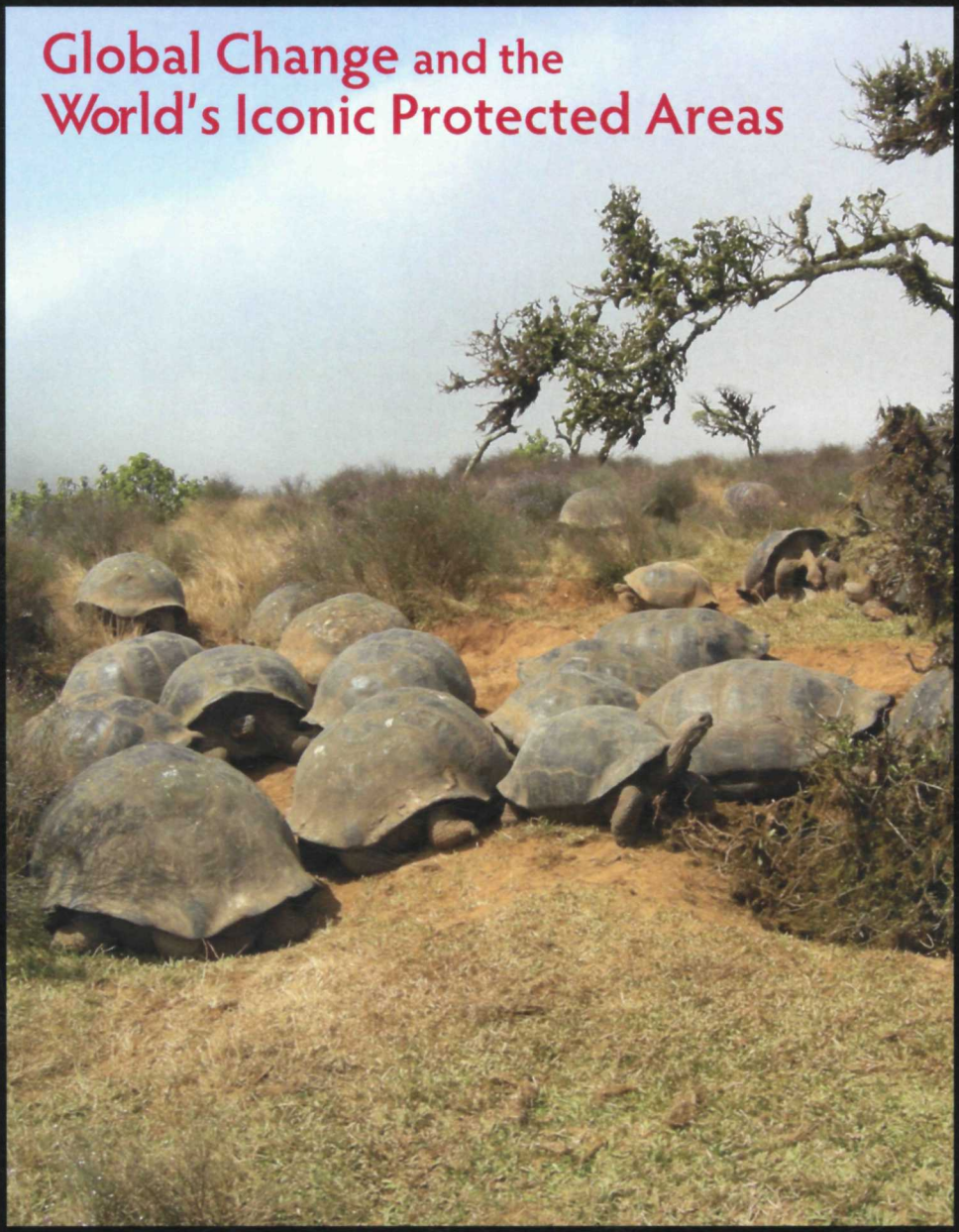
Global Change and the World's Iconic Protected Areas



The George Wright Forum

The GWS Journal of Parks, Protected Areas & Cultural Sites
volume 31 number 3 • 2014

Mission

The George Wright Society promotes protected area stewardship by bringing practitioners together to share their expertise.

Our Goal

The Society strives to be the premier organization connecting people, places, knowledge, and ideas to foster excellence in natural and cultural resource management, research, protection, and interpretation in parks and equivalent reserves.

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On the cover: Tortoises on Alcedo Volcano, Isabela Island, Galapagos National Park, Ecuador, one of the internationally recognized "iconic parks" that a group of scholars is studying as bellwethers of global change. See the set of articles guest-edited by Eagles and Taylor in this issue. Photograph courtesy of Stephen Walsh.

SOCIETY NEWS, NOTES & MAIL

Registration now open for GWS2015

Preparations are in high gear for "Engagement, Education, and Expectations: The Future of Parks and Protected Areas," the 2015 George Wright Society Conference on Parks, Protected Areas, and Cultural Sites. We'll be meeting March 29–April 3, gathering in the Bay Area for the first time. The conference venue is the Oakland Marriott City Center. The initial program features two plenary sessions, seven focus sessions, over 100 concurrent sessions, and a four-day poster/exhibit session with over 150 presentations. Because of tight US federal travel budgets, once final travel approvals come through we expect the final numbers to be somewhat lower than this, but we are on target for another vibrant week of interchange. And we have some special events in the works that will make the GWS conference experience even more valuable. Don't miss out—plan to join us in Oakland! You can sign up today by going to

http://www.georgewright.org/gws2015

and selecting the "Register" link. Complete details are on the website. See you in the East Bay!

Gagnon reappointed to Board, assumes presidency

At the annual in-person meeting of the GWS Board in early November, Nathalie Gagnon, senior analyst with the Aboriginal Affairs Secretariat of Parks Canada, was reappointed to a three-year term. Nathalie was then elected president of the Board, and so will preside over the conference in Oakland. She is the first Canadian, and the first Indigenous person, to lead the Society. The other officers for 2015 are Jerry Mitchell, vice president; Ryan Sharp, treasurer; and Dave Parsons, secretary. As noted in an earlier email to members, on January 1 David Graber will begin a three-year term, and Lynn Wilson will start serving a second three-year term, as a result of this year's Board election process.

GWS signs MOU with Clemson; first Student Chapter launched; Harmon honored

In September, GWS Executive Director Dave Harmon traveled to Clemson University to sign a memorandum of understanding with the university's Institute for Parks, one of the USA's leading academic institutions in the world of protected area education, management, and development. This is a major agreement that pledges GWS and Clemson to work together in six areas:

- Development of Clemson's Open Parks Network (https://www.openparksnetwork.org/) as an information and knowledge platform to facilitate better communication between GWS, among its members, and with the general public.
- Collaborative education and training development for conservation professionals.
- Collaborative research projects, workshops, or conferences.
- Mapping and analytical services.

- Development of the Biosphere Associates chapter of GWS and the "BRInfo" biosphere reserve information portal on the GWS website.
- Digital archiving of materials related to the Man and the Biosphere (MAB) program, and to biosphere reserves in general.
- Development of a Clemson Student Chapter of GWS.

The first steps toward the last point were made during Dave's visit when the members of an existing campus parks club decided to convert their activities into being a GWS Student Chapter. We are in the process of developing a blueprint set of bylaws for Clemson to use, and which can be used for other campus chapters. Finally, while in Clemson Dave was honored with the Walter T. Cox Award for Public Service, which he accepted on behalf of the entire GWS team. The Cox Award is part of a series administered by the Clemson University Institute of Parks honoring the renowned National Park Service director, George P. Hartzog, Jr.

Latourelle heads up roster of 2015 GWS Awards winners

Alan Latourelle, chief executive officer of Parks Canada, will receive the Society's highest honor, the George Melendez Wright Award for Excellence, at the conference in Oakland. Latourelle has led Parks Canada Agency since 2002 and is being cited for his key role in increasing the size and coverage of the Canadian national protected area system, and for retooling the agency so it is more collaborative and inclusive. The other winners are:

- GWS Social Science Achievement Award: James Gramann, for his work developing the social science program of the National Park Service;
- GWS Cultural Resource Achievement Award: Mark Michel, for his leadership of The Archaeological Conservancy;
- GWS Natural Resource Achievement Award: Karen Treviño, for her work building the National Park Service Natural Sound and Night Sky Division; and
- GWS Communication Award: Kurt Repanshek, for original news reporting on his influential website "National Parks Traveler."

The awards will be presented at a gala reception the evening of Thursday, April 2, at the conference hotel, the Oakland Marriott.

Making the Transition to the Third Era of Natural Resources Management

Nathan L. Stephenson

We are entering the third era of National Park Service (NPS) natural resources management—an era defined by rapid and unprecedented global changes. This third era promises to overturn not only some of our most fundamental assumptions about parks and protected areas, but also many of the ideals we currently hold dear. A common initial reaction to the diverse challenges of this transition is to feel overwhelmed and adrift; I have certainly had such feelings myself. But these feelings carry the risk of reducing our effectiveness as resource stewards right when we can least afford to be less effective: during a transition that is demanding us to be particularly clear-headed and far-seeing.

Here I briefly examine some of the challenges of this new era, focusing on those that can most often elicit feelings of discouragement. When we examine the challenges individually, they begin to lose some of their ability to cast gloom—especially when we consider them in the light of lessons from an earlier fundamental transition in NPS natural resources management, beginning a half-century ago.

My perspective is shaped by my 35 years as a place-based scientist stationed in a large national park (Sequoia and Kings Canyon), and by my passion for national parks in general. While the discussion that follows is most relevant to large national parks set aside primarily for their natural features, several of the ideas are also relevant to other park units.

The three eras

By defining three eras of NPS natural resources management, I greatly simplify a rich and nuanced history.[1] But by defining these eras I can highlight what I consider to be the two most profound shifts in thought and action in the history of natural resources management in NPS. Lessons from the transition from the first to the second era can help us navigate our current transition from the second to the third era.

The first era—beginning with the birth of NPS in 1916—can be thought of as the era of spectacles.[2] To survive and thrive, the young National Park Service attracted public support by encouraging recreational tourism, which often focused on scenery and a handful of char-

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ismatic natural resource spectacles, including staged spectacles such as bison stampedes in Yellowstone, firefalls in Yosemite, and public bear-feeding in several national parks.[3] But an emphasis on staged natural resource spectacles was already in decline by the transition to the second era of natural resources management—the Leopold era.

The Leopold era—referring to the influential 1963 report *Wildlife Management in the National Parks*, also known as the "Leopold report"[4]—saw a gradual shift away from an emphasis on recreation, spectacles, and a corresponding handful of charismatic plant and animal species, and toward ecological management of entire ecosystems. To understand the dramatic nature of this shift, one needs only to consider the example of fire management. Fire management went from a policy of aggressive suppression of all fires—in part meant to preserve perceived scenic values—to prescribed fires and managed wildfires, meant to restore and maintain naturally functioning ecosystems.

In addition to its emphasis on whole ecosystems and natural processes, management during the Leopold era usually had its gaze fixed firmly on the past, as reflected in the Leopold report's recommendation that a national park should represent "a vignette of primitive America."[5] Of course, management targets continued to shift during the Leopold era, such as from static snapshots of the past to motion pictures of the past (the latter being defined by historical range of variability). But planning and implementation were virtually always underlain by the implicit or explicit assumption that national parks in the future would look something like they did in the past.

Our nascent transition into the third era of natural resources management is being driven by the recognition that rapid, unprecedented global changes—particularly climatic changes—preclude key aspects of the Leopold vision, most notably the maintenance of natural resources in conditions that resemble those of the past. I will not repeat the arguments outlining the need for NPS to make this transition, which can be found elsewhere.[6] But of particular note is Colwell et al.'s 2012 report, *Revisiting Leopold*. While only hindsight will tell us which ideas and ideals will ultimately define the third era of NPS natural resources management, the ideas and ideals expressed in *Revisiting Leopold* will almost certainly be among them. They mark the start of our transition from managing for vignettes of primitive America to managing for ecological integrity.

Letting go of Leopold

As we leave the Leopold era, we will likely retain some of its ideals while discarding others. For example, we will surely retain an emphasis on management based on ecological principles, and retain a whole-ecosystem perspective. However, of necessity, we must let go of the ideal of consistently recreating or maintaining a semblance of primitive America "in the condition that prevailed when the area was first visited by the white man."[7]

This letting go of the past, and the ideals it symbolizes, can cause particular distress—distress that should not be underestimated. As has been well articulated by Richard Hobbs,[8] as natural resource managers let go, many of them will need to go through a significant period of grieving. While each person's struggle is likely to be different, here I briefly outline my own experience. Early in my career the Leopold era was hitting its stride, and I passionately

embraced its ideals. My research focused mainly on stressors that could disrupt the Leopold ideal—particularly altered fire regimes and rapid climatic changes. But in spite of the mounting evidence at my fingertips, for the first decade and a half of my career I remained firm in my belief that we could restore and maintain ecosystems so that they would continue to fall within their historical range of variability. The effect of climatic change in particular—even though it was one of my study topics—seemed like a rather distant abstraction.

But rather abruptly, like flipping a light switch, the mounting evidence broke through my idealistic barriers. I can say without exaggeration that I was thrown into a multi-year period of moderate despair—even depression—about the viability of the NPS mission, at least as I knew it. The despair I felt at letting go of ideals I held so dear was compounded by my feeling of being adrift: I had lost the safe harbor of management targets that fell within the historical range of variability, and no other mooring was in sight.

Recovery from this despair was gradual, with no flipping of light switches. Rather than abrupt epiphanies, I started to slowly piece together some possible new visions of the future of natural resources management in national parks. I eventually came to accept the loss of some of the ideals of the Leopold era, and began replacing them with new ideals that were better aligned to an era of rapid global changes.

Similar personal struggles likely occurred a half century ago, during the transition from the era of spectacles to the Leopold era. There was often substantial resistance within the NPS to such changes as the reintroduction of fire and the cessation of pesticide use to control forest insects.[9] It is not far-fetched to imagine that at least some of the resistance was accompanied by an initial sense of despair at letting go of some of the ideals of the era of spectacles.[10] Perhaps we can take comfort in knowing that we are not the first generation of natural resource managers to undergo a difficult transition.

Finding a new mooring

Letting go of the Leopold era can be particularly difficult when it appears we will be cast adrift, having no clear ideological bearing. Indeed, just as during the transition from the era of spectacles to the Leopold era, there is little doubt that it will take us years—even decades—to fill in the details within the broad outlines of a post-Leopold vision of NPS natural resources management. But the broad outlines of such a vision are already emerging.

Instead of looking to the past for our management targets, *Revisiting Leopold* suggests we manage for ecological integrity.[11] (It is worth noting that Parks Canada has been managing for ecological integrity for many years, and much can be learned from their experience.) Certainly, the term "ecological integrity" is less evocative and poetic than "vignettes of primitive America," but it does serve as a useful shorthand for more tangible concepts. Based on my own experience and my reading of *Revisiting Leopold* I offer the following thoughts about what does and does not fall within a practical concept of ecological integrity.

Ecological integrity does not demand that species be found in the same locations, or in the same abundances, as they were in the past. In the face of rapid global changes, species will move. Some will increase in abundance, and some will decline in abundance. Additionally, ecological integrity does not demand that "natural" communities (combinations of species)

be maintained. One of the great lessons of ecology is that most species behave individualistically, responding to environmental changes by leaving some of their neighboring species behind and then reassembling in new combinations.

But ecological integrity does include, to the extent possible, maintenance of regional native biodiversity. Even though native species may not occur at the same locations or in the same abundances as they did in the past, they are still present within the broader region. Some species may migrate northward out of a park and onto adjacent lands, while others migrate into the park from the south (perhaps even by assisted migration). The net result is that the broader region in which the park is embedded maintains most of its native biodiversity. As parts of broader landscapes, parks will continue to play a critical role in maintaining native biodiversity.

Ecological integrity also includes maintenance of key ecosystem functions. For example, some of the key functions of forests are hydrologic regulation, carbon storage, and providing food and shelter for myriad forest-dependent species. While forests of the future may not occur in precisely the same locations they do today, if ecological integrity is to be maintained forests must still occur somewhere on the regional landscape, providing their key ecosystem functions.

Acting in spite of uncertainty

A hallmark of the new era of natural resources management is that, even though we know that unprecedented changes are in store, their exact nature is uncertain. For example, roughly half of the climate projections for my home park in California's Sierra Nevada predict a warmer, wetter future, while the other half predict a warmer, drier future. And even though all models predict a warmer future, the pace of the predicted warming differs among models by a factor of three.

For those of us accustomed to managing for a relatively specific desired future condition—usually based on historical range of variability—the level of uncertainty we now face can feel disabling, even paralyzing. But it is useful to remember that we all have a good deal of experience planning and taking action in the face of uncertainty—namely, in our personal lives. We monitor our health for unexpected changes with regular physical examinations, we buy insurance against unexpected events, we hedge our retirement investments across a broad array of stocks and bonds, and so on. Similar principles can be used in natural resources management. In particular, well-developed tools (such as scenario planning[12]) are available for planning in the face of uncertainty, and already have a long history of being used effectively by large corporations, the Department of Defense, and others. In no way does uncertainty preclude our ability to plan and act; it just changes how we do it.[13]

Deciding to intervene

The Leopold era has been characterized by a tendency to rely, when possible, on natural processes to shape ecosystems. Accordingly, among NPS natural resource managers there is now often a strong, and appropriate, reluctance to intervene in ecosystems. But if, as suggested by *Revisiting Leopold*, ecological integrity is to become our new mooring in the era of rapid

global changes, we can expect increasing impetus to intervene. The thought that human intervention in parks will only increase is quite discomfiting for many people.

I usually hear three classes of argument against intervention: legal, ethical, and unintended consequences. Among legal constraints on intervention, the Wilderness Act is known for setting an especially high bar, making it a particularly good example to consider. But the Wilderness Act certainly allows for intervention, and we have several examples of successful intervention in wilderness by natural resource managers, ranging from mechanical forest thinning to additions of limestone sand to counteract acidic deposition.[14] Additionally, a recent legal review of climate change adaptation in the context of the Wilderness Act concluded that while the act "place[s] a thumb on the scale in favor of restraint," natural resource managers can be confident that "the vast majority of management options are available … for climate change adaptation" in legally designated wilderness.[15] Existing law does not preclude our ability to intervene.

It is not my role or desire to debate ethical arguments against intervention—such arguments reflect values, which are personal. But at the foundation of many ethical arguments I have heard is the fear that all natural areas will become managed gardens, with the utter loss of wild, self-willed nature. But such a future is profoundly unlikely. First, as a part of hedging bets in the face of an uncertain future, we are likely to explicitly designate some non-intervention areas. Second, at least in larger national parks, limited management capacity will mean that intervention only occurs on relatively small, strategically chosen parts of the landscape. Thus, by default, all areas within park boundaries will be subjected to unintended human intervention in the form of boundary-transcending global changes, while some limited areas will additionally experience intentional human intervention aimed at maintaining ecological integrity in the face of those global changes.

The final class of argument against intervention can be called the unintended consequences argument: humans should not intervene for the simple reason that intervention too often makes things worse. In its extreme form, I simply do not buy this argument. Certainly, interventions aimed at restoring or maintaining natural ecosystems have sometimes gone bad, becoming the stuff of headlines. But for each of those headlines I suspect there are dozens, if not hundreds, of success stories. In my home park alone, we have recently restored a large wet meadow that had been damaged by decades of culvert-induced downcutting; removed nearly 300 buildings from a giant sequoia grove and revegetated the scars; restored habitat for two endangered frog species, watching as the frogs recolonized those areas; controlled populations of several noxious, non-native invasive species; and continued our managed reintroduction of fire as a keystone process. It is always possible that, for reasons we currently cannot imagine, natural resource managers of the future might look back at one or more of these actions with regret. But I suspect it is more likely that they will be grateful—or, at worst, indifferent—that we took the actions.

To be clear, the very real risk of unintended consequences means that intervention should never be taken lightly. Additionally, as we enter the third era we are likely to consider unfamiliar forms of intervention—like assisted species migration—that could carry novel risks. Intervention remains a last resort that should be approached with great caution and

forethought. But good reasons to intervene seem sure to increase in the current era of rapid and unprecedented global changes.

Starting small ... but starting

A common feeling I have heard expressed during climate change education and planning workshops is that the sheer scale of the challenge before us is overwhelming. When virtually all park ecosystems, spanning vast landscapes and seascapes, stand to change in complex ways that we cannot fully understand or predict, how can we possibly manage? Taking a lesson from the dawn of the Leopold era, I suggest that we do not need to begin with entire landscapes. Rather, we can start small—in time, space, and topic area—and learn as we go.

In the 1960s, Sequoia and Kings Canyon national parks conducted some small, experimental prescribed burns, and funded parallel studies on the burns' ecological effects. Old photos show fire engines, hoses, and a number of firefighters surrounding a smoldering area measuring just a few hundred feet on a side. But the operational and ecological lessons from this small start were immediate. Park staff learned that they could overcome logistical hurdles and conduct safe controlled burns, and could also navigate any policy issues associated with the burns. Howard Shellhammer (one of the fire ecologists, then of San Jose State University) has told me of a particularly important ecological epiphany. When the researchers returned to the sites of the first experimental burns, they were greeted with carpets of giant sequoia seedlings—in an abundance they had never seen before, anywhere. The tight link between fire and profuse giant sequoia regeneration was made immediately clear. Small-scale experiments can make the abstract real, quickly propelling us to greater understanding.

Just as small experiments helped usher in the Leopold era, they can help us make the transition to the post-Leopold era. For example, we could potentially learn much from small, carefully conceived assisted migration experiments. Assisted migration experiments could initially be limited to those that could easily be undone, such as with tree seedlings (if needed, the trees could be removed well before they reach reproductive age). Any assisted migration experiment would be at least as much a social science experiment as an ecological experiment. How do NPS employees react to such proposals at the park, regional, and national levels? Are there policy roadblocks? How do the press and public react? At worst, planning for such experiments would help make the abstract real, and thus could open critical discussions within and between NPS and the public. Even if the main lesson is that large parts of the public are not comfortable with assisted migrations in national parks, this is valuable information.

Another critical lesson of the Leopold era is that to do good things, we do not need to do all things. For example, constraints imposed by air quality regulations, weather, safety, staffing, and funds have meant that Sequoia and Kings Canyon national parks have never met their original goal of restoring historical fire regimes across a large majority of the park landscape. Yet few would disagree that ecological conditions are better today as a result of the fire management program, with its careful, strategic choices about when and where to apply fire.

Science is necessary, but not sufficient

As we make the transition into the third era of natural resources management, it seems espe-

cially important to maintain a sharp distinction between the differing (but complementary) roles of science and values. At its best, science can inform decision-making. For example, it is science that is telling us that some of the key ideals of the Leopold era will be impossible to achieve in the future. Science is thus helping drive us into the third era of NPS natural resources management, and will become ever more important as we navigate that era. But even though science can suggest what is possible and what is impossible for natural resources managers to achieve, it simply cannot tell us what we want—that is, it cannot determine our values.

Even as we use science to help us manage for ecological integrity, key decisions will need to be guided by values. For example, as we abandon the ideal of maintaining entire park landscapes as vignettes of primitive America, should we still try to maintain a few small areas in something resembling their original condition—effectively as small ecosystem museums?[16] If so, which areas? How much effort, if any, should we devote to maintaining scenery, and where? With a limited capacity to intervene, how do we decide where to intervene? Where should we not intervene?

To understand the possible future interplay of science and values, we again might take some lessons from the reintroduction of fire early in the Leopold era. Like *Revisiting Leopold*, the original Leopold report painted a rather broad vision of NPS goals, without filling in details. Some "early adopter" parks began to use prescribed fire, and were almost immediately confronted with specific values-related questions: Given limited capacity, where should we burn? Should certain high-visitation areas remain unburned? How much value should be placed on maintaining green scenery in certain places, versus reintroducing a keystone process in those same places? The lessons learned and ideas generated by the early-adopter parks helped shape NPS fire policy at the national level, which in turn then fed back to those same parks, and also to those parks that were just beginning their own prescribed fire programs. The latter parks then generated their own lessons and ideas, and so on. The continuous feedback cycle among learning, ideas, and policy was more evolutionary than revolutionary.

A similar evolutionary process, perhaps kick-started by some early-adopter parks, may play out as we enter the third era of NPS natural resources management. The process may seem messy and less satisfying than having precise, detailed guidance from the start. But the fact remains that we do not have detailed guidance, and must create it ourselves as we go. To start answering our questions about the interplay of science and values, we will likely need to start small, and to get started sooner rather than later.

Getting past the tyranny of the urgent

Time—or, rather, the lack thereof—has the potential to be one of the biggest impediments and sources of frustration during our transition to the third era. Most of us now spend a greater proportion of our time than ever responding to "the tyranny of the urgent"—issues that demand our immediate attention—at the expense of devoting time to shaping a new long view.

A successful and timely transition to the third era will almost certainly require a critical mass of people—spanning all NPS organizational levels and regions, and likely assisted by

forward thinkers outside of the agency—regularly devoting quality time to deep thought, discussion, planning, and experimentation. I know of no way to accomplish this except through deliberate reprioritization, in which planning for the third era rises on our lists, displacing some tasks that may be urgent but less important to the long-term viability of national parks. I am encouraged that a few parks have formed lunchtime discussion groups devoted to climate change or other critical management issues. Actions like these leave me optimistic that we will rise to the challenge.

Conclusion

It is normal to feel overwhelmed, at least initially, at the prospect of managing national parks and their natural resources in an era of rapid and unprecedented global changes. At a personal level, many of us need to grieve the passing of the Leopold era and the loss of some of its ideals, and then become secure in knowing that the broad outlines of a new vision are beginning to emerge. Indeed, each of us can contribute to the evolution of this new vision. We do not need to figure everything out at once; we can start with small experimental steps, learning as we go.

Acknowledgments

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Nathan L. Stephenson is a research ecologist with the US Geological Survey's Western Ecological Research Center, stationed since 1979 in Sequoia and Kings Canyon national parks. He is particularly interested in the effects of rapid climatic changes on forests, and how protected area stewards can adapt to an uncertain, but certainly unprecedented, future. Stephenson is steward of a long-term forest plot network that, over the last 33 years, has annually followed the fates of some 28,000 trees in Sequoia and Yosemite national parks. In 2011, he was awarded the NPS Director's Natural Resource Award for Natural Resource Research.

Letter from Woodstock

Rolf Diamant

When Will We Really Have a System of National Parks?

I would like to use this ninth Letter from Woodstock to examine the tangible and intangible attributes and benefits of a national park system and how well are they understood, valued, and used to full advantage. I am going to talk about the US national park system, which I am most familiar with, though many of my observations may be applicable to protected area systems in other countries.

The US system is a highly complex and increasingly diverse assemblage of 401 national parks and 49 national heritage areas. The National Park Service (NPS) is also legislatively directed to oversee, as an important part of the system's portfolio, a number of national conservation and preservation assistance programs functioning outside the boundaries of national parks that work with cities and communities throughout the country (including the National Historic Landmarks (NHL) Program, which I will say more about in a moment). There are many tangible benefits that the system provides, from hiking trails to historic preservation tax credits. However, the system offers many intangible benefits as well that embrace, according to former NPS Chief Historian Dwight Pitcaithley, "the very democratic values upon which this country was built, environmental lessons with the potential to make our communities more livable, civic messages that will move us toward 'that more perfect Union' imagined over two hundred years ago."

I have experienced those intangible dimensions of the system on many occasions but perhaps none as memorable as the time I was asked to present a national historic landmark plaque to the Old Labor Hall in Barre, Vermont. Stone carvers and quarrymen who had emigrated from northern Italy to Vermont built the Old Labor Hall in 1900, and used the building in the early years of the 20th century as they organized for hard-fought social and labor reforms. Rescued from demolition in the 1990s by the Barre Historical Society, the two-story brick structure was rehabilitated by descendants of these Barre granite workers for use as a community center. The hall was designated a national historic landmark in 2000.

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No one from the NPS landmarks program office in either Washington or Philadelphia was able to attend the NHL dedication ceremony in Barre, and, as I had recently been appointed superintendent of Marsh–Billings–Rockefeller National Historical Park in Woodstock, Vermont, I volunteered to represent NPS and present the plaque. On that clear, crisp November morning, wearing my formal uniform, I arrived at the Old Labor Hall, the heavy bronze landmark plaque carefully tucked under my arm. Making my way through an overflow crowd I took my place on stage. First the governor and then each member of the congressional delegation addressed the audience to polite applause. When it was my turn at the podium. I made a few brief remarks about the national significance of landmark designation, and then lifting up the plaque so that everyone in the room could see it, I said, "Now for the best part! On behalf of the secretary of the interior and the National Park Service, it is with great pleasure"—and that was I as far as I got. The hall erupted into a wild cacophony of foot stomping, whistling, and cheering.

It was a rare moment when a public event becomes an expression of *both* local and national pride, so that people who may be infrequent users of national parks or perhaps may never step foot in a national park, on that day, made a meaningful connection with their national park system.

I think it may be useful to picture the national park system as a geologic formation, with each park and program (such as national historic landmarks) adding additional strata or layers of meaning and purpose that are further compressed and metamorphosed into a composite that is both stronger and far more interesting than any individual layer. Recreational experiences are often mixed with a pursuit of spiritual and physical health; stories of perseverance and struggle are blended with the exploration of cultural and heritage identity; lessons of resilience and sustainability are combined with the practice of civic engagement and environmental stewardship. The national park system is about people perceiving unexpected connections and relationships and being able to see the world around them differently. "How does Yosemite relate to Charles Young Buffalo Soldiers National Monument?" asks my friend John Reynolds, reviewing an early draft of this essay. "How does Yellowstone relate to Hawaii Volcanoes? How do Andersonville and Manzanar relate?"

John also reminded me of the introductory language in the Act to Improve the Administration of the National Park System, otherwise known as the General Authorities Act of 1970. On this occasion Congress, taking advantage of the hindsight and experience gained from nearly a century of national park making, thoughtfully reflected on the totality of their grand achievement and clearly articulated the linked, interdependent benefits derived from a system:

> ... these areas, though distinct in character, are united through their interrelated purposes and resources into one national park system as cumulative expressions of a single national heritage; that, individually and collectively, these areas derive increased national dignity and recognition of their superb environmental quality through their inclusion jointly with each other in one national park system preserved and managed for the benefit and inspiration of all the people of the United States....

I have also come to prefer the term *park system users* rather than *park visitors.* The term *user* suggests a more inclusive definition of the many ways people today engage with the their park system—in the national parks themselves but also in schools and communities, on vacations and weekend excursions but also on a regular or even daily basis, and as tourists and recreationists but also as volunteers and committed stewards. To underscore and popularize the complexity and richness of the system, I am joining Bob Manning, Nora Mitchell, and Dave Harmon (as co-editors) and nearly 20 contributing authors—all with important experiences and perspectives on the national park system—to produce a book, tentatively titled *A Thinking Person's Guide to the National Park System.* The book, scheduled for publication in early 2016, is designed to be a very different type of "guide," one that that will explore the themes and special places that best illustrate the extraordinary diversity of the national park system.

The book will hopefully serve as a counterpoint to a persistent tendency in the media to repeatedly publicize the same handful of large, high-profile parks—the so-called Crown Jewels—and largely pass over the system as a whole. I have come to expect this from the travel writers at *USA Today*, CNN, or Huffington Post, but nearly every mailing or communication I receive from organizations who should know better, such as the National Park Foundation (NPF) and National Parks Conservation Association (NPCA), also tend to highlight many of the same places again and again. I support and belong to both groups and they do important work I believe in, but they continually disappoint me on this point. How many times have I flipped through one of their beautiful calendars searching in vain for a set of park images more reflective of the system as a whole? I understand NPF and NPCA are marketing park images that they assume their audience will readily recognize and respond to. But if the most influential and able park advocates do not present the system as it really is, will their constituencies and funders ever fully appreciate its breadth and potential? In their public television series on national parks, filmmakers and honorary park rangers Ken Burns and Dayton Duncan, by choosing to focus their camera on the (at the time) 58 officially designated "national parks," missed an opportunity to widen their lens and present a more up-to-date and inclusive view of the national park system and its increasingly diverse users. Ironically the filmmakers did present to NPS, for internal use, a handful of wonderfully thoughtful and evocative shorter films capturing many of the broader dimensions of the system.

This is not the first time this subject has been raised in the pages of *The George Wright Forum.* Dave Harmon's excellent 2012 NPS Centennial Essay, "Beyond the 59th Park: Reforming the Nomenclature of the US National Park System," appeals for a more cognitive presentation of the system to the public. Harmon describes a "bewildering variety" of some 40 different park designations. "It stokes the confusion, already widespread, over what the purpose of the national park system is," observes Harmon, "and how its nearly 400 [at the time of writing] components relate to one another." This artificial ecosystem subtly re-enforces a balkanization that detracts from one of the inherent strengths of a system: clear brand recognition.

One unintended consequence of repeatedly promoting the same parks can be seen during the government shutdown last year. Governors of Arizona, New York, South Dakota,

and Utah cherry-picked a handful of larger national parks for re-opening (with the acquiescence of the administration) while hundreds of other parks remained closed to the public. Grand Canyon re-opened, but Canyon de Chelly, Hubbell Trading Post, Organ Pipe, and Saguaro did not. Statue of Liberty re-opened, but Gateway, Home of FDR, Saratoga, and Women's Rights did not. Utah's five national parks, including Zion, re-opened, but Massachusetts's fifteen national parks did not. As long as the national park system as a whole remains largely invisible and unsupported in the public's mind, the system will be increasingly vulnerable to selective fragmentation with inevitable winners and losers, placing the overall unity and health the system at risk. In his Centennial essay, Harmon describes how, when he explains the mission of the George Wright Society and George Melendez Wright's many contributions to science in the national park system, "most people give me a very blank look. I am then compelled to add that 'The National Park Service is the federal government agency that is in charge of national parks, like Yellowstone.' This usually—but by no means always—produces a spark of recognition."

Years ago, on a mission abroad, I complimented a European park manager on his park's innovative youth programs and superb interpretive materials. Wistfully he replied, "Yes, thank you for the compliment, but what I wouldn't give to be part of a park system like that of the United States, with your wonderful design center at Harpers Ferry and your Denver Center for planning." At the time I thought to myself about how both of these centers were being downsized, and more and more of the work contracted out. But I also thought about how much we take for granted the extraordinary national park system we have in the US, however stressed or unappreciated it might be. Who would not be envious of a system with a strong peer support network, with access to multi-disciplinary specialists, and with shared standards, guidelines, and management policies? And who would not be especially envious if such a system of parks derived "increased national dignity and recognition of their superb environmental quality through their inclusion jointly with each other?"

I am pleased to report that the "Find Your Park" campaign, recently launched by NPS and NPF, seems to be taking an important step in the right direction. Described as the centerpiece of the 2016 Centennial, the campaign calls for "making all 401 national parks go-to destinations," and pledges that NPS and NPF will also "highlight the historic preservation and outdoor recreation work the National Park Service does with communities across the country and the value it brings to Americans every day."

Time will tell how effective the cumulative efforts of the National Park System Advisory Board, Second Century Commission, the Director's *Call to Action* and now the "Find Your Park" campaign will be in re-aligning the identity of the agency, in the eyes of employees, partners and the public, with a fresh and significantly more inclusive centennial perspective.

When will we really have a system of national parks? When we recognize it, promote it, and use it to its full potential.

Iconic Parks as Environmental Arks

Patricia A. Taylor

As the vast majority of natural and physical scientists interpret the evidence, global climate change is occurring at a pace now observable in decades rather than in centuries or millennia. On land and in the oceans, global climate change is likely to have profound consequences for all life. Simultaneously, global social change is affecting the geopolitical and socioeconomic conditions of human existence across the planet to challenge the way biophysical change and other areas of human interest are perceived and addressed.

Together, the environmental and social processes comprising global change are of particular importance to the world's most famous natural protected areas. Iconic national parks, preserves, and heritage areas in various countries draw tourists from around the world, capture the imaginations of vastly more non-visitors, and symbolize a society's commitment to maintaining reservoirs of species diversity, intact ecosystems, and congruent landscapes. As such, iconic protected areas provide a critical venue for international research and education on the environmental, social, and management responses to global change, and the complex feedback effects on the parks themselves. More than this, our iconic parks and protected areas become the environmental arks during a time of possible torrential climate change.

For example, the world's protected national parks and preserves face increasingly daunting challenges in their efforts to sustain viable populations of plants and animals, especially large, wide-ranging wildlife and marine life that are often keystones to ecosystem integrity. These identified and created refuges are fast becoming ecologically disconnected islands in a sea of human-altered landscapes. International boundaries and permeable entrance points (for humans as well as for animals and plants) suggest the vulnerability of protected areas. Area managers must inevitably include the problems and interests of local communities, visitors, and stakeholders to address the problems of permeable boundaries. Thus, complex interrelationships and feedback effects from human societies are necessary parts of the environment of protected areas to be analyzed and understood. By studying the effects of

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global climate and environmental changes on protected areas within their ecosystems, and by including the biosphere, geosphere, hydrosphere, atmosphere, and human social effects in such studies, we may begin to understand how management practices can advance goals of biodiversity, sustainability, and resilience of protected areas.

The collection of papers in this special issue reflects these concerns, examining how we think about and study our iconic parks. The researchers represented here were brought together through contacts initiated by Australia's University of the Sunshine Coast, and all are conducting research on national parks, especially iconic national parks. We have been guided by a set of understandings developed as we met over the past four years to discuss the research conducted in "our" parks. Specifically, we believe that the study of selected iconic protected areas will shed light on the social and environmental sources of vulnerability to global change for parks and other protected areas as well as for nature-based tourism.

To focus our studies we considered the concept and meaning of the iconic national park. As discussed by Carter, Walsh, Jacobson, and Miller in the first article in this issue, "Iconic status is attributed to a national park when it is associated with international recognition and concern for its protection and the sustainable utilization of its valued resources." As the park and its boundaries, as well as its iconic status, are human constructs, "the concept of iconic park is culturally determined and subject to challenge depending on perspectives." Iconicity therefore rests in the acknowledged value of the park and the significance attributed to these values. A number of important considerations emerge from a park having iconic status, they argue. Not least of these considerations is the presaging of possible changes facing all protected areas. That is, iconic national parks are probably useful early indicators of changes all protected areas may experience as a result of global change.

In the second article, Miller, Carter, Walsh, and Peake continue the discussion of iconic national parks by developing a framework identifying key components or elements that help to shape the influential human impacts on the parks, and that may also increase management complexity. An especially important component in the national park system is the human actors, such as park-dependent communities, native peoples' groups, local land owners, and tourist brokers. As the number and types of human actors increase, the social complexity of park management will also increase.

Four case studies follow, illustrating a number of the concerns of these two conceptual articles. Fidelman reviews the damage already done by climate change to the Great Barrier Reef. As the Great Barrier Reef produces more nutrient value (net primary production, NPP) than any other ecosystem, damage to the reef is of grave concern. Rising global temperatures may warm the surface layers of the reef's ocean waters, preventing nutrients from circulating. Over-fishing in a reef system may lead to a species' inability to recover and thus the reef system declines in NPP. Similarly, beach erosion and damage from ocean storms may increase with global climate change, affecting edge species between ocean and land. These changes will undoubtedly affect the reef-dependent communities and the activities on which those communities depend, especially tourism and fishing. The decrease in receipts from work in and around the Great Barrier Reef will constitute an economic loss to the region, just as federal help is arriving to assist the reef in its resilience to global drivers of change.

Quiroga notes that the Galapagos National Park and Marine Reserve (Ecuador) is emblematic of one of the most famous examples of scientific interest, Charles Darwin's theory of evolution. Located at the confluence of three main ocean currents, the Galapagos Islands have a climate that is different from what one might imagine based on its equatorial location. The prevailing currents include both warm and cold surface ocean waters, along with deep up-welling of cold water. Thus the climate in Galapagos contains colder than expected equatorial waters, nutrient rich environments that ultimately result in the unique ecology of the islands. Should ocean waters warm due to climate change, marine animals may adjust to warmer water by altering migration patterns. This will affect Galapagos penguins, sea lions, and other fish-dependent species, as well as sustainable fishing for ocean-dependent communities. If more marine species become "stock straddlers" (fish stocks that migrate through, or occur in, more than one exclusive economic zone), the ecosystem risks greater loss of biodiversity. To protect this ecology, in 1988 Ecuador increased its fishing limits from 15 miles to 40 miles off-shore. Yet tourism is growing so fast in the Galapagos, argues Quiroga, that there are serious effects on the sustainability of the biophysical environment. Some of these effects include: disturbing the animals, contaminating the waters, increasing human immigration, introducing non-native species, and destroying habitats to construct tourism infrastructure. As the tourism industry grows, many of the endemic and native species become more vulnerable to predation and competition as their original habitats are disturbed. The only way to assure local compliance with regulations to protect the Galapagos' ecosystem is to involve all manner of stakeholders, including large-scale and small-scale tourist operators. This inevitably increases the complexity of decision making processes that focus on the security and long term health of the marine reserve.

Similarly, Kruger National Park in South Africa is one of the world's largest intact ecosystems, with one of the highest levels of biodiversity, including every known major predator in Africa within its boundaries. But less rainfall and greater evaporation mean less water for the park flora and fauna as well as for the bordering communities on the park edge where approximately 2 million people live. Under these conditions, park animals leave park boundaries to eat crops, and local community members and others poach animals within the park. Thus the idea of conservation becomes the focus of hostility when there are not enough resources to improve the livelihoods of local populations. While conservation of resources is critical for the health of a protected area, Peake and Carter argue that environmental interpretation efforts may have even more profound long-term impacts. Environmental interpretation leads to an appreciation of the history of a park and its resources. Moreover, "interpretation aims to build long-term behavior change through creating attachments to intrinsic environmental values," while environmental education emphases conservation and a country's wealth. In the face of global climate change, an attachment to environmental values is critical to the long-term survival of park resources.

Climate change is also evident in Yellowstone National Park. Cheatgrass is forcing out native grasses, which have higher protein content and are more resistant to fire. Pikas are being forced to move to higher elevations in mountain terrain, and wolverines may find themselves isolated as snow corridors shrink. Additionally, the Greater Yellowstone ecosystem

is facing the loss of whitebark pines, which provide an important source of food for grizzly bears. A successful grizzly bear recovery program begun in 1993 means that there are more bears competing for forage. Fortunately, bears are omnivorous and eat a wide variety of foods. Yet the competition for food sources may drive the bears into more populated areas in search of food, creating more human–bear conflict and, with it, a serious risk to the bears' long-term survival. While park programs educating visitors have helped to alert visitors to the dangers of human–bear contact, Taylor, Gunther, and Grandjean show that a significant number of visitors still do not consistently endorse the regulations established by the park.

The final article in this special issue examines the importance of biocomplexity feedbacks in ecosystems, and proposes ways of modeling the feedbacks' effects. As argued by Walsh, Carter, Lieske, Quiroga, and Mena, the world's iconic parks and ecosystems represent a range of biomes; as well, they illustrate a range of significant global social and environmental issues that confront protected areas. Moreover, these parks represent significant economic investments by their countries' governments, and by the local communities which have come to depend upon tourism for much of their livelihood. A proposal to examine feedback effects between parks, natural resources, and tourists along with local communities is outlined, including a more explicit and systematic set of inclusion criteria for protected areas. The modeling begins with the ecosystem goods and services considered as the "prey," whereas tourism and the resident populations are predators. This perspective can help us to appreciate feedback effects, such as those illustrated with the example of the Galapagos.

Taken together, these papers suggest the dynamic nature of parks and protected areas. This dynamic status can be tapped to help assure the health of the parks. For example, iconic status rests in part on the extensiveness of the protected area. To protect ecosystems, iconic parks must necessarily protect the flow of flora and fauna across their boundaries. The more extensive the protected area (e.g., a national park,with surrounding national forests) the greater the buffer and therefore the greater the protection of the park's resources, as in the case of Yellowstone. Additionally, iconic parks, so as to remain intact, must be able to control the resources underneath their surface areas, to assure that their fauna, flora, geomorphic, and hydrological processes are preserved. Such is the case for the Great Barrier Reef, Yellowstone, and the Galapagos. Finally, iconic parks must have sufficient funding to carry out both conservation and protective service work to assure the park's health in the present and for the future. As managers in Kruger and the Galapagos address the concerns of human populations in and around their parks, having resources will be essential to assist and educate the local populations, to maintain secure boundaries, and to develop healthy populations of endemic park animals such as black rhinos or sea turtles. Each of these processes (maintaining extensive land or sea areas, controlling resources not only on but also under their surfaces, and securing funding) will help to ensure that these environmental arks will help our earth systems adjust to new global conditions.

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Global Change and Human Impact Challenges in Managing Iconic National Parks

R.W. (Bill) Carter, Stephen J. Walsh, Chris Jacobson, and Marc L. Miller

Biodiversity is under increasing pressure worldwide from increasing human population, global economic and social changes, and climate change. These pressures result from the interaction between the expanding influence of humanity and ecological processes that alter the delivery of ecosystem goods and services (Dudley and Stolton 2012). Most of the world's national parks conserve places of high biodiversity value, maintain genetic diversity, protect cultural identities, and attract visitors from around the world seeking to experience iconic species and landscapes. Concomitantly, they help safeguard against the more recently identified pressures to biodiversity. In this paper, we address some of the effects that climate change has on the human and natural components of iconic national park systems, and the effects that human interactions have on the natural component of national parks, particularly at the local level.

Climate change, changes in land use, and corresponding changes in land cover have been proposed as the three greatest threats to biodiversity in the present century (Mooney et al. 2009). Climate change affects a wide spectrum of organisms, including their morphology, physiology, phenology, life history, abundance, and distribution. Land use and land cover changes have been identified as important feedback mechanisms affecting global change and corresponding shifts in social and ecological behavior of people, communities, and systems (Sommer et al. 2010). The related processes also affect the sustainability of national parks, which are compounded by socioeconomic, environmental, and political drivers to produce landscape fragmentation, over-harvesting of resources, and related pressures. Negative human impacts are two-fold: (1) local communities, reliant on natural areas for food, medicine, employment and cultural reasons, are consuming and often degrading ecosystems as the human imprint expands and intensifies within and along the edges of parks; and (2) tourism is increasingly consumptive in its demands for enhanced access to protected areas and increasing services as part of "experiencing" iconic species and landscapes.

We regard iconic national parks as local examples of human–artifactual–natural systems that are influenced by external abiotic, biotic, and globalization processes (see Miller et al., this issue; Walsh et al., this issue). The challenge for management of iconic national parks is to address threats while still meeting the protection and visitor objectives inherent in the

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national park concept; that is, providing for recreation use and values appreciation while at the same time protecting and preserving valued resources. Our focus on threats ignores opportunities inherent in any change process, but it allows us to highlight that park management can no longer stop at park boundaries, and must appreciate and take into account the dynamics and implications of exogenous and endogenous change. Without this, achievement of preferred outcomes will remain, most likely, unrealized.

Iconic national parks as early indicators

Usually, "iconic status" is attributed to a national park when it is associated with international recognition and concern for its protection and the sustainable utilization of its valued resources (see also Miller et al., this issue). As a human construct, the concept of iconic park is culturally determined and subject to challenge depending on perspectives, along with any deductive (or inductive) rationale for approaches to protection and use. Iconicity is some function of the acknowledged values of the park, the significance attributed to these values, and their perceived or real vulnerability to change or loss (Figure 1). In addition, utilization and marketing contribute to iconic status to the extent that parks and/or their valued constituent parts become symbolic of a place or concept (Table 1). Any international listing process (e.g., World Heritage listing) tends to acknowledge values and resource significance, but iconicity includes the additional criteria of status of the resource and community opinion.

Four important implications flow from a national park having iconic status: (1) while acting largely within the geographical confines of the park, managers need to give greater attention to external (exogenous) forces for change in both ecological and social system components; (2) management comes under closer scrutiny by national and international stakeholders; (3) increased numbers of national and international tourists are attracted; and (4) some members of the regional and national community are attracted also by the potential for economic benefits. The consequences are compounding, interdependent, and currently difficult to manage due to the uncertainty of relationships.

While all parks are subject to pressures, because of the number of interested observers, iconic national parks represent cases where the effects of changes in pressures are first observed and concern emerges. Therefore, iconic national parks are probably useful early indicators of changes that all protected areas will experience as a result of global change. Improved understanding of relationships between external drivers of change in the park system

Figure 1. The vulnerable red-tailed tropic bird (*Phaethon rubricaudia*) first returned to nest on Lady Elliot Island in 1982–1983 to add to its iconic status as the island with the highest seabird diversity within the Great Barrier Reef Marine Park. Photo by William (Bill) Carter.

Table 1. Explanation of terms related to what makes a park iconic.
Values are intrinsic, objectively measurable, and explicitly related to conservation status. Metrics include rarity or uniqueness and species richness or biodiversity.
Significance is extrinsic, subjectively measurable, and socioeconomically and culturally determined, and linked to perceived local, regional, national, and international importance.
Vulnerability is related to perceived imminence of loss, degradation, and reduction of integrity, often through a loss of site resilience imposed by threats to conservation and social–ecological sustainability.
Utilization relates to economic importance and community dependence on a national park for local and regional livelihoods and economic sustainability.
Promotion or marketing influences the levels of awareness of communities, from local to international, of the valued feature(s).

and the effectiveness of adaptive management strategies should help to inform park management of actions that will address problems of external drivers.

Climate change and iconic national parks (global driver dynamics)

Natural component response. Using a variety of approaches, the possible (and observed) impacts of climate change have been estimated and reported in the scientific literature. For example, at a meta level, it is possible to predict major shifts in biome types by combining biogeographic models, such as the Holdridge's Life Zone Classification Model with General Circulation Models (GCMs) that project changes under a doubled $C0_2$ scenario (e.g., Velarde et al. 2005). Biogeochemistry models, such as Forest–BGC (Bio-Geochemical Cycle), simulate the cycling of nutrients between biotic and abiotic components of the ecosystem and are useful for assessing the impacts of change in temperature, precipitation, soil moisture, primary production, and other climatic factors that give clues to ecosystem productivity. Dynamic local/global vegetation models, such as BIOME4 (see Kaplan et al. 2003) or AVIM3 (Atmosphere–Vegetation Interaction Model), integrate biogeochemical processes with dynamic changes in vegetation composition and distribution. Comparing present trends in species and communities with paleological data also provides indications of how species will accommodate future climate change, and migration dynamics (e.g., Tiffney and Manchester 2001).

As a base for assessing the impacts of climate change, the Intergovernmental Panel on Climate Change (IPCC) special report on emissions scenarios (SRES) (IPCC 2000) contains projections of future greenhouse gas emissions that supersede the IS92 family of projections made by the IPCC in 1992. The starting point for each projection is a "storyline" describing the way world populations, economics, political structures, and lifestyles may evolve over the next few decades (Wu et al. 2007). The storylines are grouped into four scenario families that have led to the construction of six SRES marker scenarios (Arnell 2004). An assortment of climate models (see Arnell 2004) from different research groups using different methods and data are often used to characterize changes in 30-year mean climate relative to 1961–1990 with comparisons with the 2020s (2010–2039), 2050s (2040–2069), and 2080s (2070–2099). Model runs are compared with gridded baseline climatology, describing climate over the period 1961–1990 at a spatial resolution of 0.5x0.5 degrees.

Global warming has the potential to cause species extinctions in many of the world's ecosystems and hence the loss of biodiversity in iconic national parks and elsewhere (Schaefer et al. 2007). Although some plants and animals will be able to achieve the required migration, or possibly even thrive, many will not have the capacity to adapt, especially those with low dispersal capabilities (Nelson et al. 2009). Global warming is likely to have a "winnowing" effect on ecosystems, filtering out species that are not highly mobile and favoring less diverse ecosystems that are dominated by pioneer and invasive species. The effects will be influenced significantly by species geographic distributions and climatic tolerances. Species with relatively larger distributions and greater climatic tolerances are at less risk. Island ecoregions may be especially at risk because of small populations, limited opportunities for migration, and sea-level rise. Barriers to migration and habitat loss will exacerbate climate-induced species loss (Adger et al. 2003), as the variety within a species becomes limited through isolation. Human population growth, land use change, habitat distribution, and pollution stress will exacerbate climate impacts. Maximizing habitat diversity and increasing connectivity may assist maintenance of existing biodiversity; however, this is likely to require consideration of lands beyond park boundaries to prevent the loss of some species from a locale. Budgets directed to enhance connectivity may, however detract from species-specific conservation efforts if overall funding is limited (Kirkpatrick 2011). Apart from the implications for ecological processes, if the species being lost are iconic, then implications cascade through the human (e.g., tourism) part of the system as well.

Human component response. While some opportunities may emerge with global climate change, societal vulnerability may exacerbate ongoing social and economic challenges, particularly for social groups dependent on resources that are sensitive to changes in climate (Leemans and Eickhout 2004). Risks are apparent in agriculture, fisheries, and many other system components that support the livelihoods of rural populations near protected areas. Vulnerability is another socially constructed feature influenced by institutional and economic dynamics, and determined by exposure, physical setting, and sensitivity and by ability and opportunity of system elements to adapt to change. Determinants of social resilience include the social, human, organizational, financial, and infrastructural aspects of societies; the flexibility and innovation in the institutions of government and the private sector to grasp opportunities associated with climate change; and the underlying health status and well-being of individuals and groups faced with the impacts of climate change. Population migration may be a limited option in many parts of the world; hence, other means of supporting adaptive capacity and enhancing resilience are required. Where migration occurs without careful planning, impacts on natural areas are foreseeable (Muriuki et al. 2011) The management challenge is to ensure that the delivery of ecosystem services is maintained (or enhanced) or the real (or perceived) benefits from the parks' existence eclipse those that come from unsustainable exploitive use. Herein lies the rationale for a strong ecotourism emphasis in iconic park management.

The threat of local human influences on iconic national parks (human–natural dynamics)

Human demographics and edge effects. Edge effects associated with increased population

growth around the margins of parks are ongoing issues for park managers, especially where park size is insufficient to protect species with wide home ranges. A study of 306 protected areas in Africa and Latin America used spatially explicit data from 1960 to 2000 to calculate the average annual rates of population growth within a 10-km buffer of the protected areas. The study found that buffer areas experienced more rapid population growth compared with randomly selected rural areas (Wittemyer et al. 2008). Increased human population growth is linked to habitat loss and disturbance that further isolates protected areas from surrounding habitats (Luck 2007). Higher rates of deforestation have been found in buffers as people move closer to national parks seeking economic and resource extraction opportunities (Messina et al. 2006; Muriuki et al. 2011).

Protected areas are often perceived to be cornerstones of conservation. Brashares et al. (2001) examined extinction rates for large mammals in West African nature reserves experiencing human influence. Actual extinction rates were compared with those predicted by reserve size alone. They found a strong positive relationship between human population outside the parks and extinction rates, where the real extinction rates for carnivores were higher than those predicted by models that only factored in reserve size (and not human population). Reserve edges showed higher extinction rates than reserve interiors. This study demonstrates that the perception of protected areas as a cornerstone of modern conservation planning and strongholds of biodiversity may be misguided. To address threats to reserve margins such as those identified above, more planning and investment should be put into the expansion and management of reserves, particularly where deleterious human influences are known to severely affect wildlife populations around protected area edges.

Human demographics and internal effects. Seeking evidence on whether parks could meet the needs of biological preservation in the context of population growth and development, Bruner et al. (2001) administered a questionnaire on land use pressure, local conditions, and management activities in 93 recently established parks larger than 5,000 ha in 22 countries. Seventy per cent of parks surveyed had human populations within their boundaries. Among the problems identified, over 50% had residents contesting park ownership in some way, had funding levels lower than the amount recommended for effective management, and had park staff lacking sufficient training. Factors such as number of people living within the protected area, local support, management budget, and local involvement of communities in management were not found to be significant correlates of park management effectiveness. The level of deterrents to illegal activities, such as hunting or logging, however, were significantly correlated, implying that increased guard presence and regulation enforcement could contribute to the success of long-term biodiversity conservation.

The challenge of effective management. In a meta-analysis of management effectiveness evaluations, Leverington et al. (2010) analysed over 4,000 assessments from around the world to find that 40% of protected areas had serious deficiencies. They found correlations between overall average management effectiveness in achieving target goals and the endogenous factors of adequacy of infrastructure, equipment and facilities, natural and cultural resource management processes, effectiveness of governance, and communication programs. Positive outcomes for values of conservation were correlated with staff skills, achievement of

outputs, and adequacy of law enforcement. Community-related indicators (e.g., community and stakeholder involvement, communication and community benefit programs) were correlated with impacts on communities. The exogenous factor of the external civil and political environment (support or otherwise) also affected outcomes. While these relationships do not establish causation (Leverington et al. 2010), they indicate multiple and interdependent factors affecting park conservation performance.

Responding to the challenge of human populations. The evidence presented supports the view that biodiversity protection and resident populations within and around parks may be incompatible. Yet many parks, perceived to be pristine, are often the result of a long history of human occupation. For numerous parks in the "old world," an ongoing human presence is often encouraged to maintain the preferred cultural landscape. In contrast, many parks in the "new world" are managed on the false assumption that they have never been occupied by humans, and human occupation is discouraged. While national park managers may deter people from living within park boundaries, displaced communities often face increased poverty, through land use restrictions, wildlife conflict, cultural degradation, increased cost of living, and isolation from urban centers. However, national parks, and their boundary areas, also afford benefits for rural inhabitants through access to road networks, employment, foreign aid, ecosystem services, and areas of safety during strife (Scherl et al. 2004).

These are ideological and ethical issues that are rightly debated. Here, we are simply making the point that the trajectory of human population growth means park management will increasingly have to respond to the pressure in innovative ways. Fostering a stewardship ethic (see Myers et al. 2011) and co-management (see Ross et al. 2009) may represent useful strategies, but they will need to be supported by demonstrable evidence that protection brings tangible benefits to affected communities and biodiversity protection. The very reasons that make protected areas ecologically interesting also make them attractive to tourists, to migrants looking for work, and for population settlement at the edges. Wittemyer et al. (2008) argue that to really understand the processes involved, one needs local data and local models. We propose a network of iconic protected areas facing social and ecological threats to their sustainability that can provide comparative case studies of system change and the effectiveness of management action.

The preserve–use debate

Central to the issue of sustainable development in and near national parks is the debate about trade-offs between environmental and social–economic benefits. Despite a park not being a "park" without people, by definition, some preservationists, especially when referring to North America, Africa, and Australia, argue that to successfully protect parks, people should not be allowed to live and work within their borders (Terborgh 1999). This is a philosophical position, in part supported by the evidence of the direct effects of human population pressure on the character of protected areas (Parks and Harcourt 2002; Cardillo et al. 2004). Conversely, others see people as an integral part of park ecosystems and their maintenance (Peres and Zimmerman 2001), again driven by a philosophical position and the rationale

that many or indeed all protected areas, especially those in Europe, Asia, and South America, are the result of human occupation. In a world increasingly shifting to governance systems that adopt democratic and egalitarian ideals, pragmatism demands that park management must work with communities, both internal and external to the park. This requires greater understanding of the capacity of the human (including management), artifactual, and natural components of iconic park systems for adaptation and the overlap and interactions between these components of the overall park system.

For populations living and working in or around national parks, we suggest that the range of benefits and negative impacts depends on the internal dynamics of the population and their responses to exogenous shocks. These are mediated by access to land and other natural resources, accessibility to labor and agricultural markets, the nature of the enforcement of protected area requirements on adjacent land uses, and the resilience of social and ecological systems to human and natural threats to the integrity and vulnerability of protected areas. The connectivity of protected areas to internal and external communities, farms, roads, and amenity resource areas are vital elements of the complex interplay between people, environment, and protected places (Brandon 2002).

The challenge of poverty alleviation and economic development. Confounding the preserve–use debate is the dialogue between conservationists and social advocates regarding the role that national parks play in the welfare of local peoples who live in and near them. In the past several decades, the dual goal of conserving natural resources, while at the same time improving human well-being, has gained greater attention (West et al. 2006; Pretty et al. 2009). However, a survey of 37 projects that attempt the joint achievement of biodiversity conservation and poverty alleviation found little systematic evidence in favor of synergies between these goals (Agrawal and Redford 2009).

Conservationists argue that environmental regulations and protected areas are essential for ensuring both the sustainability of the planet's biological systems and the health and welfare of people (Angermeier 2000). In contrast, social advocates contest the establishment and management of protected areas because: (1) only initiatives related to poverty alleviation can lead to successful biodiversity conservation, since these address the root causes of environmental destruction (Duraiappah 1998); (2) protected areas take away the property and rights of local people (e.g., Ghimire and Pimbert 1997); and (3) the distribution of economic benefits from protected areas tends to be so highly inequitable that it neither compensates for lost property and rights nor contributes to poverty alleviation (McShane 2003). As such, there is a growing literature on the impact of parks on the displacement of local people and the role of protected areas in reducing poverty (e.g., Geisler 2003; Agrawal and Redford 2009; Brockington et al. 2006). Displacement includes more than the physical dispossession of people from their lands; it also includes loss of access or restrictions on livelihood opportunities or future income related to environmental resources (Agrawal and Redford 2009), and can exacerbate poverty and human rights issues (Ghimire and Pimbert 1997; Geisler and deSousa 2001; Pilgrim and Pretty 2010). Geisler (2003) estimated that 85–136 million people have been displaced because of conservation projects, which also partly explains why many such projects have not achieved their objectives.

Part of the problem is that there are still many protected areas yet to resolve the issue of human residents (Brockington et al. 2006). Between 50% and 100% of stricter protected areas in South America and Asia are used or occupied by people (Bruner et al. 2001; Kothari 2004) and much of this occupancy and use of resources is illegal, which means that as legislation and enforcement tightens, millions of environmental refugees could be created (Geisler and de Sousa 2001). Reports from India suggest that nearly 4 million people face eviction following amendments to protected area policy (Kothari 2004).

A study of 12 cases in the Congo Basin identified the impact of protected areas on poverty reduction and displacement of local people. The study concluded that local government eviction strategies have further impoverished and displaced 120,000–150,000 people (Cernea and Schmidt-Soltau 2006). They recommended that the government desist with evictions and adopt a "pro-poor strategy" based on the "dual sustainability concept" of protecting people's livelihoods and well-being, while at the same time conserving the local biodiversity (see Roe et al. 2003). Pro-poor strategies also embrace issues of empowerment, especially for women and youth, through increasing work and education opportunities.

While many studies on the impact of protected areas have analyzed the distribution of benefits to people, comparatively few have demonstrated the benefits of protected areas for nature and biodiversity (Magome and Fabricius 2004). Nevertheless, how differences in gender, class, ethnicity, and identity structure the distribution of costs and benefits remains to be clarified (Brockington et al. 2006). In addition, studies are needed that directly analyze the effect of protected areas on human welfare through longitudinal cross-sectoral analyses at both the household and village levels before and after the establishment of parks (Wilkie et al. 2005).

Tourism and iconic national parks

Although tourism and recreation can bring significant social, economic and political benefits to an area, and draw attention to ethical issues, the presence of visitors may adversely impact biodiversity, particularly if use is made of sensitive environments (Richardson and Loomis 2004) and result in diminished attractiveness of a place for tourism (Sieck et al. 2011). Climate change alone may increase the vulnerability of numerous environments, but this may be magnified if, for example, warmer and drier weather encourages more visitors, or makes them more likely to participate in ecologically damaging and consumptive activities (Nyaupane and Chhetri 2009). Climate change is unlikely to be a homogeneous force, and its consequences are likely to vary between locations depending on the magnitude and speed of change and the characteristics of existing biological and human systems. In some cases, the change may provide an advantage to tourism with benefits also accruing to visitors and communities. As the climate changes, we can expect considerable change in the Earth's ecosystems and their functioning, and hence their capacity, positively and negatively, to deliver ecosystem services to inhabitants (both human and non-human). These changes, expressed as drought and intense rainfall events, will also affect the experiences of tourists (Hannah 2008).

Perhaps balancing the costs of tourism through over-use of vulnerable and iconic resources is the benefit tourism brings in funding conservation and management action and

supporting local communities. The paradox of iconic national parks is that the special nature of these areas is what attracts tourists to experience and interact with such places, yet in doing so, tourism can further threaten iconic settings, shaping visitation patterns and resultant satisfaction levels. Lack of understanding of the dynamics of tourism's interaction with place, especially the ability to predict ecological, cultural, and social change with changing tourism type and intensity (Carter and Beeton 2008), limits management capacity to balance the dual goals of national parks.

Conclusion

Iconic national parks epitomize society's concern for natural heritage conservation globally and the concerns of management locally. They therefore provide an ideal focus for assessing the human and natural drivers of change, connectivity between local and global forces, and capacity-building for the management of natural and cultural heritage in the face of escalating global change. National parks are often seen as islands of naturalness in a sea of human activity: the foundation stones of conservation. Nevertheless, human activity is increasingly threatening the resilience of parks, especially in the context of global environmental change. Thus, national parks are not islands. They are interconnected, reciprocal, and reinforcing components within broader ecological systems influenced by socioeconomic and political systems. Despite legislative constraints, national park managers can no longer treat parks as property where management influence must stop at the boundaries, because management influences are transgressing the boundaries. It also seems unwise to ignore the opportunities that change brings. To realize the opportunities in positive ways requires greater understanding of the human–artifactual–natural system within and around national parks.

The problem for managers is that high levels of uncertainty remain about how the national park system interacts with broader socioecological systems, how global change will affect the dynamics of these systems, and how the effect of on- and off-park action will influence the products and outcomes of system interactions. Sustainable national park management is rapidly moving from predominantly ecological considerations to becoming strongly entrenched in sociopolitical and economic considerations. We posit that iconic park systems are sensitive to changes in these domains and under scrutiny by international audiences. They therefore can act as early warning systems of responses to global and local change, and foci for exploring the dynamics of human–artifactual–natural systems where biodiversity and heritage conservation and recreational /tourism use are dual objectives.

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A Conceptual Framework for Studying Global Change, Tourism, and the Sustainability of Iconic National Parks

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Conservation has a long history of protected area experimentation in Europe, Africa, the Americas, and Oceania. The theme that the biotic and abiotic environment has value for its naturalness and therefore ought to be spared urbanization, industrialization, and other measures of economic development has found expression in the creation of national parks, forest reserves, wilderness reserves, scenic reserves, national monuments, and heritage sites. While the basic idea of national parks has been around for centuries, the formative years of the modern national park movement span the 1850–1950 period (Sheail 2010: 2). The first national park, so-named and federally managed, traces to Progressive Era legislation and the creation of Yellowstone National Park in 1872 (Sheail 2010: 19–20; cf. Meringolo 2012: 37–42). Yellowstone illustrates a double commitment to the goals of protecting nature and fostering responsible human visitation.

The national park experience can be a sacred one for the preservation of the natural environment and the enhancement of human intellect and well-being. Yet it is increasingly evident that humanity and its diverse technologies have great influence, both positive and negative, on the natural environment and on multicultural society. Physical, chemical, and ecological processes, which are affected by human technologies, are potent drivers of change even in protected areas such as national parks. Since the publication of the Brundtland Report, sustainable development has gained international acceptance as an ideal that emphasizes the responsibility of people to act ethically (WCED 1987; Kates et al. 2005). Good governance has also emerged as an ideal the United Nations and the World Bank deem worthy of adopting, despite difficulties in its application (CEPA 2008; World Bank Group 2009). In the national park context, governance options in management models have been usefully examined by Eagles (2009).

This article presents a conceptual framework for examining how iconic national parks with human, natural, and artifactual components are influenced by the internal dynamics of tourism and the external influence of several categories of global processes. As will be seen in the other contributions to this special issue, applications of the conceptual framework take a

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variety of forms, depending on the focus of researchers and the selection of dependent and independent variables of interest. The parks discussed may be described as iconic for the way in which they have captured the imagination of national and international communities, and attracted visitors and scientists. Simply, we take *iconic national parks* to be those parks that have high rates of visitation, and features and amenities that are particularly valued as well as salient in the public and scientific imaginations.

Relatedly, environmental philosopher Eugene Hargrove (1989: 10–11) has commented that "national parks are appreciated and visited for their anthropocentric–intrinsic value…. [They] are valuable to humans for their (relatively) pristine or natural condition." And, environmental philosopher Robert Elliot makes a related point:

> [T]he property of being the result of natural processes is one of the bases of the value possessed by wild nature.... [T]he value of restored or, loosely speaking, faked nature is less than the value of original or authentic nature (1997: vii, xi).

Background

Protected areas. In 1962, the International Union for Conservation of Nature (IUCN) sponsored, with others, the First World Conference on National Parks in Seattle, Washington. In a letter to conference delegates, John F. Kennedy, president of the United States, proposed the value of national parks to people:

> ... national park and reserve programs throughout the world are important to the welfare of the people of every nation. *We must have places where we can find release from the tensions of increasingly industrialized civilization, where we can have personal contact with the natural environment which sustains us.*... It is the course of wisdom to set aside an ample portion of our natural resources as national parks and reserves, thus ensuring that future generations may know the majesty of the earth as we know it today (Adams 1962, emphasis added).

Today, the IUCN defines a protected area as "[a] clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values" (Dudley 2008: 8). National parks fall, with wilderness areas, nature reserves, sanctuaries, national monuments, World Heritage sites, and protected landscapes and seascapes and variants on these forms, along an IUCN continuum according to the level of human activity permitted (see Dudley 2008). At the low end of human-permitted activity on the continuum are "Strict Nature Reserves" (Category Ia) and "Wilderness Areas" (Category Ib), while at the high-end levels of human use are "Protected Area with Sustainable Use of Managed Resources" (Category VI) (see Dudley 2008). National parks (Category II) are positioned near the low end zone of the continuum. They are" large natural or near natural areas set aside to protect large-scale ecological processes, along with the complement of species and ecosystems characteristic of the area, which also provide a foundation for environmentally and culturally compatible spiritual, scientific, educational, recreational and visitor opportunities" (Dudley 2008: 16).

A protected area is often named to suggest that its management aligns with a particular IUCN category, but in practice it may actually be managed in a way more fitting to another category. For example, a national park, which might be expected to foster both protection and human access goals, may in fact be managed as a wilderness where access is a very low priority. Also, individual protected areas, which fall appropriately in the same IUCN category, can differ substantially in terms of their management. To illustrate, national parks can vary in size, environmental and cultural amenities, lead management authority (e.g., state, federal, provincial entity), research priority and effort, operational and enforcement emphasis, educational programs, and goal priorities.

National park goals. National parks are systems that link people and nature and contribute to human health and well-being (see Maller et al. 2008). Generally, national parks can be contrasted with national forests and national wildernesses by the quantity and kinds of human access encouraged or discouraged. US parks, forests, and wildernesses are managed with blends of three kinds of conservation: *extractive conservation*, *biotelic* (*bio* = life, *télos* = purpose [Greek]) *conservation*, and *aesthetic conservation* (see Miller 2008b). US national forests are managed primarily for sustainable yield, along with recreational use. The *extractive conservation* goal permits timber to be generated for the marketplace on a sustainable basis. Recreational activities in national forests may include hiking, skiing, boating, and fishing, among others, but these generally occur alongside the extractive operations. National wildernesses are managed for *biotelic conservation* so that human presence is minimized and (relatively) pristine nature is preserved. When national parks are managed for *aesthetic conservation*, nature is preserved to a degree, but human access and enjoyment are priorities.

National parks, then, are not parks unless they are visited (see Beltrán 2000; Eagles and McCool 2002; Taylor et al. 2011). While nature preservation is a key goal, it does not trump providing recreational and transcendental opportunities to people. Certainly, one very positive target outcome of park visitation is for people to adopt an environmental ethic that changes their conduct regarding environmental practices. Correlatively, people visiting the parks helps to generate funds to maintain park infrastructure and natural resources. However, people's park experience does not only function as a means to the end of a protected environment. It also functions to enhance the individual psyche of visitors. Simply, we become better and more interesting persons for a park visit. Thus, national parks can function to create a more intelligent and creative human.

Iconic national parks

The successful design and management of national parks depends on finding an acceptable position along the continuum between extra-preservationist agendas that allow virtually no tourism, and extra-touristic agendas that encourage high levels of visitation and associated infrastructure development to service visitor needs as well as minimize visitor impact. The issue then is not simply the number of visitors *per se*, but rather the capacity to manage visitation within desired social settings. This has given rise to park planning concepts such as Recreation Opportunity Spectrum (see Clark and Stankey 1979) and Limits of Acceptable

Change (Stankey et al. 1985). However, in park management, the very language used by different constituencies often reflects underlying personal values and preferred management priorities. For our purposes, we use the term "nature" to refer to the non-human and non-artifactual world. Healthy nature indirectly benefits all living things in providing ecosystem goods and services. In a complementary way, some elements of nature, commonly referred to as "natural resources" or "natural capital," more directly benefit humankind.

We note that a working group of the Millennium Ecosystem Assessment series adopts a more restrictive terminology in which ecosystem services are limited to those particularly important for society:

> Ecosystem services are the benefits people obtain from ecosystems. These include *provisioning services* such as food, water, timber, and fiber; *regulating services* that affect climate, floods, disease, wastes, and water quality; *cultural services* that provide recreational, aesthetic, and spiritual benefits; and *supporting services* such as soil formation, photosynthesis, and nutrient cycling (Hassan et al. 2005: vii).

Of course, some would argue that *all* of nature is important for people. In addition, natural resources can have either extractive or aesthetic value to humans, or both (cf. Carter and Bramley 2002).

Scientific iconicity of species. In the overlapping "applied science" and natural resource management literatures (e.g., wildlife science, forestry, parks and recreation, marine and environmental affairs, protected area management, and tourism management), analysts and practitioners alike have found it appropriate to signal that some species (and ecosystems) merit more attention than others. This is also the case for the closely associated "basic science" literatures (e.g., zoology, biology, botany, ecology, sociology, political science, anthropology). Species categorized as *endangered, keystone, flagship, indicator* and the like are variously considered to exhibit fragility or an extra-potent functionality. To illustrate:

- The *IUCN Red List* (2014) categorizes "endangered and vulnerable species" as *extinct, extinct in the wild, critically endangered, endangered, vulnerable,* and *near threatened* to indicate their status and reflect their survivability; and
- It is common in the ecological literature to refer to some species as *keystone species* that have a disproportionately large effect on the environment relative to their abundance, thus playing a significant role in determining the structure and viability of the larger ecological community (see Paine 1995).

Levels of *scientific iconicity* of a species may be gauged in two ways. First, scientists may regard a species as iconic for its sheer potency in shaping larger ecosystem dynamics. In considering the emphasis given preservation and visitation, it is perhaps worth noting that not all visitors have equal impacts on the long-term creation and management of parks. Theodore Roosevelt (US president, 1901–1909) and Pierre Elliott Trudeau (Canadian prime minister, 1968–1979 and 1980–1984) were known to have a love of the outdoors and parks,

which possibly influenced their overseeing of the creation of more national parks than any other national leader in their respective countries (P. Eagles, pers. comm.). In the context of this paper, they could be considered to be iconic and keystone individuals for national parks.

Second, scientists may regard some of these species (or the ecosystems in which they occur) at risk. In the first instance, the scientifically iconic species is theoretically interesting, but not at risk. In the second instance, the scientifically iconic species is at risk (and, perhaps also interesting).

Touristic iconicity of species. With other motivational factors, tourists may be attracted to particular national parks to experience species for their scientific iconicity. Tourists (and scientists when not focused on their jobs) also may be attracted to experience nature subjectively, as well as objectively. *Touristic iconicity* overlaps with scientific iconicity and reflects that park visitors and scientists sometimes employ different criteria in their attributions of iconicity. Touristic iconicity is attributed by visitors to species that they accept as being scientifically iconic, and also to those that they regard as having exceptional appeal, measured in aesthetic, transcendental, historic, and spiritual terms. For example, park managers in the US refer to the attraction of "charismatic megafauna" as evidence of iconicity. Depending on the species in question, this iconicity can be scientific or touristic or both. While tourists may be drawn to national parks by touristic iconicity of species, they also enjoy seeing species that do not quite fit into this category and are not particularly special or unique.

Iconicity of national parks. Touristic amenities in national parks can be divided into three categories, which often have overlapping and interacting human, artifactual, and natural characteristics: (1) cultural units (e.g., indigenous, traditional, and resident communities; see West and Brechin 1991; Bray and Velázquez 2009; Andrade and Rhodes 2012), (2) infrastructure with social and historical value, and technologies with recreational utility (e.g., park accommodations, monuments, battlefields, archaeological sites, boats and canoes, off-road vehicles), and (3) aspects of nature with aesthetic qualities (e.g., mountains, reefs, glaciers, rivers, individual species and ecosystems, scenic viewscapes and soundscapes) and extractive value (e.g., fish and subsistence game). Just as some species compared with others are perceived as being iconic, some touristic amenities in each of these categories are more attractive, memorable and interesting to visitors and the scientific community. Therefore, we employ the term *iconic national park* to point to those national parks with *touristic iconicity* and/or *scientific iconicity.* A simple indicator of iconic status are those parks that people aspire to visit and protect (cf. Carter et al., this issue), although the aspiration may never be realized and vicarious use suffices. Most would agree that exemplars include Yellowstone, Galapagos, and Kruger national parks, and the Great Barrier Reef Marine Park area.

Conceptual framework for national park systems

Our conceptual framework (Figure 1) shows that a *national park system* (NPS) has three components. The structures of components are shaped by internal dynamics and cross-component dynamics or processes. In addition, all components are influenced by three types of external or global drivers of change. Examples of impacts of NPS components on one another in iconic parks, and some of the processes involved, are provided later in this paper.

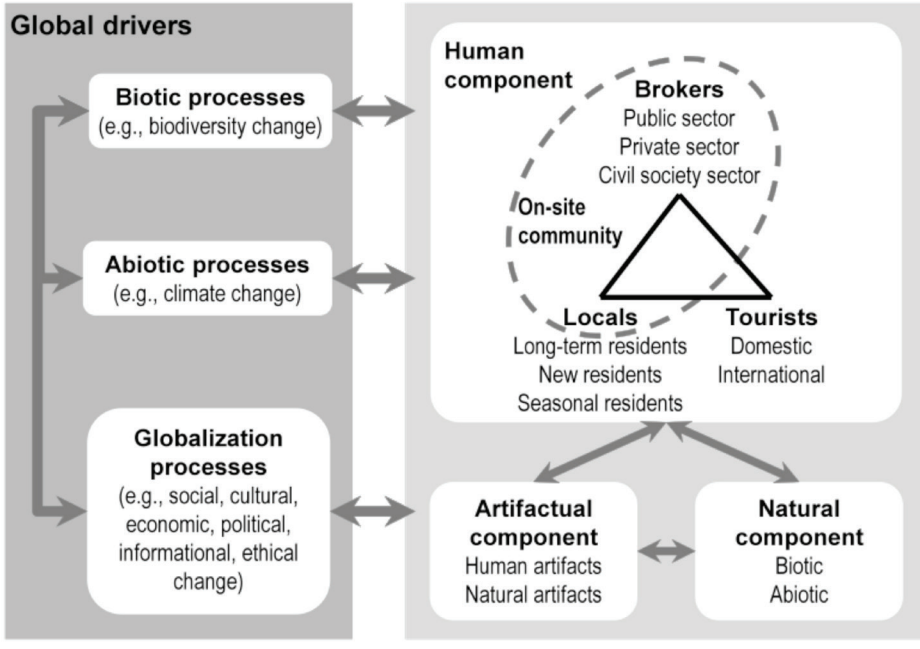

Figure 1. National park system (NPS) conceptual framework.

A national park is an example of a human–artifactual–natural system (HANS). HANSs are our modification of coupled natural and human systems (see McDonnell and Pickett 1993; Walsh and Mena 2013) and social–ecological systems (SESs; see Berkes and Folke 1998; Walker and Salt 2006; Miller et al. 2012). HANSs are elaborations of these related frameworks in that an artifactual component is added as a stand-alone element of the system. This is in recognition of the powerful influence that infrastructures, technologies, tools, and devices have on society and the environment. To be clear, we do regard humanity to be "natural" and therefore part of "nature." This said, we separate the human from the natural in the artifactual component of the HANS framework to acknowledge the unique character and extra-potency of humans to effect change in the world. This separation also acknowledges the importance of artifacts created by non-human organisms in ecological systems, their vulnerability, and their potential interest to tourists.

NPSs are relatively localized in scale. In the examples in this special issue, they encompass formally bounded national parks as well as territories immediately adjacent to parks. In a fractal way, NPSs are parts of systems within systems and, as such, respond to pressures at the regional, national, and global level.

Human component. The human component of an NPS pertains to the identification of human actors in park-dependent communities. These communities are located both within and adjacent to national parks and include gateway communities. In some cases, for example, when native cultures and traditional peoples are concerned, park-dependent communities pre-date the national parks in which they are now found. The behaviors, beliefs, knowledge,

preferences, and emotions of community members affect not only one another, but also the condition of entities in the natural and technological realms. Sociologically, this component of an NPS is described by a Broker–Local–Tourist (BLT) model (Miller and Auyong 1991; Miller 2008a and 2008b).

Tourism *brokers* are found in government (e.g., national park policymakers, managers, rangers, scientists, interpreters, enforcement agents), in the private sector (e.g., guides, service providers, retail entrepreneurs), and in civil society (e.g., nongovernmental and not-for-profit organizations with environmental and park agendas). Brokers interact with *locals* who are not engaged in the business or management of tourism (e.g., farmers, fishermen, pastoralists, homemakers, teachers, bakers) and *tourists* (both domestic and international), while some locals are part of the tourism business (bed and breakfast owners, gateway store owners, etc.).

In analyses of the human component, it is important to keep in mind (1) that the several categories of brokers and locals constitute the on-site community, (2) that locals and brokers may use national parks in their recreation, and (3) that broker–broker interactions, whether marked by consensus or conflict, directly influence the overall quality of an NPS (see Cheong and Miller 2000). In addition, national park "visitors" include not only tourists, but also brokers and locals.

Artifactual component. We use the term *artifact* to encompass all of the elements of material culture that are the products of human innovation, as well as natural and non-natural objects created or utilized by non-human organisms.

Human artifacts include technologies, tools, machines, utensils, utilities, art, clothing, artificial foodstuffs, and the countless parts constituting the built environment. NPS artifacts include a wide range of infrastructures, devices, and instruments that meet basic transportation and access needs (roads, airports, piers, boardwalks, marinas), accommodation needs (hotels, rental homes, campgrounds, restaurants) and special activity needs (scuba equipment, cameras, binoculars). The artifactual component of an NPS is an explicit acknowledgment that human daily behaviors and routines are, in part, determined by our artifacts in the same way they are by cultural and social standards, language itself, and the outer environment. What we decide to wear, where we choose to interact, and what we equip ourselves to accomplish in a national park are simultaneously facilitated and constrained by artifacts.

Technologies among artifacts are particularly influential in NPSs. Indeed, the very definition of 'technology' has changed substantially over the centuries as we have gradually come to realize that a tool or any other form of technology cannot exist without a user. In 1934, sociologist Lewis Mumford's *Technics and Civilization* made the case that machines are inextricably linked to people:

> We find there are human values in machinery we did not suspect.... No matter how completely technics relies upon the objective procedures of the sciences, it does not form an independent system, like the universe: it exists as an element in human culture and it promises well or ill as the social groups that exploit it promise well or ill (1963: vii, 6; see also Pacey 1982).

Natural artifacts denote a wide range of objects, tools, and products that are deliber-

ately employed by non-human organisms in the modification of the biotic and abiotic environment. Natural artifacts arise through what ecologists term "niche construction" and "ecosystem engineering" (Odling-Smee et al. 2013). These artifacts, as well as the behaviors exhibited by their non-human engineers, can be of significant tourist interest to national park visitors. Examples include the building of dams by beavers, the construction of nests, burrows, webs, and hives by birds, moles, spiders, and bees.

Natural component. The natural component of an NPS involves the structure and function of biotic and abiotic entities. In analyses of this component, it is important to distinguish and recognize the overlap between the elements of nature that can be extracted and are therefore valuable to humans as natural resources, those that are visited for their value as touristic amenities, and those of little immediate utility or interest to humans.

In passing, we point out that the interdependencies of the human, artifactual, and natural components of NPSs can be cast in terms of several kinds of capital. The work of political scientist and public policy expert Robert Putnam has been influential for demonstrating how social capital, as found in various kinds of social networks, can greatly increase individual and collective productivity and political power. Putnam also observes that the strategic use of social capital can result in negative as well as positive outcomes: "Therefore, it is important to ask how the positive consequences of social capital—mutual support, cooperation, trust, institutional effectiveness—can be maximized and the negative manifestations—sectarianism, ethnocentrism, corruption—minimized" (Putnam 2000: 22).

In the NPS context, the power of social capital is at play in the protection of the environment (natural capital) and the development of infrastructures and the built environment (artifactual capital; see Portes 1998; Maller et al. 2008).

Global drivers. Finally, NPSs are influenced by external or global drivers. These drivers concern three dominant categories of processes.

1. *Biotic processes,* as illustrated by biological and ecological processes influencing change in biodiversity.
2. *Abiotic processes,* as illustrated by physical and chemical processes contributing to change in climate.
3. *Globalization processes,* as illustrated by social, cultural, economic, political, ethical, informational processes shaping change in the social order.

Using the NPS conceptual framework

Just as no system can be completely studied, there is no single best approach to the analyses of NPSs as expressed in our framework. In our view, a variety of approaches and foci are valid, wherever they may fall along a basic–applied continuum (see the papers in this issue by Carter et al., Fidelman, Peake and Carter, and Walsh et al.). Any approach, however, should provide a clear specification of the overarching research goal, underlying questions, theoretical and management constructs of primary focus, methodologies appropriate to the selected dependent and independent variables, and finally, the management, academic, or public clients and audiences of the research. While the framework can be used in theoretical basic

science inquiries (i.e., studies not designed to have any immediate real-world application), we suggest its strength lies in the management context. It can help managers focus on issues specific to a park and the processes that need research to clarify interrelationships between components. Our ideas here are informed by the discussions of resource and people management approaches identified in Hockings et al. (1998: 644–646) and Orams (1999: 71–93).

In terms of overarching goals, we endorse approaches that fit NPS studies to the ideals of sustainable development and good governance. We see a continuing need for multidisciplinary and interdisciplinary research that, in complementary fashion, protects the environment while improving the quality of human life. This said, the theoretical and management constructs of central priority for any particular study will vary. Thus, studies will be attuned to a wide range of concepts (and their variants), which include natural and social system resilience, species and ecosystem vulnerability, social and environmental justice, triple bottom line sustainability, governance, optimum yield (e.g., for recreational and subsistence fisheries), and optimum visitation.

Certainly, we advocate research designed to inform park managers and others in government who make natural resource laws and policies, as well as those who implement and enforce natural resource regulations, and plan and apply technologies (e.g., facilities and access). We equally support research with education, interpretation, and outreach objectives.

As noted earlier, every component in the NPS framework can influence (positively or negatively) change in other components, as well as within its own domain. The direction of influence can, in many cases, be reversed, or can be seen to work in both directions. Change can flow also in a causal chain so that components and their parts can be linked diagrammatically in a "spaghetti-like" way (see Walsh et al. this issue, for a dynamic systems model).

In a very preliminary way, we provide a small sample of possible research topics that concern opportunities and problems within and across NPS components that may be particularly relevant to iconic national parks (Table 1; Figure 2). The list is far from being compre-

Figure 2. HANS interactions in an iconic national park: Tourists, locals, brokers and their artifacts at Fraser Island within Great Sandy National Park, Queensland, Australia. Photo courtesy of the authors.

Table 1. Sample of possible research topics that may be particularly relevant to iconic national parks.
Human component dynamics (internal)
governance: implications of institutional change for co-management, adaptive management, ecosystem-based management, social learning approaches to management
specialized tourism: impacts of broker projects and programs focused on wildlife tourism, ecotourism, pro-poor tourism, pro-women tourism, community-based tourism, heritage tourism
occupational diversification: implications of locals entering the tourism sector to become private-sector brokers
empowerment: implications for minorities and disadvantaged persons finding new jobs and roles in the tourism sector
cultural relocation: consequences of traditional cultures being displaced through increased park visitation
fishery–tourism interactions: consequences of social conflict between subsistence/ commercial fishermen and recreational boaters
enforcement: effectiveness of park management efforts to inhibit poaching and illegal activities by locals and tourists
public contact: effectiveness of park education and outreach programs to disseminate an environmental ethos to tourists, locals, and tourism businesses
optimum visitation: success of efforts to attract target markets, such as low-income and ethnic minorities to national parks
quality of life: impacts of increased tourism on the well-being of tourists, locals, and brokers
Artifactual component dynamics (internal)
technology–technology conflicts: consequences of jet skiing interference with scuba diving and kayaking
technology–technology impacts: consequences of new roadways and airports providing stimulus for commercial development and residential housing
Natural component dynamics (internal)
population dynamics: changes in population sizes of iconic/other species due to predator–prey relationships or arrival of invasive species
ecosystem dynamics: changes in the sizes/health of ecosystems due to changes in population size and behavior of iconic and other species
Human–natural dynamics (cross-component interaction)
tourist motivation: implications of change in tourist awareness of, and motivations to see, iconic species
species/ecosystem health: implications of disturbance by increased visitation and demand for resource extraction for iconic and other species and ecosystem vulnerability/resilience
Human–artifactual dynamics (cross-component interaction)
touristic attractions: management implications of increases in tourist visits to developed facilities (e.g., zip lines, suspension bridges, wildlife viewing platforms)
tourist safety and risk management: effectiveness of trail signage in alerting park visitors to dangerous routes and areas
tourism project investment: policy implications of entrepreneurial activities in finding finances to support development of infrastructure
social carrying capacity: approaches to resolving conflict between cruise ship presence inhibiting satisfaction of small-craft whale watchers
social media and technology: citizen science, monitoring and interpretation implications of GoPro cameras, apps, affordable GPS technology and social media
Natural–artifactual dynamics (cross-component interaction)
habitat boundaries: roadway impacts on wildlife corridors
environmental quality: degradation in iconic /other species and ecosystem health due to waste facilities

Table 1. Sample of possible research topics that may be particularly relevant to iconic national parks (cont'd).
Global driver dynamics (cross-component interaction)
biodiversity: impacts on species distributions
climate change: impacts on NPS iconic species/other species and ecosystem health, and on tourist motivation to visit park destinations
sea-level rise: impacts on NPS human communities and ecologies
globalization: impacts of changes in the global economic/political order on patterns of international travel to NPSs
disasters: impacts of tsunamis, earthquakes, and other extreme weather events on NPSs

hensive (e.g., we do not identify the important issues related to park financing and tourism demand), and we do not seek to infer priority, which will vary between parks. We do however seek to identify the types of links that exist between system components.

Conclusion

In this article, we have introduced a conceptual framework for the study of national parks. The NPS framework identifies key components and subcomponents or elements that have their own internal dynamics, and each component can affect others through ecological, social, and economic processes. At a larger scale of analysis, three global drivers are identified that can affect change in framework components.

This framework provides a context for the research of our colleagues concerning iconic national parks in Australia, Ecuador, South Africa, and the USA, and reported in this special issue. All of the iconic national parks discussed qualify for having both touristic and scientific iconicity. The companion articles, then, utilize the NPS conceptual framework in different ways, depending on the training and focus of the authors and the interests of their target audiences. We propose that the framework has particular relevance to the study of iconic national parks because such parks are usually the focus of public attention, are places where undesirable change is often first identified and rapid response is expected, and public tolerance of management mistakes or inactivity may be low. Iconic national parks are also places where the human component is often most influential on other components and the impact of global drivers on the human component can cascade throughout the NPS to create management complexity and increased uncertainty in terms of the efficacy of any management response applied to minimize undesirable change. Thus, the framework can provide a focus for identifying gaps in knowledge where research is needed to manage the internal dynamics of components and preempt the change effects of global drivers.

Looking ahead, we hope that our framework will prove useful in existing and new studies of national parks exhibiting the two types of iconic appeal. However, it can also be of use when the national parks of interest show only one form of iconic appeal. A national park, for example, could have substantial scientific iconicity for being interesting and/or at risk, but low touristic iconicity. One possible research topic with such a park would be to identify what might be done to reduce the risk of species extinction or increase touristic appeal, even if the species is not likely to ever be regarded by tourists as iconic.

Our framework can also be used to study national parks without any measure of iconic-

ity, but which could become iconic as sensitivities and knowledge change. Parks of this kind (i.e., not having species considered to be of any special interest or at risk by the scientific community, nor high on a tourist's travel agenda), might be studied to protect non-iconic species or to attract more tourists to help park-dependent businesses. Of course, scientific iconicity, whether concerning a species prominent for its influence or a species at risk, is, in the last analysis, a judgment call. Few scientists are comfortable with the idea that some species are uninteresting or expendable.

Finally, our framework can be used to understand and improve other protected areas that are not formally designated as national parks (e.g., monuments, reserves, heritage sites, sanctuaries), but which are, in practice, being managed as parks, or have the potential to be managed as parks. There are many examples worldwide where biotelic and extractive conservation goals drive marine protected area decisions, and where aesthetic conservation goals are not given consideration.

We hope that this national park conceptual framework will have value to those who endorse the very idea of national parks for the way in which they, by facilitating engagement of people with nature, improve the very person and life of the tourist, and protect nature.

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Climate Change Adaptation in the Great Barrier Reef Iconic National Park System

Pedro I.J. Fidelman

The Great Barrier Reef is an icon under pressure, as outlined in the Marine Park Authority's latest outlook report (GBRMPA 2014). Similar to other iconic parks (see Carter et al., this issue), the Great Barrier Reef (GBR, or the Reef) has been influenced by drivers of change that are external to it, some of which are global in nature. One such driver is climate change, regarded as the major long-term threat to the GBR (GBRMPA 2009a). Climate change is already affecting the Reef and is predicted to have far-reaching consequences in the coming decades. Further, climate change is predicted to interact with other drivers, such as poor water quality from land-based runoff and coastal development (GBRMPA 2014). Together, climate and non-climate drivers can undermine the ability of the GBR to deliver important ecosystems goods and services that underpin regional communities and industries (e.g., tourism and fishing) (Johnson and Marshall 2007). In addition, many of the GBR's heritage values (e.g., aesthetic values, biodiversity, and traditional indigenous practices) are intricately linked to the health of the Reef (GBRMPA 2014). Therefore, responding to drivers, such as climate change, emerges as a key issue requiring urgent attention in the GBR (Fidelman et al. 2013). This will necessarily require addressing the complex nature of the Reef. By using the concept of national park systems (Miller et al., this issue), this article addresses the dynamics between external drivers of change, with a focus on climate change and the GBR's natural, human, and artifactual components. It explores a range of strategies adopted in response to these drivers to gain insights that may be useful to other iconic parks subject to external drivers in a changing climate.

The Great Barrier Reef as an iconic national park system

The Great Barrier Reef of Australia (Figure 1) is a national and international icon. The GBR contains outstanding ecological, social, and cultural values, which have been recognized and protected as a national marine park (since 1975) and World Heritage site (since 1981). In addition, the GBR supports a wide range of socioeconomic activities, contributing significantly to the local, regional, and national economy (GBRMPA 2014).

The basic structure of national park systems (NPSs) consists of natural, human, and artifactual components, which are shaped by internal dynamics and influenced by external

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drivers of change (Miller et al., this issue) (Figure 2). The *natural component* of the GBR comprises the world's largest system of coral reefs. It extends 2,300 km along the state of Queensland's coast and encompasses an area of 344,400 km^2 (approximately half the size of Texas). In addition to coral reefs, the GBR features a variety of tropical marine habitats, such as beaches, mangroves, and seagrass meadows. It supports a great number and diversity of species, including 600 species of soft and hard corals, more than 100 species of jellyfish, 3,000 species of mollusks, 500 species of worms, 1,625 species of fish, 133 species of sharks and rays, over 30 species of whales and dolphins, and 22 nesting species of birds (GBRMPA 2009a). Some of the GBR species are regarded as being of "conservation concern." These include iconic species (e.g., sea snakes, seahorses, whales, and dolphins), "at risk" species (e.g., most sharks and rays, triton shells, and giant clams), and threatened species (e.g., marine turtles, dugongs, and the sooty albatross) (GBRMPA 2009a). Ecosystem goods and services associated with the GBR are critical to reef-dependent communities and industries. For example, it is estimated that the GBR contributed, mostly through tourism, approximately A$5.7 billion (US$5.15 billion) in 2011–2012 to Australia's economy (Deloitte Access Economics 2013).

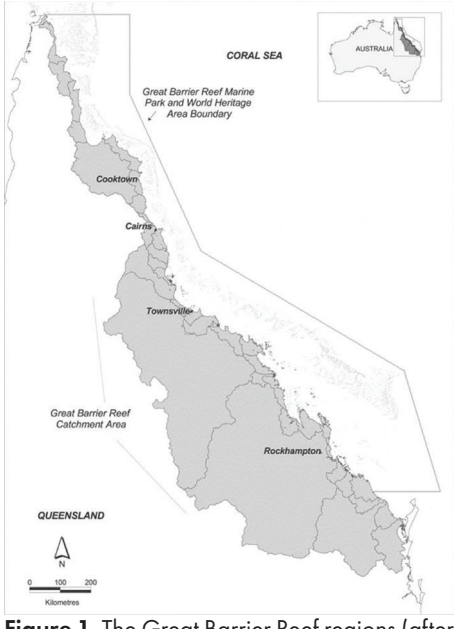
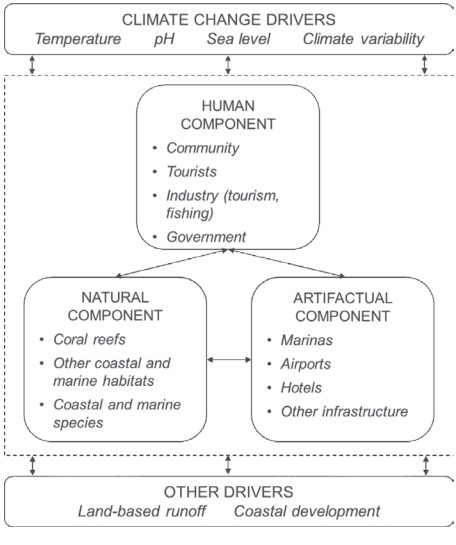


Figure 1. The Great Barrier Reef regions (after GBRMPA).

The GBR is a multiple-use marine protected area, which accommodates a range of uses under the Great Barrier Reef Marine Park Zoning Plan 2003 (GBRMPA 2004), including recreation, commercial marine tourism, fishing, ports and shipping, indigenous traditional use, and scientific research. The *human component* of this NPS comprises a wide range of social actors involved in the use, protection and management of the GBR. These include reef-dependent communities (e.g., indigenous traditional users) and industries (e.g., tourism and fishing), federal and state government agencies, local governments, nongovernmental organizations, and scientists. Protection

Figure 2. The Great Barrier Reef iconic national park system (after Miller et al., this issue).



and management of the GBR is shared between the federal and Queensland state governments. Established as a federal agency in 1975, the Great Barrier Reef Marine Park Authority (GBRMPA) has primary responsibility over the GBR Marine Park while the Queensland state government is responsible for the inshore GBR Coast Marine Park. Field management involves partnerships with a number of relevant federal and state agencies. Further, the GBR management is complemented by the contribution of natural resource management bodies, local governments, and community and industry groups (GBRMPA 2009a).

The infrastructure supporting reef-based tourism comprises the *artifactual component.* Much of this infrastructure is concentrated in the Cairns/Port Douglas and Whitsundays areas, which are responsible for about 80% of the tourism in the GBR (GBRMPA 2009a). Such infrastructure includes a wide range of accommodation facilities, restaurants, and shops; airports in the Whitsundays (Hamilton Island) and Cairns serviced with daily flights connecting the GBR with various cities across Australia and some international destinations; and networks of roads (including designated tourist routes) and rail (GBRMPA 2014). The tourism fleet, consisting of approximately 1,500 vessels and aircrafts with permits to operate in the marine park, is the primary means to explore the Reef and islands. In addition, there are approximately 80,000 registered recreational vessels. Tour-operated trips to the Reef involve largely nature-based activities with a focus on corals and other marine life. These activities include snorkeling, scuba diving, and fishing (GBRMPA 2009a).

The GRB is subject to local, regional, national and global *external drivers* (Table 1). The *Great Barrier Reef Outlook Report 2014* indicates that the three major threats to the GBR's environmental, economic and social values continue to be climate change, declining water quality from land-based runoff, and coastal development (GBRMPA 2014).

Climate change is predicted to impact the GBR through increased frequency of severe weather events, ocean acidification, increased air and sea temperature, and sea-level rise. Some impacts of climate change are already being experienced in the GBR, such as coral bleaching due to warmer water temperatures (Hoegh-Guldberg 1999; Done et al. 2003; Berkelmans et al. 2004). The impacts of climate change on the GBR are discussed in more detail in the next section.

Land-based runoff entering the reef system is influenced by land use in the adjacent catchments (watersheds), which area covers approximately 426,000 km^2. Land use includes farming activities, urban and industrial coastal development, and port expansion. Declining water quality with increased suspended sediments, nutrients, and pesticides can lead to adverse impacts on coral reefs and seagrasses (Brodie and Waterhouse 2012) and has been

Table 1. Main drivers and associated impacts in the Great Barrier Reef NPS.

Climate change	Coral bleaching, ocean acidification, severe weather events leading to loss of coral cover and mortality
Land-based runoff	Sediments, nutrients, and pesticides from land-based runoff can lead to adverse impacts on coral reefs and seagrasses
Coastal development	Loss of coastal habitats

Sources: GBRMPA 2009, 2014; Brodie and Waterhouse 2012; Day and Dobbs 2013.

linked to coral bleaching, algal blooms, crown-of-thorns starfish outbreaks, and pollution (Day and Dobbs 2013).

Coastal development is related to population growth, economic development and associated infrastructure, and socioeconomic activities. For example, the GBR region is home to a growing population of approximately 1.16 million people (GBRMPA 2014). In addition, mining and industry are driving expansion in port development and shipping activity. Coastal development adversely affects coastal habitats that support the GBR (GBRMPA 2012a).

Given the dynamic nature of NPSs, the drivers addressed above are predicted to interact with each other resulting in synergistic adverse effects. For example, climate change is predicted to compound local and regional non-climate drivers, particularly land-based runoff (see, e.g., Wooldridge 2009).

The Great Barrier Reef NPS under changing climate

As mentioned above, climate change is one of the greatest long-term threats to the health of the Reef (GBRMPA 2009a). A number of climate change variables are already changing in the GBR, and are projected to further and significantly change over the next decades (GBRMPA 2014). Climate change projections suggest increases in air temperature, sea surface temperature, sea level, ocean acidification, and weather variability by 2050 (Lough 2007) (Table 2). These are expected to affect all the components (natural, artifactual, and human) of the Great Barrier Reef NPS, as discussed below.

The natural component. Expected impacts of climate change on the GBR include high and enduring sea temperatures, which can result in mass bleaching of coral reefs, and ultimately coral mortality (GBRMPA 2014). There have been various bleaching events due to warmer seawater temperatures in the GBR; some of the most severe occurred in 1998,

Table 2. Climate change projections for the Great Barrier Reef.

Variable	IPPC 2050 B1 scenario	IPPC 2050 A2 scenario	Certainty of projections
Air temperature	+0.9° C	+2.6° C	High certainty, already observed increases
Sea surface temperature	+1.1° C	+1.2° C	High certainty, already observed increases
Sea level	+13cm	+68cm	High certainty, already observed; may accelerate
Ocean acidification (pH)	–0.15	–0.25	High certainty, already observed decreases
Weather variability	No consensus. Intensity of high rainfall events expected to increase with more extremes. Intensity of tropical cyclones expected to increase	High certainty for increased intensity	

B1 scenario: lower emissions with a global population peak in mid-century, rapid changes in economic structures; clean and resource-efficient technologies introduced. A2 scenario: high emissions with continuously increasing global population and economic growth; fragmented and slow technological change. Sea-level increase is measured relative to a 1961 to 1990 baseline. Source: after Lough (2007).

2002 and 2006 (Hoegh-Guldberg 1999; Done et al. 2003; Berkelmans et al. 2004). Given the low-lying coastline that characterizes most of the GBR, even small changes in sea level can considerably affect tidal habitats, such as mangroves, beaches, and islands (GBRMPA 2009a). Ocean acidification can have profound effects on coral reefs, decreasing their capacity to build skeletons (De'ath et al. 2009). Lastly, weather variability in the form of more intense tropical cyclones can cause physical damage to coral reefs, and extreme flooding events can affect coral reefs through increased pollution and sediment levels (De'ath et al. 2012).

The human component. Reef-dependent communities and industries are the most vulnerable to the effects of climate change on the GBR. Fenton et al. (2007) suggest that such effects may lead to reduced cultural (e.g., indigenous traditional uses) and recreational (e.g., boating and fishing) opportunities. For example, change in abundance and distribution of traditional marine resources may lead to disruption of customs and practices with likely loss of knowledge, skills, and culture. The reef-based tourism industry is also highly susceptible to the effects of climate change, such as bleaching of coral reefs and change in distribution of iconic species (Fenton et al. 2007). Decline in coral reef and fish biodiversity may cause reef trips by divers and snorkelers to decline by up to 80%. In economic terms, this corresponds to a reduction of A$103 million (US$93 million) per year in expenditure by divers and snorkelers on full-day reef trips in the Cairns area (Kragt et al. 2009).

The artifactual component. Sea-level rise and extreme weather events, such as floods and cyclones, are potentially damaging to urban and coastal infrastructure that support the GBR reef-based tourism. For example, the GBR region was affected by intense flooding and cyclone activity between December 2010 and February 2011. Tropical Cyclone Anthony (January 2011) and Severe Tropical Cyclone Yasi (February 2011) caused widespread impacts on the region's infrastructure. These included considerable damage to Queensland's road and rail networks, port and airport closures, disruption of water treatment and sewage systems, and loss of power, telecommunication, and Internet (Gooch et al. 2013). Queensland Tourism Council estimated that the losses to the industry caused by the floods and Cyclone Yasi alone totaled A$1 billion (US$900 million) (ABC News 2011).

Responding to climate change in the Great Barrier Reef

The future of the GBR will depend on its capacity to respond to a range of climate and non-climate drivers (GBRMPA 2009a). In this context, adaptation is a key societal response to these drivers and can significantly reduce their adverse impacts (Fidelman et al. 2013). In this article, adaptation refers to "the decision-making process and the set of actions undertaken to maintain the capacity to deal with future change or perturbations to a social–ecological system [such as NPS] without undergoing significant changes in function, structural identity, or feedbacks of that system while maintaining the option to develop" (Nelson et al. 2007).

This section draws largely on Fidelman et al. 2013, which examined over 100 examples of adaptation strategies—reports, plans, legislation, policies, studies and assessments—relevant to climate change and the main non-climate drivers (i.e., land-based runoff and coastal development) in the GBR.

In the GBR, adaptation results from a number of organizations pertaining to several, and

in many cases interlinked, sectors (e.g., tourism, biodiversity, fisheries, and water), and governance levels (local, regional, state, and national) with mandates within the GBR Marine Park and beyond. Examples of these organizations include local councils (e.g., Cairns Regional Council), regional natural resource management bodies (e.g., North Queensland Dry Tropics), and state (e.g., Queensland Department of Environment and Heritage Protection Management) and federal (e.g., Department of the Environment) government agencies. These organizations have developed and/or adopted a range of adaptation strategies, including (1) production, synthesis, and integration of information; (2) policies, plans, and programs; (3) planning and natural resource management legislation; (4) organizational structures; (5) tools and guidelines to cope with climate impacts; and (6) establishment of committees and networks (Table 3).

Because adaptation aims to meet diverse socioeconomic goals, it takes place in a context of interacting climate and non-climate changes (Moser and Ekstrom 2010). Accordingly, adaptation strategies in the GBR have been designed as responses to both climate and non-climate drivers (Table 4).

Strategies responding primarily to climate-related impacts include the *Climate Change and the Great Barrier Reef: A Vulnerability Assessment 2007* (Johnson and Marshall 2007), the *Great Barrier Reef Climate Change Action Plan 2007–2012* (GBRMPA 2007) and *Great Barrier Reef Climate Change Strategy and Action Plan 2012–2017* (GBRMPA 2012b). The vulnerability assessment, considered the world's first comprehensive assessment of climate change risks for coral reef systems, identified key areas of vulnerability and informed the first GBR Climate Change Action Plan (GBRMPA 2012b). The action plan was implemented over the 2007–2012 period with investments of approximately A$9 million (US$8.14 million) (GBRMPA 2007). The subsequent GBR Climate Change Strategy and Action Plan (2012–2017) are currently being implemented (GBRMPA 2012b).

Table 3. Examples of main types of adaptation in the Great Barrier Reef NPS.

Information and Research	*Climate Change and the Great Barrier Reef: A Vulnerability Assessment* examines the vulnerability to climate change of GBR species, habitats and key processes (Johnson and Marshall 2007)
Policy, Plans, Programs	*The Great Barrier Reef Tourism Climate Change Action Strategy 2009–2012* provides a framework for the tourism industry to respond to climate change (GBRMPA 2009b)
Legislation	The Queensland Great Barrier Reef Protection Amendment Act 2009 aims to ensure the adoption of management practices in catchments to improve the quality of water entering the Reef (State of Queensland 2009b)
Organizational structures	The Climate Change Group within the Great Barrier Marine Park Authority is responsible for developing and coordinating climate change measures on the GBR
Tools and guidelines	*Adapting to Climate Change, a Queensland Local Government Guide* helps local councils assess the risk of, and respond to, climate change
Committees and networks	The GBR Tourism Climate Change Action Group, consisting of representatives from Great Barrier Reef Marine Park Authority, Queensland government, and the tourism industry, addresses climate change issues

Source: after Fidelman et al. 2013

Table 4. Examples of adaptation responses in terms of purposefulness.	
Climate	**Non-climate**
Coral bleaching response plans	Caring for our Country Program
Great Barrier Reef Climate Change Strategy and Action Plan 2012–2017	*Great Barrier Reef Outlook Report 2009*
Climate Change and the Great Barrier Reef: A Vulnerability Assessment 2007	Coastal Protection and Management Act 1995
Implications of Climate Change for Australia's World Heritage Properties: A Preliminary Assessment	*Great Barrier Reef Marine Park Zoning Plan 2003*
Australia's Biodiversity and Climate Change: A Strategic Assessment of the Vulnerability of Australia's Biodiversity to Climate Change	Great Barrier Reef Protection Amendment Act 2009, Queensland
	Reef Water Quality Protection Plan for Catchments Adjacent to the Great Barrier Reef
	Natural resource management plans
Source: after Fidelman et al. 2013.	

At the core of the GBR climate action plans—and the overall approach of the GBR management—is the concept of *resilience*, understood as the capacity of the Reef system to resist disturbance and undergo change while still retaining essentially the same function, structure, and processes. It refers to the capacity of a changing and dynamic system to return to a healthy state after being subject to a disturbance or impact (GBRMPA 2014). The magnitude of adverse climate change effects on the GBR has been articulated as a function of the rate and extent of climate change and the resilience of the Reef to this change (Johnson and Marshall 2007). Therefore, a key focus has been on maximizing the resilience of the Reef system. This includes minimizing the effects of non-climate drivers, which undermine the resilience of the GBR to climate change. Further, it is assumed that a resilient GBR reduces the vulnerability of dependent industries and communities (GBRMPA 2012b).

Other strategies have been developed to address non-climate drivers, which are nevertheless expected to provide adaptation benefits to the Reef. As discussed above, this is because strategies addressing local and external threats are regarded as important to restore and/or maintain the Reef's resilience (GBRMPA 2009a). For example, the GBR Marine Park Zoning Plan and the Reef Water Quality Protection Plan for Catchments Adjacent to the GBR (the Reef plan) are major initiatives to help build resilience of the Reef (GBRMPA 2007). The GBR Marine Park Zoning Plan, which came into effect in 2004, defines the activities that are allowed in different parts of the marine park. Its aims include conserving biodiversity, and protecting key functional groups and refugia, all of which are critical to maintaining ecosystem resilience (GBRMPA 2009a). The Reef plan is a joint initiative between the federal and Queensland governments introduced in 2003 to halt and reverse the decline in water quality entering the Reef. Reducing loads of nutrients, pesticides, and sediments from land-based runoff will help enhance the GBR's resilience in the face of a changing climate (State of Queensland 2009a).

Adaptation in the Great Barrier NPS has been triggered by various factors (Table 5). In addition to climate-related impacts, adaptation has been driven by (1) the management of the marine park, which includes policy and management strategies with a particular focus on ecosystem resilience (Marshall and Johnson 2007); (2) legislation and policy, such as the Great Barrier Marine Park Act 1975 that was amended in 2007 to require the preparation of an outlook report every five years; (3) natural resource management plans and projects, which address many issues of relevance to climate change, such as soil and vegetation management, water quality, and biodiversity conservation; and, (4) planning and management schemes, such as those of local and state governments.

Concluding remarks

The Great Barrier Reef is illustrative of iconic national park systems featuring dynamic interactions between external drivers and the NPS's natural, human, and artifactual components. In fact, an NPS can be understood as parts of a system within systems and, as such, its components can influence (positively or negatively) change in other components of the NPS (Miller et al., this issue). Addressing the dynamic nature of NPSs is imperative to effectively confront multiple drivers, particularly in the context of a changing climate. In this regard, response strategies need to be sensitive to NPS complexity (Ostrom 1995). For example, the multifaceted and interacting nature of external drivers affecting NPSs requires a variety of response strategies involving a number of sectors with different mandates, which operate at multiple scales and levels. Accordingly, in the GBR these strategies include information and research; policy, plans and programs; legislation; organizational structures; tools and guidelines; and committees and networks. They have been adopted by a range of organizations across several sectors (e.g., tourism, biodiversity, fisheries, and water) and governance levels (local, regional, state, and national) with mandates within the GBR Marine Park and beyond. In sum, responding to key pressing threats to the NPS, such as climate change, requires multi-stakeholder, cross-sector, and multi-level approaches.

The future outlook of NPSs, such as the GBR, will depend to a great extent on the ability of these approaches to deliberately embrace and respond to complexity and interconnectedness. However, it is important to notice that strategies to address external drivers of change may be limited if such drivers are not mitigated (in the context of the GBR, see Bohensky et al. 2011). For example, reducing vulnerability to climate change will require, in addition to

Table 5. Triggers of adaptation in the Great Barrier Reef NPS.

Trigger	Example
Impacts of climate change	Experienced or perceived climate-induced impacts such as coral bleaching
GBR Marine Park management	Strategies developed for the management of the GBR Marine Park
Legislation	Statutory requirements and sustainable development principles
Natural resource management	Natural resource management issues, such as water quality, biodiversity, and erosion and soil conservation
Planning and management schemes	Coastal management and protection, state planning schemes

Source: Fidelman et al. 2013.

the adaptation strategies addressed in this paper, strategies to mitigate greenhouse gas emissions. Mitigation measures at the NPS level and beyond should be regarded as a complementary response to reduce risks from external drivers.

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Ecotourism in the Galapagos: Management of a Dynamic Emergent System

Diego Quiroga

Three hundred years after its discovery by Europeans in 1535, Charles Darwin visited the Galapagos and this sojourn became one of the factors that transformed the remote set of isolated islands from a place only visited by pirates and whalers to one of the most important natural spaces for the study of evolutionary biology and biogeography. Almost two hundred years after Darwin's visit, the natural laboratory has become the basis of a multimillion-dollar tourism industry. Few tourist destinations depend as heavily on science as part of their iconic character. The Galapagos are not only a destination where one can admire pristine nature and unique animals, but also a place where the idea that visitors can retrace Darwin's footsteps is part of the marketing scheme.

Just a few years before Darwin visited the Galapagos, Ecuador claimed the islands as part of the newly created republic. Thus, the basis was established in the first part of the 19th century for the evolution of the Galapagos as one of the most important natural destinations for international tourism. After the creation of Galapagos National Park in 1959, a series of conservation measures were established to control the impacts of humans on the islands. However, the rise in the number of tourists and the increased number of local residents has led to a surge in invasive species and the overuse of natural resources. These changes to the system, most of them generated outside of the Galapagos, are threatening the long-term sustainability of the islands.

Complexity and coupled human natural systems

Complex human ecological systems include non-linear system dynamics, emergent behaviors, feedback mechanisms, and critical thresholds. Uncertainty is an important characteristic of these systems. Levine (1998) has described the way complex adaptive systems contain a Darwinian bottom-up emergent process that includes three elements: (1) sustained diversity of components; (2) localized interaction among those components; and (3) an autonomous process that selects among the components on the basis of their interactions, including a subset for replication or enhancement. Both biophysical as well as socioeconomic environments must be taken into account as they generate the contexts to which emergent complex systems must adapt. Disturbances and changes to the system can be of internal or external origin,

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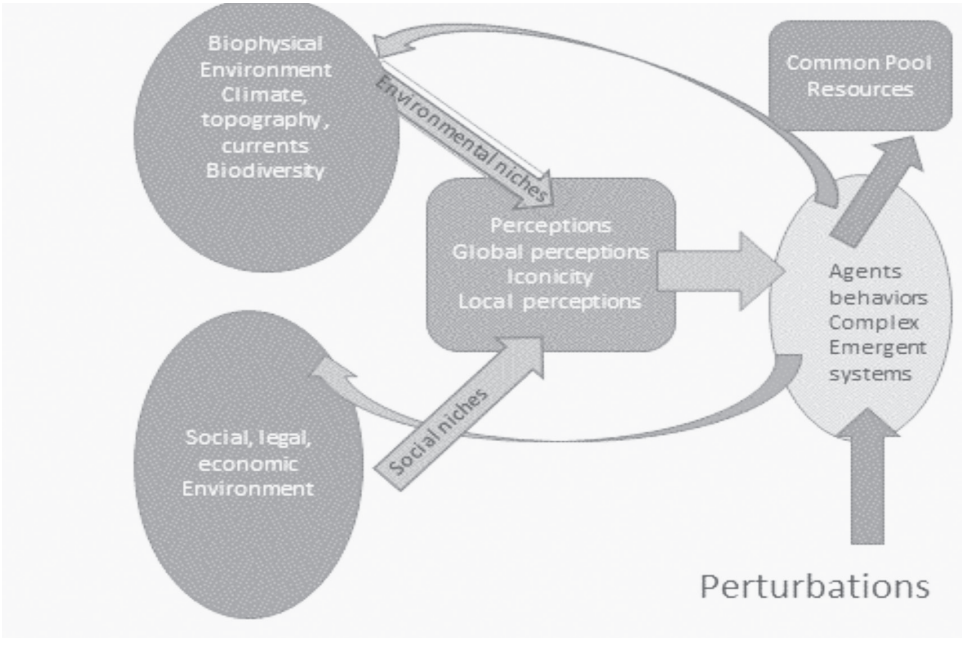
creating challenges to its stability. Resilience is a characteristic of these systems that is based on their capacity to reorganize themselves after major disturbances. Complex systems are characterized as having several points of equilibrium, with various levels of desirability from the point of view of the long-term sustainability of the environmental systems. The existence of multiple points of stability, threshold dynamics, and the high level of uncertainty present numerous challenges to managers.

In the case of the Galapagos, global changes have affected the biophysical and socioeconomic conditions, which in turn affect diverse subsystems, their resilience, and the status of the iconic features of the park and the inhabited areas. Tourism is the main economic activity in the Galapagos at the moment (Watkins and Cruz 2007) and the main driver of the economy (Taylor 2006; Epler 2007). Tourism based on the iconic features in the Galapagos has established different points of dynamic equilibrium that we will discuss below.

Tourism is one of the main factors that shapes the social and economic environment of the agents in the Galapagos. The agents, in this case local residents of the Galapagos, use and create different niches that result from the complex interdependence between natural and human phenomena and internal and external dynamics working at different scales. These niches emerge from the confluence of socioeconomic and biophysical environments (see Figure 1) with the creative and entrepreneurial activities of the local inhabitants. These environments are constantly changing. Much of the tourism industry has been dominated by large companies that operate expensive and often large boats. These boats host mostly wealthier, middle-aged Western European or North American tourists. In recent years, however, there have been a growing number of tourists that stay in the towns and have increased

Figure 1. Environments, perceptions, and emergent systems.



the demand for local services and tour packages. Most of the strategies developed by local people to attract tourists have resulted from the residents looking for new niches in a creative manner within the context of these environmental changes. In the Galapagos, small local tourism enterprises are agents that have used and created niches such as day tours, kayaking, scuba diving, and sport fishing.

Different oceanographic, terrestrial, and cultural conditions explain the existence of emblematic species, such as sea lions, tortoises, marine iguanas, and sharks. The socioeconomic environment within which tourism has flourished includes the changing demand for certain tourism products, the regulatory framework of Ecuador's national park system, access to credit and funding to provide more infrastructure, and the availability of new technologies and tools that mediate the different relations to the biophysical environment. Environments, whether biophysical or socioeconomic, are real and substantial, but they are also perceived environments, mediated by a series of culturally generated preconceptions and conditions. It is within these perceived environments and niches that emergent complexities can arise. Thus, emergent socioecological systems are dynamic entities that adapt to changing environments and may have different equilibrium points.

Human agents can influence some of the environments, but not others. This generates feedback loops as emergent systems begin to affect part of their environments. The feedback loops also create different degrees of the system's resilience, which influence the long-term sustainability of the common-pool resources (CPRs). Tourism can seriously affect the sustainability of the biophysical environment in many ways including: disturbing the animals, contaminating the waters, increasing human immigration, introducing non-native species, or destroying habitats to construct tourism infrastructure. People also shape the socioeconomic environment, of course. The Galapagos locals, for example, have had some influence on the laws and regulations as these laws must accommodate new tourist activities. These feedback loops generate complex adaptive systems that have different degrees of resilience (Berkes et al. 2003). The degree of resiliency of these emergent systems depends to a large extent on the way CPRs are managed (Ostrom 1990). Ostrom has listed the conditions under which emergent systems can evolve more sustainable interactions with the environment and protect the CPRs (Ostrom 1990; Wilson et al. 2013) (see Figure 1).

In a complex coupled system, such as the Galapagos, there is a relationship between subsystems: some structure the creative possibilities and limitations for other emergent systems. In the case of the socioecological systems, niches are partly the result of these power dynamics. They are created as the structuring components open and close possibilities for actions to take place. Thus, dynamic power relations between complex emergent systems need to be taken into account in order to account for changes and adaptations.

Biophysical environment

In the Galapagos, the primary island-building processes are related to volcanism and some uplifts. The archipelago emerged from volcanic activity only 3 million to less than 300,000 years ago (Geist and Harp 2009). Volcanism continues to this day, with the westernmost islands of Isabela and Fernandina the most active. The volcanic origin of the islands contrib-

utes to their isolation, a key factor which helps to account for the evolutionarily unique and iconographic flora and fauna found in the archipelago (Valle 2012), and for the scientific, conservation, and tourism concerns surrounding the islands.

The Galapagos marine environment is a very dynamic oceanic system shaped by several currents. The main ones are the South Equatorial Current, which affects the southeast trade winds; the eastward-traveling Equatorial Undercurrent; the westward-traveling Peru Current, which creates upwelling in the southeastern areas; and the warm Panama Current, which affects the northern islands (Houvenaghel 1984). These contrasting temperatures and other biophysical conditions vary during the year and across the various geographic areas. Key iconic species, such as penguins, flightless cormorants, sea lions, and the different species of boobies, depend to a large extent on the existence of the various currents and upwelling cells.

The islands' land climate also varies according to the topography and the amount of precipitation at the different altitudinal levels of the islands. Humidity and rain increase with altitude in the islands that have tall volcanoes and mountains that trap the clouds and the rain. Its isolation and the existence of diverse oceanographic, climatic, and geographic conditions are critical aspects that produce the biological uniqueness of the archipelago. The age and distribution of the islands, their distance from the mainland, the various altitudinal ecological zones, and the existence of different oceanographic and terrestrial regions created by the influence of diverse marine currents generate the physical and environmental conditions where rapid evolutionary processes occur. These biogeographical conditions and the process of adaptive radiation they generate in turn explain the high degree of endemism. Thus, in the case of land reptiles, 100% of the species are endemic, as are 84% of the terrestrial birds and all the terrestrial mammals (Snell 1999). Some of the most charismatic terrestrial species found in the islands are those that have been used to exemplify the Darwinian evolutionary process. Such is the case of the Galapagos finches, tortoises, and mocking birds.

The marine ecosystems of the Galapagos are also an important attraction for the tourists. The islands' marine megafauna have created a growing flow of tourists to scuba dive and snorkel. The currents provide a rich and productive set of conditions that support a diversity of marine species, including five of sharks, two of sea turtles, and many of reef fish and rays, all of which are relatively easy to see.

Ever since Darwin visited the islands, endemic species have been icons for science, becoming so later for conservation and, finally, for tourism. These organisms have become a classic illustration of important evolutionary processes, such as speciation through adaptive radiation, hybridization, and the founder effect (Grant 2008; Valle 2012b). The mockingbirds, tortoises, finches, and land and marine iguanas also constitute important elements in the constructs of the Galapagos in the global north and of the islands as a tourism product. Many of the scientific studies and publications about the evolution, distribution, biology and adaptations of these emblematic endemic animals and plants are now classic examples for evolutionary biology and a tribute to Darwin's legacy. These studies have been popularized in Western culture through books, documentaries, and magazine articles that potential tourists consume.

From a conservation point of view, one of the most important aspects of the islands is the fact that many of these iconic endemic and native species have low numbers of individuals, specific distribution ranges, and are highly vulnerable to predators or competitors. These conditions put these species at risk from introduced species, new diseases, oils spills, and land use changes, all of which are possible and real threats associated with the growing tourism industry.

Contrasting perceptions

For humans, natural and social environments are perceived environments (Berger and Luckmann 1966; Searle 1997) and our interaction with environments is mediated by socially produced constructs. The so called Cronon debate (Cronon 1995; Proctor 1998; Demeritt 2002) shows the need to take into account cognitive, normative, and emotive structures to understand the interaction between people and nature. The Galapagos has been constructed in different ways by diverse sets of actors. I consider here two general constructs that have generated different practices and emergent systems (Quiroga 2009). The global perspective regards the Galapagos as a unique and iconic place, a natural laboratory where the evolutionary process can be studied. However, the contrasting perspective of the local residents portrays the Galapagos as a frontier, a place where nature must be controlled, transformed, and humanized. Tourism, especially land-based tourism or what many call "ecotourism," is shaped by the hybridization of these two constructs (Quiroga 2009, 2012).

The global perspective and the iconic importance of the Galapagos can be traced to Darwin's visit in 1835 and his accomplishments and observations of the geology, geography, and animals and plants of the Galapagos (Larson 2001). Darwin's ideas have become the master narratives through which much of the Western secular world generates its worldview. The products and process of evolution are not only of interest to scientists, but they have become critical aspects of the paradigm through which the global north conceives the world and its origins (see Hodgson 2005). The Galapagos played an important role in this critical paradigmatic transformation. The emblematic trip of the *HMS Beagle* and the observations that Darwin made of the geology of the islands, the mockingbirds, the tortoises, and the finches, have become key elements for our understanding of the evolutionary process.

As part of this global paradigm of the Galapagos, conservationists and scientists developed schemes to protect the islands. Some scientists became aware of the challenges facing the Galapagos in the early 1930s when the first laws to protect the islands where passed (Larson 2001). An important transformation occurred in 1959— a century after the publication of *On the Origin of Species*—when the Charles Darwin Station was founded and the Ecuadorian government created Galapagos National Park, dedicating 97% of the area to conservation. In 1978, UNESCO declared the islands a World Heritage site and in 1985 named it a biosphere reserve (Durham 2008; Hearn 2008). In 1986, the first laws to protect the coastal areas were instituted and in 1998 the Galapagos Marine Reserve (GMR) was created, and 133,000 km^2 were placed under the protected area (Durham 2008; Hearn 2008).

Tourism companies use the singular aspects of the Galapagos to attract clients and create

a unique destination. Guides and tourism operators utilize Darwinian discourse and narratives to describe the landscape as well as the organisms that inhabit the islands. Names related to evolution, such as *The Beagle, Explorer, Darwin, Darwin Buddy*, and the *Finch*, are frequently used by boats, restaurants, and tourism agencies. Tour guides, many hastily trained in Darwinian sciences, facilitate the experience of the approximate 200,000 tourists that visit the islands every year. From the point of view of this global perspective, local people are either ignored or seen as invasive pests and a problem. Brochures, webpages, and other tourism advertisements often ignore or minimize the presence of the residents. To reduce the negative impact of large-scale tourism on the local population and the ecology of the islands, scientists and conservationists conceived in the 1960s a system of tourism that was based on large cruise boats touring from island to island and staying as little time as possible on the towns and inhabited areas. The military airport built in Baltra by the USA during World War II was refurbished to accommodate civilian planes; roads were built to facilitate the transport of tourists from the Baltra airport to the town of Puerto Ayora in Santa Cruz. The people who invested in these cruise boats accumulated power and wealth and had an important say in shaping the development of tourism in the islands. Paradoxically, they were also helping create new niches that would later be used by the local people and that resulted in a large migratory movement to the islands. An important goal of the system was an effort, which many locals consider to have failed, to lower the impact of tourism on the islands by controlling the growth of the towns and the movement of tourists.

The other prevalent construct of the islands is that held by local inhabitants. Many of the early visitors—starting with the Spaniards who first visited the islands in the 16th century—commented on the challenges that these islands represent for human inhabitants. The Ecuadorian colonists who settled in the Galapagos in the 19th century considered the islands as a remote, harsh, and unforgiving place (Quiroga 2009, 2013). For the early colonists and visitors, the Galapagos presented a series of challenges that they had to overcome. The distance between the islands and the mainland was one of the most critical aspects of their experience. To this day, freshwater is still one of the most limiting resources in the Galapagos—many of the inhabited islands have little freshwater and only one, San Cristobal, has any of good quality and in significant amounts. Thus, what for scientists and later for tourists was an interesting, iconic, and valuable natural laboratory, was, for the early visitors and colonists, a frontier that needed to be conquered and humanized. Local residents, one-third of whom are fourth-generation *galapagueños,* are proud of having successfully fought against the inhospitable environment. This local view reflects the experience of the local inhabitants that arrived as colonists to make a living in the Galapagos.

These contrasting views of the Galapagos are also manifested in the human perceptions of the different organisms. Thus, as in the case of the animals, the global community perceives the flora and fauna as unique and iconic examples of Darwinian evolution and classifies them as endemic, native, or introduced. Contrasting with this perception, the local people view them on the basis of their utilitarian value as useful, useless, or neutral. For the global community, which includes the tourists, conservationists, and scientists, charismatic animals such as

giant tortoises, sea lions, hawks, and sharks are considered distinctive and unique. However, to the local people, many of whom are still engaged in agriculture or fisheries, these animals are often seen as either pests, competitors for resources, or as a source of food.

Isolation also has two opposing meanings in the global and the local perspective. The rise of tourism and the increasing involvement of local people in activities related to this industry have led to the emergence of a new hybrid cultural symbolic system changing the views locals have of these animals. These one-of-a-kind animals are now seen by many local people as key elements for the attraction of tourists to the islands that in turn use many of the local services.

Social, legal, and economic environment

Between 1950 and 2000, the Galapagos resident population grew at a rate of 5–6% a year (Kerr et al. 2004). The 1998 Special Law of the Galapagos, Ley Organica de Regimen Especial para Galapagos (LOREG), established a series of regulations to try to stop this growth. However, by 2010 there were 25,140 local residents in the Galapagos, more than 60% of them living on the island of Santa Cruz, and almost 60% of the inhabitants were born outside of the Galapagos. Initially, most of the colonists lived in the highlands where they were involved in agriculture. In the 1950s, many of these inhabitants moved to the lowlands as fishing increased in importance. Different fisheries for export outside of Galapagos, starting with groupers in the 1960s, lobsters in the 1980s, and sea cucumbers in the 1990s, provided jobs and income for many of the local inhabitants. Often, these extractive activities contributed to environmental degradation and the fisheries had to adapt to the loss of the old niches, usually by extracting a new marine organism (Castrejon 2006; Hearn 2008). Thus, many of the emergent fishing activities resulted in the deterioration of the CPRs, which closed some niches for the fishermen. As the national park and the Charles Darwin Station tried to regulate the fisheries in the middle of the 1990s, riots and clashes occurred. This situation was partly resolved with the creation of the Galapagos Marine Reserve in 1998 and the Participatory Management Board (PMB). The PMB is composed of several stakeholders, including the large tourism sector, scientists and conservationists, the fishing sectors, and the national park. The PMB's main purpose was to lower tensions with respect of the management of the marine reserve. However, despite the efforts of the PMB, in the early part of the 2000s the economic collapse of the sea cucumber fishery meant that many fishermen began to explore new productive activities, especially in the tourism sector.

The Special Law of the Galapagos regulates many activities, such as residency, migration, fisheries, and tourism. A related regulation focused on tourism in protected areas, the Reglamento Especial de Turismo en Areas Naturales Protegidas, listed a series of possible tourism activities such as sport fishing, scuba diving, and daily tours open to local people. However, even before the passing of the law, the local people were already practicing some of these tourist activities. Galapagos National Park established controls on tourism in different ways, including the places that can be visited, the itineraries of the boats, the paths where tourists can walk, the training and guidelines that naturalist guides must follow, the number of cruise boats, and the number of berths on the cruise boats. Recently, the national park

managers have also started to regulate the smaller boats that provide day tours and scuba diving services. National park regulations were meant to diminish some of the negative effects that tourists have on the fragile environment; however, many tourist regulations originally did not include specific guidelines for activities. These guidelines either took a very long time to pass or have not yet been passed at all. This lack of regulation opened a gray legal area that has been used by the local residents to generate a series of tourism activities and enterprises.

Cruise boat tourism grew rapidly from 1970 to the 1990s, and this flourishing industry has been mainly based in Puerto Ayora. Commercial Galapagos tourism in the form of "floating hotels" began in the 1960s when New York-based Lindblad Travel began offering cruises on their 66-passenger ship, the *Lina A*. Later, other companies, such as Metropolitan Touring and Turismundial, brought other cruise boats to the island, and between 1974 and 1980, the cruise ship fleet more than tripled in numbers, growing from 13 to 42 (Hoyman and McCall 2012). Land-based tourism, which engaged mostly the local population, began in the 1970s with the availability of inter-island shuttles and small boats for charter (Epler 2007). In the 1980s, Galapagos National Park distributed tourism permits to fishermen and other local people, but many of these permits were bought or rented by outsiders who owned the cruise boats. This process resulted in an accumulation of permits and increased concentration of wealth in the hands of a few people who profited from tourism but do not live in the Galapagos (Epler 2007). By the early 2000s there were 80 licensed tour boats assisted by a large number of small boats called *pangas* that take visitors from tour boats to the shore. The relatively expensive tour boats are mostly owned by outsiders, from Quito, Guayaquil, or even outside of the country (Taylor 2006). The less-expensive boats are owned mostly by local residents. A number of official visitor destinations were established and most of them were assigned to the large companies. Thus, the local people had to accommodate to utilize the visiting places that were left unregulated or use areas illegally that were assigned to the cruise boats.

Local people have generated emergent complex adaptive systems in areas such as fisheries and new tourism operations that use the sociopolitical and biophysical niches opened by the changing social and ecological environments. After the 1970s, for example, fishermen had to adapt to new regulations and changes in the environment. The creation of the Galapagos Marine Reserve, new fishing regulations (Hearn 2009), and the introduction of new technologies, such as outboard engines, fiberglass boats, radios, GPS, and diving equipment, made it possible to fish for new products. In the case of locally based tourism, since the 1970s residents of the Galapagos have increasingly been developing new activities and options for tourists who decide to stay on the islands instead of taking a cruise. Local people established new hotels, sport fishing charters, daily tours, and scuba diving packages, and opened restaurants, tour agencies, and souvenir stores. These enterprises have emerged, often unregulated, and are using niches that the law, economic demand, technology, and natural resources have made possible. Whereas most of the older and wealthier foreign tourists stay on the cruise boats, visiting mostly the natural areas and occasionally a town (Mena et al. 2011), younger foreigners and Ecuadorian tourists stay in the towns and many participate and support the newly created activities. Most of these new tourist activities depend to a large extent on the

use of the images, vocabulary, and icons that are taken, albeit in a selective way, from the global Darwinian constructs of the Galapagos. Thus, as locally based tourism increases, the resources that benefit the local economy create a hybrid view of the Galapagos (Quiroga 2012).

The continuing scientific interest in the endemic species has helped to produce a number of educational and research centers on the islands. These include the Charles Darwin Research Station, Galapagos Academic Institute for the Arts and Sciences, and Galapagos Science Center; as well, there are research groups stationed elsewhere but which bring scientists to the islands. The number of groups of national and international students has increased and different organizations have also increased the inflow of volunteers that want to contribute to the conservation of the islands. These academic and "voluntourism" operations have grown in numbers and now constitute an important source of income for the local populations. Other groups of visitors that use the local accommodations and services include scuba divers, national tourists, international visitors (especially young backpackers), and sport fishermen.

In recent years, the government has tried to regulate many of these emergent tourism operations managed by the local people. Such is the case with boats that operate day tours to places like Kicker Rock in San Cristobal. In 2013, new regulations reduced the number of boats that can visit this special place, where tourists swim and dive with different species of sharks and other marine megafauna. Permits were only given to a relatively small number of boats. Furthermore, the number of passengers that each boat can carry, the length of the visit, and the day of the week when each boat can visit the sites became regulated by Galapagos National Park. These regulations that seek to protect CPRs have often proved difficult to enforce unless the people being regulated participate actively in their design and trust the process.

As with the fisheries, in the case of land-based tourism, top-down processes attempting to regulate the emergent activities of the local population have often failed. This is due, to a large extent, to the lack of confidence in the regulatory process of the local people who feel that outsiders, such as the owners of the large cruise boats and international nongovernmental organizations, are trying to control activities for their own benefit (Quiroga 2009). Furthermore, there is a complex and often contradictory system of governance with many different public institutions involved. Frequently, as new regulations are being implemented, emergent systems press on the environment and open new niches, many of which result in the degradation of the ecosystems. The old conflicts between the global and the local perceptions that were common during the sea cucumber boom years are re-emerging now in the case of tourism. The conflict with the large corporations is one of the main factors causing poor management of the CPRs, as many local residents perceive that there is an unfair distribution of obligations and benefits. Ecotourism's success in the management of CPRs depends on establishing a sense of trust and fairness in the distribution of the benefits. The sense of ownership must be created among the stakeholders. In order for the system to be more sustainable, the view has to change from one that perceives nature as a space to be conquered and dominated, to one that views nature as a resource to be preserved. This change will occur only when people see that there is a benefit for them from maintaining the CPRs. The emergence of the hybrid culture as a new worldview generates practices that lead to a

resilient, complex, adaptive system. Better management of CPRs can lead to increased resilience in the systems.

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Sociopolitical Change and Interpretation Emphasis in Kruger National Park, South Africa

Sheila Peake and R.W. (Bill) Carter

Park interpretation can focus on explaining resource qualities, supporting management, or meeting visitor needs and expectations (Hockings et al. 1998). Environmental education (EE) can be "about," "in," or "for" the environment{Government, 2005 #525}, or as more recently framed, "about," "in," or "for" ecologically sustainable development (Pavlova 2011). The relationship between environmental education and ecologically sustainable development depends on "the historic role EE has played in a country (prominent or marginal) and the way EE itself is interpreted (broad or narrow)" (Wals 2009). The same may be said of the relationship within and between park interpretation and EE, where the emphasis given is related to historical perspectives of countries and managing agencies. For the purposes of this paper, we define environmental education as a learning process that increases people's knowledge and awareness about the environment and associated challenges. In a more formal setting, EE develops the necessary skills and expertise to address environmental challenges, and fosters attitudes, motivations, and commitments to make informed decisions and take responsible action (UNESCO 1978).

In contrast, interpretation is a process of facilitating an evaluation of natural or cultural information gathered from first-hand experience in leisure settings. Interpretation is a reflective and experiential process and constructivist in its epistemology. While the semantic difference between EE and park interpretation might be considered inconsequential, we distinguish between them in terms of dominant communication processes, scope or focus, and purpose. We propose park interpretation to be primarily experiential, park resource-focused towards appreciation and protection of park values and safe and satisfying visitor engagement with park resources. It includes a management perspective. We propose EE as being a formalized learning process (teaching) about how natural environments function and how people can manage their behavior within ecosystems and live sustainably. While interpretation is usually strongly influenced by park management policy, EE tends to be more independent. However, in South Africa, since 1994 the mandate of SANParks, the country's national parks agency, has been to focus on EE over interpretation. Thus EE is influenced by government policy and lacks its normal independence.

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With these perspectives, we provide an outsider reflection on how the changing political and social culture of South Africa has affected the communication of conservation messages through the balance given to EE and park interpretation in Kruger National Park (KNP), an iconic national park of long standing. This analysis of one program in one iconic park is central to our understanding of how park managing agencies operate, especially in terms of the attention given in public contact programs seeking to foster an appreciation of the values that make features of a park, and the park itself, iconic. The research contributes to the conceptual model (see Figure 1 in Miller et al., this issue) by exemplifying how sociopolitical global change processes can influence the Broker–Local–Tourist (BLT) (Miller 2008) dynamic (within the human component of the model). This case study identifies how changing public sector emphasis (i.e., broker focus) in favor of increasing local environmental awareness (environmental education for schools) has led to declining emphasis on visitor (tourist) services (interpretation) in KNP. One consequence is the need for private sector brokers to take on the interpretation role, with the risk of communication misinterpreting park conservation messages. This has implications for the understanding of "nature" and priorities for "technological" development that services park visitors.

Background

Historical, social and cultural context. Parts of the area now known as KNP were first protected in 1898 as the Sabie Game Reserve by the president of the Transvaal Republic, Paul Kruger. He proposed the need to protect the animals of the Lowveld in 1884, but his revolutionary vision took another 12 years to be realized, when the area between the Sabie and Crocodile rivers was set aside for restricted hunting. KNP was formally established in 1926 under the National Parks Act no. 56. However, human use of and impact on KNP's ecosystems began long before.

South Africa's history dates back to prehistoric times when *Homo erectus* exploited resources of the area between 500,000 and 100,000 years ago, with Stone Age humans (*Homo sapiens*) leaving evidence of continuous human existence in this area for more than 300,000 years (SANParks 2008b). The area has over 250 cultural sites, 130 rock art sites, as well as Baobab trees that have stood for over 4,000 years. Human activity undoubtedly modified the landscape and impacted fauna populations, especially the hypercarnivores. But it was not until the arrival of early European hunting parties and gold prospectors in the mid-19th century that broad-scale impact on the land and its fauna emerged as a conservation issue (Moore and Masuku van Damme 2002). The impact of this exploitative activity on the KNP area culminated in the extinction of both black and white rhino through hunting, with reintroduction of both species occurring in the 1960s and 1970s.

The founding of KNP occurred at a time in South African history when social repression, segregation, and violence were the norm. After the British defeat of the Boers and the ensuing establishment of the Union of South Africa in 1910, white dominance of English and Afrikaans pervaded all facets of society and development. US and Australian national parks, established just prior to South African national parks, were said to be founded on the principle of linking the nation through its natural resources; but, as Carruthers asks, "Who

comprises the nation"? (Carruthers 2003, 2008). In South Africa, the "nation" was not inclusive, since segregation and then (after 1948) apartheid characterized the nation. Access to Kruger, and all national parks, reflected the social norms of the dominant white South African society. The park was established with management objectives suited to the ruling class of the day. KNP was primarily a "whites only" park, with black South Africans and coloreds excluded (Carruthers 1995; Khan 2002). If they did visit, facilities set aside for their use were, at best, inferior (Carruthers 2003, 2008). Indeed, black South Africans were excluded from land they had occupied, and only employed in the park in low-level positions, which attracted poor treatment and discriminatory conditions. This created hostility towards the national parks (Carruthers 1995, 2003, 2008). James Stephenson-Hamilton, the first park manager, noted that the park's clientele need not be wealthy (Carruthers 2001), so long as they were white.

White visitors at the time were divided into three main classes: wealthy visitors from overseas and the larger cities of South Africa; large groups of working-class visitors from local industrial areas; and local residents primarily wanting to hunt (Stevenson-Hamilton 1937). It seems that motivation to travel also delineated these white groups between "nomadic desires of working class sightseers" to "refined desires for the wilderness experience" by amateur naturalists (Bunn 2008). However, after the South African 1948 general election and formalization of the apartheid policy, KNP also became a symbol for the Afrikaner identity of God and nature (Carruthers 1995). For black South Africans, their role in the park remained as guides and camp staff. This oppression continued until the reforms of 1994, when a new political and social regime was declared in South Africa and national parks were opened to all South Africans with a new philosophy of "South African National Parks connecting to Society" (SANParks 2013)

Tourism as a driver of change

Early tourism. The first recognized tourists did not visit KNP until 1918 (Joubert 1990; SANParks 2008b). The opening of the Selati rail line in 1923 facilitated greater access, and by 1927 the first motorists entered the park. Initially the wilderness experience was accompanied by minimal comforts, but as tourism increased, so too did the development of infrastructure and services (Joubert 1990). Interpretation development paralleled infrastructure, starting with Stephenson-Hamilton in the 1930s, who believed in educating the visitor (Carruthers 2003; SANParks 2008b). Thus by the 1950s a time of focused and best-practice park interpretation ensued for white South Africans, with staff and departments employed specifically for interpretation purposes (Joubert 2007; Swemmer and Taljaard 2011). By 1990, KNP had extensive facilities and staff to inform and educate visitors (e.g., Letaba Elephant Hall and the Stephenson-Hamilton Library at Skukuza) and park interpreters were numerous. Specialized staff undertook EE, visitor interpretation, marketing, promotion, and public relations (Moore and Masuku van Damme 2002; Joubert 2007). Visitor interpretation incorporated a variety of interpretive techniques based on the US parks model (Tilden 1957; Ham 1992). However, before 1994 interpretation primarily targeted white audiences and rarely were black audiences included (Moore and Masuku van Damme 2002).

Contemporary tourism. SANParks' core business is seen to be biodiversity conservation; however, tourism is recognized as a major source of revenue (Msimang et al. 2003; Biggs et al. 2014). Today, South African parks cater to all ethnic groups, especially international tourists and increasing numbers of black South African visitors, although their numbers remain low. Much of this can be attributed to the absence, for almost nine decades, of reference to black cultural history in the park. Regardless, tourism to KNP is the major contributor to SANParks operating budget, contributing 88% of the total income (SANParks 2013, pers. comm.) for operations, conservation, and research across South Africa's 20 national parks. While Kruger is the largest park (1,962,362 ha), it is the second-most-visited park after Table Mountain National Park in Cape Town, with 1,450,481 visitors per annum and 913,237 beds and 432,515 camper visitor-nights. This brings an income of ZAR417,866,000 (South African rands, the national currency, equivalent to about US$38 million) to the park system. Of these visitors, only 10% (153,696) participated in SANParks-led activities in all parks.

Interpretation and environmental education

Changing focus of communication. SANParks' current vision statement—"South African National Parks connecting to society"—sets the overarching goal for park communication with all stakeholders, including school and community groups, scientists, and visitors. This vision also reflects the commitment to engage communities in the management of national parks and other protected areas. As Swemmer (2011) has identified, SANParks historically recognized interpretation as intrinsic to management during the establishment and growth of the SANParks protected area estate from the 1950s through to the 1980s. When the apartheid era ended in 1994, change occurred in all levels of South African government and society.

Within SANParks, changes occurred that were not always beneficial to park operations, such as the protection and presentation of park iconic conservation values. Interpretation disappeared from the revamped organization, with the new government's priority of educating South African youth, rather than continuing to provide visitor services, such that conservation was linked to issues of development and human need (Moore and Masuku van Damme 2002). After 1994, this resulted in interpretive center closures, and a number of departments within SANParks being amalgamated or disbanded. One such change was the integration of the SANParks arm responsible for overseeing park interpretation and tour guiding into an EE department within a Social Ecology Unit (Moore and Masuku van Damme 2002). A consequence was a reduction in experienced interpretive staff available to communicate park issues and conservation, and reduced interpretive services for visitors, fewer physical interpretive displays, and loss of quality in display maintenance and production (Moore and Masuku van Damme 2002). By 1994, interpretation of the iconic wildlife and values of KNP devolved to private tour operators, with limited input from SANParks staff. Today SANParks operates minimal interpretive activities and many of the private tour guides no longer operate in the park (K. Moore, personal communication).

Benefits from the change included changed management structure from a white male, Afrikaner nationalism focus (Carruthers 1995; Khan 2002), to a more gender and racially

balanced structure (Moore and Masuku van Damme 2002; Carruthers 2003). The development of a new corporate plan recognized that ecological, cultural, and socioeconomic issues were critical to the survival of the parks. Thus, an era emerged where SANParks' emphasis was on opening parks to all South Africans, regardless of color or economic status, with a priority given to bringing black South Africans into the parks. The establishment of the Social Ecology Unit in 1994 to address SANParks' relationship with local communities led to funding shifts, with more work programs and increased EE outreach to communities surrounding the parks (Moore and Masuku van Damme 2002). Emphasis shifted from interpretation and promotion of iconic values to raising general environmental awareness. This has led to an unbalanced education agenda where EE has dominated communication regarding management of the parks. Some impressive EE programs have emerged that specifically target school-age groups and increase community knowledge and awareness about conservation issues. These programs include Kids in Parks, Imbewu, Kudu Green School Initiative, Junior Ranger Program, and teacher development programs (SANParks 2012). The SANParks 2012–2013 annual report indicates that the EE program reached 213,327 children, an increase of 42.7% over the set target. EE was again emphasized in the 2012–2017 strategic plan, with budgets set to accommodate increases in EE program participation (SANParks 2012). Absent from the current strategic plan was any reference to interpretation.

Education of youth, and stewardship by local communities, is critical for the survival of South Africa's natural wealth. While acknowledging the need, merits, and benefits of the overdue change in policy for public contact, there is a possible perverse outcome. Visitors and tourists, who come to the park to experience the iconic wildlife of KNP, are left to self-interpret their value, ecological significance, and conservation management needs. At some risk is the income that tourists generate, which funds park operations and conservation initiatives across the SANParks estate.

Despite the lack of focus on interpretation in key SANParks policy and strategic planning documentation, there is evidence of interpretation activities persisting on the ground, with ad-hoc displays in every rest camp. Other interpretive activities, requiring considerable funding and planning, have included the development of the Rhino Hall at Berg-en-Dal rest camp and the construction of the Mapungubwe National Park interpretive center with the objective of presenting the area's history and providing awareness and understanding of the vulnerability of the local ecology. Outreach efforts, such as KNP's "Kruger to Kasie" program and the involvement of local communities in the construction of Mapungubwe National Park interpretive center, have also formed part of the broader conservation strategy that jointly achieves interpretation and community engagement objectives. This involvement focuses on benefit-sharing mechanisms under the premise that if local communities benefit from the parks, this will induce positive attitudes toward conservation (Moore and Masuku van Damme 2002,; Ramage et al. 2010). However, the challenge of such benefit-sharing mechanisms may be that they limit the perceived value of natural resources to material or tangible benefits, disregarding intrinsic and bequest values of such resources.

A holistic understanding of the value of natural resources provides opportunities for cultural change. In addition, using tangible benefits to induce behavior change may pose

challenges when the utility of benefits decline over time or become considered inadequate by beneficiaries. Interpretation aims to build long-term behavior change through creating attachments to intrinsic environmental values, where conservation of iconic elements become symbolic of South Africa's wealth. There is obvious need to broaden the scope of conservation efforts beyond education and benefit-sharing mechanisms to also include a wider range of interpretive infrastructure and services.

Recent research investigated the interpretive infrastructure in three rest camps in KNP (Peake 2014). This 2012–2013 study examined the available infrastructure and its content for interpretive and conservation messages. The study found that while there is a vast array of infrastructure, the content did not communicate the core values of the park or organizational objectives, nor interpret the conservation requirements of featured species and habitats (Peake 2014). Most content was information based on park operations, rather than communicating the values of the park's animals, plants, and ecosystems or critical conservation issues, such as rhino poaching. Basic information on the park and its iconic species was missing, outside of two species-specific centers: Letaba (focused on elephants) and Berg-en-Dal (on rhino).

Visitors who do not go to these centers, or go on an organized game drive, and those with expectations of learning about the environment or animals in general will be disappointed, and must rely on their personal knowledge to educate themselves while in the park.

Policy for public contact. In 2002, the Department for Environmental Affairs and Tourism developed a responsible tourism manual for South Africa (DEAT 2002), highlighting and recommending the development of a number of interpretation facilities and services (Spenceley et al. 2002). In response, SANParks prepared an environmental education and interpretation strategy (SANParks 2002). The aim of the strategy was to guide planning and decision-making, identify best practices, and monitor and evaluate environmental interpretation and education to enhance performance and improvement. However, this document remains a draft.

In 2003, SANParks established the People and Conservation Division to complement and support the Social Ecology Unit in providing EE programs in national parks (SANParks 2005). This division's responsibilities included reviewing and updating the stalled 2002 environmental education and interpretation strategy (SANParks 2002). This resulted in the preparation of an environmental education policy (SANParks 2005). However, the interpretive focus was dropped from the title and the word "interpretation" only appears three times. One reference is to the title of the previous document, the other two references are to the environmental program objective, to enhance visitors through environmental interpretation and education (SANParks 2005). There are no further details regarding strategies to achieve the interpretation part of this objective. In 2006, SANParks produced another draft document titled "Coordinated Policy Framework Governing Park Management Plans" to guide the management of all national parks. This policy framework was produced to meet the requirements of the Protected Areas Act No. 57, 2003. There is no reference to interpretation in this important guiding document. The KNP management plan (SANParks 2008a: 103), Section 2.3.1 addresses the differences between EE and interpretation, but goes no further.

In 2008, SANParks undertook an independent review of its interpretation programs. The review was critical of the state of interpretation (Bunn 2008) and as a result, in 2011, SANParks approved the "Responsible Tourism Policy" aimed at the development and management of tourism across all national parks. This acknowledged the need to address the quality of the visitor experience, and not continue to rely on visitors being satisfied with the single focus of seeing animals (Biggs et al. 2014). Drawing insights from this document, a tourism research agenda was drafted which, in part, highlighted the need to develop an "understanding of the underlying factors behind visitor satisfaction and changes in expectations and perceptions" and align interpretation "more closely with SANParks' objectives for tourism, awareness-raising and constituency building" (Biggs et al. 2014: 3). However, as noted above, SANParks' five-year strategic plan (SANParks 2012) does not budget nor plan for interpretation, reflecting a lack of commitment to this important park management tool. Instead, it continues to view interpretation as an add-on to other programs, such as environmental education and tourism marketing initiatives.

Discussion

KNP is a protected "island" in a "sea" of humanity, with more than two million people living on its borders. Thus, SANParks faces significant challenges in managing this protected area for conservation and sustainability while balancing the needs of communities and its tourism funding source. SANParks' budget and policy emphasis on supporting EE rather than park interpretation clearly responds to government policy and contributes to addressing educational inequities inherent in pre-1994 policy. In BLT (Miller 2008) terms, government (public sector) brokers of tourism have emphasized the broad educational needs of local communities at the expense of tourists. For SANParks, as brokers, there is a missed opportunity to use interpretation as a tool to support conservation management action, meet the needs of tourists for information that enhances experiences and ensures understanding of safe behavioral practices, and explain the iconic values and significance of KNP. If tourist operator (private-sector) brokers undertake these interpretive roles, in the short term the consequences are likely to be minimal. However, the risk is that operators, with a client focus and incomplete knowledge of the rationale for management actions, will misinterpret, emphasizing entertainment ahead of appreciation and understanding of conservation management, and fail to explain the iconic values and significance of KNP. Given the limited number of SANParks-led activities and the decline in private-sector operators (unless one stays at a private lodge), tourists may be left to self-interpret, with inherent risks. There is also the risk that tourist satisfaction may decline, with implications for the image of South Africa and the significant revenue streams for SANParks. The "island" nature of KNP means that secure and considerable funding is needed to manage wildlife populations. The current situation is unlikely to remain static and global and local change could signal the start of a downward spiral in values. Pressure on the iconic wildlife may increase with a changing climate (increasing temperature, increased fire events and water shortages), with consequences for the visitor experience and visitation rates. In this context, tourists visiting, or considering visiting, KNP

may perceive that their park experience will be lessened and the probability of wildlife sightings reduced, with consequences for visitation and thus funding of SANParks wildlife conservation operations.

Conclusion

Despite SANParks' historical focus on incorporating interpretation into the management of the national parks (pre-1994), there is now no clear evidence of a comprehensive interpretation program within Kruger National Park. There is evidence, however, that investment in interpretation over the past 17 years has declined. Since 1994, EE has dominated conservation strategies in the management of SANParks. Although some consider interpretation a subset of EE, there are many differences in focus, delivery, and outcomes that set the two communication and learning strategies apart. Most importantly, EE and interpretation target different audiences. EE targets schools and communities for longer-term development of ownership and stewardship (with no short-term income advantage), while interpretation targets the visitor, SANParks' main source of revenue (with potential for greater income generation) for its operational, conservation, and EE requirements. Parks such as Yellowstone in the USA have addressed park interpretation budget deficits through a user-pays system (especially for self-guiding material). One of Peake's 2014 recommendations was for the development of pay-by-donation self-guiding brochures. SANParks has not adopted this idea except for paid game drives. This could be linked to the government's mandate of making parks accessible to all South Africans, many of whom are extremely poor.

Regardless, the case of KNP demonstrates that a single, public sector, broker-sponsored policy decision can cascade through the broader park management system, with implications that are positive for local communities but negative for tourists. It also demonstrates that implications can extend beyond immediate stakeholders to affect economic issues and long-term consequences for park management capacity that may be exacerbated by global environmental change.

For now, KNP rests on its iconic status to attract and satisfy visitors, who possibly depart with a narrow view of savanna conservation because of the lack of information and interpretation. Today's park tourists have greater expectations and demands for quality experiences, including meaningful interpretation. SANParks' reduced attention to visitor services has affected the tourist experience (Du Plessis 2011), and although the consequences remain unclear, they may be highly significant for managing the park. In the interests of risk management, it might be prudent to reconsider the interpretation–EE balance, including consideration of:

- Allocating appropriate resources for interpretive infrastructure development, research, capacity-building, planning, implementation and evaluation;
- Adopting a working definition for interpretation, based on themes that reflect the values of the parks through participatory processes involving staff and community members;
- Integrating the broader scope of interpretation into SANParks' higher -level policies and individual parks' planning processes;

- Ensuring that interpretation is linked to park business goals through the communication of relevant themes as part of promotional and support resources; and
- Accommodating the needs of repeat visits in presentations and other interpretation activities.

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Viewing an Iconic Animal in an Iconic National Park: Bears and People in Yellowstone

Patricia A. Taylor, Kerry A. Gunther, and Burke D. Grandjean

Background

Yellowstone National Park (YNP) occupies 2.2 million acres of land (about 890,000 ha) in northwestern Wyoming, with some overlap into adjacent US states. It is centered near 44.5° N latitude and 110.5° W longitude. Established in 1872, the park forms the core of the Greater Yellowstone ecosystem, whose 18 million acres (7.3 million ha) also include three national wildlife refuges, five national forests, and Grand Teton National Park.

The unique geological features of the landscape, its flora and fauna, and the relative isolation of the park from the effects of human settlement all contribute to Yellowstone's enduring appeal to visitors. Especially notable among these contributing factors are the iconic animals found within the park boundaries. If the American West can be said to have an equivalent to Africa's "Big Five" list of fauna, the most likely candidates for are all present in YNP: bison, moose, elk, mountain lion, and grizzly bear, along with black bear, bald eagle, trumpeter swan, and many other spectacular animal species. In addition, there are approximately 1,300 endemic vascular plant species, some of which rely on the park's many geothermal features to survive the winters. Sixty percent of the world's geysers are within YNP, including several that erupt on a fairly regular basis, from 80 minutes apart to a few hours or longer.

The size, the thermal features, and the range of plants and animals all support YNP's iconic status as a representation of the early American West—the way it once was, or as it is now imagined. This iconic status is also evident from the more than three million visitors to the park each year, with two-thirds of those coming during June, July, and August.

Aims of this research

This special issue discusses issues facing some of the world's most iconic protected areas. Managers of such areas confront a complex challenge to preserve the features that draw visitors in great numbers, while seeking to enhance the overall visitor experience. Yet managers must also attend to protecting those very features, and the visitors themselves, from the sometimes ill-informed or ill-considered choices people might make when interacting with nature. Our focus in this paper is mainly on human–bear encounters, but in the context of human–animal encounters more generally. We briefly overview relevant bear management

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and visitor safety programs in Yellowstone, and then present results from a survey conducted at roadside "animal jams" in YNP in the summer of 2013.

Bear management in Yellowstone

Over time, the National Park Service (NPS) has initiated a number of programs at YNP to monitor and assist the stabilization or growth of particular species of both plants and animals. During the westward expansion by European descendants, several iconic animal species were virtually eliminated from much of the American West, including the grizzly bear as well as the bison and the wolf. All three of these species are again well established in YNP, in no small part as a result of the park's efforts.

The park has long maintained an active bear management program (see Gunther 1994). Both the American black bear (*Ursus americanus*) and the grizzly (*Ursus arctos horribilus*) reside in Yellowstone and the larger ecosystem. Although the focus of much of the current bear management within YNP is on the grizzly, the park's efforts for preventing human–bear conflict apply no less to black bears. The black bear is found throughout the US (except for a few of the mid-Plains states), while the grizzly is present in only 2% of its historical range in the lower 48 (NWF 2005). Within the USA outside of Alaska, the grizzly bear is now found only in Wyoming, Montana, Idaho, and Washington.

With the Endangered Species Act (ESA) of 1966, the US government began a new program in wildlife management, recognizing and providing some limited protection for endangered and threatened species. In 1975, the ESA established general criteria for determining the threatened or endangered status of a species by considering its limited numbers, the conditions of its range, and the degradation of its habitat. The grizzly bear fell into the "threatened" category, as its population in the lower 48 states had fallen from more than 100,000 at the time of European contact to less than 1,000, of which an estimated 136 were in the Yellowstone ecosystem. With the added protections of the ESA, along with the park's other bear management efforts, the Yellowstone grizzly population grew to around 245 by 1993, and had reached more than 700 bears by 2013 (White and Gunther 2013; Haroldson and Frey 2014).

The dilemma for park managers

As animal conservation programs grow in success, such as YNP's efforts for the grizzly bear and the wolf, visitors to Yellowstone increasingly expect to see a bear or a wolf on even a "drive-through" vacation. Indeed, a recent study (Richardson et al. 2014) found that YNP visitors would be willing to pay an extra $41 in entrance fees (in addition to the present $25 for up to a week's visit) if they could then be assured of seeing bears in their natural habitat (see also Steckenreuter and Wolf 2013).

This strong desire to see bears can create what is known as the "bear jam" during the summer vacation months. Several times a day on one or another of YNP's narrow two-lane roads, traffic gets backed up when 10 to 100 cars (or more) come to a stop or move ever so slowly as the occupants try to glimpse a bear. Foot traffic adds to the congestion, and to the danger, as people often leave their vehicles to get a closer look. Most visitors have traveled

long distances to YNP, at considerable expense, and the resulting intensity of their desire to see a bear in its native habitat during their visit generates more than 1,000 bear jams each summer. There are also bison jams, wolf jams, owl jams, etc., but wildlife managers are especially concerned about the potential for serious injury to visitors when people interact so closely with bears.

The roadside bear jam can create an almost carnival-like atmosphere. Visitors may walk in the middle of a road or follow a ranger who is trying to stay between the bear and a crowd of observers while the bear searches for food sources, such as sedges, grasses, roots and bulbs, and ground squirrels. Some visitors might even find themselves within a few dozen yards of a bear, although the regulation minimum distance stated by the NPS is 100 yards.

The success of the grizzly bear programs since 1970 has disproportionately increased the chances for roadside encounters between bears and people. With the growth in the grizzly bear population, there are more male grizzlies roaming their preferred backcountry areas, mostly at night. The threat posed by the males leads some female grizzlies, which have also grown in number, to move with their cubs to human-occupied places and times. It also pressures some black bears to move closer to roads (see Schwartz et al. 2010). Hence there are simply more bears active near roadsides in daylight hours than there were in prior decades.

Nevertheless, human–bear conflicts in YNP have decreased sharply in the past 50 years, even as the number of bears has increased and park visitation has reached all-time highs (NPS 2014). From the 1930s through the 1960s, approximately 48 people per year were injured by bears in YNP, mostly by black bears (NPS 2014). With changes in park policies (especially new rules against feeding bears), the figure dropped to only 1.22 bear-caused human injures per year from 1980 through 2011. This number includes backcountry and frontcountry reports of injuries caused by both black and grizzly bears (NPS 2014).

Despite the decline in the injury rate, fatalities do sometimes ensue; for example, two people died in separate grizzly encounters in 2011. Considerable effort therefore goes into providing warnings and cautionary materials to park visitors, to minimize the risk to both people and bears from dangerous bear–human contacts. This information includes educa-

Figure 1. Left: A typical "bear jam" in YNP. Right: In YNP's Hayden Valley, an adolescent grizzly bear was seen several days in a row, walking close to the edge of the forest as the bison were grazing. This bear jam took 20 minutes to move through. Photos courtesy of National Park Service (left), Patricia A. Taylor (right).

tion on bear behavior as well as on the simple mechanics of viewing bears safely. For example, YNP and the bear program stress the 100-yard distance that needs to be maintained for viewing bears. Additionally, park literature covers the two main types of attacks on people (defensive and aggressive) and how to behave in each situation.

Whether park visitors are aware of the potential dangers when encountering wildlife of any sort, and whether they read park literature on recreating safely near Yellowstone's many animal species, are important topics to park managers for assessing the effectiveness of their informational efforts. To understand whether such safety messages are getting to and being remembered by the public, YNP recently sponsored a visitor survey led by the first author of this paper. Although the primary emphasis was on bear jams, the survey was designed more broadly to cover some safety issues for other kinds of human–animal encounters as well.

The survey

The purpose of the survey was to determine whether park visitors understand and follow various safety recommendations from NPS for viewing wildlife, such as the 100-yard rule for bears and wolves. For nearly three weeks in the summer of 2013, park roads were traveled in a systematic search for animal jams, stopping for interviews whenever one was located. As a practical matter, it was impossible to distinguish a bear jam from any other jam in advance. Still, 57.5% of the interviews were conducted with visitors who said they had stopped to watch a bear (see Table 1), either a black bear (46.2%) or a grizzly (11.3%). A total of 238 interviews were completed, at 114 different jam sites.

The survey design covered the entire park from public roads (but no backcountry sites). Time of day, roads traveled, and driving direction were all varied systematically. Surveying was broken into morning (6 am to 9 am), noontime (11 am to 2 pm), and early evening (5 pm to 8 pm). Roads taken and directions traveled varied over the days, never repeating the same road on consecutive days. Interviewing was carried out from June 14 to July 6, nearly every day (except June 23–25), for 16 days of data collection. These dates captured a period of high roadside visibility for both black bears and grizzlies. All paved roads were covered at least once, but most of the traveling and interviewing were concentrated along the eastern roads of the park, where bears were most active during that period. In particular, the roads between Canyon and Mammoth visitor centers, from Fishing Bridge toward the East Entrance,

Table 1. Animals viewed by respondents at a jam.

	Frequency	%	Cumulative %
Black bear	110	46.2	46.2
Elk	33	13.9	60.1
Bison	31	13.0	73.1
Grizzly bear	27	11.3	84.4
Wolf or Coyote	17	7.1	91.6
All other	20	8.4	100.0
Total	238	100.0	

and from Roosevelt Lodge through Lamar Valley were traveled frequently. In all, we contacted 243 visitors, with a completion rate of 97.9%. A description of the research design and sampling results is provided in an online appendix (available at http://www.georgewright.org/313taylor2_appendix.pdf)); a copy of the full survey instrument is available from the authors on request.

During the three weeks of survey work, we saw numerous violations of regulations regarding animal viewing. Episodes observed at our animal-jam stops included a young man walking after a black bear into a thicket; a crowd walking on a road parallel with the movement of a black bear and cub, only 40 yards away in a lightly wooded area; parents placing a child within 10 yards of a resting male elk; four students jumping from a quickly stopped car and running toward a resting bison to take pictures, less than 20 yards distant; and a large group of photographers attempting to get a picture of an adult badger and two kits, set up about 15 yards from the entrance to a badger hole.

Descriptive results

To determine whether the park's safety messages were registering with visitors, we asked a number of questions related to the rules regarding safe wildlife viewing and recreation while in Yellowstone.

When we asked visitors whether they knew the safe distance regulations on black bear, grizzly bear, and wolf (100 yards) as well as on bison, moose, and elk (25 yards), only 21.4% stated the correct distance for all six animals. However, 87.4% identified the right viewing distance for black bears, and 89.1% did so for grizzlies. For bison, moose, and elk, visitors tended to state *longer* (therefore safer) viewing distances than the park regulations prescribe.

Some of this overestimate of the safe distance for viewing the ungulates may be related to the "social desirability bias" phenomenon in social research (Crowne and Marlowe 1960). Park visitors want to appear knowledgeable and cooperative. Therefore, they may overstate the viewing distance as evidence that they are mindful of the park's emphasis on safety. As 100 yards was both the longest distance given in the response set and the longest distance mentioned in the park's safety literature, the visitors tended to select that distance as the safest response.

A second set of questions that give some indication of how well the park message of safe viewing was getting to the visitors focused on the ways they had received such information. These questions covered receiving an oral explanation regarding safe recreation; seeing safety information on the park's website; reading information on safety from the entrance station or from a campground or a lodge; and finally, whether the visitor had seen any warning signs about safety and animals.

The messages most likely to be noted by visitors to the park were those on warning signs, as almost 93% of the respondents reported having seen such a sign (see Table 2). As a partial validity check, this last item was followed by the question, "And where was that?" Only 10%of the respondents who said they saw a sign were unable to name a likely place that the sign had been seen.

Table 2. Ways of receiving safety information.	
Survey Question	**% Yes**
Did you receive an explanation about safe recreation in an area with wild animals?	35.3
Did you read any material on the park website that discussed your safety when visiting?	58.1
Did you read material from the entrance, campground, picnic area or lodge regarding safe recreation in an area with wild animals?*	75.4
Have you seen any signs warning you about safety and animals in the park?	92.7
*This item in the table abbreviates the full wording in the questionnaire.	

More than three-quarters of the respondents said they had read written material received at the park entrance, a campground, or a lodge. Of all respondents, 39.8% stated that they had read all the material, and 35.6% stated that they had read some of it. The website reached 58.1% of the respondents in the survey, while oral explanations reached only 35.3%.

Receiving information is one thing; remembering it and acting on its warnings can be quite different. The survey therefore included a number of questions covering beliefs about iconic animals, in general, as well as the respondents' knowledge of bear behavior, in particular.

For example, we asked the visitors how strongly they agreed or disagreed with several statements that directly contradict NPS warning materials. Almost all of the respondents (96.6%) strongly disagreed with the incorrect statement that "It is okay to leave food for roadside animals." The further results in Table 3 also indicate that large majorities reject other statements that contradict the official warnings. Thus 83.4% said they strongly disagreed that grazers like moose and bison do not constitute a threat to humans, and only 5.5% responded to that statement with any level of agreement. Similarly, only 6.9% agreed at all with the statement that moose and bison are only dangerous when they have calves with them, while just 8% thought it was okay to imitate wolf howls or elk bugling.

We also asked about bear behavior. While most respondents reported ideas consistent with the park's message about bears, a number of statements show considerable departure from that message. Indeed, the risks that we observed some visitors taking at bear jams are clearly reflected in the survey findings reported in Table 4.

More than 20% of the respondents were in some agreement that they would leave their car to take a picture of a bear less than 100 yards away. Similarly, just a scant majority (52.6%) strongly disagreed with the claim that roadside bears are not really disturbed by the presence of humans. More substantial majorities disagreed with the other statements in Table 4 but, overall, the results suggest that when bears are close to human areas of the park, many visitors think they are not as threatening.

Multivariate analyses

Park managers also need to know whether the responses to such statements are affected by any of the methods for distributing information available to the park (oral explanations, written materials, and signs). To provide this analysis, we first developed a scale of each of the

Table 3. Beliefs about wildlife.					
Survey Question	**% Strongly disagree**	**% Disagree somewhat**	**% Neutral**	**% Agree somewhat**	**% Strongly agree**
It is okay to leave food for roadside bears.	96.6	0.0	0.0	3.0	0.4
Animals that are grazers (like moose and bison) are not a threat to humans.	83.4	10.2	0.9	3.4	2.1
Moose and bison are only a threat if they have calves with them.	78.8	12.2	2.2	5.2	1.7
It is okay to imitate wolf howls or elk bugling; just don't approach them.	72.8	17.8	1.5	5.0	3.0

Table 4. Knowledge of bears.					
Survey Statement	**% Strongly disagree**	**% Disagree somewhat**	**% Neutral**	**% Agree somewhat**	**% Strongly agree**
Roadside bears are used to humans so it's okay if people circle a bear to view it	90.2	8.5	1.3	0.0	0.0
Grizzly bears are the only bears that are really a threat to humans.	86.1	11.4	1.3	1.3	0.0
I have read so much on bears that I can predict when a bear will turn aggressive.	83.3	11.1	2.1	3.4	0.4
It's okay to stand closer to a roadside bear than to a bear in the backcountry.	78.0	13.4	4.3	4.3	0.0
If I thought it safe I'd leave my car to take a picture of a bear that was < 100 yards away.	55.7	16.2	5.1	20.0	0.3
Bears foraging near roads are not really disturbed by the presence of humans.	52.6	30.3	10.1	6.1	0.9

two sets of questions just discussed. We found a Cronbach's alpha of .769 for beliefs about wildlife (Table 3), and an alpha of .602 for knowledge of bears (Table 4). These alpha values demonstrate the high reliability (internal consistency) of the two scales; the questions are tapping an underlying similarity within each set of attitudes and beliefs. We summed the respondents' answers to each statement so that the higher the score on the scale, the more the responses conform to the warnings in official park materials.

We hypothesized that those individuals whose beliefs or opinions conform most closely with the official park positions on wildlife viewing and bear behavior would be older (since the young are generally greater risk-takers), more educated (hence more likely to read and understand the materials), more often female (more risk-averse), accompanied by children (more protective) and likely to have traveled shorter distances to get to the park (lower investment, so less intense desire to see animals). We further hypothesized that the respondents'

stated acceptance of official park warnings would increase with exposure to the warning materials, whether orally, in writing, or on signs.

In Table 5 we present the results of two multiple regression analyses, predicting both the beliefs about wildlife and the knowledge of bears scales. The table provides the standardized estimates of effects from the independent variables on these two dependent variables. Age, gender, distance to Yellowstone, and oral explanation are all significantly related to the beliefs about wildlife scale. As hypothesized, older visitors expressed beliefs more consistent with official park information, while younger visitors held riskier beliefs about wild animals and safety. Women were also significantly more likely to express park-consistent beliefs, as expected from studies that suggest males are more inclined to take risks, both as adolescents and as adults (Morrongiello and Rennie 1998; Zuckerman and Kuhlman 2000). And again as hypothesized, those who had traveled a greater distance to Yellowstone were more likely to hold beliefs contrary to park information and guidelines on animal viewing. Finally, of the three methods of information access, only oral explanation was significantly related to the beliefs about wildlife scale. Visitors who had heard directly from a representative in the park (such as campground concessionaire or a ranger) about wildlife safety were more likely to express beliefs consistent with official park positions on the subject.

The regression results for the knowledge of bears scale are quite similar. Gender, distance to Yellowstone, and oral explanation are all significantly related to this scale (though age is not). Women were again more likely to express opinions consistent with park-provided information, and visitors who traveled farther to Yellowstone were again more likely to express contrary opinions. As before, receiving an oral explanation of park policies was positively related to expressing opinions consistent with the official warnings.

Neither of the other modes of information-transfer (written materials and signs) was significantly related to either of the scales. The high regard for park personnel expressed in various national surveys, and the interactive nature of oral discourse, are two likely reasons for the greater impact of oral explanations on the beliefs and opinions of park visitors.

Table 5. Variables related to the scales for beliefs about wildlife and knowledge of bears (standardized regression coefficients).

Independent variables predicting scale values	Beliefs about Wildlife		Knowledge of Bears	
	Beta	P-value	Beta	P-value
Age	.169	.008*	.034	.308
Education	–.084	.115	–.089	.098
Female	.176	.006*	.106	.008*
Children	.037	.300	–.111	.051
Distance to YNP	–.228	.001*	–.134	.026*
Oral Explanation	.141	.025*	.097	.026*
Written Material	–.004	.478	–.031	.326
Warning Signs	.046	.255	–.051	.228

* Statistically significant ($p < .05$, one-tailed t-tests).

Summary

Nearly all of the survey respondents said they had seen warning signs about the animals in Yellowstone; by substantial majorities, they also said they had gotten written material on the subject either at the park or on the park website. A much smaller fraction of them (about a third) said they had received an oral explanation on recreating safely in wildlife country.

Most of the respondents identified minimum safe distances for viewing wildlife that were at least as great as those in the official park guidelines, and they generally disagreed with statements posed to them that contradicted park policies about safety around wild animals. However, only a slim majority strongly disagreed with the statement that roadside bears are not really disturbed by the presence of humans. Indeed, more than a fifth of the respondents acknowledged that they would leave their car to take a picture of a bear that was closer than the recommended safe viewing distance. Such risky opinions were also reflected in some of the visitor behaviors that were observed during the course of the interviews at animal jams.

Controlling statistically for age, education, presence of children, written warning materials, and signs, we found that gender, distance traveled to Yellowstone, and receiving an oral explanation of wildlife safety all affected the visitors' expressed beliefs and opinions about Yellowstone's animals in general, and about its bears in particular.

Discussion

A bear jam—or indeed, any animal jam—is not simply an occasion for viewing an iconic animal. For park visitors, it may be perceived as part of a shared "wilderness" experience. It provides a feeling a kinship with the first human visitors through the area, as well as with the first European explorers. It is the bonding of children and parents through travel, with the heightened awareness of nature that sometimes comes from viewing a wild animal "up close and personal." The bear jam becomes part of the "remember when?" of family life, adding to family holidays and family lore. These social sources of its appeal all contribute to the intransigence of the bear jam as a problem for park management.

In responding to the attraction of the animal jam experience, park managers need to deliver their message of safe animal viewing in a manner that will be remembered and heeded by park visitors. The results of this research suggest ways to enhance those efforts.

A visitor's gender and travel distance are, of course, not subject to influence by park management. However, awareness of how those two variables affect beliefs and knowledge about wildlife safety can be useful in targeting informational campaigns for safe viewing of park animals (Bath and Enck 2003). And allocating park personnel to places where they can deliver information orally *is* within management control. Personnel cost more than printed materials or signs, but have more impact. Indeed, over half the federal budget for Yellowstone is devoted to personnel costs (GAO 2005). Even so, the park estimates that it has a shortfall of over 200 personnel, or approximately one-fifth of the support needed to run and monitor programs and visitors. Hearing from the human icon of the national parks (a park ranger) about an iconic animal (the grizzly bear) in the nation's iconic park (Yellowstone) seems to drive home the key messages about wildlife safety (see Swearington and Johnson 1995).

Management of resources is always a difficult task, especially during times of tight fund-

ing. Yet to further program interests, using park rangers to enhance personal contact with visitors, along with devoting more resources to hiring rangers, both need to be considered in light of these findings. More generally, parks that achieve iconic status have effects far beyond their boundaries (see Carter et al., this issue), even setting a standard for the park system as a whole. YNP is one of the iconic parks of the US national park system. With its iconic animals, it draws visitors domestically and internationally, many of whom hope for a sighting of the emblems of America's western wilderness. The large size of the park means its budgetary and personnel resources are always spread thin. And yet, by virtue of its size and its iconic status, Yellowstone has more total dollars and people at its disposal than smaller parks. Effective allocation of those resources is essential for managing the park's iconic features, for informing and protecting visitors, and for supporting research to evaluate all of those efforts. YNP also actively disseminates the results of such research to managers of other parks throughout the US national park system, and indeed, throughout the world. These other parks face their own unique challenges, and our case study of human–bear safety may not be directly applicable to their specific circumstances. Nevertheless, every protected area can take something of value from the process we have described for addressing this particular management issue at America's first national park.

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Examining Threats to Iconic National Parks through Modeling Global Change, Biocomplexity, and Human Dynamics

Stephen J. Walsh, R.W. (Bill) Carter, Scott Lieske, Diego Quiroga, and Carlos F. Mena

Among the factors posing new and complex challenges to coupled natural–human components of iconic parks systems are globalization, climate and environmental change, economic development, population migration, international tourism, land use/land cover dynamics, and political instability of governments and institutions. These challenges are evident in almost all settings and are certainly emerging within and at the edges of iconic national parks (Porter-Bolland et al. 2011; Sieck et al. 2011). Created in part to maintain biodiversity, iconic national parks focus world attention on conservation by representing special places of highly valued and emblematic species, as well as sites of fragile, sensitive, and unique ecosystems (Velarde et al. 2005; Walsh and Mena 2013). Iconic protected species and landscapes, however, are under considerable threat from population migration, economic development, and environmental dynamics, which act synergistically and are exacerbated by climate change (Stolton and Dudley 2010).

Iconic national parks are often perceived by the public to be more sensitive to these issues because of their high profile and thus become targets of human interest and concern. Ultimately, the sustainability of these places depends on the adaptive behavior of society, the vulnerability and resilience of the terrestrial and/or marine ecosystems, and the ability of the social system to cope with conflicting demands and feedbacks. Management capacity to deliver sustainable conservation and recreational outcomes is challenged by uncertainty about the internal and external dynamics between elements of the park system as well as global-level exogenous dynamics. In this paper, we propose a *biocomplexity* framework for exploring the system dynamics of iconic national parks in the context of global change, both environmental and socioeconomic. The biocomplexity framework expands on the conceptual framework of Miller et al. (this issue), and is our foundation for modeling coupled human–natural systems of iconic national park systems. Dynamic systems models are suggested as an integrative and synthetic test-bed. Such models can simulate, predict, and mediate conditions given specified stocks, flows, exchange rates, and feedback loops between key parameters.

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An overarching program of collaborative research

The general intent of this project is to position research collaborators for developing overarching research hypotheses and scientific proposals, resulting in an international network of researchers and research questions for the study of iconic national parks. To better understand the drivers and patterns of change in parks and across diverse environments, we propose the fusion of disparate data and theoretical assumptions to synthesize knowledge and generate prognostic outcomes interpreted within a biocomplexity context (complex adaptive systems, non-linear system dynamics, emergent behaviors, feedback mechanisms, and critical thresholds). The fundamental questions to be addressed are:

- Can ecological sustainability be achieved for iconic national parks threatened by the direct and indirect consequences of global change and associated social and ecological dynamics?
- How might the impacts of these changes affect iconic landscapes and species?
- How might these effects mediate tourist behavior in their choice of destinations and satisfaction levels when visiting some of the most sensitive places on earth?

Tourism, an important economic driver at local, regional, and national levels, is highlighted as an international force that influences global change, a feedback to shifting patterns of ecosystem goods and services, and a central factor affecting the sustainability of iconic species and landscapes in an international network of national parks. Further, tourism heightens social knowledge regarding the central issues related to the sustainability of iconic parks.

To study the questions, we propose:

- A theoretical perspective, rooted in biocomplexity, involving a coupled human–natural system that is representative of the interactions and feedback loops within and among ecological systems, the physical systems on which they depend, and the human systems with which they interact (Michener et al. 2003; Walsh et al. 2011);
- Identification of the linkages between social–ecological subsystems for a group of national parks that are internationally recognized for their emblematic species and iconic landscapes and arrayed along a multi-dimensional gradient of social and ecological vulnerability;
- A description of how these linkages are influenced by internal and external perturbations;
- An assessment of local to national challenges to their sustainability; and,
- Use of dynamic simulation models to explore scenarios of change that are capable of accommodating human–environment interactions (including management interventions) and endogenous and exogenous dynamics (Walsh et al. 2013; Malanson et al. 2014).

This general approach provides a global model and perspective for assessing the health of national parks and other fragile and vulnerable sites under stress from human activity and natural forces (Coombes and Jones 2010).

The biocomplexity context. This context provides a link to the identification of critical thresholds in system dynamics, feedback mechanisms that mediate systems, and the emer-

gence of new system behaviors that offer insights into social and ecological interactions in non-linear systems. This will necessitate modeling multiple components, interacting in ways that link patterns and processes across scales (Walsh et al. 2011, 2013). Endogenous and exogenous factors combine in complex ways to alter the vulnerability and resilience of system components (White and Engelen 1993), but complex systems evolve through time, and their past is co-responsible for their present behavior (Cilliers 1998). Further, the uses of complex systems focus on irreducible complexity arising from simplicity. This view sees the complex nature of systems as emerging from nonlinearities due to large numbers of interactions involving feedbacks occurring at one or more lower levels within the system. Complex systems are generally far from being in equilibrium (Bak 1998), with a constant set of interactions that maintain system organization through negative feedbacks or alter subsequent alternatives through positive feedbacks. Thus, complexity theory holds that systems cannot be suitably understood without focusing on the feedbacks and nonlinearities that lead to emergent multiscale phenomena (Matthews et al. 1999). A complexity theory analysis aims at understanding feedback mechanisms and changes in state-space through nonlinearities and thresholds, in relation to a dynamic environment with the goal of understanding how simple, fundamental processes combine to produce complex holistic systems (Luhmann 1985).

While global changes, including the forces associated with tourism and population migration, exert exogenous pressures on ecosystems, the coupled human–natural systems have their own spatially contingent endogenous dynamics (Gonzalez et al. 2008). Positive and negative feedbacks that shape and re-shape the relationships between people and the environment are critically important. For example, the consumptive pressures on the environment by the expanding human dimension has serious consequences for national park sustainability, but these pressures can be ameliorated by increased adoption of a conservation ideology, scientific knowledge, and adaptive policies.

The application of biocomplexity theory is providing insights on the dynamics occurring in such settings by looking for universal properties in spatially extended systems (see the special issue of *GeoForum*, edited by Walsh and McGinnis 2008). Feedbacks between people, places, and the environment constrain or even reverse some of the original changes in land cover and land use through system dynamics (Matthews et al. 1999). In this way, properties emerging from local nonlinear feedbacks constrain the evolving patterns of land use (Blackman 2000). Critical points in the spatial structure of the environment patterns and feedbacks can produce a system with identifiable future alternative states in which instabilities can "flip" a system into another regime of behavior by changing the processes that control social–ecological interactions (Parker et al. 2003).

Adaptive capacity and resilience within a biocomplexity frame. The intent is to examine the adaptive capacity and resilience of iconic national parks and management responses by examining a suite of multi-dimensional forces and factors that threaten their social–ecological sustainability (Figure 1). These factors can be divided into three broad areas: (1) global change impacts on the biophysical and socioeconomic conditions within and around the national park that affect the status of the iconic features of the park; (2) the resource management response to these changes and their outcomes; and (3) the socioeconomic responses

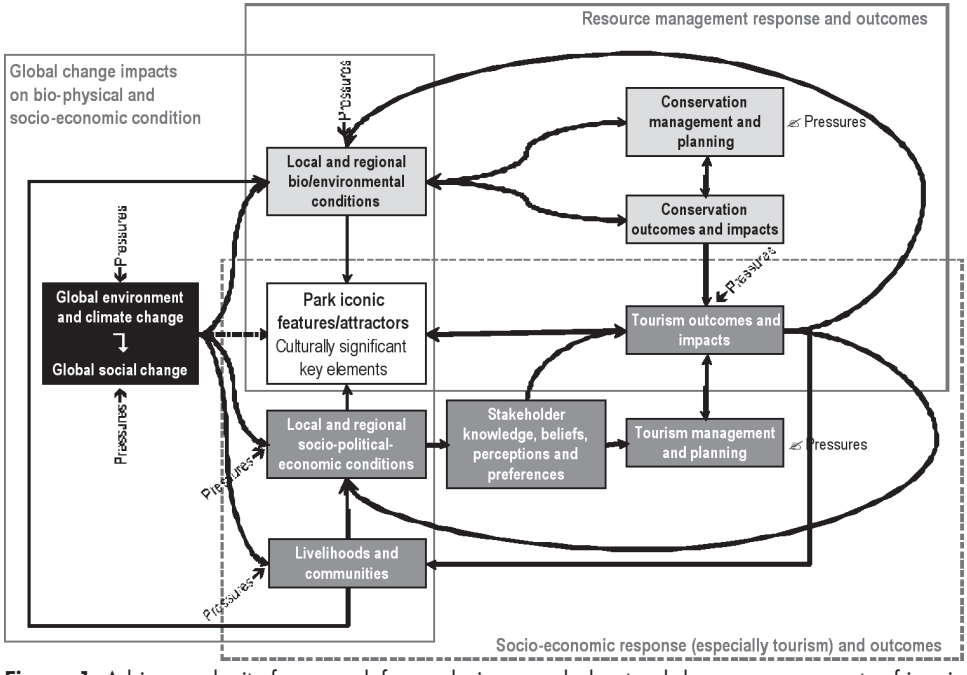


Figure 1. A biocomplexity framework for exploring coupled natural–human components of iconic national park systems towards addressing vulnerability.

and outcomes. We propose to consider tourism specifically, because of its interdependency with the status of iconic features of the parks.

The social–ecological threats to iconic national parks that we address include:

- Demographic changes (including tourist flows, migrants, and endogenous population growth);
- Economic changes (including the development of local, national, and global markets for terrestrial and/or marine resources, tourism, agricultural products, and household livelihood alternatives);
- Biophysical changes (including changes in ecosystem goods and services, such as habitat dynamics, which affect iconic, native, and endemic as well as invasive species, their influence on land productivity, and changes in system elements such a fire frequency and associated disturbance regimes);
- Marine and land use changes (including "foundational" effects on fringing mangroves and their ability to serve as nurseries for juvenile fish, crustaceans, and marine mammals linked to sea-level rise, and the impact of within and among island connectivity of marine species on habitat dynamics and value of local fisheries); and
- Global climate change, including the impacts of ENSO (El Niño–Southern Oscillation) and PDO (Pacific Decadal Oscillation) events, such as the effects of El Niño on ocean upwelling, marine productivity, and species migration.

Choice of case study national parks

We propose selecting 15 to 20 iconic national parks through a preliminary review of over 100 areas, which vary by geographic settings and circumstances, to collectively represent a social–ecological gradient as an analogue of other similarly challenged iconic national parks around the globe.

Capturing the diversity of iconic national parks. Secondary analysis of iconic national parks is needed to objectively capture the diversity of case-specific global change issues. The purpose of this secondary analysis is to select in-depth case study sites representative of the diversity of contexts in which iconic national parks exist. The set would offer differences in their direct and indirect impacts on the environment caused by an expanding human dimension (e.g., increases in tourism and the demand for economic development in bordering areas and nearby communities). They would also capture differences in ecological dynamics and changes caused by exogenous factors (e.g., ablation of alpine glaciers, increases in coral reef change, and threats within their local and regional surroundings).

Parks would need to meet four criteria: they must (1) be high profile, with nature-based tourism; (2) be potentially heavily impacted by climate and global change; (3) have local communities that rely on national park tourism, and (4) exhibit ecosystem diversity and vulnerability to change. One approach would be to plot iconic national parks against multiple axes or dimensions to develop the gradient of vulnerability. Existing databases from the World Commission on Protected Areas and other data sources could be used for this purpose. For example, the first axis might be a measure of the park's susceptibility to global change and the second a measure of the its adaptive capacity to accommodate social and ecological change (Figure 2) (cf. Leverington et al. 2010).

Among the factors to be considered to ordinate is a sample of candidate sites in multi-dimensional space (and within a space–time context). Additionally, the selection of parks for study might include: (1) population migration and tourism; (2) invasive flora and fauna; (3) land use change and food security and provisioning; (4) quality and quantity of available freshwater; (5) old versus new human settlement patterns; (6) social and ecological disturbance regimes; (7) climate change and the attendant threats related to sea-level rise, ocean warming, and ENSO and PDO events; (8) conservation and development infrastructure; (9) geographic position and accessibility; (10) governance, institutions, and policies; (11) natural hazards, geodynamics, and tectonic deformation; (12) national park status; (13) globalization and local to international connectivity; (14) terrestrial and marine participatory management and their effectiveness; and (15) levels of biodiversity and endemism.

Proof-of-concept park selection. Through a preliminary assessment, we have chosen five study areas to anchor our sustainability gradient. For each national park, we examine elements of the social, terrestrial, and/or marine subsystems with the intent of conducting innovative research that supports transformative

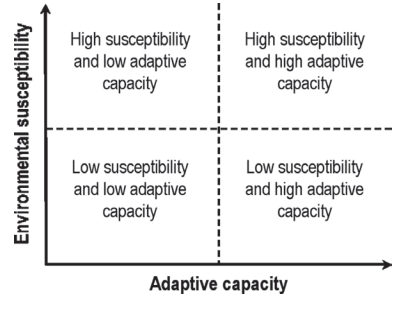


Figure 2. A two-dimensional plot for the selection of detailed case study sites.

interdisciplinary understanding of biocomplexity, dynamic systems modeling, and endogenous and exogenous forces that threaten park sustainability.

Generally, case study parks have been chosen for their biodiversity; namely, their broad representation of the planet's biological communities, species richness, biological distinctiveness, and intactness. Protection is not only about space, but also about functional groups, keystone species, climatic refugia, and multiple habitats within a biome to provide adequate representation and protection. There are a myriad of stressors that affect natural systems, and the limited body of research on the effects of climate and non-climate stressors suggests synergistic responses. Management and policy are essential to reduce local stressors on natural systems and to increase the overall resilience of systems (Tompkins and Adger 2004). If climatic alterations take place as predicted, for example, static national parks may not assure habitat persistence, ecosystem functioning, and the capacity to support all the species they were designed to protect (Burrows et al. 2011).

Our proposed research is a case study of multiple national parks recognized not only for their iconic species and landscapes, but also their international tourism markets (their possible negative consequences for the environment), and their vulnerability to global change and its effect on their associated social and ecological systems. We begin through a phased approach in which a network of "primary" national parks are used for initial study, followed by the inclusion of a "secondary" group that extends representation within the social and ecological gradient. The primary group of national parks is the Changbai Mountains Nature Reserve, China; Galapagos National Park, Ecuador; Great Barrier Reef Marine Park and Fraser Island, Australia; Kruger National Park, South Africa; and Yellowstone National Park, USA (Table 1). These have been chosen because of their diversity of stages of community reliance on tourism, available information to assess their vulnerability, personal links to the national parks and the conservation management teams, and the presence of associated project teams and institutions that have conducted preliminary research to guide more substantial and expansive efforts. In addition, these parks are high-profile and iconic tourism destinations, and management is cognizant of the need to provide leadership in addressing the impacts of climate and global change due to tourism's vulnerability.

The similarities and differences of the ecosystems allow for meaningful comparison of the issues and impacts associated with climate change on tourism as well as on ecosystems goods and services. The collective case studies provide comparative opportunities across continents where reliance on tourism, as a contributor to the local and regional GDP, is substantial. Internationally renowned, iconic national parks attract high levels of media interest. Therefore, they draw the attention of the global community to the need to reconcile social and ecological threats to the sustainability of biodiversity and endemism that enables the conservation of iconic megafauna, such as the grizzly bears and bison of Yellowstone; the giant tortoises, marine iguanas, and hammerhead sharks of the Galapagos; the Big Five wildlife species of Kruger; and the dingoes of Fraser Island.

These selected national parks capture differences in iconic species; landscape morphology; residential, migrant, and tourist populations; levels of economic and infrastructure development in the nearby communities; household livelihood alternatives in agriculture,

Table 1. Summary general vulnerability status, threat level and type, adaptive capacity, and community and tourism dependence of the selected network of international iconic national parks. (Type: HC–habitat change, SLR–sea-level rise.)

National park	Iconicity	Tourism type	Threat level	Type	Adaptive capacity	Commercial dependence	Tourism dependence	Presence of humans and local communities
Changbai Mountains, China	Wilderness	Land (drive and hike)	Medium	HC	Medium	Medium	Medium	Medium
Fraser Island, Australia	Landscape (wilderness)	Land (drive and hike)	High	SLR	High	Medium	High	Medium
Galapagos National Park, Ecuador	Landscape & Animals	Marine (boat) and land	High	HC	Low	High	Very high	Very high
Great Barrier Reef Marine Park, Australia	Animals	Marine (boat)	High	SLR	High	High	High	Very high
Kruger National Park South Africa	Animals	Land (drive and hike)	Medium	HC	Low	High	Very high	High
Yellowstone National Park, USA	Landscape & Animals	Land (drive and hike)	High	HC	High	Medium	High	Medium

fisheries, and tourism; and forecasted climate change impacts on ecosystem goods and services. The diversity of their geographic situations, both social and ecological, as well as their dynamics and change trajectories caused by human and natural forces, generate measurable differences in social and ecological characteristics and vulnerabilities that extend our findings to an array of conditions, circumstances, and geographic settings.

Proof-of-concept research tasks

Beginning with the selected national park settings, the foundational tasks involve synthesizing case study research on natural–human systems.

1. Expand the literature review of iconicity, national park status, threats to sustainability and metrics of vulnerability and resilience, tourism patterns and indicators of tourist satisfaction, social and ecological change in national parks and surrounding areas, and ecosystem responses and indicators to climate and environment change.
2. Inventory, assess, and consolidate multi-scale and multi-thematic social and ecological data for the iconic national parks as a step towards realizing the general intent of the collaborations.

3. Determine data gaps and gaps in scientific understanding of iconic species and landscapes relative to stressors imposed by demographic change, tourism, land use/land cover change, disturbance regimes, invasive species, and climate and environmental change in social, terrestrial, and marine subsystems.
4. Develop measurement and monitoring approaches to assess the vulnerability and resilience of iconic national parks and their social and ecological connectivity using, for example, social and organizational surveys, remote sensing image analysis and data fusion techniques, statistical and ecological process models, and dynamic simulation models for examining exogenous dynamics and non-linear relationships with feedbacks and critical thresholds examined within a scenario-testing context.
5. Interpret collected and/or simulated social and ecological data to examine individual and household connections and linked effects among social and ecological subsystems.
6. Within the context of each site and relying on the disciplinary and interdisciplinary expertise of each member of the project team, define and implement specific approaches for generating and visualizing preliminary relationships and project results that link people and environment, and assess the sustainability of iconic landscapes and species under scenarios of change.
7. Synthesize across approaches, data, and methods to define best practices for assessing iconic species and landscapes within the global network of iconic national parks.
8. Compare and contrast the multiple cases to increase understanding of the implications of local and global contexts and historical–contemporary–future processes and conditions on the social and ecological vulnerability of iconic national parks and their local to regional environs.
9. Examine the key descriptors of the social, terrestrial, and/or marine subsystems by focusing on important relationships unique to each study area, operating through their integrated and linked effects. Then further develop indicators of social, terrestrial, and/or marine subsystems, behaviors, and dynamics around a locally compelling and internationally important set of questions to construct system perspectives that can be used to conceptualize and model national parks as a complex, adaptive, and dynamic systems.
10. Apply integrative geospatial data and methods (e.g., GIS and satellite remote sensing) to assess landscape conditions and states. This will require the development of metrics, indices, and data fusion strategies for landscape characterization for each study area.
11. Develop dynamic simulation models for case study national parks, extended to global settings through generalization approaches, so scenarios of change can be examined that involve multi-scale processes, both in space and time, and explicitly link social and ecological threats to park sustainability. Linking adaptive management to scenarios of change will be vital as we explore the impacts of climate and environmental change on tourism with direct and indirect implications on the environment and for management.

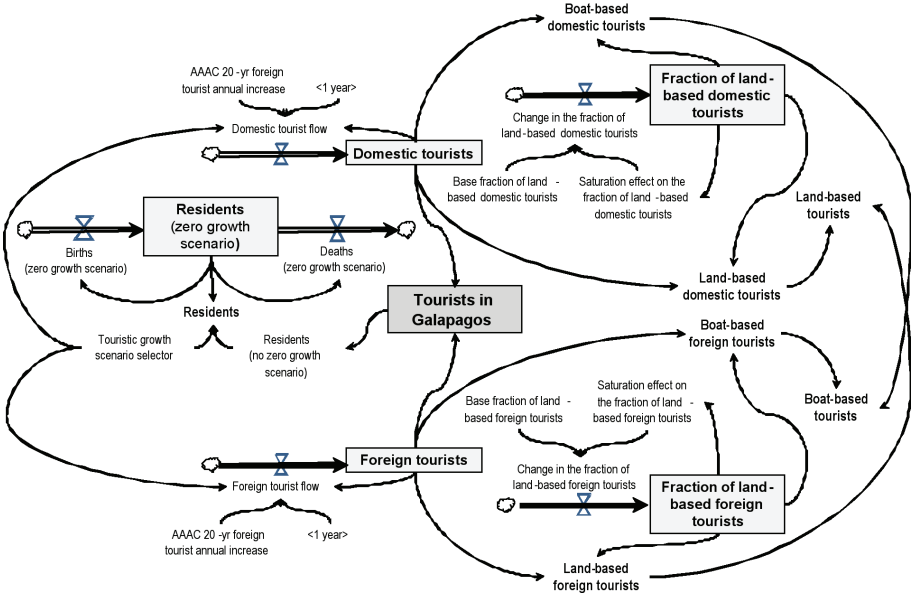
The key to undertaking these foundation tasks and expanded application is to identify local collaborative groups and shared data sets for a broader, multi-dimensional analysis that extends the pilot studies to give greater validity to generalizations. In application, the tasks

will emphasize co-learning between science, management, and national park stakeholders. These tasks will also build on the findings of the pilot studies, relevant literature and local informal knowledge, measurement networks, and multi-resolution satellite image time-series and ecological models of changes in ecosystem properties. In doing this, it will be important to be mindful of the need for developing compatible data, methods, and comparable approaches across the study areas, while allowing for local contexts, data, and constraints to be infused into subsequent studies.

Developing dynamic systems models

We propose developing dynamic systems models that examine social–ecological vulnerability of ecosystems using a predator–prey relationship as the general test-bed to examine the drivers of change. For example, ecosystem goods and services are the prey, whereas tourism and the resident population are predators. Our models will enable examination of the evolution of "physical" capital (e.g., water), "social" capital (e.g., social networks), and "natural" capital (e.g., landscape structure) on the adaptive behaviors of tourists and residents (locals and brokers, see Miller et al., this issue) relative to changes in ecosystem goods and services (Hernandez and Leon 2006). Ordinary least squares regression can link key variables in the dynamic systems models, such as the number of tourist arrivals and growth in the local population (Villacis and Carrillo 2013). Biocomplexity serves as the lens through which we can study social–ecological processes and their co-evolution and adaptive resilience to synthesize the feedbacks among system parameters. A dynamic simulation model for the Galapagos National Park exemplifies what is possible for other iconic parks (Figure 3).

Figure 3. A preliminary template example of a dynamic systems model for the Galapagos Islands. (Residents = Local and Brokers; see Miller et al., this issue.)



Several studies have used dynamic systems models to assess the economic, environmental, and/or social impacts of tourism development on social–ecological processes (see, for example, Johnston and Tyrell 2005; Sainaghi 2006; Garin-Munoz and Montero-Martin 207: Lacitignola et al. 2007; Xing and Dangerfield 2011).

Using a dynamic simulation model, Rey-Maquierira et al. (2009) examined the dynamics between tourism policy, environmental externalities, and policy tools (e.g., tourism taxation, land management policies, and accommodation standards). Sinay et al. (2008) used Bayesian logic to model the dynamics between tourism, national park ecosystem services, and cultural change. Finally, dynamic systems models are used to study the dynamic resilience of tourism or the ability of social–ecological systems to recover or move to an alternative and dynamic form of equilibrium once perturbed (Tyrrell and Johnson 2008). In these examples, the models have integrated social–ecological factors to emphasize "whole-system" assessments. Interdisciplinary perspectives were achieved through a framework conceptualizing human–environment impacts and tourism development strategies (Patterson et al. 2004). Such models simulate, predict, or mediate conditions given specified feedbacks between key parameters.

Facilitating collaboration and data-sharing

The foundation network of scholars in the USA, Australia, Ecuador, and South Africa align thematically, theoretically, and geographically to selected national park settings and contexts, represented by key discriminant factors that are integrated in multi-dimensional space and viewed within a space-time context. To advance this work with an expanded network of selected scholars, we will enable the coupled natural–human research initiatives by developing an open and pluggable cyber infrastructure (CI). This will use off-the-shelf technologies wherever possible, and unique systems and linkages to campus and national research resources, programs, and expertise for analysis, discovery, collaboration, and dissemination. Data and information will integrate across a range of disciplines using disparate data models that must be made interoperable with advanced CI tools. A highly functional and adaptable CI layer is critical to the success of our long-term research objectives. The required services will include the full range of CI capabilities including: data and telecommunications; sensor networks and reconfigurable computing; data assimilation, management, analysis, and mining; visualization and collaborative technologies; remote sensing image analysis; and statistical and spatial modeling using high-performance and distributed computing. The CI framework also will need to support a diverse set of virtual organizations and project affiliates on different continents.

Technical sustainability will be achieved through the use of data preservation standards, hardware and software system revision, and the virtualization and evolution of the CI as the project evolves to accommodate new findings, data collections, and analyses. CI contributions in mapping, data management, and geo-analytics will involve a system for sharing and building applications using geographic data consisting of distributed data models, data management schemes, and web services that can be used for data assimilation, analytics, and visualization, and to manage the processes and results involved in high-performance computation.

Conclusion

To understand and conserve sensitive ecosystems, it is imperative to investigate the connections among social, terrestrial, and marine subsystems of iconic national parks at multiple space-time scales. Doing so requires working across traditional disciplinary boundaries as well as developing international collaborations among universities, conservation groups, government organizations, and key entities in the management of iconic national parks. The interdisciplinary nature of coupled natural–human systems has been well documented, so we have identified an initial set of international iconic national parks and an associated international network of scholars and institutions that extend across the social, natural, spatial, and computational sciences. How tourism is shaped by global change, shifts in ecosystem goods and services, changes in land use and land cover, and the corresponding patterns and dynamics of iconic landscapes and behavioral shifts of iconic species is our fundamental concern.

This initiative aims to build understanding, raise awareness, and strengthen capacity to manage the world's iconic national parks in the face of global change. The partnerships envisaged will ensure that the research incorporates local knowledge, a gradient of vulnerability for a global network of iconic national parks, and buy-in from local to global management agencies, conservation organizations, and national and international funding institutions that emphasize research, education, and community outreach and engagement.

The project's focus on iconic national parks is based on: (1) the ability of these areas to attract international attention to the risks of global change on natural and cultural heritage; (2) recognition of inherent values of these areas to local communities and global societies; (3) importance of international tourism to the socioeconomic vitality and ecological integrity of national parks and the places that border them; (4) changes in the integrative effects of population and environment as a consequence of global change and the expanding human dimension; (5) impact of ecosystem dynamics on iconic species and landscapes around the globe; (6) the strengthening of management capacity of iconic national park managers through the engagement of management agencies and the implementation of findings through training and development programs and technology transfer to local constituencies; and (7) the building of community capacity and resilience to social and ecological change.

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The Antiquities Act and How Theodore Roosevelt Shaped It

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Introduction

The Antiquities Act of 1906 is among the most important of American conservation and preservation laws. It provides specifically for the preservation of archaeological, historical, and natural resources on public lands. It also provides the foundation of a century's worth of further developments in statutes, regulations, and policies for the conservation and preservation of archaeological, historical, and natural resources throughout the United States.[1] Theodore Roosevelt, of course, was instrumental in enacting this statute. As president, in June 1906 he signed the act making it United States law. As a leader of the Progressive political movement, Roosevelt encouraged the development of conservation and preservation legislation like the Antiquities Act. Once the act became law, Roosevelt used it actively and effectively, establishing an approach to national monument establishment and precedents that were applied by his successors.

Yet, the Antiquities Act is not commonly or widely known except among federal agency resource managers, politicians, and legislators concerned with the management and uses of public lands, especially but not exclusively in the western United States. The Antiquities Act has come to public attention in 1996 and 2000–2001 when President Bill Clinton, acting under the authority of Section 2 of the statute, established or enlarged 20 national monuments, ultimately designating more public acres as national monuments than Roosevelt did in his initial uses of the law.[2] President George W. Bush, Clinton's successor, criticized Clinton's proclamations of these Monuments during his campaign for the presidency in 2000; however, after conducting its own review, his administration decided not to reverse any of the designations. In 2006, Bush himself used the national monument authority to set aside the African American Burial Ground National Monument in the center of Manhattan, New York

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City. Before the end of his term, President Bush again used this authority to designate national monuments, among them the largest, Papahanaumokuakea Marine National Monument (80 million acres) and the Marianas Trench Marine National Monument (60.9 million acres), plus the World War II Valor in the Pacific National Monument, the Pacific Remote Islands Marine National Monument, and the Rose Atoll Marine National Monument.[3]

My aim in this article is to describe how and why the Antiquities Act became federal law, how the president who signed the law, Theodore Roosevelt, influenced its enactment, and how Roosevelt's use of the law affected the ways in which his successors, presidents throughout the 20th century and into the 21st century, made use of the Antiquities Act.

The road to the Antiquities Act

The impetus for the Antiquities Act was late 19th-century concerns about the preservation of archaeological sites in the American Southwest.[4] These concerns, often expressed by individuals and organizations in the eastern United States, led to a variety of actions and activities in the last quarter of the 19th century.

Interest in the ancient archaeological sites of North America developed before the 1800s. One notable scholar with interests in examining American archaeological sites was Thomas Jefferson. He is credited with being America's first archaeologist based on having conducted and reported the purposeful, systematic excavation of an ancient Indian mound near his Monticello property in Virginia.[5] Jefferson's archaeological study was in part a response to an enquiry by a French diplomat stationed in Philadelphia. Francois Marbois circulated a letter to representatives of the newly formed United States with questions about the country, including one asking for "a description of the Indians established in the state before European settlements and of those still remaining … [and any] indication of the Indian Monuments in that state…." In reporting about the monument he excavated, Jefferson carefully and clearly described the size, shape, structure, and contents of the Indian mound. He included this report as a section of his *Notes on the State of Virginia*, which he wrote originally in 1781, 125 years before the Antiquities Act became law.[6]

In the first half of the 19th century more attention turned to recording and interpretation of ancient American archaeological sites. The American Philosophical Society in Philadelphia and the American Antiquarian Society in Worcester, Massachusetts, gathered information on the topic from their members and published reports and studies.[7] In 1848, the newly created Smithsonian Institution in Washington published an extensive archaeological study as the first volume in its professional publication series *Contributions to Knowledge*. The book, *Ancient Monuments of the Mississippi Valley*, by Ephriam Squier and Edwin Davis, includes a large series of plan drawings from surveys conducted by the authors and colleagues that still are used by modern investigators. The volume also includes artifact illustrations and some details of individual monuments that still are useful.[8]

Reports and studies of archaeological remains of the United States, which began with a small group of scholars, explorers, and public officials in the 18th century, expanded throughout the century. Interest in the topic grew both socially and geographically through the 19th century. The Squier and Davis study mentioned above, for example, described and inter-

preted the substantial and visible remains of ancient earthen architecture in the Mississippi and Ohio valleys. Such ancient archaeological remains were encountered by Euroamerican settlers pushing into these regions. The new settlers asked who had built these monuments? Speculative interpretations, at least some of them overtly racist and designed to justify removal of the contemporary Indian inhabitants of the regions, linked the ancient architecture to the wandering tribes of Israel, Aztecs, earlier European visitors, and others. These earlier architects, it was said, had been driven or killed off by the contemporary "savage Indians." It was not until the end of the 19th century when the "Moundbuilder myth" was repudiated substantially.[9]

During the first half of the 19th century, in the American Southwest, United States Army exploratory and topographic mapping expeditions encountered and recorded evidence of ancient and earlier historic settlements and human activities. After the Civil War, as the region was settled by migrants from the Eastern and Midwestern states, the ancient sites and architectural remains of towns and villages were encountered with increasing frequency and became known widely. For example, beginning in the 1870s major public exhibitions, two of the best known being the World's Columbian Exposition in Chicago (1893) and the Louisiana Purchase Exposition in St. Louis (1904), exposed more of the American public to United States antiquities. Municipal and university museums in large cities throughout the country featured American Indian antiquities in their displays. Investigators of the Southwestern ruins and archaeological sites in other parts of the country and hemisphere published popular accounts of their adventures and the archaeological sites they visited. The growing popular appeal of American archaeology was accompanied by a commercial demand for authentic prehistoric antiquities. Unsystematic removal of artifacts from archaeological sites for private use expanded, especially in the increasingly accessible Southwest.[10]

Expanded interest led not only to public displays and interpretations, but also to plundering of some of the prehistoric ruins, removing ancient artifacts for personal use or commercial sale. At some ancient sites, building stone and roof beams were removed for contemporary uses. Other people, some of them explorers from newly established natural history museums or archaeological organizations, came to the region to examine and study ancient sites, as well as make collections for their institutions and the public they served. Investigators who began to visit and report on the condition of prominent ruins noted and reported on the destruction that was occurring.

In the final quarter of the 1800s, much of the interest in American archaeological sites was focused on the Southwest. During this period the political effort to protect archaeological sites through government action began. The historian Ronald F. Lee, who wrote the first detailed history of the Antiquities Act, suggests that a series of events in 1879 related to American archaeology make it an appropriate year to begin discussing the history of the act.[11] The events are:

- The establishment of the Bureau of Ethnology, later renamed the Bureau of American Ethnology, in the Smithsonian Institution. The new bureau was set up to increase the recording of information about American archaeology and American Indian tribes. Be-

tween its creation and 1906, the bureau explored hundreds of archaeological sites, expanding the knowledge base about sites in different parts of the country. W.W. Holmes, who headed the bureau in the first decade of the 20th century, was a key individual in the activities that resulted in the final text of the Antiquities Act.[12]

- Frederic Ward Putnam edited and published a well-illustrated book about the ancient pueblo sites of Arizona and New Mexico and the archaeology and ethnology of the Indians of Southern California.[13] Putnam held numerous important positions in American archaeology, including that of curator of the Peabody Museum of American Archaeology and Ethnology at Harvard University. Putnam also influenced the creation of the Antiquities Act as a member of boards and committees that were involved in developing and reviewing the texts of federal legislation leading up to the act itself.
- The Anthropological Society of Washington was founded. The members of this organization included anthropologists, ethnologists, and geologists, many of whom worked for the federal government, which was beginning to hire these types of professionals at the time. In 1902, some members of the society founded the American Anthropological Association (AAA), which provided crucial professional support for legislation that led to the Antiquities Act in 1906.
- The Archaeological Institute of America (AIA) was founded in Boston by Charles Eliot Norton, a classicist and professor at Harvard, with the help of friends and associates in and around Boston. The AIA's purpose was to promote and direct archaeological research, both classical and American.

The initial AIA members and others in the Boston area played important roles in the development and enactment of the Antiquities Act. However, there was tension within the organization about this involvement. Norton, who served as the president of AIA, was a proponent of classical archaeology and was unenthusiastic about any attention by AIA to American archaeological sites. Fortunately for the development of American archaeology, other founding members of AIA also were devoted Americanists. One of these was Putnam, who, as noted above, was curator at the Peabody Museum and an instructor at Harvard University. Perhaps the most important Americanist member of the AIA's influential executive committee was Francis Parkman, the American historian. Parkman was a hero for Roosevelt, who viewed his own four-volume history of the United States' frontier, *Winning of the West*, as in the same vein of historical writing as Parkman's well-known and popular volumes on early American history, *The Oregon Trail*, the *France and England in America* series, and other works. Roosevelt dedicated his frontier history to Parkman.[14] Within the nascent AIA, Parkman and his associates championed the support of American archaeological studies by the organization.[15]

In formulating its first project in the field of American archaeology, the AIA leaders decided to investigate the archaeological sites in the American Southwest. Such a study was recommended to them by the noted American anthropologist Lewis Henry Morgan. To carry out the investigation, AIA hired Adolph F. Bandelier, who also was recommended by Morgan. Bandelier, forty years old when he started the investigation, was born in Bern, Swit-

zerland. As a boy, he moved with his family to America in 1848, settling in Illinois. Bandelier trained initially in geology, but turned to the study of history and ethnology and acquired valuable knowledge of linguistics generally. Prior to being hired by the AIA, Bandelier has published results of his research on ancient Mexico through the Peabody Museum, so his prior work also was familiar to Putnam.

Bandelier began working on the AIA study in 1880 and pursued it for the next five years. He visited ancient sites in the American Southwest, in particular in Arizona and New Mexico. In all, Bandelier prepared and published five reports of his studies for the AIA.[16] His report on the looting and destruction of the ruins and archaeological deposits at the site of Pecos in New Mexico sparked discussions and debate in the United States Senate when the issue of government action to protect archaeological sites was raised. In May 1882, Senator George Hoar from Massachusetts presented to the Senate a petition from the New England Historic Genealogical Society requesting that the federal government take action to preserve archaeological sites in Arizona and New Mexico. While the petition resulted in a discussion among some of the Senators, no further action was taken at this time.[17]

The legislative and political history of the Antiquities Act begins with the concern for protection of archaeological sites raised by Senator Hoar on behalf of some of his constituents. At that time and subsequently, debates between those who favored conservation or preservation and those who favored commercial uses of public lands laced the issue. Interestingly, objections to conservation and preservation did not include statements that such efforts were unnecessary. It was acknowledged generally that looting of archaeological sites was occurring and descriptions of such activities were found with increasing frequency.

Between the 1882 Senate discussion about archaeological site protection and the ongoing looting of sites in the Southwest and the beginning of the 20th century, Congress and the president took important steps for the future preservation of American archaeological sites by government action. This involved the successful effort to save the Casa Grande site just north of the small town of Coolidge, Arizona, located about midway between Tucson and Phoenix. Casa Grande is an extensive ancient settlement containing several compounds of buildings and habitations, including a ball court, dating to about AD 1350. A special and significant feature of the site is the multi-story "Big House," that is, the major structure in one of the compounds of the site. This ancient structure may have been the largest ever constructed by the Hohokam culture, which occupied what is now southern Arizona a thousand years ago, and its function still is debated.[18] The Casa Grande structure was prominent on the historic landscape. In the late 19th century the ancient structure and surrounding archaeological remains were being destroyed by casual and deliberate removal of wood beams and other parts of the site.

Early in 1889, citizens of Boston petitioned the US Senate to create a special preservation area covering the ancient site to prevent further removal of material from the site and provide for its preservation. Unlike the more general petition of 1882, this one, again introduced by Senator Hoar, was effective. Congress quickly acted to provide for the protection and repair of Casa Grande in an appropriation act. Funds ($2,000) were appropriated for the secretary of the interior to repair and protect Casa Grande. More importantly, Congress

also authorized the president to withhold the public land on which the ruin was situated from settlement and sale. Repair work soon began, however, it took three years to establish the reservation. On June 22, 1892, President Benjamin Harrison signed an executive order reserving the Casa Grande Ruin and 480 acres around it for permanent protection because of its archaeological value. This presidential action established the first formal national archaeological reservation in the United States and was an important precedent regarding the protection of archaeological sites by the federal government.[19]

Conservation and documentation of the ancient structure were carried out by experts from the Smithsonian Institution: in 1891 and 1892 by Cosmos Mindeleff; in 1895 by WJ McGee; and, from 1906 and 1908 by Jesse Fewkes. The repair and stabilization work at Casa Grande funded by Congress in 1889 initiated a long history of work to stabilize Southwestern ancient architecture not only at Casa Grande but throughout the region that continues to today (Figure 1).[20]

Roles in the creation of the Antiquities Act, 1900–1906

The late-19th-century struggle to protect archaeological sites overlaps with the development of conservation and preservation efforts throughout the rapidly developing United States. During this same period, efforts were underway to conserve natural and scenic resources. Notable successes among these undertakings included the creation of Yellowstone National Park in 1872; the creation of Sequoia, General Grant, and Yosemite National Parks in 1890;

Figure 1. "The Big House" at Casa Grande Ruins, 1892, near Florence, Arizona Territory. Unattributed image courtesy of National Park Service Historic Photo Collection, Harpers Ferry Center.

the enactment of the Forest Reserve Act in 1891; and the creation of Mount Rainier National Park in 1899.[21] Private and public preservation of historic structures and places (or example, Civil War battlefields) also was occurring during this time. Examining these developments, the historian Richard West Sellars points out that such early preservation efforts led to the gradual recognition of the need for group or joint or public ownership devoted to the preservation of important historic properties.[22]

In 1900, efforts to preserve archaeological sites on public lands focused again on congressional actions. This time, the purpose was a law that would protect many archaeological sites on public lands and not require site-by-site legislation to do so. Advocates for archaeological preservation and protection began producing draft bills that would accomplish their aims and working directly with legislators on submitting these drafts for consideration in the US Congress. The ardent, but diffuse initial method of petitioning Congress to save ancient ruins and sites was replaced by direct work with members of Congress and officials in the Department of the Interior (DOI) on specific legislation. Between 1900 and 1906, scholars and scientists, archaeological organizations, politicians, and government officials played key roles in the creation of the Antiquities Act.

Scholars and scientists and their supporters played important roles in the long effort to devise a means of protecting archaeological sites from looting and vandalism during the last quarter of the 19th century and the first decade of the 20th. The activities of Francis Parkman, Frederic W. Putnam, Adolph Bandelier, and the Archaeological Institute of America have been described. In addition, Edgar Lee Hewett and Francis W. Kelsey, in written reports and congressional testimony, described the destruction of archaeological sites that was occurring. Hewett, in particular, was important in coordinating the support of different professional organizations for passage of the Act.[23]

Congressman John F. Lacey, a Republican representative from Iowa and, in 1900, chairman of the House Committee on Public Lands, was crucial to the ultimate success of enacting the Antiquities Act (Figure 2). Lacey's support and interest in the preservation of archaeological sites was a key factor in the development of the legislation. His involvement with American antiquities included his membership as a freshman representative on the Committee for Public Lands in 1889, the year Congress authorized the Case Grande Ruins preserve and funding for repair of the ancient architecture there. Historian Rebecca Conard describes Lacey's extensive involvement in conservation and preservation legislation during the last decade of the

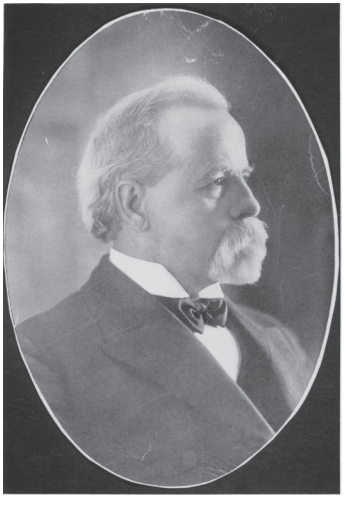


Figure 2. Congressman John F. Lacey, the "legislative father" of the Antiquities Act. From 1900 to 1906, Lacey sponsored bills to protect and preserve American archaeological sites. He chaired House of Representatives committee that reviewed and ultimately endorsed the legislation that became the Antiquities Act. Unattributed photograph courtesy of the State Historical Society of Iowa, Des Moines; negative no. 291.

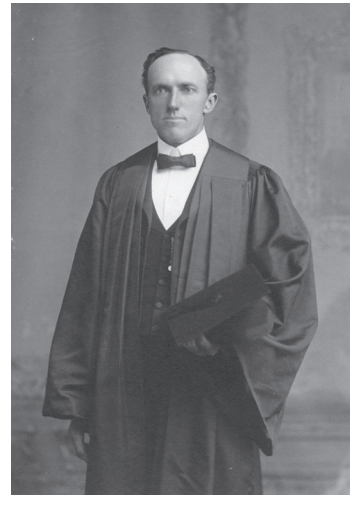


Figure 3. Edgar Lee Hewett, new to the national archaeological stage in the first years of the 20th century. Hewett was an ambitious administrator, scholar, and friend of Congressman Lacey who was able to reconcile differences and coordinate support from the national archaeological organizations for the ultimate bill that became the Antiquities Act. Unattributed photograph courtesy of Palace of the Governors (MNM/DCA), negative no. 7324.

19th century and the first decade of the 20th.[24] As a first-term Congressman, Lacey participated in the drafting of the Forest Reserve Act, and in 1894 he secured passage of the Yellowstone Park Protection Act. Lacey was also the principal force behind the 1900 Bird and Game Act, which prohibited the interstate transport of wild animals or birds killed in violation of state laws. The law still is referred to by some officials in the US Fish and Wildlife Service, which administers its provisions, as the "Lacey Act." In 1905 and 1906 in particular, Lacey worked on legislation that led to the Antiquities Act and introduced it as a bill in 1906, shepherding it safely through hearings and votes in Congress.

Lacey's familiarity with and interest in American archaeological sites were enhanced by a trip to northern New Mexico with Hewett in 1902 (Figure 3). The men were introduced in 1900 when Hewett traveled to Washington, DC, to build his own professional and political connections and promote the designation of a national park in the Pajarito Plateau area of northern New Mexico. The park creation was not successful, but later Hewett invited Lacey to tour archaeological sites in the area with him. In August, 1902, the two men made the tour and developed a relationship of mutual respect and friendship that would prove to be very helpful a few years later when they worked together on the final development of the Antiquities Act bill.[25]

Officials of the DOI, in particular Binger Hermann and William A. Richards, the first the commissioner of the General Land Office (GLO) from 1897 to 1903, and the second his successor, also played important roles and actively shaped and promoted the archaeological preservation and protection legislation. Both men were political progressives: Hermann a congressman from Oregon appointed head of the GLO by McKinley, and Richards a former governor of Wyoming. Other GLO officials, field agents stationed in the American Southwest, where the results of archaeological site looting could be observed regularly, provided on-the-ground information about the destruction of archaeological sites and emphasized the need for government action to protect archaeological sites.[26]

The creation of the Antiquities Act, 1900–1906

Between February and April 1900, four bills providing for the protection of archaeological sites on public lands were introduced in Congress, one by Representative Jonathan P. Dolliver of Iowa and three by Representative John F. Shafroth of Colorado.[27] Representative Lacey,

as chair of the House committee that would consider these bills, asked the secretary of the interior to review them and offer advice or suggestions. From this point onwards until the passage of the Antiquities Act in 1906, officials at the DOI were active in evaluating proposed laws, drafting substitutes, and providing information on this topic.

Binger Hermann, then commissioner of the GLO, responded for the secretary to Representative Lacey's request. The commissioner's report on the bills endorsed the notion of enacting a law to protect archaeological sites and other objects of scientific interest on public lands. He criticized some of the means by which the bills sent for review would accomplish this and offered a substitute bill.

The text of the commissioner's substitute bill contains a Section 3 that is remarkably similar to the Section 3 ultimately included in the Antiquities Act itself. The DOI substitute bill's Section 3 is likely to have been the prototype for the final text. The language of this section describes the permitting authority assigned to the land managing department (in 1900 it was assumed that this would be the DOI), and provides general guidance for how permits are to be used to regulate archaeological investigations. In a two-sentence paragraph it includes an important set of policies that established the approach public agencies would take in their treatment of archaeological resources from 1906 onwards. The text of Section 3 in the 1900 DOI substitute bill reads:

> Sec. 3. That the Secretary of the Interior be, and is hereby, authorized to permit examinations, excavations, and the gathering of objects of interest within such parks by any person or persons who he may deem properly qualified to conduct such examinations, excavations, or gatherings, subject to such rules and regulations as he may prescribe. Provided, always, that the examinations, excavations, and gatherings are undertaken for the benefit of the Smithsonian Institution or of some reputable museum, university, college, or other recognized scientific or educational institution, with the view to increasing the knowledge of such objects and aiding the general advancement of archaeological science.[28]

Section 3 of the substitute bill provided by Hermann establishes three important policies about how the government regards and treats archaeological sites. Most importantly, the first sentence establishes as a matter of public interest that government officials shall regulate the treatment of archaeological sites on public lands. The text identifies archaeological sites as important resources for the American public and authorizes the secretary of the interior to use a system of permits to direct and oversee how they are used. The second half of the first sentence establishes the second important policy. It requires that only persons who are "properly qualified" will be permitted to conduct archaeological investigations. In this phrase, there is an immediate assertion of the need for special capability, expertise, experience, and commitment for the treatment of these public archaeological sites to be allowed. The third policy is equally important and described in the final sentence of the section. This sentence describes the intent of the permitted investigations. It is established that the objective of the investigations—"examinations, excavations, gatherings"—is to advance knowledge; the goal is to improve understanding of the past using archaeological methods. The

objective is not commercial or personal gain; it is not the collection of objects for public or personal display. Rather, investigations that are permitted must have as their objective and result improving understanding of the past. Section 3 of the original DOI draft and the ultimate law are remarkably congruent. The fundamental policies embedded in the text of Hermann's Section 3 seem not to have been contested. In the final version of the Act, still only two sentences long, expresses the same principles as in the 1900 DOI proposed bill.

Congressman Lacey introduced the DOI substitute bill late in April 1900, but Congress took no action on any of the 1900 bills. Between 1900 and final passage of the Antiquities Act in 1906, other bills and versions of bills were presented and debated.

Disagreements about whether or not to give the president general authority to create "national parks" or set aside public lands as "national monuments," and if so, how large these designated units should be, was a primary topic. Detractors of the effort to provide protection and preservation argued that the government couldn't possibly protect all of these resources. Some congressmen and senators, in particular those from Western states, already were troubled by the president's authority to create federal forest reserves, which by 1901 totaled 46 million acres. These individuals objected to the creation of another authorization by which the president could set aside unilaterally large areas of the public domain for conservation or preservation, further reducing the land available for private development and economic activity. Eventually, the public sentiment, expressed by advocates from archaeological organizations, museums, and universities, to remedy the increasing destruction of archaeological sites in the Southwest and the wholesale removal of artifacts that was occurring overcame these objections. Efforts to protect specific archaeological sites, such as Mesa Verde and Chaco Canyon, became more frequent and widespread.

Another matter of controversy was the role of the Smithsonian Institution—specifically, whether the Smithsonian should be the agency that managed archaeological sites that would be protected by the act. Alternatively, this role might be assigned to field agents and land managers of the DOI, which already was responsible for overseeing the public lands and regulating how they were used. These matters eventually were resolved and the outcomes articulated in Section 2 of the act.

Although none of the legislation in the initial flurry of bills in 1900 was acted on by Congress, the debate about how to protect archaeological sites on public lands continued. One aspect of debate was which government agency should be given responsibilities regarding archaeological sites if federal legal protections were enacted. The two obvious candidate agencies were the DOI, which managed most of the public lands, and the Smithsonian, which employed archaeologists and carried out research on American archaeological sites.

Officials at DOI acted to show the department's competence on the topic and used existing federal authorities to protect specific sites and sensitive areas. One particular activity undertaken by DOI officials in the development of antiquities legislation was the collection and distribution of information about archaeological sites in the Southwest and the need for their protection. In 1904, GLO Commissioner W.A. Richards, who had succeeded Binger Hermann, moved to provide an official report on the overall situation regarding archaeological sites in the Southwest. Sizing up the contested situation in Congress, and presented with

another request for the department's opinion on the bills being considered, Richards took the opportunity to submit a detailed description of the archaeological sites in the Southwest that were endangered by looting and vandalism.

For information on the situation, Richards turned to Edgar Lee Hewett. Hewett submitted the report requested by Richards in September 1904. Hewett's text provided a clear summary of the state of knowledge about archaeological sites in the territories of Arizona and New Mexico, in particular, but also in the southeastern corner of Utah and the southwestern corner of Colorado. The report grouped sites into a series of districts, generally organized around river drainages and provided an apparently comprehensive list of manuscript and published sources. The report

> ... for the first time ... provided the General Land Office and eventually Congress with a comprehensive review of all the Indian antiquities located on federal lands.... Better than any other single document, Hewett's memorandum clearly foreshadowed, in remarkable detail, the system of archaeological national monuments established in the Southwest following passage of the Antiquities Act.[29]

Richards took Hewett's report and made it the GLO's. Before the end of the year, he had Hewett's report printed as an official GLO report, entitled *Circular Relating to Historic and Prehistoric Ruins of the Southwest and Their Preservation*.[30] In addition to Hewett's text and map, the circular includes an interesting set of excerpts from letters and GLO documents as addenda. Hewett's introductory paragraph in the addenda summarizes clearly its purpose:

> Since the ... [preparation] of the foregoing I have had the opportunity to inform myself fully as to the care which the Interior Department has exercised, and is prepared to exercise when properly informed, over the ruins in the Southwest. Much more has been accomplished than is known to the general public. It will be helpful to all who have the subject under consideration to know that a vigorous policy has been developed and is in operation, which accomplishes the main object to be desired.

The various letters and documents, apparently supplied by Richards, describe the activities by DOI bureaus related to the preservation of antiquities. By publishing the information, DOI officials showed that the department had expertise on the topic of American antiquities and laid out the steps that were being taken for their protection and preservation. The report indicated that DOI was able to carry out archaeological preservation and protection. Richards' intention in having the report prepared and published may well have been to emphasize to congressional supporters that DOI was the proper government agency—as opposed to, for example, the Smithsonian Institution—to be assigned this responsibility in any legislation considered by Congress.

In December 1905, Hewett presented a paper on the "antiquities bill alliance" at a joint meeting of the AAA and AIA, the two archaeological organizations involved with earlier efforts to create a law protecting archaeological sites. At the joint business meeting following

the presentation, the approach advocated by Hewett in his paper was approved. Hewett had managed to bring the archaeological community together in support of the proposed legislation.[31] Early in 1906, Lacey introduced the bill that would become the Antiquities Act in the House and arranged for the same bill to be introduced in the Senate.

The Antiquities Act and the Progressive agenda

Theodore Roosevelt was not engaged in the details of legislative crafting of the Antiquities Act between 1900 and 1906; however, his overall executive and legislative philosophy supported those working on the law. Government and private efforts to protect archaeological sites on public lands coincided with the rise of scientific resource management, a part of the Progressive political agenda. Support for Progressive ideas and methods were boosted substantially when Theodore Roosevelt rose to the presidency following the death of William McKinley in September 1901. In his detailed history of the early years of natural resource conservation during the Progressive era, the historian Samuel P. Hays presents a wealth of information about how Progressive-era political leaders and civil servants developed and applied scientific information and methods for the management of a wide range of natural resources.[32]

Scientific and hydrographic recording in the West by US government expeditions and survey parties since the 1880s extended into a variety of kinds of natural resource management. First, irrigation, then forest management, then grazing were incorporated into a coherent policy. Eventually, a number of public agency leaders who espoused scientific management of resources combined all of these management schemes into an overall approach to federal land management.

These leaders were especially enthusiastic about the possibilities of vast economic growth in the West if the federal government planned the development of its resources on a large scale. By 1906, Gifford Pinchot, the first chief of the US Forest Service, and other officials had formulated comprehensive land management concepts which, during the remainder of Roosevelt's presidency, they tried to apply to the public domain.[33]

The elements of scientific land management involved a revision of the standard way in which the public lands had been dealt with under the laws passed by Congress up to that point. These earlier laws were modeled on homesteading. They focused mainly on distributing public land to private individuals who would develop the land according to the requirements of the land laws. In the fall of 1903, President Roosevelt appointed a Public Lands Commission that reflected the desire for a more orderly and planned approach to use of the public lands.

Hays describes four aspects of the new orderly, rational, and scientific approach to public land management as it developed in the early years of the Roosevelt administration. The authorities embodied in the Antiquities Act, and the activities by DOI officials as they demonstrated their competence to protect archaeological sites in anticipation of the act, display all of the characteristics of this new approach to resource management.

First, scientific land management required that federal agencies have control over the resources and could regulate their use. Requiring permits by resource users provided a means

of control. By issuing permits of limited duration, the government could control use. By setting conditions with the permits, limits of use and scientific management principles could be enforced. For example, grazing should not exceed the carrying capacity of the vegetation. Section 3 of the Antiquities Act, and the archaeological protection bills back to 1900 from which it derived, assert a federal interest in the control of American antiquities and includes such a permitting requirement.

Second, scientific management required that the appropriate uses of resources be determined and applied objectively. Decisions had to be made consistently about who would be allowed to use the public resources. For example, regarding uses in the forest reserves,

> the administration never set down a definite code but did assume a rough system of priorities in attempting to resolve specific use conflicts. In the national forests Pinchot granted top priority to domestic use of water, followed by irrigation and power.... On agricultural lands homesteading should precede grazing.... The conflict between recreation and commercial use Pinchot found to be extremely hazardous to resolve, but he firmly argued that commercial uses of the public lands should precede their use for recreation. Reservoirs for municipal supply of water, for example, should be permitted in national parks.[34]

Regarding archaeological sites, Section 3 of the Antiquities Act directs that permits are to be used to carefully examine and record sites and provides that the information and items collected will be cared for and interpreted in public museums.

Third, scientific management required expertise in handling resources. "The new land management entailed administrative innovations. Experts rather than politically appointed officials, for example, should take charge of the program."[35] Pinchot, for example, had long stressed the need for properly trained foresters and the use of civil service exams to select them. "The Roosevelt administration constantly increased the number of trained foresters, range specialists, and geologists in its public lands program."[36] Again, Section 3 of the Antiquities Act requires that permits be given only to qualified institutions that can carry out the proper kind of examination and subsequent duration and public interpretation.

Finally, scientific land management involved understanding the resource. Information about the resource was gathered, classified, summarized, and used in making decisions about how the resource should be used. By the early 1900s, the Forest Service was classifying areas within the forest reserves according to their best function. Richards' use of Hewett's 1904 report on the archaeological areas and sites of the Southwest represents an attempt to show that the GLO had a systematic understanding of these public resources. The inclusion in the report addenda of a series of DOI documents and letters describing activities the agency already had taken for the protection of archaeological sites was intended to show that the department and its field offices had the expertise and knowledge to take responsibility for American archaeological sites on public lands in the West.

The Antiquities Act is mentioned only once in the index and national parks only a few times in Hays' book. Yet Section 3 of the act calls for three of the four components of the scientific land management approach recognized as part of Progressive conservation. The

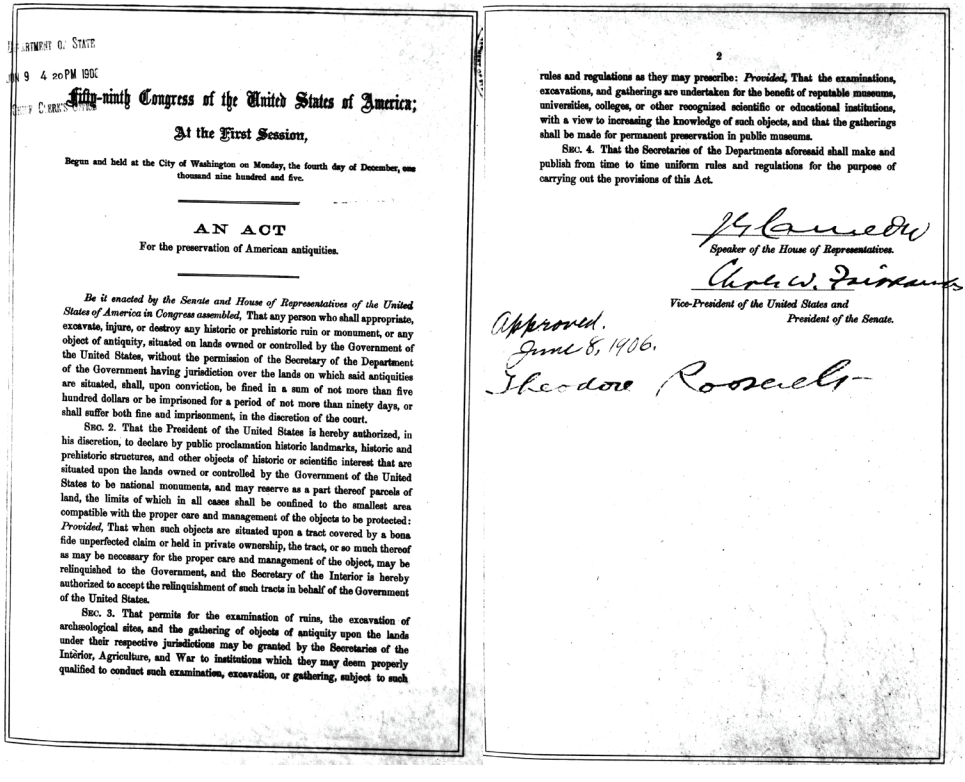
increased role of the federal government envisioned by the Antiquities Act is characteristic of many laws and programs established in the decades immediately before and following the turn of the 20th century through the influence of Roosevelt and others who were part of the Progressive political movement. Progressive politicians asserted new ways of looking after the public good within a federal system staffed by professional civil servants able to provide technical assistance to the public and for public resources. The policies and objectives of the Antiquities Act certainly were influenced by this national movement.[37]

Roosevelt's use of the Antiquities Act

President Roosevelt signed the Antiquities Act into law on June 8, 1906 (Figure 4). The law is short, only one page long. In its final form, the statute includes three sections. Section 1 prohibits the excavation or removing of ancient items from public land without permission and Section 3 establishes a permitting process, the general requirements that those who wish to receive permits for excavations must meet, and what values of archaeological sites and objects are to be protected and preserved under the authority of the statues.

The second section of the law authorizes the president to establish, or in the terminolo-

Figure 4. The Antiquities Act, signed into law by President Roosevelt on 8 June 1906. Image courtesy of National Park Service Historic Photo Collection, Harpers Ferry Center.



DEPARTMENT OF STATE
JUN 9 4 20PM 1906
SIXTY CONGRESS, U.S.A.

Fifty-ninth Congress of the United States of America;

At the First Session,

Begun and held at the City of Washington on Monday, the fourth day of December, one thousand nine hundred and five.

AN ACT

For the preservation of American antiquities.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That any person who shall appropriate, excavate, injure, or destroy any historic or prehistoric ruin or monument, or any object of antiquity, situated on lands owned or controlled by the Government of the United States, without the permission of the Secretary of the Department of the Government having jurisdiction over the lands on which said antiquities are situated, shall, upon conviction, be fined in a sum of not more than five hundred dollars or be imprisoned for a period of not more than ninety days, or shall suffer both fine and imprisonment, in the discretion of the court.

SEC. 2. That the President of the United States is hereby authorized, in his discretion, to declare by public proclamation historic landmarks, historic and prehistoric structures, and other objects of historic or scientific interest that are situated upon the lands owned or controlled by the Government of the United States to be national monuments, and may reserve as a part thereof parcels of land, the limits of which in all cases shall be confined to the smallest area compatible with the proper care and management of the objects to be protected: *Provided,* That when such objects are situated upon a tract covered by a bona fide unperfected claim or held in private ownership, the tract, or so much thereof as may be necessary for the proper care and management of the object, may be relinquished to the Government, and the Secretary of the Interior is hereby authorized to accept the relinquishment of such tracts in behalf of the Government of the United States.

SEC. 3. That permits for the examination of ruins, the excavation of archeological sites, and the gathering of objects of antiquity upon the lands under their respective jurisdictions may be granted by the Secretaries of the Interior, Agriculture, and War to institutions which they may deem properly qualified to conduct such examination, excavation, or gathering, subject to such

2

rules and regulations as they may prescribe: *Provided,* That the examinations, excavations, and gatherings are undertaken for the benefit of reputable museums, universities, colleges, or other recognized scientific or educational institutions, with a view to increasing the knowledge of such objects, and that the gatherings shall be made for permanent preservation in public museums.

SEC. 4. That the Secretaries of the Departments aforesaid shall make and publish from time to time uniform rules and regulations for the purpose of carrying out the provisions of this Act.

J. G. Cannon
Speaker of the House of Representatives.

Chas. W. Fairbanks
Vice-President of the United States and President of the Senate.

Approved.
June 8, 1906.
Theodore Roosevelt

gy of the act "to declare by public proclamation" national monuments and reserve them for proper care and management. The relevant text of the section is:

> The President of the United States is authorized, in his discretion, to declare by public proclamation *historic landmarks, historic and prehistoric structures, and other objects of historic or scientific interest* that are situated upon the lands owned or controlled by the Government of the United States to be national monuments, and may reserve as a part thereof parcels of land, *the limits of which in all cases shall be confined to the smallest area compatible with the proper care and management of the objects to be protected.…*

Two phrases are highlighted in the portion of Section 2 of the Antiquities Act above. The first lists the kinds of resources that the President can designate as national monuments. The first three terms seem clear and directly related to the "American antiquities" in the law's title. However, the last portion—"other objects of historic or scientific interest"—leaves some room for interpretation. In the final editing of the legislation, Lacey apparently added this general phrase to the more specifically archaeological and historical terms. In his application of the Antiquities Act, Roosevelt interpreted the phrase broadly.[38]

The issue of whether there should be a size limit to national monuments that the president could proclaim unilaterally had been resolved in the final version of the law without settling on a particular acreage. Rather, the second highlighted phrase in Section 2 was to be used as a general guideline for the size of national monuments. The text provides for a useful flexibility in the size of designations, but also permits a wide range of options for presidents considering the appropriate size of new national monuments.[39] As described below, Roosevelt took full advantage of the options that the statute text presented him regarding the potential size of national monuments. Regarding this Antiquities Act authority given to the president and considering how Roosevelt and most of his successors have used it, one might paraphrase Churchill and remark that, "never has so much been preserved for so many with so little statutory text."

Before 1906 was over, Roosevelt designated four national monuments: Devils Tower in Wyoming, El Morro in New Mexico, and Montezuma Castle and Petrified Forest in Arizona.[40] In 1907, the president designated five more: Chaco Canyon and Gila Cliff Dwellings in New Mexico, Lassen Volcanic and Cinder Cone in northern California, and Tonto, in Arizona. Of the monuments proclaimed by Roosevelt in these two first years, many were those that had been noted for protection in the 1904 GLO report about the archaeological resources of the American Southwest: El Morro, Petrified Forest, Montezuma Castle, and Chaco Canyon. Also on the 1904 list is Mesa Verde, a portion of which was established as a national park by statute in June 1906, shortly after the enactment of the Antiquities Act.

Roosevelt proclaims the Grand Canyon National Monument

In 1907, Congress amended the Forest Reserves Act, limiting the president's authority to establish forest reserves independently. Now the Antiquities Act was the only means the president had to set aside public land for conservation or preservation on his own authority.

Roosevelt was prepared to use the Antiquities Act as a strong conservation and preservation tool and events in northern Arizona at the Grand Canyon led him to do so.

Roosevelt first visited the Grand Canyon during his three-month-long Western tour in 1903. The text of his remarks to a crowd of approximately 800 appreciative listeners on the South Rim of the canyon reflects his perspective on that extraordinary place. Roosevelt said:

> ... I have come here to see the Grand Canyon of Arizona, because in that canyon Arizona has a natural wonder.... I shall not attempt to describe it, because I cannot. I could not choose words that convey or that could convey to any outsider what that canyon is. I want to ask you to do one thing in connection with it in your own interest and in the interest of the country—to keep this great wonder of nature as it now is.
>
> I was delighted to learn of the wisdom of the Santa Fe railroad people in deciding not to build their hotel on the brink of the canyon. I hope you will not have a building of any kind, not a summer cottage, a hotel or anything else to mar the wonderful grandeur, the sublimity, the loneliness and beauty of the canyon. Leave it as it is. Man cannot improve it; not a bit. The ages have been at work on it and man can only mar it. What you can do is to keep it for your children and your children's children and for all who come after you....[41]

Roosevelt went on in his remarks to make the general point that his contemporary fellow Americans must be good caretakers and stewards of the nation's resources so that their children, grandchildren and other future Americans would have the benefits of the same resources.

But even in 1903, as Roosevelt spoke, developments were underway on and near the South Rim. Some northern Arizonans were planning to profit from the increasing interest in visiting the Grand Canyon.[42] Ralph Cameron was one of these persons. He had arrived in Arizona Territory in 1890 from Maine and began various business ventures in mining, toll road construction, and tourist services. Cameron and his associates used federal mining law to stake claims on key parts of the Grand Canyon, in particular trailheads and trail routes using the mining claims and other means to develop the Canyon and the land along its southern rim commercially.

By 1908, five years later, the ongoing developments and pressure for more became intolerable for Roosevelt. Cameron's plan to build a trolley line along the south rim was the proximate cause of Roosevelt's national monument proclamation on January 11, 1908, setting aside for conservation and preservation 808,120 acres, including the popular area along the South Rim. Federal government officials on hand in northern Arizona used the new national monument designation to prevent Cameron's development of the trolley and prohibit his control of access to the canyon trails.

Cameron and other local development advocates called "foul." They fought back, appealing to and pressing claims with the territorial and national government agencies. Cameron used local and regional political influence as well. He eventually became senator from

Arizona and used his position to argue for his claims. Ultimately, Cameron sued the federal government and his case went as high as the United States Supreme Court, where in 1920 he lost his appeals of the national monument designation. But, the political and social winds already had changed regarding the Grand Canyon. One year before the Supreme Court decision that upheld Roosevelt's Grand Canyon National Monument proclamation and affirming in general the president's authority to designate national monuments and to determine their proper size, Congress and President Wilson expanded the national monument acreage and created Grand Canyon National Park, preventing the kind of development that Cameron had pursued so intently.[43]

Roosevelt's influence on use of the Antiquities Act by later presidents

Theodore Roosevelt died a month before the Grand Canyon National Park was created out of the most controversial national monument that he designated. That is one specific legacy of his eventful presidency. A more general and pervasive legacy is the example he set in his use of the Antiquities Act. Roosevelt's use of the Section 2 authority has had substantial effects on how other presidents in the 20th and 21st century have used it.

During his three years in office following passage of the Antiquities Act, Roosevelt created 18 national monuments encompassing approximately 1.5 million acres. His proclamations included a wide range of sizes and kind of resources protected. He created national monuments that focused on ancient archaeological sites, some of them small, such as Montezuma Castle (161 acres), El Morro (160 acres), and Tonto (640 acres). Other monuments encompassed larger areas and collections of related ancient sites, such as those in Chaco Canyon (10,643 acres). Roosevelt also created monuments of a variety of sizes for outstanding natural and scenic resources, such as Devils Tower, the first national monument he created (1,194 acres), Petrified Forest (60,776 acres), Lassen Peak (1,280 acres), Jewel Cave (1,275 acres), Natural Bridges (120 acres), and, of course, the Grand Canyon.

Roosevelt also was careful to ensure that the text used in his national monument proclamations described the outstanding nature of the resource in terms specified by Section 2 of the Antiquities Act. For example, in his proclamation creating the Grand Canyon National Monument, the president states that "the Grand Canyon of the Colorado River … is an object of unusual scientific interest, being the greatest eroded canyon within the United States…."[44]

By adhering closely to the wording used in the statute, Roosevelt ensured that any judicial review of his proclamation would give deference to the president's action for its consistency with the law, as was the case in the 1920 Supreme Court decision in *Cameron v. U.S.* (252 US 450).

Presidents who followed Roosevelt during the first half of the 20th century, while somewhat less active users of the Antiquities Act, in general followed the pattern that Roosevelt had pioneered (Table 1).[45] Presidents have proclaimed new national monuments in a variety of sizes and with a consistent frequency. They also have proclaimed monuments that reflect the variety of important archaeological, historic, natural, scenic, and scientific resources the Antiquities Act was designed to encompass.

Table 1. Number and extent of national monument proclamations by Theodore Roosevelt's immediate successors.

President	Number of National Monuments Proclaimed	Total Acres of National Monuments Proclaimed
William Howard Taft	10	31,112
Woodrow Wilson	13	1,120,577
Warren G. Harding	8	8,671
Calvin Coolidge	3	1,462,937
Herbert Hoover	9	1,360,099
Franklin D. Roosevelt	11	1,516,679

Surely, part of Theodore Roosevelt's legacy is the 125 National Monuments proclaimed by himself and the 20th-century presidents who succeeded him, from Taft to Clinton. These proclamations have covered in total nearly 100 million acres of land and resources now set aside for conservation and preservation on behalf of all United States citizens. Congressional leaders, while not unanimously agreeing with every presidential proclamation, have created 38 national monuments through enacted legislation. In addition to the national monuments, the Antiquities Act established a foundation for government policies that recognize an important public interest in cultural and natural resources and their commemorative, educational, and scientific values.[46]

Roosevelt's legacy in creating national monuments also seems to have spurred President Bill Clinton both officially and personally. In the last five years of his presidency, Clinton created more national monuments and a larger acreage of monuments than did Roosevelt. Clinton's secretary of the interior, Bruce Babbitt, was the force behind this surge of proclamations. In addition to coordinating and overseeing the background research and political discussions regarding these monuments, Babbitt and his staff provided Clinton with excellent rationales and justifications for the monument designations. Babbitt also knew his boss and Clinton's own interest in his presidential legacy. There is a story that during these years, whenever he had the opportunity to see Clinton, Babbitt would hand him a 3x5 index card. On one side of the card was a list of the monuments proclaimed by Theodore Roosevelt; on the reverse were the monuments proclaimed (so far) by Clinton.[47] Ultimately, Clinton surpassed Roosevelt's record by proclaiming nineteen new monuments and expanding three more, thereby designating nearly six million acres of new land as national monuments (Figure 5).

Clinton also had a personal experience of Roosevelt's legacy that may have given him additional impetus to proclaim the number of national monuments that he ultimately created and expanded. He described this in his remarks at the South Rim of the Grand Canyon when he signed the Grand Staircase–Escalante National Monument proclamation in 1996. In his speech, Clinton described visiting the Grand Canyon as a young man and being awe-struck at the sight. He alluded to Roosevelt's speech on the South Rim in 1903. President Clinton recalled Roosevelt's admonition to Arizonans to keep it the canyon as it is, as well as his broader challenge to American citizens to conserve and preserve America's resources for all

Figure 5. President Bill Clinton, with Vice-President Al Gore, at the South Rim of the Grand Canyon announcing the proclamation creating the Grand Staircase–Escalante National Monument in 1996. NPS photograph by Mike Quinn, courtesy of the National Park Service.

future generations. Roosevelt's use of the Antiquities Act had a double effect that was both official and personal on President Clinton.

In the end, Roosevelt's legacy from his use of the Antiquities Act affects all United States citizens. Robert Pogue Harrison, in his *New York Review of Books* article on Douglas Brinkley's terrific account and assessment of Roosevelt's conservation and preservation contributions, *Wilderness Warrior*, concludes, after wandering around examining various perspectives on Roosevelt's official achievements and personal attributes, that Roosevelt amply deserves to be considered one of America's greatest "keepers," or in modern terms, conservationists.[48] This attribution, once again, echoes Roosevelt's own admonishment to his fellow Americans from the South Rim of the Grand Canyon to care for and pass along to future generations the natural, historic, and cultural resources of our nation.

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Principles of Sustainable Transportation in the National Parks

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Introduction

Transportation and national parks are intimately linked. For example, nearly 300 million visitors per year travel to and within the US national parks. Moreover, American national parks comprise over 80 million acres of public land and include extensive networks of transportation corridors—roads, trails, bike paths, waterways, and public transit—that link a vast array of iconic attraction sites—viewpoints, historical and cultural sites, visitors centers, campgrounds, and gateway communities. The inherent complexities of this intersection between transportation and national parks demand more explicit research and management attention.

But transportation is more than a means of access to national parks. It can be a form of recreation itself, offering most visitors their primary opportunities to experience and appreciate the natural and cultural landscapes embodied by national parks. For example, the iconic roads of many of the "crown jewel" national parks—Going-to-the-Sun Road in Glacier, Tioga Road in Yosemite, Trail Ridge Road in Rocky Mountain, and the Park Loop Road in Acadia—were designed for visitors to experience the parks in their cars and are important manifestations of the historic and contemporary linkages between transportation and national parks (Louter 2009; Runte 2010). In fact, entire units of the national park system, such as Blue Ridge Parkway, have been designed specifically for this purpose. All of these roads were a response to demand for "driving for pleasure," historically one of America's most popular recreation activities (Manning 2011).

Transportation can be even more than this: it is also a potentially powerful tool for managing the national parks. The transportation networks and linkages in parks help determine where park visitors travel (and where they don't) and can be used by park managers to help deliver the "right" number of visitors to the "right" places at the "right" times (Manning 2007; Lawson et al. 2009; Manning 2009). In this way, transportation can be used to manage national parks in a sustainable way by protecting park resources and the quality of the visitor experience.

Interest in these linkages between transportation and national parks has led to a growing body of scientific and professional literature on this topic. The studies referenced in this

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paper are representative of a growing body of knowledge. These studies address the interface between transportation and a diverse group of national parks, use natural and social science methods, and address a range of transportation systems and issues. They draw on the scientific and professional literature in the fields of transportation and parks and outdoor recreation. While study of transportation in the context of national parks is in its early stages, a set of principles to help guide transportation management in national parks is beginning to emerge. Based on our review of the scientific and professional literature, we develop and present a set of principles for sustainable transportation in the national parks.

Principles of managing sustainable transportation in the national parks

Principle 1. Transportation and national parks are inextricably linked. This is the initial premise of this paper, and the growing scientific and professional literature bears this out in multiple ways. In their early history, transportation—by horse, stagecoach, and railroad at first and later and more generally by automobile—provided public access to the parks that was needed to build widespread societal appreciation and support (Louter 2009; Runte 2010). Even today, roads and to a lesser extent trails are the primary ways in which the vast majority of visitors experience and enjoy the national parks. But ease of access has led to a number of contemporary issues regarding the impacts of large and growing use of the parks, as well as the impacts of conventional transportation itself, primarily in the form of automobiles. (These issues are described more fully in Principles 2 and 3 as well as subsequent related principles). National parks have entered a new era in which transportation management is evolving to address these issues; examples include many forms and innovative applications of alternative transportation systems (ATSs; e.g., shuttle buses) and more deliberative and purposeful management of transportation to more fully meet the array of issues associated with contemporary park management. Examples include recent programs of interdisciplinary research at Yosemite (Meldrum and DeGroot 2012; White et al. 2012; Reigner et al. 2012) and Denali National Park and Preserve (Phillips, Hooge, and Meier 2010; Phillips, Mace, and Meier 2010; Manning and Hallo 2010; Morris et al. 2010) where research is helping guide transportation planning and management to protect foundational park resources (e.g., wildlife), enhance the quality of the visitor experience, and employ transportation as a powerful park management tool.

Principle 2. Transportation is central to the foundational two-fold mission of the National Park Service (NPS). National parks are to be managed in ways that protect park resources and the quality of the visitor experience while providing public access for enjoyment and appreciation. But under conditions of high and growing demand, these objectives can often conflict. There was little concern over road building in the early history of the national parks because use levels were low and parks were primarily considered to be monumental scenery (Runte 2010). However, as use of the national park system now approaches 300 million visits annually, transportation is an increasingly vital manifestation of the tension between use and preservation. Roads and other components of park transportation systems largely dictate the levels and types of uses the national parks accommodate. Moreover, these roads and other elements of the transportation systems in parks can themselves impact park

resources and the quality of the visitor experience (these resource and experiential impacts are addressed more fully in Principles 5 and 6, respectively). A growing number of studies of transportation in the national parks describe these issues and how they are playing out across the landscape of the national park system. Yosemite is often considered the poster child for the issue of use versus preservation, and the defining role of transportation in Yosemite is described in several recent studies and papers (Youngs et al. 2008; Meldrum and DeGroot 2012; White et al. 2012; Reigner et al. 2012). Similarly, a number of studies have addressed the role of transportation in meeting the two-fold mission of national parks at a diversity of other parks, including Denali (Phillips et al. 2010; Phillips et al. 2010; Manning and Hallo 2010; Morris et al. 2010), Rocky Mountain (D'Antonio et al. 2013; Lawson et al. 2011; Park et al. 2009–2010; Pettebone et al. 2011), Acadia (Roof et al. 2002; Pettengill et al. 2012; Hallo and Manning 2010; Holly et al. 2010), and Zion (Roof et al. 2002; Mace, in press). These studies are designed to help guide transportation planning and management through development of ATSs and using transportation in purposeful ways to deliver the "right" number of visitors to the "right" places at the "right" times.

Principle 3. Transportation is central to the foundational issue of carrying capacity of the national parks. This principle follows directly from Principle 2. Carrying capacity is a long-term and increasingly urgent issue in the national parks and is generally defined as the amount and type of use that can be accommodated in parks without unacceptable impacts to park resources and the quality of the visitor experience (Manning 2007). Principle 2 suggests that transportation plays a vital role in mediating and managing the inherent tension between use and preservation that is at the heart of the carrying capacity concept. Transportation networks (e.g., roads) and services (e.g., ATSs) dictate the amount and distribution of park use and thus the impacts of this use. As noted in Principle 2, several studies have been conducted on the relationship between transportation and carrying capacity in Yosemite, the park that is often thought of as most representative of that issue (Youngs et al. 2008; Meldrum and DeGroot 2012; White et al. 2012; Reigner et al. 2012). Contemporary management of the park aspires to use the transportation network to deliver the "right" number of visitors to the "right" places at the "right" times as informed by a program of research. Likewise, studies of the role of transportation in the carrying capacity of national parks have been conducted on the Denali Park Road (Burson et al. 2000; Phillips, Hooge, and Meier 2010; Phillips, Mace, and Meier 2010; Manning and Hallo 2010; Morris et al. 2010). In this case, it's the carrying capacity of the road itself that's an important part of the issue: how many vehicles can use the road without unacceptable levels of disturbance to the park's iconic wildlife and while maintaining the wilderness character of the road experience? These and related issues permeate the scientific and professional literature.

Principle 4. Transportation management in the national parks should be guided by a management-by-objectives framework that incorporates formulation of indicators and standards of quality. Several conceptual and organizational frameworks have evolved in the scientific and professional literature on parks and outdoor recreation and transportation (Manning 2011; Transportation Research Board 2010). Examples include the concept of carrying capacity, indicators and standards of quality, and levels of service (LOS). These

frameworks have contributed to development of a broader, management-by-objectives framework to guide transportation management in the national parks. This framework comprises three primary steps: (1) formulating management objectives and associated indicators and standards of quality; (2) monitoring indicator variables; and (3) taking management actions to ensure that standards of quality are maintained (Manning 2007). A growing number of papers incorporate this approach to transportation management in the national parks and support formulation of transportation-related indicators and standards of quality. Examples include studies at Denali (Phillips, Hooge, and Meier 2010; Phillips, Mace, and Meier 2010; Manning and Hallo 2010; Morris et al. 2010), Yosemite (Meldrum and DeGroot 2012; White et al. 2012; Reigner et al. 2012), Acadia (Roof et al. 2002; Pettengill et al. 2012; Hallo and Manning 2010; Holly et al. 2010) and Rocky Mountain (D'Antonio et al. 2013; Lawson et al. 2011; Park et al. 2009–2010; Pettebone et al. 2011). All contribute to transportation-related programs of research aimed at supporting and implementing the management-by-objectives framework described above, including formulating indicators and standards of quality.

Principle 5. Transportation in the national parks can have important environmental implications. Transportation, primarily in the conventional form of private automobiles, can have important environmental impacts on park resources. For example, an NPS-wide survey estimates well over 10,000 vehicle–wildlife collisions over a recent 18-year period (Ament et al. 2008). Research at Denali has documented changes in wildlife behavior related to traffic on the Denali Park Road (Burson et al. 2000; Phillips, Mace, and Meier 2010). Impacts on soil and vegetation caused by unauthorized parking, along with other traffic-related issues, led the NPS to close the road in Zion Canyon to private autos and institute a shuttle bus system (Mace, in press). Studies at Rocky Mountain, Zion, and Acadia document the noise generated by transportation, which can impact animals and detract from the quality of the visitor experience (Park et al. 2009–2010; Roof et al. 2002). And, of course, there are substantial air pollution and greenhouse gas problems associated with the cars and other vehicles visitors use in national parks (Roof et al. 2002).

More sustainable transportation, primarily in the form of ATSs, can lead to substantial environmental benefits. For example, the shuttle bus system in Denali has been designed to limit the number of vehicles on the park road, reducing the chance of collisions with and disturbance of wildlife (Phillips, Mace, and Meier 2010). In particular, the scheduling of shuttle bus service allows for the vehicle-free intervals needed by Dall sheep to safely cross the road corridor. A sophisticated modeling approach demonstrates the substantial reductions in both air pollution and human-caused noise that have been gained by use of shuttle bus systems at Zion and Acadia (Roof et al. 2002).

However, poorly planned ATSs can lead to unanticipated environmental impacts (or "downstream effects") as described in studies at Rocky Mountain (D'Antonio et al. 2013; Park et al. 2009–2010). In this case, the shuttle bus system delivered more visitors to sites in the Bear Lake area of Rocky Mountain than these areas could accommodate, and this has resulted in substantive impacts to soils and vegetation along trails and at attraction sites.

Principle 6. Transportation in the national parks can have important experiential implications. Given the strong historic and contemporary linkages between transportation and

the national park experience as described in Principle 1, transportation can affect the quality of the visitor experience in many ways. When visitor-use levels are relatively low, visitors can leisurely drive uncongested park roads, stopping and parking at iconic park attractions, hiking uncrowded trails, and experiencing park resources that are protected in their natural condition. However, when visitor-use levels are high, park roads can become congested, visitors can have difficulty finding a place to park, and park resources can become degraded, particularly at iconic park attractions and trails. These kinds of traffic conditions and associated impacts on the quality of the visitor experience are characteristic of a growing number of national parks. ATSs can help maintain high-quality visitor experiences by substantially reducing traffic congestion and parking problems. But even ATSs can be subject to crowding, can be inconvenient or otherwise stressful (e.g., run on an infrequent schedule), and can deliver too many visitors to selected locations, causing crowding and resource impacts and degrading the quality of the visitor experience (as described at Rocky Mountain in Principle 5). Transportation must be planned and managed in ways that create and maintain high-quality visitor experiences.

Principle 7. Transportation is an important form of recreation in the national parks. Following on Principle 6 and emphasizing its importance, transportation is a form of recreation for the vast majority of national park visitors. As described earlier, the iconic roads of many of the national parks were designed to facilitate enjoyment and appreciation of the parks. Driving for pleasure has long been a favorite American pastime, and nowhere is this more true than in the national parks. Of course, ATSs can be added to the list of transportation networks that are vital to shaping the quality of the visitor experience. A growing number of studies illustrate ways in which transportation can be planned and managed to help ensure high-quality visitor experiences. For example, several studies suggest standards of quality for traffic congestion on roads in Acadia, Denali, and Yosemite (Pettengill et al. 2012; Hallo and Manning 2010; Manning and Hallo 2010; White et al. 2012). These studies also suggest standards of quality for trail use in these parks. Other studies suggest standards of quality for ATSs at Acadia (Pettengill et al. 2012), and illustrate the extent to which ATSs have (or can) reduce air and noise pollution at Zion, Acadia, and Rocky Mountain (Park et al. 2009–2010; Roof et al. 2002). These and related studies offer guidance on planning and managing transportation to help ensure the quality of the visitor experience.

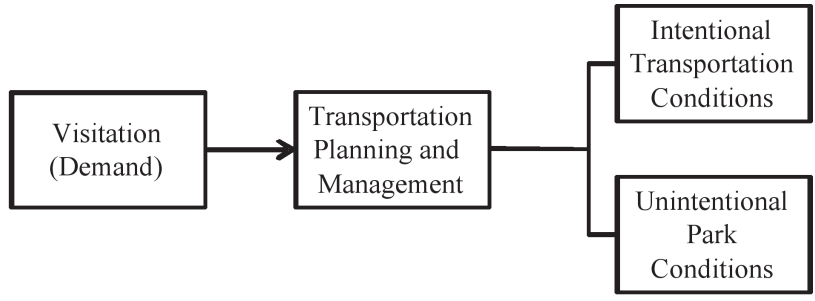
Principle 8. Transportation can be an effective management tool in national parks. Given the linkages between transportation and visitor use in the national parks, as described above, transportation can and should be used as a potentially powerful park management tool. Several studies offer good examples of the ways in which this can be done. For example, the ATS program at Denali has been designed to limit the impacts of vehicles on wildlife along the Denali Park Road (Phillips, Hooge, and Meier 2010; Phillips, Mace, and Meier 2010; Manning and Hallo 2010; Morris et al. 2010). ATSs are also effective at reducing air pollution and greenhouse gas emissions at Zion, Acadia, and Rocky Mountain (Lawson et al. 2011; Roof et al. 2002), and reducing noise pollution at Rocky Mountain (Park et al. 2009–2010). Simulation modeling at Acadia suggests that traffic congestion on the Park Loop Road could be substantially mitigated by eliminating parking in the right-hand lane

(though this would also reduce availability of parking at several key attraction sites) (Hallo and Manning 2010). Research programs at Rocky Mountain and Yosemite illustrate the way in which transportation can and probably should be used to help manage the carrying capacity of national parks by delivering the "right" number of visitors to the "right" places at the "right" times (Meldrum and DeGroot 2012; White et al. 2012; Reigner et al. 2012; D'Antonio et al. 2013; Lawson et al. 2011; Park et al. 2009–2010).

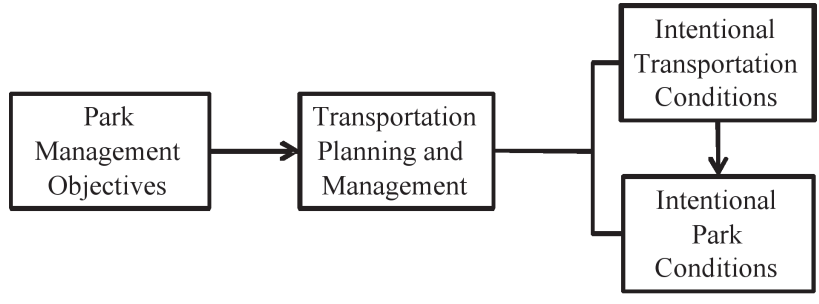
This is in contrast to the more conventional "demand-driven" approach to transportation management as illustrated in a study at Grand Canyon (Byrne and Upchurch 2011). At Grand Canyon, parking facilities were developed at the park's new visitor center based on estimates from a robust statistical model of the number of parking spaces needed to accommodate visitor demand. This study was well designed and executed and has helped solve the parking problem. However, it is unknown whether the new parking lot is sized to accommodate the "right" number of visitors (i.e., a sustainable level of visitation), or results in levels of visitor use that cause unacceptable impacts to park resources and/or the quality of visitors' experiences at nearby attraction sites and trails.

Other studies illustrate a more deliberative and ultimately informed management approach by using transportation to help achieve park management objectives. For example, studies at Rocky Mountain, Denali, and Yosemite have identified standards of quality for traffic congestion on key park roads, the number of hikers on key trails, and the number of people-at-one-time at iconic attraction sites (White et al. 2012; Reigner et al. 2012; Manning and Hallo 2010; Lawson et al. 2011; Hallo and Manning 2010). In this way, park transportation infrastructure and programs—amount and location of parking, design and scheduling of ATSs, hiking permit systems—can be planned and managed to help meet park management objectives related to minimizing impacts to park resources and the quality of the visitor experience. This approach to using transportation as a park management tool, in contrast to a conventional demand-driven approach, is illustrated graphically in Figure 1.

Principle 9. There is growing use and support for ATSs in the national parks. Several studies describe early and relatively large ATS programs at Acadia (Roof et al. 2002; Pettengill et al. 2012; Holly et al. 2010), Rocky Mountain (D'Antonio et al. 2013; Lawson et al. 2011; Park et al. 2009–2010; Pettebone et al. 2011), Denali (Phillips, Hooge, and Meier 2010), and Zion (Roof et al. 2002; Mace, in press). These are widely regarded as successful models for the national park system. Beyond these high-profile examples, many other units of the national park system have adopted large and small ATS programs that involve shuttle buses, ferries, and historic and specialized vehicles. Some of the ATS programs are voluntary and others are mandatory, while some charge a fee and others are "free" (though, of course, all must be paid for in some way). There is a growing body of evidence that ATSs are well received by most visitors and that ATSs can be designed to serve the needs of both park management and visitors. For example, visitors overwhelmingly support the mandatory shuttle bus system at Zion (Mace, in press). At Grand Canyon, more visitors are choosing to use the voluntary shuttle bus system than expected (Byrne and Upchurch 2011). At Great Smoky Mountains, a general population survey found that 75% of respondents supported a mandatory (but free) shuttle bus system at iconic Cades Cove, and over 50% reported they would



a. Conventional Transportation Management Model



b. Sustainable Transportation Management Model

Figure 1. Conventional and sustainable transportation management models.

pay a fee for this service (Sims et al. 2005). Moreover, the value of the improved services to visitors (e.g., reduced traffic congestion) was estimated to be $32 million.

Several studies identify desirable properties of ATSs that encourage visitors to choose them over private autos. For example, a study at Yosemite (Youngs et al. 2008) found that ease of use (e.g., frequent scheduling), perceived freedom (e.g., ability to reach desired destinations), and stress reduction (e.g., less concern over issues such as parking) were highly desirable characteristics of ATSs and would help persuade visitors to choose them over their cars. Another study at Rocky Mountain found that visitors were more inclined to use ATSs when they were aware of the ways ATSs would improve the quality of the visitor experience: less traffic congestion, less crowding on trails, and no parking problems (Pettebone et al. 2011). Day visitors to Acadia suggested that desirable qualities of ATSs include frequent service (intervals of 15-to-25 minutes between buses), perceived freedom (convenient stops), knowledge of the environmental benefits of ATSs, and availability of educational/interpretive programming on shuttle buses (Holly et al. 2010).

Finally, successful use of ATSs seems to lead to a reinforcing cycle of more support of them. For example, at Zion, 98% of visitors who rode the park's shuttle bus system reported that they would use ATS programs at other parks as well (Mace, in press). The study at Yosemite described above also found that experience with ATSs in parks leads to greater support for and use of them (Youngs et al. 2008).

Principle 10. Conventional guidelines for managing transportation may need to be re-registered in the context of national parks. Transportation is generally managed according to guidance contained in the *Highway Capacity Manual* (HCM) (Transportation Research Board 2010). Research underlying the HCM has been conducted primarily in the context of "utility" trips where the primary objective is to provide the most efficient way to travel from origin to destination. However, these guidelines will often need to be re-registered in the context of national parks and related areas where driving, walking, biking, public transit, and other forms of transportation are designed to offer a more leisurely experience to allow greater enjoyment and appreciation of the landscape and associated park attractions and features. A study at Acadia is especially instructive by developing density-related standards of quality for three modes of transportation in the park: driving on the Park Loop Road, hiking and biking on the park's carriage roads, and riding the park's Island Explorer shuttle bus system (Pettengill et al. 2012). Study findings were overlaid with a conventional HCM LOS framework, and results suggest that for driving and hiking/biking, LOS A and B define a high-quality experience in the park context, LOS C and D define cautionary or "yellow light" conditions, and LOS D and E are unacceptable to visitors in the context of the national park. Results are similar but more complex for public transit. Moreover, findings from a study of the social carrying capacity of the Acadia Park Loop Road also provide compelling evidence that LOS needs to be registered in the context of national parks (Hallo and Manning 2010).

Principle 11. Transportation research and management in the national parks should be as integrative as possible. Carrying capacity in the context of national parks has both environmental and experiential components and these components are often interrelated. Moreover, the scientific and professional literature on transportation and parks and outdoor recreation should be integrated where possible. Principle 8 suggests that transportation can (and often should) be an important management tool. Finally, research methods can be integrated in ways that complement one another and offer synergistic advantages. Several studies offer illustrations of all these integrative approaches. For example, as described in Principle 10, the framework of indicators and standards of quality from the park and outdoor recreation literature was combined with the LOS framework from the transportation literature to develop insights into the quality of transportation in the context of national parks (Pettengill et al. 2012). As described in Principle 8, park transportation has been integrated with park and outdoor recreation management objectives and associated indicators and standards of quality in a coordinated program of research designed to use transportation as a park management tool at Yosemite (Meldrum and DeGroot 2012; White et al. 2012; Reigner et al. 2012), Denali (Phillips, Hooge, and Meier 2010; Phillips, Mace, and Meier 2010; Manning and Hallo 2010; Morris et al. 2010), and Rocky Mountain (Lawson et al. 2011). All of these programs of research incorporate both resource (e.g., impacts to soil, vegetation, and wildlife) and experiential (e.g., crowding) components.

Principle 12. Transportation management in the national parks should be conducted at a park-wide, regional, or landscape scale where appropriate. Impacts on parks from outdoor recreation often manifest themselves first at selected sites, such as iconic attractions and popular roads and trails. However, these areas and issues should be studied and man-

aged in a more geographically inclusive way to help prevent problems from arising elsewhere. In fact, "fixing" a problem in one area can sometimes simply shift the problem to another area. Several of the research and management programs described in the scientific and professional literature offer good examples of more geographically expansive approaches. For example, research at Rocky Mountain illustrates how the ATS system in the Bear Lake corridor has helped solve the road congestion and parking problems in this area, but has caused "downstream" problems of resource and experiential impacts at selected attraction sites and trails served by the transit system (D'Antonio et al. 2013; Lawson et al. 2011). Research and management attention has now shifted to identifying other sites in the park (and perhaps sites on public lands outside the park) where some park visitors might be diverted from the Bear Lake area. Transportation management at a larger, regional scale is illustrated in studies at Zion (Mace, in press; Manning and Anderson 2012) and Cape Cod National Seashore (Anderson and Manning 2012). At Zion, the park's shuttle bus system serves both the park and the gateway town of Springdale, offering convenience and "connectivity" for both visitors to the parks and residents who are employed in the park. At Cape Cod, all regional transportation providers cooperate and coordinate their schedules and services to offer the possibility of "car-free" vacations to the park and the surrounding region.

Principle 13. Transportation should be incorporated into comprehensive park management plans. Following on several of the above principles, transportation is an integral and vital component of national parks: it is an important form of recreation and park appreciation, and transportation can be an effective park management tool. Moreover, there are important environmental and experiential implications of transportation. Given the centrality of transportation to park management, transportation should be given explicit consideration in park planning and management. NPS has recently begun a program of preparing long-range transportation plans and this has the potential of being a very constructive initiative.

Principle 14. Transportation offers important opportunities to deliver information, education, and interpretive programs to park visitors. Visitors use many forms of transportation to travel to and through national parks, and information, education, and interpretive programming can be used to reach visitors during all phases and modes of transportation. Conventionally, visitor centers and wayside exhibits are used to communicate with visitors as they travel by personal vehicle through the park, and they can be effective. However, ATSs offer opportunities that may be especially efficient and effective in communicating with visitors. Public transit, by definition, gathers groups of visitors who may then be reached very efficiently. Moreover, a study of a proposed extension of the Island Explorer shuttle bus system to parking areas outside the Mount Dessert Island section of Acadia found that many potential transit riders placed a high value on interpretive services designed to inform and enhance the quality of their park visit (Holly et al. 2010). The highly successful ATS program at Zion has made the shuttle bus system an important visitor attraction in and of itself, in part due to the audio and personal interpretive programming delivered to visitors on the buses (Mace, in press).

Principle 15. Transportation management in the national parks should be conducted in a proactive manner. Like all good planning and management, transportation should be

used to avoid problems before they arise. Perhaps the best example of this is management of the Denali Park Road (Phillips, Hooge, and Meier 2010). With construction of a new highway in Alaska in the early 1970s that would make Denali much more accessible, park staff instituted a limit on the annual number of vehicle trips that could be taken on the Denali Park Road, the principal means of visitor access to the park. This limit was instituted to protect park wildlife and the quality of the visitor experience. This proactive approach to transportation planning has been a cornerstone and effective component of park management as use has increased dramatically over the past several decades.

Principle 16. Transportation management in the national parks should be as informed as possible. The management-by-objectives framework described in Principle 4 is fundamentally adaptive; that is, it encourages managers to make decisions based on the best information available. Moreover, through long-term monitoring of indicators of quality, the framework allows managers to update, revise, and refine management as new information becomes available. However, this shouldn't be used as an excuse not to seek out the best information possible. The growing number of studies on transportation in the national parks represent good-faith efforts on the part of park and transportation planners, managers, and scientists to help create a foundation of knowledge about managing transportation in national parks. The emerging set of principles presented in this paper is an effort to further this process.

Principle 17. Transportation management in the national parks can draw on an array of research methods and approaches. The studies described in this paper use highly diverse research methods to address a range of transportation-related problems and issues. These research approaches employ natural science methods when assessing environmental impacts of park use and use social science methods to address human dimensions-related issues. Methods common to many studies include qualitative and quantitative surveys of park visitors, park managers, and the general public; visual simulations of a range of park conditions; GPS-based tracking of visitor travel patterns; GPS-based tracking of park wildlife; traffic and parking data collection and analysis; computer simulation models of visitor travel patterns; acoustic modeling; and sophisticated statistical analyses. These and other research methods can be productively used to better inform transportation management in the national parks.

Principle 18. Transportation management in the national parks should be based on partnerships with important stakeholders. Transportation management at Cape Cod is an excellent example of this principle (Anderson and Manning 2012). The park is deeply embedded in the surrounding towns of the Outer Cape and it has successfully partnered with all levels of government, a variety of nongovernmental organizations, regional planning commissions, the local congressional delegation, a local university, and several businesses to create an increasingly coordinated transportation network that serves the needs of park management, park visitors, and local residents. Similarly, the public transit systems at Zion (Mace, in press; Manning and Anderson 2012) and Acadia (Pettengill et al. 2012; Holly et al. 2010) have worked closely with gateway communities to build strong elements of connectivity that serve the needs of park visitors and surrounding towns.

Principle 19. Transportation management in the national parks needs strong leadership. Strong leadership is a prerequisite of most successful planning and management proj-

ects, and transportation is no exception. Though this leadership is not always obvious in the papers that comprise the scientific and professional literature, it is more evident to those who have been involved in these efforts and understand and appreciate the vital role of key individuals and organizations; national park superintendents, planners, resource managers, and program directors; community leaders; non-profit groups; and congressional delegations. For example, at Cape Cod, the Cape Cod Commission (especially Clay Schofield) and the Massachusetts congressional delegation (especially US Representative William Delahunt) have been instrumental in building and supporting the coalition of park-related transportation partners on the Outer Cape (Anderson and Manning 2012).

Principle 20. Transportation management in the national parks should address traditionally underserved populations. National parks are important symbols of our nation's commitment to democracy; they are icons of our shared natural and cultural history, and they should be accessible to all people. Transportation management at Cape Cod represents one manifestation of this issue (Anderson and Manning 2012). In this case, the park is using beach wheelchairs and wheelchair-accessible beach paths to help ensure access to mobility-impaired visitors. However, there are other groups in society, particularly racial and ethnic minorities, who are substantially underrepresented in the national parks (Floyd 1998). Research suggests that transportation to national parks may be a barrier to visitation, and more research and planning are needed to help ensure equal opportunities to visit the national parks (Solop et al. 2003). Transportation management has an important role in this issue.

Principle 21. Transportation in the national parks should be managed by design, not by default. The growing scientific and professional literature illustrates ways in which resource and experiential conditions in national parks are related to transportation. Transportation can exacerbate or help mitigate these impacts depending on how transportation systems are designed and managed. Transportation management can be guided in many ways, including the types of studies noted in this paper. However, management will often require exercise of professional judgment. As described in Principle 16, management should be as informed as possible, but there are inherent limits to our knowledge at any point in time.

After attempting in good faith to inform themselves of the problems and issues facing parks and outdoor recreation areas, park and transportation managers must ultimately exercise their professional judgment. Unfortunately, there will rarely be perfect knowledge about the types of problems that exist in parks and their seriousness, the causes of these problems, and the effectiveness of alternative management practices. Nevertheless, park and transportation managers should find courage in their knowledge of the burgeoning scientific and professional literature, the conceptual and management frameworks that have emerged from this literature, the inherently adaptive nature of park and transportation management, and in the responsibilities with which they have been entrusted. Management programs can (and should) be revisited and revised based on monitoring and advances in scientific and professional knowledge. But the seriousness of transportation and related park and outdoor recreation issues in the national parks—the tension inherent in two-fold mission of the national parks, the growing urgency of carrying capacity, the need to formulate indicators and standards of quality—will require strong and deliberate management action.

Sustainable transportation in the national parks

Sustainability has emerged as a vital concept for the contemporary world, and for good reason: we must learn to live within the constraints posed by our environment or face the possibility of grave consequences in the form of a degraded planet and diminished quality of life. What better place to address this issue than in the national parks, iconic symbols of our commitment to protecting the environment? What better issue than transportation, one of the world's greatest consumers of fossil fuels and contributors to air and noise pollution and greenhouse gases? Sustainable transportation in the national parks makes good, common sense.

In important ways, the national parks have been at the forefront of sustainability for decades. National park management has been historically based on its foundational two-fold mission: to foster public use and appreciation of the parks while protecting their environmental and experiential integrity. This is at the heart of sustainability. In the context of the national parks, this issue is often called *carrying capacity*—how much and what kinds of use can be accommodated in the national parks without unacceptable impacts to park resources and the quality of the visitor experience? With annual visitation to the national parks nearing 300 million, this is an increasingly urgent question.

In the context of national parks, carrying capacity/sustainability has multiple dimensions: concern for the quality of the environment, concern for the quality of the visitor experience, and attention to the opportunities and constraints of management. This multidimensional framework is in keeping with the emerging body of scientific and professional literature on sustainability more broadly. For example, the earliest expression of sustainability in the contemporary environmental literature suggested that it had two important dimensions: ecological and social (Bruntland Commission 1987). More recent treatments of sustainability are based on what are often called the "three pillars" of sustainability, or the "three E's", or the "triple bottom line" (Elkington 1997). All of these frameworks suggest that comprehensive consideration of sustainability must address matters of environment, society, and economy. In the case of transportation in the national parks, the scientific and professional literature is beginning to address all of these dimensions. Most studies address the relationship between transportation and the environment and the quality of the visitor experience. However, less is known about the economic dimension of sustainable transportation. Long-term funding of public transit in the national parks is likely to be challenging, although research at Great Smoky Mountains found substantial willingness to pay for the benefits of ATSs (Sims et al. 2005), and Acadia's Island Explorer shuttle bus system is heavily subsidized by philanthropic giving, a model that might be more broadly used across the national park system.

Alternative transportation systems are one of the most promising manifestations of sustainable transportation in the national parks. The national parks feature many innovative and prominent forms of ATSs. Other national park ATS programs use ferries, trains, vans, historic vehicles, and other conveyances. Many of these ATS vehicles use alternative, less-polluting fuels. Of course, ATSs can mean pedestrian and bicycle travel as well. Properly planned and managed, ATSs can reduce many of the environmental impacts of private automobiles while maintaining and even enhancing the quality of the visitor experience. Many visitors will take

these positive experiences with more sustainable transportation back home with them, and be more prepared to support sustainability in all forms. This will be good for national parks and the greater world.

This paper illustrates ways in which transportation management in the national parks is becoming more sustainable and can become even more so. There is greater understanding of the potential impacts of transportation on park resources and the quality of the visitor experience. Programs of natural and social science research in the national parks are providing a stronger theoretical and empirical foundation for formulating indicators and standards of quality for defining and measuring the sustainability of transportation in the national parks. This research is also testing the effectiveness of a range of management actions designed to maintain standards of quality. This growing body of work draws on the literature in the fields of both parks and outdoor recreation and transportation, and integrates this work where possible. In particular, the conventional paradigm of demand-driven transportation is being revolutionized by a more sustainable approach in which management objectives for park resources and visitor experiences serve as the foundation upon which transportation systems are designed and managed (see Figure 1). While a great deal more research on sustainable transportation in the national parks is warranted, the scientific and professional literature on this topic is beginning to reach a critical mass as reflected in the emerging principles described above.

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Nature Needs Half:
A Necessary and Hopeful New Agenda for Protected Areas in North America and around the World

Harvey Locke

Americans celebrated a milestone in global conservation this year: the 50th anniversary of the Wilderness Act. For many, wilderness designated under it has become the gold standard of nature protection in the US. While few protected areas in the world can match designated wilderness in a US national park for ensuring nature's well-being, it is well to remember important cousins in the protected areas family. National and state parks, state wilderness areas, designated roadless areas in national forests, the national monuments in the Bureau of Land Management's national landscape conservation system, US Fish and Wildlife Service's national wildlife refuge system, the National Oceanic and Atmospheric Administration's (NOAA's) marine protected areas, tribal wilderness, and private lands set aside explicitly for nature conservation are all part of the nature protection clan. While more wilderness is devoutly to be wished in this celebratory year, wilderness alone will not be sufficient to save nature in all its glorious expressions. It is therefore timely to consider how much of all kinds of protected areas we need to ensure that nature and natural processes continue into the future.

In a world where humans are just one species interacting among many, we would not need protected areas. This was the case for most of human history. Now we need them, for it is well- settled scientifically that humanity's relationship with the natural world is in trouble. The Intergovernmental Panel on Climate Change (IPCC 2007) stated bluntly: "The resilience of many ecosystems is likely to be exceeded this century by an unprecedented combination of climate change, associated disturbances (e.g., flooding, drought, wildfire, insects, ocean acidification), and other global change drivers (e.g., land use change, pollution, overexploitation of resources)." The human species has become so dominant that some argue we have entered a new geological age dominated not by the chemical and physical workings of the earth as they exist under their own motion from time to time but by us humans, and propose we call this new period the Anthropocene (Zalasiewicz et al. 2011).

This is not new. Our species' troubled relationship with nature has been widely understood for at least 25 years. In 1987 the United Nations published *Our Common Future*,

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known widely as the Brundtland Report (World Commission on Environment and Development 1987). It stated, "As the century closes, not only do vastly increased human numbers and their activities have that power [to alter planetary systems], but major unintended changes are occurring in the atmosphere, in soils, in waters, among plants and animals and in the relationships among all these." A few years later, the "World Scientists' Warning to Humanity," which was signed by the majority of the living Nobel Prize winners in science at the time, said starkly:

> Human beings and the natural world are on a collision course. Human activities inflict harsh and often irreversible damage on the environment and on critical resources. If not checked, many of our current practices put at serious risk the future that we wish for human society and the plant and animal kingdoms, and may so alter the living world that it will be unable to sustain life in the manner that we know. Fundamental changes are urgent if we are to avoid the collision our present course will bring about (Union of Concerned Scientists 1992).

The concerned scientists identified the need to bring environmentally damaging activities under control in order "to restore and protect the integrity of the earth's systems we depend on" and stated that "we must halt deforestation, injury to and loss of agricultural land, and the loss of terrestrial and marine plant and animal species."

The first global conservation targets for protected areas: 10 or 12%

Protected areas were identified by the authors of the Brundtland Report as a critical response to the troubled relationship between humanity and the rest of nature. They called them "areas managed explicitly to conserve species and ecosystems" and stated:

> Conservation of living natural resources—plants, animals, and micro-organisms, and the non-living elements of the environment on which they depend—is crucial for development. Today the conservation of wild living resources is on the agenda of governments: nearly 4 per cent of the Earth's land area is managed explicitly to conserve species and ecosystems, and all but a small handful of countries have national parks.

The chapter concluded: "A consensus of professional opinion suggests that the total expanse of protected areas needs to be at least tripled if it is to constitute a representative sample of Earth's ecosystems." This led to the first widely accepted goals for protected areas. Depending on who did the math it became the 10% goal or the 12% goal for global protected areas. Note that the goal spoke to representation of ecosystems.

A global target emerges from the Convention on Biological Diversity

The urgency of the scientific declarations in the late 1980s and early 1990s about humanity's failing relationship with nature led to the Earth Summit in Rio de Janeiro in 1992. Many of the world's political leaders attended. They signed two conventions intended to confront the integrated problems: the Framework Convention on Climate Change and the Convention on

Biological Diversity (CBD) (UN 2013). The objective of the Convention on Biological Diversity is "the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources." Biological diversity was defined as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems." America declined to be party to the Convention on Biological Diversity. The rest of the world carried on but it has not gone well.

In the foreword to the 2010 Global Biodiversity Outlook 3, an assessment of the state and trends of biodiversity in the world, UN Secretary General Ban-Ki Moon summarizes the current state of global affairs: "In 2002, the world's leaders agreed to achieve a significant reduction in the rate of biodiversity loss by 2010. Having reviewed all available evidence, including national reports submitted by Parties, this third edition of the Global Biodiversity Outlook concludes that the target has not been met" (Convention on Biological Diversity 2013).

In 2012 at Nagoya, Japan, the failure of this approach was recognized by the parties to the Convention on Biological Diversity and a more specific Target 11 for protected areas was set: "By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes."

While these references to protected areas in the broader landscape and connectivity are important new developments, no scientific rationale is given for the protected area targets of 17% land and 10% marine. Nor was a longer-term target set against which these might be considered mileposts.

In 1998, one of the fathers of conservation biology, Michael Soulé, and his then-student, M.A. Sanjayan, published a provocative paper titled "Conservation targets: Do they help?" in which they demonstrated that protecting only 10% of the earth would not protect biodiversity (Soulé and Sanjayan, 1998). No other paper has scientifically defended such low numerical targets.

What scientific analysis suggests protected area targets ought to be

We should be asking ourselves one simple question: "What does nature need in order to conserve biodiversity and how do we get there given the desires of humans?" Strangely, that is not what has happened. Instead, the focus has been, "What are humans willing to spare?" This of course is political, not scientific. So what is the best scientific information on how much we should protect?

Noss and Cooperrider (1994) concluded that in most regions 25% to 75% (or on average 50%) of an area will need protection to maintain biodiversity and ecological processes. In 2003, a poetic suggestion for the amount of protected areas needed came from biologist and author E.O. Wilson, who called for: "Half the world for humanity, half for the rest of life,

to make a planet both self-sustaining and pleasant" (Wilson 2003). Tropical ecologist John Terborgh (2005) noted that half the world was degraded and called for the protection of the other half. Pressey et al. (2003) noted that "recent comprehensive conservation plans have delineated around 50% or more of regions for nature conservation." Svancara et al. (2005) reviewed 159 articles reporting or proposing 222 conservation targets and assessed differences between policy-driven and evidence-based approaches. By evidence-based approaches they meant an adequate understanding and mapping of the distribution and viability of the conservation requirements of individual biodiversity features, such as species and vegetation types, and found that the average percentages of area recommended for evidence-based targets were nearly three times as high as those recommended in policy-driven approaches.

Rodriguez and Gaston (2001) considered the needs of species and found the minimum percentage of area needed to represent all species within a region increases with the number of targeted species, the size of selection units, and the level of species' endemism, and stated that "the 10% target proposed by the IUCN is likely to be wholly insufficient, and that much larger fractions of area are estimated to be needed, especially in tropical regions."

Regional studies from North America

For regions such as the boreal forest of Alaska, there are widely accepted principles that tell us what we ought to protect. The Canadian Boreal Initiative coordinated 1,500 scientists from over 50 countries around the world to write to Canadian governments to urge protection of "in the range of half" of that country's vast boreal forests (Boreal Scientists' Letter 2007; Curry 2007). Their letter included the following succinct summary of the widely known conservation science:

> The relatively intact state of Canada's northern Boreal region provides an opportunity to implement conservation strategies to protect the region's ecological integrity. The field of conservation biology identifies four objectives that must be achieved to ensure the long-term viability of an ecosystem: (1) all native ecosystem types must be represented in protected areas; (2) populations of all native species must be maintained in natural patterns of abundance and distribution; (3) ecological processes such as hydrological processes must be maintained; and (4) the resilience to short-term and long-term environmental change must be maintained. Achieving these objectives requires an extensive interconnected network of protected areas and sustainable management of the surrounding areas. Reviews of previous conservation planning initiatives provide further direction by indicating that protected areas should cover in the range of half of the landscape to achieve the objectives listed above.

Note that representation, the basis of the 10% or 12% goal that began with the Brundtland Report, remains fundamentally important but is only one of four elements needed to sustain ecosystems over time.

In 2001, the Greater Yellowstone Coalition engaged a team of experts to assess the amount of protected areas need in the Greater Yellowstone ecosystem (GYE). They ad-

dressed the four goals and concluded: "Our proposed portfolio, if fully protected and combined with existing protected areas (totaling 7,140,000 acres), would bring the total protected area in the GYE to 18,440,000 acres, nearly 70% of the ecosystem" (Noss et al. 2001).

Similarly, in the early 2000s The Nature Conservancy conducted conservation assessments of ecoregions across North America. These drew on regional experts and were focused on local conditions with the goal to identify the suite of conservation sites and strategies that will ensure the long-term survival of all viable native plant and animal species and natural communities in the ecoregion (basically the four goals noted above). The ecoregional plan for the Blue Mountains, which includes Central Idaho, southwestern Montana, and a portion of Oregon, recommended that 57% of the region be in protected areas (The Nature Conservancy 2000). The assessment done for the Florida peninsula concluded that 52% ought to be protected, while noting it left some gaps the report (The Nature Conservancy 2005). The portfolio of conservation sites came in at 47% on the California North Coast (The Nature Conservancy 2001). In 2004, The Nature Conservancy in the US and The Nature Conservancy of Canada concluded their expert-driven assessment of most of the area extending from the Peace River in British Columbia to the Clark Fork River in Montana. They concluded that 49.7% of the region should be in conservation areas, but noted this did not address connectivity needs for wide-ranging mammals (The Nature Conservancy of Canada 2004).

Traditional ecological knowledge combined with Western science has reached the same conclusion on at least one occasion. Grand Chief Herb Norwegian (2005) described a process in which elders were consulted about their traditional use of the boreal forests and mountains along the Mackenzie River in Canada's Northwest Territories and developed a land-use plan that called for the conservation of more than half of the Dehcho region in an interconnected network of protected areas (Norwegian 2005).

A 2012 editorial in *Conservation Biology*, to which the present author contributed, surveyed several studies of the percentage of area needed and compared those results with politically derived targets. We noted that current political and convention targets tended to be much lower than those based on scientific assessment, review, and expert opinion, where the mid-point of the range of evidence-based assessments was slightly below 50% and called for a precautionary target of 50%. We concluded, "Nature needs at least 50% and it is time we said so" (Noss et al. 2012).

The meaning of protected area

The United States has tended to chart its own course when it comes to protected areas. In 1989, a national assessment was done in the through US Geological Survey's Gap Analysis Program (GAP). (Current statistics are online at http://gapanalysis.usgs.gov/padus/protected-areas-stats/.) It came up with four categories of lands:

- GAP Status 1: An area having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a natural state within which disturbance events (of natural type, frequency, intensity, and legacy) are allowed to proceed without interference or are mimicked through management.

- GAP Status 2: An area having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a primarily natural state, but which may receive uses or management practices that degrade the quality of existing natural communities, including suppression of natural disturbance.
- GAP Status 3: An area with permanent protection from conversion of natural land cover for the majority of area. It is subject to extractive uses of either broad, low-intensity type (e.g., logging) or localized intensive type (e.g., mining). It confers protection to federally listed endangered and threatened species throughout the area.
- GAP Status 4: An area with no known protection. The remaining area of a state (not designated as GAP Status 1–3) is classified as GAP Status 4. Status 4 areas are primarily private lands. They have no known public or private institutional mandates or legally recognized easements.

Gap 1 and Gap 2 would easily meet a standard for a protected area for the purposes of this paper. Gap 3 is more problematic as it involves resource extraction. Though the tendency for Americans has been to pay little attention to international discussions about protected areas, nonetheless the international norms, as promulgated through the CBD and the International Union for Conservation of Nature (IUCN), can be helpful to Americans grappling with ideas such as the meaning of protected area.

The CBD definition of protected area is "a geographically defined area which is designated or regulated and managed to achieve specific conservation objectives." This definition does not provide specific guidance about the range of protected area types that could be adapted to different situations. In the mid-2000s, IUCN's World Commission on Protected Areas engaged in a multinational expert consultation process to update its guidelines for protected areas that culminated in a summit in Almeria, Spain, in 2007 (Dudley and Stolton 2008) . That process came up with a useful definition of protected area: "A specifically delineated area designated and managed to achieve the conservation of nature and the maintenance of associated ecosystem services and cultural values through legal or other effective means" (Dudley 2008).

This definition includes the six categories of protected area that had already been recognized by IUCN for some time: strict nature reserve/wilderness area (Category I), national park (Category II), natural monument (Category III), habitat/species management area (Category IV), protected landscape/seascape (Category V), and managed resource protected area (Category VI). While some of these categories allow some resource extraction for local use, industrial activity is not included. This can be described as the difference between tapping sap from a maple or rubber tree and cutting trees down to feed to a pulp mill. Notably, there is a linked governance framework that can range from international, national, provincial, regional, municipal, private or indigenous as long as the area is managed by legal or other effective means.

Applied to the United States, the IUCN general definition would include the full suite of protected areas described in the opening paragraph of this essay. This would correspond to USGS's Gap 1 and Gap 2 areas. When applied to a place like Boulder County, Colorado, we

find that through a mix of national parks, national forest wilderness areas, private land conservation, and open space maintained by the city of Boulder and Boulder County that over half of the county is protected in line with the IUCN definition of (cf. http://natureneedshalf.org/case-studies/).

Protecting half of the earth's lands and waters

Conservation targets expressed in percentages can be misleading and will not be effective in protecting the full range of life on earth if they are rotely numerical or area- based. In other words, protecting all of Antarctica is an excellent idea, would materially enhance the percentage of the world designated as protected area, and would do great things for life there, but would do nothing for tigers, toucans, lions, or grizzly bears. To halt and eventually reverse the terrible trend demonstrated by successive editions of IUCN's *Red List of Threatened Species* (IUCN 2013b), we ought to apply across all ecoregions of the world the four broadly accepted conservation planning principles. To recap, those are: represent all native ecosystem types in protected areas as well as protect sufficient area to maintain populations of all native species in natural patterns of abundance and distribution, maintain ecological processes such as fire and flooding, and maintain resilience to short- and long-term environmental change.

The idea of protecting half gives a better sense of the order of magnitude of protected areas required than using the figure "50%," which might imply a mathematical formula of universal application. What is required is principled study and conservation planning based on each ecoregion's unique characteristics, followed by determined implementation of the results. When such rigorous study occurs it usually results in a finding that we should protect about half of any given ecoregion. Some noted conservation biologists have expressed private opinions to the author that that may well be too low a figure. Thus it would be most accurate and precautionary to say nature needs *at least* half.

Connectivity among protected areas

In addition to the question of how much is needed in protected areas, there is the now-widespread scientific understanding that these areas must also be connected to each other to allow for gene flow and to adapt to climate change (Dudley 2008; Locke and Mackey 2009; Heller and Zavaleta 2009; Worboys et al. 2009; Nature 2011; Noss et al. 2012). Hodgson et al. (2009) issued an important reminder that connectivity is a supplement to, and not a substitute for, core protected areas.

Nature on the other half

Lands outside of protected areas can be valuable for some species and are worthy of attention. They can provide connectivity between habitat patches and support migratory processes for birds and insects. Gap 3 lands can be critical to the survival of endangered species. Some species (e.g., white-tailed deer) even thrive in landscapes fragmented by humans and a few (e.g., Norway rats and rock doves) even thrive in high urban concentrations of humans. But many species are habitat specialists and human-altered habitats do not support them. Intensely cultivated lands on which chemically supported agriculture is practiced have very

low value for biodiversity. Humans on pasture lands outside of protected areas tend to have very low tolerance of species that compete with us for meat or forage for our domestic animals. Thus we kill them or erect impermeable fences to exclude them that also have the effect of fragmenting the landscape, which can terminate critically important seasonal migrations of large mammals. Humans outside protected areas often make large efforts to suppress inconvenient natural processes such as fire and flooding that are vital to the ecosystem dynamics on which many species depend. So while lands intensely used by humans support some threads of nature (and more nature-friendly practices should be encouraged on them), they cannot support the full tapestry of life. Simply put, we need to share the world with nature.

Self-censorship in the conservation community when it comes to targets

The closing session at the ninth World Wilderness Congress, WILD 9 in Merida, Mexico (2009), called for the protection of at least half the world in an interconnected way (see http://natureneedshalf.org). Delegates from many countries were wildly enthused (Harman 2009). When those enthusiasts returned to other settings, self-censorship set in, along these lines: "Of course that is correct, but we will not be taken seriously" or "We must be realistic about what is politically achievable and that is not." This self-censorship raises important questions about the role and function of ideas in society and of park professionals as social participants.

Ideas clearly expressed have the most power. We in the parks community have the best product in the world to sell—intact nature with its myriad benefits for our species. We have a rational foundation for our passions. The science is that nature needs about half. Some of our caution can no doubt be explained by the fact that many park professionals work for governments who set the policy context for their work. There is no mandate to state one's own preferences and goals in such an institutional setting. That is entirely true and right. But this rationale does not apply to nongovernmental organizations (NGOs) whose role in civil society is to say the things that governments ought to do and to help find ways to bring that about.

The explanation for NGO caution could be found in the concern that the expression of ideas too radical will result in exclusion from participating in certain fora, to the detriment of one's institution's work or one's own career. The concern is that it is better to be there in a less-than-perfect process than it is to be excluded or humiliated. Fear of the loss of such status or access is the motivation for self-censorship. This is a loser's game.

A different but cynical explanation for self-censorship could be that NGOs are very invested in their programs and priorities and fear that their donor relations require them to keep inconvenient new ideas away. This would be shameful conduct and requires no further comment than that.

The basic problem with self-censorship in an NGO setting is that it focuses on the actors, not the outcome. That which is necessary for the conservation of all life should drive our behavior. If no one brings forward the best scientific knowledge of what is needed to achieve this goal, then we are doomed to fail. AIDS advocates cannot back down when sexual transmission of disease is denied by politicians, nor can doctors back down when the health effects of tobacco are denied, for to do so would fundamentally impair their cause. So it is

with advocates for nature conservation: we should insist on that which is necessary to keep nature healthy. We can do it politely and thoughtfully but do it we must.

Another possible explanation that does not involve self-censorship is that, after assessment, NGOs conclude that there is no possible way that such a goal as nature needs half could be met and therefore it should be discarded. The thinking could be that in some places with huge human populations and vast intensive agriculture, such a goal seems so fanciful as to be absurd. Though lower targets are known not to be sufficient, they are better than nothing and their deficiencies are better left unsaid. This approach is rooted in pessimism, but is called "realism" by its proponents. The problem is that such "realism" denies possibilities that are real without first taking the chance to bring them about. Hope is suspended and a dark future guaranteed.

Protecting at least half of the earth is a viable goal

There are several places around the world in which the nature needs half goal has already been realized through public policy. In western North America, there are several examples of governmental action to protect at least half of a region. On Haida Gwaii, British Columbia (previously known as the Queen Charlotte Islands), a mix of national park, provincial park, and First Nations conservation has resulted in over 50% protection of the terrestrial system and an initial marine conservation area (http://natureneedshalf.org/case studies). The Capital Regional District of Victoria, British Columbia, has set a goal of protecting at least 50% of its lands and waters after a public process that saw it explicitly "subscribing to the idea that nature needs half" (Capital Regional District 2012). Ontario committed in 2008 to protecting half of its north and has enshrined in its Far North Act a commitment to protect "at least 225,000 square kilometres [55,598,710 acres] of the Far North in an interconnected network of protected areas designated in community based land use plans" (Government of Ontario 2010). In 2014, Quebec Premier Philippe Couillard committed to protect half of that province's vast north as part of its Plan Nord (Couillard 2014). Boulder County, Colorado, as noted above, is over 50% protected. Note the varied forms of governance types that have achieved the nature needs half goal.

The Seychelles archipelago is over 50% protected "as a contribution to fulfilling its obligations under the Convention on Biological Diversity" (IUCN 2013a). The Galapagos Islands of Ecuador are much more than 50% protected.

The Serengeti ecosystem in Tanzania and Kenya is over 50% protected. The Canadian Rockies biome in Alberta, Canada, is about 65% protected through a mix of national parks, provincial parks, and wilderness areas. The American portion of the Crown of the Continent Ecosystem in Montana is over 50% protected by national park and wilderness designation, and a similarly high percentage of park and wilderness areas in present in the core of the Greater Yellowstone ecosystem. It is no coincidence that these areas in the Yellowstone-to-Yukon region and East Africa still support all their native species.

An obvious retort to these examples is that they are areas that have received special attention and are far way from large population centers. As to receiving special attention, yes, they

have, and they should be taken as examples of how we should treat the whole world. In the US, these areas also do well economically. In fact, those western US counties with the highest amount of Gap 1 and Gap 2 protection on federal lands have the highest employment growth of counties in the entire rural West (Rasker et al. 2013). As to their distance from population centers, this raises a different concern. Is it impossible to do something like this in the crowded areas of places such as Europe, India, China, or the East Coast of North America?

We are unlikely ever to protect half of the best agricultural land that has been in production for centuries. We may not even want to because we like the food it produces. But so much marginal land has been brought into cultivation in the last 250 years that we could make enormous inroads in restoring it.

In eastern North America, most of western Massachusetts, Vermont, New Hampshire, and Quebec's Eastern Townships were denuded of forests by farmers, sheep grazers, loggers, and charcoal makers. But the land was marginal and largely abandoned as other lands became available. Today, there is extensive forest cover across the region and significant species recovery. In upstate New York, the 2 million-ha Adirondack Park was created in 1895 to recover cut-over lands whose degradation threatened downstream water quality. Today, just under half is managed as "forever wild" under the New York State constitution.

On the Indian subcontinent, nature needs half is a reasonable near-term goal along the length of the Western Ghats and has already been realized in part of the Himalayas (Locke 2014b). In fact, the ancient kingdom of Bhutan recently announced that it has achieved 50% protection by putting over 42% of its land in protected areas and over 8% in biological corridors (see http://natureneedshalf.org/case studies/Bhutan; Bhutan Nature Conservation Division 2009).

The rewilding of Europe has occurred at a remarkable rate as marginal hill and mountain farms are being abandoned by a declining population. The corresponding recovery of large mammals in western Europe, including brown bears, is remarkable. Natura 2000 was a deliberate pan- European policy that increased Europe's protected areas to 20% and some jurisdictions, such as Germany, are seeking formally to protect wilderness.

Even where challenges are great, the short-term feasibility of an idea does not invalidate the idea. It simply shifts to becoming an aspirational goal.

A philosophical moment for the protected areas movement

We in the nature conservation community are at a philosophical crossroads. No one who studies the global state of nature or the list of endangered species in the US could be satisfied. Indeed, things are bad and getting worse, with a few happy exceptions (IUCN 2013b).

At moments of philosophical crisis there are two ways one can turn. One is in the direction of deeper determination, higher aspiration, and courageous commitment to clear ideals. This is what the persecuted Christians did during the Roman Empire and ultimately converted its rulers to their way. This is what the US Civil Rights movement has done and continues to do, and that country now has a second-term African American president. This is what the nature needs half movement seeks to do: collectively assert a vision in which humanity returns to being one species among many that is humble enough to understand that

we must protect all life and the processes it depends on, both for own well-being and because it is ethically the right thing to do. It is about fixing the human relationship with nature by recognizing that any relationship needs mutuality to be healthy (Martin 2010). This is called "radical hope" because though the idea is clear, the course of action that will make it possible is not yet fully clear (Lear 2006).

The other road to follow is to decide that the goal of biodiversity conservation is impossible and to set a new agenda. Thus some postmodern conservationists consider this a time of defeat and that now is the moment to abandon traditional conservation goals based on parks and wilderness areas. Instead, the Green postmodernists would have us embrace the idea that we should convert the earth to a garden that serves the interests of local people and urban dwellers (Marvier et al. 2012). This of course would mean the end of inconvenient and difficult-to-conserve species such as grizzly bears, tigers, lions, and elephants. It would also mean concerted efforts to prevent the natural and necessary but deeply disruptive process of renewal, such as fire and flooding (Locke 2014a).

The death of the wild in favor of the garden with *Homo sapiens* triumphant is no vision for those who proclaim to love nature. It will also inevitably be disastrous for the human species. We do not know how to run the world. It is time for our species to become humble and wise and to stop being greedy and clever (Locke 2013).

The philosopher Immanuel Kant summed up the human dilemma with two questions: *What can I know?* and *What ought I to do?* These are appropriate questions for conservationists in the 21st century. And we can answer them. We know that nature needs at least half. We ought to assert it even if it is not clear that we will succeed. Those who dared to dream of a Wilderness Act saw their dream come true fifty years ago. It is our turn to step up boldly for nature by fearlessly working to protect half the world in an interconnected way.

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