify the connecting theme for all the activities. Visiting a site or series of sites without a connecting theme results in unpredictable learning. Unifying the activities through such a theme allows the content to transfer from a base knowledge of definition and description to complex understanding of interactions and relationships.

Hawaii Volcanoes National Park example. The theme used for Hawaii Volcanoes is change from newest lava on the Big Island to oldest on Kauai. This theme looks at the rock chemistry, plant adaptation, surface features, and human interaction. The flow of activities reinvestigates these four components at each new site. Observing new land formed through eruption and later the chemical breakdown of these lavas into clay and sand becomes the conceptual base for the activities. While at Hawaii Volcanoes, participants visit numerous locations at the summit caldera; hike out to PuuOo (the present eruption site) and later down to the ocean to view lava entering into the ocean (newest land). While on Kauai, the group visits Waimea Canyon and the Na Pali Coast for chemical breakdown and soil studies.

Grand Canyon National Park example. The theme in this study is identifying ancient environments through rock characteristics utilizing national park and other sites, from Capitol Reef National Park, down the Grand Staircase, through Escalante, Bryce Canyon, Zion, Marble Canyon, and finally rafting through the Grand Canyon. Initial sites of sedimentary rocks are used as lecture points to review and observe environmental characteristics. Then sites in the Grand Canyon are used by the students utilizing the knowledge learned earlier to interpret the environments for the instructor. This transfer of responsibility moves the knowledge to understanding for the students through application.

Identifying appropriate site resources

Planning field experiences. Park information and other resources are extensive and available for most sites. Park websites provide a great deal of this information. However, the understanding of this content by the instructor/planner is obtained during a site visit prior to the group field study. Utilizing trail guides and maps, study sites are identified based on the study objectives, Rangers provide specific information through guided hikes and visitor center talks, and at the information desk. Geographic information systems (GIS) and contour maps are identified for the field site. Without the on-site planning the educational objectives will be difficult to address.

A content-analysis procedure is used to evaluate NPS on-line and written content selected for the field study. The procedure is based on the learning objectives determined for the field study. The steps are given in Table 1.

Hawaii Volcanoes example. A detailed field guide is developed to provide specific content information, field study directions, and activities. The guide uses a day-by-day timeline. Content information was derived from published sources produced at the Hawaii Volcano Observatory, the Hawaii Volcanoes website, and the U.S. Geological Survey (USGS) and National Park Service (NPS). Trail guides and volcano safety information from the park are used.

Table 1. Steps in the content-analysis procedure.

• Make a preliminary review of the materials to determine if they address the targeted learning objectives. • Analyze the materials for the alignment between content and the theme of the field study. Important criteria considered in this step of the analysis include the following:
1. Materials support the field study theme.
1.1. Can the materials be used to support an overall sense of purpose and direction that is understandable and motivating to students?
1.2. Can the material be used to support the purpose of each activity and its relationship to others?
1.3. Can the materials be used to involve students in a logical or strategic sequence of activities (versus a collection of activities) that build toward understanding of a concept(s)?
2. Materials support the student's prior knowledge.
2.1. Can the material be used to support specific prerequisite knowledge/skills that are necessary to the learning of the content?
2.2. Can the materials be used to explicitly address commonly held ideas the teachers may bring into the experience?
3. Materials engage the students with phenomena.
3.1. Do the material provide multiple and varied science phenomena to support the field study theme?
3.2. Do the materials support activities that promote first-hand experiences?
4. Materials develop and use scientific ideas.
4.1. Can the materials be used to develop an evidence-based argument in support of the field study theme?
4.2. Can the materials be used to introduce technical content knowledge in conjunction with experience that facilitates thinking and promote effective communication?
4.3. Do the materials include accurate and comprehensible representations of scientific ideas?
4.4. Do the materials explicitly draw attention to conceptual connections?
4.5. Can the material be used to provide tasks/questions for students to practice skills or use of knowledge in a variety of situations?
5. Materials promote student reflection.
5.1. Can the material be used to develop tasks and question sequences to guide student interpretation and reasoning about the experiences?
6. Materials enhance the learning process.
6.1. Can the materials be used to explicitly draw attention to appropriate connections to other content?

Grand Canyon example. The Grand Canyon field guide is divided into a number of sites located in various national parks. Information for each site is obtained from park websites and USGS resources. Colorado River guidebooks are used on the raft.

Establishing content base and then transferring to understanding through problem-solving

Field guide development. Content base development is the traditional purpose of field experiences. An instructor leads the learners through guide walk, roadside stops, and field lectures. Learners dutifully take notes, draw pictures and record observations. Activities such as this may develop some understanding on the part of the student and perhaps support later classroom discussions. To increase the value of the field experience the newly learned or observed content needs to be applied through a series of problem solving, critical thinking activities. These activities need to become more complex as the field experience progresses.

Hawaii Volcano example. The approach to this field experience first requires the development of knowledge about lava chemistry, volcanic formations and features in order to establish a content base for the following field problems. Prior to the trip, I provide each student with readings, a field guide ,and specific information on each site. These materials are enhanced by a range of USGS/NPS on-line documents and trail guides. Once at the park the first priority is to build on the content knowledge. For example the first morning at Hawaii Volcanoes utilizes a series of sites and trails beginning with a hike down the Halemaumau Trail. Along the trail and onto the caldera floor, the students are introduced to lavas and features: fault blocks, fissures, tumulus structures, pahoehoe and aa, lavas, lava chemistry and breakdown. Later that morning: lava tubes, volcanic ash, cinder, ejecta, and rift zone features. In the afternoon the activity changes to student interpretation. The Kilauea Iki crater floor is used as the site for the first student application. They develop an interpretation of what happened during the Kilauea Iki eruption, applying the content learned in the morning. This approach is utilized throughout the rest of the field study, alternating content learning through instructor lecture and group discussion at one site, and individual learner application of the new content at a new site.

Grand Canyon example. This field study utilizes a different approach. Content is developed through a series of stops on the way to the canyon. Sedimentary rocks in the various parks are investigated as to composition, structural features, and sediment sorting. Methods of identification are modeled such as sedimentary signatures. The students keep field notes and iPod audio records of the various environments and identification features. In the second stage of the field course while rafting through the canyon, the students do the interpretation and explain their conclusions.

Reporting understanding

Post-trip report development. It is extremely important in the establishment of true understanding that the learner design and implement a means of explaining their understandings. The process of doing so forces clarification and deepens understanding. During the actual field experience this reporting is done verbally. Following the field experience the reporting is presented in a more formal way utilizing such technologies as power point or digital stories. These presentations utilize GIS/global positioning system (GPS), digital photography, and iPod recordings.

Technology

On our field studies, students use an iPod with a voice recorder to take notes and a digital camera to take photos. They then create a digital movie in iMovie.

iPod. We use Apple iPods (30 GB 7500) with a Micromemo microphone allowing us to easily record in the field. The microphone is attached to the iPod through the remote/ headphone connector, basically sitting on the side of the iPod. It is omni-directional. No special software is required beyond the iPod software. The iPods are easily connected to Macs via iTunes and also work with Windows XP or 2000 on PCs. With either attachment the iPod can record interviews to hard disk. The iPod has mono, low-resolution sound recording capabilities. Sound quality is outstanding, battery life excellent, and recording capacity amazing (hours and hours). With a hard disk, there is no media to purchase, lose, or have jam up. The unit is very small. Transfer to computer is via a USB cable, usually included.

Digital photography. We use both digital stills and video for our inquiries. Images are stored on a computer in files identified by content titles. All participants contribute to these files that are later made available to all for the digital story development.

GIS/GPS. GIS is a computer program for storing, retrieving, analyzing, and displaying data. It combines two kinds of information or databases. One is geographically referenced information: latitude and longitude coordinates, and spatial or location information. The second is attribute or descriptive information: characteristics or qualities of a particular place. Attribute data could be natural resources (e.g., trees, soil types), infrastructure (e.g., trails) or events (e.g., eruptions, earthquakes). We use GIS/GPS technologies to enrich understanding, locate sites on maps, and provide context for the data collected.

Digital stories. Education student field reports have traditionally been written narratives or PowerPoint presentations that asked students to describe the experience, perhaps answering some questions and reflecting on impacts in order to demonstrate active participation. This approach limits student products—both text and electronic—to being mostly summary reports: a slide show on geological terminology, or a PowerPoint product showing the site features. However, a true knowledge-building environment facilitates inquiry research to support producers of information. We use digital story technology for this purpose. This enables learning to be centered around critical questions, deeper levels of understanding, and expecting original thinking that goes beyond existing information rather than patching together known facts. Digital stories allow the use of digital stills and movie clips, iPod recordings, and GIS maps to develop a report of findings, observations and impacts of the experience.

We use video editing tools that are low-cost or free: Apple's iMovie on the Macintosh platform, Microsoft's MovieMaker2 and Pinnacle Studio on the Windows XP platform. Microsoft has also created PhotoStory, an inexpensive program that is part of Windows XP Plus Digital Media Edition to create digital videos from still images, and Apple's iPhoto for Macintosh OSX is used to create digital videos from still images.

Recommendations

The national parks provide great locations for field studies. Websites for these parks contain a great deal of valuable information. What is not easily available is GIS information on many of the parks. GIS maps and site-specific data would allow research activities related to the park. Virtual trail guides would provide an invaluable resource for trip preparation.

References

Davis, B., and D. Sumara. 1997. Cognition, complexity, and teacher education. *Harvard Educational Review*, 67:1,105–125.

Lave, J., and E. Wenger. 1991. *Situated Learning: Legitimate Peripheral Participation.* Cambridge, Mass.: Cambridge University Press.

Varela, F.J., E. Thompson, and E. Rosch. 1991. *The Embodied Mind: Cognitive Science and Human Experience*. Cambridge, Mass.: MIT Press.

Research Learning Centers: Promoting Resource Stewardship through Partnerships

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National parks throughout the system are encouraged to engage in partnerships that allow us to most effectively fulfill our mission. Research learning centers (RLCs) are directed to increase the amount and effectiveness of research and research education through partner projects. Each RLC has its own unique partnerships; the range includes bringing together organizations with overlapping goals, to collaborating on funding and facilitating science and research education efforts. Four RLCs highlight the scope of collaboration.

Partnering to provide the program

The new Crater Lake Science and Learning Center was born from the collective vision of the park and its partners to establish Crater Lake National Park as a wellspring for research information, a testing ground for educational techniques, and a source of inspiration for artistic expression. Unlike many of the other RLCs, no federal funds are used for the ongoing operations of this center.

The Crater Lake Science and Learning Center is a public–private partnership. The center is managed through a collaborative partnership with two Oregon universities. Southern Oregon University and the Oregon Institute of Technology provide faculty staffing and support to coordinate educational and artistic programs and to implement independent research activities, respectively. The park retains the authority to review and approve the center's programs and projects and to assume responsibility for management and maintenance of the center's facilities.

Building renovations, furnishings, office equipment, and other start-up costs totaled $2,317,376 and were financed through federal construction funding, Crater Lake National Park budget allocations, park entrance fees, and major individual and foundation gifts from the greater Oregon philanthropic community. Funding for center operations comes primarily from an endowment derived from the sale of a Crater Lake commemorative motor vehicle license plate. Proceeds are held in trust, invested and made available to the park upon request. So far, net proceeds from the sales of the plate have exceeded $2 million, providing an on-going corpus of funding after investment. Eventually, we estimate a 5% return on this investment that will provide the necessary operating capital for the center.

Ivory-billed woodpecker recovery

The Old-Growth Bottomland Forest Research and Education Center, in Congaree National Park, greatly contributes to the stewardship of floodplain forests at the regional and national level by providing critical support to the recovery of the recently rediscovered ivory-billed woodpecker. In order to investigate the potential existence of ivory-billed woodpeckers in South Carolina, a joint partnership was formed between federal and state agencies, non-governmental organizations, and private entities to share information and resources relating to this critically endangered species. Core members of this working group include the National Park Service, U.S. Fish and Wildlife Service (USFWS), U.S. Forest Service, South Carolina Department of Natural Resources, and The Nature Conservancy.

In January 2006, the working group secured $75,000 in USFWS funding to conduct formal surveys for the ivory-billed woodpecker at Congaree National Park. The center hosted and coordinated all field activities associated with this search, including providing logistical and technical support throughout the entire four-month survey effort, and training citizen scientist volunteers on field protocols. The Southeast Coast Inventory and Monitoring Network also provided essential in-kind support, including development of an observational database and funding for a Student Conservation Association intern for database management.

More than 46 volunteer citizen scientists contributed over 2,000 hours to survey significant wilderness acreage across Congaree National Park. Survey data were analyzed, summarized, and compiled into a final report submitted to the USFWS. Results of this work were presented at a historic three-day regional meeting and training workshop coordinated by the center and held at Congaree at the end of August 2006. This workshop included meetings, presentations, and field demonstrations led by Cornell University Lab of Ornithology and USFWS and was attended by more than 60 people representing 11 states involved with ivory-billed woodpecker recovery activities. Field activities and support through this partnership are on-going in 2007.

Training citizen scientists to assist researchers

The Appalachian Highlands Science Learning Center works with Great Smoky Mountains National Park, Discover Life in America, and scientists from colleges and universities across the nation to train volunteers with the skills they need to assist with research activities in the park. Volunteers are either trained to work side-by-side with a researcher or carry out simple protocols for researchers to expand their capacity.

Since 2000, hundreds of college students, park neighbors, and other interested people have attended workshops to gain skills that will be used during bio-blitzes (intense biological inventories usually centered on one taxonomic group or one habitat) and the "adopt-a-plot" project for the Smokies' All Taxa Biodiversity Inventory. During bio-blitzes, an additional 600 people, mostly students and teachers, have participated in collecting specimens. These citizen scientists have been responsible for reaching areas of the park that researchers don't have the time to get to and during times of the year that researchers aren't in the park. Some of these species have turned out to be new to science, while others were new park records. In addition, eight exotic species were seen for the first time within the boundaries of the park. To date, the All Taxa Biodiversity Inventory has added 4,740 new species to the park list and 829 species previously undescribed to science.

Collaborating on internet field trips

The Jamaica Bay Institute at the Gateway National Recreation Area collaborated with the New York/New Jersey Harbor Estuary Program in proposing Jamaica Bay as a featured site in EstuaryLive 2006. It was selected as one of four estuaries nationwide; the others were: Peconic Bay, New York; Tillamook Bay, Oregon; and, Padilla Bay, Washington. On National Estuaries Day, September 29, 2006, a field trip to Big Egg Marsh on Jamaica Bay was broadcast live on the internet. Designed as an interactive field trip for classrooms, on-line participants joined local middle and high school students as they explored the estuary with scientists, resource managers, educators, and community members. More than 250 schools from 35 states, representing at least 15,000 students, registered to participate in this live virtual tour of Jamaica Bay. During the hour-long EstuaryLive broadcast, participating students submitted more than 300 questions to our on-site field trip leaders. The goal of this field trip was to increase students' awareness and understanding of the urban estuary, giving them the knowledge they need to become good stewards of estuarine resources. A series of interactive segments on the following topics were presented:

- Aquatic organisms of the estuarine environment;
- Aerial photography kites;
- Salt marsh restoration and functions;
- Sediment core examination;
- Water chemistry and healthy levels; and
- Stewardship and connections to everyday life.

Methods of Public Engagement

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Problem statement

The question of how, and to what degree, the public should be involved with policy-setting is fundamental to strengthening—and thereby improving—the democratic process. Public agencies, including land management agencies, wrestle with appropriate and meaningful strategies for stakeholder involvement. Even the framers of our Constitution struggled with the basic question of "whether democratic citizens should be expected to work out the solution to such struggles directly among themselves or whether it is possible to adopt a machinery of government which would pump out solutions without requiring such direct citizen engagement. Should the burden of solving public problems rest most directly on citizenship or on government?" (Kemmis 1990:11). It's no wonder then, that throughout the western United States where large swaths of public land abut private and state lands—and where second homes sprout like weeds—land managers and interested parties alike struggle for meaning in the public participation process.

Background

Building on a wellspring of environmental concerns and regulations, Congress established the National Environmental Policy Act (NEPA) in 1969. This act, a "capstone to the entire national environmental statutory structure" (Kemmis 2001:41), states the following purposes:

- To declare a national policy which will encourage productive and enjoyable harmony between man and his environment;
- To promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man;
- To enrich the understanding of the ecological systems and natural resources important to the nation; and
- To establish a Council on Environmental Quality.

Additionally, the act recognizes "that each person has a responsibility to contribute to the preservation and enhancement of the environment." Federal agencies are required to comply with NEPA and have distinct policies or guidance to follow. In essence, any proposed federal action is subject to varied levels of NEPA review. By policy, the act requires agencies to "encourage and facilitate public involvement in decisions which affect the quality of the human environment" (CEQ 2007).

Through personal choice or circumstance, many citizens do not involve themselves with governmental concerns. Civil servants, caught up in a race to meet a deadline or simply going through the motions of the NEPA process, may also preclude opportunities for meaningful public involvement. As described in the National Issues Forum's *Democracy's Challenge: Reclaiming The Public's Role*, a general public disengagement has led to "professionals with special training and expertise" "making decisions and shaping priorities" (Wharton 2006:4). The question remains whether this lack of involvement evolved by conscious choice, or by default as overwhelmed suburban, two-wage earners and single-parent households simply cannot afford the time and energy commitments of such endeavors. One wonders whether the level of public involvement will increase as a large segment of society (the boomers) retire and have more leisure time to pursue various interests. Their impact could be revolutionary.

Public meetings, while sometimes vituperative and harmful to the policy process, remain an important tool in the gathering, creation, and sharing of ideas and information. Structuring the format of such meetings to meet public and agency needs presents an extraordinary challenge. In general, the very fact that a need for a public meeting exists demonstrates varied opinions and values about the subject at hand. Civility is not a safe assumption. At times, arrangements are necessary to ensure personal safety for public servants and the public. Land managers ponder the constructive value of various meeting formats, and in particular the old standby of a public hearing, which according to Daniel Kemmis in *Community and the Politics of Place* (1990) is anything but a listening opportunity. "In fact, out of everything that happens at a public hearing—the speaking, the emoting, the efforts to persuade the decision maker, the presentation of facts—the one element that is almost totally lacking is anything that might be characterized as 'public hearing'" (p. 53).

How, then, does the land manager create a safe environment whereby the agency and issue stakeholders can meaningfully exchange knowledge and ideas to reach durable decisions? This paper explores a range of public engagement strategies ranging from information-sharing to full collaboration, as shown in Figure 1. Each of these perspectives illustrates varying levels of commitment (between citizens and government) that the agency may choose as appropriate to the amount of time, money and energy available for a particular project or process. Examples from the literature and from the author's work in various federal land management agencies demonstrate the value of each of these strategies.

Perspective One: Inform

Information-sharing represents a low-to-moderate level of public and agency involvement. This gives the agency an opportunity to provide information such as technical reports and draft strategies or ideas for problem resolution to the public. Importantly, it also provides the agency an opportunity to learn from its stakeholders. Documents or discussions shared with stakeholders may produce essential critiques of an agency proposal. Likewise, venues such as open houses, information fairs, and newsletters generate discussion and new perspectives on issues. Two key elements to the success of this approach include (1) whether the public believes their opinions and concerns are heard, and (2) how the agency incorporates new information and ideas. Transparency, while difficult to achieve given the various managerial facets to any problem, is critical in this otherwise fairly low-risk method of public involvement.

Examples of contentious issues that benefit from this approach include past approaches to winter use management in Yellowstone and the wilderness debate in some states. In the northern Rocky Mountains for example, Kemmis describes wilderness issues as "[pitting]

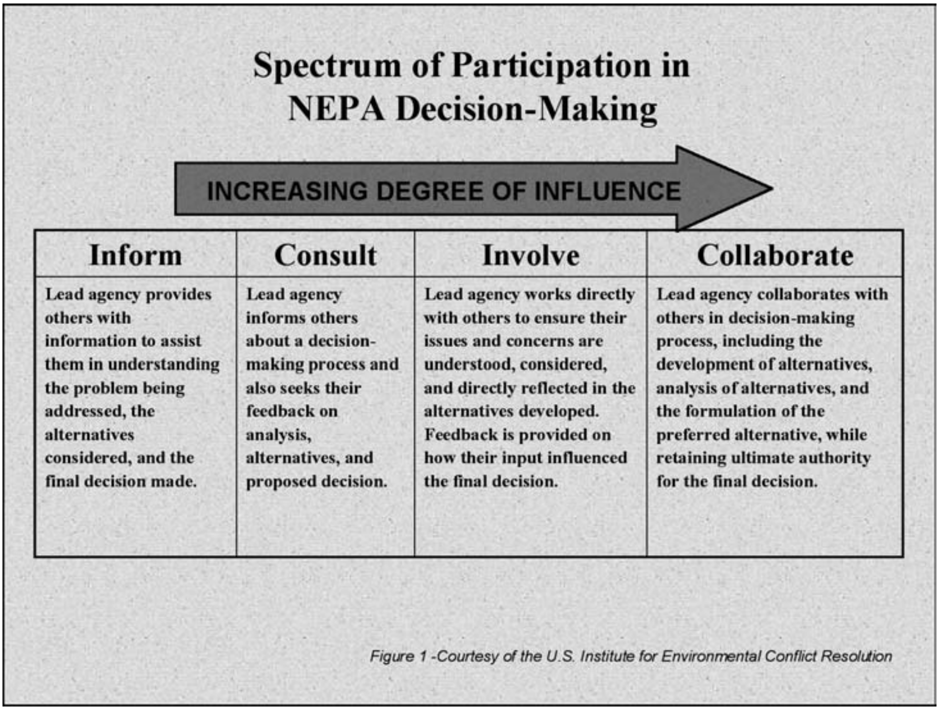

Figure 1. The spectrum of participation in decision-making under the National Environmental Policy Act.

various interests … against each other in a standoff struggle which has sapped the energy and resources of all concerned. At the same time, this struggle has gradually undermined nearly all parties' faith that the process of public decision making is in fact capable of identifying or producing the public interest" (1990:39). The same could be said of the running debate over appropriate winter uses in Yellowstone or off-highway vehicle travel on public lands throughout the West.

Information-sharing is one way to transmit ideas and information to and from polarized interests in a non-threatening manner. This technique may allow discourse that would otherwise not occur. Information-sharing is an opportunity to be transparent about agency action. It allows for public review and comment without consensus or collaboration. To succeed with this or any other method of engagement requires diligence, repetition, facilitation, and meetings of all types.

Perspective two: Consult and involve

"The input and advice of citizens may be necessary to develop effective public policy, but they are rarely sufficient to build agreement among diverse interests. Because of the diversity of viewpoints expressed during public involvement processes, government officials typically receive competing, conflicting ideas on what to do. It is then up to them to make the necessary trade-offs among competing viewpoints and to render a decision" (McKinney 2001:36). Although Figure 1 shows consultation and involvement as distinct methods, actual implementation of either involves significant elements of both; it is a porous rather than impermeable line that separates the middle ground between information-sharing and collaboration.

Effective techniques of consultation and involvement are much the same as those used in information-sharing and collaboration—the difference being largely one of tone and level of involvement. Agency actions under perspective two would clearly state the role of the decision-maker, but greater effort towards understanding stakeholder positions and incorporating or revising elements of concern are likely. Examples of this method include the recently completed Gallatin National Forest travel plan and on-going winter use planning in Yellowstone and Grand Teton national parks. This method involves moderate risk and is unlikely to satisfy either stakeholders or the agency because it produces a decision where everyone feels disgruntled.

Perspective three: Collaborate

Occasionally, situations are ripe for full collaboration. This process is lengthy and untidy, but when used appropriately, it will generate durable decisions because all relevant parties are involved in creating solutions. "The essence of collaborative decision making is to reconcile the interests of affected parties.… Interests are needs, desires, concerns, and fears, the intangible items that underlie people's positions or the items they want. [Collaborative decision-making] involves probing and examining concerns, devising creative solutions, and making trade-offs to accommodate competing interests … it refers to a process whereby a group of people work together to achieve a common purpose and share resources. Collaborative processes may be more or less inclusive, depending on the intent of the participants, and may or may not rely on consensus as a way of making decisions" (McKinney 2001:35).

One example of this approach is from Missoula, Montana, where an environmental group and a pulp mill operator started as adversaries and moved toward collaboration. "Eventually the two sides were able to agree on a solution which they jointly presented to the Water Quality Bureau. [T]he crucial element which made this possible … was the gradual building of a sense of trust between the parties. Moving slowly, a small step at a time, the parties had gradually demonstrated to one another their good faith and reliability, to the point that they were able to trust each other to make a joint presentation to the decision maker. By that time, they had themselves in effect become the decision makers, but only because they had been willing to move together into the unoccupied territory of collaboration" (Kemmis 1990:114).

While examples of shared decision-making are not yet commonplace—and the frustration and unsuccessful examples of previous decades indicate that consensus lies somewhere over the rainbow—both agency personnel and the public truly want better opportunities to create and influence durable decisions. It would seem then, that since all parties yearn for meaning in the public participation process, opportunities for shared decision-making exist. Our job is to seek them out and inject combined knowledge, skills, and abilities to create a satisfactory public process. One technique to accomplish this is a collaborative learning approach.

Two instances of successful stakeholder engagement in complex and controversial situations are described by Gregg Walker, Susan Senecah, and Steven Daniels as situations in which "collaborative learning emphasizes activities that encourage systems thinking, joint learning, open communication, constructive conflict management, and a focus on appropriate change" (Walker et al. 2006:195). In essence, these experiments in collaborative learning demonstrate that listening well, relationship-building, and transparency can all lead not only to appropriate change, but to acceptable change.

Conclusion: It's all about relationships and communication

No matter the technique, engaging the public in decision-making is a difficult process. Over the years since the implementation of NEPA, federal agencies have struggled with how best to involve stakeholders in decisions. Shared decision-making, whether consensus based or collaborative learning or something else entirely, is clearly the most hopeful means of improving a situation through desirable and feasible change. Polarization and deeply held values color decisions and influence public processes. Civil servants must recognize this and harness the valuable resource of democratic opportunity. If durable agency decisions are the objective, then meaningful stakeholder involvement is essential and collaboration is the best approach.

Potential roadblocks to meaningful stakeholder engagement include misinformation, distrust, and a lack of sincerity (real or perceived). An honest approach to information-sharing or full collaboration (or anything in between) can build trust. Building relationships between agency personnel and issue stakeholders—while time-consuming and difficult—leads to relevance in public meetings of any format. While the level of influence and amount of participation in agency decision-making can be legally driven, developing an appropriate level of engagement outside the legal process is obviously preferable. Because the information-sharing method is low-risk, it is likely to minimally satisfy stakeholders and the agency. Conversely, high-risk collaboration efforts bring significant reward.

"It is doubtful if any society has ever used the word *public* as incessantly as we now do. We have public hearings to help us shape public policy about issues like public lands, public education, public welfare, and public health…" (Kemmis 1990:4). Kemmis goes on to state that public decisions are determined by opinion polls; although one could argue that public agencies don't originate public opinion polls—that is exactly what most public comment periods devolve to. While this rather pessimistic viewpoint discounts the value of individual and group input to agency processes, it sheds light on the baggage typically brought to a public meeting or process. It takes time, energy, skill and determination to overcome this and move forward collaboratively. The obvious benefits of durable decisions and enhanced stakeholder relationships make these resources ones public land managers should find ways to develop.

References

CEQ [Council on Environmental Quality]. 2007. NEPAnet. (March 2007). On-line at www.nepa.gov/nepa/regs/nepa/nepaeqia.htm. Accessed April 1, 2007.

Kemmis, Daniel. 2001. *This Sovereign Land: A New Vision for Governing the West*. Washington, D.C.: Island Press.

———. 1990. C*ommunity and the Politics of Place*. Norman: University of Oklahoma Press.

Mainella, Fran P. 2003. *Director's Order 75A: Civic Engagement and Public Involvement.* National Park Service memorandum to directorate and field directorate. Washington, D.C.: National Park Service.

McKinney, Matthew J. 2001. What do we mean by consensus? Some defining principles. In *Across the Great Divide: Explorations in Collaborative Conservation and the American West*. Philip Brick, Donald Snow, and Sarah Van De Wetering, eds. Washington, D.C.: Island Press.

National Park Service. 2005. [George Wright Society conference presentation.] Unpublished file. Management Assistant's Office. Yellowstone National Park, Wyoming.

———. 2007. *Director's Order 12 and DO 12 Handbook.* On-line at www.nps.gov/policy/DOrders/RM12.pdf. Accessed March 26, 2007.

U.S. Institute for Environmental Conflict Resolution. On-line at www.ecr.gov/. Accessed March 26, 2007.

Walker, Gregg B., Susan L. Senecah, and Steven E. Daniels. 2006. From the forest to the river: Citizens' views of stakeholder engagement. *Human Ecology Review* 13:2, 193–202.

Wharton, Tony. 2006. *Democracy's Challenge: Reclaiming the Public's Role*. Dayton, Oh.: National Issues Forum Institute.

Healthy Parks Healthy People: A Broad-based Partnership Program, Linking People with Parks for Better Health Outcomes and a Sustainable Future

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Background

Parks Victoria was established in 1996 through the merger of three agencies: namely, Melbourne Parks and Waterways (predominantly managing metropolitan parks, including reservoir parks), the National Parks Service (national parks, state parks, and wildlife reserves) and the non-commercial port functions of the disbanded Port of Melbourne Authority. The amalgamation provided a unique entity that was able to provide management services for parks, reserves, metropolitan rivers and bays, and other land under control of the state of Victoria, Australia.

Parks Victoria's comprehensive management services profile directly connects to the vast majority of the people of Victoria. With nearly 18% of the state under direct management, including responsibility for biodiversity protection, recreation services, cultural sites and wildfire response, we are able to approach issues in an integrated and comprehensive way. Given this scale and diversity of responsibility, there exists significant opportunity for innovation in the development of programs and delivery of services.

Our parks and visitor profile

Our park system is one of the most comprehensive and diverse in the world. We manage:

- **National parks.** These are generally large areas of nationally significant public land managed to protect their natural and cultural features and to provide for people's enjoyment, education, and inspiration. The largest in Victoria is Alpine National Park, at 645,615 hectares.
- **State parks.** Generally smaller and less nationally significant than national parks, state parks are areas of public land managed for the same purposes and under the same general guidelines. They complement the national parks to form a statewide system. State parks have an average area of 6,315 hectares.
- **Wilderness parks.** These are large areas managed for conservation and self-reliant recreation. No facilities are provided, nor are vehicles allowed.
- **Marine and coastal parks.** These are established to protect representative examples of marine and coastal environments.
- **Regional parks.** These include a variety of historical, cultural, and conservation reserves.
- **Conservation reserves.** Areas managed for conservation, generally with few or no facilities for visitors. They range from large areas in the Mallee savannah lands (e.g., 35,030 hectares) to small bush land areas of 1 hectare or less.

- **Metropolitan parks.** These parks are managed for intensive recreation and for conservation outcomes in and around metropolitan Melbourne.
- **Waterways.** The Yarra and the Maribyrnong rivers drain the catchment of greater Melbourne, emptying into Port Phillip, one of the largest embayments in the world. Parks Victoria is the recreational boating manager of those waterways, including built infrastructure (piers and jetties), non-commercial navigational aids, several small harbors, and boat launching facilities.

Our visitor profile reflects the diversity of opportunities for people to interact with parks across the state. Using sophisticated visitor survey techniques, we monitor visitor numbers, community perception of our management programs and activities, and our visitor satisfaction. Our survey data show that each year there are around 42.7 million visits to our parks and protected areas, and 30.8 million visits to piers and jetties around the bays and waterways. This figure has shown steady growth from 2001 and reflects keen interest in the many and varied places in the park network. Visitation is predominantly from the state of Victoria, with significant numbers from other Australian states and from overseas. This volume of people interacting with the parks and waterways provides us with a large opportunity to link our programs with other partners in the community and provide new ways to develop the role of parks in society.

Healthy Parks Healthy People

Like many natural resource management agencies around the world, Parks Victoria is challenged to respond to the breadth of issues that face society and to be relevant to communities and governments when there are so many other pressing issues facing us. Issues within areas such as education, health, security, transport, energy, and water, among others, can predominate when legislators are considering environment priorities. Increasingly, governments are seeking solutions within these areas that include partnerships between sectors, and which involve collaborations that produce better outcomes for society.

With this in mind, Parks Victoria reviewed its programs and found there were significant opportunities for collaboration across sectors, including the health sector. Beginning as a campaign to promote the benefits of a healthy environment to the community, Healthy Parks Healthy People has developed into a broad-based program supported by many of Australia's leading professional health organizations.

After commencing the first tentative promotional campaign to highlight the benefit of parks to society in 1998, Parks Victoria initiated a preliminary literature review with the Health & Behavioural Science Faculty of Deakin University in Melbourne. This review of the scientific and medical literature was so promising that we arranged for collaborative funding from a group of leading Australasian park organizations for a more comprehensive study and annotated bibliography to be produced.

The final report and bibliography are available and have created great interest with researchers and other bodies locally, nationally, and internationally. To access the report and associated bibliography, titled "The Health Benefits of Contact with Nature in a Park Context," go to www.parkweb.vic.gov.au/resources/mhphp/pv1.pdf. To keep up to date with related research, go to www.deakin.edu.au/hbs/hsd/research/niche.

Our programs

Since the first promotional programs were developed based simply around the Healthy Parks Healthy People proposition, there has been a steady development of activities and support for the initiative. The key activities supported by Parks Victoria include:

- Our extensive volunteer program, in which we engage with a broad cross-section of the community in park and waterway management activities.
- Our partnership program, in which we seek to develop formal links with key stakeholders groups and supporters and develop complementary programs and activities.
- Our partnership with the peak medical and health bodies within the state of Victoria and nationally to develop complementary promotional campaigns and referral activities that support improved community health. This includes active support for new research that improves the knowledge available to policy-makers and health professionals.
- Our partnership with our employees, in which we provide opportunities to develop healthy lifestyles through provision of information and services that encourage better health outcomes.

Program activities: An example

The range of possibilities to develop activities under the Healthy Parks Healthy People program is very broad. The scope is really only limited by the imagination and the individual context in which the park agency operates. Parks Victoria has developed a range of signature activities relevant to our situation.

The World's Greatest Pram Stroll. This program was developed in close consultation with health and medical practitioners to respond to concerns over the mental and physical health of new mothers. There is significant evidence in the medical literature that new mothers can feel isolated and have reduced self-esteem following the birth of their baby. In some cases, there is a strong risk of mental illness leading to further problems. Getting mothers together and involved in social activities can be beneficial for the mother and for the new baby. Getting them together in a park and involving physical activity, thereby linking the health benefits on offer, was the objective of the first World's Greatest Pram Stroll.

Held in Albert Park, one of Melbourne's most popular metropolitan parks, the first event was supported by leading groups in the health sector and attracted hundreds of mothers with their new babies for a walk in the park. Some six years on, the event has grown in size and spread to over 26 locations across the country. The 2007 event attracted several thousand mothers and families and was widely featured in the media. On-going benefits include social support groups for new mothers, health professionals supporting the concept and continuing to refer patients, and a whole new group of people actively involved in the parks and enjoying the benefits that they provide. Moreover, parks were seen to provide benefits well beyond those previously envisaged by the community.

This and similar activities developed under our programs have worked to develop knowledge and awareness of the role that our parks and waterways play in society, in addition to the significant natural ecological and physical benefits that they bring. By working with key policy institutions, health providers, and community groups, we have developed a significantly wider network of people who appreciate and support the role that parks play in our society. At a time when there is increasing pressure on the availability of resources for services to the community, the health sector has become a confident supporter of the benefits that our parks and waterways bring to a modern society.

While there will always be temporal issues over individual priorities in the government service sector, we are confident that our relevance to the community has been broadened and our resourcing has improved year on year especially in the provision of services that support improved and more equitable access to parks. At the same time, awareness of all our parks, including support for even the most remote and inaccessible areas, is strong.

The future

Principal researcher at the Deakin University, Mardie Townsend, is continuing to progress the initiatives started in 1998. The school is collaborating with municipal governments in the east and north of Melbourne on a study to examine the benefits of community involvement in civic and environment programs. She is also collaborating with researchers in the U.K. and U.S. (e.g., Professor Howard Frumkin, Emory University, Atlanta).

On a more specific front, another study covering municipalities in the north and east of Melbourne is examining the health and well-being benefits of volunteering in environmental management programs.

One regional health authority, Barwon Health, has developed an initiative linking people suffering depression with opportunities to work with environment practitioners in rehabilitation treatments that respond to severe depression (and possible suicide risk).

A consortium comprising the city of Melbourne, Parks Victoria, Centennial Park Authority, Sydney Olympic Park Authority, and Deakin University is studying people's response to high-density multi-story living and their interactions with parks. Surveys have been completed, and a draft report prepared with the final report expected soon.

International interest is growing following presentation of related papers at the World Parks Congress in Durban in 2003 (see www.interenvironment.org/pa/papers2.htm) and at the World Parks Leadership Forum in La Paz, Mexico, in 2006. More recently, the convener of the IUCN World Commission on Protected Areas urban task force and president of the California Institute of Public Affairs, Ted Tryzna, hosted a meeting in Sacramento, California, at which this author presented on the practical and strategic elements of the Healthy Parks Healthy People program. Based on attendance at the forum and subsequent follow-up, there is significant interest from the state of California in adopting the program.

Further development of the program here in Victoria will occur in coming years as more states in Australia and overseas institutions develop their own Healthy Parks Healthy People initiatives. Our long-term objective is to continue to work with the health and medical community and with the research community to broaden the range of programs and to build awareness in Australia that parks are a vital part of a healthy and sustainable future.

Paleontological Parks and Global Change

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Introduction

Paleontology, the study of organisms and processes preserved in a geologic context, can be practiced in over 180 units of the national park system. Much more than just the collecting of different kinds of fossils to be stored in a museum, the study of the fossil record is the only means by which we can understand past climatic changes and the effects of such changes on biotas (changes such as extinction, speciation, immigration, and evolutionary events). In combination with the fossil record, comprehensive studies of geological, sedimentological, and geochemical records can inform us about other aspects of major climatic perturbations in earth history, such as the causation of climatic shifts, including tectonic events (i.e., mountain-building, plate collisions, and continental movements), greenhouse gas events, and a myriad of other natural processes occurring on geologic timescales.

There is now incontrovertible evidence that CO_2 concentrations are at the highest level in the last 650 thousand years (ky) (Petit et al. 1999; IPCC 2007). Environmental impacts associated with rising levels of elevated CO_2 are being recorded nearly everywhere on earth. Sea and land temperatures are rising rapidly, sea level is increasing, plant and animal ranges are shifting to higher latitudes and higher elevations, acidification of the oceans is occurring, global ice-volume is decreasing, and rates of extinction are unprecedented (IPCC 2007).

Unfortunately, there are individuals, media spokespersons, government officials, and at least one scientific society (American Association of Petroleum Geologists; AAPG 2007) who dispute that current global warming is the result of human activities. Many skeptics of anthropogenically induced global warming rationalize their arguments with the idea that "[t]here have been too many global heating and cooling cycles long before man came along and industrialized the planet" (Rush Limbaugh, August 15, 2005) for this warming to be caused by humans alone. One of the key contributions paleontology can make is an examination of the fossil record to determine whether the processes occurring today are within the natural range of variability recorded in earth history prior to the evolution of *Homo sapiens*. Specifically, how do the rates of current and predicted factors of climate change (i.e., greenhouse gas concentrations, rising sea and air temperatures, rising sea level, decreasing global sea-ice volume, etc.) compare with events preserved in the fossil record?

Homo sapiens has only existed on this planet for about 150,000 years. Our species evolved in an "icehouse" world, where carbon dioxide concentrations are relatively low

(180–380 ppm), where vast glaciers cover the poles, and where a large temperature gradient between the poles and the equator exists. Global climate over the last 2 million years (the Pleistocene epoch), has largely been influenced by orbital forcing mechanisms (Milankovitch cycles) in concert with global ice-volume, sea level, and ocean circulation patterns that have kept the earth in a period of glacial/interglacial cycles. Such "icehouse" conditions developed approximately 34 Ma (million years ago) during the earliest Oligocene, when global CO_2 levels dropped to near present levels, oceans and air temperatures cooled, and large-scale ice-sheets formed on Antarctica (Zachos et al. 1996; DeConto and Pollard 2003). Prior to 34 Ma, earth experienced "greenhouse" or ice-free conditions that had existed since the last major deglaciation 260 Ma. "Greenhouse" climates have atmospheric CO_2 concentrations that are 500 ppm and higher.

Search for an analogue in the fossil record

Paleoclimatologists use changes in ratios of certain stable isotopes derived from various sources such as fossilized shells, teeth, bones, carbonate nodules, and leaf waxes as proxies for climatic parameters. Concentrations of $\delta^{13}C$ are used as a proxy to measure ancient CO_2 concentrations, while $\delta^{18}O$ concentrations indicate ancient temperatures. A nearly continuous record of stable isotope data provides global climate CO_2 and temperature curves for the last 65 million years (see Zachos et al. 2001). Within that time span is a pronounced greenhouse gas event known as the Paleocene-Eocene Thermal Maximum (PETM) that occurred 55.8 Ma. This event is marked by a dramatic negative excursion in $\delta^{13}C$, indicative of a large release of methane (CH_4) and/or CO_2 into the atmosphere within a 10,000-year span. Although the exact source of the greenhouse gas spike is unknown, sources that have been implicated included the dissociation of methane hydrates (Dickens et al. 1995), massive volcanism beneath organic-rich strata in the Norwegian Sea (Svensen et al. 2004), evaporation of epicontinental seaways (Higgins and Schrag 2006), and extensive burning of peatlands (Kurtz et al. 2003). A pronounced increase in global temperature was coincident with the greenhouse gas release. Middle and tropical latitudes experienced a temperature increase between 5–10°C (Wing et al. 2005), while high latitudes experienced an 8–10°C increase in sea surface temperature (Zachos et al. 2003).

Past versus present comparisons

The PETM event is considered by many to be analogous to our present increases in greenhouse gases. Comparisons of the rates of greenhouse gas emissions, coincident temperature increases, and biotic responses from the PETM event to current conditions provide the information necessary to evaluate whether the current conditions are within the natural range of variability known from the last 65 million years.

CO_2 past and present. Records of $\delta^{13}C$ from marine fossils and sediments indicate that during PETM times, CO_2 levels increased from approximately 600 to 2800 ppm in 10 ky (Pagani et al. 2005). Despite some inconsistencies between the amount of $\delta^{13}C$ needed to raise temperatures to PETM levels, the extreme temperature increase, and actual measured values of CO_2 from the marine record (see Pagani et al. 2006), a striking fact emerges. The estimated volume of CO_2 and methane released during this major geologic event pales in comparison to modern levels of CO_2 released from anthropogenic sources.

For instance, during the PETM it is estimated that 0.2 gigatons (Gt) of CO_2 per year were released into the atmosphere (Gibbs et al. 2006). Current levels of anthropogenic CO_2 release, including consumption of fossil fuels and land use change is 8.8 Gt per year (IPCC 2007).

At the current rate of atmospheric CO_2 emissions, 1.9 ppm per year, we could reach PETM levels of atmospheric CO_2 (approximately 2500 ppm) within 1115 years. This estimate is potentially conservative given the current and anticipated acceleration of CO_2 emissions. The IPCC 2000 *Special Report on Emissions Scenarios* (SRES) suggests within their worst-case scenario that we could reach atmospheric CO_2 levels as high as 1000 ppm by the end of this century.

Temperature past and present. Proxy data for ancient temperature based on $\delta^{18}O$ records from marine fossils and temperature estimates made from fossil plant assemblages from the Bighorn Basin of northern Wyoming indicate that during the PETM surface air temperature increased from 5–10°C in approximately 10 ky concurrent with the rise of CO_2 (Wing et al. 2005). It is predicted that surface air temperature will rise anywhere from 1.1–6.4°C by 2100 (IPCC 2007). Predicted temperature increases in the next 100 years exceed those rates attained during the PETM by a hundredfold.

Effects on biotas. The most catastrophic biotic impacts of the PETM event occurred in the oceans. Sedimentological evidence indicates that acidification of oceans occurred, causing major extinctions among benthic foraminiferan species. Surprisingly, terrestrial vertebrates didn't experience high levels of extinction, but major immigration events from Asia to North America occurred over high-latitude land bridges during the PETM event. These groups include many lineages of rodents, perissodactyls, artiodactyls, and creodonts. Terrestrial vegetation also showed changes in geographic distribution that occurred in less than 10 ky. Plant taxa previously known from the Gulf Coast region and Colorado appeared in northern Wyoming during the PETM event, probably as a result of the rapid temperature rise (Wing et al. 2005).

The effects of the current warming trend on extant populations have been modeled taking several factors into account (see Thomas et al. 2004). These factors include the variable rates of extinction expected among several groups of plants and animals depending on their specific habitat needs, the presence or absence of restrictions to range shifts such as human-made barriers or altered habitats, and the effects of temperature rise on different ecosystems. Thomas et al. (2004) provide estimates of extinction rates for the year 2050 that range from 15–37% of all species. Similarly, the IPCC (2007) projects that we will see the extinction of 20–30% of earth's species by 2100. With an estimated total diversity of 10–30 million species on earth (Erwin 1991) that is a loss of 2–11 million species by the end of the century.

The PETM is considered to have been one of the most rapidly occurring greenhouse events in earth history. However, is the PETM really a good analogue for our modern climatic crisis? With respect to CO_2 emissions and transient temperature increases, anthropogenic forces appear to be altering the earth's carbon cycle and global climate at rates one hundredfold faster than the PETM event. One major difference between the PETM and the current crisis is the rate of extinction. The PETM event shows very little perturbation to terrestrial ecosystems besides changes in dispersal patterns and shifts in species' ranges. The high rates of extinction expected in the next 100 years have the potential to far surpass those recorded from the PETM. Why? The PETM greenhouse event occurred in a greenhouse world free of human constraints on plant and animal movements. In an ice-free world, the effect of a warming event should have less impact on biotas that are adapted to warm climates, and are able to move about freely to find suitable habitat. The pressing question we need to address now is: What happens when an icehouse world transitions to a greenhouse world very rapidly? How will rapid temperature increases affect cold-adapted ecosystems whose species' ranges are additionally restricted by human-altered land surfaces? The last time earth experienced a major greenhouse event in an icehouse world was during the late Permian, approximately 250 Ma. This event was the most catastrophic extinction event in earth history, during which about 95% of both marine and terrestrial species on earth perished (Montañez et al. 2007). It is significant to note that there were no human-induced barriers to dispersal 250 million years ago.

The National Park Service and global climate change

The national park system, especially the more than 180 units containing significant fossil resources, is in a unique position to both conduct research and educate the public on what the geological record informs us about our current climatic situation. Several of the paleontology parks in the western U.S. contain rocks that span significant climatic perturbations. For instance, taken together, Fossil Butte National Monument (Wyoming, 50 Ma), John Day Fossil Beds National Monument (Oregon, 45–5 Ma), Badlands National Park (South Dakota, 37–28 Ma), Florissant Fossil Beds National Monument (Colorado, 34 Ma), Agate Fossil Beds National Monument (Nebraska, 20 Ma), and Hagerman Fossil Beds National Monument (Idaho, 3–4 Ma), contain fossil resources that span almost the entire Cenozoic (the last 65 Ma). Study of these fossil resources helps us understand how terrestrial environments have changed through time. For instance, a nearly continuous section of geologic time spanning 45–5 Ma is represented by fossiliferous strata in the John Day Basin. Over that 40-million-year span, one can observe shifts in climates from subtropical forests, where alligators and palm trees thrived, to the modern-day near-desert environment inhabited by coyotes and sagebrush. Through that 40-million-year interval, climate has fluctuated and species have evolved at various rates (mammals, for example, average 1.5 my for one species to evolve into another morphologically distinct species). When plants and animals can evolutionarily keep pace with the rate of climatic change, they can adapt; when the rates of climate change exceed organisms' abilities to adapt, mass extinctions occur.

National parks are also well positioned to facilitate and interpret the science of climate change and its potential impacts. Important geological repositories of climatic and paleoenvironmental data are afforded permanent protection. Parks serve as *in situ* laboratories and learning centers that are accessible to everyone. The paleontological parks, especially, are ideally situated to interpret not only the particular paleoclimatic story of their fossil resource, but are also a framework that informs the public about past changes in climate and how they relate to anthropogenic changes in the modern world. This message is one that can be interpreted at all units of the national park system, not just the paleontological parks. Through scientific research, curation, public education, and leading by example, the National Park Service should become a leader in public education on climate change issues.

Virtually all national parks are experiencing environmental changes attributable to increasing global temperatures. Whether these changes are infestations of exotic species, extinction or extirpation events, shrinking glaciers, bleached coral reefs, or severe drought, seeing is believing. It is crucial for the public, our stakeholders, to understand that these potentially irreversible changes are occurring even in protected areas. Humans are certainly the first species in earth's long history to cause, and be cognizant of, the alteration of the planet's physical and chemical properties. These significant alterations risk the existence of most species on the globe, including our own. We also are the first species that can change our behaviors conscientiously to limit our impact on the planet and the organisms that have fostered our existence for so long.

References

AAPG [American Association of Petroleum Geologists]. 2007. Climate change policy. Online at http://dpa.aapg.org/gac/papers/climate_change.cfm.

Erwin, T.L, 1991. How many species are there?: Revisited. *Conservation Biology* 5:3, 330–333.

DeConto, R.M., and D. Pollard. 2003. Rapid Cenozoic glaciation of Antarctica induced by declining atmospheric CO_2. *Nature* 421, 245–249.

Dickens, G.R., J.R. O'Neil, D.K. Reah, and R.M. Owne. 1995. Dissociation of oceanic methane hydrate as a cause of the carbon isotope excursion at the end of the Paleocene. *Paleoceanography* 10, 965–971.

Gibbs, S.M., P.R. Bown, J.A. Sessa, T.J. Bralower, and P.A. Wilson. 2006. Nannoplankton extinction and origination across the Paleocene–Eocene Thermal Maximum. *Science* 314, 1770–1773.

IPCC [Intergovernmental Panel on Climate Change]. 2007. Summary for policymakers. In *Climate Change 2007: The Physical Science Basis.* Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor, and H.L. Miller, eds. Cambridge, U.K., and New York: Cambridge University Press.

———. 2000. *Climate Change—The IPCC Special Report Emission Scenarios (SRES).* Online at www.ipcc.ch/pub/sres-e.pdf.

Kurtz, A.C., L.R. Kump, M.A. Arthur, J.C. Zachos, and A. Paytan. 2003. Early Cenozoic decoupling of the global carbon and sulfur cycles. *Paleoceanography* 18:4, 1–13.

Montañez, I.P., N.J. Tabor, D. Niemeier, W.A. DiMichele, T.D. Frank, C.R. Fielding, J.L. Isbell, L.P. Birgenheier, and M.C. Rygel. 2007. CO_2-forced climate and vegetation instability during late Paleozoic deglaciation. *Science* 315, 87–91.

Pagani, M., J.C. Zachos, K.H. Freeman, B. Tipple, and S. Bohaty. 2005. Marked decline in carbon dioxide concentrations during the Paleocene. *Science* 309, 600–603.

Pagani, M., K. Caldeira, D. Archer, and J.C. Zachos. 2006. An ancient carbon mystery. *Science* 314, 1556–1557.

Petit, J.R., et al. 1999. Climate and atmospheric history of the past 420,000 years from the Vostok ice core, Antarctica. *Nature* 399, 429–436.

Thomas, C.D., A. Cameron, R.E. Green, M. Bakkenes, L.J. Beaumont, Y.C. Collingham, B.F.N. Erasmus, M.F. de Siqueira, A. Grainger, L. Hannah, L. Hughes, B. Huntley, A.S. van Jaarsveld, G.F. Midgley, L. Miles, M.A. Ortega-Huerta, A.T. Peterson, O.L. Phillips, and S.E. Williams. 2004. Extinction risk from climate change. *Nature* 427, 145–148.

Thomas, E. 1998. Biogeography of the late Paleocene benthic foraminiferal extinction. In *Late Paleocene–Early Eocene: Climatic and Biotic Events in the Marine and Terrestrial Records.* M.P. Aubry, W.A. Berggren, and S. Lucas, eds. New York: Columbia University Press, 214–243.

Wing, S.L., G.J. Harrington, F.A. Smith, J.I. Bloch, D.M. Boyer, and K.H. Freeman. 2005. Transient floral change and rapid global warming at the Paleocene–Eocene Boundary. *Science* 310, 339–996.

Zachos, J.C., T.M. Quinn, and K.A. Salamy. 1996. High-resolution (10^4 years) deep-sea foraminiferal stable isotope records of the Eocene–Oligocene climate transition. *Pale-oceanography* 11:3, 251–266.

Zachos, J.C., M. Pagani, L. Sloan, E. Thomas, and K. Billups. 2001. Trends, rhythms, and aberrations in global climate 65 Ma to present. *Science* 292, 686–693.

Zachos, J.C., M.W. Wara, S. Bohaty, M.L. Delaney, M.R. Petrizzo, A. Brill, T.J. Bralower, and I. Premoli-Silva. 2003. A transient rise in tropical sea surface temperature during the Paleocene–Eocene thermal maximum. *Science* 302, 1551–1554.

Global Climate Change: Leadership in the Pacific West Region

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For my entire 31 years of service in the National Park Service, I have been a reader. I like to go back and forth between some trashy escapism novels, usually supplied by my brother, to a solid book on some aspect of science. I like all kinds of science: string theory, the big bang, quantum theory, genetics, geology, astronomy, anthropology, psychology, climatology, and of course anything biological. For me and the many other people in the National Park Service, the science of climate change has been in the literature for years and is nothing new.

Twenty years ago, I became the first chief of resource management at North Cascades National Park Complex. One of the first things I did was to bring in a team of scientists who sat around with me and my staff and we talked about the future of the park. I asked each one to suggest what we should do to better understand the challenges before us. Jim Agee, then with the Cooperative Park Study Unit at the University of Washington, suggested that we deploy remote weather stations every one thousand feet from the lowest to the highest range in the Cascades. He actually suggested that the climate could be changing and we should be documenting it. We all thought he was nuts, of course, and ignored his idea. But ever since then, I have tried to stay up on the science and the politics of climate change.

A few weeks ago, I was watching the former Vice President Al Gore on CSPAN testifying before congress on global climate change. Let me make sure you all understand that Congress and particularly the Senate is an exclusive club and they treat members, especially former members, with a certain respect. That comes with the knowledge that membership in the club can be fleeting and they never know when they themselves might be sitting up there testifying before the body. Al Gore was answering questions when one senator called him a movie star. Gore responded, "No, senator, Rin Tin Tin was a movie star and all I did was put on a slide show." I want you to remember that quick retort as I will come back to it.

Soon after I became the regional director of the Pacific West Region (PWR), I turned to our team of PWR science advisors to tell me what are the major issues facing our parks in the future. One of the issues they identified was global climate change.

We in the Pacific West pride ourselves with at least trying to think strategically and moving forward on major issues facing our parks. An employee of our Washington Office recently told me that she has a note above her desk that says if you want to get something done, give it to the Pacific West. We are also smart enough to not try and tackle them all at the same time. So in January of 2006, at the PWR Directorate Retreat, we decided that it was time to take on the issue of global climate change and the national park system. The first goal was to bring scientists, resource managers, and park superintendents together to build a baseline of understanding of the issue. Assuming that everyone had a working knowledge of the issues and implications would have been a mistake.

Over 2006, we held three workshops: one in Oakland, California, one in Seattle, Washington, and one in Honolulu, Hawaii, with a full day devoted to the topic of global climate change. The morning was devoted to presentations by invited scientists with special expertise in climatology and public lands. We had three very different presentations and they were all excellent. At each workshop we had a breakout session to address the following questions:

- What changes have you seen or do you expect to see in your park?
- How can we manage the parks to be "unimpaired for future generations"?
- How can we adapt to an issue that is outside of our control?

We had a second set of breakout sessions to address the following questions:

- What role should NPS have in engaging the topic?
- What should NPS messages be?
- What specific actions should we take?

Here are a few examples of what our managers are observing in the parks:

- Receding glaciers at Mount Rainier, Olympic, and North Cascades.
- More rain-on-snow events at North Cascades and Mount Rainier, which resulted in major flooding.
- Less snow pack in the Sierras, and, particularly, lower water content in the snow.
- Lake Mead is at 54% of capacity, resulting in the need to move marinas, while Las Vegas continues to pressure for more water.
- A record year for wildland fire in the West.
- Species shifting upward at Yosemite, well documented by the Grinnell Resurvey.
- Coral die-off in Pacific Island parks.

There was a lot of great conversation in these workshops, much more than I can articulate here, but I want to focus on four component conclusions regarding the role of the NPS in global climate change:

- That this is the defining issue for our future, potentially throwing into disarray the standard of impairment. Based on the predictive models, the future of Joshua Tree National Park is that it will have no Joshua trees. That my friends, is the essence of impairment. The NPS, by the Organic Act, is legally compelled to engage in this issue so that future generation may enjoy their parks unimpaired.
- That we must first and foremost get our own house in order in terms of sustainability, energy conservation, green building and design, and alternative energy. We must lead by example. In the PWR we have started but we have a long way to go. The PWR has some parks that are over 50% solar and we are purchasing green power throughout the region. We are currently investigating carbon credits for our travel miles. When we are planning a project, sustainability must be the first consideration and the last thing to cut, rather than the traditional opposite. As a member of the Development Advisory Board, I was amazed that NASA had decided years ago to meet LEED (Leadership in Energy and Environmental Design) standards with all new construction but the NPS had it as an option.
- That the NPS must open its arms to scientists and to the long-term monitoring that will become so essential to understanding the changes we are facing. The overused

metaphor of the canary in the mine needs to be expanded. The value of our parks as centers for excellent science and long-term datasets cannot be overstated. The monitoring programs we have all initiated during the Natural Resource Challenge must become institutionalized and made available to the world.

- That the NPS engage the public in understanding this issue at a personal level. We must be the translators of the dry and often obtuse scientific reports into something that evokes the power of the places we protect. So we want to connect youth to this issue and the Gorical references to Rin Tin Tin and a slide show. If he wanted to connect to youth, he should have said "SpongeBob SquarePants and a podcast."

Let me read you two examples of what I mean: the first from a scientific journal, the second from literature:

> The larger glaciers are now approximately one-third their size in 1850 (range: 23–38%) and numerous smaller glaciers have disappeared. There has been a 73% reduction in the area of Glacier National Park covered by glaciers from 1850–1993. Only 27 km2 of glaciers remain from the 99 km2 which previously existed. Out of 84 watersheds, only 18 have 1% glacier cover, 8 have 2% and 4 have 3%. Average glacier area in the accumulation zone for September 1993 was 35%, indicating negative mass balances for most glaciers and continued shrinkage.
>
> —*USGS-BRD Glacier National Park Science Center*

> As long as I live, I'll hear waterfalls and birds sing, I'll interpret the rocks; learn the language of the flood, storm, and avalanche. I'll acquaint myself with the glaciers and wild gardens and get as near the heart of the world as I can.
>
> — *John Muir*

John Muir took Teddy Roosevelt to Yosemite National Park and he was struck with its awesome beauty. There in 1903, Teddy spoke:

> There can be nothing in the world more beautiful than the Yosemite, the groves of giant Sequoias and redwoods, the canyon of the Colorado, the Canyon of the Yellowstone, the three Tetons; and our people should see to it that they are preserved for their children and their children's children forever, with their majestic beauty all unmarred.
>
> — *Theodore Roosevelt, Yosemite National Park, 1903*

"… their children's children forever, with their majestic beauty all unmarred." I would say that Joshua Tree National Park without Joshua trees is not "unmarred."

I read with interest that the Christian Right and the Evangelicals are beginning to take global climate change as a serious platform issue. Perhaps they are finally hearing the old adage that there is a special place in hell for those uncommitted in times of crisis.

We who manage the most spectacular protected areas in the world have the power of the place, and those places are threatened by global climate change. It is our job to help understand those changes and communicate them to the public. In doing so, we must be optimistic, not harbingers of doom. We must be rational interpreters of an inconvenient truth that these special places, so revered by the American people and the people of the world that they have been set aside for future generations, are changing as a result of global climate change.

That is our challenge, that is our responsibility, and it is our job.

State Agency Responses to the Challenges of Climate Change Impacts for Fish and Wildlife Resources (panel discussion summary)

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Introduction

State fish and wildlife agencies are responsible for the management of most of the fish and resident wildlife in our nation and have a critical interest in the potential impacts associated with climate change. Since climate change will either impact or has the potential to impact the wildlife resources for which they are responsible, state resource management agencies, tribes, and the federal agencies will all be challenged to manage populations and ecosystems in the face of these changes, and the uncertainty about how ecological systems will adapt. This two-hour panel discussion highlighted approaches and strategies that state fish and wildlife agencies are taking to address potential impacts and challenges associated with climate change on a variety of natural resource issues.

This paper summarizes excerpts of the presentations and discussion that took place during the panel. This workshop was sponsored by the Association of Fish and Wildlife Agencies, U.S. National Park Service, U.S. Geological Survey, and U.S. Fish and Wildlife Service.

Presentations

- "First Steps in Responding to Climate Change—One State Fish and Wildlife Agency's Experience," Dave Schad, director, Division of Fish and Wildlife, Minnesota Department of Natural Resources
- "Global Warming Impacts on Big Game Winter Habitat," Jim DeVos, retired chief of research, Arizona Game and Fish Department
- "Trout in a Warming Environment: No Kitchen Door," Fred Harris, chief deputy director, North Carolina Wildlife Resources Commission
- "It's on the List: Global Climate Change Impacts on the Prairie Pothole Region," Randy Kreil, chief, Wildlife Division, North Dakota Game and Fish Department
- "How Does Implementation of State Wildlife Actions Plans Help Us Manage for Climate Change?", Martin Nugent, wildlife diversity program manager, Oregon Department of Fish and Wildlife
- "Nowhere to Run, Nowhere to Fly: Ecosystem Effects of Climate Change on Declining Herpetofauna," Priya Nanjappa Mitchell, state agencies coordinator, Partners in Amphibian and Reptile Conservation

Summary

The Association of Fish and Wildlife Agencies (the Association) serves as the collective voice of North America's fish and wildlife agencies at every level of government. It provides its member agencies and their senior staff with coordination services that range from migratory birds, fish habitat, and invasive species, to conservation education, leadership development, and international relations. Each wildlife agency of the United States and all its territories are members, as well as the Canadian Provinces, Mexican states, and the federal wildlife agencies of both Canada and United States.

In 2003, the Association began working on carbon sequestration at the policy level and produced a white paper that focused on integrating conservation principles into guidelines for terrestrial carbon sequestration. The Association continues to remain engaged on this topic through its work on the reauthorization of the Farm Bill. In 2006, the Association took a larger step towards addressing climate change through the creation of a climate change subcommittee housed under the Energy and Wildlife Policy Committee. This subcommittee is chaired by Dave Schad (director, Division of Fish and Wildlife, Minnesota Department of Natural Resources) and has grown under his leadership. Putting this panel together is one of the first steps the subcommittee has taken to become more active on the topic.

Unlike many non-governmental organizations, academia, and some federal agencies, the state agencies are just beginning to talk about climate change. There are some state fish and wildlife agencies that have been leaders on climate change issues, but also others who do not yet have it on their radar. The challenge before all natural resource agencies and organizations concerned with fish and wildlife conservation is how to make relevant, to both managers and the public, the impacts of climate change on our ability to manage resources.

At the state level, one way of doing this is to increase the visibility of the issue among state fish and wildlife agencies. We need to be working collaboratively to create tools that will help natural resource agencies talk about the real and perceived impacts associated with climate change so that we can begin to address potential impacts in our management strategies. To accomplish this we need the kind of forum assembled today to start having this discussion with all of our partners to help identify those opportunities to work together on this issue. We may have different missions and do not always see eye to eye, but we have a common end goal, and we need to find ways to work together to achieve these goals.

The intent of this panel was to present the state wildlife agency perspective on climate change and the ways in which the states are starting to think about this issue. There were six presentations followed by time for discussion between the panel and the audience with the intent that we might as a group start to come up with some ideas on how to bridge this gap between our agencies, and some realistic ways in which we can start addressing this challenge.

Regardless of whether the discussions focused on specific taxa, a state agency perspective, or opportunities for collaboration through state wildlife actions plans, all the presentations and discussion session identified common themes to address climate change.

- There is a need for strong leadership from the natural resource agencies and a commitment to improving coordination and collaboration. When it comes to fish and wildlife conservation we need to be proactive now because it will be harder to make a case for fish and wildlife when other impacts are directly affecting human livelihood (e.g., loss of homes or damage due to flooding caused by sea level rise).

- Basic inventory and monitoring is needed to determine which resources are particularly vulnerable that will allow managers to reassess their efforts in light of potential climate change impacts.
- When it comes to mitigating impacts we need to improve resiliency of habitats and communities to prepare for unknown, unpredicted, and synergistic impacts. As one example, as distribution ranges of plant and animal species change and move into areas where they are not currently considered to be native, we will need to be adaptive in our management strategies and assess whether to treat these as invasive species, or to protect them if their natural range is now compromised.
- We need to find ways to build uncertainty into planning in order to address changing priorities. Managers may need to re-assign land conservation policies and the focus of land acquisition based on emerging climate science data.
- We need better tools to speak with the public. We need common messages to build momentum around action in order to avoid skepticism.
- We need to build on existing collaborative frameworks such as state wildlife action plans and national fish habitat actions plans to meet common goals for species and habitat conservation.

If we are going to build support for conservation we need to be working together to educate the public and engage constituents. To achieve this we will need experts to champion the cause and make the science more accessible. Even within our own organizations we need to be working to make climate change a priority in our agency activities, and foster a change in the culture of fish and wildlife management to allow for the opportunity to think long term. With so many management challenges before us it is critical that we work together to address these and associated synergisms with respect to climate change.

Opportunities in a Changing Climate: British Columbia Parks and Protected Areas

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Overview

British Columbia (BC) is a large (948,191 km^2, or 366,099 mi^2) and biologically diverse province by Canadian standards. It is intersected by three of the four ecoregions in North America and is influenced by a long coastline on the Pacific Ocean. It is topographically complex with five major mountain ranges (Coast, Rocky, Columbia, Cassiar-Omineca, and Cariboo). This complexity of ecoregional influences and topography has provided the diversity of habitats that has spawned the biodiversity that British Columbia Parks and Protected Areas are charged with maintaining today. In the terrestrial realm the topography has worked to limit human influences and has therefore left the biodiversity in relatively good condition. The same steep mountains that have limited human development on land have led to high impacts in the aquatic realm. Most of the major river valleys have been dammed at least once to provide hydroelectric energy and irrigation.

The British Columbia protected areas system has been growing since its first park was established in 1911. By the early 1990s, six percent of the land base was in the protected areas system. At that time, the government pledged to double the system by 2000. According to the science of the day, the best approach for designing a protected areas system was to represent the underlying ecosystems in a system of protected areas that included a variety of sizes and replication. British Columbia succeeded admirably. Today, 14% of the province is in protected areas (federal, provincial, regional and private) and these areas do a reasonable job of representing the ecosystems in the province (British Columbia Ministry of Water, Land and Air Protection 2002; note that more than 1.5 million hectares have been added since 2002).

But what was good science in 1990 is now becoming outdated. The protected areas system has an additional role to play. Not only is it important that a variety of ecosystems are protected throughout the province, but managers have to take into consideration the fact that the ecosystems that were so carefully represented are now shifting and the species that were associated with those systems are going to stay and demonstrate that they can tolerate a range of conditions, move to stay within their comfort zone, or become extirpated. As protected areas managers our role needs to shift from trying to maintain the diversity within our boundaries to facilitating movement, identifying climate refugia and reducing all other stresses within our abilities.

Hamann and Wang (2006) have modeled the changes in the climate envelops underlying biogeoclimatic zones in British Columbia at three time intervals (2025, 2055, and 2085) based on an ensemble simulation. Biogeoclimatic zones are one of the ecological classification systems on which the representative increase in the protected areas system was based. The shift in representation that occurs with the shift in the underlying climate envelops can be seen in Table 1. There are some significant changes in representation of individual zones,

Biogeoclimatic Zone	Current		2025		2055		2085	
	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)
Alpine tundra	47.1	17,261,568	55.5	4,476,786	63.5	1,564,850	82.6	362,151
Bunchgrass	8.6	313,344	4.7	1,348,664	3.7	2,701,273	3.8	4,548,059
Boreal white and black spruce	6.4	15,397,120	5.9	16,640,536	7.9	14,263,542	13.2	8,995,126
Coastal Douglas fir	1.8	249,600	2.4	443,155	3.7	756,388	10.8	1,192,705
Coastal western hemlock	12.2	10,806,016	14.4	14,357,959	15.0	15,860,741	15.3	17,017,941
Englemann spruce sub-alpine fir	15.4	14,495,744	18.2	19,647,152	19.8	19,122,730	21.7	13,504,261
Interior cedar hemlock	9.5	5,248,768	8.6	13,051,638	10.7	15,611,417	12.3	18,921,798
Interior Douglas fir	5.0	4,367,104	9.4	6,338,037	7.4	14,324,295	11.9	11,451,546
Mountain hemlock	14.4	3,509,248	16.3	2,660,508	16.5	1,685,830	15.8	738,767
Montane spruce	7.6	2,771,200	18.9	2,804,106	19.2	2,436,432	17.1	1,770,253
Ponderosa pine	4.4	345,600	2.6	948,378	4.2	2,226,821	3.3	14,398,987
Sub-boreal pine spruce	8.7	2,403,840	4.7	1,476,219	5.9	518,636	51.3	50,233
Sub-boreal spruce	6.3	10,303,744	9.8	8,343,938	8.9	2,937,184	8.2	1,443,870
Spruce willow birch	20.1	7,144,963	23.1	1,933,576	37.9	460,513	56.1	74,955

Table 1. Modeled changes in ecosystem representation of British Columbia Protected Areas system with climate change.

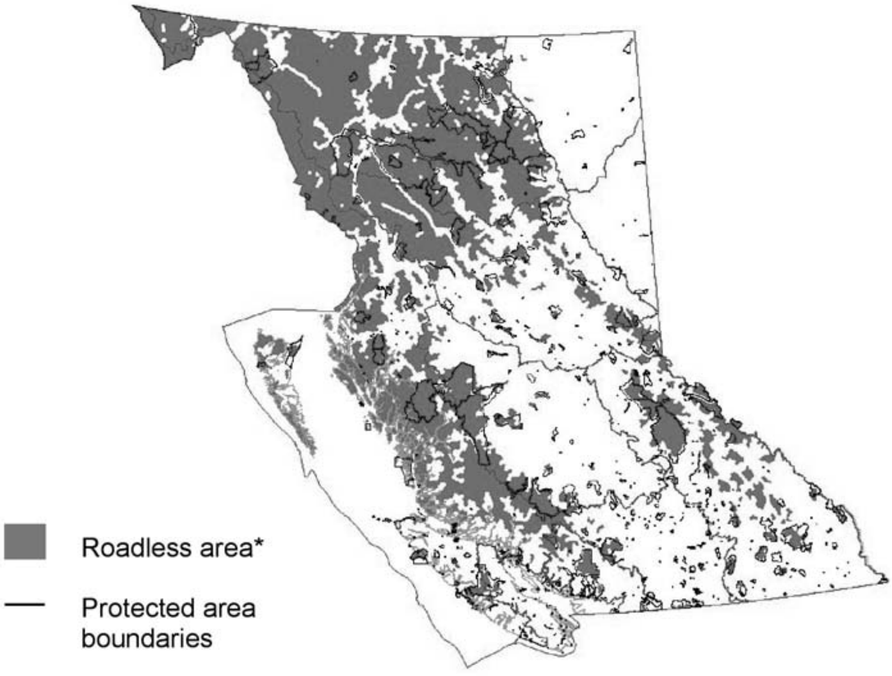
but the range of values is not much different because of the good distribution of protected areas across all portions of the land base.

Identifying highest regional opportunity

One of the mandates of British Columbia Parks and Protected Areas is to maintain the biodiversity of the protected lands. These lands have been called the cornerstone of biodiversity conservation in BC. In this new era of rapidly changing climate, maintaining biodiversity is no longer about keeping all the pieces, but about facilitating movement and reducing stresses to try to keep as many of the pieces as possible.

To that end, the less developed, northern portion of the province was identified as having the most opportunities based on a map of roadless areas in the province (Figure 1). This map was generated using two rules. All the linear developments that have been mapped (roads, railroads, power lines, seismic lines and airports) were buffered by 5 km on each side. Every resulting polygon that was less than 2000 ha was eliminated. The resulting polygons are defined as the roadless areas. The mapped information dated from 1984–2002.

At the ecoprovincial level, there are nine units in the province. The most northern of these is the Northern Boreal Mountains Ecoprovince. The roadless map was intersected with the ecoprovincial map to find the ecoprovince with the most intact landscape. This



*The roadless areas are 5 km from any linear feature (roads, railroads, power lines, seismic lines and airports) and part of a polygon of at least 2000 hectares.

Since this map was made, an additional 1.2 million hectares of protected areas have been added, primarily along the central and north coast.

Figure 1. Roadless areas of British Columbia.

intersection showed that 70% of the Northern Boreal Mountains was still intact (Table 2). Reflecting the low human presence in this area, the northern part of BC still has the most intact predator prey systems still functioning in North America (Laliberte and Ripple 2004). At a North American scale, Laliberte and Ripple (2004) show how the ranges of 17 carnivore and ungulate species have collapsed into BC. Much of this is in the Rocky Mountains and the northern boreal mountains. Northern areas have also been identified as the areas that are going to see the most significant temperature changes. This has already been demonstrated in the increase in temperature minimums from 1971–2000 (Murdock et al. 2007).

Opportunities and obligations

In the context of biodiversity management and rapid climate change, there is a fine line between opportunities and obligations. Our primary opportunities (in the north) and obligations throughout the province are to look after the ability of species to migrate, identify and protect refugia, and reduce other stresses.

Eco-Province	Total % Roadless (matrix plus reserves)	% Roadless in Reserves
Northern Boreal Mountains	70	77
Coast & Mountains	47	67
Sub-Boreal Interior	28	41
Southern Interior Mountains	16	47
Central Interior	15	65
Southern Interior	4	22
Georgia Depression	3	28
Taiga Plains	1	10
Boreal Plains	0	0
Provincial Totals	32	60

Table 2. Roadless area by ecoprovince in British Columbia.

Movement of individuals is dependent on what has been called the porosity of the landscape. This refers to the lack of barriers to movement. The barrier threshold varies significantly by species with some able to cross eight lane highways or highly urbanized areas and others unable (or unwilling) to cross a footpath. There is concern that the modern landscape is so fragmented outside of protected areas that individuals will not be able to survive outside of protected areas but will not be able to remain inside and stay within their comfort zones. The speed with which the climate is changing is also a factor. Even with completely unfragmented landscapes, some species will not be able to move with the rapidity necessary.

The protected areas system in British Columbia is 60% intact using roadlessness as a surrogate for intactness. The area outside protected areas (the matrix) averages 37% intact. Therefore, I restricted the following analyses to protected areas, and only those protected area complexes that met the minimum reserve size defined by Gurd et al. (2001). The minimum size is 270,000 hectares and is satisfied by 10 protected area complexes in the province that together make up 60% of the system. Some of them include protected areas in adjacent jurisdictions. In each of them I identified the elevational breadth and the latitudinal breadth and compared that with the necessary breadth given a range of climate scenarios (Table 3).

The analysis of elevational breadth was based on the assumption that an organism needs to move about 100 m in elevation for every 1°C in order to remain in a similar comfort zone. The elevational breadth was so large in each of the 10 protected area complexes that in every case they could deal with a change of 10°C or more. A more varied result came in the analysis of latitudinal breadth. This analysis was based on the assumption that an organism needs to move 100 km north for each 1°C temperature increase in order to stay within its comfort zone. In this case the protected area complexes that are oriented basically north to south had an advantage. They ranged from an ability to deal with 5°C in climate change to less than 1°C. The predicted change in British Columbia based on three climate models and three scenarios ranges from 3–4.8°C between now and the thirty-year period centered on 2080 (Compass Resource Management 2007), with the highest changes in the north. Therefore, the organisms in every one of these protected area complexes will be at the limit of their flex-

Protected Area Complex[1]	size (ha)	latitudinal breadth (degrees)	Degrees of flexibility (°C)[2]	elevational breadth (m)	Degrees of flexibility (°C)[3]
Manning	315,021	1°0'	1.1	2621	+10
Akamina-Kishinena	627,982	1°4'	1.2	2242	+10
Garibaldi	295,190	1°0'	1.1	2741	+10
Tweedsmuir	1,525,858	1°55'	2.1	3229	+10
Wells Gray	778,160	1°46'	2.0	2339	+10
Mt. Robson	3,079,172	4°3'	4.5	2970	+10
Spatsizi	1,527,034	1°25'	1.6	2673	+10
Dune Za Keyih	428,594	0°54'	1.0	2049	+10
Northern Rocky Mountains	795,988	1°9'	1.3	2355	+10
Tatshenshini	7,974,376	4°52'	5.4	5488.8	+10

[1]The complexes are named with a prominent provincial park name, but they are made up of groups of adjacent parks including national parks and parks in other jurisdictions.
[2]Based on the assumption that to remain in the same comfort zone, an individual must move 100 km north for every increase of 1 degree C. One degree latitude equals 111 km.
[3]Based on the assumption that to remain in the same comfort zone, an individual must move 100 m higher in elevation for every increase of 1 degree C.

Table 3. Latitudinal and elevational breadth of 10 protected area complexes in British Columbia.

ibility to cope with the degree of climate change predicted. In both these analyses it is important to note that the complexity of the landscape will provide opportunities for refugia that are not reflected in this simple approach. Also, organisms at the top of mountains or the north end of the protected areas will not have the full range of options for movement.

One of the most important obligations that we have as stewards of biodiversity in British Columbia is to encourage the province to augment the protected areas system in ways that will increase north–south connectivity. The opportunity to do this is much higher in the northern parts of the province where the porosity of the matrix is still high. There are several initiatives already underway that can and should be consulted for the most efficient planning. These include the Kaska Dena First Nation Traditional Territory plan, the Y2Y Initiative, and the Nahanni National Park Reserve expansion proposal.

Future investigations

In the remainder of the protected areas system, we can identify the most likely areas for refugia—areas where the climate changes will be ameliorated by such influences as topography (north slopes and toe slopes), or legacies of older ecosystems (large old trees). Throughout the province, but particularly in these refugia, it is essential that we reduce the non-climate stresses.

Our ability to track and manage individual species is going to be sorely taxed by climate changes. For those who want to pursue species level management, species that will be affected earliest are those at the north end of protected areas that will be moving outside in order to maintain their comfort zone, and those already at the edge of their suitable range in alpine areas.

At the biogeoclimatic zone level, it is clear that representation of the underlying climate envelopes will shift significantly with the current configuration of protected areas in British Columbia (Table 1). Some of the zones increase their area manyfold although their representation in the protected areas system decreases (bunchgrass and ponderosa pine). The opposite also occurs with a large increase in representation within the protected areas system of zones that are substantially reduced in total area in the province (alpine tundra and spruce willow birch). These are ecosystems to watch carefully.

References

British Columbia Ministry of Water, Land, and Air Protection. 2002. *Environmental Trends in British Columbia 2002.* Victoria, B.C.: State of Environment Reporting.

Compass Resource Management. 2007. Major impacts: Climate change. On-line at www.biodiversitybc.org/assets/Default/BBC%20Major%20Impacts%20Climate%20of%20-Change.pdf.

Gurd, D.B., T.D. Nudds, and D.H. Rivard. 2001. Conservation of mammals in eastern North American wildlife reserves: How small is too small? *Conservation Biology* 15, 1355–1363.

Hamann, A., and T. Wang. 2006. Potential effects of climate change on ecosystem and tree species distribution in British Columbia. *Ecology* 87, 2773–2786.

Laliberte, A.S., and W.J. Ripple. 2004. Range contractions of North American carnivores and ungulates. *BioScience* 54, 124–138.

Murdock, T.Q., A.T. Werner, and D. Bronaugh. 2007. Preliminary analysis of British Columbia Climate Trends for biodiversity. On-line at www.biodiversitybc.org/assets/Default/BBC%20PCIC%20Preliminary%20Analysis%20of%20Climate%20-Trends.pdf.

Protecting Biodiversity in a Changing Climate: The State of Adaptation Policies Dedicated to Enhancing the Resiliency of Biota

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Introduction

Due to the unprecedented rate of human-induced climate change, there is now widespread consensus that unless proactive adaptation efforts are embraced, significant and sustained biodiversity loss will occur. Climate change has already begun to impact biodiversity, and trends are becoming visible, including modification of migration patterns, length of growing seasons, species distributions, and invasive species outbreaks (Parmesan 2006). While conservation biologists have performed extensive research on climate impacts to biodiversity and have dramatically improved scientific understandings of the problem, as well as adaptation tools to contend with the challenge, the influence of this knowledge in shaping policy responses has been limited. Mitigation of greenhouse gas emissions remains the focus of climate change policy, and advancement of adaptation measures, especially for biodiversity conservation, has been slow to take form. This prioritization is problematic because institutional coordination for biodiversity at all scales will be essential in a changing climate (Lovejoy and Hannah 2005).

A few jurisdictions have developed adaptation policies for enhancing biodiversity resiliency in a changing climate. However, an unexplored puzzle has emerged: these policies have diverged with regard to the tempo of policy advancement—with some jurisdictions embracing adaptation policies more readily than others—and have begun to converge with regard to the type of measures that the final policy embraces. In other words, no policy has yet to incorporate precautionary targets and timetables that contend with the magnitude of the problem, as defined by scientific assessments. This paper will provide an overview of climate impacts to biodiversity, an introduction to adaptation measures for biodiversity conservation, and a brief assessment of the current state of adaptation policies for enhancing the resiliency of biodiversity in a changing climate.

Overview of climate impacts to biodiversity

Human-induced climate change has been recognized as one of the greatest challenges facing our planet. It is already rapidly transforming our world, affecting both human-built and natural environments. Overall, the Earth has already warmed 0.8°C in the last century, having increased 0.2°C per decade within the last thirty years. Even if we were to stabilize emissions at lower levels, we would still witness significant impacts. For example, if greenhouse gas levels were stabilized at 2000 levels, atmospheric temperatures would increase by 0.5°C by the end of this century and the amount of sea level rise would increase by 320% by the end of this century (Meehl et al. 2005). And if we were able to halt greenhouse gas emissions altogether, the Earth would still undergo significant increases in both temperatures and sea level rise as a result of the lag effects of greenhouse gases in the atmosphere, as well as thermal inertia. Hence, the science is clear; even if we were to stabilize at lower emissions levels, or eliminate emissions, we would still have already committed to substantial impacts, supporting the need for adaptation policies.

Changes in ecosystems often parallel changes in local climates. As climates are altered, ecosystems can, in turn, be affected. Rising temperatures will have significant implications on precipitation trends and hydrological cycles, as some regions become wetter, while others become drier due to the changes in atmospheric circulation and water-holding capacity of a warmer atmosphere. Changes to biota can be carried out at the micro scale of the cell—and, scientists are now finding, even the genetic composition of some species is changing—to the macro level of the biome. Species will vary in their responses to a changing climate, and several indicators have been developed to assess vulnerability to climate change impacts. Some species will have high tolerances to change, while others will quickly become threatened or extinct, namely those with poor dispersal capabilities, restricted ranges, habitat or niche specialization, low tolerance to climate sensitive variables, and isolated population distributions such as mountaintops or islands. And some species will migrate to more tolerable regions. For example, species in high latitude regions are likely to shift tens of kilometers poleward by 2050, whereas temperate and tropical montane species are likely to shift hundreds of meters in altitude by mid-century (Forrest 2003). Species migration will in turn affect ecosystem composition.

Climate change will likely become a leading driver of biodiversity degradation in the 21st century. The Intergovernmental Panel on Climate Change (IPCC), an international body created by the United Nations Environment Program and the World Meteorological Organization to provide authoritative assessments on climate science and impacts, has recently suggested that 20% to 30% of species will likely be at a higher risk of extinction with temperature increases greater than 1.5°C to 2.5°C, and risks will increase with additional temperature rise (IPCC 2007). For those species that can adapt, they may dramatically change their ranges (Forrest 2003). As species migrate—and species will migrate individualistically—new assemblages of species will be created, which can have adverse impacts to food chain and community dynamics, presenting new challenges to biodiversity management and conservation. Moreover, other human-induced stressors, such as land conversion and fragmentation, habitat destruction, pollution, and overexploitation, leave ecosystems and biodiversity more fragile in a changing climate. Thus, non-climate drivers of degradation act synergistically with climate change impacts, a combination of effects that arguably presents the greatest challenge facing conservation today (Lovejoy and Hannah 2005).

Overview of adaptation for biodiversity conservation

As indicated above, because thermal inertia and the lag of climate change impacts will result in significant effects (Meehl et al. 2005), a two-pronged policy approach that employs both mitigation and adaptation will be required to ameliorate future environmental degradation. While mitigation activities will direct efforts to curb greenhouse gas emissions, adaptation efforts will bolster biodiversity resiliency. Although adaptation strategies will not protect all species from climate change impacts (e.g., there may be physical barriers to migration), adaptation is a critical component of biodiversity conservation in a changing climate.

The notion of adaptation is not novel. Ecologists have long used the concept of adaptation to depict the evolution of organisms in a new environment. Broadening this definition, adaptation in the context of climate change connotes the evolution of humans and ecosystems to new environments caused by climate change (Abramovitz et al., undated). (However, it should be noted that this change will not occur on an "evolutionary" time frame, as human-induced climate change has ensued at a much faster rate.) Indeed, adaptation has been defined similarly by climate change experts. The IPCC defines adaptation as the "adjustment in natural or human systems in response to actual and expected stimuli or their effects, which moderates harm or exploits beneficial opportunities" (IPCC 2007:6).

Adaptation strategies to bolster biodiversity resiliency require assessments of vulnerability and impacts on the local level, primarily through the advent of sophisticated modeling (Abramovitz et al., undated). There are a number of modeling tools now available for assessing climate change impacts to biodiversity, including regional climate models, dynamic and equilibrium vegetation models, species bioclimatic envelope models, and others. After vulnerabilities are assessed, adaptation strategies could include: rigorous monitoring and evaluation, control of invasive species, establishment of corridors, reduction of non-climate stressors, and acquisition of new reserves (AHTEG 2005). In addition, rehabilitation of previously degraded ecosystems can aid in the maintenance of viable habitat (Dharmaji et al. 2003). Another essential component of adaptation for biodiversity conservation is the reduction on non-climate stressors, such as habitat fragmentation, over-harvesting, pollution, and other factors which augment the impacts of climate change on ecosystems and biodiversity (AHTEG 2005). Ultimately, the most effective basket of adaptation tools for strengthening biodiversity resiliency will be context-specific and require rigorous assessments by trained experts in conservation biology, managers and other scientific knowledge holders.

Adaptation measures for protecting habitat and species diversity will benefit not only ecological communities but also human communities that depend on ecosystem services. Ecosystems and biodiversity constitute food, water supply, and medicine, as well as water filtration systems, arable land, and other provisions (Dharmaji et al. 2003). The benefits that can be obtained from ecosystems are known as "ecosystem services." Ecosystem services translate natural assets, such as trees, snow cover, soil fertility, etc., into valuable benefits for humans, such as wood production, winter tourism, and arable land. Climate change has implications for ecosystem transformation, which can in turn impact services from ecosystems and compromise human wellbeing. Thus, the conservation of biodiversity is inextricably bound to the safeguarding of ecosystem services that provide for basic human needs.

Adaptation policies for biodiversity conservation also have ramifications for sustainable development agendas. In its Third Assessment Report, the IPCC claims that developing countries will be most vulnerable to climate change impacts, as a result of their low adaptive capacity and dependence on ecosystem services (IPCC 2001). Due to institutional and financial barriers to the establishment of adaptive capacity, developing countries are accordingly more vulnerable. Strengthening adaptive capacity entails reducing natural resource depletion, alleviating poverty, mitigating pressures on resources, improving management of risk, and other facets of sustainable development goals. Thus, as the IPCC aptly notes, strengthened adaptive capacity can lead to the enhancement of sustainable development and vice versa, and these goals are "mutually reinforcing" (IPCC 2001:8).

Overview of the state of adaptation policies for biodiversity conservation

Dharmaji et al. categorize adaptation policy responses into four classes: (1) *maintenance of status quo,* which could result in significant risks and costs in the future; (2) *no regret strategies*, which employ only strategies that do not present great costs to communities; (3) *precautionary measures*, which are based on the premise that actions should be taken to contend with predicted impacts; however, precautionary strategies must be cost-effective; and, lastly, (4) *proactive strategies*, which entail the implementation of far-reaching and aggressive measures in an attempt to mitigate adverse climate impacts (Dharmaji et al. 2003). The majority of adaptation measures remain in the "maintenance of status quo" or "no regret strategies" categories; yet adaptation measures for the enhancement of biodiversity resiliency, given that species loss is irreversible, require both "precautionary measures" and "proactive strategies."

A brief overview of adaptation policies for biodiversity conservation in five case studies follows: Finland, Australia, Canada, United States, and international deliberations.

Finland. In 2003, Finland's Parliament commenced work on its National Strategy for Adaptation to Climate Change. The strategy calls for evaluating existing protected areas networks, reducing non-climate stressors in degraded areas, improving monitoring and planning, and studying thresholds of biodiversity to climate impacts. The document also has a number of short-, medium-, and long-term measures (MAFF 2005).

Australia. The Australian government has backed widespread monitoring of climate effects in protected areas and, most significantly, adaptation measures for management. The government has released a "National Biodiversity and Climate Change Action Plan" which is the first national adaptation strategy of its kind (NRMMC 2004). Most significantly, as of late February 2007, state and federal governments, led by the New South Wales government, have decided to create a 2,800-km conservation corridor from Victoria to Queensland, known as the "Alps to Atherton" corridor, to assist species migration in a changing climate. While land will not be acquired by the governments, and, thus, participation remains voluntary, this project is one of the first corridors to be designed to address climate impacts to biodiversity and will be among the longest conservation corridors in the world (Wood 2007).

Canada. Paralleling the Australian government, the Canadian government has been a leader in adaptation efforts for biodiversity management. The government's report entitled *The State of the National Parks* identifies climate change as a leading factor in ecosystem degradation, and Parks Canada has since launched a project to improve the resiliency of their park network (Scott 2003).

United States. While the U.S. Environmental Protection Agency has developed a pilot "Climate Friendly Parks" project, which calls for voluntary action to address climate change, measures resulting from the project focus on mitigation efforts solely, e.g. energy-efficient buildings and facilities. The U.S. Climate Change Science Program is finalizing a review of "adaptation options for sensitive ecosystems and resources" (USCCSP 2006).

International. Although no timetables or binding targets exist for adaptation for biodiversity conservation on the international level, adaptation measures have increasingly been folded into multilateral environmental agreements and funding mechanisms, including the U.N. Framework Convention on Climate Change, Kyoto Protocol, Convention on Biological Diversity, Ramsar Convention on Wetlands, and the United Nations Educational, Scientific and Cultural Organization's (UNESCO) World Heritage Convention. However, the large majority of measures define adaptation broadly and do not stipulate that parties must carry out adaptation activities for the preservation of species diversity and habitat. In addition, with the exception of the World Heritage Convention's Danger List, these measures fail to establish a methodology for project prioritization, which is necessary given global constraints in capacity (AHTEG 2005).

Conclusion

Despite scientific advancements on assessing climate impacts to biodiversity, as mentioned above, decision making on adaptation for biodiversity conservation has yet to progress towards "precautionary" or "proactive" policy solutions on either the international or national levels. While a number of adaptation strategies can be employed to strengthen the resiliency of biodiversity in a changing climate, a coordinated policy response has yet to emerge, and binding targets and timetables are needed to ensure that appropriate strategies are adopted to contend with climate effects.

References

Abramovitz, J., T. Banuri, P.O. Girot, B. Orlando, N. Schneider, E. Spanger-Siegfried, J. Switzer, and A. Hammill. Undated. *Adapting to Climate Change: Natural Resource Management and Vulnerability Reduction*: Background Paper to the Task Force on Climate Change, Adaptation and Vulnerable Communities. Gland, Switzerland: Stockholm Environment Institute, IUCN–The World Conservation Union, International Institute for Sustainable Development, and Worldwatch Institute.

AHTEG [Ad Hoc Technical Expert Group]. 2005. *Report on the Meeting of the Ad Hoc Technical Expert Group on Biodiversity and Adaptation to Climate Change*. Montreal, Canada. On-line at www.cbd.int/doc/meetings/sbstta/sbstta-11/information/sbstta-11-inf-05-en.pdf.

Dharmaji, B.D., P. Balakrisha, and H. Baulch, ed. 2003. *Mainstreaming Biodiversity and Climate Change: Proceedings of the Asia Regional Workshop 2003.* Colombo, Sri Lanka: IUCN.

Forrest, J. 2003. *EarthTrends Featured Topic: Protecting Ecosystems on a Changing Planet.* Washington, D.C.: World Resources Institute.

IPCC [Intergovernmental Panel on Climate Change]. 2001. Climate change 2001: Impacts, adaptation, and vulnerability. In *Report of the Intergovernmental Panel on Climate Change*. J. J. McCarthy, O.F. Canziani, N.A. Leary, D.J. Dokken, and K.S. White, eds. Cambridge, U.K.: Cambridge University Press.

———. 2007. Climate change 2007: Impacts, adaptation, and vulnerability. In *Report of the Intergovernmental Panel on Climate Change.* M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden, and C.E. Hanson, eds. Cambridge, U.K.: Cambridge University Press.

Lovejoy, T.E., and L. Hannah, eds. 2005. *Climate Change and Biodiversity*. New Haven, Conn.: Yale University Press.

Meehl, G.A., W.M. Washington, W.D. Collins, J.M. Arblaster, A. Hu, L.E. Buja, W.G. Strand, and H. Teng. 2005. How much more global warming and sea level rise? *Science* 307, 1769–1772.

MAFF [Ministry of Agriculture and Forestry of Finland]. 2005. *Finland's National Strategy for Adaptation to Climate Change.* Vammala, Finland: MAFF.

NRMMC [Natural Resource Management Ministerial Council]. 2004. *National Biodiversity and Climate Change Action Plan 2004–2007.* Canberra: Australian Department of the Environment and Heritage. On-line at www.environment.gov.au/biodiversity/publications/nbccap/.

Parmesan, C. 2006. Ecological and evolutionary response to recent climate change. *Annual Review of Ecology, Evolution, and Systematics* 37,637–639.

Scott, D. 2003. *Climate Change and Canada's National Parks.* Ottawa: Environment Canada. On-line at www.pc.gc.ca/docs/v-g/ie-ei/cc/index_E.asp.

SBSTA [Subsidiary Body for Scientific and Technological Advice], UNFCCC. 2004. *Application of Methods and Tools for Assessing Impacts and Vulnerability, and Developing Adaptation Responses.* Background Paper. FCCC/SBSTA/2004/INF.13.

USCCSP [U.S. Climate Change Science Program]. 2006. Preliminary review of adaptation options for climate-sensitive ecosystems and resources. On-line at www.climatescience.gov/Library/sap/sap4-4/sap4-4prospectus-final.htm. Accessed 2007.

Wood, S. 2007. Australia plans massive conservation corridor. *Cosmos Magazine Online.* Online at www.cosmosmagazine.com/node/1083.

When It's Better Not to Manage NPS Resources

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From the very beginning, one of the main reasons for establishing national parks was to provide natural places for humans to recreate and enjoy the outdoors free of human influences. Such thinking has gradually evolved as people moved from fear of nature to enjoying the benefits nature could provide (Wilson 1984). Thoreau, writing in the 19th century, wrote about living a good life close to wild nature. And when John Muir and Teddy Roosevelt camped at Yosemite National Park in 1903, both men shared their appreciation of the virtues of outdoor life and the benefits of spending time in wild places. But for the entire history of the national parks, those who would leave nature natural have long been at odds with those who seek to "manage" or improve upon it.

Current National Park Service (NPS) policy strongly emphasizes the word "natural," as in this quote from the 2006 NPS *Management Policies:*

> *4.1 General Management Concepts*
> [The Service will] try to maintain all the components and processes of naturally evolving park ecosystems, including the natural abundance, diversity, … etc.… [N]atural change will be recognized as an integral part of the functioning of natural systems. By preserving these components and processes in their natural condition, the Service will prevent resource degradation and therefore avoid any subsequent need for resource restoration.… The Service will not intervene in natural biological or physical processes, except … to restore natural ecosystem functioning that has been disrupted by past or ongoing human activities.…

We believe that this means preserving the full complement of native flora and fauna, and allowing these species to live their lives without interference from humans. It also means preserving unruly, unpredictable processes such as fires, floods, and insect outbreaks that have shaped park landscapes and, over the eons, helped create wild species themselves.

Since its inception, the "leave nature alone" philosophy has had strong advocates within the Park Service and among its friends. In the 1920s, for example, George Wright (NPS scientist), Joseph Grinnell (Zoology professor at the University of California–Berkeley), and Charles C. Adams (at the College of Forestry, Syracuse, New York) argued that national parks should be ruled chiefly by natural processes. Although Wright felt that active management might be needed in "combating the harmful effects of human influence," Wright and Grinnell argued forcefully against fencing the bison for display, feeding the bears, and killing predators in Yellowstone (Pritchard 1999).

But for just as long, another faction within NPS has argued for compromises in order to accommodate visitors, encourage economic development, or improve on nature. Yellowstone Superintendent (and later NPS Director) Horace Albright overruled Wright and Grinnell, arguing that visitors' desires to see animals up close could only be ensured by management or direct human intervention. Albright is famously shown in photographs of the time, demonstrating to visitors how to feed the bears. Albright supported the Bison Ranch at Yellowstone, a fenced corral (where the animals could be viewed comfortably and reliably), and presided over the wholesale slaughter of predators well into the 1930s (Pritchard 1999).

Although it could have been accomplished with less harm to wildlife and lighter ecological impacts, some development of visitor facilities (roads, campsites, even hotels) was necessary to accommodate visitors to the national parks. In the early days of the national parks (up until, say, the 1940s) these efforts and the numbers of visitors were small enough to have negligible impact on park resources (Sax 1980). But we contend that the collective impact of building, manipulation, and "management" have seriously compromised NPS's primary mission: to preserve wild nature *as* wild nature. In any case, the history of the parks provides convincing evidence that philosophical differences of opinion among rangers, naturalists, scientists, and public visitors are as old as the Park Service itself (Sellars 1997; Pritchard 1999). When to manage, what to manage, and how to decide these questions have proven difficult questions throughout NPS history.

It is a fact of life that administrators and moneyed interests will often have the upper hand in an argument with staff or scientists. But in the end, neither administrators nor scientists can claim a moral high ground. While NPS has long professed adherence to scientific principles, an abundance of grievous errors have been made by managers *and scientists* responsible for national park resources. Whether due to lack of scientific understanding, a desire to encourage visitors, or simply an idea insufficiently thought through, the list of erroneous and regrettable management actions is long and well-documented.

A resource management "Hall of Shame" includes the benighted effort to rid parks of predatory animals, an effort that continued for decades. It includes numerous examples where animals were fenced, displayed in pens, or fed by park staff for public amusement. It includes the unseemly dismissal of the Craighead brothers when scientific discourse lost out to power politics over how to wean grizzlies from a routine of long-time human feeding.

Finally, the Hall should reserve a special place for NPS fire policy; probably the most ecologically damaging of all these policies. For much of the 20th century, NPS followed a policy of absolute fire suppression: putting out fires anywhere it could reach, as quickly as possible. As early as the 1960s, research began to show that this was bad for forests and particular species, yet policies changed very slowly. We now know that fire is vital to the continued health of forests, prairies, seasonal wetlands and other ecosystems in many national parks and are trying, timidly in many places, to restore it to its rightful ecological role.

Acknowledging that people make mistakes, we should not take the arrogant position that those errors are now past and that we manage today through a clearer lens or with greater wisdom. Past NPS managers who made even the most grievous mistakes were neither fools nor cranks of the time but were typically well-intentioned, mainstream thinkers. As we move forward, park managers should adopt a minimalist posture towards management, place humility (rather than pride) as the highest goal, and take the advice of Hippocrates (*Epidemics*, Book 1, Section 11) who counseled doctors to "at least, do no harm."

Because we so often err and the effects of our errors can be long lasting and dire, simply doing nothing probably commits the least harm in the long run. This then is our suggestion to managers: do as little as you can get away with. If possible, do nothing.

This approach will of course frustrate many managers' desire to act, to "do something" for nature. But we believe it has the best chance of fulfilling the Park Service's primary mission: to preserve wild nature. And in the long run, the manager who does nothing will be proven right time and again.

However, human nature and institutional imperatives being what they are, we doubt many managers will take us up on this suggestion. So as an alternative, we propose the following checklist or matrix, to be used in evaluating whether or not to engage in management projects (Table 1).

A few examples of good resource management projects will suggest how this matrix might be applied.

One particularly excellent recent management project is the reintroduction of wolves to Yellowstone National Park. In this project, a relatively small amount of money was used to obtain and release the wolves. After reintroduction, the animals re-established themselves

Table 1. A matrix for deciding whether to undertake resource management projects.

A Good Project:	**A Poor Project:**
• Runs itself (becomes self-sustaining)	• Requires constant work (never-ending fight)
• Re-establishes natural control	• Depends on continued human actions
• Requires least input of energy and/or cash	• Requires constant and continuing input of dollars and/or energy
• Manages people rather than nature	• Tries to manage nature rather than people
• Leads to stable biodiversity of native species (but not necessarily highest biodiversity—e.g., exotics or weedy species)	• Results in community structure and species composition vacillating strongly when the project ends, with unpredictable outcome
• Serves ecosystem needs in objective, non-anthropocentric ways	• Primarily serves human needs (anthropocentric)
• Is likely to be successful over the long term	• Is unlikely to last longer than the funding
• Supports top-down control (e.g., restoring top predators)	• Tries to substitute for top-down control (e.g., shooting ungulates)
• Restores larger areas (umbrella/keystone effects)	• Is small-scale and intensive, pertaining only to specific sites
• Is fail-safe (Hippocrates: "Do No Harm")	• Has collateral impacts that are uncertain, hard to estimate, or not adequately considered

with a torrent of associated results up and down the food chain. Predator–prey cycles were restored, vegetation patterns changed significantly, and visitors flocked to the park to witness the new, big dog in town. The project can be monitored long-term but requires no input of additional resources. It affected the entire park and perhaps even the surrounding ecosystem.

Contrast this with the Park Service's proposal to control overpopulation of elk in Rocky Mountain National Park by bringing in sharpshooters or licensed hunters to shoot them. The original problem (too many elk) is a function of people feeding them (outside of the national park boundary) and the absence of natural predators. Rather than working with local governments to prohibit this practice ("managing people") or reintroducing predators, NPS proposes to manage the wildlife ("managing nature") with hunting. But this human intervention will need to be repeated year after year, in perpetuity. It will also create a large new class of people (hunters) with a vested interest in continuing such intensive management. From just about any angle, this proposed project fails the test of good management. Reintroducing top predators (wolves) is politically charged, but the result would be infinitely better.

Another excellent project is the planned removal of the two hydropower dams on the Elwha River in Olympic National Park. When accomplished, this project will restore five species of salmon to 70 miles of river from which they've been excluded for more than 90 years. Once re-established in the river, the salmon will again provide marine nutrients to upland forests. Widespread ecological benefits will accompany the restoration of sediment transport and large woody debris dynamics. Although this project will be quite costly ($185 million), it will restore natural regulation and will require little action from managers once the dams are removed.

Of course, most projects are neither black nor white, but some shade of gray. Such is the case of Exotic Plant Management Teams (EPMTs) now working in many national parks. These teams attempt to control exotic weeds before they spread and become uncontrollable. Considered in terms of the checklist, the EPMTs fight a constant battle requiring continuous input of funds and effort. They may win against one species or perhaps several, but the war is never-ending and unlikely to succeed in the long run (Cousens and Mortimer 1995). When the funding stops, the weeds resume their march. Mechanical removal can be used in some cases, but others rely on chemical applications with undesirable environmental impacts. If new methods were found to effectively control exotic plants when they were at very small population sizes, EPMTs would get a higher score from our matrix. As they stand, we rate them lower than the previous "excellent" examples.

For many NPS managers, projects have seemed a way of restoring a *status quo* or returning the parks to a previous condition. Unfortunately, many issues now facing the Park Service will be due to rapid changes in that *status quo*. Global climate change, in particular, will inevitably confound efforts to do "what is right." As Dave Graber (2003) said, "there may well be an unhappy trade-off between permitting ecosystems their own—albeit anthropogenically altered—destiny, or engaging in aggressive, intrusive intervention in an attempt to direct ecological trajectory."

Graber's words are particularly apt, given that even the best management today cannot set things back to a previous, unimpacted, pristine condition. With climate change forcing systems into new and unknown trajectories, how can we even guess which direction we should be heading? Or to put it even more succinctly, "If we don't know where we're going, why be in a hurry to get there?"

We maintain that doing nothing is a valuable and under-utilized management tool. Doing nothing saves money and avoids confounding global trends with our own efforts. It allows us to document change occurring in these relatively unimpacted parks, and whatever happens is likely to happen anyway, regardless of our efforts! This documentation of what's happening in unimpacted systems may prove to be unimaginably valuable, yet another gift of our national parks to all Americans.

We are essentially pessimistic that people, serving their own agendas, will do the right thing for nature. Time and again, human efforts have proven wrong-headed, fallacious, short-sighted, or unwise. In the long history of the Park Service some people were right (like George Wright) … and we see them as wise today. But others with more power or more money had fallacious opinions, unwarranted assumptions, and untenable philosophies, and had their way. We are unconvinced that any part of that formula is different today.

In the long run, you could do a lot worse than to do nothing. But if management is clearly needed, a ranking matrix (ours or another) should be used carefully and conservatively to rate projects before they're attempted.

References

Cousens R., and M. Mortimer. 1995. *Dynamics of Weed Populations.* Cambridge, U.K.: Cambridge University Press.

Graber, D.M. 2003. Ecological restoration in wilderness: Natural versus wild in National Park Service wilderness. *The George Wright Forum* 20:3, 34–41.

Pritchard, J.A. 1999. *Preserving Yellowstone's Natural Conditions: Science and the Perception of Nature.* Lincoln: University of Nebraska Press.

Sax, J.L. 1980. *Mountains Without Handrails: Reflections on the National Parks.* Ann Arbor: University of Michigan Press.

Sellars, R.W. 1997. *Preserving Nature in the National Parks: A History.* New Haven, Conn.: Yale University Press.

Wilson, E.O. 1984. *Biophilia.* Cambridge, Mass.: Harvard University Press.

Managing to Give Nature a Chance

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[Ed. note: This is a counterpoint to the preceding paper by Freilich and Cafaro, "When it's Better Not to Manage National Park Service Resources." Both papers attempt to capture the extremes of an argument.]

My task is to speak to managing to give nature a chance. The debate: to manage resources, or to leave nature alone. Philosophical debate? Maybe. For my agency (the National Park Service) this debate may strike at our deepest beliefs, our corporate creed, our organizational religion, per se.

If you see Jerry Frielich's position as saying, "Don't mess with Mother Nature," or, as a puritan cleric might say, "Thou shalt not sin," then I will take the posture of the fire-and-brimstone preacher. "But you have sinned. The earth is a mess, humans, and you are responsible. Look at all that you have done to all of the Gardens of Eden. Out—into the wilderness! Do research, find the path of righteousness. Then you shall manage, and you may carry that burden for eternity."

Fun, and yes, this is a philosophical argument.

But why should there be a need to manage in a protected area? If a place is protected, then natural processes should be in control. And that's not a philosophical point. In the national parks, we manage for unimpaired. We manage for wild.

But unimpaired? Are they? A few examples from my own experience:

Grand Canyon and the Colorado River, and managing for natural conditions: What does "natural" mean with the context of an upstream dam? After I transferred to Grand Canyon I was asked to manage NPS involvement in the Glen Canyon Environmental Studies, the interagency research program that brought changes to the operations of Glen Canyon Dam. One of the things I did first was caucus my colleagues from Glen Canyon, Lake Mead, and other National Park Service offices, including national natural resource divisions. When I asked for what we should manage the Colorado River in Grand Canyon, I was told by several colleagues that we should manage for natural conditions. But how—with a dam sitting upstream? The Colorado River is now a cold, sediment-starved river, rather than a warm, sediment-laden one. Its flows are now more defined by within-day variability than by within- and between-year variability. The National Park Service may be successful in seeking to preserve and maintain important fluvial and ecosystem values, but not the natural system that existed pre-dam.

And fire, the age-old example: After years of fire suppression there have been consequences. Fuel loads and plant community structures are (or were, in many cases) altered.

The outside world controlled predators, and often so did we, and the story is the same for critters that affected the beauty of the parks, including forest insects.

It is that period that marks much of the early history of resource management in the national parks.

A varied history of managing natural resources in the national parks

First period of our history: We saw ourselves as protecting the parks, standing at the boundary, assuming that if we protected them they could take care of themselves, but we put out fires, we killed predators, we exterminated forest insects, all in the name of protecting them.

The second period: We often associate this with the time following the Leopold Commission's findings in the 1960s, over 40 years into NPS history. Their recommendations: to recognize that we need to manage wildlife populations (including ungulates, which we are still struggling with managing well today). They recommended that we recognize fire as an important ecosystem process. They gave us that mission we embrace, of restoring primitive America to the way it looked before the arrival of Europeans.

So we began to embrace not just protecting resources, but also re-establishing natural processes, to allow natural processes to prevail.

Fire has risks, so we needed prescribed burning in some locations to reduce fuel loads and restore forest structure. Doing so would allow us to teach fire to play nice again before we removed its curfew. Now, in many ecosystems, we have removed that curfew, and that important natural process does prevail.

We ceased treating many of the forest insects, stopping our pouring of insecticides into the ecosystem.

But for wildlife we were timid—about re-establishing predators, and about managing population numbers. And in being passive about managing wildlife populations we were effectively managing to allow those populations to grow and to impact their habitats. As Jim Agee says of passive management of wildland fire, "A choice to do nothing is a choice of action, not always with a desired outcome."

The third period of our history is essentially where we are now. We have many examples of our willingness to re-establish natural processes, to re-establish predator populations, to restore fire regimes, to restore biodiversity, etc.

We have also completed many inventories of natural resources, and we are preparing vital signs monitoring plans for each of our networks of natural area parks. We recognize that we have to understand, and we endeavor to manage to give nature a chance.

And we manage because there are statutes on the books, from the Endangered Species Act to the Clean Air and Clean Water acts. We are responsible for taking action if needed.

Yes, there are threatened and endangered species in the national parks, and we must manage for recovery. We have invasive species—both plants and animals—and we must manage to eliminate and/or control them.

So, yes, we manage resources, and we play triage. We consider what effects we can or should manage. We consider what falls outside the realm of our capacity (our expertise, our science, our funding levels). We consider what we should not do, considering what we do not know, and we consider what we should do, considering what we do know. And, we consider other realities. I believe it is David Mech who tells us that wolves have to be managed to be tolerated.

But, if we manage for awhile, can we not move the parks to a point where the agency can back off and allow natural processes to do it all? That would be ideal, but national parks are not buffered from outside influences, and the prospect of erasing past human influences is diminishing.

A period of unprecedented challenges

Unfortunately, we are entering a new period, one with great uncertainties, and one with unprecedented challenges.

Consider climate change and its looming effects: range shifts; changes in assemblages, both plants and animals; changes in disturbance regimes—fire, flood, disease, and insect.

Changes in disturbance regimes: In the West, average fire seasons are two-thirds longer than they were 20 years ago (about 200 days, compared with 120 days) and there are nearly four times as many large fires, and they burn about five times longer, consuming seven times as much forest (Westerling 2006). Patterns of precipitation may change: less rain in some locations; in others, more rain instead of snow. With changes in disturbance regimes come opportunities for invasion—both plants and animals—and opportunities for disease—in plants and animals. West Nile virus, as an example, may spread and increase in influence.

Mountain pine beetles are devastating the piñon pine in New Mexico. White pine blister rust in the northern Rockies is expanding, creating additional opportunities for mountain pine beetle. The implications for the ecosystem go beyond loss of forest, and may include impacts upon grizzly bear. Without winter cold to limit their distribution and effects, populations of mountain pine beetle are exploding, and in some areas, they now reproduce twice a year, rather than once.

Consider globalization and its challenges: Plant pathogens—every dominant tree species in the east is under attack, and the same is true of many of the tree species of the west.

Mission: Unimpaired

Unimpaired is our mission in the National Park Service, but what will "unimpaired" mean in the context of all this change? What will we mean by "wild"? What about "natural"? Will "natural" be defined by policy, or by science? We face tremendous challenges. Challenges bigger than we are, certainly bigger that any one national park.

Managing to give nature a chance

There is much we don't know. We are entering a period for which we have no experience, and disturbance regimes that are different than what were typical for these ecosystems. But, do we know so little that it is wisest to back away and let the climate change and globalization reshuffling begin, taking us along any path to any possible outcome? Or, do we manage for biodiversity and to preserve our natural heritage?

We manage.

Some might argue that this is the same perspective that drove our earliest history in NPS resource management. I would argue it is not. Our management direction today is shaped by research, policy, and experience. Then it was largely shaped by individual actions and the norms of the day, including the thinking at the time concerning fire, predators, forest insects and all manner of things. Still, we are not yet prepared to manage park resources in the context of this future change, and we will make some mistakes.

We need new kinds of research. If we will have changes in patterns of climate, range shifts, and changes in assemblages, then we need research on adapting systems to buffer them from the extremes of disturbance regimes. We need research to help us put brackets on variability to drive our management actions, including actions to adapt systems. We need to plot possible successional pathways, to give us contexts for discussion of policy, revisions of policy, and discussions of priorities for management action.

However, our perspective is fairly limited: 10, 20, 50 years. We need a better understanding of the long-term variability within the system. We don't want to over-react, and we want to have a context for understanding the changes we are seeing. Thus, we need more research in paleoecology. We need more work on leading-edge and rear-edge populations. We need research on all kinds of possible management actions. We need to forecast change, and adapt to it. We need to bank seed and genetic material, and prepare for the opportunity to restore populations and communities. We need to partner with those who face the same challenges.

To "preserve unimpaired" in the future will imply some complexities of management that far surpass protecting the parks from the visitor, and standing at the boundary and preserving what's inside.

Conclusion

I started with the point that this could be seen as a philosophical debate. I would like to conclude with a point I borrow from Richard Dickerson, in his comments to a Young Earth creationist, someone who believes the earth is only 6,000 years old. He reminded them that most people of faith also believe in evolution, and that their position—against teaching evolution—was intellectually destructive, discouraging the next generation of young people from going into mainstream science.

The same may be true of those who argue there is no role for management in national parks, that the nature of parks is that they do not need our help or intervention. This is an entirely philosophical position at this point, and potentially intellectually destructive. If embraced too literally—rather than accepted as a challenge, to sharpen our thinking, to give us humility in our role, to give us restraint—then we discourage the next generation of young people from entering important areas of mainstream science.

We face challenges few of us have trained for, and we need young people with new training and new thinking now more than ever. Without that knowledge, we will be ill-prepared to do what we need to do—and we may be tempted to do more than we should.

But we should be prepared to manage to give nature a chance.

References

Agee, James K. 2002. The fallacy of passive management: Managing for firesafe forest reserves. *Conservation in Practice* 3:1, 18–26.

Dickerson, Richard E. 1990. Letter to a creationist. *The Science Teacher* 37 (September), 49–53.

Westerling, A.L., et al. 2006 Warming and earlier spring increase western U.S. forest fire activity. *Science* 313, 940–943.

Beyond Hunting: Increasing Options for Effective Wildlife Management in the National Park System

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In natural systems, animal abundance is determined through a complex relationship of environmental factors on natality and mortality rates of animals. Therefore, natural populations normally undergo fluctuations. Wildlife managers often attempt to blunt fluctuations in populations to avoid negative impacts of extremes. So, for example, hunting is employed with the dual goal of achieving sustained yield for human recreation and consumption, and a more generally stable population. And democracy of hunting is one of the cornerstones of the North American model of wildlife conservation.

However, hunting is not implemented in many units of the national park system, so it is obvious that the situation in these units will be different from surrounding areas. Specifically, we can expect the fluctuations to be greater. These wide fluctuations can lead to concern because of side effects that occur. Too many deer lead to traffic accidents, concern over Lyme disease transmission, and impacts on ornamental plants and to the forest understory.

The National Park Service (NPS) goal is to maintain natural processes (NPS *Management Policies 2006,* 4.4.2: "Whenever possible, natural processes will be relied upon to maintain native plant and animal species and influence natural fluctuations in populations of these species"). As mentioned, animal populations can be expected to fluctuate under natural conditions. Some would argue that animal overabundance in parks is just part of this natural fluctuation, and this may be the case in some situations. However, if a system is disturbed, flux may be greater—for example, when predators are removed and populations of prey are released from "top-down" control. So I would argue that fluctuations are currently greater than what was seen historically because of the significant anthropogenic influences on these systems.

Anthropogenic changes, such as loss of habitat and increase in edge due to human development, removal of predators, and landscape modifications that serve as attractants to congregate animals, must play a crucial role in these fluctuations. With the possible exception of parks in Alaska and in the Greater Yellowstone Area, it is difficult to argue that these anthropogenic influences do not affect animal abundance.

Thus, an issue arises: Overabundant wildlife populations need to be managed to minimize negative impacts and return systems to more natural function. Unfortunately, the means to get to this more natural end may not be natural.

In this issue, I am assuming that parks have determined that management is necessary due to one of the factors listed in NPS *Management Policies 2006,* that goals for measuring success (e.g., reduction of negative impacts) have been identified, and that it is the method of animal control that is being discussed—not just that managers have "action bias." Also, from here on we'll be focusing on deer and elk populations.

So once a park has determined that there need to be fewer deer or elk in an area, what are the options to achieve that objective so goals of understory recovery, biodiversity of native species, restoring a cultural snapshot, etc., can be attained? NPS units generally start by looking to policy. NPS *Management Policies 2006* address when actions to remove native animals can be taken in section 4.4.2.1: "Where visitor use or other human activities cannot be modified or curtailed, the Service may directly reduce the animal population by using several animal population management techniques, either separately or together. These techniques include relocation, public hunting on lands outside a park or where legislatively authorized within a park, habitat management, predator restoration, reproductive intervention, and destruction of animals by NPS personnel or their authorized agents. . . ."

A list of actions that have been proposed as alternatives to manage deer or elk to achieve "natural conditions" include one or a combination of:

- No action—not the National Environmental Policy Act (NEPA) term that means "existing management continued," but truly, no management;
- Passive management–monitoring of the system, but no deliberate manipulation to alter it;
- Lethal removal by agency personnel or authorized agent, either in the field or via round-up;
- Fencing;
- Redistribution of deer or elk—to reduce herbivory on an area or to make animals more accessible to hunters outside the park;
- Translocation;
- Fertility control, either in the field or via round-up;
- Intensively managed wolves;
- Wolf restoration;
- Hunting—used here synonymously with "harvest"; and
- Use of public marksmen.

With the exception of wolf reintroduction, none of these could be considered natural. While on the surface, the "no action" approach would appear to be most natural, conditions are not natural due to anthropogenic influences—loss of winter range by development adjacent to a park, loss of predators, supplemental feeding adjacent to a park (by means of intentional illegal feeding or from landscaping). These alterations have led to the issue of deer and elk numbers being outside the range of natural variation (i.e., wide fluctuation) and resultant negative impacts that have served as the impetus for these plans.

Overall, hunting is the most widely applied of these approaches outside the NPS. It has utilitarian application. It is the principal tool used by state wildlife management agencies to control ungulate populations, and is allowed in some units of the NPS, particularly those units designated as national preserves, recreation areas, rivers, lakeshores, and seashores. However, Congress and the American public have conveyed that hunting is not an appropriate activity in all situations—for example, in the vast majority of our national parks.

So why not hunting? Hunting is not considered an appropriate use or alternative to control wildlife populations in NPS units unless specifically authorized by Congress in the unit's enabling legislation or other federal statute. This conclusion is supported by at least three important indicators.

Direction from Congress. First, the NPS Organic Act (1916) provides authority to the NPS to manage wildlife on NPS lands and, further, to prohibit hunting unless specifically authorized by Congress. Hunting has been authorized by Congress in 69 of the 390 NPS units. However, outside of Alaska, Grand Teton National Park is the only unit designated "National Park" in which hunting is authorized. Congress passed specific legislation in 1950 authorizing controlled reduction of elk for management purposes by licensed hunters deputized as park rangers in portions of Grand Teton National Park.

Long-standing NPS policy. The NPS has maintained a written policy of no hunting in national parks since at least 1918 when Secretary of the Interior Lane sent a memo to NPS Director Mather to reaffirm long-standing management practices in parks, including the prohibition of hunting. In 1963, a report issued by the Advisory Board on Wildlife Management appointed by Secretary of the Interior Udall (i.e., the Leopold Report) concluded that lethal removal by shooting should only be conducted for the sole purpose of animal removal and not recreational hunting.

That guidance stands in NPS *Management Policies 2006*, which state: "hunting, trapping, or any other methods of harvesting wildlife by the public will be allowed where it is specifically mandated by federal law."

Further, the concept of appropriate use must be considered. In managing the national park system the NPS must consider the impact of uses on park resources, including cultural and natural. The NPS must determine appropriate uses in fulfilling its obligation to provide for the enjoyment of the parks by the public. An "appropriate use" has been defined as a use that is suitable, proper, or fitting for a particular park or portion of a park. Providing enjoyment to the public is a critical component of the Organic Act. The types of enjoyment that NPS units provide are "uniquely suited and appropriate to the superlative natural and cultural resources found in the parks." Congress and the American public have recognized that national parks are special places. Hunters have access to many other federal lands that provide appropriate, multiple-use opportunities. In contrast, outside of Alaska, national parks comprise an extremely small proportion of the public land. In these limited areas, national parks provide high-quality opportunities for every segment of American society to enjoy an atmosphere that is open, inviting, and accessible. Hunting is not an appropriate activity in these locations because the activity of a small segment of the public would have a significant impact on access to and enjoyment of park resources by the larger public.

Case law. NPS interpretation of the Organic Act to provide authority over management of wildlife in NPS units has been challenged, but maintained in several court decisions (e.g., New Mexico State Game Commission v. Udall). In 1984, the NPS enacted regulations stating that hunting shall be allowed in park areas where such activity is specifically mandated by federal law. In a challenge of this regulation (NRA v. Potter), the court ruled that NPS' interpretation of the Organic Act—that the primary management function with respect to wildlife is its preservation unless Congress declares otherwise—was reasonable.

So unless already mandated, hunting will not be pursued as a management approach in NPS units. But if not hunting, then what? If the primary tool used in other areas is not available, what are some of the other options? Let's return to the list of options we looked at earlier. None of these options is clearly the best. All have drawbacks, particularly when you consider that they will need to be implemented over the long term … there is no end in sight. However, without this management the natural system will continue to deteriorate due to anthropogenic changes.

While the methods may help us meet our objectives for population size or vegetation condition, fencing will have significant aesthetic impact as well as impacts on movement of a variety of species; the ability to successfully redistribute deer and elk in a way in which vegetation goals can be met is questionable—one elk can eat a lot of new aspen shoots in a short period; fertility control is still in the experimental stages and a logistically feasible agent is not yet available; round-up treats deer and elk like domestic animals and detracts from their true wildness; wolves still evoke strong opposition from livestock producers, and even pet owners; translocation of animals as "biological packages" complete with pathogens is not a prudent approach for wildlife health management; sharpshooters are thought of as "hired guns," regardless of whether they are agency personnel and authorized agents, and carcass disposition is more of an issue when individuals (i.e., hunters) do not shoot and take possession of an individual animal.

Although very intensive, lethal removal of ungulates by sharpshooters to meet NPS management goals is not contrary to NPS authority or long-standing policy. It is hypothesized that sharpshooting would be more effective in meeting management goals and reducing indirect impacts to park resources and direct impact upon visitors than hunting. Further, sharpshooting may be necessary to achieve the desired level of management, particularly if the national trend in decreased hunter participation continues.

Who does this sharpshooting is the most recent wrinkle in the lethal removal saga. The initial assumption was that would be agency staff or contractors. But what about tribal personnel or volunteers—could they be "authorized agents"? Whether or not this is within policy is a matter of current discussion. But regardless, even if it were, would it present advantages over agency personnel or contractors? Would these volunteers reduce costs to the government? Be as effective in controlling the population? Be as acceptable to other stakeholders?

These are questions that need to be answered. While decisions may need to be made initially with incomplete data, it is imperative that if they are implemented, they are done so in a way that can be evaluated. Just as we plan experiments to measure changes to impacts on vegetation or effectiveness of fertility control, we need well-designed studies to answer these questions about cost and effectiveness of approaches (such as different groups of sharpshooters) and also inquiry to understand public perception of methods of management we use and our justification for it. We also need to continue to think outside the box to find unique options—even if those options aren't "preferred alternatives" today. Ideally, these options would return systems to natural function, and would be applied proactively to prevent negative impacts from even occurring.

I think I can speak for NPS's Biological Resource Management Division in that we appreciate the opportunities that come from parks seeking, or at least being willing to listen to, input on new alternatives and approaches. Through discussions that our division chief, Jerry Mitchell, is leading with our collaborators in Environmental Quality Division and Cornell University Human Dimensions Research Unit, we've speculated that perhaps development of a tool that would allow a way to commonly approach the issue of management of overabundant wildlife might be very useful. It might take the form of a matrix, with management options on one axis and, on the other, considerations or factors such as efficacy, cost, duration of artificial action, naturalness, etc. This is likely contributing to the way decisions are currently being made, but through illustration of this conceptual model it may make decision-making more transparent to all and may serve as a tool that others can refer to without reinventing the wheel.

If management is necessary to prevent the occurrence of, or to reduce, overabundant native wildlife species, and if hunting is not an option in NPS units where Congress has not already deemed it so, then our work is not done. It is imperative that work must continue in the biological and social sciences to identify effective and acceptable approaches to provide long-term solutions. Ideally, the means used would be "natural," but this may not always be the case. However, inability to use a "natural" approach, or inability to use a technique that our neighbors have used for decades (i.e., hunting), does not justify doing nothing if population fluctuations, and resultant negative consequences, are occurring due to the ever-increasing impact of civilization.

Using Students to Monitor the Effects of Ground-level Ozone on Plants

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The Appalachian Highlands Science Learning Center (AHSLC) is part of a network of research learning centers in the national park system established to increase the amount and effectiveness of research and research-based education. Located in Great Smoky Mountains National Park, and serving the parks of the Appalachian Highlands Monitoring Network (Blue Ridge Parkway, Big South Fork National River and Recreation Area, Great Smoky Mountains National Park, and Obed Wild and Scenic River), staff at the AHSLC often collaborate with researchers to develop ways to extend their field season using citizen scientists. One of the longest running citizen science projects sponsored by the AHSLC is an ozone biomonitoring garden project.

This project is a direct offshoot of research originally funded through a grant from the National Geographic Society (project no. 6617-99) and later continued under funding from the National Park Service's Natural Resource Preservation Program (NRPP) (PMIS no. 66941). The research was headed up by a team of five researchers, but the two who specifically assisted National Park Service staff in developing the student monitoring program were Howard Neufeld, Appalachian State University, Boone, North Carolina, and Arthur Chappelka, Clemson University, Clemson, South Carolina.

One objective of the research study was to determine the relationship between ambient ozone concentrations and the growth and reproduction of native wildflowers both *in situ* and in bio-indicator gardens. The researchers set up ozone biomonitoring gardens composed of plants that were genetic clones of one another. Gardens were located at three different elevations in Great Smoky Mountains National Park, with the highest-elevation garden at the AHSLC (5,000 feet). Ideally, these plants should be monitored once every two weeks during the growing season, but researchers were only in the park for two weeks total, which meant they were missing important information about the plants they were studying. To assist the research team, staff at the AHSLC began training high school summer interns in how to collect field data during the team's absence. This allowed the staff to let the researchers know important information, such as when the plants first begin showing symptoms and how quickly the rate of symptoms progressed. The students did such a competent job collecting data that the education staff decided to modify the protocols a bit to use with 7th grade students and other high school students participating in day-use education programs in at the AHSLC. The education program that grew out of the research fulfills the needs of several audiences; it allows scientists to communicate the needs for and the result of their research to a non-traditional audience, and it gives classroom educators a way to teach a difficult subject in an engaging manner.

The education portion of ground-level ozone biomonitoring has been developed in a way to encourage teachers to use inquiry-based teaching methods as recommended by the National Science Education Standards. Inquiry-based learning, which is student-driven, encourages students to seek solutions to their own scientific questions. This differs from hands-on science, which is teacher-directed and is designed to confirm scientific ideas that are already known by the teacher. The style of learning the teacher wants to focus on is flexible depending on a teacher's classroom goals. A teacher may decide to teach a lesson about air pollution and have students collect data in their own schoolyard garden to illustrate an effect of ozone on plants. This would be hands-on science. If the teacher wanted to move the student towards inquiry-based learning, he/she might pose a question for the students to answer with their data, such as "Are our data different from the data collected at Purchase Knob in Great Smoky Mountains National Park?" Students would then have to search the Hands on the Land database to answer a question that was provided to them. An even more inquiry-based technique a teacher can use would be to let students choose from a list of provided questions or allow them to pose their own question using methods directed by the study. Total inquiry-based teaching would entail the student posing their own unique question that integrates the garden data posted on the Hands on the Land website. The student, rather than the teacher, would determine what data are needed and what other sources of information are needed. Since data are posted in a raw form on the Hands on the Land website, a teacher is able to utilize a spectrum of teaching styles.

Methods

The wildflowers in the ozone biomonitoring gardens in Great Smoky Mountains National Park were randomly collected in the field. Species and locations included cutleaf coneflower *(Rudbeckia laciniata* L. var. *laciniata)* and crownbeard *(Verbesina occidentalis* L.). Gardens were then established at three different locations in the park so that comparisons of the rate of ozone symptoms could be made.

A six-point scale is used to rate the relative severity of symptoms (1 = 0%, 2 = 1–6%, 3 = 7–25%, 4 = 26–50%, 5 = 51–75%, 6 = 76-100%). The lowest eight leaves of each plant are rated for foliar injury symptoms, which include ozone stippling, chlorosis, and necrosis. Various measures of plant growth are also collected, such as height, total number of leaves, flower presence, and any other observations.

Before students collect data, they are required to practice their foliar injury estimation skills on an internet training site (http://mona.psu.edu/scripts/FhWeb2.dll/intro). Details on how to use this site are available in the Ozone Bio-monitoring Garden's training section on the Hands on the Land website (www.handsontheland.org/monitoring/projects/ozone/ozone_bio_search.cfm).

Each student who is going to collect data must score 80% or better on 10 leaves and can't be more than one rating category off in their guess. A 20-minute video about air pollution in the Southern Appalachian Mountains is also available for teachers to show to students, giving them required background knowledge. This video is produced by the North Carolina Mountain Air Quality Coalition and is geared towards an upper-elementary age group.

Student groups collect data at least bi-weekly from June until the first hard frost. Ozone levels are tracked daily at Purchase Knob using data from a real-time internet weather and air quality website (www2.nature.nps.gov/air/webcams/parks/grsmpkcam/grsmpkcam.cfm).

Other sites may use the GLOBE Program's Surface Ozone protocols to obtain their current ozone levels using one-hour exposure cards and a Zikua card reader (www.globe.gov).

Data for each plant are collected by students working in pairs, with one person collecting data and the other recording. Each plant is visited by three pairs of data collectors in order to ensure data quality. If there is a discrepancy in the data, then the garden supervisor will visit the plant in question to determine which data are accurate. All data are then posted to an internet database. Data from any participating garden can be viewed, graphed, compared, animated over time, or otherwise analyzed. This website also contains a detailed "Implementation Guide" (www.handsontheland.org/monitoring/projects/ozone/ozone_bio_search.cfm).

This original park-centered project has grown into a citizen science education program where each year approximately 300 middle school, high school, and college students and teachers learn about the visible effects of an invisible pollutant. Additionally, over 75 companion gardens have been set up in locations as far west as Dallas, Texas, and as far north as Maine. The protocol for this project is also being added to the GLOBE network as an "Advanced Atmosphere Study." Evaluations show that this student-centered, citizen science monitoring project has succeeded in making the invisible (ground-level ozone) visible to students. Teachers applaud the real-world and relevant nature of the study, and scientists appreciate the extension of their field season.

Citizen Science: A Best Practices Manual and How it Can be Applied

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- Amateur birdwatchers visit their local nature center and record observations for a one-hundred-year-old national study to monitor bird populations.
- Schoolchildren sample stream invertebrates for a long-term study of water quality in Yosemite National Park.
- Park visitors collect and identify fungi for an All Taxa Biodiversity Inventory in Great Smoky Mountains National Park.
- Coastal residents work with the North Carolina Aquarium to survey for horseshoe crabs.
- Youth at an Audubon summer camp track wood turtle movement and use the data to suggest an alternative, turtle-friendly design for a new shopping center development.

These examples are all forms of "citizen science" happening at environmental education centers, National Park research learning centers, nature centers, and other non-formal education institutions. Citizen science is a research and education tool that involves everyday people in real and meaningful forms of science, including biological inventory, long-term monitoring, and investigative research. All of these examples demonstrate ways that these institutions are using citizen science as a tool for furthering their missions of educating the public about the environment, teaching people about the process of science, and connecting people to the natural world. They also demonstrate ways that citizens are helping to generate reliable, useful data for science.

While this approach is known by many names (e.g., citizen monitoring, collaborative research), "citizen science" is a term in wide use and recognized by many individuals in both the education and science community. Citizen science can take many different forms, but typically includes several elements that make it distinct from other education and research tools.

A key component of citizen science is, of course, the citizens. The citizens may be youth or adults and come from backgrounds as varied as the citizenry itself. Often the citizens are considered volunteers. Their roles in a citizen science project can vary widely as well. Citizens may participate in just the data collection step of the scientific process or they may play larger roles by posing their own research questions, designing protocols and collecting data to answer them, and sharing their results with interested stakeholders.

Another key component is that citizen science projects are done under the direction of professional scientists. Like the citizen participants, the roles for scientists may vary greatly. Often scientists play the role of primary investigator; in other cases, the professional scientists may play more of an advisory role. This involvement ensures that the research is "real" and the connection to the greater scientific community is vital, or else the project is an education program based on science.

The goal for citizen science projects is to obtain meaningful, useful data that aim to advance scientific understanding and can be applied to real-world problems. This quality is what makes citizen science different from a canned laboratory or field activity that produces data, but that data are never reviewed or used. Exercises with known results or that generate unused data may have educational value in teaching about scientific processes, but they fall short of contributing to scientific understanding. The marriage between researcher involvement and educational goals is what makes citizen science such a powerful tool for both scientists and educators. Properly trained volunteers can:

- Assist with inventory work;
- Conduct long-term monitoring;
- Provide baseline / pilot data with which to apply for funding for professional study; and
- Provide justification for conducting a study that would not otherwise be a priority but, depending on results, could become a priority.

Regardless of the length of study, the ultimate goal of using the data is critical, whether in peer-reviewed publication or the management plan for a natural area or some other significant use.

A citizen science project also must have objectives that include education of the citizenry, whether it is education about a specific organism or study system, the scientific process, or conservation and natural resource management. A project that uses citizen volunteers to collect data, but does not include educational objectives and strategies for achieving them, is not a successful citizen science project. In this type of project, the citizens may not be aware that their activities are part of the scientific process, and thus are no more than unpaid data collectors. In other words, education without the science protocols is incomplete science. Using citizen science but leaving out the education objectives equals cheap labor. In some cases, cheap labor is the right tool for your needs—just be careful not to call it citizen science.

Case study 1: A simple one-time project

Chris Carlton, a coleopterist from Louisiana State University, is interested in a particular type of small beetle that is found living in rotting fungi. One out of a hundred or more individual beetles in a given fungi is the species he is looking for, so he has to find the right fungi and then collect a lot of beetles. In 2002, he spent four weeks at the Appalachian Highlands Science Learning Center (AHSLC) in Great Smoky Mountains National Park. After several weeks, he had failed to find the correct fungi or the beetles he was seeking.

Does this situation have the potential to be a good project for using citizen scientists? You could involve the public, especially those with knowledge of fungi, to find the correct mushroom species. There is oversight and direction from a professional scientist who will ensure scientific meaning. The results contribute to the park's All Taxa Biodiversity Inventory, so there is a need for this data. A bigger question to ask is, Can there be an educational component or is this just a good case of recruiting for cheap labor? Other considerations are that the project is short-term, does not require significant funding or sustainability planning, and the fungi sought are non-toxic species so there would not be a significant safety concern.

Paul Super, the science coordinator at the AHSLC, contacted a local mushroom club and coordinated with one of their field trips to collect the mushroom species in question. Carlton met with the club before their outing to provide them with some information about the beetles, his research, and larger issue of biodiversity. The mushroom club, since they knew the area, was able to quickly locate the fungi species sought and brought them to Carlton in pillowcases. Next, Carlton knew he would have to search through this mass of rotting, stinking mushrooms, collecting hundreds of beetles for the type he studies. To assist in this part of the project, Susan Sachs, education coordinator at the AHSLC, knew she had the perfect group: 8th grade summer campers. Carlton gave the students a program introducing them to beetle biology and biodiversity—the education component—then put them around a pan and emptied out the smelly, rotting fungi. Hundreds of beetles were collected in minutes, including the species sought by Carlton, which turned out to be new to science.

Case study 2: Fungimap

Great Smoky Mountains National Park is in the middle of an All Taxa Biodiversity Inventory and seeks georeferenced data on fungi and their fruiting periods. The Smokies are also the destination for many a mushroom fancier, and there is at least one social group devoted to identifying (and eating) mushrooms from the area. These mushroom hunters were helpful for Carlton, but could they provide useful data for the All Taxa Biodiversity Inventory? A model was found on the internet: a project called Fungimap out of Australia.

Working with regional university mushroom experts, staff at the AHSLC developed protocols, a list of target species, a pictorial guide, and data sheets that are posted on the web at www.nps.gov/grsm/pksite/fungimap.htm. Presentations were made to mushroom clubs, with training on the project provided by local mycologists. The data sheets proved easy to use and a wealth of data was provided, with good identifications for many species. One problem that occurred early on is that mushroom hunters do not seem to like to map their findings, either with GPS units or on topographic maps. Only checklist information was produced. To rectify this problem, on some occasions volunteers who specialized in taking coordinates for finds went out with club members, learning about mushrooms while providing the georeferenced data. This example is low-cost, and all materials can be downloaded from the web; it is providing useful data for park staff to use in GIS mapping and needs little oversight from staff. Its weakest link is the educational component, which is only offered if someone attends one of the trainings. Many people participate only by downloading datasheets and guides off of the internet; in such instances, the park is getting cheap, but valuable, labor. Development of more web-based educational material and updates on the progress of the fungal inventory would help elevate this project to the level of citizen science.

Case study 3: Ozone biomonitoring gardens

Research by scientists from Appalachian State University, Auburn University, and elsewhere have identified a number of plant species native to the Smokies that show visible signs of damage by ground-level ozone exposure. Howard Neufeld and Art Chappelka envisioned establishing gardens of several of these species that could be used to monitor ozone exposure under different conditions (elevation, proximity to roads, etc.) and over different seasons. Early on in their studies, the researchers asked staff at the AHSLC if there was any way the staff could monitor the plants so that the researchers would have a better picture of the progression throughout the growing season. The research team would only be in the park during a two-week period in late July, but wanted to know when symptoms first developed, how quickly they progressed, and how quickly the plants grew. This sounded like a great citizen science opportunity for staff at the research learning center.

First, this would be a long-term monitoring project, so considerable attention needs to be made to ensuring sustainability and developing clear protocols since personnel might change. Staff worked closely with the researchers to develop easy-to-use protocols and training materials. After looking at the complexity of the protocols, it was decided by Sachs that high school students studying earth science and advanced placement biology would be a perfect target audience, since the state curriculum standards have them studying air pollution impacts. To develop a well-rounded curriculum education program, a grant was obtained from the National Park Service's Parks as Classrooms program. Teachers and the park staff, with oversight from the researchers, developed a three-hour field trip with pre- and post-site activities that provide skill development, the research context, and multiple learning opportunities. An on-line database was developed with Hands on the Land, which allows students to view all data collected (www.handsontheland.org/monitoring/projects/ozone/ozone_bio_search.cfm). Quality control is provided in the design of the study, since each plant is monitored by three different student pairs. If there are discrepancies in the data, trained park staff visit the plants in question to determine the actual condition. This saves time, since often only one plant needs to be checked rather than 30.

The project has been so successful that the protocol is being replicated through an "Advanced Atmospheric Study" under the direction of GLOBE (www.globe.org). The park continues to monitor the plants, and even though the original research is completed, some of the questions asked by students have resulted in new research questions. One question posed by a 7th grade student—"What does ozone damage on a plant do to its nutritional value when it is eaten by animals?"—did spur a separate study that was published in the journal *Environmental Pollution* (Burkey et al. 2006). This citizen science study has grown to become the focus of several teacher training workshops each year, and a project that has been replicated at over 80 schools across the country.

Conclusion

A *Best Practices Manual to Citizen Science* is scheduled to be published in fall of 2007 by the Association of Nature Center Administrators (ANCA). A portion of it will also be available on the internet on the website of the Great Smoky Mountains Institute at Tremont (www.gsmit.org).

Citizen science is not the answer to all research needs, and is not necessarily less time-consuming or expensive than doing the work one's self. Its benefits can be that the educational component often justifies funding a project that cannot otherwise find funding. The citizen scientists can also increase a project's scale, both temporally and spatially.

Additionally, by involving the right groups in your citizen scientist team, you may increase the buy-in to research results by important constituents. Following best practices that are discussed in the soon-to-be-published manual can help one avoid pitfalls and shortcomings, allowing your project to be a greater success.

Reference

Burkey, K.O., H.S. Neufeld, L. Souza, A.H. Chappelka, and A.W. Davison. 2006. Seasonal profiles of leaf ascorbic acid content and redox state in ozone-sensitive wildflowers. *Environmental Pollution* 143:3, 427–434.

Ivory-billed Woodpecker Searches with Citizen Scientists: Lessons Learned at Congaree National Park

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The ivory-billed woodpecker (*Campephilus principalis*) is the largest woodpecker in North America, and, according to Tanner (1942), the second largest in the world. The ivory-bill originally lived in the extensive bottomland forests of the coastal plain within the southeastern United States and in Cuba. As early as 1891, naturalists noticed population declines and range restrictions (Hasbrouck 1891; Tanner 1942). The ivory-bill was thought to be extinct, with the last confirmed sighting in the United States in 1944. However, in April 2005 it was announced that the woodpecker had been rediscovered in the Cache River National Wildlife Refuge in Arkansas (USFWS 2005). As a result, reassessments of the historic range of the ivory-bill have begun throughout the Southeast. Historic records prior to 1940, coupled with potential sighting reports from recent years have brought resources and expertise together in an effort to evaluate the possible presence of ivory-billed woodpeckers in South Carolina. Congaree National Park became a focal point for these search activities, supported through a multi-agency working group.

In order to investigate the potential existence of ivory-billed woodpeckers in South Carolina, the South Carolina Ivory-billed Woodpecker Working Group was formed in August 2005. This joint partnership between federal and state agencies, non-governmental organizations, and private entities has helped compile and share historic and more recent data related to the ivory-billed woodpecker. The specific objectives of the working group are to (1) share resources for the investigation and evaluation of possible existence of ivory-billed woodpeckers in South Carolina; (2) provide a framework and strategy for conservation of ivory-billed woodpecker habitat in South Carolina; (3) provide a working organization for coordination with the U.S. Fish and Wildlife Service's ivory-billed woodpecker recovery team; and (4) provide a consistent platform to address public information and outreach. In January 2006, funding was provided to the U.S. Fish and Wildlife Service to conduct surveys for ivory-billed woodpeckers within South Carolina. Beginning in February 2006, a large-scale field survey protocol for ivory-billed woodpeckers was implemented at Congaree National Park. This adaptive survey design and the data generated through this effort tie directly to recovery objectives for the ivory-billed woodpecker, which include determining the status and number of birds, describing local ecology and behavior, and quantifying percentages of dead and dying trees.

The Old-Growth Bottomland Forest Research and Education Center at Congaree National Park hosted and coordinated all field activities associated with this effort until the end of April 2006. The National Park Service research coordinator and GIS technician provided logistical and technical support throughout the entire survey process, and played a lead role in training volunteers regarding identification and equipment use. The Southeastern Inventory and Monitoring Network provided essential data management support, including developing an observational database. This research effort provided an opportunity for volunteers to experience Congaree National Park in a unique way and participate in data collection directly tied to recovery efforts for the ivory-billed woodpecker. Forty-six citizen scientists contributed more than 2,000 volunteer hours as they surveyed approximately 7,210 acres within Congaree National Park. They field-tested search protocols now in use throughout the region. Volunteers completed systematic searches noting the presence of migratory birds and documenting the abundance of seven woodpecker species, including the pileated woodpecker *(Dryocopus pileatus)*. Areas of high-quality habitat and areas with dead and dying trees were also recorded. Volunteers searching for the ivory-bill concentrated on listening for the species' "kent" calls and distinctive double knocks. These citizen scientists documented more than 98 species of resident and migratory birds, and despite not filming an ivory-bill, volunteers investigated hundreds of large cavities, foraging evidence, double-knocks, and other vocalizations that give researchers hope of confirming the existence of the ivory-billed woodpecker in South Carolina. This project was funded through the U.S. Fish and Wildlife Service and supports a regional survey effort in the historic range of the ivory-billed woodpecker.

References

Hasbrouck, E.M. 1891. The present status of the ivory-billed woodpecker *(Campephilus principalis)*. *The Auk* 8, 174–186.

Tanner, J.T. 1942 [2003]. *The Ivory-billed Woodpecker*. Research Report no. 1. New York: National Audubon Society. (Reprint edition 2003. Mineola, N.Y.: Dover Publications.)

USFWS [U.S. Fish & Wildlife Service]. 2005. Once-thought extinct ivory-billed woodpecker rediscovered in Arkansas. Press release, U.S. Fish and Wildlife Service, Southeastern Region, April 28.

Community Attitudes towards Wildlife Conservation in Ethiopia

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Introduction

Mutually supportive relationships between communities and nearby protected areas are critical to the long-term success of conservation efforts. In sub-Saharan Africa, many protected areas were first created during colonial times as hunting grounds or parks for European elites, with little or no regard for the needs or desires of local communities (Anderson and Grove 1987; Neumann 1998; Adams 2003). Today, many of these areas harbor long-standing conflicts over land tenure and resource use (IIED 1994). These conflicts may create tensions between local communities, protected area staff, and conservation goals (Newmark et al. 1994; Lilieholm and Romney 2000; Whitesell et al. 2002).

In Ethiopia, 40 protected areas cover roughly 16.4% of the country's land area (186,000 km^2). These areas face many challenges due to growing populations, border conflicts, and recurring drought. A chronic and growing issue for Ethiopia's largely pastoral rural people is local access to grazing lands (Tedla 1995; Ashenafi and Leader-Williams 2005). As in other parts of the developing world, increased concern over the burden that conservation often places on local communities has led to efforts to incorporate development goals into conservation practices (Hulme and Murphree 2001). In 1991, community-based conservation programs were established in several Ethiopian national parks in an effort to gain local support for conservation. Participatory management and benefit-sharing were also adopted, along with the granting to local communities of limited ownership rights for some resources.

Given the recurring nature of conflict between conservation and local communities, it is critical that conservationists better understand local views with respect to wildlife and protected areas. Toward that end, we sought to better understand local community attitudes towards wildlife, protected areas, and protected area staff in and around four Ethiopian protected areas.

Methodology

We examined community perceptions in and around four Ethiopian protected areas: (1) Abijata-Shalla Lakes National Park; (2) Awash National Park; (3) Bale Mountains National Park; (4) and Senkelle Swayne's Hartebeest Sanctuary. These protected areas represent a wide range of ecological, social, economic, and policy conditions. Key informants from randomly selected Peasant Associations located inside and surrounding each of the four areas were invited to participate in focus group discussions. These discussions solicited information about local community perceptions of wildlife and protected areas. Two focus group sessions were conducted per site, with group sizes ranging from 8 to 15 people. The information gathered was subsequently used to develop an interview questionnaire to gauge broader community perceptions of wildlife and wildlife conservation in and around the four protected areas.

Heads-of-households were randomly selected for interview on a first-come, first-served basis. In total, 384 household heads from 25 Peasant Associations were interviewed—85 to 101 households from each of the four sites. The survey included both closed and open-ended questions across three broad categories: (1) views towards wildlife and wildlife conservation; (2) views towards protected area management and staff; and (3) a series of household demographic questions, including information about each household's source of income.

Information collected from the focus group discussions was collated and summarized using text analysis (Bernard 2002) to discover the regularity with which discussants told their story. Questionnaire data were analyzed using both Chi-square tests and logistic regression to determine relationships between socioeconomic variables and factors affecting attitudes. Open-ended questions were grouped into different categories based on similarity.

Results and discussion

Community characteristics. Residents in communities located in and around each of the four protected areas depended almost exclusively on subsistence agriculture and the rearing of livestock. Residents living in the highlands in and around Bale Mountains National Park raised horses, sheep, donkeys, and cattle. In contrast, lowland residents in and around Abijata-Shalla Lakes National Park, Awash National Park, and Senkelle Swayne's Hartebeest Sanctuary raised goats, sheep, donkeys, camels, and cattle. Subsistence agriculture was largely dependent upon the availability of arable land. While the Ethiopian government owns these lands, rural communities enjoy free usufruct rights. Roughly half of questionnaire respondents worked land holdings of less than 1 hectare, though many (42.2%) held 1 to 3 hectares. Most respondents depended on agriculture for subsistence, while one-quarter depended on livestock and the balance engaged in both activities. Roughly half of all respondents cited a shortage of pasture as their main challenge in raising livestock, while nearly one-quarter cited disease and predation as major constraints. Less than 10% of respondents relied on other income sources like small-scale business.

Local views toward wildlife. Focus group discussions revealed that local residents generally held positive attitudes towards wildlife and nearby protected areas. Reasons given for the importance of wildlife across the four protected areas included its attraction to tourists, hunting opportunities during drought, enjoyment derived from viewing wildlife, and its value for future generations. Indeed, residents near Abijata-Shalla Lakes National Park saw wildlife as a source of national income and pride. Others valued wildlife for aesthetic reasons, and because of historic links between wildlife and traditional tribal culture. One exception was residents around Senkelle Swayne's Hartebeest Sanctuary. There, views of Swayne's hartebeest turned negative after the sanctuary was created in 1976, largely due to loss of access to grazing lands and harsh enforcement actions by Sanctuary staff.

Across all four sites, 94% of respondents supported policies designed to protect wildlife. However, levels of support differed across the four study sites, with the lowest level of support (60%) expressed by respondents from Abijata-Shalla Lakes National Park. Logistic regression showed that the probability that a community wished to protect wildlife was related to whether they had previously received benefits from the protected area, the numbers of livestock they owned, the frequency of wild animal predation, and whether they had visited the protected area.

Overall, three-quarters of respondents felt that wildlife and people could co-exist. Local views on co-existence varied across the four study sites, however, with the least support (16%) expressed by respondents from Bale Mountains National Park. Logistic regression indicated that the probability of a community expressing the belief that wildlife and people can co-exist was related to income source and whether or not the respondent had received benefits from the nearby protected area.

Local views toward protected area management and staff. Across all four sites, three-quarters of respondents expressed the view that protected areas have both economic and ecological value. Many respondents valued these areas for their potential for tourism revenues and resource use in times of need (e.g., dry-season pasture and sources of water in drought). Residents that expressed value for protected areas tended to be older, better educated, have large families, and to have previously received some tangible benefit from the reserve.

Residents from some protected areas were less supportive of their nearby reserves. For example, the relationship between Abijata-Shalla Lakes National Park staff and local communities was generally poor. Indeed, only individuals employed or receiving other benefits from the park expressed positive attitudes. Other residents expressing negative views had experienced poor relations with protected area staff, and felt that staff were antagonistic to or disliked local residents. Oftentimes these conflicts stemmed from controversy over resource use and access—particularly in times of drought or special need.

Residents in and around Abijata-Shalla Lakes National Park cited community–park mistrust stemming from limited dialogue and a lack of transparency over the last 30 years. In fact, most discussants were unsure of the park's boundary—a sure recipe for conflict over resource use and access. At Senkelle Swayne's Hartebeest Sanctuary, many discussants expressed the belief that the sanctuary was too large, and felt that some lands could be returned to the community. Part of the rationale for a smaller sanctuary was the historic coexistence between humans, livestock, and Swayne's hartebeest. Indeed, discussants expressed their desire to look after Swayne's hartebeest like their own livestock, and to continue to protect the species if the government supported local communities and included them in conservation activities. And while many residents acknowledged that community relations had improved in recent years, some admitted to illegally gathering firewood, thatching grasses, and using pasture within the sanctuary because they felt that these resources still belonged to them.

At Awash National Park, residents expressed disappointment over the number of employees that were non-locals. Many felt that the park should favor local residents for Park jobs over non-locals. In support, residents noted that many conflicts between park staff and communities arose from misunderstandings, often due in part because most staff originate from other parts of Ethiopia. A similar concern was expressed at Senkelle Swayne's Hartebeest Sanctuary, where local residents complained that sanctuary staff tended to comprise people from outside the area who viewed wildlife as more important than local people.

Improving community relations. Across the four protected areas, two-thirds of respondents believed that they derived tangible benefits from their nearby reserve. In contrast, one-third expressed the view that they had received no benefits. Benefits most often cited included opportunities for jobs and social services such as health clinics and schools, along with opportunities for resource use during the peak of the drought season.

While most residents wished to see both wildlife and habitat protected, they also expressed frustration over the limited level of benefits they received from protected areas and wildlife. Indeed, the strong correlation between protected area benefits and local community support is critical to sustaining conservation efforts. For example, most discussants in and around Awash National Park clearly believed that the park's future depended upon good relationships between park staff and local communities. Toward this end, many locals felt that community relations could be improved by allowing access to traditional resources like pasture, firewood, and key water points.

At Abijata-Shalla Lakes National Park, some residents indicated that they had benefited from the park through job opportunities, social services such as transport during emergencies, and the construction of a local school. All discussants, however, believed that assistance in improving their household economies through the sharing of tourism revenues would increase their willingness to support conservation activities.

Discussants compared past and present management at Bale Mountains National Park and noted that staff were showing increased interest in providing benefits and involving local people in park management. Examples of benefits included the construction of a health clinic, expansion of electrical services, and the creation of various job opportunities. Residents felt that park staff could foster better community relations through continued dialogue and transparency. Residents also expressed support for increased park development and infrastructure, believing it would attract more tourists which would in turn enhance local opportunities to earn more benefits.

While most discussion centered on protected area management and staff, some respondents expressed disappointment toward non-governmental organizations working in and around Awash and Bale Mountains national parks. Locals felt that these organizations promised community benefits from wildlife conservation, but seldom delivered. Part of the problem may be that these projects work only in a few selected pilot villages and are thus unable to satisfy the interests of all communities. Nonetheless, the poor public perception of these projects is consistent with other critiques of integrated conservation and development projects in Africa (see, for example, Hannah 1992, Western et al. 1994, and Alpert 1996).

Most discussants around Awash National Park felt that human population growth threatened the long-term coexistence of both humans and wildlife. Indeed, many older community members witnessed first-hand the impacts of overpopulation, and were able to explain in stark contrast the difference between resource conditions now and when they were young.

Across all four sites, three-quarters of respondents opposed degazetting their adjacent protected area. Among respondents, those that had not received benefits and those who had suffered from problem wildlife were most supportive of abolishment—findings similar to Newmark et al.'s (1993) research in nearby Tanzania. Hence, while few residents support the degazetting of nearby protected areas, the support for such action could increase if residents fail to realize benefits in the future. Ensuring continued local support for wildlife conservation over the long term suggests the need for proactive programs of benefit-sharing and local awareness of conservation values. In this regard, residents in and around Abijata-Shalla Lakes and Bale Mountains national parks supported public awareness programs and conservation education as ways to improve the attitudes of young people.

Conclusions and recommendations

Ethiopian protected areas face significant challenges in meeting human and wildlife needs. Indeed, while most communities viewed protected areas and wildlife favorably, the lack of benefits limited local willingness to aid conservation work. In this study, we found that protected area benefits, household income, education, age, and relationships with protected area staff were key factors in explaining community views towards protected areas and wildlife. Improving cooperation between communities and protected areas requires that villagers gain benefits from conservation, including some level of land rights and resource control. While policy changes since 1991 have led to improvements, existing laws fall short of empowering communities and stimulating participation.

A number of policy options could enhance local attitudes toward wildlife and protected areas. These include: (1) clarify the respective conservation roles of regional and federal governments, as well as the private sector; (2) ensure that community development efforts consider the high levels of illiteracy in communities surrounding protected areas; (3) enhance employment opportunities in and around protected areas; (4) encourage conservation and development projects to expand their planning horizons to more realistically assess their impact on poverty alleviation and conservation; (5) ensure that future management plans for protected areas include active participation from local communities; and (6) explore strategies to share and transfer land rights and security of tenure to give communities near protected areas negotiating power, security, control, and access to lands.

References

Adams, W.A. 2003. Nature and the colonial mind. In *Decolonizing Nature: Strategies for Conservation in the Postcolonial Era*. W.A. Adams and M. Mulligan, eds. London: Earthscan.

Alpert, P. 1996. Integrated conservation and development projects. *BioScience* 46, 845–855.

Anderson, D., and R. Grove. 1987. The scramble of for Eden: Past, present and future in African conservation. In *Conservation in Africa: People, Policies and Practice*. D. Anderson and R. Grove, eds. Cambridge, U.K.: Cambridge University Press.

Ashenafi, Z.T., and N. Leader-Williams. 2005. Indigenous common property resource management in the Central Highlands of Ethiopia. *Human Ecology* 33:4, 539–563.

Bernard, H.R. 2002. *Research Methods in Anthropology: Qualitative and Quantitative Approaches.* 3rd ed. Lanham, Md.: AltaMira Press.

Hannah, L. 1992. *African People, and African Parks: An Evaluation of Development Initiatives as a Means of Improving Protected Area Conservation in Africa.* Washington, D.C.: Conservation International.

Hulme, D., and M. Murphree, eds. 2001. *African Wildlife and Livelihoods: The Promise and Performance of Community Conservation.* Oxford, U.K.: James Currey Ltd.

IIED [International Institute for Environment and Development]. 1994. *Whose Eden? An Overview of Community Approaches to Wildlife Management.* London: International Institute for Environment and Development.

Lilieholm, R.J., and L.R. Romney. 2000. Tourism, national parks, and wildlife. In *Tourism and National Parks: Issues and Implications*. R.W. Butler and S.W. Boyd, eds. New York: John Wiley and Sons, 137–151.

Neumann, R.P. 1998. *Imposing Wilderness: Struggles over Livelihood and Nature Preservation in Africa.* Berkeley: University of California Press.

Newmark, W.D., N.L. Leonard, H.I. Sariko, and D.M. Gamassa. 1993. Conservation attitudes of local people living adjacent to protected areas in Tanzania. *Biological Conservation* 63, 177–183.

Newmark, W.D., D.N. Manyanza, D.G. Gamassa, and H.I. Sariko. 1994. The conflict between wildlife and local people living adjacent to protected areas in Tanzania: Human density as a predictor. *Conservation Biology* 8, 249–255.

Tedla, S. 1995. Protected areas management crises in Ethiopia. *Journal of the Ethiopian Wildlife and Natural History Society* 16.

Western, D., R.M. Wright, and S.C. Strum, eds. 1994. *Natural Connections: Perspectives in Community-based Conservation.* Washington D.C.: Island Press.

Whitesell, S., R.J. Lilieholm, and T.L. Sharik. 2002. A global survey of tropical biological field stations. *BioScience* 52:1, 55–64.

Bridging the Gap: Assessing Managers' Perspectives of Visitor Experiences at Canyon de Chelly National Monument

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Introduction

A central interest of park and recreation researchers is to understand how visitors view their park experiences. Visitor attitudes as perceived by managers do influence policy, and knowledge of visitor and manager perceptions can inform planning practices to better meet visitors' expectations. This requires that managers understand user preferences and also understand how to direct on-site compliance that supports the implementation of appropriate management prescriptions. Obtaining "objective information on visitor attitudes, preferences, and perceptions is needed because this may differ from perceptions of recreation managers" (Manning 1999:62). Visitor perception studies are routinely conducted to identify motives, preferences, and evaluations of park services; however, few studies have examined whether managers are truly aware of visitors' needs and desires. A few notable exceptions include studies that compared visitor and manager assessments of wilderness areas (Hendee and Harris 1970), campgrounds sites (Clark et al. 1971), ski touring on national forest lands (Rosenthal and Driver 1983), and managers' predictions of visitor perceptions of Cape Hatteras National Seashore and Shenandoah National Park (Wellman et al. 1982). While these comparisons have focused on manager and visitor opinions of recreation experiences, no studies have evaluated these components at a cultural park. The present study was conducted at a remote park, which is co-managed by the Navajo Nation and the National Park Service. We hypothesized that the complex relationships present at this cultural site would challenge managers to predict visitor experiences. Our main objective in this study is to present an in-depth examination of natural area planning and management at a cultural park by examining the degree to which manager and visitor perceptions align.

Methods

Study area. We conducted our study in Canyon de Chelly National Monument. This is an 83,840-acre natural area located on Navajo tribal trust land in northwestern Arizona. The National Park Service works in cooperation with the Navajo Nation and the Bureau of Indian Affairs to manage the cultural resources, as well as administrative and visitor facilities, at the park (Sanders 1996). Access to the park is limited for non-Navajo (i.e., most visitor activities in the canyon require the accompaniment of an authorized Navajo guide). In addition to the large proportion of Navajo staff members, there is a unique relationship among managers, local residents, and park visitors.

Canyon de Chelly is one of the few parks in the United States with a resident community. In community-controlled protected areas there is typically an unbalanced and unidirectional role of indigenous people in the decision-making process (Stankey 1989). The World Conservation Union (IUCN) reports that at least 80% of the world's biological hotspots are the homelands of indigenous people. It is important to understand that there is a unique relationship between managers and visitors within the collection of international protected areas. The relationship present in Canyon de Chelly serves as a representation of international parks, which include resident communities.

Sampling design. We collected data from a probability sample of visitors between 1 June and 30 November 2006 (n=386). Data were attained at a response rate of 86%. We accepted statistical significance at $p \leq 0.05$. Researchers at Arizona State University designed the questionnaire in cooperation with the National Park Service to inform planning and management. We distributed identical questionnaires to a sample of park managers (n=24), asking them to predict how they thought visitors would complete the survey. Managers from the following divisions of park employment were provided the same visitor survey: administration, interpretation, cultural and resource management, and law enforcement. We compared the two groups across six constructs: (1) motivation, (2) experience, (3) crowding, (4) place attachment, (5) satisfaction, (6) and perceptions of authenticity. An independent-samples t-test was employed to analyze differences between the visitor group and the manager group. In addition to paper surveys, we interviewed managers and used their opinion as a representative model for each level of analysis in an effort to further interpret our findings; this information is incorporated into the discussion section.

The initial visitor survey contained ten constructs (White et al. 2007); however, we only deal with six constructs in this paper.

1. **Motivation.** We examined visitor motivation to clarify the reasons why people engage in recreation activities. Thirteen items were asked of visitors and managers to indicate motivation. The foundational concepts surrounding park visitor motivations have allowed recreation professionals to maximize user benefits, minimize conflicts, and to determine consequences of these activities (Manfredo et al. 1996).
2. **Experience.** The visitor experience is a unique and important factor formed of the values associated with environmental settings (Manfredo et al. 1996). A series of 10 items were assessed as the product of recreation-related activities.
3. **Crowding.** This study also assesses crowding in the context of carrying capacity, and can be defined as a psychological phenomenon that is felt if individual need for a given amount of space is not adequately met by environmental circumstances (Manning 1999). We utilized one standard 9-point Likert-type scale to examine this concept.
4. **Place attachment.** Through 12 items we examined the construct of place attachment, in the context of two fundamental dimensions: place identity and place dependence. Place dependence is the importance of a physical area to attain a desired experience,

and place identity conceptually allows an individual to identify with a setting to satisfy one's goals (Davenport and Anderson 2005).

5. **Satisfaction.** Eight items were measured to evaluate the construct of satisfaction. Relative satisfaction measures the quality of recreational opportunities and is defined as the degree to which a visit fulfills a desired experience (Manning 1999).
6. **Authenticity.** To determine what contributes to an authentic visitor experience, we measured this construct through a series of six items.

Results

To identify the similarities and differences between managers' and visitors' perceptions we utilized quantitative and qualitative data.

Motivation. For 12 of the 13 items of motivation, managers' results were similar to those reported by park visitors. The only statistically significant difference was found in an item relating to archaeology ($t = 0.04$, $p \le 0.05$), in which managers predicted that visitors would rate archaeology 12% higher than visitors reported (Table 1).

Visitor experience. Managers' predictions of the visitor experience construct aligned closely with visitor responses (Table 2). There were, however, three significant differences: the staff at Canyon de Chelly thought that visitors learned more about the National Park Service in their park experience than the on-site respondents claimed ($t = -2.58$, $p \le 0.01$); visitors were more impressed with how Navajos have thrived in the canyon ($t = 2.15$, $p \le 0.05$); and, visitors were more impressed with the cooperation between the Park Service and the Navajo Nation ($t = 2.33$, $p \le 0.05$).

Park crowding. There was a significant difference in the single item that measured perceived crowding levels between managers and visitors. Based upon mean scores, managers

Table 1. Comparison of manager and visitor responses to the construct of motivation.

Statement	Visitor Mean	Visitor Std. Dev	Manager Mean	Manager Std. Dev	t–value
Learn about archeology	3.03	1.19	3.57	1.08	–2.03*
Experience a different temperature	2.41	1.39	2.83	1.19	–1.60
Be close to nature	3.80	1.15	3.48	1.12	1.28
Get away from the usual demands of life	3.76	1.26	3.48	1.24	1.04
Develop personal, spiritual values	2.54	1.35	2.81	1.25	–0.89
Have an authentic experience of Navajo culture	3.57	1.15	3.35	1.15	0.91
Be with people who share my values	3.18	1.40	3.00	1.18	0.68
Be with family or friends	3.33	1.45	3.14	1.39	0.58
Learn about Navajo traditions	3.45	1.13	3.38	1.07	0.28
Experience solitude	2.90	1.35	2.96	1.26	–0.17
Develop my knowledge of history	3.49	1.11	3.52	0.93	–0.13
Learn about nature	3.20	1.17	3.17	0.98	0.10
Experience a connection with Navajo culture	3.37	1.22	3.39	1.12	–0.06

Note. Mean score value is on a scale ranging from 1 (Not at all important) to 5 (Extremely important).
* Significant at $p \le 0.05$

Statement	Visitor Mean	Visitor Std. Dev	Manager Mean	Manager Std. Dev	t–value
Learned about the National Park Service	2.88	1.02	3.48	0.93	–2.58*
Impressed by the cooperation of NPS and the Navajo Nation	3.82	0.93	3.35	0.93	2.34*
Impressed with how Navajo people have thrived in the canyon	4.15	0.79	3.78	0.67	2.15*
Learned about the biological diversity	3.41	1.03	3.14	0.96	1.16
Learned about the scientific value of the area	3.20	1.03	3.39	0.94	–0.84
Canyon de Chelly NM provided me with an authentic experience	3.82	0.92	3.96	0.71	–0.70
Nostalgic feeling for a simpler way of life	3.42	1.09	3.26	0.96	0.69
Learned about human history	3.91	0.76	3.95	0.92	–0.29
Felt proud to see the preservation of archeological resources	4.12	0.83	4.10	0.77	0.13
Learned how ancient cultures are related to modern tribes	3.67	0.87	3.67	0.97	0.02

Note. Mean score value is on a scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).
* Significant at $p \leq 0.05$

Table 2. Comparison of manager and visitor responses to the construct of the visitor experience.

predicted that visitors would report a value of 4.0, while visitors actually reported a value of 1.8 ($t = -5.45$, $p \leq 0.01$). In other words, managers predicted that the visitors at Canyon de Chelly would perceive conditions to be 37% more crowded than visitors claimed.

Place attachment. We examined visitor survey results within two dimensions of place attachment: place identity and place dependence. Managers' predictions of visitor place attachment levels were ranked higher than visitors on half of the tested items (Table 3). Park visitors had higher levels of place identity than was predicted by managers ($t = -2.18$, $p \leq 0.01$), while within the dimension of place dependence, four out of five items were ranked significantly higher by managers ($t = -3.09$, $p \leq 0.01$; $t = -2.36$, $p \leq 0.01$; $t = -2.28$, $p \leq 0.01$; $t = -2.13$, $p \leq 0.01$).

Satisfaction. In our examination of satisfaction levels, manager and visitor opinions aligned for 75% of the items measuring the construct (Table 4). Of the two items that held significant differences, managers predicted that visitors would be 20% less satisfied with the educational exhibits ($t = 4.43$, $p \leq 0.01$), and 12% less satisfied with informative trail signs ($t = 2.93$ and $p \leq 0.01$).

Authenticity. In our analysis of an authentic visitor experience there was close agreement, while disagreement was found on one component of the construct titled "attending interpretive programs" ($t = -2.40$, p value ≤ 0.01). Managers rated this indicator 13% higher than visitors, and, in turn, believed that visitors saw these programs as more important to an authentic experience at Canyon de Chelly.

Discussion

We found consistent agreement between manager and visitor perceptions at Canyon de Chelly National Monument. It is apparent that these park managers, in a large part, under-

Statement *Subscale Items*	Visitors Mean	 Std. Dev	Manager Mean	 Std. Dev	 t–value
Place Dependence					
I get more satisfaction out of visiting Canyon de Chelly than from visiting any other park	2.87	0.98	3.52	1.04	–3.09*
I enjoy recreating in this park more than any other area	2.95	0.90	3.43	1.03	–2.36*
I wouldn't substitute any place for the type of recreation I do here	2.77	0.99	3.26	0.96	–2.28*
Recreating here is more important than recreating in any other place	2.70	0.92	3.14	0.96	–2.13*
I will (do) bring my children to this place	3.61	1.10	3.96	0.77	–2.00
Place Identity					
I have a special connection to the park and the native people who live here	3.20	0.97	3.65	0.71	–2.18*
I feel no commitment to the park	2.38	1.09	2.57	0.84	–0.77
I have a lot of fond memories about the park	3.91	0.88	4.05	0.74	–0.70
I don't tell many people about the park	2.16	1.02	2.00	0.84	–0.71
I identify strongly with the park	3.42	0.94	3.52	0.81	–0.47
Canyon de Chelly means a lot to me	4.08	0.81	4.00	0.84	0.44
I am very attached to the park	3.62	0.92	3.65	0.88	–0.18

Note. Mean value score is on a scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).
* Significant at $p \leq 0 .01$

Table 3. Comparison of manager and visitor responses to the construct of place attachment.

Facilities, Programs, or Services	Visitors Mean	 Std. Dev	Manager Mean	 Std. Dev	 t-value
Quality of educational exhibits at visitor center	4.05	0.89	3.14	1.06	4.43*
Educational signs on the trails	3.71	0.91	3.10	1.04	2.93**
Cleanliness of visitor center	4.63	0.86	4.38	0.67	–0.07
Overall condition of campground	3.91	0.98	3.70	0.88	1.01
Availability of hiking trails	3.68	1.16	3.48	1.12	0.81
Overall quality of horseback riding tour	3.55	0.91	3.47	1.01	0.35
Overall quality of concession jeep tour	3.92	0.96	3.84	0.76	0.33
Cleanliness of restrooms	3.94	0.98	3.96	0.71	–0.07

Note. Mean value score is on a scale ranging from 1 (Very Dissatisfied) to 5 (Very Satisfied).
*Significant at $p \leq 0 .01$ **Significant at $p \leq 0 .05$

Table 4. Comparison of manager and visitor responses to the construct of satisfaction.

stand their visitors. As such, they have the potential to continue maintaining and encouraging visitors to return and enjoy this protected area. Our findings align with a limited body of past recreation research. Rosenthal and Driver (1983), for instance, found that managers had a reasonably good understanding of experiences sought by ski-tourers in the Colorado Rockies. Also in the Shenandoah National Park section of a study by Wellman et al. (1982), park managers predicted motivation items to be consistent with visitor reports. These studies point to accuracy in managers' predictions of visitor preferences. Hence, the present study provides support for these findings as related to Canyon de Chelly visitor motivation, experience, satisfaction, and authenticity.

It is important to note the differing perceptions pointed out in this study. A number of researchers have highlighted the disparity between manager and visitor opinions (Hendee and Harris 1970; Clark et al. 1971). Several theoretical explanations synthesized by Manning (1999) hypothesize why these opinions may differ. First, managers may project their own feelings into their interpretation of visitor experiences. In this study, we found half of the place attachment items ranked higher by managers, which suggests that they might have reflected their personal views. Often times, managers are more concerned with on-site conditions and report what visitors *should* prefer (Hendee and Harris 1970; Wellman et al. 1982). Second, managers selectively notice visitor behavior and, furthermore, only interact with visitors who might not comprise a representative sample (Manning 1999). We believe that the difference in perceived crowding levels between our sampled groups is exacerbated by managers' perceptions of visitor experiences in densely crowded areas (i.e., the visitor center). In turn, this reinforces existing notions toward appropriate management decisions.

Manning (1999) reviewed a series of prior studies comparing manager and visitor perceptions, none of which, however, took place in a cultural park. The closeness of managers' and visitors' perceptions at Canyon de Chelly may be due in part to the setting of this study. Cultural parks often focus on human aspects of the visitor experience. Thus, managers may be more attuned to visitors' preferences than managers of more remote natural areas. Furthermore, prior research in this area was conducted between 1970 and 1996. It may be the case that managers have improved their understanding of visitors over time. The comprehensive nature of this study, which compared visitors and managers perspectives across six constructs, lends support to the notion that contemporary managers are better able to predict visitor perspectives.

Consistency between the two sampled parties in our study suggests that Canyon de Chelly managers understand their visitors for the most part and thus have potential to select appropriate management strategies. We recommend that future researchers examine manager and visitor perceptions at additional cultural resource parks to determine if the findings reported here are supported elsewhere.

References

Clark, R.N., J.C. Hendee, and F.L. Campbell. 1971. Values, behavior, and conflict in modern camping culture. *Journal of Leisure Research* 3, 143–159.

Davenport, M.A., and D.H. Anderson. 2005. Getting from sense of place to place-based management: An interpretive investigation of place meanings and perceptions of landscape change. *Society and Natural Resources* 19, 625–641.

Hendee, J.C., and R.W. Harris. 1970. Foresters' perception of wilderness-user attitudes and preferences. *Journal of Forestry* 68, 759–762.

Manfredo, M.J., B.L. Driver, and M.A. Tarrant. 1996. Measuring leisure motivation: A meta analysis of the Recreation Experience Preference Scales. *Journal of Leisure Research* 28:3, 188–213.

Manning, R.E. 1999. *Studies in Outdoor Recreation: Search and Research for Satisfaction.* Corvallis: Oregon State University Press.

Rosenthal D.H., and B.L. Driver. 1983. Managers' perceptions of experiences sought by ski-tourers. *Journal of Forestry* 88, 88–105.

Sanders, J.M. 1996. A comparative study of the planning and management of Monument Valley Tribal Park and Canyon de Chelly National Monument. *Landscape and Urban Planning* 36, 171–182.

Stankey, G.H. 1989. Linking parks to people: The key to effective management. *Society and Natural Resources* 2, 245–250.

Wellman, J.D., M.S. Dawson, and J.W. Roggenbuck. 1982. Park managers' predictions of the motivations of visitors to two National Park Service sites. *Journal of Leisure Research* 14:1, 1–15.

White, D., C. van Riper, J. Wodrich, and J. Aquino. 2007. *Canyon de Chelly National Monument Visitor Study Final Technical Report.* Prepared for the National Park Service. Phoenix: Arizona State University.

A Comparison of Wildlife Management in Mid-size Parks in South Africa and the United States

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Introduction

In many parts of the world, national parks are the last remaining wild areas and the best hope for conserving native wildlife and natural processes. This is true in the United States and in South Africa, where both countries are viewed as leaders in wildlife conservation. However, both countries face similar threats and issues when attempting to conserve native grassland wildlife, especially large fauna. For example, many native grassland ungulates historically traveled great distances in response to changing environmental conditions, yet landscape fragmentation and societal concerns (e.g., impacts on cropland) now prevent large-scale movements. Hence, parks in both countries often use fences to constrain large animals. These fenced areas are often less than 100,000 acres and isolated within agrarian landscapes. Despite these similarities, there are striking differences in management approaches. We compare large-fauna management in national parks in the Northern Great Plains of the United States with similar parks and protected areas in South Africa. Such a comparison can improve agency effectiveness and wildlife conservation by inspiring management actions and policies currently outside of agency paradigms.

Policy

The U.S. National Park Service was established in 1916. The agency has a hierarchical organization with centralized planning and oversight. Agency-wide policy and management plans are produced approximately every 10 years, with the most recent document being completed in 2006 (National Park Service 2006). In contrast, SANParks is a comparatively young agency that is reinventing national oversight of parks in South Africa (SANParks 2006) since it took over from the old South Africa National Parks Board in the newly democratic South Africa.

At a national level, the agency mission statements and policy are very similar. Consider the mission statement for the U.S. National Park Service:

> . . . preserves unimpaired the natural and cultural resources and values . . . for the enjoyment, education, and inspiration of this and future generations.

Whereas the SANParks mission statement is:

> To acquire and manage a system of national parks that represents the indigenous wildlife, vegetation, landscapes and associated cultural assets . . . for the joy and benefit of *the nation.*

However, at the provincial level some noticeable differences are evident. Consider the mission statement of the Northwest Parks and Tourism Board in South Africa:

> To direct and develop the integration of tourism and nature conservation in a manner that uplifts the people of the province, by creating value where the mark would not intervene on its own.

The emphasis on ecotourism and revenue generation from park activities is more prevalent in South Africa than in the United States. South African national and provincial parks must be financially self-supporting due to the minimal amount of government appropriations in the face of social imperatives. In contrast, U.S. national parks are funded primarily through federal appropriations and therefore have little incentive to generate revenue for their own operations. Although there are economic benefits from the presence of parks in the United States, such benefits are typically viewed as indirect and not the primary reason for establishment of the site. In contrast, revenue generation and local economic development is a primary purpose for the creation of most new conservation areas in South Africa. The ecotourism model in South Africa has been so successful in generating revenue that there are many for-profit private conservancies. The laws, government oversight, and integration of these private conservancies varies among provinces; however, they are often operated similarly to the government-operated parks in that they strive to conserve native fauna in large part for the economic benefits. In this paper we collectively refer to these private, regional, and national conservation lands in South Africa as "parks." No comparable privately owned for-profit natural areas model exists in the United States (although some models are being cautiously explored and developed; see www.americanprairie.org).

Management

To better compare park management between the countries, we examined the presence and management of megafauna in a subset of parks from both countries. Specifically, we compared large animal abundance from three fenced parks in the Northern Great Plains of the United States (Badlands National Park, Theodore Roosevelt National Park, and Wind Cave National Park) to 10 fenced parks (public and private) of comparable size (8,600–220,000 acres) and habitat (grassland–savannah parks) from various regions in South Africa.

The differences between parks within a country in terms of the diversity of large animals were minor compared to those between countries. For example, the three U.S. parks all supported 5–7 large fauna species, whereas the South African sites all supported 15–30 such species. Therefore, for illustrative purposes we will compare the representative 46,200-acre South Unit of Theodore Roosevelt National Park in North Dakota, United States (Table 1) to the 39,026-acre Kwandwe Conservancy (a privately owned site) in the Eastern Cape province of South Africa (Table 2).

One of the most striking and obvious differences between the two representative sites is the huge disparity in large animal abundance and biomass, with the slightly smaller South African unit supporting more than three times the abundance of the United States site (this disparity would be even greater except for the fact that elk abundance in Theodore Roosevelt National Park is currently well above desired levels due to the presence of chronic wasting disease, which is precluding the removal of surplus elk). A small part of this difference may be due to the South African parks striving for wildlife abundance (for tourism value), whereas the United States parks tend to be more lightly grazed due to decades of concerns about overgrazing on most rangelands. However, the most likely reason for the great disparity in terms of megafauna abundance and biomass is that primary productivity is greater on the South African site, and therefore probably more comparable to the tallgrass region of the central United States, a region which has been effectively destroyed ecologically and which has no mid-size park units applicable to this study.

Common Name	Abundance
bison	310
horse	120
elk	900
mule deer	300
white-tailed deer	100
pronghorn	50
Total	*1,780*

Table 1. Large animals at Theodore Roosevelt National Park (South Unit: 46,200 acres), North Dakota, USA.

The second item of interest from Tables 1 and 2 is the disparity in large animal species richness between the two parks. This contrast is more difficult to explain, i.e., why should one grassland–savanna site have so much higher megafauna richness then another site on the other side of the world? The answer likely lies in the history of the sites. According to the "overkill" theory, when humans first came to North America shortly after the last ice age (about 20,000 years ago) they encountered a high diversity of large animals that roamed the plains of North America, which the human colonizers subsequently eliminated via over-hunting (Martin 2005). Whatever the cause, 20,000 years ago the Northern Great Plains of the United States had a megafauna richness comparable to that of modern-day South Africa.

The third item of interest from Tables 1 and 2 is the difference between the two sites in terms of the low end of the animal populations. This disparity is a reflection of the policies and operational differences of the two countries, and is a main point of this paper. In Theodore Roosevelt National Park (Table 1), all of the large animal populations consist of at least 50 individuals (however, only the bison are fully contained; all other animals have movements hindered by the fence, but regularly find openings). In contrast, several large animal populations at Kwande Conservancy consist of less than 50 individuals, and some have less than 20 individuals (in contrast to Theodore Roosevelt, the fence at Kwande effectively prevents escapes). The presence of very small populations of some megafauna occurs at all sites in South Africa. This is a deliberate management strategy in South Africa and applies to both large prey and large predators. Large charismatic species are supported, even if it must be at low numbers, to increase economic potential of reserves. Also, in some cases parks form part of a metapopulation of endangered species (e.g., wild dog and black rhinoceros) that contribute to the national conservation plan for such species. The presence of even small populations of certain species (e.g., lion and elephant) also conserves ecological processes.

The willingness to support very small populations of megafauna means that South African parks better meet the goals and policy of conserving native biological diversity and indigenous fauna, a goal common to both countries. Almost all of the South African sites reviewed as part of this study supported the full assemblage of native species, whereas none of the United States sites did. Of the over 270 national park units in the United States with

Common Name	Abundance
African buffalo	83
bushbuck	117
black wildebeest	173
brown hyena	17
cheetah	14
duiker	114
eland	128
elephant	35
gemsbuk/oryx	213
giraffe	47
red haartebeest	264
hippo	17
impala	396
kudu	1,900
leopard	7
lion	18
ostrich	50
mountain reedbuck	43
black rhinoceros	11
white rhinoceros	39
springbuck	530
steenbuck	73
warthog	1,050
wild dog	6
waterbuck	137
zebra	236
Total	*5,718*

Table 2. Large animals at Kwande Conservancy (39,026 acres). (Thanks to Angus-Sholto Douglas for providing these data.)

significant natural resources, less than 10 can claim to support all of the indigenous large fauna, and all of those are extremely large (e.g., Yellowstone National Park) or situated within or adjacent to large wildernesses and natural areas. The benefits that South African parks derive from having all of the native species present include ecological as well as human benefits (e.g., ecotourism).

The downside to having these very small populations present in a fenced park is that their existence necessitates a very hands-on approach to replenish extirpated populations, preserve genetic fitness, maintain desired sex and age ratios, and other needs. In South Africa, the numerous disjunct natural areas essentially manage their large wildlife species as subpopulations of larger multi-park metapopulations. If a park needs new animals due to local extirpation, genetic concerns, sex ratio imbalances, or other needs, they translocate animals between units. With the exception of imperiled species (e.g., wild dog: see Gusset et al. 2006) the implementation of this multi-park management approach is completed with minimal government oversight. In contrast, national parks in the United States have a high level of central planning and hierarchy, yet virtually no between-park exchanges of animals nor a metapopulation approach.

Some wildlife reintroductions in South Africa involve very few animals, but are remarkably successful. The Makalali Conservancy African lion population provides an excellent example. In 1994, a lioness and four cubs were introduced into the fenced 34,580-acre site (Druce et al. 2004). Since then, more than 30 lions have been produced, with many surplus individuals being translocated elsewhere. Throughout South Africa there are similar experiences where even small populations of predators within fenced sites adequately limit ungulate numbers, perform other ecosystem services, and survive for long periods. However, there are considerations when managing small populations in small closed systems. On small sites the margin for error is less, and even apparently minor changes can have profound effects. For example, a shift in the male:female sex ratio of lions can significantly impact predation rates of key species through prey switching or sex-specific targeting of particular species (Gus van Dyk, pers. comm.). For example, male lions attack valuable buffalo when in large enough groups, whereas females target blue wildebeest. Similarly, the distribution of watering sites within small enclosed sites can alter prey selection by lions (Gus van Dyk, pers. comm.). Reintroduced packs of wild dogs have been observed using fences to help capture prey (van Dyk and Slotow 2003). With such small populations of both predator and prey, managers must closely monitor their actions and adapt where necessary. This hands-on approach has resulted in some notorious unforeseen consequences, such as occurred after the introduction of young bull elephants into Pilanesburg National Park, which, in the absence of older males, initiated musth earlier than expected and killed rhinoceros (Slotow et al. 2000). Yet in spite of these negative instances, the metapopulation approach is extremely successful in conserving the full assemblage of native species in small South African parks.

The presence of large predators such as lions does result in additional management costs. For example, sites in South Africa must gain permission from adjacent landowners before reintroducing lions, a predator-proof electric fence must be installed and maintained, there must be a comprehensive predator management plan in place, and there must be liability insurance in case of breakouts. However, these additional costs are typically more than offset by the increase ecotourism revenue generated by the presence of the predators. Although wolves have not been reintroduced into small parks in the United States, an increase in ecotourism associated with wolf reintroduction has been documented at Yellowstone National Park (Duffield et al. 2006).

At this time the U.S. National Park Service policies (National Park Service 2006) actually discourage the conservation of small populations, both predator and prey. The policies state that the agency will strive to restore extirpated native species when "[a]dequate habitat to support the species … exists … and, once a natural population level is achieved, the population can be self-perpetuating." The policies also clearly discourage the hands-on management needed to successfully implement a metapopulation approach as practiced in South Africa. Yet such an approach would undoubtedly have benefits in the United States.

The professional organization, The Wildlife Society, recognized the potential for reintroducing small numbers of wolves and managing them as a metapopulation when it stated that "if national parks and other protected areas cannot provide large enough areas for self-perpetuating populations of wolves, systematic and periodic reintroduction of wolves from outside may ensure population survival" (The Wildlife Society 1991:8).

The same paper stated that populations that are "ecologically functional" may be a more suitable goal in some cases than those that are "minimally viable." Ecological functions include prey population control, removal of unfit prey animals, modification of prey behavior, creation of carrion, and interspecific impacts that have a ripple effect through the system (Smith et al. 2003). Even small populations of wolves may have the potential to control exotic diseases such as chronic wasting disease (Margaret Wild, in prep.).

Documenting the causes for these different approaches between the two countries is beyond the scope of this paper. An easy speculation is that there are social and cultural differences that result in these differing strategies. However, other differences may be equally important. For example, many parks and conservancies in South Africa are much younger than the United States parks evaluated in this study. The establishment of these new sites, both public and private, creates a clean slate from which to propose bold new ideas. In some cases these new reserves were developed by newly constituted staff, including innovative individuals with experience in other countries and agencies. Another significant causal factor is that South Africa wildlife must "pay their way." South African sites that support the "big five" (lion, leopard, elephant, buffalo, rhinoceros) are a greater draw than those that don't.

Summary

Although there are many similarities in how the two countries manage large grassland–savanna animals, there are also stark differences. The most significant difference in terms of wildlife management is that: (1) mid-size South African parks are more likely to support small populations that are not self-sustaining; (2) South African parks implement a more hands-on approach that includes the regular translocation of animals between parks using a meta-population approach; and (3) South African parks are more likely to support top-level predators for their ecological role and for increasing ecotourism and revenue. Park management in the two countries can benefit from understanding the other country's approaches. Furthermore, consistencies in research and management between the countries may lead to a better understanding of ecological principles and of anthropogenic effects such as climate change (Knapp et al. 2004).

References

Druce, D., H. Genis, J. Braak, S. Greatwood, A. Delsink, R. Kettles, L. Hunter, and R. Slotow. 2004. Population demography and spatial ecology of a reintroduced lion population in the Greater Makalali Conservancy, South Africa. *Koedoe* 47:1, 103–118.

Duffield, J., C. Neher, and D. Patterson. 2006. *Wolves and People in Yellowstone: Impacts on the Regional Economy.* Missoula, Mont.: University of Montana.

Gusset, M., R. Slotow, and M.J. Somers. 2006. Divided we fail: The importance of social integration for the re-introduction of endangered African wild dogs *(Lycaon pictus). Journal of Zoology* 270, 502–511.

Knapp, A.K., M.D. Smith, S.L. Collins, N. Zambatis, M. Peel, S. Emery, J. Wojdak, M.C. Horner-Devine, H. Biggs, J. Kruger, and S.J. Andelman. 2004. Generality in ecology: Testing North American grassland rules in South Africa savannas. *Frontiers in Ecology and the Environment* 2:9, 483–491.

Martin, P.S. 2005. *Twilight of the Mammoths: Ice Age Extinctions and the Rewilding of America.* Berkeley and Los Angeles: University of California Press.

National Park Service. 2006. *Management Policies: The Guide to Managing the National Park System.* Washington, D.C.: National Park Service.

SANParks. 2006. Coordinated policy framework governing park management plans: Draft 3—Work in progress document. July 2006.

Slotow, R., G. van Dyk, J. Poole, B. Page, and A. Klocke. 2000. Older bull elephants control young males. *Nature* 408:6811, 425–426.

Smith, D.W., R.O. Peterson, and D.B. Houston. 2003. Yellowstone after wolves. *BioScience* 53:4, 330–340.

van Dyk, G., and R. Slotow. 2003. The effects of fences and lions on the ecology of African wild dogs reintroduced to Pilanesberg National Park, South Africa. *African Zoology* 38:1, 79–94.

The Wildlife Society. 1991. *Restoration of Wolves in North America.* Technical Review no. 91-1. Bethesda, Md.: The Wildlife Society.

Environmental Contaminant Hazards to Wildlife at National Capital Region and Mid-Atlantic National Park Service Units

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Introduction

Part of the mission of the National Park Service (NPS) entails preservation of natural resources, processes, systems, and associated values of its units in an unimpaired condition. Environmental contamination and pollution processes are well recognized stressors that can adversely affect park units and are addressed by NPS management policies and plans. Nonetheless, biota remain at risk to contaminants at many NPS units. One U.S. Department of the Interior activity that addresses pollution hazards is the Biomonitoring of Environmental Status and Trends project (Zylstra 1994). Its does so through active field monitoring and by use of decision support tools, including the Contaminant Assessment Process (Coyle et al. 1999) and the Contaminant Exposure and Effects-Terrestrial Vertebrates (CEE-TV) database (Rattner et al. 2005). A recent study using the CEE-TV database found that contemporary terrestrial vertebrate ecotoxicological data are lacking at 59 of 126 Park Service units located in coastal watersheds exhibiting serious water quality problems or high vulnerability to pollution. Based upon this finding, a study was undertaken at 23 Inventory and Monitoring (I&M) Program units in the National Capital Region and Mid-Atlantic networks to evaluate contaminant threats to terrestrial vertebrates. The specific objectives included compiling ecotoxicological data for terrestrial vertebrates (viz., amphibians, reptiles, birds and mammals) residing at these I&M units, using additional pollution data from various federal and state agencies to assess potential hazards at these sites, recommending management activities to mitigate risk, and prioritizing sites for potential contaminant biomonitoring activities.

Methods

Using Geographic Information System procedures, shapefiles were obtained for each park boundary and a 10-km buffer was created around each unit. Because of their proximity, Gettysburg National Military Park (NMP) and Eisenhower National Historic Site (NHS) were joined as one unit.

Potential pollution sources that could affect terrestrial vertebrates were compiled, including (1) National Priorities List (NPL) Superfund sites; (2) Clean Water Act Section 303(d) impaired waters for 2002; (3) pesticide and herbicide use at NPS units for 2004; (4) Toxic Release Inventory (TRI) sites for 1997 through 2003; (5) fish consumption advisories for 2004; (6) solid waste facilities; and (7) wastewater treatment sites. Extant terrestrial vertebrate contaminant exposure and/or effects information was obtained from the CEE-TV database (Rattner et al. 2005). In an attempt to garner additional data, interviews were conducted with staff of each I&M unit using questions derived from the Contaminant Assessment Process guidance document (Coyle et al. 1999). All of these data were overlaid on the NPS unit boundary and buffer shapefiles.

Initially data were qualitatively reviewed (presence of contaminants in abiotic media and prey species, pesticide and herbicide use, presence of critical areas or sensitive species, and existing wildlife toxicology data). A semi-quantitative ranking scheme was then applied to rank contaminant threats at or near each national park unit (e.g., NPL sites, impaired waters, number of pesticides and relative toxicity, number of TRI sites and fish consumption advisories). A data richness metric was also derived that reflected the quantity and type of wildlife exposure and effects information. This data richness score in combination with known contaminant threats and size of the national park unit was examined to identify and rank relative contaminant monitoring/research needs of each park unit. For example, parks with low contaminant threats or a large number of terrestrial vertebrate ecotoxicological data were ranked low, while parks with high contaminant threats and relatively little terrestrial vertebrate data were identified as priority sites for study.

Results and discussion

The qualitative review of data revealed that over half of the national park units are near air pollution sources of concern, and lead, mercury and dioxins from TRI sites may be deposited at or near several of the national park units. Many priority pollutants (e.g., PCB, chlordane, mercury) were present in water ways within or near 12 national park units, and with the exception of Appomattox Court House National Historical Park (NHP), fish consumption advisories are in effect at or near 22 study units. Application of pesticides and herbicides at national park units is highly regulated, and with the exception of units with major agricultural leases (Antietam National Battlefield [NB], Gettysburg NMP, Fredericksburg & Spotsylvania NMP, and Monocacy NB), use on parks is minimal. Only 70 unique terrestrial vertebrate contaminant exposure and effects records were found, and these included 27 necropsy reports, 16 monitoring studies, and 27 hypothesis-driven investigations. Only 58 unique compounds were quantified, and the vast majority of these reports dealt with legacy organochlorine pesticides and PCBs, many of which are now banned. Other contaminants included organophosphorus and carbamate pesticides, rodenticides, petroleum hydrocarbons, and metals. Only one report (Rattner et al. 2004) addressed exposure to compounds of more contemporary concern (alkylphenols, perfluroinated compounds and brominated flame retardants).

Environmental contaminant threats appeared to be substantial at eight of the 22 study areas, while such threats were seemingly low at five park units (Table 1). Parks with the seemingly greatest threat of contamination were those near (1) impaired waters, (2) numerous TRI sites, and (3) TRI sites releasing large numbers of priority pollutants (i.e., Fort McHenry National Monument and Historic Shrine [NM & HS], Richmond National Battlefield Park [NBP], National Capital Parks-East, and Chesapeake & Ohio Canal NHP). Other units that appear to be moderately threatened by contaminants included Petersburg NB and Valley Forge NHP, principally because of their proximity to numerous TRI sites. In contrast, Shen-

Table 1. Rank of Overall Contaminant Threat to Mid-Atlantic and National Capital Region Network Park Units[a]

Park Name	NPL Sites	Percent Surface Waters Impaired	No. of Toxic Pesticides[b]	Relative Toxicity of Pesticides	No. of TRI Sites	No. TRI Sites Discharging POPs[c]	State Fish Consumption Advisories	Overall Contaminant Threat[d]
Antietam NB	0	1	2	2	1	0	1	7
Appomattox Court House NHP	0	0	2	1	1	1	0	5
Booker T Washington NM	0	0	1	1	0	0	2	4
Catoctin Mountain NP	0	0	1	1	1	0	1	4
Chesapeake & Ohio Canal NHP	2	0	1	1	4	3	2	13
Fort McHenry NM & HS	2	3	2	2	4	3	2	18
Fredericksburg & Spotsylvania NM	0	0	2	1	1	1	2	7
George Washington MP	1	0	0	0	2	1	2	6
Gettysburg NMP & Eishenhower NHS	0	0	3	2	1	0	1	7
Harper's Ferry NHP	0	0	3	2	1	1	2	9
Hopewell Furnace NHS	0	1	2	2	2	1	2	10
Manassas NBP	0	0	0	0	2	1	2	5
Monocacy NB	0	0	3	2	3	1	1	10
National Capital Parks-East	4	1	0	0	4	3	2	14
National Mall & Memorial Parks	1	1	0	0	2	1	2	7
Petersburg NB	0	1	1	1	4	2	2	11
Prince William FP	1	0	1	1	1	1	2	7
Richmond NBP	1	0	2	2	4	3	2	14
Rock Creek Park	1	1	2	2	2	1	2	11
Shenandoah NP	2	1	3	2	3	1	2	14
Valley Forge NHP	2	1	1	1	4	1	2	12
Wolf Trap NP for the Performing Arts	0	0	0	0	1	0	1	2

[a] Classification threat ranking scheme ranges from low (0) to high.

[b] Based on the toxicity classification scheme in Hill and Camardese (1986) and Smith (1987); pesticides classified as moderately toxic, highly toxic, and very highly toxic.

[c] Persistent organic pollutants.

[d] Overall contaminant threat score was derived as the sum of individual contaminant threat categories (2, low; 7, moderate; 18, serious).

andoah National Park (NP), located in a rural forested area, also ranked high in this scheme, due to the use of a large number of pesticide formulations containing active ingredients that are suspected to be highly toxic to amphibians (Birge et al. 2000). National park units with apparently lowest contaminant threats were located in areas with no NPL Superfund sites, few TRI sites, and a low percentage of impaired waters (e.g., Wolf Trap NP for the Performing Arts, Catoctin Mountain Park, and Appomattox Court House NHP). Some of the parks with seemingly low contaminant threats either contain or are close to affected waterways. For example, Smith Mountain Lake and the Roanoke River have fish consumption advisories due to elevated PCB burdens, and are within two kilometers of Booker T. Washington NM. Fish consumption advisories due to PCBs exist for Bull Run, a stream that runs through the northeastern portion of Manassas NBP.

Terrestrial vertebrate ecotoxicological data derived from hypothesis-driven studies are available at or near several park units (e.g., National Capital Parks-East, Fort McHenry NM & HS, Petersburg NB). However, there are a number of study units for which there are no contemporary exposure and effects information for terrestrial vertebrates (e.g., Hopewell Furnace NHS, Antietam NB, Harpers Ferry NHP, and Catoctin Mountain Park).

Those national park units with the most significant monitoring or research priority are sites with the greatest contaminant threat *and* little or no terrestrial vertebrate ecotoxicological data. Units that match this criterion include Shenandoah NP, Richmond NB, Valley Forge NHP, Hopewell Furnace NHS, Monocacy NB, and Harpers Ferry NHP (Table 2). Although the threat of contaminants to terrestrial vertebrates is great at Fort McHenry NM & HS, National Capital Parks-East, and Chesapeake & Ohio Canal NHP, a number of necropsy, monitoring, and research study reports are available for these sites. However, the Chesapeake & Ohio Canal NHP and its buffer constitute the largest study area in this investigation, and based upon its size deserves special consideration. The hazard of contaminants to terrestrial vertebrates at Wolf Trap NP, Booker T. Washington NM, and Catoctin Mountain Park appears to be minimal, but little if any terrestrial vertebrate ecotoxicological data are available at these sites.

Conclusions

Based upon these and other findings, ecotoxicological monitoring and research investigations of terrestrial vertebrates are warranted at several national parks in the National Capital Region and Mid-Atlantic Networks. These include Shenandoah NP, Richmond NBP, Chesapeake & Ohio Canal NHP, Valley Forge NHP, Hopewell Furnace NHS, Monocacy NB, and Harpers Ferry NHP. The types of investigations vary according to the species present at these parks and potential contaminant threats, but should focus on contemporary pesticides and herbicides, PCBs, mercury, lead, and perhaps, emerging contaminants including antibiotics, flame retardants, pharmaceuticals, and surfactants. Other management recommendations include additional training for natural resource staff members in the area of ecotoxicology, inclusion of terrestrial vertebrate contaminant monitoring and the Contaminant Assessment Process into the NPS Vital Signs Program, development of protocols for handling and toxicological analysis of dead or seemingly affected wildlife, consideration of some alterna-

Table 2. Prioritization of ecotoxicological research and monitoring needs at NP units

Park Name	Area, inc. buffer (km^2)	Data Richness Score[a]	Overall Contaminant Threat[b]
Shenandoah NP	4042.3	1	14
Richmond NBP	1311.3	1	14
Valley Forge NHP	482.6	1	12
Hopewell Furnace NHS	403.5	0	10
Harper's Ferry NHP	560.4	0	9
Monocacy NB	438.8	1	10
Antietam NB	503.5	0	7
Chesapeake & Ohio Canal NHP	5088.4	3	13
Fort McHenry NM & HS	331.0	4	18
National Capital Parks-East	1826.0	4	14
Rock Creek Park	542.8	3	11
Fredericksburg & Spotsylvania NM	1467.9	1	7
Gettysburg NMP/Eishenhower NHS	666.5	1	7
Catoctin Mountain NP	563.3	0	4
Petersburg NB	1190.2	3	11
Prince William FP	673.9	1	7
Appomattox Court House NHP	491.7	1	5
Manassas NBP	544.7	1	5
National Mall & Memorial Parks	524.8	3	7
George Washington MP	1013.1	3	6
Booker T Washington NM	359.5	1	4
Wolf Trap NP for the Performing Arts	341.0	1	2

[a] 0, low; 4,high.
[b] 2, low; 7, moderate; 18, serious.

tive methods and compounds for pest management and weed control, and use of non-toxic fishing tackle by visitors.

References

Birge, W.J., A.G. Westerman, and J.A. Spromberg. 2000. Comparative toxicology and risk assessment of amphibians. In *Ecotoxicology of Amphibians and Reptiles.* D.W. Sparling, G. Linder, and C.A. Bishop, eds. Pensacola, Fla.: Society of Environmental Toxicology and Chemistry.

Coyle, J., C. Moore, S, Bristol, M. Henry, T. Hall, and T. Kubiak. 1999. *CAP User Guide: Assessing Environmental Contaminant Threats to Lands and Biota Managed by the U.S. Fish and Wildlife Service*. U.S. Geological Survey Open File Report 99-108. Reston, Va.: Office of the Associate Chief Biologist for Science, U.S. Geological Survey.

Rattner, B.A., P.C. McGowan, N.H. Golden, J.S. Hatfield, P.C. Toschik, R.F. Lukei, Jr., R.C. Hale, I. Schmitz-Afonso, and C.P. Rice. 2004. Contaminant exposure and reproductive success of ospreys (*Pandion haliaetus*) nesting in Chesapeake Bay regions of concern. *Archives of Environmental Contamination and Toxicology* 47, 126–140.

Rattner, B.A., K.M. Eisenreich, N.H. Golden, M.A. McKernan, R.L. Hothem, and T.W. Custer. 2005. Retrospective ecotoxicological data and current information needs for terrestrial vertebrates residing in coastal habitat of the United States. *Archives of Environmental Contamination and Toxicology* 49, 257–265.

Zylstra, S.J. 1994. A new program for biomonitoring status and trends in the environment. *Journal of Aquatic Ecosystem Health* 3, 81–85.

The Role of Protected Areas as Bird Stop-over Habitat: Ecology and Habitat Utilization by Migrating Land Birds within Colorado River Riparian Forests of Southwestern North America

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Introduction

In southwestern North America, riparian habitats have declined precipitously in the last century both within and outside protected areas such as national parks, U.S. Fish and Wildlife Service refuges, and Bureau of Land Management and biosphere reserve lands. These declines are primarily due to anthropogenic perturbations such as alterations in river flow regimes, agricultural conversion, livestock grazing, and urban expansion (Webb et al. 2003). In the southwestern United States and northwestern Mexico the decline of riparian habitat and loss of native cottonwood (*Populus fremontii*), willow (*Salix gooddingii*) gallery forests, and adjacent mesquite (*Prosopis* sp.) bosques has been accompanied by the invasion of non-native tamarisk (*Tamarisk* sp.), or salt cedar. This change has resulted in a dramatic shift towards the dominance of tamarisk in riparian vegetation communities within most protected areas (Shafroth et al. 2005). The reduction and shift in vegetation composition within riparian habitats in western North America has resulted in their classification as globally imperiled by The Nature Conservancy (Comer at al. 2003), and has had a tremendous impact on neotropical migrant birds. Although riparian habitat comprises less than one percent of the landscape in southwestern North America, it supports more breeding bird species than all other western habitat types combined (Anderson and Ohmart 1977). Riparian areas serve as critical breeding, winter, and stop-over habitat for birds, supporting 10 times greater bird numbers than surrounding uplands (Anderson et al. 2004). In fact, most wildlife within xeric environments of protected areas in Mexico and the United States depend on resources (e.g., water, cover, food) provided by riparian habitats during some time of their annual cycle (Rosenberg et al. 1991).

Vegetation species' composition is an important component of avian habitat selection (Anderson and Ohmart 1977), and several studies have examined the effects of tamarisk invasion in riparian areas on subsequent avian community structure (Rice et al. 1983; van Riper et al. 2007). These studies focused on comparing pure stands of tamarisk to native dominated stands, and showed that tamarisk monocultures contained less diversity and lower absolute numbers of birds. The earlier studies resulted in the perception that tamarisk provides relatively unsuitable habitat for bird species, and that a negative relationship exists between avian diversity and tamarisk abundance. This perception helped to shape early restoration policies for southwestern riparian habitats, which commonly aim to eradicate tamarisk (e.g., Cohn 2005). The recent work by van Riper et al. 2007), who compared bird numbers in mixes of native and tamarisk habitats, suggests a suitability threshold for birds when 20–40% native trees occur in predominately tamarisk habitat.

In this study we compare the responses of neotropical migrant bird species' arrival and visual cues to differing sizes of vegetation patches within protected areas (e.g., Cibola and Bill Williams River national wildlife refuges) on the Lower Colorado River in the southwestern United States and northwestern Mexico. We developed research hypotheses that examined ways in which individual birds as well as avian communities respond to differing amounts of tamarisk and other vegetation within protected areas along the Colorado River. We will also discuss stop-over movement patterns and foraging in relation to plant phenology patterns and insect abundance. It is our hope that this information will allow land managers to re-examine present land configurations and more precisely address avian community needs within future restoration projects throughout southwestern North America.

Materials and methods

Study areas. Our studies were conducted along the entire length of the lower Colorado River, from the delta in Sonora, Mexico, to The Nature Conservancy reserve in Moab, Utah (Figure 1). Areas of most intense data collection were at Cibola National Wildlife Refuge (33°18' N, 114°41' W; elevation 60 meters) and Bill Williams River National Wildlife Refuge (34°18' N, 114°08' W; elevation 200 meters) in La Paz County, Arizona (Figure 1; nos. 2 and 3). Cibola is located adjacent to the main channel of the lower Colorado River, where intensive water management and land-use practices have resulted in large expanses of the landscape being dominated by tamarisk monocultures. The remaining native habitat patches presently found at Cibola are primarily the result of restoration efforts (Rosenberg et al. 1991). In contrast, the Bill Williams River is a perennial tributary of the lower Colorado River, and while tamarisk is a dominant tree species, the area contains some of the last remaining extensive stands of natural cottonwood and willow gallery forests within the lower Colorado River watershed. Honey mesquite (*Prosopis glandulosa*) and to a lesser degree screwbean mesquite (*Prosopis pubescens*) are other native tree species found at Bill Williams River, while common woody under-story species include seep willow (*Baccharis salicifolia*), arrow weed (*Tessaria sericea*), and saltbush (*Atriplex* sp.).

Field methods. We established point-count stations along the Colorado River corridor, following Reynolds et al. (1980). Each station was at least 300 meters from adjacent stations to minimize double counting. Over a five-year period (1998–2002), during March–May and August–November, we surveyed for birds every 7 to 10 days at our intensive study sites, located at Cibola and the Bill Williams River national wildlife refuges, and once each month (1998–1999) in Mexico, northern Arizona, and Utah. Surveys were conducted between sunrise and 1000 hours, except during rain or high winds. At each station, observers waited one

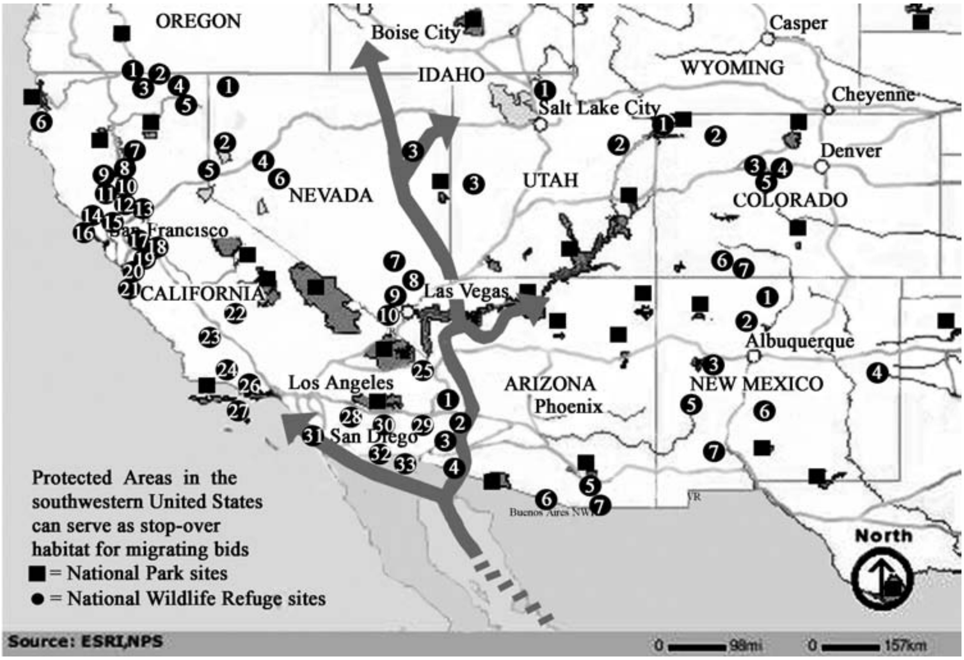

Figure 1. Protected areas in northwest Mexico and the southwestern USA that can serve as stop-over habitat for migrating birds. Large arrows depict major bird migration routes. National Park Service areas are indicated by squares. National Wildlife Refuge (NWR) areas are numbered as follows:

- California: (1) Klamath Basin; (2) Clear Lake; (3) Lower Klamath; (4) Tule Lake; (5) Modoc; (6) Humboldt Bay; (7) Sacramento; (8) Willow Creek-Lurline; (9) Delevan; (10) Butte Sink; (11) Colusa; (12) Sutter; (13) Stone Lakes; (14) San Pablo; (15) Antioch Dunes; (16) Farallon; (17) San Joaquin River; (18) Merced; (19) Grasslands; (20) San Luis; (21) Salinas River; (22) Blue Ridge; (23) Hem; (24) Bitter Creek; (25) Havasu; (26) Hopper Mountain; (27) Seal Beach; (28) Coachella Valley; (29) Cibola; (30) Sonny Bono Salton Sea; (31) San Diego; (32) Sweetwater Marsh A; (33) Tijuana Slough.
- Nevada: (1) Sheldon; (2) Anano Island; (3) Ruby Lake; (4) Fallon; (5) Lurline; (6) Still Water; (7) Pahranagat; (8) Moapa Valley Desert; (9) Ash Meadows.
- Arizona: (1) Bill Williams River; (2) Kofa; (3) Imperial; (4) Cabeza Prieta; (5) Leslie Canyon; (6) San Bernadino; (7) Buenos Aires.
- Utah: (1) Big Bear; (2) Ouray; (3) Fish Springs.
- Colorado: (1) Arapaho; (2) Browns Park; (3) Rock Flats; (4) Rocky Mountain Arsenal; (5) Two Ponds; (6) Monte Vista–Alamosa.
- New Mexico: (1) Maxwell; (2) Las Vegas; (3) Sevilleta; (4) Grulla; (5) Bosque Del Apache; (6) Bitter Lake–San Andreas.

minute to minimize influences of disturbance, then recorded all birds heard or seen within a 100-meter radius for five minutes. Distance to each bird was recorded, and birds flying overhead were excluded. We also mist-netted birds on alternate days when counting did not occur.

To quantify vegetation characteristics we randomly selected two azimuths, and located two 11.3-meter radius plots 30 meters from the center of each station along those random directions. Vegetation parameters were measured during the spring of 1999 using a combination of vegetation sampling techniques from James and Shugart (1970) and the BBIRD protocol (Martin and Finch 1995).

To obtain an overall representation of arthropod abundance, we sampled all dominant riparian tree species. Insects were sampled twice during peak spring migration in 2003 with branch-bagged samples collected of foliage dwelling insects. This technique captures active and inactive insects likely to be hunted by the predominantly leaf-gleaning insectivores (after Johnson 2000). One branch sample was collected per tree. The branch was shaken into a sweep net, and insects collected from the net were transferred into one-gallon zip-lock bags. We controlled for foliage surface area by choosing branches with similar stem diameter. Samples were frozen immediately and brought to the laboratory for processing. From each sample, arthropods were sorted, counted, and identified. Voucher specimens from samples were mounted and placed in a reference collection at Northern Arizona University, Flagstaff, and the University of Arizona, Tucson. The remaining insects were stored by sample in 70 percent ethanol.

Results

Migrant arrival timing. We found that migrant bird species arrived asynchronously along the Colorado River, particularly neotropical migrant warblers which appear to partition their arrival times to minimize overlap with other species (Figure 2). Moreover, we found that the more northern breeding members arrive later and "leap-frog" over their southern breeding counterparts during migration (Paxton et al. 2007). Thus, we see that individuals who winter in northern Mexico arrive first and then move on to their breeding grounds in the southwestern United States. Birds that winter further south, arrive later and "leap" over the earlier arrivals to reach their more northern breeding grounds in Canada and Alaska. The Colorado River corridor appears to be a less important fall migration route, as seen in the differences between spring and fall numbers of migrant species and duration of stop-over (Figure 2).

Visual cues. When birds arrive during migration at areas along the Colorado River, we believe that they assess stop-over habitats at multiple scales (Figure 3). The coarsest scale (A) is the largest, and appears to be a genetically influenced corridor selection, coupled with weather frontal patterns. When following a migration route, a bird then selects specific stop-over habitat next on the basis of large-scale landscape features (B). Once the large-scale feature has been selected, the bird then decides on the type of vegetation patch (C). Finally, the bird makes microhabitat selection about specific foraging and roosting locations within the vegetation patch (D), selecting between native and introduced tamarisk vegetation. Over time, this selection process ultimately maximizes resources for each bird species during migration stop-over (Hutto 1985).

Movement and feeding. We have found that once a bird selects a stop-over location, daily movement is minimal. At Cibola National Wildlife Refuge for example, we found that birds rarely move more than 100 meters throughout a day. In fact, in 2006 some birds visited only a few trees for the entire stop-over period. Birds were preferentially choosing to forage in honey mesquite trees (Figure 4). This was due in a large part to the greater abundance of insects on flowering honey mesquite trees (McGrath and van Riper 2005).

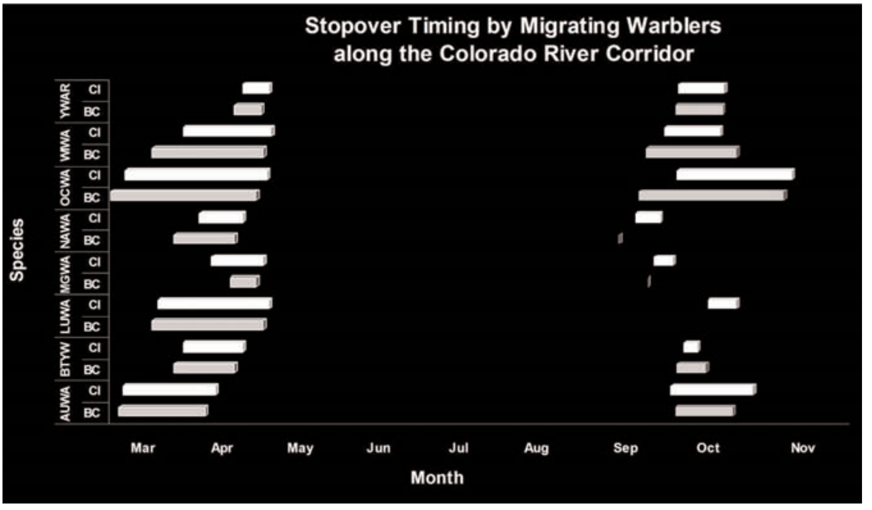

Figure 2. Arrival times and duration of stop-over during spring and fall migrations for neotropical warbler species. The horizontal axis is month of the year while the vertical axis lists bird species identified as being present: AUWA (Audubon's warbler), BTYW (black-throated grey warbler), LUWA (Lucy's warbler), MGWA (MacGillivray's warbler), NAWA (Nashville warbler), OCWA (orange-crowned warbler), WIWA (Wilson's warbler), and YWAR (yellow warbler).

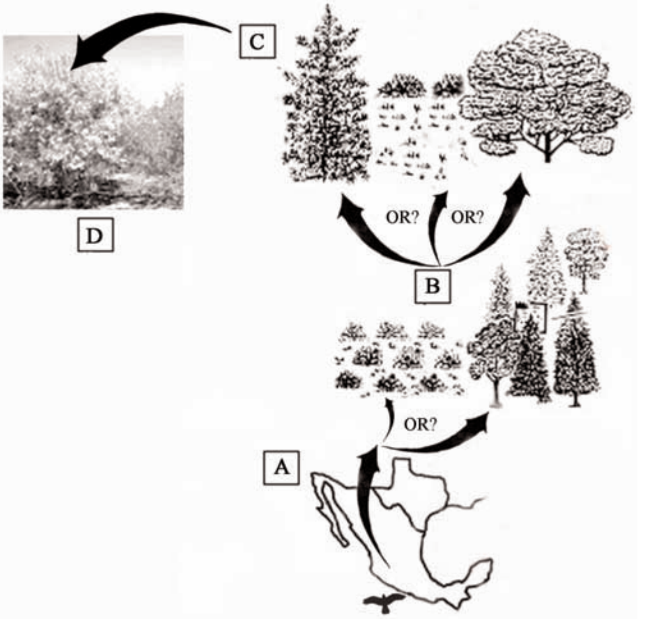

Figure 3. Figure depicting how migrant birds, passing from Mexico to the southwestern United States, assess stop-over habitat. The birds appear to assess migrant routes and stop-over habitats at four major scales. These scales correspond to the letters in the figures and are identified as: (A) genetically influenced corridor selection; (B) large-scale landscape features; (C) vegetation patches; and (D) microhabitat selection within the vegetation patch.

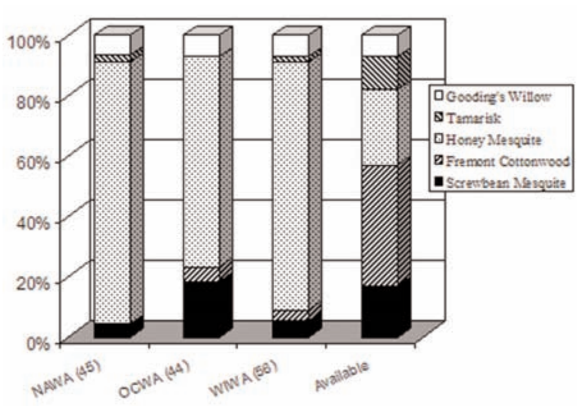

Figure 4. Proportion of substrate used by some neotropical migrant birds during 2002 and 2003 at Cibola NWR on the lower Colorado River near Blythe, Arizona. Data are from observations of a single attack maneuver and the associated substrate that the bird foraged on. Amount available is the percentage of canopy coverage based on random point vegetative sampling. Species are: NAWA (Nashville warbler), OCWA (orange-crowned warbler), and WIWA (Wilson's warbler). Numbers in parentheses are sample sizes.

Phenology. When we correlated migration at protected areas with plant phenology data, the only significant correlation was that migrant arrivals coincided with honey mesquite flowering (R=0.76, p= 0.03). In fact, we found that almost every warbler species preferentially chose honey mesquite as a foraging substrate and utilized this tree significantly more often than would have occurred by chance (Figure 4). Correlations were not significant for the other tree species' leaf cover and flowering compared to the relative abundance of migrants. Screwbean mesquite leaves emerged at the end of peak migration. Fremont cottonwood showed no pattern with migrant stop-over patterns, as there was no flowering and leaves were much older by the time the first migrants arrived (McGrath and van Riper 2005). Although peak tamarisk flowering occurred after spring migration, flowers were present and leafing was almost complete during the migration period. Gooding's willow also bloomed in spring, but no correlation with migrant arrival and tree phenology was detected by McGrath and van Riper (2005).

Tamarisk. The avian community structure at Cibola and Bill Williams River national wildlife refuges varied significantly across a gradient in tamarisk abundance. At both sites, van Riper et al. (2007) found a significantly high degree of avian community structure between tamarisk dominated and native dominated habitats. We found that avian communities associated with low and intermediate levels of tamarisk did not differ, while both differed significantly from avian communities associated with high tamarisk levels (ANOSIM: r=0.52, p=0.003). Thus, habitats with low and intermediate levels of tamarisk support similar avian communities, but contrast markedly to avian communities associated with higher tamarisk levels.

Discussion

Managers of protected areas throughout southwestern North America should realize that habitat selection by avian species varies seasonally as energetic demands and habitat requirements change with differing phases of the annual cycle (Anderson et al. 2004). Migrant birds partition their arrival times to maximize food resources and allow for prey recovery. Although birds generally arrive at more southern latitudes first during spring migration, managers should be aware that a "leap-frog" migration pattern occurs in spring and fall for many neotropical bird species migrating along the Colorado River corridor. Thus, the longer-distance migrants come through most stop-over areas at a later date.

Both large and small protected areas are important for neotropical migrant bird stop-over sites. Birds appear to assess migrant routes and stop-over habitats at multiple scales, with larger protected areas providing the initial target for stopping. Once a location is chosen, at the smaller local scale phenological phases of major plant species strongly influence when and where birds stop. Smaller protected areas such as United States Fish and Wildlife Service refuges and state parks, provide important vegetation patches and suitable microhabitats for bird refueling during spring migration. Importantly, however, these areas must include areas with mixes of native vegetation. We found the greatest abundances of birds in habitats composed of 40–60% native vegetation with a tamarisk under-story (van Riper et al. 2007), and the lowest abundances in homogenous tamarisk stands. However, the selection by birds of habitats with small amounts of tamarisk, suggests that mixed native-tamarisk habitats can adequately meet avian requirements in protected areas along the Colorado River corridor in western North America.

Conclusions

We found that western migrant land bird species arrived at different times within protected areas along the Colorado River. The birds appear to assess migrant routes and stop-over habitats at multiple scales: (1) genetically influenced corridor selection; (2) large-scale landscape features; (3) vegetation patches; and, (4) microhabitat selection within a vegetation patch. Weather, vegetative species, structure, plant phenology patterns, and food resources variously influence migrating birds along the lower Colorado River. Species arrival dates and numbers of neotropical migrant warblers were variable among years, being largely influenced by large-scale weather patterns and plant phenology cycles. Protected areas are important stop-over sites because once selected, there was minimal movement by individual birds over the landscape during the stop-over period. Therefore, stop-over and bird foraging patterns were greatly influenced by plant species and phenological patterns of the selected microhabitat. Neotropical migrant bird species rely on protected areas in the southwest, as these habitats provide suitable stop-over and foraging habitat. It thus appears that larger protected (and unprotected) areas such as biosphere reserves and national parks, provide the appropriate landscape features that attract migrating birds, while smaller protected areas may play a more important role as micro-sites for stop-over habitat. Managers must recognize that within their protected areas, vegetation, structure, plant species, phenology, abundance, and food availability all play a role in structuring bird migration patterns along the lower Colorado River corridor.

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References

Anderson, B.W., and R.D. Ohmart. 1977. Vegetation structure and bird use in the lower Colorado River Valley. In *Importance, Preservation, and Management of Riparian Habitat*. R.R. Johnson and D.A. Jones, technical coordinators. General Technical Report RM-43. Fort Collins, Colo.: U.S. Department of Agriculture–Forest Service, Rocky Mountain Forest and Range Experiment Station, 23–33.

Anderson, B.W., P.E. Russell, and R.D. Ohmart. 2004. *Riparian Revegetation: An Account of 2 Decades of Experience in the Arid Southwest*. Blythe, Calif.: Avvar Books.

Cohn, J.P. 2005. Tiff over tamarisk: Can a nuisance be nice, too? *BioScience* 55, 648–654.

Comer, P., D. Faber-Langendoen, R. Evans, S. Menard, M. Pyne, M. Reid, K. Schulz, K. Snow, and I. Teague. 2003. *Ecological Systems of the United States: A Working Classification of U. S. Terrestrial Systems*. Arlington, Va.: NatureServe.

Hutto, R.L. 1985. Habitat selection by nonbreeding, migratory land birds. In *Habitat Selection in Birds*. M.L. Cody, ed. Youngstown, N.Y.: Academic Press, 455–476.

James, F.C., and H.H. Shugart, Jr. 1970. A quantitative method of habitat description. *Audubon Field Notes* 24, 727–737.

Johnson, M.D. 2000. Evaluation of an arthropod sampling technique for measuring food availability for forest insectivorous birds. *Journal of Field Ornithology* 71, 88–109.

Martin, T.E., and D.M. Finch. 1995. *Ecology and Management of Neotropical Migratory Birds.* Oxford and New York: Oxford University Press.

McGrath, L.J., and C. van Riper III. 2005. *Influences of Riparian Tree Phenology on Lower Colorado River Spring-migrating Birds: Implications of Flower Cueing.* Open File Report 2005-1140. U.S. Geological Survey, Southwest Biological Science Center, Sonoran Desert Research Station. Tucson: University of Arizona Press.

Paxton, K.L., C. van Riper III, T. Theimer, and E. Paxton. 2007. Isotopes in migrating Wilson's warblers on the Colorado River. *Auk* 124, 162–175.

Reynolds, R.T., J.M. Scott, and R.A. Nussbaum. 1980. A variable circular-plot method for estimating bird numbers. *Condor* 82, 309–313.

Rice, J., R.D. Ohmart, and B.W. Anderson. 1983. Habitat selection attributes of an avian community: A discriminate analysis investigation. *Ecological Monographs* 53, 263–290.

Rosenberg, K.V., R.D. Ohmart, W.C. Hunter, and B.W. Anderson. 1991. *Birds of the Lower Colorado River Valley*. Tucson: University of Arizona Press.

Shafroth, P.B., J.R. Cleverly, R.L. Dudley, J.P. Taylor, C. van Riper III, E.P. Weeks, and J.N. Stuart. 2005. Control of Tamarix in the western United States: Implications for water salvage, wildlife use, and riparian restoration. *Environmental Management* 35, 231–246.

van Riper III, C., K.L. Paxton, C. O'Brien, P.B. Shafroth, and L.J. McGrath. 2007. Rethinking avian response to *Tamarisk* on the lower Colorado River: A threshold hypothesis. *Restoration Ecology* 15 (in press).

Webb, R.H., J.E. Bowers, and J.R. Hastings. 2003. *The Changing Mile Revisited: An Ecological Semiarid Region Study of Vegetation Change with Time in the Lower Mile of an Arid Land.* Tucson: University of Arizona Press.

The Effects of Fire on Beach Grass *(Ammophila breviligulata)* at Apostle Islands National Lakeshore

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Introduction

Apostle Islands National Lakeshore is one of four units designated as a National Lakeshore in the national park system. Established in 1970, the park comprises 21 islands and a mainland unit that stretches along 12 miles of Lake Superior shoreline in northern Wisconsin. This large body of water imposes a maritime influence on local conditions because it absorbs and releases heat more slowly than the surrounding lands. Subsequently, temperatures change at a lower rate and winters are warmer on the islands as compared with the adjacent Bayfield Peninsula. Spring also arrives later, summers are cooler, and fall is longer. The growing season is 120 days and precipitation averages 29 inches annually, with about 78 inches of snow.

Winds are variable, potentially strong, and impact a great deal of area, especially along the exposed perimeters of the islands. Historical data (National Oceanic and Atmospheric Administration [NOAA] Devils Island weather buoy DISW3 at www.ndbc.noaa.gov) indicate that between 1983 and 2001 average wind speeds were 3–26 miles per hour (mph) with a range of 0–69 mph. Gusts above 46 mph occurred in all months during this time and peak gusts of 69 mph and 76 mph have been reported in March.

Unique land features at Apostle Islands National Lakeshore include rocky cliff faces, clay banks, sandscapes, and bogs. Clay banks contain a high percentage of sand which is eroded rapidly and transported by long shore currents to form a variety of coastal sand features or sandscapes. Sandscapes include several unique landforms such as barrier beaches (Julian Bay on Stockton Island) and spits (Long Island); cuspate forelands, which are triangular-shaped seaward extentions (Raspberry and South Twin islands); tombolos, which are sand or gravel bars stretching from an island to the mainland or another island; a double tombolo (Stockton Island); and sand spits (Cat and Outer islands). These various landforms are located primarily on the southern sides of the islands. Sandscapes typically comprise a beach that is devoid of vegetation, active dunes vegetated with beach grass (*Ammophila breviligulata*), interdunal hollows, stabilized dunes and/or beach ridges, and frequently a former lake basin covered with bog or alder thicket community type vegetation.

Beach grass is a cool-season, perennial grass. Seed production is poor but the species is very strongly rhizomatous, and reproduction is primarily by vegetative means. Six to ten feet of expansion annually is common (NRCS 2002). Dispersal is aided by movement of the population towards the high-risk shoreline area which increases the likelihood of destruction by violent storms. During these conditions rhizomes are broken up into many pieces and then cast about by water. The emphasis on vegetative reproduction is reflected in the various floating capacities of reproductive parts: fruits were found to float for 108 hours, while rhizomatous fragments lasted up to 140 hours (Maun 1985). This species is highly adapted for unstable habitats. Beach grass has a strong capability to grow vertically when overtopped by sand and studies have shown individuals extending through 100 centimeters of soil both initiating and continuing dune formation. In addition Maun (1985) reported increased vigor in areas of continual sand accretion and decreased vigor in areas of more stable conditions.

Beach grass burns infrequently under natural situations and its response to fire is poorly represented in the literature. The fuel components for this community type are the grass itself and a nearly continuous and sometimes thick layer of dead beach grass. Approximately 24% of the total biomass of beach grass is accounted for in dead leaves and sheaths (Maun 1985). The species fits a grassland fuel model (Anderson 1982).

Stockton Island is the largest island at Apostle Islands National Lakeshore and the single location with the most campsites. Visitation is high at this island, both at the campsites and along beaches associated with day use purposes. On 1 July 2006, a visitor inadvertently ignited a fire at Julian Bay while using sparklers. The fire started on the landward side of the sand dunes and wind conditions were such that the fire moved northeastward towards the lake. The weather was sunny with temperatures in the low 80s and winds from the southwest at 15 to 20 knots. Visitors reported flame heights of one to three feet as the fire moved through the beach grass community. Visitors were able to put the fire out within 15 minutes of ignition, and park staff inspected the area upon their arrival and declared the fire out.

Beach grass is frequently planted to promote sand and dune stabilization near public travel corridors as well as during habitat restoration efforts. These types of areas are frequently affected directly or indirectly by public recreation, which is also often a source of fire ignitions. Considering these factors, the primary objectives of this project were to document the effects of fire on beach grass as well as to describe how this species responds to fire. A secondary objective was to increase the available knowledge base regarding this species.

Methods

The area of the burn was delineated with a global positioning system (GPS) unit and maps were later created in a geographic information system (GIS, ArcMap 9.2). Point-line intercepts were completed near the center of the burned area and in adjacent unburned habitat one month after the fire following methods outlined in the National Park Service's Fire Monitoring Handbook (1992). A total of 268 data points were recorded in the burned area and 100 from the adjacent, unburned habitat. Data was collected on the number of points with living vegetation, vegetation and litter, vegetation and sand, litter, or sand exclusively along transects. Vegetation heights (stretched to the maximum height, $n = 30$) were taken along parallel compass headings from both the burned area and the adjacent unburned habitat three months after the fire on 5 October. Photographic documentation of the effects of fire on the plants and regeneration were also obtained during both visits.

Point-line intercept data was summarized by proportions of points with a given parameter and differences between the burned and unburned habitat were compared with a two-sample proportion test using Statistix 7 (2000). The height data was evaluated with a two-sample T-test with this same statistics program.

Results and discussion

Fire frequently moves through an area in a mosaic pattern, leaving small patches of unburned habitat. This was not strongly evident on Stockton Island. In one section of the burned area a few sand cherry (*Prunus pumila*) plants were growing and their woody nature seemed to have the effect of slowing the fire down. The typical effect of fire on individual beach grasses differed between two conditions, depending on location. Plants located along the perimeter of the fire showed evidence of scorch, which served to discolor the leaves. Scorch apparently does not strongly impact the plants however, as other portions of the leaves retained their green coloration through both monitoring timeframes, and plant vigor was not obviously impacted. In the majority of plants affected by the fire, all but the basal portion of the culms (approximately 8 cm) was consumed. The senescent layer of vegetation was completely removed throughout the burned area.

Post-burn monitoring one month later indicated significant differences for various parameters between burned areas and adjacent unburned habitat. The number of times living vegetation was detected in the burned area was less than that of the unburned habitat ($p = 0.00$). The same was true for the number of points with vegetation and litter ($p = 0.00$) between the two sites. In addition, significance was detected for the number of points that had only sand present ($p = 0.00$) with a higher percentage in the burned habitat.

Post-burn monitoring three months after the fire focused on how the plants were recovering. The site was still readily discernible due to the complete lack of senescent vegetation and the blackened stems that were still apparent. Visual inspection of the individual plants revealed that the majority of clumps that had burned were resprouting. A very few new shoots were noted throughout the burned area. These were readily identifiable because only a single culm was present in each case whereas the vast majority of the plants had existed as clumps. In addition, the basal portion was purplish in color rather than the typical straw color of plants existing prior to the fire.

The height data recorded indicated that the mean stretched height of plants in the unburned habitat was 50.1 cm while the mean height in the burned habitat was 45.0 cm, which was significantly different (two-sample T-test; $p = 0.0377$). In spite of this difference the burned vegetation had attained 90% of the height of the unburned plants within three months of the fire.

The area experienced a wind-driven fire that moved rapidly thus minimizing the conduction of heat into the soil. As a rhizomatous species the roots were apparently not harmed. It is not known from this case how the rhizomes and roots of beach grass would respond to a fire with a longer residence time and the associated stronger heat impacts that would undoubtedly occur in that situation.

The senescent vegetation was still absent three months after the fire. It is unknown what role this component of the beach grass community plays in soil stabilization, although it is assumed to contribute to some degree. Dunes are typically strongly affected by lakeward winds and this is indeed the case at Stockton Island. Follow-up monitoring is scheduled for the 2007 summer season to determine the condition of the dunes in the area of the fire.

Beach grass is seemingly a fire-tolerant plant, defined by Kramp et al. (1986) as a plant is able to survive fire and grow afterwards. These types of plants have also been identified as resprouters, some species of which have been shown to store additional energy in root systems for recovery after disturbance (Kramp et al. 1986; Knox and Clarke 2005). It is likely that beach grass adapted this strategy due to the ephemeral habitat it is associated with and the effects following a fire are coincidental, but beneficial to the species.

References

Anderson, H.E. 1982. *Aids to Determining Fuel Models for Estimating Fire Behavior.* General Technical Report INT-122. Ogden, Utah: U.S. Department of Agriculture–Forest Service, Intermountain Forest and Range Experiment Station.

Knox, K.J.E., and P. Clarke. 2005. Nutrient availability induces contrasting allocation and starch formation in resprouting and obligate seeding shrubs. *Functional Ecology* 19, 690–698.

Kramp, B.A., D.R. Patton, and W.W. Brady. 1986. *Run Wild: Wildlife/Habitat Relationships.* Albuquerque, N.Mex.: U.S. Forest Service, Southwestern Region.

Maun, M.A. 1985. Population biology of *Ammophila breviligulata* and *Calamovilfa longifolia* on Lake Huron sand dunes. I. Habitat, growth form, reproduction, and establishment. *Canadian Journal of Botany* 63, 113–124.

NOAA [National Oceanic and Atmospheric Administration]. 2007. National Weather Service, National Data Buoy Center, Stennis Space Center, Miss. On-line at www.ndbc.noaa.gov/station_page.php?station=disw3. Accessed 25 April 2007.

NPS [National Park Service]. 1992. *National Park Service Western Region Fire Monitoring Handbook*. San Francisco: NPS Western Region.

NRCS [U.S. Department of Agriculture –Natural Resources Conservation Service]. 2002. Plant fact sheet and plant guide for American beach grass (*Ammophila breviligulata* Fern.). On-line at http://plant-materials.nrcs.usda.gov.

Statistix. 2000. Version 7.1. Tallahassee, Fla.: Analytical Software.

ROVs in the Great Lakes: National Park Case Studies

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Introduction

The ways we connect with the natural environment and our actions, or lack of actions, relative to the environment are under increasing scrutiny. Recent publications, e.g., Louv (2005), have sparked discussions regarding the perceptions that people, particularly youth, are spending less time in the outdoors than previously. In addition, the National Park Service reports a 4.8% decrease in visitation since 1987 (NPS 2006). Evidence suggests we are more likely to engage in protective behaviors towards places with which we interact and understand (Vaske and Kobrin 2001). A reduction of interactions with the outdoor environment, then, could predict a future lack of support for our public recreation lands.

One proposed reason for less outdoor activity participation among youth is the increased used of indoor electronics such as video games (Pergams and Zaradic 2006). Rather than working against the attraction of modern technology, it may be possible to, instead, use technological advances to generate interest about natural environments with youth. In this study, we used such a technology, a remotely operated vehicle (ROV), as a tool for introducing youth and adults to underwater environments.

Remotely operated vehicles (ROVs) were introduced to the public in the early 1950s via the marine work of Jacques Cousteau. The original vehicles were quite large and cumbersome, generally weighing several hundred pounds. Following work conducted by marine researchers such as Edward Link in the 1960s and Robert Ballard in the 1980s, coupled with technological advances in electronics, underwater robots were built that were smaller and more maneuverable. Some of the small ROVs can be seen in James Cameron's work on the film *Titanic*. The design of these smaller robots greatly facilitated the development of ROV-based marine exploration programs, such as JASON (Ba et al. 2002).

New marine exploration programs are being increasingly introduced as strategies for increasing students' understand of the marine environment. The National Oceanographic and Atmospheric Administration (NOAA), for example, developed a curriculum meeting national science standards of the K–12 public schools. The JASON project is another program, which, in addition to the standard curriculum, offers a component where participants can use an underwater robot fitted with a camera to observe marine life in real time. While these programs are popular, minimal systematic data measure the specific impact of the ROV or how the ROV impacts people and their interactions with aquatic environments (Ba et al. 2002). Therefore, this study was designed to examine the impacts using an underwater ROV had on individuals' interactions with and connection to the natural environment.

ROV program development

In 2004, 2005, and 2006, we used an underwater remotely operated vehicle to research and involve the public in aquatic educational programs. Prior to initial program implementation, demonstration programs and focus group studies were conducted in early 2004 to identify general expectations, concerns, and interests relevant to using an ROV for exploration and education. Demonstration programs were conducted at Isle Royale National Park, Keweenaw National Historical Park, Pictured Rocks National Lakeshore, and Sleeping Bear Dunes National Lakeshore. Focus group studies were also conducted with volunteer participants that included K–12 educators participating in an ROV enhanced program at Indiana Dunes National Lakeshore. The ROV program was modified based on their feedback.

In late 2004 and early 2005, ROV-based programs were designed and implemented. In one program, K–12 teachers participating in a science exploration program on the *R/V Lake Guardian* were given the opportunity to use the ROV for shipwreck exploration in lakes Superior and Michigan. In another program, youth, grades 7–12, operated the ROV and explored an inland lake at the U.S. Forest Service's Clear Lake camp in Michigan. There were also numerous public demonstrations of the ROV for educational programs such as Elderhostel, Michigan 4-H, and high school groups during this initial time period. Participants were encouraged to operate as well as observe during these programs. In each case, observational data were collected and analyzed to identify emergent positive and negative interaction themes. These data were used to develop the more structured educational programs used in the final data collection process.

The ROV program was formalized and implemented in summer 2005 for the purpose of measuring perceptions of technology as an environmental education tool. Programs were implemented and data were collected at the U.S. Forest Service's Clear Lake Education Center (participants were youth in grades 7–12), a series of small inland lakes in northern Michigan where programs were organized by SEE (Science and Environmental Education) North (participants were local adults), the Thunder Bay National Marine Sanctuary (participants were youth grades 6–12 observing from a remote location and K–12 teachers interacting onsite), and lakes Michigan, Huron, and Superior (participants were youth in grades 6–12 and K–12 teachers participating in science exploration programs on the *R/V Lake Guardian, S/V Denis Sullivan,* or *M/V W.G. Jackson*).

Methods

The ROV used for this study was small, weighing less than fifteen pounds, and approximately 28x18x14 inches in dimension (Figure 1). It had forward and rear video cameras, a manipulating arm to pick up small items, forward and rear lights, and three motors to propel it forward, backward, upward, and downward through the water. Power and control was supplied through an attached tether that allowed for operation from the surface. This ROV could reach depths of 500 feet. Controlled from the surface via cable, it was operated from boats and from the shore during the various programs.

Participants interacted with the ROV directly, by controlling its movements with a joystick and accompanying controls, or indirectly, by observing others operating the ROV in person, or by observing via satellite the live images as they were being recorded by the ROV. In each case, a facilitator/educator accompanied the participants as interpreters of the images. The educators also facilitated discussion of the image contexts. In addition, partici-

Figure 1. Participant prepares to deploy the ROV from the *S/V Denis Sullivan* during an exploration program.

pants interacting in person were given charts with photos and written descriptions of aquatic life they were expected to encounter during the program as part of their educational component. Upon completing the ROV program, participants were asked to respond to a five-page written questionnaire regarding their experience.

The questionnaire used for data collection was divided into three sections consisting of qualitative and quantitative questions. The first section was designed to establish the participants' personal reactions to the ROV experience. The second was designed to elicit the participants' feelings of connection to the place and their perception of how the ROV impacted their experience. The final section measured familiarity with other types of technology and demographics.

Results

Two hundred ninety individuals completed the questionnaires in summer 2005. The respondents in the study ranged from 12 to 84 years of age with over a third (39.3%) between 12 and 15 years old and another third (38.5%) over 55 years old. The remaining respondents were spread equally between 16 and 54 years old. Participants were predominantly white (96.4%), equally from rural, suburban, and urban residential areas, and reported a range of annual incomes from $20,000 to $100,000 or more.

Regarding initial perceptions of the ROV, respondents indicated strong agreement with the ROV's usefulness and positive perceptions of the ROV, including its ability to be used creatively and educationally (Table 1). They also indicated it was easy and exciting to use. Respondents predominantly indicated it was not difficult, stressful, or boring to use.

Examination of open-ended responses for emerging themes regarding the impact of the ROV resulted in predominantly positive perceptions, however, negative perceptions were also noted. Positive perceptions of the ROV included its ability to be used as a tool for environmental education. One respondent indicated, "I learned more and was more interested in conservation using the ROV," while another respondent suggested she had a "…better understanding of human impacts on natural resources."

First-hand experience or the ability to directly observe the natural world was also indicated as a positive impact of the ROV. One adult suggested, "Visuals speak a thousand words. We are visual creatures and need to see and feel what is going on versus what is read." And, a youth participating in the program told us, "Being able to see what is below makes it more real."

Respondents also noted accessibility as an important feature of the ROV. For example, one adult suggested, "The exploration of natural resources is available to everyone."

Positive perceptions expressed also included the ability of the ROV to be fun, safe, and interesting to use as well as safe, low impact, and conservation oriented. In addition, respondents suggested it was a good science and research tool, could be very useful for exploration, and had the ability to be used for connecting people to natural resources. Respondents further suggested the experiential facet of using the ROV fostered a deep understanding of Great Lakes resources and strengthened the place connection they felt.

Table 1. ROV perceptions.

Perceptions of ROV	Mean	Stand. Dev.
The ROV could be useful.	4.76	.67
The ROV was creative.	4.50	.98
The ROV was exciting.	4.39	.97
The ROV helped me understand the natural resource.	4.19	1.12
The ROV was easy to use.	3.80	.25
The ROV was difficult to use.	2.02	1.27
The ROV was stressful to use.	1.77	1.24
The ROV was boring to use.	1.38	.90

Note: Responses were measured on a 5-point scale with 1=strongly disagree and 5=strongly agree.

Negative perceptions were noted only among adults and included the possibility of becoming disconnected from nature, the cost associated with purchasing and maintaining and ROV, unfamiliarity with using technology, and the possibility for replacing humans, e.g., no longer needing divers. In addition, the possibility of environmental damage was noted. For example, one adult suggested the ROV could be "… potentially intrusive [to various species]". Another respondent was concerned with the vessel from which the ROV was operated and indicated, "Big boats could leak gas and oil to disturb shorelines."

Observationally, participants in the program were highly engaged during the program and interested in sharing their perceptions of the ROVs upon its completion. In addition, approximately one-third of participants engaged in extensive follow-up conversations with the educator/facilitator at the close of the programs. However, no formal data were collected in this context.

Discussion

Using technology as a tool for natural resources engagement can be quite effective. In this study, youth as well as adults found the ROV to be exciting and fun to use. They also believed it helped them connect to the natural environment in ways they had not previously considered. For individuals who may fear the water, have physical limitations, or want to explore depths not physically possible, the ROV offers an alternative. Not only is the ROV easy to use—the joystick is not very different from that used in a video game—it provides clear, high-resolution images of real-time activities and allows users to observe aquatic life in its natural habitat. The strong positive reaction to the ROV by users and observers alike, attests to its potential usefulness for increasing the likelihood of bringing people outdoors.

There are several limitations in this study. The polar age distribution, i.e., over two-thirds of the respondents were young teenagers or adults over 55 years old, limits our ability to generalize results across age groups. In addition, racial and ethnically diverse perceptions are not represented in this study and caution is suggested when translating these results to various user groups. However, future studies are being designed to address these limitations.

Future research will include detailed measures of specific learning outcomes, learning preference styles, and aptitude for natural science learning. Further research is suggested in the area of distance education. Specifically, the impact of using an ROV remotely can be explored in the context of a classroom or via the worldwide web. Finally, in order to further examine the effect using an ROV has on environmental learning, it will be important to compare the ROV-infused programs with equitable environmental education programs not using the ROV.

Technologically advanced products are being increasingly embedded in our daily lives. People take notes with laptops and electronic notebooks, communicate regularly via text messages, listen to music on MP3 players, and download podcasts to share with friends. We also incorporate GIS tracking systems as part of our backcountry camping gear and day hikes, participate in electronic-based outdoor activities such as geocaching, and share digital images on a variety of websites. We have an opportunity to use this societal fascination with technology as an advantage in our quest to connect visitors, especially young people, to nature. Using the ROV as a tool for engaging with and observing aquatic environments can be one such opportunity.

References

Ba, H., W. Martin, and O. Diaz. 2002. *The JASON Project's Multimedia Science Curriculum Impact on Student Learning: A Summary of the Year One Evaluation Report.* Needham Heights, Mass., and Washington, D.C.: JASON Foundation for Education and U.S. Department of Education.

Louv, R. 2005. *Last Child in the Woods: Saving Our Children from Nature-Deficit Disorder.* Chapel Hill, N.C.: Algonquin Books.

NPS [National Park Service]. 2006. *Public Use Statistics—2006 Regional Report.* Washington, D.C.: Public Use Statistics Office, National Park Service.

Pergams, O.R.W., and P.A. Zaradic. 2006. Is love of nature in the US becoming love of electronic media? 16-year downtrend in national park visits explained by watching movies, playing video games, Internet use, and oil prices. *Journal of Environmental Management* 80, 387–393.

Vaske, J.J., and K.C. Kobrin. 2001. Place attachment and environmentally responsible behavior. *The Journal of Environmental Education* 32:4, 16–21.