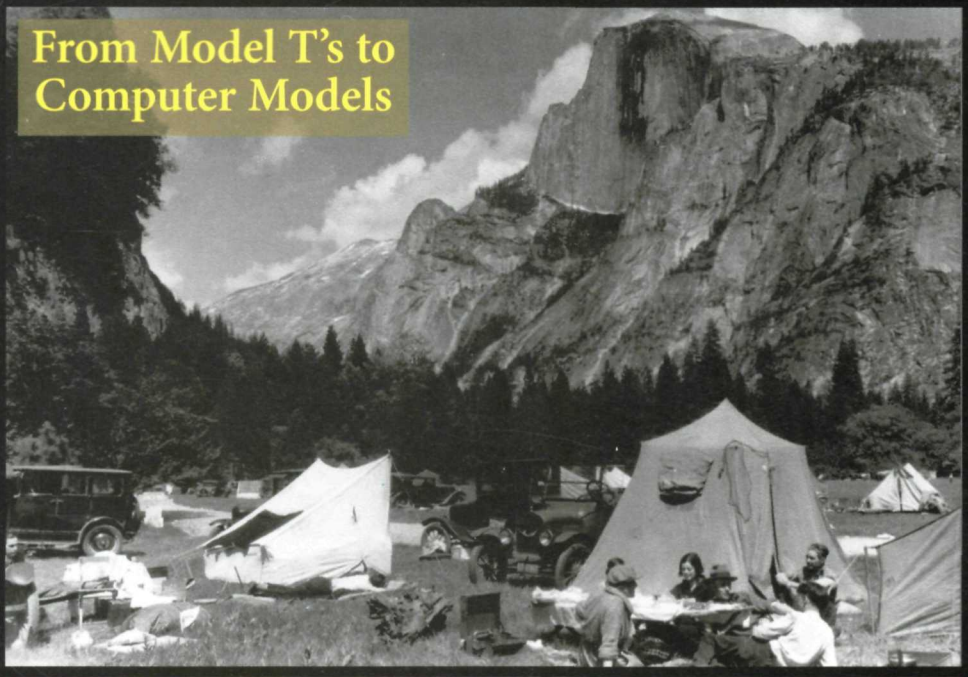

Integrating Transportation with Visitor Capacity Research and Planning at Yosemite National Park

The George Wright Forum

The GWS Journal of Parks, Protected Areas & Cultural Sites

volume 29 number 3 • 2012

GEORGE WRIGHT SOCIETY

Origins

Founded in 1980, the George Wright Society is organized for the purposes of promoting the application of knowledge, fostering communication, improving resource management, and providing information to improve public understanding and appreciation of the basic purposes of natural and cultural parks and equivalent reserves. The Society is dedicated to the protection, preservation, and management of cultural and natural parks and reserves through research and education.

Mission

The George Wright Society advances the scientific and heritage values of parks and protected areas. The Society promotes professional research and resource stewardship across natural and cultural disciplines, provides avenues of communication, and encourages public policies that embrace these values.

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.

Executive Office

DAVID HARMON, **Executive Director**
EMILY DEKKER-FIALA, **Conference Coordinator**
P. O. Box 65 • Hancock, Michigan 49930-0065 USA
1-906-487-9722 • info@georgewright.org • www.georgewright.org

Publications Committee

JAN W. VAN WAGTENDONK (**Chair**), NATHALIE GAGNON, DAVID GRABER, ROLF DIAMANT, LAVELL MERRITT, JR., ABIGAIL MILLER, JOHN WAITHAKA; REBECCA CONARD & DAVID HARMON (**Co-editors, *The George Wright Forum***)

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On the cover: For the last century, the relationship between automobiles and Yosemite National Park has been a vexed one. This issue highlights recent research and new management techniques that link transportation with the visitor experience in the park–with implications that go far beyond Yosemite. Upper photo: Automobile access and visitor use in a meadow below Yosemite's Half Dome, 1927. Photo courtesy of National Park Service Historic Photograph Collection, Harpers Ferry Center. Lower photo: While working on the Merced River visitor study, field researcher Dan Shelby climbed a sign post to get just the right photo-angle on this traffic jam. Although Yosemite is not busy all of the time, peak-use levels have become ever more frequent. As in urban areas, traffic problems can "go exponential" and cause hours of gridlock. Photo courtesy of Dan Shelby.

SOCIETY NEWS, NOTES & MAIL

Registration for GWS2013 now open

We are in the home stretch of preparations for the 2013 George Wright Society Conference on Parks, Protected Areas, and Cultural Sites. We'll meet in downtown Denver at the Sheraton Hotel March 11th through the 15th. It's a week to get recharged with new ideas, reconnected with old colleagues, and just plain reinvigorated. If you don't want to miss out—and we'd like to strongly suggest that you don't!—the first step is to register. Start by going to

www.georgewright.org/gws2013_regnoverview

and follow the links. We hope to see you in the Mile High City!

Mitchell, Sharp win seats on GWS Board; van Wagtendonk reappointed

Jerry Mitchell, a retired US National Park Service natural resource professional, and Ryan Sharp, a professor at Eastern Kentucky University, were the leading vote-getters in the 2012 GWS Board of Directors election. They topped Harry Butowsky, Peter Dratch, Patricia O'Donnell, and Jack Potter in a very close vote. Mitchell and Sharp will serve three-year terms starting in 2013. Jan van Wagtendonk, retired from the US Geological Survey after a career in fire ecology and management, was reappointed to a second three-year term, also starting in 2013.

What Should NPS Tell Visitors (and Congress) about Climate Change?

Philip Cafaro

What we are doing

Anthropogenic climate change is already degrading America's national parks and other protected areas, in the US and around the world. And the prognosis under "business as usual" demographic, economic, and energy policies is for their continued decline.[1]

Item: Glacier National Park is losing its glaciers; the last one may melt away by 2030. Loss of glacial run-off and reduced snowpacks will decrease stream flows, possibly driving native bull trout extinct. Iconic wildlife species such as grizzly bears, wolverines, and mountain goats are likely to decline due to dryer, warmer conditions.

Item: Rocky Mountain National Park and surrounding wilderness areas contain hundreds of thousands of acres of dead or dying pine forests. As the National Park Service (NPS) Climate Change Response Program website explains: "Pine beetles are natural to this system, but normally the harsh Colorado winters are cold enough to kill off many of these beetles. However with warming winter temperatures it has allowed the beetle population to explode, causing the devastation of lodgepole pine trees in the park." In addition, like Glacier, Rocky Mountain could lose rare wildflower species as alpine habitats shrink or are degraded.

Item: Joshua Tree National Park may lose all its Joshua trees within this century. The trees are dying in enormous numbers due to a drought more severe than any experienced during the past five hundred years.

Item: In Everglades National Park, climate change-induced sea level rises of only a few meters threaten to submerge large areas of the park, including most current mangrove stands:

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key nurseries for ocean fishes. Wading bird populations, already greatly decreased since the park's establishment in 1947, due to excessive water withdrawals, will decline even further due to habitat loss. Coral reefs at nearby Biscayne National Park will probably be lost due to higher temperatures and ocean acidification. American alligators, at the southern edge of their distribution, may disappear from Everglades, like pika from Rocky and harlequin ducks from Glacier.

So that is what we are doing. We are degrading our national parks and other natural areas: pushing them far outside natural climatic and ecological parameters, and ensuring that future generations will find their native flora and fauna significantly depleted, compared with the parks we ourselves have known.

How are we doing this? The primary causes of climate change are no mystery: rapid, unremitting economic and demographic growth. As the *Fourth Assessment Report* from the Intergovernmental Panel on Climate Change (IPCC) succinctly put it: "GDP/per capita and population growth were the main drivers of the increase in global emissions during the last three decades of the 20th century.... At the global scale, declining carbon and energy intensities [i.e., increased efficiency] have been unable to offset income effects and population growth and, consequently, carbon emissions have risen."[2] With rising carbon emissions (and deforestation and other land use changes, also driven by growth) have come climate destabilization.

Crucially, the IPCC's projections for the next several decades see a continuation of these trends; more people living more affluently mean that under "business as usual," despite expected technical efficiency improvements, greenhouse gas emissions will increase between 25% and 90% by 2030, relative to 2000.[3] If humanity continues along this path, which we give every indication of doing, we will almost surely lock in global temperature increases of more than two degrees Centigrade over pre-industrial levels, perhaps much more, further degrading national parks and protected areas. According to the *Fourth Assessment Report*, climate change combined with other growth-induced stressors could extinguish one-quarter or more of the world's species by 2100, including many rare or threatened species currently hanging on in national parks.

One hundred years ago, fifty years ago, perhaps even twenty-five years ago, educated people might well have pled ignorance regarding the full ecological effects of that growth for which our political and business leaders endlessly bray. But after the work of the IPCC, the authors of the 2005 *Millennium Ecosystem Assessment,* and others, the age of ecological innocence is over. We now know that the continued growth of humanity displaces other species and degrades the entire planetary ecosystem, even areas previously protected by their remoteness. Henceforth our growth is synonymous with the decline of wild nature.[4]

What NPS should say about what we are doing

I propose that NPS tell its visitors the truth about this—all of it, not just the parts that visitors feel comfortable hearing, or that park interpreters feel comfortable saying. We owe it to the parks to do so. We owe it to the pikas and grizzly bears, the Joshua trees and Parry's primroses, to do so. *Not* doing so conflicts with the "fundamental purpose" of NPS, as stated in the 1916 Organic Act, since it is clear that anthropogenic climate change is "impairing" the

parks and undermining efforts "to conserve the scenery and the natural and historic objects and the wild life therein."

Where climate change is harming the parks, NPS should say so. Where plausible scenarios show that further climate change is likely to damage them even more, NPS should vividly convey that. Most important, but perhaps also most difficult: NPS should explain to the American people plainly that growth—ever more people, consuming and producing ever more goods and services, living ever more luxuriously—is driving the climate change that is degrading their national parks. We owe American citizens this honesty, because ultimately, it is their responsibility to behave in ways that preserve the parks, just as it is their government's responsibility to pursue policies that preserve them.

Here we confront the serious problem that climate change is typically treated as a technical or managerial problem that can be solved by increased efficiency (hybrid cars, compact fluorescent bulbs, etc.) and not as evidence that humanity is bumping up against ecological limits.[5] There is no public consensus, even among those who care about wild nature, that we have to choose between pursuing further growth, on the one hand, and preserving protected areas and leaving some non-degraded habitat and resources for other species, on the other.

Nevertheless, the science strongly suggests that we do face such a choice.[6] Even if continued growth could conceivably be squared with limiting climate change enough to protect the national parks, in the face of the *actual* harms caused by growth, the burden of proof should be on those claiming such *potential* benignity. NPS should not carry water for them, even inadvertently.

Readers of Thomas Friedman's techno-optimist best-sellers (*The World is Flat*; *Hot, Flat, and Crowded*, etc.) lap his stuff up because it makes them feel good. Everyone can get rich as the world becomes "more green": eat cake and lose weight. Meanwhile, back in the real world, according to the US Department of Energy, "economic growth is the most significant factor underlying the projections for growth in energy-related carbon dioxide emissions in the mid-term, as the world continues to rely on fossil fuels for most of its energy use."[7] Meanwhile, back on the round sphere with a finite surface area called Earth, according to the IPCC, economic growth and population growth are driving climate change. That is what NPS should tell visitors to the national parks.

What NPS *is* saying about what we are doing

When we look at what NPS actually tells visitors about climate change, we find a mixed bag. NPS has developed some good materials explaining the harms climate change is causing or may cause particular parks. At its best, this material forthrightly states that climate change will damage the parks or the wildlife within them. For example, the website for Point Reyes National Seashore tells visitors:

> Due to global warming, Point Reyes and other national parks are currently confronting one of the greatest threats in their history. The world is heating up, and the signs are already visible in National Parks: rising temperatures, prolonged drought, severe wildfires, diminished snowfall, acidifying oceans, and changing habitats. . . .

> Rising sea levels impelled by melting glaciers and polar icecaps will likely dramatically change this coastal park's environment upon which animals have come to rely and humans come to enjoy. The U.S. Geological Survey (USGS) predicts that rising seas could erode beaches and coastlines, submerge wetlands, and swallow up Native American cultural artifacts at Point Reyes and several other national parks. Rising temperatures may make this area uninhabitable for many species of plants and animals that currently live here. . . .

At other times, though, the language NPS uses seems limp, given the magnitude of the threats, or euphemistic. "Climate change transforms the natural and cultural landscapes of national parks and impacts your national park adventure," states the Climate Change Response Program's homepage, and clicking on "Consequences" brings one to a long, diffuse discussion of how climate change will "change" the parks:

> As the climate drivers *change,* the natural ecosystem and human use of that landscape are bound to *change.* Even subtle shifts in climate can create substantial *changes*—earlier snowmelt, a slight increase in summer temperatures, and a slight decrease in rainfall can combine to *change* the intensity of forest fires, or render forests more susceptible to pests and diseases. With climate *change,* nature will begin to *rearrange* itself, and our ability to protect and manage national parks will be challenged . . . (emphases added).

But "change" and "transformation" are not necessarily bad things, nor is "nature rearranging itself" in response to changed conditions, nor are people "being challenged" in response to those changes. This passage and a previous section on climate change "drivers" also undermine any sense of *agency* for these "changes," making it seem like they are just happening.

Now imagine rewriting this passage to emphasize the harms of climate change and our responsibility for those harms. It might read something like this:

> As populations increase and people consume more, burning more fossil fuels and generating more pollution, natural ecosystems such as those of the national parks are stressed and pushed beyond historical ecological parameters. Even subtle shifts in climate can degrade habitat that is essential for rare and endangered species, driving them to extinction, or dry out forests, killing them and displacing their inhabitants. Climate change is already harming the parks in these ways and threatens to further degrade them in the future, unless we act to prevent it. Future generations will not be able to fix this damage. . . .

I contend that the second passage is not just more vivid, but more accurate. It better captures what the scientists tell us is happening and could happen to the national parks, and why. It suggests a more forthright ethical accounting of our responsibilities regarding this looming disaster.

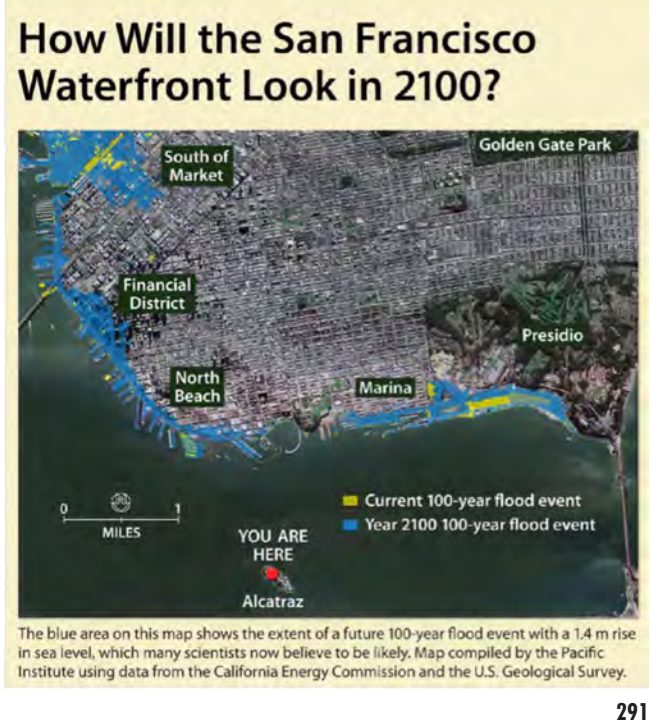
In general, strong, direct, clear statements seem preferable when speaking about all this. "Losing a Legacy: A Photographic Story of Disappearing Glaciers" is a good headline for a USGS project documenting climate change impacts in Glacier National Park. "Glacier's

Changing Landscape" is a bad headline for a section of the park visitor guide dealing with the same topic.[8]

The best interpretative materials on climate change tend to be the most vivid. Particularly powerful, it seems to me, are wayside exhibits, based on prototypes developed at Golden Gate National Recreation Area (Figure 1), currently being planned for eight to ten coastal parks. These will show visitors contour lines of potential future sea levels, vividly portraying how sections of these parks and adjacent landscapes could be under water if climate change continues unabated. This is sort of a limit case: because the potential loss is so obvious and complete, these exhibits will hardly have to explain why these effects would be bad (although they can amplify the message; for example, by having a map which shows how much of the surrounding area would be under water with particular sea level rises).

These exhibits show the power of the concrete and particular, in driving home the costs, to the parks, of climate change. They suggest that efforts to interpret subtler impacts might benefit from making them more concrete. For example, at the end of a wildflower identification walk in Rocky Mountain National Park, an interpreter might ask young people to imagine coming back to the park with their grandchildren in 50 years, describing what fairy primroses or alpine forget-me-nots looked like, and explaining to them why those species are no longer there.

Figure 1. Sea level rise exhibits at Golden Gate National Recreation Area, San Francisco. (Left): Exhibit at Crissy Field with gauge marking future sea levels with colored balls. (Right): Detail of exhibit panel on Alcatraz Island.



Above all, NPS should avoid normalizing the losses expected from climate change. Currently, a list of frequently asked questions ploddingly explains that Glacier National Park will keep its name after its last glacier disappears. Why not instead solicit visitors' suggestions for renaming "the National Park formerly known as Glacier," or "Joshua Tree-Free National Park"? Such exercises might help visitors understand how radically we are changing the parks, and spur some of them to consider what it would actually take to protect them.

When it comes to discussing the *causes* of global warming, NPS interpretive materials again appear to be a mixed bag. On the positive side, these materials insist that "global warming is real," to quote again from the NPS Climate Change Response Program website, and emphasize that climate change is anthropogenic. Rising greenhouse gas emissions, driven by increased fossil fuel use, are clearly identified as the leading cause of global climate change in many NPS publications. In our current political context, with one major political party in the grip of climate change denial, NPS deserves credit for this forthright defense of reality.

On the negative side, nowhere in any NPS publication have I found a clear restatement of the IPCC's conclusion that growth in human numbers, wealth, and economic activity are the fundamental drivers of rising greenhouse gas emissions and attendant climate change. And when we turn to the "what you can do to help" sections of several NPS climate change websites and publications, the focus is on individual, voluntary actions, rather than policy changes or mandatory, society-wide improvements. In one representative discussion, concerned individuals are told that they can "walk, carpool, bike or use public transportation if possible," replace incandescent bulbs, use recycled products, "purchase a travel coffee mug and a reusable water bottle to reduce use of disposable products," and carry reusable bags, among a laundry list of possibilities.[9]

This non-threatening approach makes some sense when reaching out to individuals with diverse political leanings. It is hard to imagine NPS proposing that visitors "drive less, replace incandescent bulbs with compact fluorescents, demand that politicians pass strong climate change legislation that taxes carbon emissions, and vote them out of office if they do not." Still, when interpretive materials combine silence regarding the underlying forces driving climate change with easy, voluntary suggestions for emissions cuts, they reinforce the notion that such efforts are sufficient to deal with climate change. And that is seriously misleading.

As things stand, then, NPS interpretive materials do a decent job of teaching visitors that climate change is real and that it is a serious problem threatening their parks, while doing a poor job of explaining its causes and potential solutions to the problem.

How to improve what NPS says about what we are doing

One way to build on these efforts would be to drop the weak parts. If NPS personnel feel squeamish talking about the real causes and adequate solutions for mitigating climate change, then they should at least avoid giving incomplete explanations or promoting inadequate solutions which mislead visitors. Instead, NPS interpreters could focus on what they care most about: the well-being of the national parks. Talk about how we are harming the parks and leave contentious discussions regarding causes and solutions to those who are willing to confront their fellow citizens with hard truths. Even politically conservative park

visitors typically care about the parks, so this approach might provide a window to get them thinking more seriously about climate change.

The other way to build on current efforts would be to take a deep breath and talk more honestly about the causes of climate change. After all, melting glaciers, dead forests and rising shorelines provide potentially powerful "teachable moments" for visitors. Some NPS personnel would probably welcome the opportunity to look beyond the "hundred cuts" afflicting the parks and speak candidly about what really ails them: too many people making too many demands on nature. If any settings could put visitors in a receptive mood, willing to consider the downside of growth or the possibility of sacrificing some unnecessary consumption in exchange for preserving wild nature, it might be the national parks.

Getting the general public to think about limits to growth will be difficult, no doubt. But I believe it is also essential to preserving the national parks over the long term. It is a shame the big environmental groups have largely abandoned talk about ecological limits. Perhaps an honest discussion of what further growth means for the national parks can help revive this topic, reinvigorating these timid giants in the process.

As for directly promoting the necessary *solutions* to climate change, however, my suggestion would be for NPS to simply let those alone. "101 easy suggestions for mitigating climate change" is just that—too easy. But the real solutions needed are too controversial for advocacy by the personnel of a non-political government agency, at least without the "cover" provided by an honest discussion of these matters by environmental groups and mainstream politicians. Reining in population growth in the United States will have to involve reducing immigration and maintaining the legal availability of abortion, a one–two punch guaranteed to alienate people across the political spectrum.[10] Reining in economic growth will demand nothing less than an economic revolution, given our current economy built on the premise of endless growth.

In order to protect our national parks and create sustainable societies, we must move from a political system and an economy which seek to supply ever more people with ever more stuff, to a political economy which provides a limited number of people with a sufficiency. What that will look like, in detail, remains to be seen.[11] Probably the best NPS can contribute to clarifying such questions is to raise the alarm about what we are doing to our parks, while avoiding the usual "happy talk" that only obscures what needs to be done to protect them.

National parks cannot adapt to climate change

Speaking of clearing out the rubbish, NPS should drop all talk about helping national parks "adapt" to climate change. According to the NPS Climate Change Response Program: "The National Park Service can improve the long-term health of national parks by making natural, cultural, and social systems better able to withstand and recover from climate changes through adaptation." According to NPS's official *Climate Change Response Strategy*, NPS seeks to "implement adaptation strategies that promote ecosystem resilience … and support the ability of natural systems and species to adapt to change." "By focusing on resilience," its authors claim, park managers can "accommodate and respond to emerging knowledge of cli-

mate change effects and alternative management strategies that can lessen the impacts" of climate change.[12]

This is simply whistling in the dark. NPS cannot refreeze glaciers. It cannot replant millions of acres of degraded forests. It cannot bring back species extinguished by climate change. Attempts to protect what the parks are losing are bound to fail, in the long run. Suggesting otherwise just provides cover for those whose actions and policies are degrading our national parks.

In addition, intensive manipulation of national park landscapes or wildlife populations will inevitably turn them into something less than national parks: botanical gardens or zoos, rather than genuine holdfasts for wild nature. As the National Park System Advisory Board science committee recently reminded us, the NPS mission includes "preserving [the] ecological integrity" of the lands entrusted to its care. That means maintaining what nature, not a resource manager, creates within the parks, including "complete food webs, a full complement of native animal and plant species maintaining their populations, and naturally functioning ecological processes."[13] If achieving this is impossible in the warming, destabilized, ecologically degraded world we are creating with our excessive numbers and demands on nature, then NPS should say so.

But a "can-do," managerial stance is popular among land managers, and probably selected for among those competing for leadership roles in large bureaucracies. Just as mainstream economists cannot accept limits to growth, and assume, against the preponderance of evidence, that efficiency improvements can sufficiently mitigate climate change, so managers seem to have a hard time accepting that better management, by itself, cannot save wild lands (Figure 2). Here is NPS Director Jon Jarvis, testifying in 2009 before the Senate Subcommittee on National Parks, at a hearing devoted to climate change:

> For adaptation planning and implementation, our highest priority is to support the ability of species, communities, and ecosystems to respond to changing conditions. For example, changes in weather patterns, water availability, and wildland fire will stimulate changes in the distribution and abundance of plants, animals, and ecological communities through both adaptation and migration. NPS actions to build resilience and reduce other ecosystem stressors, especially the effects of exotic species, will help to reduce the extent or intensity of some of the most deleterious impacts on park resources from climate change. . . .[14]

Big words—but essentially empty ones. NPS efforts to cull exotic species, transplant natives, or buffer waters or soils that are departing from historical conditions are well-intentioned. In some instances, they may do some short-term good. But as long-term strategies, such efforts are hopeless: unlikely to achieve their stated goals, even as they ensure that park landscapes become ever more humanized, losing their wild integrity.

In jumping on the adaptation bandwagon, NPS has followed the lead of the climate change policymaking community. But while adapting to climate change already "in the pipeline" makes sense for human societies, it is not possible for natural ecosystems that we want to remain natural.[15] If Director Jarvis wanted to speak a good word for nature in his congressional testimony, he would have been better served by something like the following:

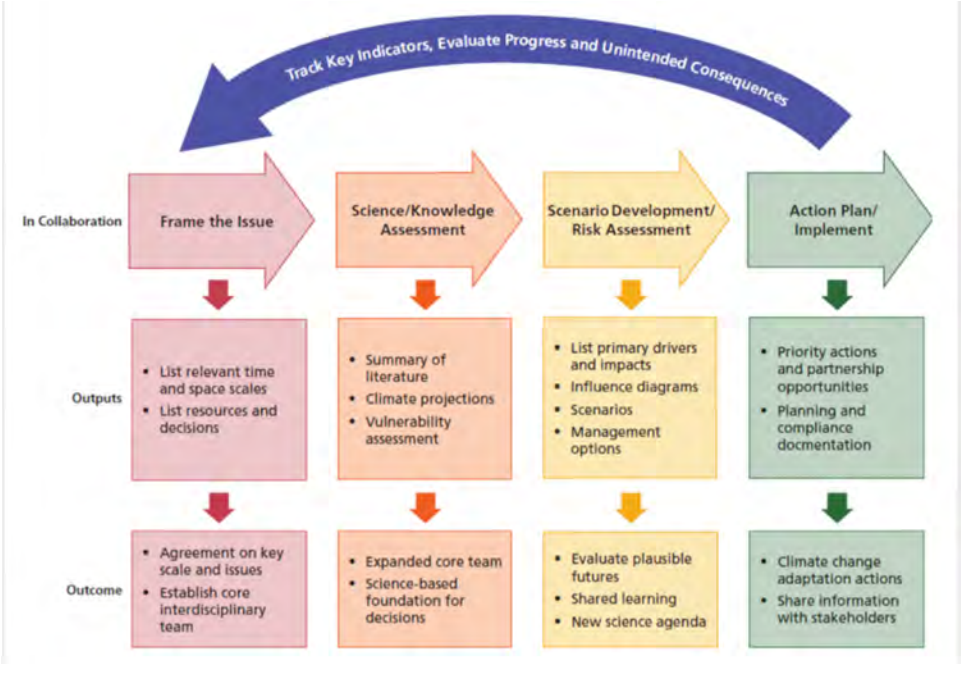


Figure 2. "Conceptual Approach for Collaborative Adaptation Planning." Note the inclusion of many favored aspects of "adaptive management," such as collaboration, action at appropriate scales, prioritizing goals, etc. This jargon enhances the comforting illusion that better management will help protect the national parks from climate change. Source: National Park Service, *Climate Change Response Strategy* (Fort Collins, CO: NPS Climate Change Response Program, 2010).

> I and the dedicated professionals of the National Park Service would love to manage the parks in ways that keep them safe from the worst harms of global climate change. But we can't. We need Congress and the American people to help protect the national parks by managing our excessive and growing energy use. A world in full adaptation mode to climate change (perhaps with planet-wide geo-engineering to keep 'ecosystem services' available to humans) will be a world that has degraded and altered national parks beyond recognition. In order to preserve our national parks, we must limit climate change, by working harder at managing *ourselves.*

Such a statement might have helped build the case for strong action to fight climate change (a decent climate change bill died in the Senate the following year). Talk about adaptation instead lulls listeners into believing that we can continue with "business as usual" and still protect our parks.

Your mission, should you choose to accept it

The "fundamental purpose" of NPS is "to conserve the scenery and the natural and historic objects and the wild life [within the national parks] and to provide for the enjoyment of the

same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." Over the past hundred years, as NPS has struggled to understand and uphold its mission, three aspects of this fundamental purpose have been clarified that deserve emphasis as we consider this essay's guiding question: what should NPS say about climate change?

First, NPS's purpose includes preserving *all* species native to the parks—not just those we like or which can coexist with particular human behaviors. Second, it involves limiting or prohibiting activities within the parks that harm them—even popular ones. Third, over time, Park Service leaders have found that they must weigh in on activities *outside* the parks when they threaten the parks themselves—despite the backlash such efforts are bound to provoke.[16]

This generous vision remains compelling. In a crowded, warming world, where human beings threaten to overwhelm nature, it is needed more than ever. But applying this vision to the issue of climate change does not mean accepting changes emanating from beyond the parks' boundaries that threaten to destroy them, or pretending that such changes can be "managed." Instead it means ringing out an unambiguous warning aimed at all those who care enough about the national parks to fight on their behalf.

The National Park Service was originally a product of Progressive Era conservation, which included preservation of wild nature and economic growth as goals, and assumed that both could be achieved indefinitely, if resources were managed rationally and efficiently. Whatever the merits of such a philosophy in 1916, it is patently unsuited to 2016. National parks in the US and around the world cannot survive intact another century of human demographic and economic growth. It is time for those committed to preserving the parks and biodiversity generally, including NPS managers, to acknowledge this and act accordingly.

NPS should tell visitors the truth: that growing human numbers and economic activity are damaging their national parks and other wild lands, through climate change and other mechanisms; that we are on course to leave our grandchildren a severely degraded and significantly depauperate national park system; and that unless we change course, we may largely destroy some of them in the future by drying them out, burning them up, or sinking them below the waves of the ocean.

We owe it to the parks and to their owners, the American people, to give them this bad news without any sugar coating. What they do with it, of course, is beyond our control.

Acknowledgments

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Endnotes

1. For an overview of observed and anticipated impacts of climate change on the national parks, click on "climate effects" on the website for the NPS Climate Change Response Program: www.nps.gov/climatechange/effects.cfm. The following description is based

on this and the following sources: Jennie Hoffman and Eric Mielbrecht, *Unnatural Disaster: Global Warming and Our National Parks* (Washington, DC: National Parks Conservation Association, undated); Kurt Repanshek and Jennie Hoffman, *Climate Change and National Park Wildlife: A Survival Guide for a Warming World* (Washington, DC: National Parks Conservation Association, undated); National Park Service, *Understanding the Science of Climate Change: Talking Points—Impacts to Western Mountains and Forests,* Natural Resource Report NPS/NRPC/NRR—2009/090 (Washington, DC: NPS, 2009); National Park Service, *Understanding the Science of Climate Change: Talking Points—Impacts to Arid Lands,* Natural Resource Report NPS/NRPC/NRR—2010/209 (Washington, DC: NPS, 2009); National Park Service, *Potential Ecological Consequences of Climate Change in South Florida and the Everglades: 2008 Literature Synthesis,* Resource Evaluation Report SFNRC Technical Series 2009:1 (Washington, DC: NPS, 2009).

2. Intergovernmental Panel on Climate Change, *Climate Change 2007: Mitigation: Technical Summary* (Geneva: IPCC), 107.
3. Ibid., 111.
4. Paul Ehrlich and Anne Ehrlich, *The Dominant Animal: Human Evolution and the Environment* (Washington, DC: Island Press, 2009); Dave Foreman, *Man Swarm and the Killing of Wildlife* (Durango, CO: Raven's Eye Press, 2011).
5. Philip Cafaro, "Beyond Business as Usual: Alternative Wedges to Avoid Catastrophic Climate Change and Create Sustainable Societies," in *The Ethics of Global Climate Change,* Denis Arnold, ed. (New York: Cambridge University Press, 2011), 192–215.
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7. United States Energy Information Administration, *International Energy Outlook 2009* (Washington, DC: Department of Energy, 2009), chapter one.
8. "Losing a Legacy: A Photographic Story of Disappearing Glaciers," photography exhibition, Hockaday Museum of Art, Kalispell, MT, January 29–April 10, 2009; National Park Service, "Glacier Visitor Guide," Summer 2008.
9. National Park Service, *Understanding the Science of Climate Change: Talking Points—Impacts to the Pacific Coast,* Natural Resource Report NPS/NRSS/CCRP/NRR—2012/513 (Washington, DC: NPS, 2012), 18–19.
10. Steven Camarota, *100 Million More: Projecting the Impact of Immigration on the U.S. Population, 2007–2060* (Washington, DC: Center for Immigration Studies, 2007); Progressives for Immigration Reform, "US Immigration Policy—Environmental Impact Statement," online at www.immigrationeis.org.
11. Interesting work exploring this question includes Herman Daly and John Cobb, *For the Common Good: Redirecting the Economy toward Community, the Environment, and a Sustainable Future* (Boston: Beacon Press, 1989); Samuel Alexander (ed.), *Voluntary Simplicity: The Poetic Alternative to Consumer Culture* (Whanganui, New Zealand: Stead & Daughters, 2009); Tim Jackson, *Prosperity without Growth? The Transition to a Sustainable Economy* (Brussels: European Union Sustainable Development Commission, 2009).

12. National Park Service, *Climate Change Response Strategy* (Fort Collins, CO: NPS Climate Change Response Program, 2010), 14–15.
13. National Park Service System Advisory Board Science Committee, *Revisiting Leopold: Resource Stewardship in the National Parks* (Washington, DC: National Park System Advisory Board, 2012), 11–12.
14. Senate Subcommittee on National Parks, "Impacts of Climate Change to National Parks," Senate Hearing 111-239, October 28, 2009 (Washington, DC: US Government Printing Office, 2010).
15. Here I part company with Richard J. Hobbs et al. ("Guiding Concepts for Park and Wilderness Stewardship in an Era of Global Environmental Change," *Frontiers in Ecology and the Environment* 8 (2010): 483–490), who argue that "naturalness" is outmoded as an organizing goal for protected areas. Space constraints prevent me from arguing against this position in detail. Suffice it to say that I do not think that the components of "naturalness" that Hobbs et al. continue to see as valid management goals, such as "ecological integrity" or "historical fidelity," are any more amenable to preservation through adaptation programs, nor do I believe that we can jettison "naturalness" as a goal for the parks and still "manage with humility," as they advise. There is nothing humble about accepting human domination of the national parks.
16. For a good account of these developments see Alfred Runte, *National Parks: The American Experience,* 4th ed. (Boulder, CO: Taylor, 2010).

Philip Cafaro is professor of philosophy at Colorado State University and an affiliated faculty member with CSU's School of Global Environmental Sustainability. A former interpretive ranger with the National Park Service, his main research interests are in environmental ethics, consumption and population issues, and wild lands preservation. Cafaro is the author of *Thoreau's Living Ethics* and co-editor of the forthcoming anthology *Life on the Brink: Environmentalists Confront Overpopulation*, both from University of Georgia Press. He is the incoming president of the International Society for Environmental Ethics.

Letter from Woodstock

Rolf Diamant

Revisiting Leopold — More Frequently

This third "Letter from Woodstock" looks at the recently released *Revisiting Leopold: Resource Stewardship in the National Parks*, which is appended to this issue of *The George Wright Forum*. The report is a product of the National Park System Advisory Board's Science Committee and its recommendations are currently under review by the National Park Service (NPS) and other interested parties.

Revisiting Leopold is both encouraging and, at times, disappointing. The most important outcome of this Advisory Board report is its unequivocal recognition that national parks are increasingly subject to continuous, potentially destabilizing, anthropogenic-triggered changes and that many of these changes are at scale and have impacts that reach far beyond existing park boundaries. "Significant uncertainty exists," the report warns, "regarding responses of park ecosystems and historical resources to these conditions." To its credit, the report also emphasizes how essential comprehensive cross-boundary cooperation, as well as broad public understanding and engagement, will be to any conservation response.

It is worth noting that the pages of *The George Wright Forum* have provided a valuable platform for sharing practical park-based experiences with environmental change and advancing the kind of pioneering thinking that undergirds many of the Science Committee's observations. In a series of provocative *Forum* articles, current and former NPS resource managers and researchers have been challenging the long-held canon that parks can be managed in a way that guarantees resources remain largely unimpaired or unchanged over time. The traditional "hands-off" approach to natural area and wilderness stewardship was questioned by David M. Cole and colleagues in their article "Naturalness and Beyond: Protected Area Stewardship in an Era of Global Environmental Change" (*The George Wright Forum*, vol. 25, no.1, 2008): "The key challenge to stewardship of park and wilderness ecosystems is to decide where, when, and how to intervene in physical and biological processes to con-

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serve what we value in these places." As William C. Tweed declared in his article "An Idea in Trouble: Thoughts about the Future of Traditional National Parks in the United States" (vol. 27, no.1, 2010), "The concept that a 'fence of law' can be erected around a portion of an ecosystem and that the area contained within that hypothetical fence can be maintained forever 'unimpaired for future generations,' can no longer be defended." And Sarah Stehn, in her article "Keeping Up with the Mountain: The Challenge and Prospect of an Adjusted Management Paradigm" (vol. 27, no.1, 2010), made the case that the tremendous challenges facing national parks transcend science: "Recognized as not just an ecological challenge but as a cultural and intellectual one, the scope of climate change and its effects requires developing a shared vision among multiple agencies and regional groups. . . ." Stehn acknowledges the need for additional partners "from outside the normal realm of operation(s). . . ."

Revisiting Leopold was intended to serve as a timely response to many of the issues raised in the *Forum*, and the report does represent a foundational step in the right direction. However, it is still a foundation that needs to be extended. Seemingly on the verge of recognizing that new thinking and greater management flexibility are needed now and in the future, the report authors also seem reluctant to depart from more traditional resource management objectives. This reticence on the part of the Science Committee perhaps should not come as a surprise. David J. Parsons noted in his *George Wright Forum* review (vol. 28, no.1, 2011) of William Tweed's recent book *Uncertain Path: A Search for the Future of National Parks* that Tweed predicts "transitioning from a largely 'hands-off' management approach to a more aggressive 'hands-on' one is sure to be a politically dangerous process that will be opposed by many of those who have traditionally been the parks' biggest supporters."

For example, there are a few sections of the report where the committee's choice of words seemingly contradicts otherwise forward-thinking intentions. In the same sentence, the report calls on NPS to "formally embrace the need to manage for change" and also "to the maximum extent possible to maintain or increase current restrictions on impairment of park resources." Implicit in managing for change should be an understanding that an "unimpaired" standard for park stewardship, as envisioned by the original Leopold report, may no longer be realistic or achievable in many national parks. To double down on holding the line on change and strict unimpairment may in the long run be counterproductive; or, as Cole and his co-authors state, "According to resilience theory, attempting to prevent or resist change is likely to increase the risk of larger future change. . . . As change and uncertainty increase, managers are less likely to possess the requisite knowledge to specify desired future conditions. Attempts to achieve long-term objectives, as conditions change, could lead to loss of biodiversity, decreased resilience, and ecosystem degradation."

At first read, the Science Committee's assertions that NPS managers "need to embrace more fully *the precautionary principle*" and that "stewardship decisions reflect science-informed prudence and restraint" seem reasonable enough. That is, as long as the precautionary principle is not applied in such a way that it unintentionally discourages necessary interventions and a degree of trial and error as park resource managers try to grapple with problems they have never before encountered. Cole and colleagues predicted that "managers may need to anticipate and guide change, to actively transform systems rather than let them passively degrade—to create novel ecosystems in new places, for the purpose of protecting

something of value and enhancing system resilience.... Managers need the flexibility to respond to deliberate experimentation and effectiveness monitoring."

The report's observation that the division of national parks into "natural parks" and "cultural parks" is "artificial" and does not advance effective resource management is particularly commendable. However, the authors go on to develop interpretations of "cultural and historic authenticity" that would benefit from broader consultation and cooperation with cultural resource management professionals.

And lastly, while *Revisiting Leopold* correctly recognizes that "investing in science is essential, but it is only one element in preparing NPS stewardship for the future," it is easy to lose sight of the enormity of the challenge facing NPS in working and partnering effectively outside park boundaries. Large landscape-scale initiatives require a sustained commitment of people and resources over time if meaningful and lasting conservation outcomes are to be achieved. Years ago when my NPS colleague Drew Parkin and I arrived in the small, rural community of Jackson in the White Mountains of New Hampshire to organize a Wild and Scenic River study on the Wildcat River, Parkin, sizing up the political opportunities for conservation, presciently suggested we'd better invest our time "in counting (and cultivating) the selectmen as well as the fish." In addition to enhancing its science capacity, NPS will have to also significantly scale up its capacity in social science, cultural competencies, community planning, new models of governance, and sustainable development.

Over the next several months, as NPS reviews the Science Committee report and gathers comments, there is an opportunity not only to improve it but perhaps as importantly to envision a ongoing process of feedback and refinement. In this new era of uncertainty and continuous change, NPS may need to more frequently revisit the practice of resource stewardship—continually testing assumptions and objectives and adapting investments and strategies—in a struggle to perpetuate the high purposes and values of national parks in an increasingly challenging global environment.

FROM MODEL T'S TO COMPUTER MODELS: INTEGRATING TRANSPORTATION AND VISITOR CAPACITY RESEARCH AND PLANNING AT YOSEMITE NATIONAL PARK

Nathan Reigner, Steven Lawson, David White, Bret Meldrum, and Robert Manning, guest editors

Integrating Transportation and Recreation in Yosemite National Park

Bret Meldrum and Henrietta DeGroot

Yosemite National Park is one of the crown jewels of the national park system. Its remarkable convergence of natural features—the iconic Yosemite Valley, vast wilderness, ancient giant sequoias—along with its importance in environmental history—the precedent-setting establishment of the state reserve in 1864, the national park's close association with John Muir, the public battle over damming Hetch Hetchy—contribute to its well-deserved legendary reputation. However, its high profile as a recreation resource and its proximity to large urban centers combine to make the park an exemplar of the issues that challenge many national park managers. Primary among these are balancing public access and park protection, determining recreational "carrying capacities," and managing visitor use in ways that protect the quality of park resources and visitor experiences. In this thematic issue of *The George Wright Forum* we describe a new approach to park planning and management that is designed to address these challenges. This approach recognizes and quantifies these relationships between transportation and recreation in parks.

The following four articles in this issue of *The George Wright Forum* outline the Integrated Transportation and Capacity Assessment (ITCA) model in detail, discuss its application to visitor-use management in Yosemite National Park, and consider the historic intersections

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of transportation and recreation. David White, Stacy Tschuor, and Bill Byrne present the vehicle-based road monitoring, modeling, and evaluation in which transportation is considered as recreation. This is followed by Nathan Reigner, Brett Kiser, Steve Lawson, and Robert Manning's presentation of the recreation-site pedestrian monitoring, modeling, and evaluation that addresses transportation's influence on recreation use. Doug Whittaker, Bo Shelby, Bret Meldrum, Henrietta DeGroot, and James Bacon extend discussion of the ITCA model to its application in park management, specifically the Merced River Plan. Christopher Johnson concludes the thematic set with reflections on the historical and ongoing relationships between transportation and recreation in America's parks and public lands.

Visitor use and management

With increasing visitation come corresponding visitor-use management challenges. In Yosemite these challenges are posed by both visitor use and the park's capacity and have the potential to impact the quality of visitors' experiences. In 1970, when annual visitation was two million, overcrowding in the campgrounds and meadows in Yosemite Valley sparked the Stoneman Meadow Riot. In 1997, when annual visitation reached four million, the park's capacity to accommodate visitors was compromised when Yosemite Valley infrastructure was severely damaged by flooding. Today, visitation hovers near four million individuals annually and the park confronts a litany of resource protection, visitor enjoyment, and operational challenges as a result (National Park Service 2012). For many parks and public lands, visitor-use management challenges are often related to transportation (Daigle 2008). High levels of visitor use induce congestion along Yosemite's roads and at major attractions nearly all days of the park's summer season. Park staff struggle to deal with the ever-increasing use and associated impacts through education, staff-intensive on-site enforcement of regulations, and design modifications.

Transportation and recreation in national parks

The prevalence of visitor-use management challenges associated with transportation in Yosemite is emblematic of the connections between transportation and recreation in in park and on public lands in general. Transportation and recreation are connected in two basic ways. A first connection is the implicit unity of transportation and recreation (White 2008). When visiting parks, transportation activities such as driving and walking are often the primary recreation activities of visitors (Cordell 2004). Indeed, scenic driving and day hiking are some of the most common recreational activities of visitors to Yosemite. As such, the quality of recreation experiences is analogous with the quality of transportation system performance. In this case, transportation *is* recreation.

A second connection between transportation and recreation is processual: transportation systems largely influence the distribution of visitors within parks (Lawson et al. 2009). To the extent that visitors primarily move about Yosemite along the park's road and trail networks, elements of the transportation system shape where visitors go and when they get there. The quality of recreation experiences, particularly with respect to crowding and congestion within recreation sites, is a function of the transportation system's delivery and distribution of visitors. If used to deliver the "right" number of visitors to the "right" places at

the "right" times (based on resource, experiential, and park facility considerations), transportation can be an important park and outdoor recreation management tool.

Planning for visitor-use management in Yosemite

Planning history. Managers at Yosemite National Park have long understood transportation to be a key element of visitor-use planning and management. Transportation infrastructure and systems are present in the some of the earliest plans for the park (Olmsted 1865). With the 1980 General Management Plan (GMP), transportation and its connections to recreation quality and visitor experiences became a central focus of park planning and management (Yosemite 1980). This plan laid out an ambitious vision for promoting the quality of visitor experiences by removing day-use vehicular traffic from the eastern portion of Yosemite Valley. While this initiative was never implemented, the planning effort was effective at focusing attention on the connections between transportation and recreation quality.

Following the 1980 GMP, the park consolidated a number of localized management plans into comprehensive planning efforts in the form of the Yosemite Valley Plan and the Merced River Plan (National Park Service 2000a, 2000b). These plans outline a number of objectives, including preservation of high-quality natural and experiential resources and facilitation of public access and enjoyment. Transportation systems and their operation are positioned within the plans both as key components of recreation quality and important tools for managing visitor use. Subject to the public and legal process of the National Environmental Policy Act (NEPA), these plans have been challenged in court and remanded for refinement and further development.

Objectives for future planning and management. The discussions and deliberations about planning and managing visitor use in Yosemite have suggested several management objectives, including providing a diversity of recreation experiences, encompassing multiple spatial scales, being quantitatively rigorous, and being proactive and flexible. To accomplish these objectives to the satisfaction of legal requirements and public scrutiny, park managers must be able to document visitor-use levels and the quality of recreation experiences associated with these levels of use.

Integrated Transportation and Capacity Assessment

Leveraging the connections between transportation and recreation to structure the relationships between visitor use and experiential quality, Yosemite embarked on a program of research that culminated in 2010 with the ITCA project. Acknowledging transportation as recreation and transportation's influence on recreation, the ITCA project integrates monitoring and evaluation of visitor use and experiential quality for both vehicle-based and pedestrian recreation in a quantitatively explicit and proactive way.

Basic conceptual model. The ITCA project has its roots in a basic conceptual model that links visitor-use levels with experiential quality (Figure 1). This model is informed by indicators and standards of quality and powered by computer-based simulation modeling and visual simulation. Indicators of quality are measurable, manageable variables that serve as proxies for management objectives—for Yosemite, preserving natural resource and experiential quality while facilitating public access and enjoyment. Standards of quality are the

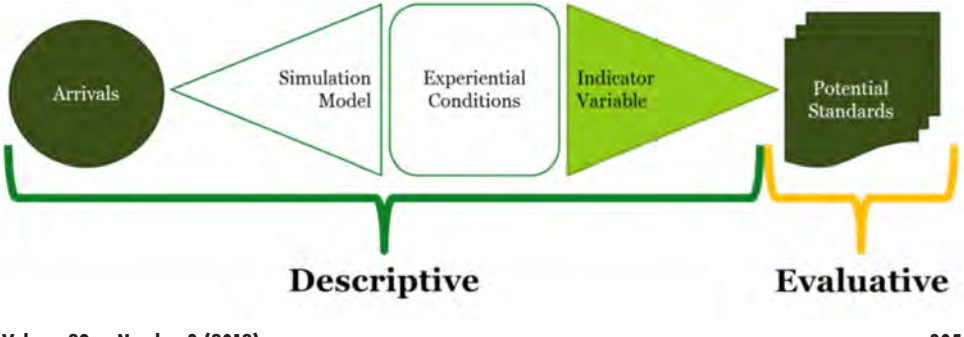
minimum acceptable conditions of indicator variables; they are quantitative benchmarks by which accomplishment of management objectives can be evaluated. Computer-based simulations enable scenarios of visitor use and experiential quality to be experimented with, extending the range of ITCA beyond current use levels and patterns to incorporate many alternative future conditions. Within the basic conceptual model, conditions of visitor use are first described and then evaluated.

The basic ITCA conceptual model begins with counting visitors as they arrive at the park itself, at specified road segments, or at recreation sites to describe and monitor the level of visitor use. This level of use is then distributed throughout the park's road and trail networks by simulation models in ways representative of the observed patterns of visitor behavior and movement. These simulation models estimate the experiential conditions of visitors. Translated into indicator variables, such as the time needed to travel park roads, the number of vehicles in view along road segments, the number of people at one time at attractions, or the number of other visitors encountered along trails, these experiential conditions can be evaluated against a range of standards of quality derived from surveys of park visitors. This progression of monitoring, modeling, and evaluation transforms counts of visitor use through predictions of experiential conditions to assessments of recreation quality with flexibility and the power to proactively consider alternative park use and management scenarios.

Applied conceptual model. While the basic conceptual model has served visitor-use planners and managers well, ITCA's unique contribution is its application of the basic model to the connections between transportation and recreation. The conceptual model illustrates how the basic progression of monitoring, modeling, and evaluation is applied (1) on roads for vehicular-based recreation and (2) at recreation sites for pedestrian-based recreation (Figure 2). These dual tracks of the ITCA applied model acknowledge the connections between transportation and recreation.

The road and vehicle track addresses the transportation-as-recreation connection. The numbers of vehicles entering the park and traveling along specific road segments are counted. Simulation models of vehicle use on park roads estimate the conditions of roadway congestion visitors may experience . These estimates are translated into indicators of quality for visitors' road-based experience —a key element of visitors' recreation experience as scenic and pleasure driving is a nearly ubiquitous and important recreation activity. Finally, road-

Figure 1. The basic conceptual model upon which the ITCA project is based.



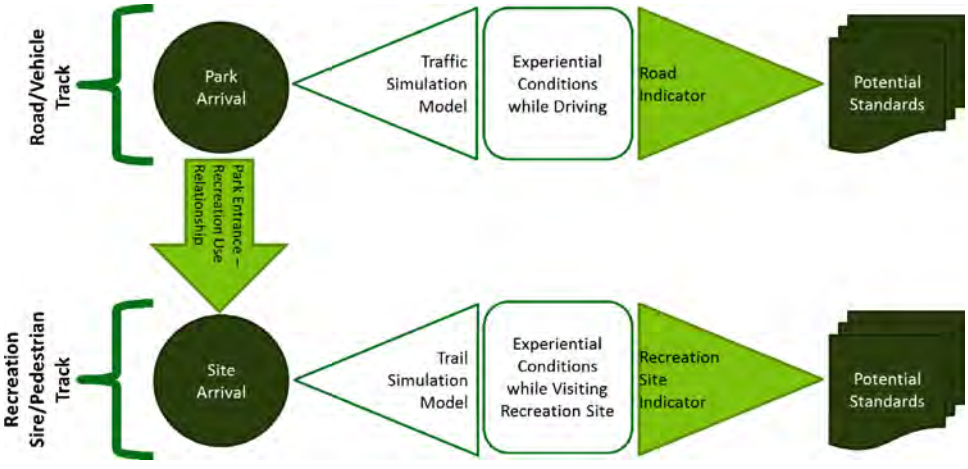


Figure 2. The dual tracks of the ITCA applied model: vehicular- and pedestrian-based recreation.

based recreation quality is evaluated against standards of quality elicited from park visitors.

The recreation site and pedestrian track addresses transportation's connection to visitor distribution. Based on statistical relationships between the number of vehicles entering the park and traveling specific road segments, the number of visitors expected to arrive at selected recreation sites and trailheads is estimated. The distribution and behavior of these arriving pedestrians is simulated and the experiential conditions, in terms of indicators of quality, are estimated and evaluated against a range of potential standards of quality elicited from park visitors.

Implications for visitor-use management

The ITCA conceptual models leverage the connections between transportation and recreation for the purpose of informing park planning and management. Understanding that transportation is indeed recreation for visitors in parks and that transportation systems influence recreation use enables park managers to employ transportation planning and operations as recreation management tools. Starting with counts of vehicle and visitor arrivals, the ITCA model supports these efforts with empirical data. Simulation lends flexibility and proactivity to the process by enabling alternative and hypothetical scenarios to be considered. Translation of visitor use and experiential conditions into indicators and standards of quality allows both monitoring and evaluation of recreation use and quality. By integrating transportation and recreation, roads and recreation sites, and monitoring and evaluation of visitor use, the ITCA model can provide Yosemite and other parks with a transparent, scientifically sound, and legally defensible process for examining and determining recreational carrying capacities at multiple scales and for diverse activities.

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Bret Meldrum, Yosemite National Park, P.O. Box 577, Yosemite, CA 95389; bret_meldrum@nps.gov

Henrietta DeGroot, National Park Service, P.O. Box 577, Yosemite, CA 95389; henrietta_degroot@nps.gov

Assessing and Modeling Visitors' Evaluations of Park Road Conditions in Yosemite National Park

Dave D. White, Stacy Tschuor, and Bill Byrne

Introduction

Park visitors' travel choices and behavior are longstanding concerns for the National Park Service. Travel behaviors can affect natural and cultural resources and the quality of the visitor experience. Driving park roadways has been central to the American national park experience since the earliest days of park preservation. As historian David Louter (2006) argued in his book *Windshield Wilderness,* "We cannot understand parks without recognizing that cars have been central to shaping how people experience and interpret the meaning of national parks, especially how they perceive them as wild places" (p. 164). Youngs et al. (2008) concurred, adding, "We cannot understand national parks without understanding transportation systems more broadly." Understanding transportation in parks is thus critical to both the recreational use and preservation mandates of the National Park Service.

Nowhere are these issues more prominent than in Yosemite National Park, which has struggled with an appropriate balance between automobile access and park preservation since the turn of the 20th century (Havlick 2002). Roads were first built into Yosemite Valley in the 1870s and by 1913 the first cars entered the valley. During the 1930s, park roads were improved, widened, and paved (Runte 1990). Meanwhile the popularity of auto tourism in America expanded (Colten and Dilsaver 2005), sparked by the "See America First" campaign (Shaffer 2001) and the increase in personal automobile ownership. Private automobiles have since become entrenched in park management and visitor culture, leading to what

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Dilsaver and Wyckoff (1999) have called a "spiraling of interdependent development and use" (p. 76). According to Youngs et al. (2008), this "has produced a cultural landscape in portions of Yosemite Valley and other areas of the park that is dominated by roads and automobiles and fostered a widely shared and scripted visitor experience, best described as a 'travel narrative.'" (p. 805). Many Yosemite visitors consider scenic driving to be an important activity (NPS 2009) and they value the sense of freedom, convenience, and access driving provides (White 2007).

There are, of course, also longstanding concerns about the impacts of an automobile-dominated transportation system on visitors' experiences and park resources. Issues include perceived crowding, conflict, traffic congestion, air pollution, vegetation loss, degradation of scenic views, and visitor displacement. To address these problems, Yosemite managers have implemented strategies to improve the transportation system by adjusting traffic patterns, removing cars from the eastern section of Yosemite Valley, initiating a free public bus service in the valley (Greene 1987), and, during periods of extreme congestion, diverting inbound vehicles away from the eastern portion of Yosemite Valley. Despite these efforts, the lingering effects of geography, park design, visitors' preferences for private automobiles, and intensive use continue to challenge the best efforts of park managers.

To deal with these ongoing challenges, Yosemite has in recent years undertaken a program of coordinated research and planning aimed at an integrated transportation capacity assessment (Meldrum and Degroot, this volume). This program has been informed by contemporary thinking on capacity and visitor-use management in national parks (e.g., Graefe et al. 2011; Whitaker et al. 2011) and by an adaptive visitor-use management framework of management objectives and associated indicators and standards of quality (NPS 1997; Manning 2001). Generally, this approach includes: (1) crafting specific goals and objectives in terms of desired conditions and empirically based indicators and standards; (2) monitoring visitor-use levels and associated conditions of experiential quality; and (3) evaluating use levels and experiential quality in comparison with visitor-informed standards of quality to assess achievement of management objectives. This process requires research on current and potential future conditions of visitor use and their relationship to the quality of visitors' transportation experiences. The research that informs this management by objectives, indicators, and standards of quality follows the conceptual models outlined by Meldrum and DeGroot in the introduction to this special edition of *The George Wright Forum*. This effort is also informed by long-standing traffic engineering research, modeling, and practice, which have developed indicators and standards for the quality of transportation service, largely based on measures of travel time and delay (TRB 2010).

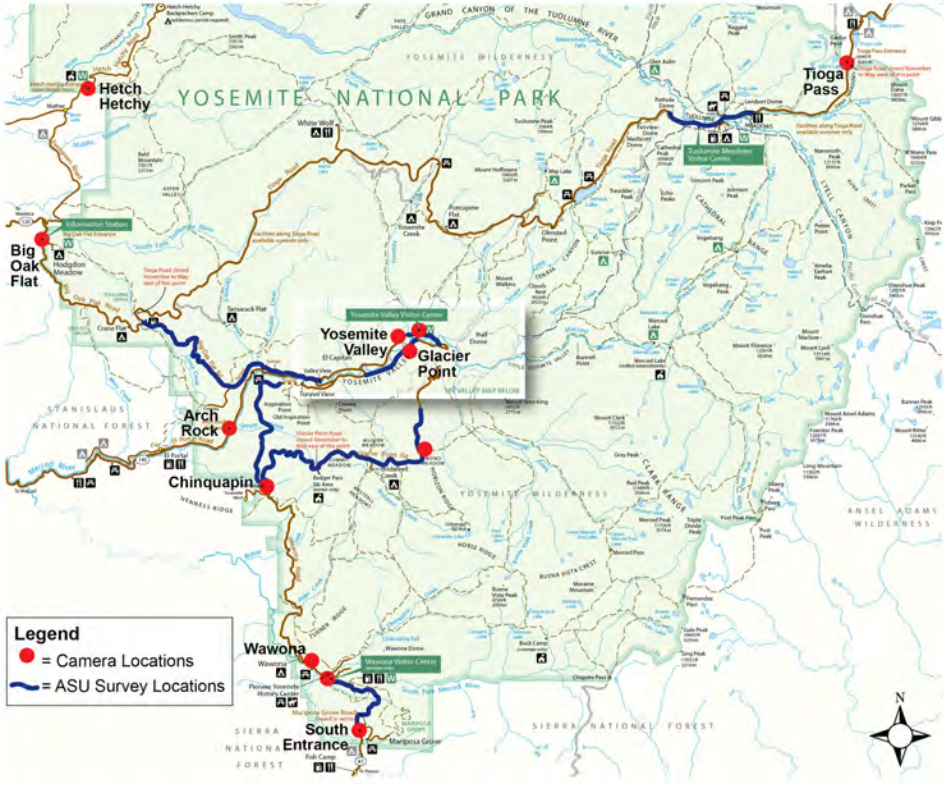
In this paper, we present research to monitor transportation and experiential conditions on park roadways and to model elements of the relationship between use level and quality within this system. First, we describe the formulation of indicators and visitor-based evaluative standards to guide monitoring for visitors' experiences on Yosemite roadways. This evaluative research is conducted with survey research methods. Second, we discuss descriptive modeling of roadway conditions that develops relationships between roadway use levels and indicators of quality. Additionally, this simulation modeling can be used to simulate different

conditions of use and quality to assess alternative transportation management scenarios. Evaluative survey research and simulation modeling can be integrated to facilitate empirically based, visitor-informed, proactive management to assess the types and levels of visitor use that can be accommodated under varying assumptions or potential management actions while maintaining desired conditions. In the final section of the paper, we describe implications of this research for park planning as well as research on transportation experiences in national parks.

Methods

Evaluative survey research. For the evaluative survey research component of this project, we employed a cross-sectional design (Creswell 2009) with data collected via on-site, surveyor-assisted questionnaires. To ensure the study findings were representative of visitors to the park during the study period (July 2010), we employed a stratified random sampling strategy with three-stage selection (Lohr 2009). First, we divided the park into eight geographic zones based on segments of the transportation system (see Figure 1). Second, we randomly

Figure 1. Map of Yosemite National Park with survey sampling locations and modeling data collection sites.



selected sample dates within the sample period for each site, stratified by weekday/weekend. Third, each sampling day was then partitioned into morning and afternoon sampling blocks, and a block of time within each day was randomly selected. Surveyors followed a traffic control plan and flagged and pulled over motorists to administer the questionnaire at roadside pullouts, scenic overlooks, and parking areas. The questionnaire scales and visual simulation methods used in this study are well-established in the field and supported by peer-reviewed scientific literature. Several previous studies have used similar methods and questions (see Manning 2011 for a review). Specific examples include visitor surveys in Yosemite (White et al. 2011) and at Acadia National Park (Hallo and Manning 2009). We obtained 1,054 completed questionnaires with an overall response rate of 64%. The survey has a margin of sampling error of +/–3% at the 95% confidence interval. Results of a non-response bias analysis, coupled with the high response rate, ensure that there are no systematic differences between groups who did participate in the survey and those that refused, thus enhancing the generalizability of the results.

In a prior study, researchers used open-ended interviews to identify salient aspects of visitors' transportation experience by asking them to report on what added to or detracted from the quality of their experience of driving cars on the park roadways. The findings revealed that visitors value convenience, perceived freedom, access, personal control, and opportunities to experience nature. Negative influences included feelings of stress, traffic congestion, difficult route finding, crowding, and conflict (White 2007). A subsequent study documented travel mode choices and travel patterns in Yosemite, identified the importance and satisfaction of travel by various modes, examined visitors' perceptions of the experiential dimensions of traveling via car versus park shuttle bus, and identified visitors' preferences regarding transportation management options (White et al. 2011). Based on these studies, and in consultation with park officials, the team selected two key variables to serve as indicators of quality for visitor experiences and to guide future monitoring and management: vehicles per viewshed (VPV) and travel time.

Vehicles per viewshed. To represent varying levels of congestion on park roadways realistically, we used a visual measurement approach to assess VPV (Manning et al. 1996; Manning and Freimund 2004). We prepared two sets of photographs: one with a representative Yosemite Valley roadway viewshed and another with a representative high-alpine roadway viewshed. The images, which embody the VPV indicator of quality, showed a range of roadway conditions varying from free-flow (0 VPV) to full roadway capacity (24 VPV). The photographs were prepared using digital editing software (see Figure 2).

Respondents were shown the photographs in random order and asked to rate each photograph by indicating how acceptable it was based upon the number of vehicles shown using a nine point scale ranging from –4 ("very unacceptable") to +4 ("very acceptable").

Travel times. In addition to VPV, visitors were asked to evaluate the acceptability of travel times on park roadways. Respondents were flagged and pulled over at the terminus of a study road segment, and asked to report the amount of time it had taken to travel that segment. Then, they rated the acceptability of that travel time on a nine point scale ranging from –4 ("very unacceptable") to +4 ("very acceptable").

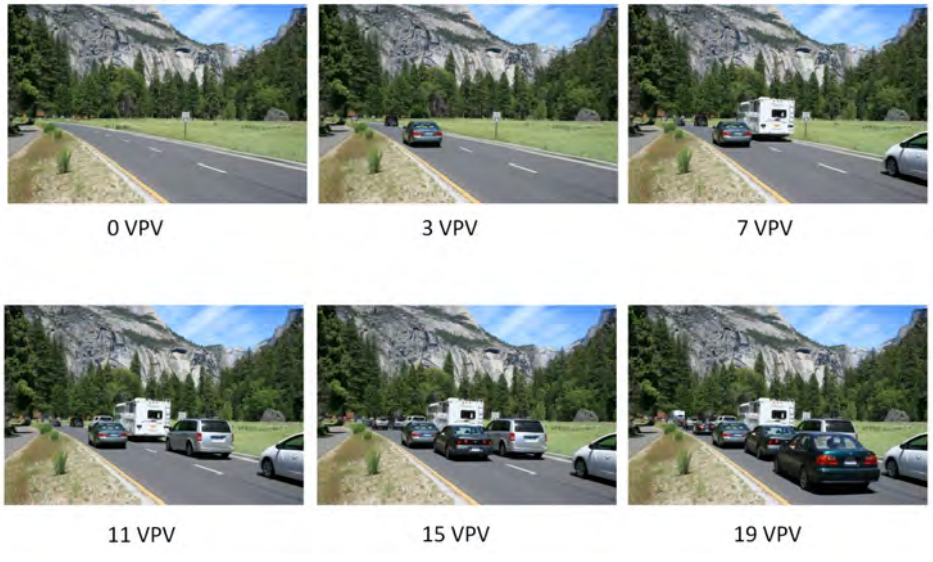


Figure 2. Sample study photographs showing a range of vehicle use on park roadways.

Standards of quality, benchmarks by which the achievement of management objectives can be judged, are formulated from visitor evaluations of the VPV and travel time indicator variables (Shelby and Heberlein 1986; Vaske et al. 1986). This approach posits that individuals have standards for evaluating social and environmental conditions and that empirical research can measure these standards and describe the distribution in groups. This information can then be used to inform a range of potential management standards.

Descriptive modeling research

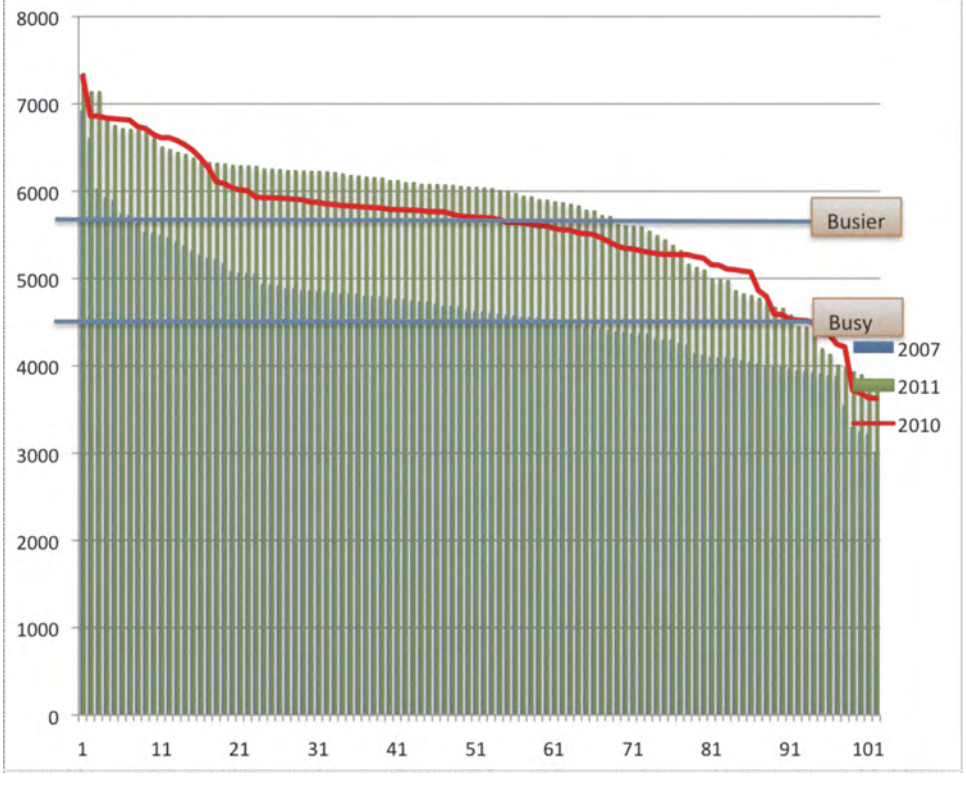
Coinciding with visitor surveys (July 2010), we also conducted a license plate study to record and match vehicles traveling past 23 cameras placed at the entrance stations and key locations within the park. We used a license plate recognition program to match plates captured at two or more cameras and constructed a database to identify matches for any given route across camera locations. The final dataset included a total of 71,120 license plate data points with approximately 15,100 license plates matches. Traffic counts from each license plate data collection location showed that capture rates varied by location. Generally, capture rates around 90% were achieved. The information generated by this license plate study, combined with traffic counters deployed along the park's road network, supplied counts of vehicles arriving to the park and road segments of analytical interest.

In previous work, traffic engineers developed a TransCAD travel demand model for Yosemite Valley (Smith et al. 2003) and a VISSIM transportation simulation model for the Yosemite Valley roadway network (Chase 2006). For the current project, engineers updated

and expanded these demand and simulation models to include all major roadways within the park. Next, we used the license plate data and traffic counts collected in July 2010 to validate the models. The travel demand and simulation models were developed to estimate volumes and simulate vehicular traffic along the park roadways at different levels of visitor use and under different traffic management strategies. These estimates of experiential conditions along park roadways can be translated into indicators of quality, facilitating evaluation against the standards of quality formulated from the survey research described above.

The evaluation of seasonal visitation in Yosemite focused on the 100 busiest days of the summer peak use season. Figure 3 shows the number of vehicles per day entering eastern Yosemite Valley, as recorded by permanent traffic counters located near the Yosemite Chapel on Southside Drive. Data are presented for 2007, 2010, and 2011, with the days ordered from the highest entering volume to the lowest entering volume for each 100-day peak season. In 2007, benchmark volumes were established, including the "busiest day," (i.e., highest volume), a "busier day" (i.e., 7th highest volume) and a "busy day" (i.e., median volume). The travel demand and simulation models generally follow the "busier day" traffic scenario

Figure 3. Vehicles per day entering Yosemite Valley: Summer 2007, 2010, and 2011.



with traffic volumes in the 90th to 95th percentile of the summer season volumes. The park-wide models were initially developed for a 2007 "busier day" traffic scenario and the current project updated the models to calibrate to the data collection time period, which was the fourth-highest visitation day of the 2010 summer season.

Survey findings and modeling results:
Visitors' evaluations of transportation experience indicators of quality

Vehicles per viewshed. To explore the range of visitor evaluations of VPV conditions as potential inputs for managerial standards, respondents were asked evaluate the series of VPV photographs and to identify the photograph that represented: (a) the number of vehicles they preferred to see; (b) the number of vehicles on the roadway that would be so unacceptable that they would no longer visit that area of the park; (c) the number of vehicles that the National Park Service should allow on this roadway; and (d) the number of vehicles they typically saw on that day. The results for evaluation of each depicted VPV level are summarized in the graph in Figure 4, which is constructed using the mean acceptability ratings of respondents. Figure 5 summarizes visitors' evaluations of the roadway conditions on multiple dimensions. For instance, the findings show that:

- The *preferred condition* for valley and non-valley sites was 0 VPV. Thus, this is the optimum condition, which received the highest acceptability by the aggregate sample.
- The *range of acceptable conditions* for valley sites is 0 to 11 VPV; for non-valley sites, 0 to 14 VPV. Thus, all of the conditions represented in this range meet some level of acceptability by about half the respondents.
- The *minimum acceptable condition* for valley sites is approximately 11 VPV; for non-valley sites, 14 VPV. At this point, about half the sample finds these conditions acceptable.

In both sub-samples (valley and non-valley), visitors expected to encounter more vehicles than they actually reported experiencing. It is noteworthy that valley respondents identified their expected condition (11 VPV) as the point at which NPS management should take action. In both subsamples, respondents rated the photo with maximum congestion as the point at which they would no longer visit that area of the park.

Travel times. Results of travel time indicator of quality evaluations suggest that, in aggregate, acceptability ratings for six of the eight segments were above 3.0 on the scale, indicating that the respondents found the travel times to be acceptable to very acceptable. For another site, Northside Drive–Curry Village to Camp 6, the mean rating was 2.88, still in the acceptable range but lower than the other sites. The mean rating for Chinquapin to Tunnel View Point was 0.86, near the unacceptable point of the scale. The results also demonstrated that the correlation between travel time and acceptability ratings was $r = -.287$ ($p<.001$, N=1029), indicating a small to moderate inverse relationship. That is, for each one-unit (one-minute) increase in travel time there is a corresponding –.287 unit decrease in the acceptability rating.

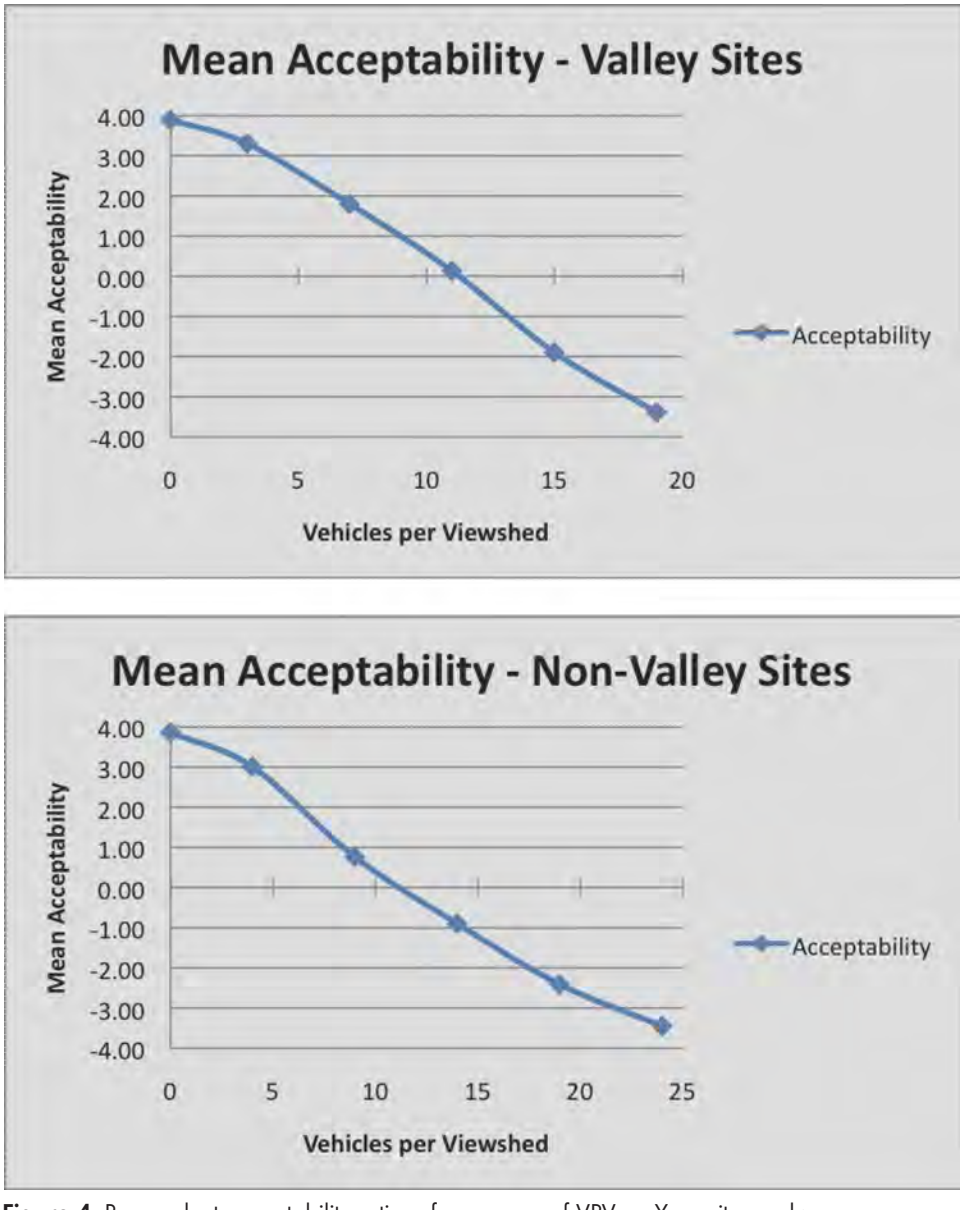


Figure 4. Respondent acceptability ratings for a range of VPV on Yosemite roadways.

As with VPV, respondents were asked to identify (a) the amount of time they would prefer it to take to travel that road segment; b) the amount of time that would be so unacceptable that they would no longer visit that area of the park; and (c) the amount of time that the National Park Service should allow. The results, shown in Table 1, provide managers with

	Median VPV for Valley (Sites 1-3)	Median VPV Non-Valley (Sites 4-8)
Preferred	 0 VPV	 0 VPV
Expected	 11 VPV	 9 VPV
Experienced	 7 VPV	 4VPV
Management action	 11 VPV	 14 VPV
Displacement	 19 VPV	 24 VPV

Figure 5. Summary of visitors' evaluations of VPV.

information on current conditions as well as visitor-based evaluations of travel time across a range of dimensions. It is important to note that not all respondents were able to express a personal standard for travel time for the management action and displacement dimensions. Depending on the road segment and sub-sample, 1–7% of respondents answered "don't know" on these items. Furthermore, across the entire sample for the acceptability dimension, 16% said no amount of time would be so unacceptable that they would no longer visit this area of the park; for the management action standard, 7% responded that no amount of time is so unacceptable as to restrict vehicles using the roadway; and 13% said the number of

Roadway segment	Free-flow	Self-reported	Preference	Management action	Displacement
	Mean (Mins)				
Northside Drive – Sentinel Bridge to Camp 4	3.25	6.78	4.46	17.33	21.46
Northside Drive – Curry Village to Camp 6	2.36	5.26	4.36	23.08	38.91
Southside Drive – Bridalveil Falls to Chapel	7.16	8.66	6.73	24.95	30.65
South Entrance to Wawona	8.43	9.73	8.99	18.72	31.16
Chinquapin to Washburn Point (Glacier Point Road)	—	32.03	26.64	76.16	66.03
Chinquapin to Tunnel View Point	—	43.40	36.30	82.40	101.80
Crane Flat on Hwy 120 to its intersection with Hwy 140	10.08	26.23	24.23	51.41	64.36
Tioga Road – Lembert Dome to Pothole Dome	—	11.04	8.72	23.65	28.86

Table 1. Summary of visitors' evaluations of travel times.

vehicles using the roadway in this area should not be restricted at all. These respondents are not included in the calculations for travel time standards.

Modeling transportation indicators—linking monitoring with evaluation

We then compared visitor-based evaluative standards of quality for the travel time indicator derived from the survey study with traffic modeling results using traffic volume data from both 2007 and 2010. This allowed us to evaluate multiple scenarios of varying use levels and the potential effects on visitors' experiences. Using travel demand and simulation models developed in 2007, we simulated travel times for a representative roadway segment within Yosemite Valley, Northside Drive from Sentinel Drive to Camp 4 (see Table 2). (Note that this roadway segment was also one of the segments for the survey research.) Comparing modeled travel times with the visitor-based evaluations for the Northside Drive segment, the results show that travel time conditions on the "busy day" scenario (3.6 minutes) were within standard for the visitor-based preference dimension (4.46 minutes). The visitor preference standard, however, was not met under the "busier day" (7.0 minutes) and "busiest day" (9.0 minutes) conditions. None of the simulated conditions exceeded the visitors' standard for management action (17.33 minutes).

Traffic volumes entering Yosemite National Park, however, have increased since 2007. For instance, the average daily volume of traffic entering Yosemite Valley for the 100-day peak season has increased by about 24% overall. Traffic volume on the median day has increased about 30% overall, with the median day having more than 6,000 vehicles entering eastern Yosemite Valley in 2011. While the average and median traffic volumes have

Scenario: Northside Drive – Sentinel to Camp 4	Modeled Travel Time (minutes)	Visitor Evaluation (minutes)
Free-flow conditions	2.8	
2007 Busiest day	9.0	
2010 Busiest day (4th busiest day)	9.1	
2007 Busier day (7th busiest day)	7.0	
2007 Busy day (median busiest day)	3.3	
2010 Visitor preference		4.46
2010 Visitor management action		17.33
2010 Visitor displacement		21.46

Table 2. Simulation model results: Travel time on Northside Drive.

increased substantially, there has been relatively less of an increase in traffic on the maximum day. This is likely reflective of the fact that the roadway system and parking areas in the East Valley have a physical capacity which is being attained on the highest use days. In addition to the constraints on traffic from the roadway system, park management takes action to redirect traffic away from the eastern portion of the valley when congestion reaches severe levels. Diverting traffic away from eastern part of the valley tends to limit the total number of vehicles that can enter over the course of a busy day. Furthermore, observations at the park entrance stations on very busy days indicate that when very long queues of vehicles form at the entrances, some visitors turn around and depart without entering the park.

To evaluate the effects of the recent increase in traffic volume, we updated the simulation models with 2010 traffic conditions for the roadway segment along Northside Drive from Sentinel Drive to Camp 4 (see Table 2). As shown, the travel time on the roadway segment is 30% higher than the same day during the 2007 summer season, due to the general increase in traffic volumes within the park. Comparing these travel times with the visitor-based evaluations of travel time for the Northside Drive segment, the results show that the visitor preference standard was not met, but the travel time remains well under the management action standard. Future research will assess of the relationship between modeled VPV conditions and visitor standards of quality.

The park is currently installing permanent traffic counters at the entrance stations and other locations within the park to establish a traffic monitoring program. The program will use the counters to measure real-time traffic volume data within key sections of the transportation system. These counters can supply the data to facilitate ongoing application of the conceptual models employed in this research to monitor use, estimate experiential conditions, and evaluate their quality. The program will also provide a more complete and reliable historical record of traffic volumes for enhanced analysis of trends and relationships among volumes at various locations in the park. This real-time monitoring will inform park staff whether management objectives are being achieved or if visitor-informed standards of quality may be violated by roadway use levels. The travel demand and simulation models can be

used to proactively evaluate the impacts of different management alternatives on roadway traffic volumes, travel time, and the associated impact on visitor-based evaluations.

Conclusion

In recent years, there has been a sharpening focus by researchers and planners on transportation experience in national parks (Hallo and Manning 2009; Holly et al. 2010; White 2007; White et al. 2011; Youngs et al. 2008). Indeed, transportation management is now considered an essential aspect of capacity and visitor use management in national parks (Daigle 2008; Lawson et al. 2009). In recognizing that transportation and recreation are often synonymous in parks, this paper illustrates a process of integrating traffic engineering modeling with transportation experience indicators and standards of quality to evaluate roadway conditions in terms of experiential quality.

In this study, visitors' experiences of travel times and VPV along park roadways were within the range of acceptable conditions. Modeling results indicate, however, that recent visitation patterns threaten to push conditions outside of that acceptable range. Looking forward, researchers and planners will develop and assess multiple scenarios of potential future use levels and model the impact of alternative management actions on visitor experiences. This fosters an anticipatory approach to management that allows for decisions to be made that are robust against a wider range of future conditions.

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Dave D. White, School of Community Resources and Development, Arizona State University, 411 North Central Avenue, Suite 550, Phoenix, AZ 85004; dave.white@ asu.edu

Stacy Tschuor, David Evans and Associates, 1331 17th Street, Suite 900, Denver, CO 80202; sst@deainc.com

Bill Byrne, IBI Group, 401 17th Street, #610, Denver, CO 80202; bill.byrne@ibigroup.com

Using Transportation to Manage Recreation Carrying Capacity

Nathan Reigner, Brett Kiser, Steve Lawson and Robert Manning

Introduction

NATIONAL PARKS ARE CHARGED WITH THE DUAL AND SOMETIMES CONFLICTING MISSIONS of providing public access while protecting park resources and the quality of visitor experiences. When public demand for use is high, this two-fold mission can be daunting. Yosemite National Park may be a poster child for this issue, receiving over four million visits per year. The majority of this use is concentrated at iconic attraction sites, with as many as 15,000 visitors occupying the narrow and confined Yosemite Valley each day (Manning et al. 2003; Lawson et al. 2009; NPS 2012).

The inherent tension between public access to parks and protection of resource and experiential quality is often discussed in terms of carrying capacity (Manning 2007). Originating in the study of biological habitat and range management, carrying capacity's applicability to parks and outdoor recreation has been widely recognized and investigated (Wagar 1964; Whittaker et al. 2011). Carrying capacities can be understood as the amounts and types of visitor use that can be sustained without unacceptable impacts to park resources or the quality of recreation experiences (Grafe et al. 2011; Whittaker et al. 2011). At root, the determination of recreational carrying capacity is a significant visitor-use management decision to be made by land managers and informed by research and public input.

Objectives, indicators, and standards-based adaptive management

Contemporary approaches to determining and managing visitor use and recreational carrying capacity employ a management-by-objectives framework (Manning 2001; Stankey et al. 1985). Capacity is formulated with the definition of management objectives and associated indicators and standards of quality. Management objectives are typically broad narrative statements about the level of resource protection and the type and quality of recreation experience to be maintained. Indicators of quality are measurable, manageable variables that serve as proxies for management objectives. Standards of quality are benchmarks by which achievement of objectives is judged. Once formulated, indicators of quality are periodically

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monitored and evaluated in comparison with standards; management actions are taken if standards of quality are threatened or violated. Monitoring and evaluation of indicators places the conditions visitors experience along the continuum of use-impact relationships and suggests when standards of quality may be violated and management action is required. This process is fundamentally adaptive in the way that cyclic monitoring informs management, and the efficacy of management actions is tested and evaluated through the monitoring program (Stankey et al. 2005).

Like realizing visitor-use objectives, the process of formulating standards of quality can be challenging. Adoption of specific standards of quality, and subsequently carrying capacities, is ultimately a judgment to be made by managers. Their judgments can benefit from public input, especially visitors' evaluations of experienced and desired conditions (Vaske and Whittaker 2004; Manning and Krymkowski 2010). By incorporating such evaluations, along with ecological constraints and administrative capacities, in the formulation and selection of standards of quality, managers can best satisfy competing access and protection demands inherent in visitor-use management.

Transportation and recreation

Transportation and recreation are inherently linked in many national parks (Daigle 2008; Hallo and Manning 2009; Pettengill et al. 2012). This is particularly true of parks such as Yosemite where much of the visitor use is concentrated along roads, trails, and public transit routes. Indeed, the spatial and temporal distribution of visitor use in Yosemite is largely a function of the transportation system (Manning et al. 2003; Youngs et al. 2008; Lawson et al. 2009). The extent of road and trail networks, availability of vehicle parking, and location of transit routes are key determinants of where and how much visitor use occurs throughout the park. From one perspective, this dependence of visitor use on transportation can be an additional challenge for management, as visitors are concentrated within relatively small areas of the park. However, the influence transportation exerts on visitor use also provides powerful leverage for carrying capacity management. If the connections between transportation system performance and the quality of recreation experiences can be understood, transportation can be used as a tool to manage visitor use, maintaining high experiential quality and mitigating some of the challenges of carrying capacity (Lawson et al. 2009; Lawson et al. 2011). These connections are reflected in the second, recreation site- and pedestrian-based track of the Integrated Transportation and Capacity Assessment (ITCA) conceptual models outlined in the introduction to this edition of *The George Wright Forum* (Meldrum and DeGroot, this volume).

Study objectives

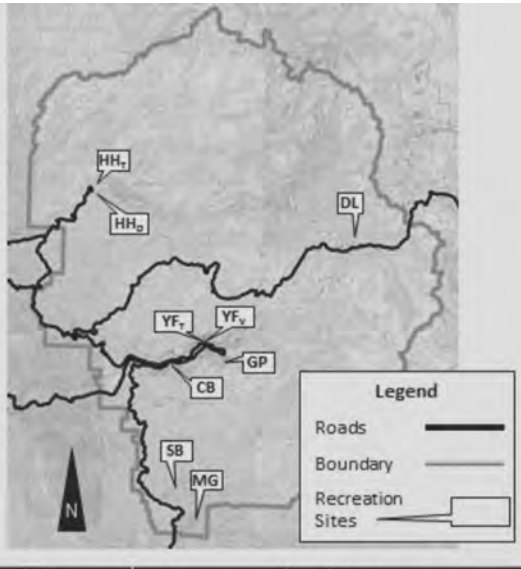
The program of research described in this paper was designed to inform the use of transportation as a tool to help manage visitor use and the carrying capacity of Yosemite. Toward this end, the study seeks a systematic understanding of the relationships between visitor use and experiential quality at recreation sites and how these relationships depend on transportation systems as key origins for visitor use. Specific objectives were to (1) understand how transportation affects visitor use, (2) collect information on crowding-related indicators

and standards of quality, and (3) illustrate the ways in which transportation might be used to manage visitor use and carrying capacity. The program of research employed visitor-use counts and observation, statistical and simulation models of visitor use, and visitor surveys incorporating visual simulations. These methods were applied at nine diverse recreation sites in Yosemite. The program of research is described in general and conceptual terms in the following section. This is followed with an illustration of its application at Hetch Hetchy, an important recreational and interpretive site in the park.

Study sites

Like most parks, much of the visitor use in Yosemite occurs in close proximity to its roads. A diversity of dramatic natural features and outstanding recreation opportunities are easily accessible by car and bus. Primary visitor destinations are spread throughout the park, yet are connected by less than half a day's drive along the park's extensive road network. Nine diverse sites were selected by managers and researchers to be included in this study (Figure 1). These sites are broadly distributed across the park landscape and transportation net-

Figure 1. Study recreation sites in Yosemite National Park.



Site	Description
Cathedral Beach (CB)	sandy river beach & developed picnic area
Dog Lake (DL)	Wilderness, high country trial
Glacier Point (GP)	developed overlook above Yosemite Valley
Hetch Hetchy Dam (HH$_D$)	O'Shangunsee Dam at Hetch Hetchy Reservoir
Hetch Hethcy Trail (HH$_T$)	trail along Hetch Hetchy reservoir
Mariposa Grove (MG)	Grizzly Giant in the Mariposa Grove of giant sequoia
Swinging Bridge (SB)	rock river beach and swimming holes 0.8 miles from parking.
Yose. Falls (YF$_V$)	viewing Platform at the base of Yosemite Falls
Yosemite Falls Trail (YF$_T$)	paved ADA accessible path leading to Lower Yosemite Fall

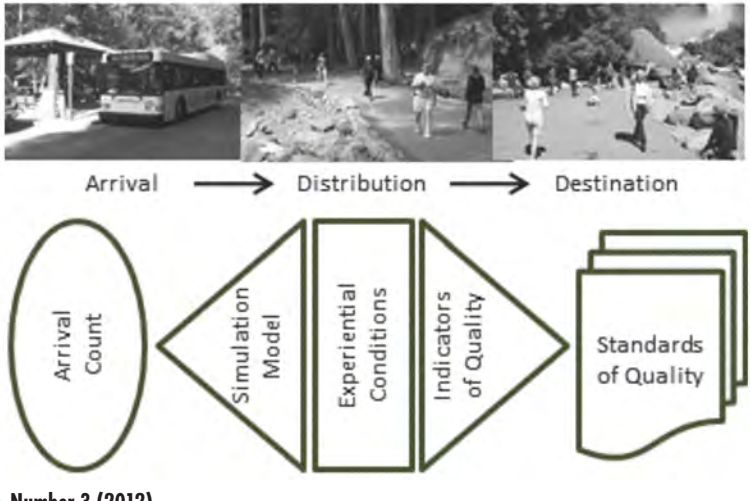
work. Some sites are highly developed, while others lie within Yosemite wilderness. Some are intensely visited; others less so. All sites are accessible by the park's road and trail networks and many are also served by shuttle and tour busses. The sites cannot represent the entire diversity of the park's recreation resources or transportation contexts, but they are inclusive of many visitor uses and geographically extensive.

Modeling transportation and the park experience

Recreation experiences in Yosemite, particularly those at popular recreation sites easily accessible by the park's road network, typically follow a pattern of arrival, distribution, and destination (Figure 2). Visitors arrive at recreation sites, like scenic vistas, beaches, or interpretive sites, via road and trail networks. Upon arrival, perhaps by disembarking from a parked car or alighting from a shuttle bus, visitors distribute themselves throughout recreation sites. They walk paths and negotiate routes to explore rocks and rivers, search for photogenic views, and engage with interpretive installations. While such distribution and activity is part of their recreation experience, visitors are often destined for focal attractions or other essential features within recreation sites. Such destinations can include viewing platforms adjacent to natural features, beaches and swimming holes along rivers, and quintessential trails. This pattern of arrival, distribution, and destination can be broadly interpreted to represent many types of park visits and distills key elements of the park's complex use systems. This schematic pattern mirrors the conceptual models presented in the ITCA introduction (Meldrum and DeGroot, this volume; Figure 2).

Indicators of quality, such as the number of hikers encountered along trails or the number of other visitors sharing a viewing platform, capture and express important qualities of the visitor experience at these destinations (Manning 2011). Standards of quality, identified by park managers and informed by visitors, evaluate the acceptability of indicator variable conditions (Manning 2011). Coupling the progression of arrival, distribution, and destina-

Figure 2. Conceptual and methodological models integrating transportation and recreation.



tion depicted in Figure 2 with indicators and standards of quality, levels of visitor use flowing from the transportation system to recreation destinations can be systematically quantified, modeled, and evaluated. The following section of the paper outlines how conceptual elements of arrival, distribution, and destination, along with indicators and standards of quality, are measured and integrated at nine key recreation sites in Yosemite.

Modeling arrival, distribution, destination

Visitors arrive at recreation sites within Yosemite via the park's transportation system. This system includes the modes by which visitors enter and move among locations within the park. Thus, the delivery of visitors by the transportation system is a key determinant of use levels and experiential quality at recreation sites (Lawson et al. 2009; Lawson et al 2011). The arrival of visitors from the transportation system initiates this study's conceptual modeling and is its analytical origin (Figure 2). In this program of research, arriving visitors were counted as they entered recreation sites. Counts were divided by increments of time, in this case by weekday and weekend/holiday and hour of the day. With these divisions, the arrival counts generate both the volume and temporal distribution of visitor use at recreation sites. Using regression models, these recreation site arrival patterns were related to transportation system use and performance. This relationship is the link, depicted in the applied conceptual model of the special edition's introduction, between road and vehicular modeling and recreation site and pedestrian modeling (Meldrum and DeGroot, this volume; White et al., this volume). In these models, entrances to the park and vehicular use on road sections such as Southside Drive in Yosemite Valley were used as independent variables to estimate the amount of visitor use any particular site received. This statistical connection is a primary point of the integration between transportation and recreation experience quality.

After arriving, visitors distribute themselves throughout recreation sites and to destinations. The experiential conditions induced by these distributions, such as the numbers of hikers on trails or the numbers of visitors on viewing platforms, were modeled with computer simulations. A simulation model was built for each recreation site. Using the rate of visitor arrivals, and observations of visitor routing and travel speed collected on-site, the simulations replicate where visitors go and how long they spend there. Beginning with transportation system arrivals, the simulations distribute visitors and estimate the levels of visitor use that can be expected within the sites. These estimates document the numbers of visitors present at destinations such as viewing platforms and beaches, and along trails.

Indicators of quality

The simulation model estimates of experiential conditions at destinations constitute indicators of experiential quality that are specific, measurable, manageable, and relevant to visitors. Indicator variable estimates from the simulation models capture and communicate use levels in a way that can be measured against management objectives for experiential quality. They describe levels of use and quality in terms relevant to and actionable by managers. For this study, three indicators of quality with proven records of utility were selected by Yosemite park managers: the number of people at one time (PAOT) at experiential destinations, the number of people per view (PPV) along a section of trail, and the number of other visitors encountered (encounters) while hiking sections of trail. Each of these indicators is a ratio of

use per area or time. As applied in this study, the numerators of indicator variables are either the number of people or encounters, and the denominators are either the area, length of trail, or period of time. Each indicator variable, as measured for description and presented to visitors for evaluation, expresses both numerator and denominator components of the ratio.

PAOT is used as an indicator of quality for sites whose experiential destinations are areas in which visitors linger (Manning et al.1996). Examples of such destinations are viewing platforms and beaches. In these locations, it is assumed that the number of other people sharing a space bears a strong relationship to feelings of crowding and freedom, important elements of experiential quality in parks and outdoor recreation (Manning et al.1996; Fleishman et al. 2007). As noted above, PAOT indicators are essentially ratios of use per space and time. In this study, experiential destinations were depicted in photographs of the area. The area bound by these photographs serves as the denominator of the PAOT ratio. The number of visitors within this area supplies the numerator. Figure 3 depicts a photographically defined PAOT indicator (Y) for a recreation site (X) at the dam at Hetch Hetchy, an important recreation and interpretive attraction in the park. While the entirety of a recreation destination often cannot be fully depicted in a single photograph, the area depicted may capture the essence of a site's experiential qualities and represent it as a whole. If visitor use and experiential quality can be effectively managed in this essential area, perhaps it will be effectively addressed throughout the site's entirety. When predicting visitor use based on arrival rates, the simulation models estimate the number of visitors that can be expected in the entirety of a destination area. These whole area estimates must be translated into PAOT values for just the area represented in a photograph, and regression models must be used for this purpose. In essence these models define the relationship: if X number of visitors are in the whole area, then Y number of visitors are expected to be in the photograph area (Figure 3). The regression equations for this study were created by simultaneously and repeatedly counting the numbers of visitors within the whole area and area of the photograph and then conducting a regression analysis on the paired observations to derive the general relationship. With these methods, PAOT serves as an indicator of quality for recreation destinations such as the dam at Hetch Hetchy.

PPV serves as an indicator of quality for relatively high-use trails (Manning 2011). PPV is similar to PAOT in that it seeks to capture and communicate the visual density of visitors. Contrary to PAOT, however, PPV is suited to characterize recreation experiences that involve movement through or along trails rather than lingering within an area (Manning, et al 2003). Like PAOT, this study operationalizes PPV photographically. A photograph depicting a section of trail bounds the area of the indicator, designating the denominator of its ratio. The number of visitors moving along this section of trail supplies the numerator. When distributing visitors throughout recreation sites, the simulation models can directly estimate the number of visitors expected to be walking along a PPV trail section, eliminating the need for the regression analysis conducted with PAOT. PPV is an indicator variable that can be used to measure and evaluate quality in highly used places where the central experience is based on movement through rather than lingering within an area.

The number of encounters with other hikers is an indicator of quality for relatively low-use trail sections (Vaske et al. 1986; Manning 2011). Like PPV, it seeks to capture and

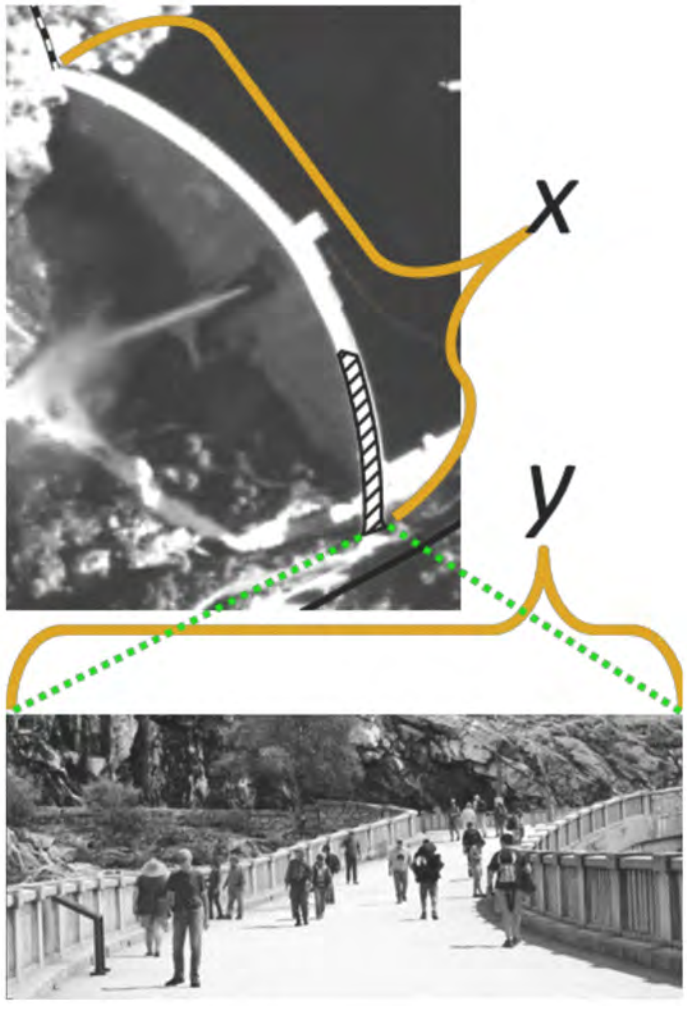


Figure 3. Recreation destination and PAOT photograph area.

express quality and use for recreation where movement through a landscape is central to the visitor experience. Encounters are often used as an indicator for more backcountry-oriented recreation such as wilderness hiking or backpacking (Roggenbuck et al. 1993; Lawson et al. 2006; Watson et al. 2007). Here, experiential destinations are of greater geographic extent than the socially and spatially concentrated experiences characterized by PAOT and PPV. Like those indicators, encounters is a ratio. Its numerator is a count of other hikers met. Its denominator, however, can be more varied than photographed areas of PAOT and PPV. The denominator of an encounters ratio can be either spatial or temporal. A spatial denominator is trail based, for example the number of other hikers encountered along a mile of trail. A temporal denominator is time based, for example the number of other hikers encountered

during an hour of hiking. After designating either a spatial or temporal denominator, the simulation models that distribute visitor arrivals throughout recreation sites calculate estimates of the number of encounters expected.

Standards of quality

Standards of quality define thresholds by which to judge or evaluate the condition of indicator variables. Standards describe, in specific and numeric terms, objectives for the quality of recreation experiences and help to answer the question "how much use is too much." While formulating standards of quality is ultimately a management judgment, eliciting visitors' evaluations of the conditions they experienced during their visits can help inform such judgments. However, use levels and associated experiential quality vary dramatically by time of day, day of week, and season of the year. Additionally, use levels and recreation behaviors may change over time in response to management action and increasing or decreasing popularity. Reliance on existing conditions for the formulation of standards of quality limits the ability of research and management programs like that described here to adapt to these sorts of changes (Manning and Krymkowski 2010).

Recognizing the potential for change in visitor-use levels and their relationships to experiential quality, a range of potential scenarios beyond just those currently experienced by visitors must be examined. Photographic simulations of a range of indicator variable conditions depicting use beyond extant levels can inform formulation of standards broad and flexible enough to guide management in the face of short- and long-term change. For PAOT and PPV, a range of indicator conditions were depicted using photographic simulation, and presented to visitor survey respondents. The photographs defining indicator areas were populated, using digital image editing software, to depict varying levels of visitor use. Encounters were simulated using a narrative text describing a range of encounters with other hikers. Visitors to each recreation site were surveyed and presented with a range of indicator conditions, either in photographic or narrative format, and asked to evaluate their acceptability on a scale from –4 (very unacceptable) to +4 (very acceptable). Resulting data allow the construction of acceptability curves that can be used to judge experiential quality at recreation sites under a range of use levels (Jackson 1966; Manning et al. 1996).

A hypothetical acceptability curve is shown in Figure 4. In the example, the curve traces aggregate acceptability evaluations for a range of encounters with other groups along a wilderness trail. The average of visitors' evaluations fall out of the acceptable range and into the unacceptable range at 10 encounters. This information provides an empirical understanding of visitors' crowding tolerances, and thus may help inform park managers' judgments about crowding-related standards of quality. Respondents were also asked to indicate, from among the photo simulations and/or narrative descriptions, the level of use they preferred, the level of use at which park managers should impose limits, and the level of use that would displace them from the area. These multiple evaluations inform management judgment in the formulation of standards of quality associated with experiential quality for range of use levels and visitor arrival rates. The inherent multiplicity of potential standards of quality is depicted in Figure 2.

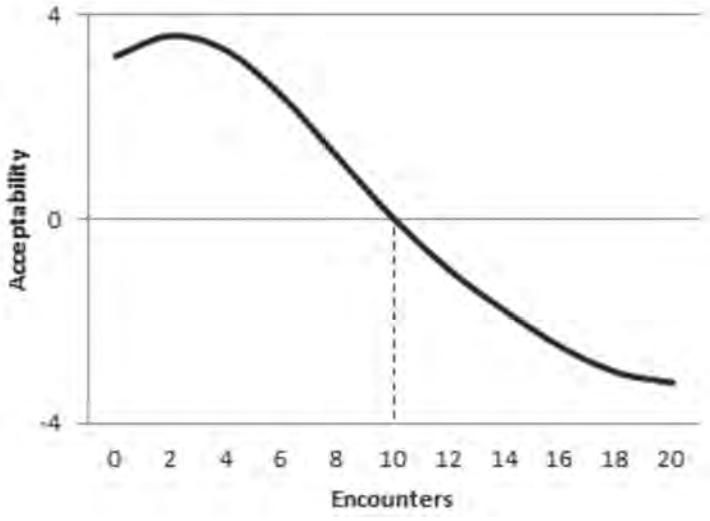


Figure 4. Hypothetical acceptability curve.

An example: Hetch Hetchy

Hetch Hetchy was one of the recreation areas included in this study. For the purposes of the study, it has two sites, the top of O'Shaughnessy Dam (HH_D) and the trail beyond the dam leading to destinations north of the reservoir including Wapama Falls (HH_T). The following description uses Hetch Hetchy to illustrate how the program of research addresses the relationship between transportation and recreation experience quality (as portrayed by the arrival, distribution, and destination conceptual model), and development and application of indicators of quality and visitor-based standards of quality. This empirical approach facilitates use of the park's transportation system to manage carrying capacity and maintain the quality of visitor experiences. Figure 5 provides a map of the Hetch Hetchy area and its two recreation sites. HH_D occupies the top of O'Shaughnessy Dam between the locations denoted X_1 and X_2. HH^T occupies the trail extending north from O'Shaughnessy Dam, stretching between the locations X_2 and X_3.

Visitors arrive at Hetch Hetchy via a road, approaching the dam form the south, along which there is vehicle parking. After arrival, most visitors are bound, at the very least, for the top of the dam (HH_D), and some for a hike along the reservoir (HH_T) and perhaps onward into the backcountry. During such visits, individuals distribute themselves throughout the recreation sites, walking across the dam, enjoying the view and engaging with interpretive information, proceeding along the trail beyond the dam, eventually returning to their vehicles by crossing the dam again. While distributing themselves in this way, visitors move through destinations whose visitor-use conditions serve as indicators of quality, characterizing the visitor experience of the Hetch Hetchy area. For our Hetch Hetchy example, there are two indicators of quality: PAOT within the photograph area on top of the dam (Figure 5 between X_1 and X_2), and encounters along the trail beyond the dam (Figure 5 between X_2 and X_3). The goal of this research was to measure and evaluate the conditions of these indicators of quality based on visitor arrivals from the transportation network.

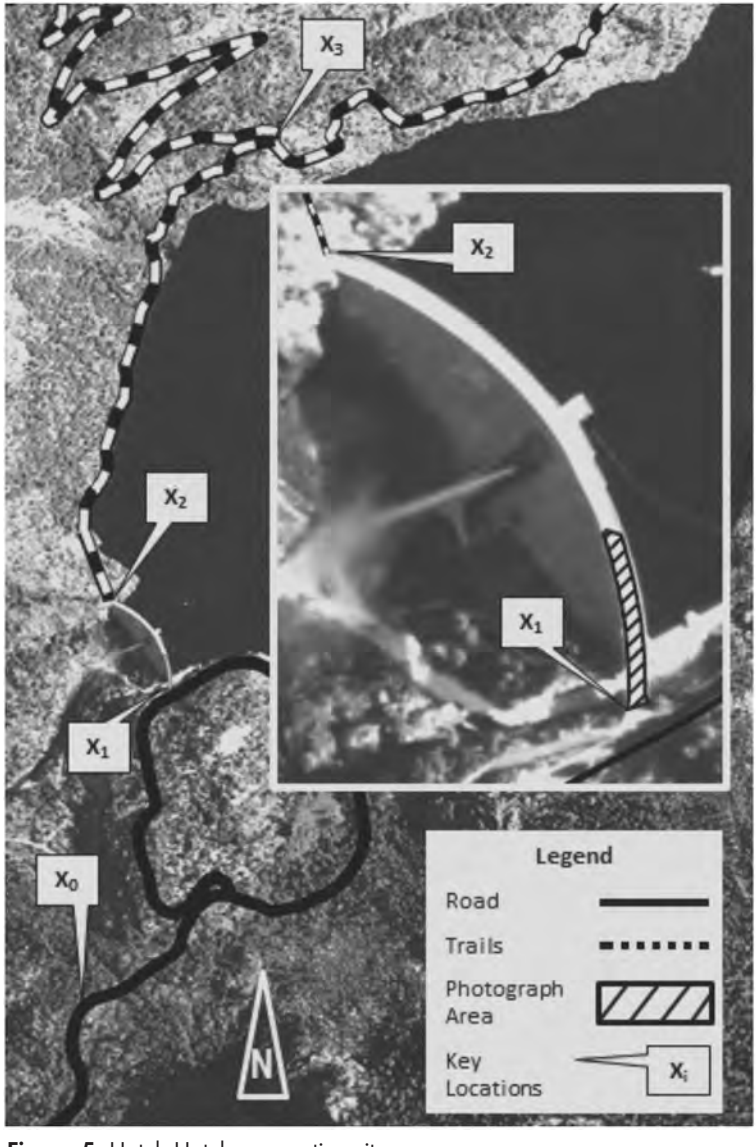


Figure 5. Hetch Hetchy recreation sites.

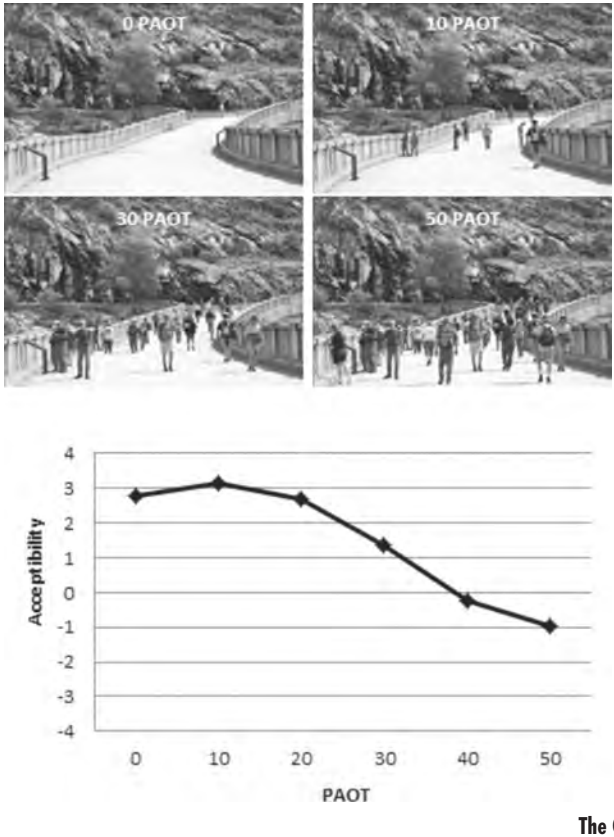
The program of research began with counting the number of visitors arriving to recreation sites via the transportation system. At the Hetch Hetchy sites, this was done with road-based vehicle counters deployed along the access road. By combining these vehicle counts with information about the number of visitors per vehicle from entrance station observations, estimates of the number of arriving visitors were generated.

Next, simulation models replicated the distribution of visitors at recreation sites. Using observations of the behavior of and routes taken by visitors, the conditions of indicators of quality were estimated by simulation models. In the case of HH_D, PAOT values on the dam

for various levels of vehicle arrivals were estimated. For HH_T, the numbers of encounters among hiking groups along the trail beyond the dam, between X_2 and X_3, were estimated.

The simulation and regression models described above were used to estimate the experiential conditions (PAOT and encounters) at Hetch Hetchy based on the number of visitors delivered by the park's transportation system. But are these conditions acceptable or unacceptable? This question was evaluated, from the perspective of visitors, with visitor surveys and standards of quality. For HH_D, visitors were presented with a series of photographs depicting a range of PAOT levels, representative samples of which are shown in Figure 6. Based on respondent ratings of the acceptability of these photographs, an acceptability curve was constructed (Figure 6) that facilitates evaluation of the PAOT conditions estimated by the simulation and regression models. For example, if simulation modeling estimated that 15 PAOT were at the HH_D site based on the number of vehicles that arrive via the road to Hetch Hetchy, then that level of transportation system access and visitor use is considered by visitors, on average, as being highly acceptable. This is suggested by the acceptability curve in Figure 6. However, if additional vehicles arrived before any departed and 45 PAOT were estimated to be at the site, then conditions would be, according to aggregated and averaged visitor evaluations, unacceptable (Figure 6). By comparing estimates of indicator conditions

Figure 6. Photographic simulations and visitor-based acceptability curve for Hetch Hetchy PAOT.



to the standards of quality formulated from visitor surveys, the performance of the park's transportation system and its influence on experiential quality can be evaluated. This, in turn, can help inform decisions about the crowding-related capacity of Hetch Hetchy.

Discussion

The research presented here addresses one of the primary connections between transportation and recreation: the role of transportation systems as a determinant of recreation use. In shaping where visitors go in parks and when they go there, visitation and crowding at recreation sites can be understood as a function of the transportation systems and facilities that provide access to the sites. The approach used in this study represents this connection in conceptual and methodological models that combine monitoring, simulation, and visitor surveys.

Like many national parks, much of Yosemite's visitor use is centered about its transportation system, especially its roads. Typical visits to Yosemite begin with arrival to the park via one of its five highway entrances, parking personal vehicles or alighting from buses at recreation sites, then proceeding, often not very far from the roads, to experiential destinations such as overlooks, beaches, or interpretive features. Within such patterns, there is an inherent relationship between the number of vehicles on park roads and the volume and timing of visitor use at recreation sites (Manning et al. 2003; Lawson et al. 2009). The conceptual and methodological models used in this research reflect and empirically document these patterns. First, counts of visitors arriving at recreations sites are generated from observation and statistical estimation. Then, simulation models replicate the distribution of visitors throughout recreation sites, estimating corresponding experiential conditions, in terms of indicator variables. Finally, these experiential conditions are evaluated against standards of quality formulated with the help of visitor surveys. This process of monitoring and evaluation helps inform adaptive management of recreation use as it is determined by the park's transportation network.

This integrated program of research provides park managers and scientists with two types of systematically connected information to support decision-making: descriptive and evaluative. The descriptive information characterizes what use *is* occurring. The evaluative component informs management about visitors' perceptions of the amount of use that *ought* to be occurring. In counting visitor arrivals and estimating experiential conditions throughout recreation sites and at destinations, visitor use is described. These levels are then evaluated by visitors using surveys and photo simulations or narrative descriptions. When these methods are joined, the extent and distribution of current use can be described and its impact on experiential quality, in terms of visitor crowding, can be evaluated. By both describing and evaluating visitor use, the conceptual and methodological models lay a foundation for research to support integrated transportation and recreation carrying capacity management.

While the joining of descriptive and evaluative information establishes a foundation for carrying capacity research and management, simulations render this approach flexible and proactive. Flexibility and proactivity allow managers to explore a diversity of alternative and potential future scenarios, assessing their predicted impacts on carrying capacity and recre-

ational quality. This study employs two types of simulations: visual simulations of indicators of quality to depict a range of experiential conditions and simulation models of visitor distribution within recreation sites. Visual simulations of indicators of quality promote flexibility in carrying capacity research and management by representing visitor-use indicator conditions not directly experienced by visitors, including levels of use less than or in excess of current use. Presenting survey respondents with visual and narrative simulations of indicator variables rather than asking them to simply evaluate the conditions they experienced, allows for a full range of use levels, including potential future levels, to be evaluated. This frees managers and researchers from assessing visitors' perceptions of experiential quality and based only on current conditions (Manning et al. 1996; Manning and Krumkowski 2011).

The study's other simulated component, simulation models of visitor distributions, enables a proactive, experimental approach to carrying capacity management and integration of transportation and recreation experiential quality. In essence, simulation models are virtual replicas of the transportation systems, recreation sites, and experiential destinations. These models can be configured to simulate alternative visitor arrival and distribution patterns, estimating the quality of recreation experiences given different transportation systems and management regimes (Cole 2005). This ability allows park managers to experiment with actions in model space rather than on-the-ground, helping to foresee and mitigate the potential political, ecological and economic costs inherent in carrying capacity management (Lawson et al 2009; Manning et al 2003). Indeed, management actions can be investigated before they are necessarily needed, transforming a traditionally reactive approach to a more proactive one (Lawson et al. 2003). By facilitating examination of alternative and future scenarios of use and action, simulations, both simulated indicators of quality and simulation models of visitor distribution, add flexibility and proactivity to the integration of transportation and recreation management.

In building conceptual and analytical linkages between transportation and recreation, this research measures visitor-based crowding standards of quality and monitors crowding-related indicators of quality as a function of transportation system. Thus, this work informs recreation carrying capacity and visitor use management in transportation-based terms. The power of this research approach is not fully realized, however, until the information it provides is applied in management action. Management action in response to threatened or violated standards is explicit in and essential to adaptive visitor-use management. Through its influence as a determinant of experiential quality, transportation can be an important and useful tool for managing recreation carrying capacity.

When considering how to manage transportation in support of high-quality recreation experiences, basic strategies include increasing or decreasing the supply of and demand for recreation resources or altering visitors' behavior and the recreation settings they use (Manning 2011). These strategies are not exclusive. Indeed, most effective management programs seek to enact complimentary strategies. At a recreation site level, if carrying capacities are reached and standards of quality violated, alterations in the transportation system infrastructure and operation can serve to reduce demand and change visitor behavior. Examples of this can include reducing the number of vehicle parking spaces proximate to recreation sites or reducing the frequency and capacity of shuttle buses serving the site. Such reductions can be

complimented with information and education and transit services that direct and transport visitors to relatively little-used sites that may have an excess of visitor capacity, expanding management from a site-specific to a parkwide level. Such redirection must be done with sensitivity to the character and quality of experience unique to each site, ensuring that a range of recreation opportunities is maintained rather than homogenized. Beyond providing information to redirect visitors, informing them about what social conditions they may experience upon arrival at recreation sites may help to alter their expectations so that visitors desiring quieter or more social experiences can plan accordingly.

At Yosemite, as with many national parks, transportation and recreation are inherently connected. A primary connection is the direct influence transportation systems have on the spatial and temporal patterns of visitor use, and subsequently experiential quality, at the recreation sites they serve. Recognizing this connection, transportation and recreation can be integrated for both research and management of visitor carrying capacity and related issues. Conceptualizing the arrival of visitors to recreation sites from the transportation system as the origin of an analytical process, a program of monitoring, simulation, and surveying can observe, estimate, and evaluate experiential quality at recreation sites in terms of transportation system facilities and operations. Ultimately, this research approach can help inform park managers' judgments about visitor carrying capacities for recreation sites and the effects existing and alternative transportation systems may have on the quality of recreation experiences.

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Nathan Reigner, Park Studies Laboratory, University of Vermont, 81 Carrigan Drive, Burlington, VT 05405; nreigner@uvm.edu

Brett Kiser, Resource Systems Group, Inc., 55 Railroad Row, White River Junction, VT; bkiser@rsginc.com

Steve Lawson, Resource Systems Group, Inc., 55 Railroad Row, White River Junction, VT; slawson@rsginc.com

Robert Manning, Park Studies Laboratory, University of Vermont, 356 Aiken Center, Burlington, VT 05405; robert.manning@uvm.edu

Transportation, Recreation, and Capacities in Yosemite National Park

Doug Whittaker, Bo Shelby, Bret Meldrum, Henrietta DeGroot, and James Bacon

Peak-season visitors to Yosemite Valley know first-hand that use levels can affect the quality of their experiences in the park. The sheer volumes of vehicles and people sometimes produce long lines at entrance gates, traffic jams at intersections, full parking lots, and congested trails or viewpoints. These problems have been challenging the park's infrastructure and operational staff for decades, but more frequently in recent years (White et al. 2012). A 2011 study of mid-summer river users in Yosemite Valley also helps quantify the general problem: 82% report feeling some degree of crowding during their visits (Whittaker and Shelby 2012). Meta-analyses of the hundreds of studies using this same measure suggest that recreation settings with crowding levels above 65% are probably "over capacity," and those above 80% may be "greatly over capacity" (Shelby et al. 1989; Vaske and Shelby 2008).

More detailed information shows that Yosemite visitors feel more crowded while using the park's transportation system than when participating in other activities. The percentage of those feeling crowded was highest while engaged in driving roads (90%), finding parking (88%), or riding free shuttles (83%), followed by hiking or biking on trails (68%). In contrast, crowding ratings were considerably lower for river-based activities, such as boating (60%), relaxing (54%), or swimming (45%). These are considered to be in "high normal" (50–65%) or "low normal" (35–50%) ranges (Shelby et al. 1989).

These general crowding ratings by themselves are insufficient to determine capacities, but they provide perspective in relation to other studies, allow comparisons among areas within Yosemite, and show that transportation conditions affect overall perceptions, as anticipated by the conceptual model developed in Meldrum and DeGroot (this volume). As the park addresses capacities and other management actions in Yosemite Valley, the transportation system is a key component of high-quality visitor experiences as well as a primary mechanism for managing use and impacts.

Previous papers in this issue have described the conceptual foundation, objectives, methods, and findings of Yosemite's Integrated Transportation and Capacity Assessment

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(ITCA) program (Meldrum and DeGroot), which addresses a range of transportation (White et al.) and attraction site impacts (Reigner et al.). This information is being used to develop different potential futures (including capacities) for the Merced River Plan (MRP). The Merced is a designated national wild and scenic river, which includes segments in the park's wilderness as well as the iconic Yosemite Valley. The MRP is the primary planning initiative that will guide transportation, development, and capacity decisions in these areas.

This paper briefly reviews the process used to develop capacities, and describes how ITCA information helped develop plan alternatives that represent tradeoffs between transportation infrastructure, visitor numbers, and the conditions that affect visitor experiences. We conclude with considerations for integrating transportation and capacity programs into planning processes, some of which are further illustrated by short sidebars with specific information from the MRP. Because the draft MRP and its environmental impact statement have not been released as this publication goes to press, information in the sidebars are preliminary capacities or conceptual alternatives presented to the public during earlier planning steps (NPS 2012a, 2012b).

Addressing capacity in the Merced River Plan

The Wild and Scenic Rivers Act (WSRA) provides the most recent impetus for addressing capacity in Yosemite. The act requires agencies to prepare comprehensive management plans to protect and enhance a river's "outstandingly remarkable values" by "addressing resource protection, development of lands and facilities, user capacities, and other management practices" (WSRA, section 3(d)(1)). Capacities specify the kinds and amounts of use the river corridor can sustain without causing unacceptable impacts to those values (Departments of Interior and Agriculture 1982). Consistent with recent literature (Whittaker et al. 2011), user capacities are numbers on a use-level scale that have units of use, timing, and location components, such as people per hour hiking along the Mist Trail or vehicles per day in Yosemite Valley.

After more than a decade of legal challenges, NPS is developing a third plan for the Merced River. The decision-making process is guided by the National Environmental Policy Act (NEPA). which requires NPS to describe the current situation (the "affected environment" and "no action alternative"), develop a "reasonable range" of alternatives, analyze their environmental consequences, and choose a preferred alternative while involving the public throughout the process.

Capacities are one component of "management prescriptions" developed for each alternative. These prescriptions describe management objectives, quantitatively define standards of natural resource health or experiential quality, and show how management actions (including capacities) will achieve those objectives (Haas 2003; Whittaker et al. 2011). Specific steps follow from several well-established resource and visitor-use frameworks (Brown et al. 1978; Stankey et al. 1985; Shelby and Heberlein 1986; Graefe et al. 1990; and Manning 2001, 2004). Applied to wild and scenic rivers, they include:

- Describe "outstandingly remarkable" river values to be protected;
- Identify indicators to represent desired conditions;

- Identify management standards for each indicator to define when impacts become unacceptable;
- Analyze relationships among use levels, impacts, and potential management actions; and
- Organize management actions and related capacities into a reasonable range of alternatives that are logically consistent and define alternative ways to protect river values, each with inherent tradeoffs.

The process is designed to clarify how use levels affect conditions, given assumptions about the transportation and overnight accommodation infrastructure, amount of visitor regulation, and site management or "hardening." It also included analyses of how different use measures are related to each other, thus addressing use and impacts at different spatial or temporal scales. This is an iterative process that included some adjustments after revisiting earlier steps. Alternatives were designed to have different capacities, which work with other management actions to protect or enhance river values.

ITCA information helped structure decision-making and clarify tradeoffs

Use and development in Yosemite's Merced River Corridor are multifaceted, and developing capacities for the area is similarly complex. Resource conditions, capacities, and infrastructure are parts of a three-way tradeoff system, and ITCA information shows how changing one has implications for the others. User capacities in different alternatives show how higher and lower amounts of use fit with infrastructure and other management actions to produce different resource conditions, protecting river values in different ways. These represent choices about the kind of place the Merced River corridor will be and the visitor experiences it will offer (as required by NEPA), while at the same time protecting river values (as required by WSRA).

Transportation and capacity-focused analysis identified information needs, required explicit evaluative information and decisions, and "solved for" (1) conditions, (2) capacities, or (3) infrastructure when the other two were identified. In the Merced River planning process, ITCA-based analysis specifically helped:

- Focus attention on specific, measurable *indicator variables* for transportation and recreation experience conditions (e.g., travel times on key road segments, the availability of parking, and densities at specific recreation attraction sites such as falls viewpoints, hiking trails, and beaches).
- Provide *evaluative information* from visitor studies about specific transportation and experiential conditions (preferred and acceptable travel times or use densities), including those higher than current use levels as illustrated through photo simulations (Reigner et al., this volume; White et al., this volume; Whittaker and Shelby 2012).
- Encourage *"calibration" to standardized use-level measures*. Capacity analysis requires specific use-level metrics (units, location, and timing), which helps agencies and stakeholders stay on the same page when describing use and the conditions it creates. Prior to the most recent analyses, park staff and stakeholders often talked past each other by

using different use-level descriptors (e.g. people vs. vehicles, different counting locations, or aggregating by time periods as different as days, months, or years).

- Describe *relationships between multiple-use and impact metrics* (and provide assumptions that allow "translations" between related variables). It is important to understand all the metrics in a chain of variables: at-one-time densities at a site (via photo simulations), daily use levels at the site, overall daily use levels in the valley, and overall daily use levels in the park. The goal, as Einstein once advised, is the "simplest model possible, but not simpler." The planning process requires ITCA research and monitoring information to "connect the dots" and clarify the source of information or assumptions.
- Specify "*sideboards" on the range of transportation and capacity actions* to analyze. Alternative development can be overwhelming if infrastructure and capacity choices are unbounded. There are always historical, physical, legal, administrative, budget, and political constraints during decision-making, but it can be challenging for agencies to identify them. Because capacity analyses require specific input for these variables, decision-makers are encouraged to explicitly decide what is or is not "on the table" and within the "reasonable range."
- Identify *specific model input*. Transportation and capacity models are relentless in requiring specific information. The models require NPS to specify circulation patterns, number and type of road intersections, parking supply, people per vehicle, numbers of day and overnight visitors, and numbers of residents and commuters.
- *Vary conditions, capacities, or infrastructure* in the analyses. In general, modeling scenarios for Yosemite Valley set infrastructure and use levels to provide output about resulting transportation conditions. However, one early model determined which use level would allow existing infrastructure to provide "acceptable" transportation conditions, and another estimated the highest use levels that would provide acceptable conditions if infrastructure were improved.

Transportation modeling was an integral part of the capacity analysis, and each alternative assessed how levels of vehicle use (associated with overnight accommodation and day-use parking decisions) would affect traffic circulation (Byrne et al. 2011; Chase et al. 2012). Modeling also explored relationships between circulation and infrastructure choices such as pedestrian underpasses, intersection improvements, and additional parking. Understanding relationships between use and impacts to river values (see Box 1) helped shape infrastructure choices in the alternatives.

Considerations for future capacity efforts

As ITCA information has been integrated into decision-making for the MRP, several considerations have emerged for developing capacities in similar high-use parks and resource areas. Sidebars illustrate several of these ideas with ITCA information or ITCA-based standards, capacities, or management actions in the MRP.

Focus on indicators for the most salient impacts. Indicators seldom represent all objectives and desired conditions. In Yosemite, attention has focused on travel time on specific

Box 1. Capacities in the Merced River corridor above Nevada Falls

The outstandingly remarkable value in this segment is river-related recreation in an iconic High Sierra setting. The river features "opportunities for primitive and unconfined recreation, self-reliance, and solitude which are intimately tied to the corridor's wilderness character." The most capacity-sensitive indicator focuses on trail encounters per hour, a salient visitor experience metric studied in many higher-use wilderness areas (Cole and Hall 2008; Broom and Hall 2010). Both overnight and day visitors contribute to trail use in the segment, requiring research to assess how existing overnight wilderness zone capacities and trailhead quotas affect trail encounters. Relationships between overall trail use levels and encounters appear to be direct and linear, with lower use and encounters on trail segments farther from trailheads and developed areas (NPS 2009–2011). Standards vary from one to four group encounters per hour across different trail segments and alternatives.

Overnight use in the segment is managed by an existing permit system developed through earlier travel pattern and ecological impact studies (van Wagtendonk,1986), updated with a more recent travel pattern assessment (Van Kirk et al. 2011) and expert judgment. The current system manages overnight use in backcountry zones. This use comes from six different trailheads with hiker-per-day quotas ranging from 10 to 50 for a total of 170 people per day. Some alternatives in the MRP reduce these quotas to reduce trail encounters and the people camping in areas such as Little Yosemite Valley (LYV).

The major user capacity tradeoffs in the segment are between use (access), infrastructure (at LYV), and social conditions (encounters on trails and at camps). The size of the designated campsites at LYV affects the levels and timing of use on trail segments. In the higher-use alternatives, encounter levels in one trail segment are twice those in lower-use alternatives. The higher-use alternatives also maintain LYV and Lake Merced High Sierra Camp (HSC) at levels similar to recent management; this requires more infrastructure (LYV toilet, HSC facilities), produces higher encounter rates with other users and stock trips, and reduces wilderness character components such as opportunities for solitude.

high use road segments in East Yosemite Valley, parking availability at specific parking lots (particularly the day use lots), and densities of people at specific "indicator sites" such as Vernal Falls, Yosemite Falls, Bridalveil Falls, high use beaches, or the East Valley boating segment. These are the "hot spots" where most crowding and congestion occurs and experiences may be degraded. Likewise, attention is focused on the highest use times of the year (the summer season from Memorial Day through Labor Day), assuming that if these areas are managed to acceptable levels, lower densities and impacts (and thus higher quality experiences) will be available at other locations and times.

Pay attention to the scale and number of capacities. Some people refer to "the capacity" of an area, but multifaceted areas like Yosemite Valley actually have several. Agencies or stakeholders may focus on the number of visitors in the entire area over the course of a day,

but developing capacities for smaller areas or shorter times also may be important to protect experiences or values. This requires appropriate "boundaries" or scales for capacities, as well as appropriate use-level units (Whittaker et al. 2011). There are additional challenges in combining capacities and deciding which ones to manage.

The capacity of a hotel resort is a useful analogy. There is an overarching capacity (total guests) that can stay at a resort, but there are also capacities for the dining room, exercise facility, pool, or parking lot. The total number of guests is probably measured in groups (rooms) per night with certain assumptions about people per room, but the capacity for the dining room is independent of the overall capacity, with a different metric (people at one time) and allocation system (reservations for dinner are distinct from reservations for a room).

Capacities are designed to control impacts, so empirical relationships are important. For example, ITCA data show "vehicles per day in the valley" are directly related to intersection congestion impacts (circulation), parking availability, and densities at popular day-use attractions (e.g., Yosemite Falls, Bridalveil Falls). But "vehicles per day in the valley" have lower correlations with on-river boating, so addressing those impacts may require a sub-capacity for commercial or private boating use (see Box 2).

Analyze use–impact relationships within a reasonable range. Agencies have the most information about existing conditions, particularly across a season or on "typical" days in the primary use season. But without robust monitoring, there may be less information about peak days, or the relationships between use and impacts through a range of relevant use levels. Monitoring also may not predict how impacts increase if use rises beyond current levels.

Similarly, it is important to collect evaluative information about use levels that are higher and lower than the current situation. The ITCA photo simulation technique is particularly effective for exploring evaluations of higher use levels that have not yet occurred, although care should be exercised to avoid asking about unrealistically high levels. The goal is careful assessment of the reasonable range that will be considered during planning.

Evaluative or descriptive information for use levels above those directly observed should be interpreted cautiously. There is greater uncertainty about evaluations of conditions that have never occurred, or in extrapolating from existing use–condition relationships. The effects of more use for transportation conditions may be particularly challenging to model at these higher levels because they include probabilistic but variable circulation "friction" (e.g., from random pedestrian crossings, wildlife sightings). In addition, specific locations of new transportation infrastructure (e.g., roads, intersections, and especially parking lots) may affect specific densities at attractions that are hard to predict. ITCA descriptive research was conducted assuming existing infrastructure and taking advantage of variable use levels through a study season. But if parking lots or circulation patterns are changed, these assumptions need to be reconsidered.

Consider other management actions (mitigation). Analyses that account for infrastructure changes (e.g., new pedestrian underpasses, new multi-use trails, and improved intersections) or other management actions (split rail fencing, boardwalks/trails, and education/enforcement programs that funnel pedestrian use away from sensitive areas) are critical. ITCA analysis is most helpful when it allows decision-makers to explore "what if" scenarios

Box 2. Attraction site densities and capacities in Yosemite Valley

The primary indicators selected to represent social conditions in Yosemite Valley were densities at or on the way to attractions (e.g., beaches, boating, the trail to Vernal Falls, viewing areas at Yosemite and Bridalveil Falls). The focus on attraction site densities followed from research in many frontcountry settings (Manning 2009), and is the higher-density analogue of encounters in backcountry settings. Information about these indicators came from ITCA studies at popular high-use sites (Manning et al. 1998; Manning et al. 1999; Manning et al. 2003; Lawson et al. 2009), plus research on shore and boating use in East Yosemite Valley (Whittaker and Shelby 2012). All densities in these studies can be translated into people at one time (PAOT), people per viewscape (PPV), or boats at one time (BAOT) in a specific photo, as evaluated in the studies. They can also be translated into daily use in an area (with assumptions about the size of the photo polygon, use in the larger attraction site area, and temporal distributions through a typical peak-season day).

Standards for these density indictors vary by type of site and alternative. Higher-use sites and alternatives have higher-density standards, and range from 35 to 70 square feet per person at higher-use areas (e.g., the trail to Vernal Falls, several popular trails in East Yosemite Valley) and 80 to 140 square feet per person on lower-density trails in the West Yosemite Valley. Higher-use beaches ranged from 5 to 20 linear feet of waterfront per person, while lower-use beaches were set at 20 linear feet per person for all alternatives. Boating standards range from one to nine boats per viewshed (about 400 feet). In all cases, standards are "better" than current visitors say "they will accept" or "NPS to allow," while more stringent standards (for lower-use sites or alternatives) are closer to visitors' preference evaluations.

Relationships between use and densities at these sites were generally direct, linear, and moderately strong. Explained variance (R^2) between the number of vehicles arriving in East Yosemite Valley per day (and daily use at these attractions) was higher for iconic roadside attractions (e.g., 0.81 for Bridalveil Falls and 0.64 for Yosemite Falls) than for sites farther from the road (e.g., Vernal Falls; 0.12 and 0.24 in different years) or that require more time (e.g., river rafting; 0.11). These relationships also vary in different years, possibly due to weather and flow conditions. For example, in high-water years the waterfalls are more spectacular and attract a greater proportion of day use, while in lower-water years visitors are more likely to spread out and this reduces congestion at particular sites.

Differences in use–impact relationships and standards make setting overall capacities more challenging for Yosemite Valley than a simpler area such as Hetch Hetchy, which has a single access road, very strong use–condition relationships, and simpler standards (Reigner et al., this volume). In the valley, decision-makers need to consider several attractions, each responding differently to use and having different standards.

An analogy here is the difference between a simple boom box (with just volume, treble, and bass controls) and a professional sound system with dozens of slider controls. It

is easier to make decisions about the right level of use for Hetch Hetchy, just as it is easier to "mix" the sound from a boom box. When you move to the more complicated situation in the valley, there are more variables in play and more judgments to make. ITCA information has helped inform those choices and clarify the conditions provided with higher and lower use.

Primary user capacity tradeoffs in Yosemite Valley are between the amount of use, infrastructure (especially lodging, campground, and day-use parking lots) and social conditions (densities at attraction sites, roadway travel times, and parking availability). In the lower-use alternatives, densities at attractions are closer to "preference" evaluations than "acceptability" evaluations. Higher-use alternatives allow more access, but conditions are less desirable at some sites, though still within the acceptable range identified in ITCA studies.

across a full range of actions, as demanded in multi-dimensional planning efforts. Trade-offs can be best understood through multiple model iterations, with systematic variation of key infrastructure, use, and condition variables. In some cases, mitigation actions essentially solve a capacity-related impact (see Box 3); in others, they trade off different capacities and levels of infrastructure. Yosemite ITCA transportation analyses, for example, showed how "fixing" parking or intersection congestion alone was destined to fail. More parking without intersection improvement, or redesigned intersections without commensurate parking, were both recipes for exponentially increasing traffic queues and travel times.

Focus on "limiting factor" indicators. Capacity experts have long-recognized that not all impacts are related to use in the same way, and some conditions become unacceptable at lower use than others (see discussion in Box 2). When setting a capacity, the focus is on the standard that is violated first as use rises because it is the most sensitive, even if that indicator may not be the most important (Whittaker et al. 2011). While some of the key transportation conditions appear to "break down" at similar use levels, standards for the experiential indicators at different attraction areas would be violated at very different use levels.

The most obvious differences are at Bridalveil and Yosemite Falls. Bridalveil has a smaller trail system, narrower trails, and a cul-de-sac viewing area, compared with the wider, longer, loop trail system at Yosemite Falls. It is not surprising that users' evaluations of acceptable densities at Bridalveil are exceeded at lower use levels at these two sites. The questions for decision-makers are whether (1) Bridalveil should be the "limiting factor" (which would require a lower overall capacity for the valley); (2) a Bridalveil redesign can reduce site densities to acceptable levels by redistributing use temporally or spatially; or (3) conditions at Bridalveil should be allowed to exceed current users' acceptability evaluations (thereby establishing a new higher-density standard).

Be proactive. Capacities can be most easily implemented before impacts become unacceptable, change becomes irreversible, or the public becomes accustomed to high use levels (Whittaker et al 2011). Managers should indicate which management actions they will employ if parts of the management prescription are violated, particularly if direct use limits are contemplated, so stakeholders can prepare for them. Restrictions or allocations may be

Box 3. Meadow conditions and capacities in Yosemite Valley

An example biological indicator shows that many visitor impacts can be controlled by mitigation actions. Meadow function and health were assessed by a "fragmentation index," the percent of a meadow in its five largest patches. The measure is sensitive to the size of intact areas and the amount of informal trails, and indicates impacts related to meadow hydrology, soil moisture, non-native species, habitat quality, and barriers to small mammals. Although research has documented visitor-related resource impacts in meadows, data and experience in Yosemite showed that fragmentation or other measures of meadow condition were related to type and location of use rather than specific amounts of use. As a result, the focus shifted to other management actions that address those impacts.

Meadow fragmentation standards were the same for all alternatives. Alternatives with different capacities thus required different levels of infrastructure (boardwalks, trails, and split rail fencing) to control the location and type of use. This addresses the impact problem by changing the impactful behavior rather than the amount of use so the meadow condition is no longer a limiting factor for capacity. New roadway designs remove most roadside parking in all alternatives, and trails/fencing are used to control impacts from increased use and development (e.g., new or expanded campgrounds) in two higher-use alternatives. The success of such approaches has been demonstrated at Stoneman Meadow, where fragmentation scores improved from 40% in 1978 to 99% in 2011 as a result of developing a single boardwalk trail, even though annual park use rose more than 50% during the same period. Monitoring will continue to assess meadow condition, use levels, and visitor compliance with formal trails and protective barriers in order to better understand relationships between these variables.

more readily accepted by users or stakeholders if they are prescribed before they need to be implemented. Management actions, including capacities, should be set so that impacts slow before they have "crossed the line."

ITCA modeling in Yosemite shows that this is particularly important for transportation conditions, which deteriorate quickly once a tipping point has been reached. With existing infrastructure in the eastern part of the valley, there are several major bottlenecks. In some cases congestion is a function of lack of parking (vehicles clogging the roads in search of spaces), but in others it is caused by intersections or on-grade pedestrian crossings that cannot handle the volume of use. As these bottlenecks approach and exceed their design capacity, conditions such as travel times, queue lengths, and vehicles per road viewscape "go exponential" (increase at a dramatically increasing rate). Anecdotal accounts of traffic gridlock from 2011 suggest modeling may actually underestimate travel times, queue lengths, and other transportation conditions, so it is important to be conservative in choosing capacities to avoid reaching a tipping point (see Box 4).

Vary standards or mitigation across alternatives. Transportation and experiential models allow decision-makers to illustrate the tradeoffs of different infrastructure, use levels, and

Box 4. Transportation conditions and capacities in Yosemite Valley

Two frequent questions from visitors are: "How long will it take to get there?" and "Will parking be available?" Many visitors are acutely aware that congestion can affect their ability to experience the Yosemite Valley, and NPS developed two ITCA-based indicators to address transportation system performance.

Parking availability compares the number of accumulated vehicles with parking supply (number of spaces). In different alternatives, parking supply was constrained by restoration initiatives, the removal or repurposing of existing facilities, and the space occupied by camping and lodging complexes (which also varied across alternatives). Modeling then analyzed how day use would occupy the remaining available spaces, applying assumptions about arrival and parking duration times, and about the proportion of spaces that would be paved and striped, actively managed by parking staff, or could be utilized efficiently at one time. Urban planners assume 85% maximum occupancy so drivers can find, enter, or leave spaces without creating bottlenecks; in Yosemite's generally larger lots, planners applied a 90% standard. East Yosemite Valley currently has about 5,000 parking spaces, with 4,000 available to visitors; modeling explored a range from about 4,000 to 6,500 spaces (3,000 to 5,550 for visitors).

Travel time measures how long it takes to drive from Curry Village to Yosemite Village parking and indicates circulation efficiency. It is a function of the number of vehicles, the amount of space on roadways, the number of intersections of different types, and the amount of "friction" caused by pedestrian crossings or vehicles blocking the roadway as they enter or leave parking. Although visitors appear more sensitive to vehicles per viewshed (VPV) than travel times (White et al., this volume), modeling and observations from recent high-use days show that congested roadways can cause unacceptable travel times, intersection queues, or constrain emergency vehicle access. Alternatives ensure travel times do not reach these dysfunctional levels by increasing infrastructure in higher-use alternatives (e.g., adding up to three roundabouts and two sub-surface pedestrian crossings, while substantially reducing roadside parking that encroaches on circulation). Alternatives also include congestion mitigation, such as traffic operations programs to direct parking and or improve intersection efficiency, enhanced traffic information (redirecting use from congested areas on high-use days), and incentives for visitors to use transit options from gateway communities. Transit systems may help accommodate increasing visitation even when parking and circulation-based capacities are reached, assuming visitation levels are high enough to justify system costs.

If monitoring shows vehicle use levels still exceed parking or travel time standards, alternatives include on-site day use traffic restrictions (a "shunt" that delays or redirects traffic away from the East Valley) or a day use parking permit system (with potential reservation and onsite components). The full day use parking permit system would only be implemented if capacities or standards have required use of the shunt for more than 14 days per year for two consecutive years.

conditions. Differing alternatives highlight these tradeoffs through varying capacities, infrastructure, and transportation or experiential standards. For some indicators, standards may not vary across alternatives—these are situations where there is broad agreement about acceptable conditions and the park will not consider a less protected state (see Box 3). But in other cases there may more diverse opinion about acceptable standards, and the alternatives can highlight different choices (see Box 2). A more protective standard may allow less use, while a less protective standard may allow more.

When standards do not vary across alternatives, the other choice is to vary mitigation. As discussed in the Bridalveil Falls example, NPS may choose to manage for current visitors' acceptability evaluations across several alternatives, but vary the redesign features to allow higher use while keeping the same densities.

Develop data describing simple use–impact relationships. The conceptual model described in Meldrum and DeGroot (this volume) emphasizes the complex nature of transportation and capacity relationships, and the ITCA research and monitoring program collected evaluative information for multiple sites and developed sophisticated simulations with several spatial and temporal variables. This makes sense for a park with considerable research and monitoring resources, not to mention the contentiousness associated with years of litigation. But other parks have less capability, which encourages simpler observation-based relationships and logical calculations based on stated assumptions.

Regardless of the resources available, simpler and easier-to-explain relationships are often more useful than sophisticated analyses that can be opaque to some decision-makers or stakeholders. For example, ITCA analyses that involve several "translations" between density evaluations (via photos) and use-level metrics at different geographic or temporal scales require more assumptions and effort to understand, and they have greater margins of error as they model use levels further from current levels. Although complex modeling has its place, we often wished for more straightforward data that could have been collected at the same time as other ITCA information, and analyzed more simply.

Conclusion

Researchers have long advocated separating descriptive and evaluative information in capacity decision-making (Shelby and Heberlein 1986; Manning 2007). The descriptive component is often less complex and controversial, requiring mostly technical information about how the system works. In contrast, the evaluative component is usually more contentious, because stakeholders have different value judgments about the type of experience to be provided or how much impact is acceptable. In Yosemite however, both were challenging because of the complexity of resources, development, uses, and users. The ITCA research, planning, and monitoring programs recognize this in both concept (Meldrum and DeGroot, this volume) and practice (White et al., this volume; Reigner et al., this volume; Chase et al. 2012; Whittaker and Shelby 2012). As applied in the MRP process, ITCA information helps clarify the complex tradeoffs involved in choices about use, infrastructure, and the conditions that will be provided. This allows a more clear discussion of the kind of place stakeholders want Yosemite to be.

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Doug Whittaker and **Bo Shelby,** Confluence Research and Consulting, 6324 Red Tree Circle, Anchorage, AK 99507; crc0@comcast.net

Bret Meldrum, Yosemite National Park, P.O. Box 577, Yosemite, CA 95389; bret_meldrum@nps.gov

Henrietta DeGroot, National Park Service, P.O. Box 577, Yosemite, CA 95389; henrietta_degroot@nps.gov

James Bacon, Yosemite National Park, P.O. Box 577, Yosemite, CA 95389; jim_bacon@nps.gov

Getting There: Yosemite and the Politics of Transportation Planning in the National Parks

Christopher E. Johnson

Yosemite is, in many respects, the prototypical national park. It was the nation's first park devoted to the preservation of undeveloped land for public recreation and reflection. It is also where the National Park Service, since its inception in 1916, has grappled most intensely with the challenges of preserving nature for the benefit of a public accustomed to experiencing nature from their cars. Over time, higher levels of visitor use stemming from the growth of San Francisco, rising affluence, increasing automobile ownership, and the Park Service's own road-building and promotional efforts threatened to overwhelm the scenic landscapes the park was meant to protect. Critiques of the Park Service's accommodation of car-based tourism began to take shape as early as the 1920s, reaching a crescendo during the 1960s and 1970s with the rise of the wilderness movement. Facing criticism from some of their oldest allies in conservation, including the Sierra Club, administrators and planners at the national and park levels struggled to adapt transportation policies to evolving and increasingly contested cultural conceptions of a quality national park experience.

While always contentious, transportation planning became even more complex in the latter 20th century. The passage of the National Environmental Policy Act (NEPA) in 1969 and the suite of preservation legislation that accompanied it gave an increasingly active public a direct say in management decisions. Since then, the Park Service has faced scrutiny from environmentalists, concessionaires, local communities, recreation groups, historic preservationists, Native tribes, and others in the development and implementation of new visitor management policies for Yosemite. Although planners have devised creative strategies for anticipating, soliciting, and incorporating public responses, the costs and time commitments of preparing the required environmental impact statements and responding to public comments have resulted in a series of drawn-out battles among groups of people who, while generally sharing an interest in protecting the park for future generations, have continued to disagree over specifics.

The essays in this edition of *The George Wright Forum* outline a new strategy which planners in Yosemite have developed in response to the more complex politics of the present era. In part, the philosophy behind the Integrated Transportation and Capacity Assess-

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ment (ITCA) project reflects the experience of over 140 years of transportation and recreation planning in Yosemite. It derives from a basic recognition that how people get to and move through the park affects the quality of their experiences and the condition of park resources. ITCA also represents a move towards a more integrated, quantifiable, and legally defensible approach to capacity assessment and visitor management. It makes use of new computer modeling techniques to evaluate the relationships between transportation, visitor experience, and resource quality at different scales. If successful in breaking the political (and literal) gridlock in Yosemite, ITCA could provide a model for park planning systemwide.

Transportation and the politics of management

For most Americans in the late 19th century, the Yosemite Valley might as well have been located beyond the ends of the earth. Following Congress's 1864 decision to grant the valley to the state of California, only the wealthiest Americans had the time and finances to actually see it with their own eyes. The completion of the transcontinental railroad in 1869 significantly eased travel to the Pacific Coast, but tickets were pricey and the trip from New York to San Francisco took several days.[1] From Stockton to Coulterville, travelers endured a dusty, bone-jarring stagecoach journey before climbing onto a horse for the final 37-hour leg. By the time they arrived, many were too exhausted and homesick to enjoy the sights. "As we creep heartsick to bed," wrote one visitor in 1870, "we can think of nothing but—the Yo Semite Fall, the Bridal Veil, El Capitan, the Cathedral Rocks? No! Of the weary distance which lies between us and civilization."[2]

If somehow transported to present-day Yosemite, the stage traveler of 1870 would no doubt be amazed by the sheer numbers of people from all walks of life converging on the park in motorized vehicles. They would probably be stunned by the extent of development in the valley and baffled by the myriad regulations and procedures governing visitors' experience of the natural scenes for which the park was created. The transformation of Yosemite from an elite tourist destination to an icon of the motoring age to a symbol of nature on the verge of being loved to death has reflected the historical transition from stagecoaches to railroads to private cars and more recently to mass transit as modes of conveying people to the parks. Understanding how these changes occurred and what they have meant for Yosemite and the national park system requires an appreciation for the deep connections between shifting cultural perceptions of nature, changes in transportation technology, and the increasingly political nature of national park planning.

From rails to roads

The establishment of the first national parks in the late 19th century was linked closely to the growing popularity of western tourism. Stage operators, lodge owners, and railroads promoted parks and mediated people's experience of them. Railroads even contributed directly to campaigns to expand the park system. Reflecting on the 1890 establishment of Yosemite National Park, John Muir commented that "even the soulless Southern Pacific R.R. Co., never counted on for anything good, helped nobly in pushing the bill for this park through Congress." During the campaign, Muir forged personal friendships with some representa-

tives of the Southern Pacific, including magnate Collis P. Huntington, who saw the creation of a large national park in the region as a way to both attract tourists and protect the watersheds supplying irrigation to railroad-owned agricultural lands in the Central Valley.[3]

If the railroads were crucial to establishing and promoting the first national parks, the automobile was the key to making the 19th-century idea of a national park relevant in the 20th century. Americans' desire to encounter nature in the national parks through their windshields reflected a conflicted view of technology at the heart of 20th-century conceptions of modernity. As cars became more affordable and more reliable in the 1910s and 1920s, they were widely embraced as mechanical means to escape the problems of the industrial city and return to nature. They also provided an impetus for national park promotion. In 1908, Mount Rainier became the first national park to admit auto tourists. For residents of the nearby cities of Seattle and Tacoma, accommodating automobile travel to Mount Rainier would not only make the park more accessible, it would also draw attention to the region and increase tourist revenue.[4]

From the start, automobile tourism to Yosemite was not universally embraced. Due to safety and noise concerns, cars were initially excluded from the park. Muir was also ambivalent about admitting cars. On one hand, he believed that allowing automobiles would help build a stronger constituency for the parks and perhaps even forestall the proposed dam at Hetch Hetchy. In 1912, he recommended that a road be extended up the canyon of the Merced River, through Tuolumne Meadows, and down to Hetch Hetchy to enable more people to see it. On the other hand, Muir was skeptical of automobile club delegates who spent "a prodigious lot of gaseous commercial eloquence" defending their presumed right to drive wherever they pleased. Ultimately, he recognized that lifting the ban on "these useful, progressive, blunt-nosed mechanical beetles" would be necessary to build support for preservation. Cars, he conceded, "will hereafter be allowed to puff their way into all the parks and mingle their gas-breath with the breath of the pines and waterfalls."[5]

In comparison to Muir, Stephen Mather, the first director of the National Park Service, was unequivocal in his embrace of the automobile. In 1915, just prior to the establishment of the agency, he drew on his own personal fortune to purchase the then-private Tioga Road. He then repaired the road and donated it to the government for use as "a motor gateway to the upper wilderness" of Yosemite.[6] By the summer of 1918, some 50 to 60 cars were navigating the single-lane dirt track each day. In the following year, approximately 75% of all park visitors arrived in private vehicles. "The advent of the automobile," Mather remarked in 1921, "has been the open sesame for many thousands."[7]

For Mather and his successor Horace Albright, accommodating auto tourism was entirely consistent with the young agency's core mandate to preserve America's natural treasures while providing for their enjoyment by the public. Through the 1920s, as part of his effort to promote the parks and the Park Service, Mather pushed for a 5,000-mile Park-to-Park Highway. He also worked to persuade skeptical locals of the economic benefits of car-based tourism. Roads, he declared in 1925, would bring "a great flow of tourist gold … adding life to communities unprogressive for years."[8] Mather and Albright also coordinated a massive advertising campaign employing the promotional slogan "See America First" to encourage Americans to view the national parks not only as scenery but as expressions of

national culture. By the 1920s, the availability of cheaper, better-made cars, coupled with a rapidly expanding national network of roads, opened the parks to millions of middle-class Americans. Driving to and through the national parks came to be seen as basic American freedoms.[9]

Mather's and Albright's promotional drive was tempered by their belief that poorly planned development could detract from what they considered an appropriate national park experience. They sought out prominent landscape architects, including Frederick Law Olmsted, Jr., Herbert Maier, and Thomas Vint, to develop plans which harmonized with the natural landscape. Roads, lodges, visitor centers, and other projects were meant to enhance scenic vistas and bring visitors in closer contact with the natural features for which the parks were created. These kinds of "improvements" amounted to "the dignified exploitation of the national parks," as one planner put it.[10]

Despite this restraint, by the 1920s the rapid influx of automobiles into Yosemite was beginning to stress the park's natural environment and infrastructure. Pressures mounted as more Americans discovered that auto camping could be a cheap and enjoyable way to spend their vacations. For the most part, the Park Service welcomed the trend. Between the 1920s and 1930s, Mather and Albright oversaw improvements to the Wawona and Big Oak Flat roads and the construction of the Merced River All-Weather Highway. The Park Service also took advantage of cheap labor provided by the Civilian Conservation Corps and the Works Progress Administration during the New Deal to further develop the parks. Even with the additional infrastructure, cars backed up at the Arch Rock entrance station during busy summer weekends. Campgrounds filled to capacity and many drivers encroached into forests and onto meadows in search of free space to set up camp. In 1935, Yosemite officials sought to mitigate the problem of overcrowded campgrounds by enacting a 30-day camping limit.[11] At the national level, Albright instituted a requirement that each park draw up a "Master Plan" to guide future development. Although these policies were put in place in response to rapid visitation increases, their primary purpose was to better manage growth, not to limit it.[12]

Wilderness and the politics of access

The unwillingness of the Park Service and other public land agencies to limit auto tourism in this period led some conservationists, including the founding members of the Wilderness Society, to form a new conception of wilderness as an area accessible only by non-mechanical means.[13] Faced with the rising tide of auto tourists in Yosemite, some Sierra Club members began to rethink the club's mission to "render accessible the mountain regions of California." In 1930, veteran outing organizer Marion Randall Parsons proposed a new approach: "Our problem is no longer how to make the mountains better traveled and better known," she wrote. "Rather it would seem, how from the standpoint of the mountain-lover 'to render accessible' may be more truly compatible with 'to enjoy.'"[14] It was no longer enough to bring people to the mountains. In Parson's view, the club also had a responsibility to encourage people to experience wilderness appropriately, which for her meant getting out of their cars and walking or hiring a pack outfit to take them beyond the road head.

This reframing of the aims of wilderness preservation was put on hold as the nation's attentions shifted during World War II. After the war, the problem of defining appropriate

use became acute. Population growth in western cities, better roads, and the proliferation of automobile ownership contributed to an unprecedented surge in national park tourism. Between 1944 and 1945, visits to the parks leapt from approximately 5 million to nearly 12 million per year before jumping to 25.5 million in 1947. By the mid-1950s, approximately 50 million people were visiting the parks each year, and the number kept growing.[15] Roads, lodgings, campgrounds, ranger stations, and trails not upgraded since the New Deal proved inadequate to handle the barrage of tourists. In 1956, the Park Service responded with Mission 66, a program to revitalize the parks by the agency's 50th anniversary in 1966. Director Conrad Wirth described the program as necessary to bring the parks "up to a consistently high standard of preservation, staffing and physical development."[16] However, as plans took shape for ambitious road expansion projects and huge, modern visitor centers, conservationists began to challenge the Park Service's accommodating stance towards increasing tourism.

The Park Service's decision to widen, pave, and reroute the Tioga Road in the Yosemite high country galvanized the growing anti-development contingent in the Sierra Club and set the tone for future debates over roads in national parks. The rationale for the project echoed the prewar aims of park planning: an improved road would accommodate more cars, but it would also make other development schemes unnecessary and would channel visitors along a single route, leaving the surrounding wilderness untouched.[17]

The proposal divided the Sierra Club. Traditionalists supported the plan but sought to minimize the road's intrusiveness. A smaller but more vocal and generally younger group led by David Brower and Ansel Adams questioned whether the road should be improved at all.[18] Their concerns were twofold: not only would the project damage some of the most scenic features of the high country (it would require blasting portions of the granite benches along the shore of Tenaya Lake), it would also grant easy access to "those who must have speed to be happy; those who are not sufficiently interested to invest the time and effort; those who require a house on wheels when they rough it; those who are timid, or incompetent and realize it," as club member Harold Bradley expressed in 1949. The presence of so many people unwilling "to pay the price in terms of effort and time," Bradley and others felt, would destroy the qualities that defined the Yosemite high country as wilderness.[19]

Ultimately, the Tioga Road expansion carried too much momentum to be stopped by these objections. The availability of Mission 66 funds after 1956 all but ensured that the project would go forward. Rising affluence, population growth, and greater mobility continued to fuel massive increases in national park visitation. Public support for limiting auto access also continued to grow. By the mid-1960s, concerns over crowding in the national parks inter-mingled with other concerns about dam construction, nuclear weapons testing, chemical pesticides, air and water pollution, and the loss of open space to spark a broad-based political movement to protect environmental amenities. At the same time, the rising popularity and accessibility of hiking, backpacking, mountaineering, and other more vigorous forms of outdoor recreation contributed to a feeling among many park advocates that cars did not belong in wilderness.

The 1964 Wilderness Act inscribed this conception of wilderness into federal law. The act defined wilderness as "as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain." It also specifically pro-

hibited permanent or temporary roads and any form of mechanical transport within designated wilderness areas. Though initially concerned about the act's compliance requirements, the Park Service gradually incorporated these definitions into park planning. In 1968, North Cascades National Park in Washington State was created as a wilderness park entirely free of roads. However, the Park Service also recognized that most visitors might not be ready to give up their cars altogether. While no roads entered the park itself, North Cascades was established as part of a larger park complex. Roads and other accommodations were permitted in two adjacent National Recreation Areas.[20]

The Wilderness Act also had no direct effect on existing developed areas within national parks. Edward Abbey, one of the more outspoken critics of the Park Service's continuing emphasis on accessibility, saw cars and roads as exemplars of what he deemed "Industrial Tourism." In his widely read 1968 polemic *Desert Solitaire*, he accused the Park Service of ignoring the protests of those visitors who were "determined to get outside of their motorcars for a least a few weeks each year" in favor of "that other crowd, the indolent millions born on wheels and suckled on gasoline, who expect and demand paved highways to lead them in comfort, ease and safety into every nook and corner of the national parks."[21] Abbey's critique, and others like it, established a divide between a minority of park advocates who favored limiting visitor use for the sake of fulfilling the Park Service's mandate to preserve nature "unimpaired," and the majority of park goers who were presumably more accepting of (or even dependent upon) roads, modern campgrounds, and visitor services.[22] This division underlay the political battles that erupted over transportation planning in Yosemite and other parks in the decades that followed.

The era of public planning

The challenges of managing visitor use in this period were especially daunting in Yosemite, where visitation numbers doubled from 1 million in 1954 to 2 million in 1967. By the late 1960s, the narrow confines of the Yosemite Valley "reflected more the noise and honky-tonk of an urban amusement park than the pristine beauty and wildness of a national park," as one historian has observed.[23] Traffic jams, car accidents, gasoline odors, nighttime drag races, and the drone of motor home generators became unavoidable parts of the overall park experience. In 1970, Yosemite officials departed from their historically automobile-friendly orientation by closing the Mariposa Grove and the eastern third of the Yosemite Valley to private cars. From then on, these areas were served by clean propane-powered trams and shuttle busses. Beginning in 1971, the Park Service considered various proposals to exclude cars from the valley. These proposals encountered opposition not only from visitors reluctant to leave their cars behind but also from conservationists critical of plans to build large parking lots in ecologically sensitive areas outside the park. Members of the Sierra Club were especially distressed to learn that park officials were considering a gondola to run from the valley floor to Glacier Point.[24]

Political disputes over transportation intensified in the years that followed. Yosemite's struggles to gain approval for the 1974 and 1980 master plans, both of which called for limiting automobile access, reflected a new era in park planning in which new legislation enabled the public to play a more direct role in administrative decisions. Meeting the

requirements of the NEPA became a central challenge. The act required all federal agencies to prepare and make available for public comment an environmental impact statement for any development project. By the early 1970s, the Park Service had also begun to place greater emphasis on ecological considerations in natural resource management. Addressing the problems resulting from high levels of visitor use within these new frameworks became a primary goal for the new general management plan.

In developing the plan, planners found themselves under attack from all sides. The Music Corporation of America (MCA), the parent company of Disney and the park's concessionaire at the time, saw the proposed restrictions on cars as a threat to their bottom line. The company argued that if automobile traffic was to be limited, planners should consider "alternative travel options, such as the Aerial Tramway to Glacier Point and increased parking within the valley." The Automobile Club also weighed in, urging the park to favor "those who prefer a more moderate stand, much along the lines existing today." Fearing that park planners would bow to the demands of MCA and the automobile lobby, the Sierra Club called for even greater reductions on automobile use, including the removal of 1,200 day-use parking spots in the valley. The club also supported providing bus service from "staging areas" outside the park, believing that Yosemite "could be a vanguard for alternative transportation systems." Park officials attempted to steer a course between the two sides, assuring MCA that the valley would not be closed to auto traffic while also entertaining proposals for parking lots outside the park. Lacking confidence that these disputes could be resolved, the Department of Interior rejected the draft plan in December 1974, and the Park Service came out looking like "a weak sister, an outfit easy to manipulate," as one critic put it.[25]

Addressing the concerns of the various interest groups that prevented the approval of the 1974 plan became the primary consideration in developing a revised plan beginning in 1978. Park planners came up with an innovative scheme of using interactive graphic displays to allow the public to choose from a variety of alternatives. The thousands of public comments were directed towards a specific set of proposals, and the planning team revised the draft based on the results. This strategy became a model for involving the public in park planning systemwide. To meet the goals of allowing natural processes to prevail and reducing traffic and crowds, the final plan called for the removal of "all private vehicles from Yosemite Valley." It also recommended expanding the shuttle bus system to provide service from parking areas at El Portal, Crane Flat, Wawona, and eventually from outlying areas and gateway communities.[26]

While the park's effort to incorporate public comment during the revision process was effective, implementation proved more complicated. Following the release of the final draft in 1980, concessionaires, local businesses, environmentalists, and recreational user groups continued to challenge aspects of the plan. The stricter legislative requirements also meant that the park would have to propose alternatives and conduct scientific studies to evaluate each component of the plan. These challenges were compounded by shrinking federal appropriations during Ronald Reagan's presidential administration.[27]

Some aspects of the plan were eventually carried out. In 1992, the five counties surrounding the park formed the Yosemite Area Rapid Transit System (YARTS). Budget issues and disagreements with some of the counties delayed the start, but in 2000, YARTS buses

began transporting visitors from several staging areas located outside the park. The system received funding from a combination of user fees and federal and county subsidies and represented a crucial first step in a more extensive regional mass transit network. The rainstorm and flood that inundated the valley in January of 1997 provided another opportunity to break the political gridlock and address long-standing transportation and planning issues. An infusion of federal money for flood repairs allowed the park to reduce the number of campsites, eliminate some infrastructure, improve the El Portal road to accommodate busses, and require reservations for overnight stays during the summer. The 1997 flood also provided the impetus for drafting the Yosemite Valley and Merced River plans.[28]

Despite this progress, the more substantive transportation goals outlined in the 1974 and 1980 plans remained unmet by the start of the 21st century. For instance, while the 1980 plan had called for the reduction of parking spaces in the valley from about 2,400 to 1,200, the amount had more than doubled to 5,000 by the late 1990s.[29] In a speech in November 2000 announcing the release of the Yosemite Valley Plan, which reiterated many of the goals of the earlier plans, Secretary of the Interior Bruce Babbitt summed up the planning challenges of the past three decades, telling the crowd, "You are a cantankerous, irascible, quarrelsome and passionate people." While the planners eventually "produced paper," he said, they also developed "planning fatigue" as they struggled to navigate the complicated legislative terrain and scores of public meetings and comment sessions.[30]

Criticisms persisted even after Babbitt's announcement. Local communities remained concerned about the economic impacts of reduced visitation; representatives of Native tribes pressed for greater involvement in the planning process; and environmentalists continued to demand more attention to transportation alternatives. Just before his death on November 5, 2000, David Brower wrote an editorial charging the Park Service with "trying to do too much, too fast in Yosemite." To him, the agency seemed "intent on converting this temple into a profit center, with pricey hotels, scant camping, few modest accommodations, wider roads to field bigger diesel busses, ecological roadside mayhem, atmospheric damage and requiring people who want to celebrate Yosemite Valley to park outside the park in various still unspoiled places that are soon to be paved."[31] Underlying all of this, most park visitors, even those supportive of reducing car traffic, retained psychological attachments to the perceived freedom of encountering nature from their cars.[32]

Conclusion: Quantifying quality

Planning battles also extended into the courtroom. Between 2000 and 2008, the local environmental coalition Friends of Yosemite filed three lawsuits alleging that the park's proposed Merced River Plan (and its revisions) violated the Wild and Scenic Rivers Act (WSRA) by failing to establish limits on user capacity. In all three cases, the court agreed, ruling that the plan failed to "describe an actual level of visitor use" that would not degrade the river's "outstandingly remarkable values" as defined under the WSRA.[33]

These rulings have forced the Park Service to once again rethink how it measures and evaluates the relationship between visitor use and resource quality. In the early years, agency leadership dealt with capacity issues by building roads and providing accommodations, the purpose being to satisfy public demand for car-based recreation while building support for

preservation. As the pressures of increasing visitation mounted after World War II, the Park Service struggled to balance its traditional obligation to provide visitor services with new demands to limit development and restrict use. In the 1960s and 1970s, administrators adopted the concept of carrying capacity, which blended techniques from range science, ecology, and psychology to measure the impacts of backcountry recreation. The political and legal controversies of the past three decades have further elevated the importance of carrying capacity, creating a demand for more transparent, quantitative, and scientific methods of calculating user capacities for all of Yosemite's natural and cultural landscapes.

The ITCA project, initiated in Yosemite in 2010, gives the Park Service a new tool for meeting this objective in Yosemite and elsewhere. Building on an understanding of the historical importance of transportation in Yosemite, the four preceding papers in this special issue suggest that the park's transportation system forms the basis for how visitors engage with, perceive, and impact park landscapes and resources. By using computer simulations to integrate transportation data with visitor surveys, ITCA can help planners and managers better understand the relationship between how visitors get to and move through the park and how they perceive the quality of their experience. The resulting models quantify the quality of visitors' experiences in terms of statistical data on pedestrian and vehicle traffic, allowing planners and administrators to propose clear, legally defensible capacity limits for different activities at multiple scales.

ITCA represents an innovative response to the complex politics of the era of public planning. By establishing a metric for measuring public perceptions of a quality experience and anticipating the impacts of different transportation options, it can provide a basis for a more proactive approach to park management. At the same time, the history of national park planning reveals that "quality" has always been a moving target. How visitors have valued their experiences in Yosemite and other parks has changed relative to broad changes in culture, politics, science, and technology. Perceptions of what constitutes a quality national park experience have also varied tremendously, especially since the 1960s when the parks became more accessible to a broader cross-section of the public. Any effort to quantify quality must contend with the possibility that measurements taken today might not apply tomorrow; and that they may not even be accepted by all (or even most) of the people with something at stake in how the parks are managed in the present.[34]

Endnotes

1. While Yosemite was predominantly an elite destination in its early years, as Anne Hyde points out, its proximity to urban San Francisco and Sacramento actually made it more accessible than other early parks such as Yellowstone and Glacier. Anne F. Hyde, "From Stagecoach to Packard Twin Six: Yosemite and the Changing Face of Tourism," in *Yosemite and Sequoia: A Century of California National Parks*, edited by Richard J. Orsi, Alfred Runte, and Marlene Smith-Baranzini (Berkeley: University of California Press, 1993), 69.
2. Quoted in Stanford Demars, *The Tourist in Yosemite, 1855–1985* (Salt Lake City: University of Utah Press, 1991), 45. Access was an administrative concern from the beginning. In 1865, famed landscape architect and chair of the Yosemite Park

Commission Frederick Law Olmsted recommended that the majority of the appropriations for the newly established reserve ($25,000 out of a total of $37,000) be dedicated to the construction of a road to the valley and the Mariposa Grove of giant Sequoias. Frederick Law Olmsted, *Yosemite and the Mariposa Grove: A Preliminary Report,1865*. Online at www.yosemite.ca.us/library/olmsted/report.html.

3. Richard J. Orsi, "'Wilderness Saint' and 'Robber Baron': The Anomalous Partnership of John Muir and the Southern Pacific Company for Preservation of Yosemite National Park," *Pacific Historian* 29 (Summer/Fall 1985): 136–156.; For a broad treatment of railroads and preservation see Alfred Runte, *Allies of the Earth: Railroads and the Soul of Preservation* (Kirksville, MO: Truman State University Press, 2006).
4. David Louter, *Windshield Wilderness: Cars, Roads, and Nature in Washington's National Parks* (Seattle: University of Washington Press, 2006), 19–20, 27–28.
5. John Muir to Howard Palmer, secretary, American Alpine Club, 12 December 1912. Reprinted in David Page, "Useful, Progressive, Blunt-nosed Mechanical Beetles: John Muir's Notes on Cars in Yosemite." Online at www.sierrasurvey.com/notes/useful-progressive-blunt-nosed-mechanical-beetles-john-muirs.html
6. Quoted in Keith A. Trexler, "The Tioga Road: A History, 1883–1961." Online at www.yosemite.ca.us/library/tioga_road/automobiles_arrive.html.
7. Quotes in Ethan Carr, *Wilderness by Design: Landscape Architecture and the National Park Service* (Lincoln: University of Nebraska Press, 1998), 86.
8. Ibid., 334.
9. Margaret Shaffer, *See America First: Tourism and National Identity, 1880–1940* (Washington: Smithsonian Institution Press, 2001), chapter 3.
10. Quote attributed to Richard B. Watrous, secretary of the American Civic Association, included in Dwight T. Pitcaithley, "A Dignified Exploitation: The Growth of Tourism in the National Parks," in *Seeing and Being Seen: Tourism in the American West*, edited by David M. Wrobel and Patrick T. Long (Lawrence: University Press of Kansas, 2001), 302.
11. Demars, *The Tourist in Yosemite*, 82–83, 101–102.
12. Andrew Kirk and Lincoln Bramwell, *The Yosemite Way: An Administrative History of Yosemite National Park* (draft under review by the National Park Service, 2007), 150–153, 191–192, 385.
13. Paul Sutter, *Driven Wild: How the Fight Against Automobiles Launched the Modern Wilderness Movement* (Seattle: University of Washington Press, 2002).
14. Quoted in Michael Cohen, *History of the Sierra Club, 1892–1970* (San Francisco: Sierra Club Books, 1988), 65.
15. Richard West Sellars, *Preserving Nature in the National Parks: A History* (New Haven: Yale University Press, 1997), 173.
16. Quoted in Ronald A. Foresta, *America's National Parks and their Keepers* (Washington, DC: Resources for the Future, 1984), 52–57.
17. Ethan Carr, *Mission 66: Modernism and the National Park Dilemma* (Amherst: University of Massachusetts Press, 2001), 257–260.

18. Ibid., 260–265; Cohen, *History of the Sierra Club*, 134–142.
19. Carr, *Mission 66*, 262.
20. Louter, *Windshield Wilderness*, chapter 4.
21. Edward Abbey, *Desert Solitaire: A Season in the Wilderness* (1968; reprint, New York: Touchstone, 1990), 49.
22. For this minority argument see especially Joseph Sax, *Mountains without Handrails: Reflections on the National Parks* (Ann Arbor: University of Michigan Press, 1980), 2. For Sax, the question facing Congress, the Park Service, and the American people was, "Should the national parks basically be treated as recreational commodities, responding to the demands for development and urban comforts that visitors conventionally bring to them; or should they be reserved as temples of nature worship, admitting only the faithful?" He identified public education as the key to more widespread acceptance of the latter view.
23. Demars, *The Tourist in Yosemite*, 1.
24. Alfred Runte, *Yosemite: The Embattled Wilderness* (Lincoln: University of Nebraska Press, 1990), 202–204.
25. Kirk and Bramwell, *The Yosemite Way*, 321, 350, 352–355; Michael Frome, *Regreening the National Parks* (Tucson: University of Arizona Press, 1992), 192; William R. Lowry, *Repairing Paradise: The Restoration of Nature in America's National Parks* (Washington, DC: Brookings Institution Press, 2009), 70–71.
26. Kirk and Bramwell, *The Yosemite Way*, 386–393.
27. Ibid., 389–390.
28. Lowry, *Repairing Paradise*, 80.
29. Ibid., 77.
30. Kirk and Bramwell, *The Yosemite Way*, 393–394.
31. David R. Brower, "Brower on the Yosemite Valley Plan," *San Francisco Chronicle*, 20 November 2000.
32. Dave D. White, "An Interpretive Study of Yosemite National Park Visitors' Perspectives toward Alternative Transportation in Yosemite Valley," *Environmental Management* 39:50 (2007): 50–62.
33. These lawsuits are described in detail in John Cathcart-Rake, "The Friends of Yosemite Valley Saga: The Challenges of Addressing the Merced River's User Capacities," *Environmental Law* 39:3 (2009): 833–866.
34. I would like to give special thanks to David Louter for his support and assistance in writing this article.

Christopher E. Johnson, National Park Service, Pacific West Regional Office, 909 First Avenue, Seattle, WA 98104; christopher_e_johnson@nps.gov

Developing Landscape Plant Selection Lists for the Presidio of San Francisco

Mark Frey

The problem

The Presidio of San Francisco is an urban national park with significant natural and cultural resources. Over the last 15 years both natural and cultural landscapes on the Presidio have undergone extensive restoration. Restoring cultural landscapes often involves planting nonnative plants. How can the Presidio protect both its cultural and natural landscapes during this process? By developing lists of approved and prohibited plants.

The Presidio

The Presidio is home to a dozen distinct plant communities, made up of more than 300 species of native plants (Frey and Stevenson 2010). The plants of the Presidio include nineteen plant species identified as rare by the California Native Plant Society, five of which are on the federal list of threatened and endangered species. Because of its historic significance, the Presidio was designated a National Historic Landmark District in 1962 (National Park Service and Presidio Trust 2001). The Presidio was included within the legislative boundary of the newly formed Golden Gate National Recreation Area in 1972. In 1996, Congress created a new federal agency, the Presidio Trust, to manage the interior 80% of the Presidio. The Presidio Trust's mission is to preserve and enhance the natural, cultural, scenic, and recreational resources of the Presidio for public use in perpetuity, while achieving long-term financial sustainability. The Presidio Trust and the National Park Service work together, supported by the Golden Gate National Parks Conservancy, to manage the 1,500 acres of the Presidio. The Vegetation Management Plan (National Park Service and Presidio Trust 2001) and the Presidio Trust Management Plan (Presidio Trust 2002) are two of the key documents that guide work in the Presidio.

Rehabilitating cultural landscapes

Rehabilitating cultural landscapes requires an analysis of current conditions, historic photos, historic aerial images, and an understanding of historic cultural norms to identify what exists at the site and what was there historically. Period photos can be particularly useful to help determine the complexity and extent of the historic plantings. Trees and any unique or old specimen plants that may date from the period of significance are often retained. However,

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additional plants are usually required to rehabilitate the look and feel of the landscape. If possible, species used historically are used during rehabilitation. However, certain factors can lead to species being substituted for; the historic species may be (1) not identifiable, (2) hard to maintain, (3) pose a genetic contamination risk, or (4) be invasive. In these cases, a species that has similar form may be chosen as a substitute. Many of the Presidio's landscapes were created over time without specific planting plans so the Presidio has some latitude to select plants that fit our modern-day restrictions and then arrange them in a manner that is both within the guidelines of rehabilitation and consistent with any restrictions and desires for the site.

Landscape plant selection lists

Weed risk assessments have been used to evaluate plants proposed for use for at least 25 years (e.g., Forcella et al. 1986). These assessments evaluate traits of the potential invader (Goudet and Keddy 1988), characteristics of the recipient habitat, climate matching (Thuiller et al. 2005), and information on whether the species has been recorded elsewhere as a weed (Westbrooks 1981; Rejmánek 2000; Thuiller et al. 2005; Richardson and Thuiller 2007). Inclusion of all of these factors helps to accurately predict invasiveness, but the factor that is most predictive is whether or not the species is invasive in another region (Mack 1996; Reichard and Hamilton 1997; Kolar and Lodge 2001; Gordon et al. 2008). If the region where the species is already invasive has a climate similar to the recipient region , the risk of invasion increases (Thuiller et al. 2005).

Our goal was not only to evaluate a species for invasiveness but also to evaluate a host of other factors including potential to cross-pollinate with native and non-native plants, maintenance, and historic compatibility. These other factors were added to invasiveness for evaluation. In addition, we adopted a simplified approach assessing whether the species is invasive elsewhere and whether the species is invasive in particular regions (Mediterranean climates, coastal California, Bay Area, and San Francisco) as a proxy for a more complete weed risk assessment.

Making Version One: List creation

After the Presidio became a park, the rehabilitation of designed landscapes came under new scrutiny. Natural resources staff were sometimes faced with the challenge of seeing new plantings go in, or being asked about a plant, and not having a clear policy that would allow for the prohibition of unwanted plants.

The need for a systematic approach led to the creation of a set of landscape plant selection lists in January 1999 as part of the creation of the Vegetation Management Plan (National Park Service and Presidio Trust 2001). The three lists contained 256 taxa.

The plant lists were intended to provide plant selection guidance only; any planting design used the Presidio lists only as a starting point. Plant choices were then assessed as part of project review by a team including planning, natural resources, integrated pest management, and maintenance staff.

Plant List 1 contained plants that could be used without conditions: they met sustainability goals, did not pose a threat to native plant resources, and maintained the character of

the Presidio's historic landscapes.

Plant List 2 contained plants that could be considered for use under certain conditions. Proponents were encouraged to avoid the use of any plant species that might escape into natural areas, historic forest, or other landscaped areas. The condition usually referred to how far away from the Native Plant Community Zone (NPCZ) the species could be planted, but other restrictions could be applied. Some examples include:

- Do not plant within 300 feet of the NPCZ.
- Limited to historic neighborhoods and do not plant within 100 feet of the NPCZ.
- Limited to historic neighborhoods and do not plant within 50 feet of the NPCZ.
- Surround by at least 15 feet of lawn or a hard barrier (e.g., sidewalk).
- Only to be used in turf and must be mown to prohibit seed set.
- Only sterile variety is allowed.
- Grown at Presidio Native Plant Nursery.[1]

Plant List 3 contained plants that were prohibited from use. This list contained:

- Horticultural species that are difficult to confine to formal landscape areas, become aggressive competitors, and/or are difficult to eradicate once established in natural areas;
- Species that, for pest management reasons, are inappropriate inside the Presidio (e.g., those which attract aphids); and
- Horticultural species, including commercially available "California Native" species, that have the potential to cross-pollinate or hybridize with Presidio-native plants.

The 1999 lists served their function well, but as the number and scale of designed landscape rehabilitation projects accelerated, additional plants were requested. The 1999 lists had not made any provisions for reviewing new species, so the evaluation differed by species over time. And, because new information on species became available over time, some species need to be shifted to a different list—but there was no process for that either. Each year new species are introduced into the landscape trade. A list that doesn't change means that these new species are not available. It became clear that the system needed to be updated.

Making Version Two

Once we determined that we were going to update the lists we made a comprehensive list of plants to be evaluated and identified experts who could help us.

In May 2010 we compiled a list of 446 taxa for review. The list included most of the 256 taxa on the 1999 lists, excluded a few taxa that are invasive and not likely to be requested (e.g., *Rubus discolor*), included only a few natives (or potential natives) that are routinely used in the landscape trade in the Bay Area (e.g., *Prunus ilicifolia*), added all species that had been proposed since the original list had been published, and added any species that Presidio Trust staff identified that might be useful in creating designed landscapes in the future.

We identified Marcel Rejmánek, Barrie Coate, and Frank Almeda as professionals whose input could assist our process. Rejmánek is a professor at the University of California–Davis who has published widely on predicting and quantifying the risk of invasions by plants. Coate owns a business in the Bay Area, Barrie D Coate & Associates, and has been practicing horticultural analysis for decades. Frank Almeda is chairman and senior curator of botany at the California Academy of Sciences. He has published widely on the taxonomy of various tropical plant groups, plant biodiversity, biogeography, and evolution, and is a co-author of the Marin County Flora (Howell et al. 2007).

We asked Rejmánek and Coate to review the list of the 446 taxa, note invasiveness risk as they perceived it, and make comments about suitability in the Presidio landscape. We asked Almeda to identify genera for which we should be concerned about cross-pollination. Once Almeda determined that there was only a very small possibility of intergeneric crosses for any of the species in the Presidio, we asked him to review all the genera that include both a native plant found inside the Presidio and a non-native plant on the landscape plant selection lists. He reviewed 49 genera and identified ten that would likely pose a risk (Table 1).

After compiling our expert input on the 446 taxa, we were able to assign each to one of our three lists.

Moving beyond Version Two: Reviewing species

After building Version Two, we developed a process for reviewing new proposed species (and periodically evaluating species already on the list). First, we identified characteristics of each list to which a plant might get assigned (Table 2) and built a matrix (Figure 1) to help assign plants to lists. List 2 was broken down into sublists to keep the total number of lists to three while keeping the conditions diverse enough to capture restrictions that might be imposed. Second, we creating a questionnaire for proponents of plant species. The questionnaire functions to collect information relevant to the listing process. See Figure 2 for the most recent version.

From May 2010 through August 2011, 16 new plant taxa were reviewed for the first time, and 23 taxa already on a list were reviewed again. Of the 16 new species, eight have been added to List 1, four to List 2, and four to List 3. Of the species that were already on a list that were reviewed again, six remained on their respective lists; four were moved from List 1 to List 2, five from List 1 to List 3, one from List 2 to List 1, and six from List 3 to List 2; and one was left on List 2 but had its condition changed.

Table 1. Genera reviewed to determine risk of cross-pollination with native species.

Low risk		High risk
Acer	Galium	Arctostaphylos
Aesculus	Lasthenia	Ceanothus
Allium	Lathyrus	Fragaria
Alnus	Lonicera	Iris
Arbutus	Mahonia	Lotus
Aristolochia	Mimulus	Salix
Asarum	Nassella	Quercus
Bromus	Poa	Ranunculus
Carex	Prunus	Rosa
Clarkia	Rubus	Rumex
Cornus	Sambucus	
Cyperus	Satureja	
Daucus	Silene	
Dichelostemma	Solanum	
Dichondra	Solidago	
Equisetum	Vaccinium	
Erigeron	Vicia	
Euphorbia	Viola	
Festuca	Vulpia	
Fraxinus		

List	Title	Definition	Condition
1	Approved plants	Low invasive risk, no hybridization risk, supports the historic character of the landscape, and does not require excessive maintenance once established.	Allowed without condition
2A	Historic and moderate invasion risk and spreads by seed	Historic Presidio species, excluding species with high invasive potential and most genera that are hybridization risks with natives, except Rosa sp.	Limited to historic neighborhoods and do not plant within 100 feet of the NPCZ
2B	Historic and moderate invasion risk and not known to spread by seed		Limited to historic neighborhoods and do not plant within 50 feet of the NPCZ
2C	Moderate invasion risk and only known to spread vegetatively	Moderate invasive not known to spread by seed, or historic Presidio species that are not known to spread by seed and are not invasive in the Bay Area or coastal California but are invasive in other relevant climates.	Surround by at least 15 feet of lawn or a hard barrier (e.g. sidewalk)
2D	Moderate invasion risk and spreads by seed	Moderate invasive known to spread by seed, or historic Presidio species that are known to spread by seed and are not invasive in the Bay Area or coastal California but are invasive in other relevant climates.	Do not plant within 300 feet of the NPCZ
2E	Presidio native or presumed Presidio native	Select natives likely to be requested.	Grown at Presidio Native Plant Nursery. Requests due July 1st 18 months before planting.
2F	Insufficient information	Insufficient information or conflicting information to assign to either low or moderate risk. Treated as moderate risk. Not historic.	Do not plant within 300 feet of the NPCZ
2G	Turf	Turf species	Only to be used in turf and must be mown to prohibt seed set
3	Restricted plants	High invasion potential - Invasive in Bay Area, coastal California, or other relevant climates. Or, important vector for SOD.	Not allowed

Table 2. List definitions.

Definitions

Invasive - Difficult to confine and difficult to eradicate

Relevant climates - Mediterranean Europe, Australia, Southern South America, South Africa

Non-relevant climates - all other climates

Historic - documented as being present for more than 50 years

	Invasiveness				Genetics
	High potential - Invasive in Bay Area, coastal California, or other relevant climates	High potential - Invasive in other relevant climates but not in Bay Area or coastal CA	Moderate potential - Invasive only in non-relevant climates	Low potential - Not known to be invasive	Potential to cross-pollinate with natives
Historic @ Presidio (spreads vegetatively)	3	2C	2B	1	2A/3*
Historic @ Presidio (spreads by seed)	3	2D	2A	1	2B/3*
Non-historic (spreads vegetatively)	3	3	2C	1	3
Non-historic (spreads by seed)	3	3	2D	1	3
Native	2E	2E	2E	2E	2E

* Requires case by case review to assign to either category

Figure 1. Matrix used to assign plants to lists.

PLANT QUESTIONAIRE

Latin name	Common name
Is this species already listed?	List 1 / List 2 / List 3 / Not yet listed
Note any latin synonyms:	
Evaluator	Date

Determination: To be completed by Presidio Trust

A	Use	Y	N
A1	Was species planted historically (more than 50 years ago) at the Presidio?		
A2	Has species been used subsequent to historic period of significance but maintains the character of the designed landscapes found at the Presidio?		
A3	Was species planted historically (more than 50 years ago) in the SF Bay Area?		
A4	Was species planted historically (more than 50 years ago) in California?		
	Check 1950s or 60s Sunset Western Garden or 1950s or 60s Manual of Cultivated Plants by L. H. Bailey.		
A5	Is species low maintenance, long-lived, or drought tolerant once established?		
A6	Is species commonly subject to pests or diseases?		
A7	Is species native or potentially native to San Francisco?		
B	**Genetics**		
	Does species pose a threat because of potential cross-pollination to:		
B1	Native plant species?		
B2	Horticultural plant species?		
C	**Invasiveness**		
C1	Does species spread vegetatively?		
C2	Does species spread by seed?		
C3	Is species documented as invasive anywhere? See www.hear.org/GCW		
C4	Is species documented as invasive in other Mediterranean climates?		
	Mediterranean Europe, Australia, Central Chile, Southern South America, or South Africa		
	www.hear.org/GCW		
C5	Is species documented as invasive in the US? In which states (or regions)?		
	http://plants.usda.gov/java/		
C6	Is species documented as invasive in Bay Area or coastal California?		
	http://science.nature.nps.gov/im/units/sfan/vital_signs/Invasives/atlas/2010Priority%20Lists_GOGA.pdf		
	http://www.cal-ipc.org/ip/inventory/weedlist.php?region=CW		
C7	Does species occur in the Bay Area? If so, report counties.		
	www.calflora.org		
C8	Is species known to spread in horticultural practice in Bay Area?		

Notes / Report of findings

Figure 2. May 2011 questionnaire.

Each time a list is updated, a PDF is created and posted on a shared network drive. That new document joins the most up-to-date questionnaire and a text description. Presidio Trust staff that are managing projects have access to this file and share it with any consultants they work with.

Conclusions

There is inherent tension between being true to historic landscape species and filtering that list for concerns about invasive species, maintenance, and cross-pollination risk. However, the transparent process and questionnaire described above (1) empowers a project proponent to identify potential new species, (2) makes the process of adding new species clear, (3) almost doubled the number of reviewed species (Table 3), and (4) has established transparent criteria for species assessment.

Using only the characteristic of whether a species is invasive elsewhere to evaluate invasiveness has the benefit of speeding up the review process but increases the risk of allowing invasive species and of excluding non-invasive species.

All 446 taxa reviewed by the experts have not yet gone through the questionnaire process, so they have received a different level of scrutiny than the species being reviewed using the questionnaire. A questionnaire should be developed for all species and periodically reviewed.

Occasional problems crop up when dealing with plant synonyms. If the species is reviewed under one name and reviewed again under a different name, there is a risk that the result of evaluation will not be the same. This is particularly true if one species was reviewed as part of the long list and a synonym is reviewed with a questionnaire. A database would help with this problem.

The compiled information should be transferred to a new web-accessible database. In an online database links can be checked more easily by a project proponent and any information relevant to the species can be stored along with the questionnaire.

This process can be a model for other parks and municipalities considering plants for use in the designed landscape. All landscapes include natural and cultural resources, and all landscapes are at risk from invasive species.

Acknowledgments

The Presidio Trust allowed me time to summarize this work and remains committed to protecting the natural and cultural landscapes of the Presidio. Marcel Rejmánek, Barrie Coate, and Frank Almeda have encyclopedic knowledge of the world's flora and were generous in dispensing it for the good of this project. Michael Boland has been dedicated to the Presidio for more than a decade and was essential in getting the lists to Version Two. Michael Lamb is a vigilant steward of the Presidio's landscape and was a partner in building these lists.

Table 3. Taxa on each list for Version 1 (1999), Version 2 (2010), and after one year of Version 2 (as of 22 August 2011).

	List			
	1	2	3	Total
1999	137	26	93	256
2010	139	167	140	446
8/22/2011	139	180	143	462

Endnote

1. The Presidio's own native plant nursery collects seed by watershed to be grown for projects in the Presidio. To protect genetic diversity, our protocols call for collecting no more than 5% of available seed, collecting throughout the growing season, and collecting from as many individuals as possible. Under some circumstances propagules from outside the Presidio are used. In these cases it must be determined that (1) there are insufficient propagules inside the Presidio to maintain a viable population, (2) a suitable collection site exists, and (3) a suitable planting site exists.

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Mark Frey, National Park Service, 4598 MacArthur Boulevard NW, Washington, DC 20007; Mark_Frey@nps.gov

The Effects of Ecotourism on Women's Traditional Activities in Gateway Communities Bordering Fray Jorge National Park, Chile

Susan Qashu

Introduction

In the semiarid Limarí province of northern Chile's Coquimbo region, households not only sustain themselves through farming, but also rely on fishing, mining, and animal husbandry. This region experiences yearly droughts, resulting in decreasing water supply, diminishing crops, and desertification—all factors that potentially affect households. The people of these agrarian communities, until now completely dependent upon traditional rural practices, will soon be forced to cope with a major change to their livelihoods: the advent of ecotourism.

The Corporación Nacional Forestal (CONAF), the Chilean national park service, decided to move the entrance road to Fray Jorge National Park (FJNP), rerouting it from its isolated location to one that passes through three agricultural communities, though there were two additional communities who wanted to be included in the road's relocation. One result will be that various ecotourism activities that take place outside of the park's boundaries will be shifted into these rural communities' backyards. This inspired me to ask: How will FJNP's management decisions affect livelihood practices, specifically women's household roles, in the affected communities? In cooperation with the park service and a local university, I worked with Chilean colleagues to facilitate meetings with five communities along FJNP's northern and southern boundaries, using various methods to study the issue, including participant observations, individual interviews, and focus groups. We used these mixed methods to assess future tourism development and the need for community training.

The yearly environmental stresses mentioned above prompted Chile to adopt UN policies that aim to combat desertification through empowering women and integrating them into the labor market, which should alleviate household poverty. From the 1970s to the 1990s, Chilean women's groups, including the National Women's Service (SERNAM), were promoting their issues onto Chile's political agenda. Currently, one function of SERNAM is to collaborate with local government agencies to encourage women to develop small busi-

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nesses, such as tourism, in their poor rural communities. With this in mind, the new policies concerning ecotourism have important implications for women's household decisions in the Coquimbo region. As an interview with a regional tourism director described, such projects directed at women provide a higher standard of living for rural people in the Coquimbo region.

The jewel of the Coquimbo Region

Limarí, a semi-arid province in the Coquimbo region, is bounded to the east by the Cordillera de los Andes (Andes Mountains) and to the west by the Cordillera de la Costa (Coast Range) and receives 72 mm of precipitation annually. The topography is dominated by alternating valleys and ridges trending east–west. Level land is found on marine and fluvial terraces; alluvial plains stretch from Ovalle, Limarí's provincial capital, to the marine terraces (Bahre 1979).

The jewel of the Coquimbo region, Fray Jorge National Park, lies 80 km west of Ovalle and 100 km south of La Serena, the regional capital. Founded in 1941, it protects 9,959 ha and in 1977 the United Nations Educational, Scientific, and Cultural Organization (UNESCO) designated it as a biosphere reserve for its diverse ecological landscape. The park includes four ecosystems: Valdivian temperate cloud forest, surrounded by coastal Mediterranean scrub, bordered on the south by the Limarí River's riparian zone, and limited to the west by an intertidal zone facing the Pacific Ocean. FJNP's coastal semi-arid desert landscape emerges at sea level and receives 113 mm average annual rainfall. The relic temperate forest at the nucleus of the park is located at 600 m elevation and receives 1,000 to 1,500 mm of moisture annually, due to the *camanchaca*, or coastal fog (Campodonico 1997: 65).

In addition to its unique biological features, the area where FJNP is today was once home to indigenous people and later to settlers of European descent. This has led to a unique situation of conflicting claims of land ownership based on the following synthesized summary of 200 years of agrarian land reform. Before the land reform, there existed *comunidades*, which held land in communal ownership. Bahre (1979: 3) describes these comunidades (small-scale agricultural communities) as the following: "A property holding that includes both private and communal land." The comunidad is a system of land tenure that originated in the early colonial period. It has its own legal status and is frequently encountered in the Coquimbo region. Until the advent of land reform, a small number of (largely absentee) owners of *fundos* or *haciendas* (land holdings) controlled the majority of Limarí's productive lands.

Changes in Chilean land tenure from 1965 to 1975 brought about small-scale property ownership (Dubroeucq and Livenais 2003: 193). Land reform has allowed comunidad members to exercise more legal control and management over their communal land. Comunidad members inherit the use of portions of communal land and often sell it as private property by a group vote, generally selling off small plots of land for a house or fields, small- or large-scale agriculture, or small- or sometimes large-scale tourism. Many community members claim to know their genealogy and can trace their ancestral rights to land on the comunidad to the 1620s (Bahre 1979: 3). Today, this region has the largest remnant of these

historic agricultural comunidades, contributing to conflicts between the legal property owners to whom the comunidades sold their land, who are often absent from their newly acquired estates, with those who, by virtue of continued residence on the land, perceive themselves to still hold ancestral ownership ties to it, despite having sold it. The five gateway communities explored in this study, Valdivia de Punilla (Valdivia), Lorenzo Peralta de Punilla (Lorenzo), Peral Ojo de Agua (Peral), Limarí, and Sauce, are examples of the conflict between legal property owners who purchased the land from the comunidades following the land reform and those with ancestral ties who do not recognize that their communal land was sold.

My experience with many of these communities began as a Peace Corps volunteer stationed at FJNP from 1993 to 1996. I returned to the area in 2005 for my pre-dissertation research to observe the changes in these resource-dependent communities caused by their neighboring protected area. In the 1990s, CONAF began encouraging gateway communities nationwide to develop a change to their traditional livelihoods: ecotourism.

Based on the UN's Agenda 21 and subsequent UNESCO biosphere reserve meetings on the importance of integrating local communities into park management strategies, CONAF began a participatory process throughout Chile in 1994 (UNESCO 1996, 3; Rao and Geisler 2001: 23). In the five communities I visited, this process began ten years later. In 2005, 2008, and 2011, I interviewed several CONAF directors and learned that integrating resource-dependent communities and women into the conservation and use of FJNP is challenging. The process is burdened by diminishing budgets and larger-scale political transformations, including changes in property and water rights and in leadership in communities, provinces, and regional governments.

In 2005, CONAF decided to move the entrance of FJNP, rerouting it from its isolated location to one that passes through three of the five gateway communities. At the same time, CONAF began a pilot ecotourism project with Peral, Valdivia, and Lorenzo (CONAF N.d.: 6). CONAF, with Chile's Department of Transportation, rehabilitated the existing road, which had been constructed in 1940. The road winds from the Pan American highway 8 km west to Punilla; then it passes by Lorenzo, 1.3 km farther to the west; finally, after climbing southwest through the coastal range for 9.3 km, it reaches Peral. Once the existing road was repaired, CONAF constructed a 10-km road south of Peral to the new park entrance. CONAF's objectives for this project were to: (1) better its relations with its park neighbors and (2) provide them with alternative income-generating opportunities. The Minesterio de Obras Públicas (Ministry of Public Works) will eventually connect this road to a new coastal highway, called the *Borde Costera*, which will extend from the Coquimbo region's northernmost limit to its southern border. This massive coastal highway construction promises to bring large-scale tourism development to the province. Many of the institutions working in the province are seeking ways of converting large-scale tourism practices to an alternative, rural tourism.

Posing the question

In 2003 and 2004, CONAF worked with local, provincial, and regional stakeholders to foster the involvement of surrounding communities along and within the park, an example of

which was a project to build a network of trails connecting the communities. In addition, CONAF conducted a series of surveys. The ostensible reason for conducting these surveys was to collect data on households that would potentially be involved in new ecotourism ventures made possible by the rerouting of the road and entrance to the park. Of a 90-household socioeconomic survey, CONAF selected 44 for a further study to determine whether small-scale tourism would be an effective alternative to traditional livelihoods. CONAF gave preference to the households closest to the road, with reliable access to food and water, and home construction sturdy enough to host tourists safely. Fourteen were in Peral, 11 in Lorenzo, and 19 in Valdivia. Of those 44, CONAF chose a subset of 11 households for FJNP's ecotourism pilot project. Of these households, in Punilla, three were headed by women and one by a man; in Lorenzo, three by women and one by a man; and in Peral, three by women. The project was a collaboration between CONAF, who commissioned the project and included me as an observer and analyst, and a local university, which conducted the fieldwork.

The question driving the 11-household pilot project was: How would FJNP's decision to move the road and park entrance affect household livelihood strategies in the three agrarian communities, both within their own communities and inside the park? To answer this question, the team aimed to uncover past, present, and likely future provincial livelihoods and to investigate the relationships among gateway communities outside the park and park management inside the park, and their interactions across the park boundary. The team used a mixture of techniques, including observation, interviews, and focus groups, to discover if the neighboring households would shift their traditional livelihoods to tourism. CONAF suggested that tourism in this area consist of handicraft and goat cheese production and sales, and campground maintenance and management. Because men were the principle pastoralists and farmers before the relocation of the park entrance, while women ran the household, I hypothesized that men would retain traditional livelihood strategies and women would embrace new, tourism-focused activities made possible by the new entrance.

Community field visits

We interviewed the 11 households in July 2005. The interviewees had diverse responses. We learned of issues that affected the households: discontent about CONAF's initial selection criteria, lack of training in the new tourism practices and emergency response, and lagging tourism-focused infrastructure development around the park. When selecting households for the project, CONAF excluded many of the economically disadvantaged families who might benefit from inclusion, though some of those households have alternative means of participating in tourism. One household head stated, "Just because the road does not pass by my garden does not mean that I cannot sell vegetables to the tourists as well." When I observed CONAF employees in the field while they delivered wooden posts and nursery netting to the families involved in the project, they frequently spoke of the jealousies within the communities. They discussed how the community of Punilla, which lies to the north of Peral, Lorenzo, and Valdivia, feels excluded from the project.

Many households voiced concerns about a lack of training and its effects on their business practices. Three households expressed fear of not receiving the correct amount of money. One interviewee explained: "We are in dire need of further training and elementary

education: basic arithmetic, map reading, first aid, and tourism guiding." Several households reported that they did not know how to operate small-scale tourism businesses or interact with visitors, and those households that had been given some training felt it was insufficient and without follow-up. One Limarí leader described how CONAF promised a training program geared towards developing small business projects, such as selling fish and collecting seaweed with the tourists, but that program never happened. Some women explained that the only way to receive training and physical infrastructure development, such as materials for new tourism ventures, was to seek it from other institutions, such as SERNAM.

Others expressed the need for CONAF to train them on how to respond to emergencies such as fire. Because of persistent drought and and the attendant extreme risk of fire, the process of moving the park entrance included a decision to relocate the campgrounds from within the park to the gateway communities. Families who were chosen to host the new tourist campgrounds had neither training in emergency response nor access to water. One participant told us, "We have picnic tables, camping spots, but no running water. What do we do if our guests create a fire? I guess my *morrones* [bell peppers] will be roasted! We need fire training and basic infrastructure such as hygienic facilities and running water." Without water or emergency training, the families feared that the campgrounds and their property would not be safe. Local leaders also expressed concern about the lack of first aid training, since the communities are isolated from medical services.

In all communities, there was a general concern about how they could support a new tourist population with existing water supplies, which were already scarce. Peral has a communal well, though the water level is dropping annually and the well is shared with nearby Sauce. In the other communities, there are no communal wells, though some owners do have private wells. Registration of wells and water rights, however, are often changing and even a family in the tourism project with a private well can lose access it if they have not kept up with fluctuating water rights policies. Families without access to wells depend on municipal water deliveries trucked in weekly. The supply is inconsistent, however, with two months sometimes passing between water deliveries. In addition, the municipality fills plastic containers along the roadway but many households have no way to transport the containers to their property. In Limarí, they are sometimes forced to collect brackish water from the river along the park's southern boundary.

CONAF and collaborating government institutions promised new tourism infrastructure, road development, and water access by December 2004. My visits revealed that CONAF has made some progress, but specific tourism infrastructure and water access is still not complete. Although the new park entrance, fee booth, and visitor center were built in 2007, coastal highway construction has not begun. One unclear sign has been placed by the Department of Transportation near the Pan American highway exit, but no other signage is visible. Due to lack of official signage, local residents have made some of their own after enduring frustrated and lost visitors. Today, community members complain that the government institutions have still not provided tourism training or infrastructure development.

Conclusion

When the team finished their final community visits, there was a general impression concern-

ing the region's seemingly inevitable mass tourism development. While CONAF asserted in its environmental impact statement that the only changes in the area would be positive ones, many households doubt CONAF's long-term commitment to the project. One of the women's leaders in Punilla expressed it this way: "If I do not take the risk [referring to her new small business venture, a restaurant], then I will never cross the wild river. I cannot improve the way of life for my family, if I do not further my own training and education." Women, whether part of the project or not, showed dedication in seeking outside funding sources and means to further their own small business ventures. Comparatively, only two men, one in Lorenzo and one in Punilla, agreed to manage campgrounds. The latter also made leather horse bridles and was the only man in the project who was engaged in traditional handicrafts. Future small-scale tourism developments and initiatives appear to be driven by local women.

Not only households that CONAF chose for the gateway community pilot ecotourism project but other households have begun their own rural tourism ventures. Some women have sought out park managers and asked these officials if they could sell local food and display their handicrafts at FJNP's visitor center. Today, the gateway community tourism participants and FJNP managers claim that changing regional park politics strained the relationship between the communities and the park. CONAF claims dwindling budgets do not allow staff to interact regularly or foster continued relationships with local communities. Local women counter that CONAF has sufficient funding, though they hire many more park rangers from outside the communities rather than locals. As such, they argue that CONAF has forgotten their promise to connect and strengthen their communities ties to their local protected area.

FJNP's sustainability will depend on how well its management coordinates with local agrarian needs. A methodology directed towards tourism planning needs to be implemented whereby CONAF managers and other agencies observe, listen to, and learn from the rural coastal agrarian peoples' values through participatory appraisal techniques. Hopefully, the use of a wide range of methods will help officials understand which factors influence critical behaviors, including neglected sociocultural ones within this Chilean province. Additionally, the confused state of land ownership and property and water rights in and around FJNP's gateway communities contributes to an equally confused system of tourism development.

In the future, a cooperative tourism plan could be slowly integrated into the Limarí province. Our rapid assessment provides a glimpse of this trend, in which rural women will have a stronger leadership role and households will have more meaningful interactions with park management. Power imbalances between the households fostered by CONAF's pilot ecotourism project will make it challenging to implement cooperative values among the gateway communities and the protected area. Park management should share information concerning park operations and explain why projects do always not proceed as originally planned. This may ease tensions with the gateway communities.

Since CONAF no longer has funding to supply the 11 households, local leaders could approach other agencies to provide tourism training for all interested community members. Training could be facilitated by a non-biased consultant where workshop participants would establish an equality of voices, share power and responsibility, and respect the values of others.

This research has led to answering equity, empowerment, and gender household issues. In the communities surrounding FJNP, the majority of men continue to practice fishing, growing local produce, and animal husbandry. Some of these men, with their wives' encouragement, are learning to greet visitors, manage campgrounds, and practice otherwise lost traditional handicrafts. The majority of women are attempting to find training or seeking support to learn new small-scale tourism trades such as family management, campgrounds, lost artisan handicrafts, traditional food sales, and improving their communication with visitors.

Because the Chilean park service lacks funding, there is little effort to provide training to gateway communities. Funding focuses on operational management of the park itself. Thus, women who want training to foster tourism must go out and seek training from other institutions or find it in larger towns and cities. The necessary infrastructure for tourism projects can be maintained if households take the initiative to find government institutions that can foster training and infrastructure projects. Individual households must find a way to secure small business loans; this is challenging because many of the households are illiterate and must rely on community leaders or more educated family members living outside of their community to advocate on their behalf.

This ecotourism project could be successful in the future if given ample funding and collaboration from institutions that can supply households with long-term development. If future CONAF managers coordinate projects and collaborate with the gateway communities instead of working against them, they can create a motivated environment for the communities to be actively involved as ambassadors of the park's operations and as protectors of its biodiversity.

Acknowledgments

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Susan Qashu, 945 West Las Palmas Drive, Tucson, AZ 85704; sqashu@email.arizona.edu

LEOPOLD REDUX: REVISITING AND REINTERPRETING A SEMINAL REPORT

Editorial Introduction

As readers of the latest Centennial Essay or installment of "Letter from Woodstock" will have already seen, in this issue of *The George Wright Forum* we are beginning to mull over *Revisiting Leopold: Resource Stewardship in the National Parks.* Philip Cafaro's observations, Rolf Diamant's reflections, and Mary Ellen Hannibal's comprehensive introduction (following next) are the first of what we expect will be additional considerations in our journal of this important report, which was released this past August almost 50 years after the original Leopold Report came out in 1963.

To make *Revisiting Leopold* accessible in its original format to all GWS members and friends, we are trying something new for *The George Wright Forum:* the publication of a facsimile version. This is possible because *Revisiting Leopold* is succinct—only 23 pages long—and because its page format is very close in size to the *Forum's*. Rather than reformatting the report to our specifications, by publishing a facsimile we can make it available to anyone who wishes to circulate it in PDF format. The only changes we've made to the report's original format are two omissions: of the inside front cover page, which is blank except for a credit line (which reads "Cover: Grand Canyon National Park / Alicia Burtner. Illustrations by Rob Wood / Wood Ronsaville Harlin, Inc.")≥.; and of page 2, which is blank in the original. The rest is an exact facsimile, and includes the transmittal cover letter.

We are grateful to the National Park Foundation for a subvention to help cover the extra printing cost of including *Revisiting Leopold* in this issue. We hope you find it stimulating reading.

Dave Harmon & Rebecca Conard
Co-editors, *The George Wright Forum*

The George Wright Forum, vol. 29, no. 3, p. 379 (2012).

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America's Next Best Idea: The National Park System Looks to the Future

Mary Ellen Hannibal

For almost 50 years, the 23 pages officially titled "Wildlife Management in the National Parks," colloquially known as the "Leopold Report," has had a comprehensive and outsize influence on how America's national parks are run. As the National Park Service (NPS) looks to its 100th birthday in 2016, and acknowledging the unprecedented challenges facing our natural resources today, last year Director Jonathan Jarvis convened a committee of the NPS advisory board to update the report. *Revisiting Leopold: Resource Stewardship in the National Parks* counts among its authors a Nobel Laureate, two recipients of the Presidential Medal of Science, and two members of the National Academy of Sciences. Contributions include those from conservation luminaries like Thomas Lovejoy, and, reflecting the contingencies it grapples with, Healy Hamilton, a scientist specializing in geospatial modeling of species persistence under different climate change scenarios. Remarkably, like its predecessor *Revisiting Leopold* also comes in at 23 pages.

The Leopold of the title is Starker, son of the famed Aldo, and a revered wildlife ecologist in his own right. Starker Leopold clearly inherited both his father's deep passion for wildlife and his literary flair. The instigation for the original report was what Secretary of the Interior Stewart Udall (serving under President John F. Kennedy) called a "public relations crisis," as superabundant elk decimating places like Yellowstone were culled by hired guns; some members of the public were appalled by the killing, and others wanted to do the killing themselves. It was clear that a coherent policy around wildlife management was necessary, and Leopold's own illustrious committee set its sights on goals, policies to support them, and methods for getting things done. The historic report reads easily and much of it still makes a lot of sense. Its recommendations reflect a sophisticated ecological understanding, and include counsel that while maintaining habitat is "the key" to sustaining animals, habitat is "not a fixed or stable entity that can be set aside and preserved behind a fence, like a cliff dwelling or a petrified tree." The report acknowledges that nature is made up of "biotic communities" that change; it points out that processes such as dispersal and migration regularly bring species into and out of park boundaries—this all in a time when the term "biodiversity" had yet to be coined. "Leopold's report was dramatic at the time," says Gary Machlis, science advisor to Director Jarvis. "Not everybody liked it, and it took about 15 years for the park managers to really put their minds around it." The report references "successional" trajectories whereby natural fire and flooding regimes routinely change what grows where. It penetrates beyond the emotional charge around the seemingly destructive force of fire, which at the time was routinely suppressed, and its support for controlled burns

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was instrumental in reintroducing the practice to the parks. At the time, Machlis remarks, "general wildlife management was more about hunting and fishing and not so much about the elements of ecosystems. Leopold's report brought science to the parks, something the new report fully endorses and builds on."

Perhaps the Leopold report's most prescient and relevant observation was that "few of the world's parks are large enough to be in fact self-regulatory ecological units; rather, most are ecological islands subject to direct or indirect modification by activities and conditions in the surrounding areas." The insight here, that national parks are embedded in larger systems, is taken up with emphasis by the authors of the revised report. Today's report reprises the original's initial characterization of the national parks as flash points in a network of adjacent landscapes of influence, and strongly suggests that the national parks be conceived of as "anchors of conservation in a continuum of uses." The national parks are among the most protected land and seascapes in our nation. While the federal government owns and manages vast acreage—for example, Bureau of Land Management and Forest Service lands—these are mostly multi-use. With some exceptions, wildlife within their boundaries rarely enjoy the same level of protection as that within NPS terrain. As we go forward into a future in which nature's traditional couplings and associations become unhinged by quickly changing temperature and precipitation patterns, national parks will become ever more important as core areas where natural systems are less perturbed by human activity. Marking these parks as a network, like a central nervous system, and connected to the other natural parts of our country is a brilliant and important idea. Providing plants and animals with the ability to move across boundaries to renew their genetic viability and to fulfill their migrational and territorials needs is essential; as Healy Hamilton puts it, "connecting up the natural places is the only way to ensure their long-term viability."

Sign of the times

For all its wisdom, the original Leopold report got one thing really, really wrong. So wrong that this one sentiment justifies and even demands contemporary correction. It offers up a literal picture of what its management recommendations should result in: "As a primary goal, we would recommend that the biotic associations within each park be maintained, or where necessary recreated, as nearly as possible in the condition that prevailed when the area was first visited by the white man. A national park should represent a vignette of primitive America."

Perhaps it summarizes our moral evolution of these past fifty years to enumerate the many ways this idea of a "vignette of primitive America" is chauvinistic, naïve, colonial, even offensive. To contemporary ears, more politically incorrect language is hard to imagine. But maybe we can give Leopold and his committee something of a pass here, and say the original report was a product of its time. Some of its language is misguided but in so many other ways it gets things right. The report decries the fact that white-man impacts, such as indiscriminate logging and livestock grazing, had profoundly altered landscapes, making many into "artifacts," and it seeks to return them to what they once were.

Past perfect

The original Leopold report's endorsement of restoring a past idea of nature resulted in at

least one major ecological controversy over the years. Interpreting the report to mean significantly reducing human influence on wildlife populations, Yellowstone National Park instituted a bear management program in 1970 that directed the removal of garbage dumpsters from the vicinity of grizzlies within the park's bounds. As far back as the late 1800s, tourists regularly gathered around Yellowstone's garbage dumps to watch the bears, which, along with other top carnivores, most notably the wolf, had been almost totally exterminated outside park boundaries. Researchers John and Frank Craighead, monitoring the park's grizzlies from 1959 onward, famously counseled against abrupt removal of the dumps. The Craigheads argued that the summary loss of an accustomed food source would put the bears in direct conflict with human visitors. The dumps were closed anyway, and more than 140 grizzly deaths attributed to human causes were documented in the years in which this was carried out.

The new report takes on this sensitive dimension of Starker Leopold's legacy with a distinctly literary flair. The prologue summons the reader to gaze upon "an early summer morning in a western national park.... The scene stands as a portrait of a national park at a single moment in time." The authors then fast-forward through the retrospective lens of all that has been learned and more deeply understood since Leopold committed his report to paper. "[T]here is another window through which this scene can be viewed, one fitted with the lens of science. Monitoring stations show that the soil is warming earlier in the season.... [N]ow widespread non-native grasses ... dry into fire fuels more rapidly than in previous years.... The scene shifts from just a moment in time or 'portrait' to a moving record of a dynamic and continuously moving system. And it is one we do not yet fully understand." The new report also addresses a seismic shift in the way we currently understand what we are protecting within our national parks. Today we view our cultural resources as not separate from but intimately connected to our ecological resources. Cultural resources include archaeological sites and historic built structures such as military fortresses. The concept of bridging biodiversity and cultural values finds itself most tightly twined in resources like salmon and maple trees; a bison is both "ecologically important and culturally significant." Elements of the biotic world have tremendous cultural and historical value to people now and going back in time.

Fast forward

As the new report enumerates them, the ecological woes impacting our national parks include "widespread, complex, accelerating and volatile changes" due to "biodiversity loss, climate change, habitat fragmentation, land use change, ground water removal, invasive species, overdevelopment, and air, noise, and light pollution." But there is also good news, as Hamilton points out: "Science knows so much more now, and we have amazing tools." It has only been 25 years since conservation biology became a formal discipline, and parallel with its drill-downs on such functions of nature as predation and extinction have come mind-stretching advances in computing power and statistical models. Satellite-transmitted imagery measures what is happening to vegetation on an hourly basis; from there we can infer what birds and mammals are making use of it. We can now track nature on a continental level, and we can understand the finest points of species differentiation through molecular examination of DNA. We have new capacities for macro- and micro-scale analysis of what is going on out

there, and it can help us make rapid decisions and move quickly to manage fast change. The new report emphasizes that to make management of our natural resources possible at the rate and to the extent necessary, the national parks must be equipped with consistent decision-making tools and connected with parallel efforts at other state and federal agencies. There are significant initiatives in this direction already underway.

At the same time, our contemporary landscape is even more beset by economic pressures to develop open land and repurpose its natural resources than the purview Leopold faced. The environmental degradation Leopold referenced is still a problem, but with ever-increasing consequences. The revised report advocates the "precautionary principle" be used to guide decision-making around potential park impacts—not only within the parks but on adjacent lands. Hamilton says, "We emphasize that the 'precautionary principle' be used to guide decision-making around potential park impacts—not only within the parks but on adjacent lands. For example, we need to look at connectivity 'pinch points' on the landscape, and not destroy these before we even recognize they are there."

The cultural component

The report addresses the vast cultural and demographic shifts of the past 50 years; now each year, 279 million people visit our 398 national parks, historic sites, urban recreation areas, national monuments, wild and scenic rivers, and national trails. These visitors represent a big age range, from preschoolers to a bumper population of retirees, and likewise personify many ethnicities and nationalities. Our pluralist present makes the true nuances of our past more important. The report replaces the "primitive" ideal with a goal to support "authenticity" both on the landscape and in how cultural artifacts are interpreted.

Stephanie Toothman, associate director for cultural resources at NPS, remarks that the new report "captures a trend that has been developing in the field and the NPS for years; we need to understand the impact and effects of people's interaction with their environment, not just immediately, but long-term." Toothman addresses Leopold's "vignette" concept as, yes, "poorly conceived to restore some pre-European context," but she adds that "the act of creating parks and wilderness is a cultural construct. That makes some people uncomfortable but we have to understand how we got to where we are, and see our management as a multicultural effort."

Ergo, the revised Leopold report expressly integrates what for many have historically been separate protective imperatives, the need to sustain nature in the parks, and the need to sustain their cultural artifacts, including, for example, the remains of ancient human settlements. Where the ecological lens of the report calls out the need for comprehensive sustenance of the "functional qualities of biodiversity, evolutionary potential, and system resilience," it also calls for a deeper interpretation of our cultural resources, extending these "to include … diverse forms of cultural knowledge." An example of this kind of thinking is relevant in California's Yosemite Valley, which is currently faced with the spread of conifers and a potential reduction in black oak due to the fact that Native Americans once actively cultivated an acorn crop there and no longer do. "What we inherited," says Toothman, "is not just due to negative post-European impact, but thousands of years of favoring one species over another in the valley." Native American use of fire was an integral part of the ecosystem,

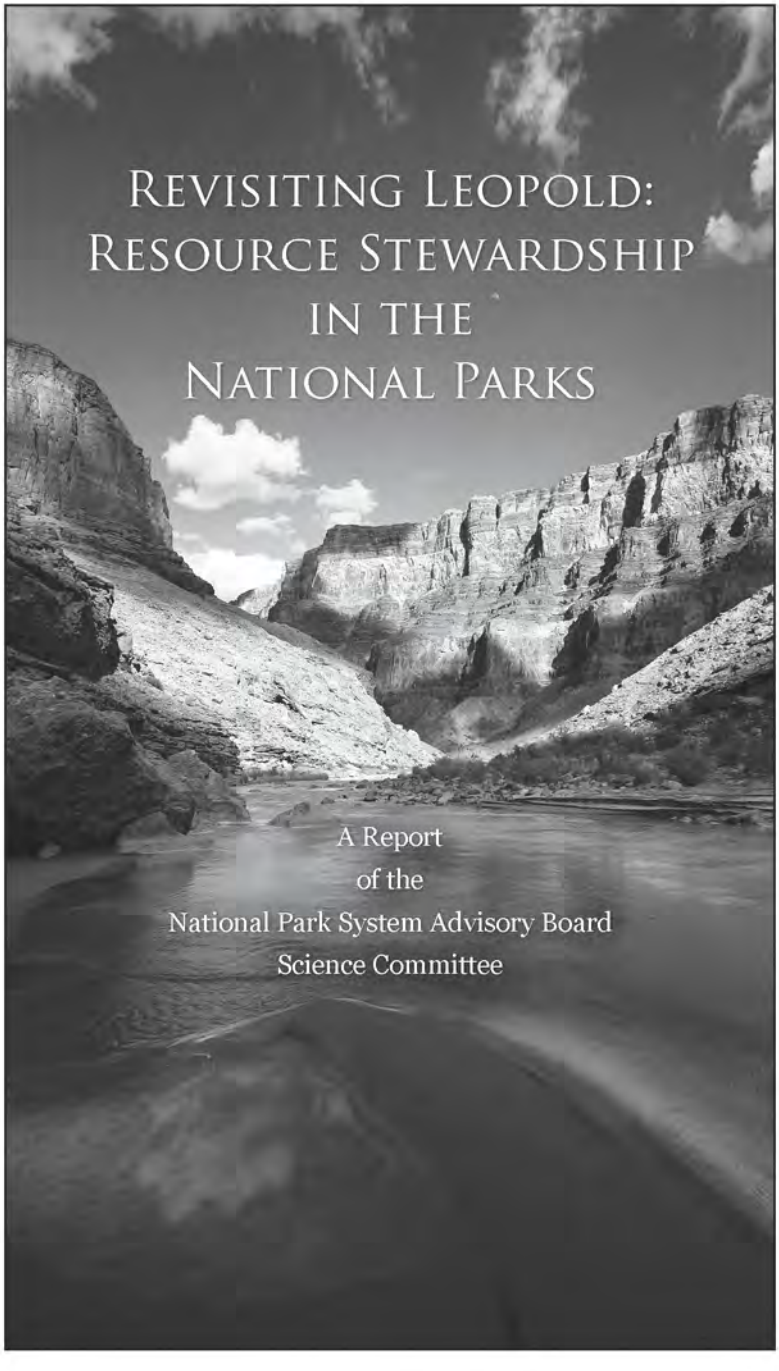
a sterling example of the inextricability of natural and cultural resources.

Climate change poses enormous challenges to our cultural as well as our natural inheritance. Marcy Rockman, climate change adaptation coordinator for cultural resources for NPS, provides an example in Fort Jefferson, in the Dry Tortugas. This is "a brick and iron fort with enormous repair issues. But how much money should we invest in it, given sea level rise" due to global warming? Yet Fort Jefferson is a great place for on-the-ground visitor interpretation. As Rockman points out, "Fort Jefferson tells the story of a mid-19th century fort and allows visitors to get a sense of the kind of isolation the builders and inhabitants" went through. The Dry Tortugas are indeed not a good place to put your brick and iron structure, but strategically, it was the only place to put it at the time. "Fort Jefferson also gives us information about how political decisions can take precedence over environmental considerations." Another dimension of the layers of learning possible in studying even disappearing resources is in coastal archaeological sites, including those subject to increasingly rapid erosion. For example, Rockman highlights the western Alaska coast, where soil "that used to be frozen hard almost all year is now the consistency of soggy bread—destroying the stratigraphy of archaeological sites." NPS is inventorying the area as fast as it can—after all, this is an internationally important place, connected to the Bering Land Bridge across which North America's first plants, animals, and people migrated. The treasures now quickly decomposing as they are exposed to air hold invaluable information about how life here began and evolved. As Rockman points out, the area illustrates "how learning to live and persist in that environment took place over thousands of years." It is no small mission for the NPS to both identify and address the impact of climate change on these resources with the intention of conserving them, while at the same time examining them for information that can help us understand our contemporary situation in a variable environment. Rockman points out that the revised report recognizes that, while our resources cannot be "effectively frozen in time," it also provides the guidance that as repositories for understanding human-environmental interactions over vast periods of time, they are "tremendous assets."

All hands on deck

One of the most progressive and useful recommendations of *Revisiting Leopold* is that the national parks enlist us Americans as "citizen scientists" in helping to monitor what's going on in the national parks. Regular people are now able to make valuable contributions to scientific research through the use of smart phone apps, and even by the use of regular old pencil and paper, providing a level of data input for which there are simply not enough PhDs around to supply otherwise. The quick-change challenges of the future above all necessitate that we keep our fingers on the pulse of what is happening with nature in order to make timely responses. Only mob-sourcing is adequate to provide this service, and it will do us citizens a great deal of good to participate. The new report references the "transformative experiences" the parks can provide; citizen science often begins with paying close attention to nature, which has a way of making people interested in understanding it, and also leads to loving nature. We want to love it before we lose it. *Revisiting Leopold* tells us how.

Mary Ellen Hannibal, 2834 Divisadero Street, San Francisco, CA 94123; meh@znet.com



Revisiting Leopold: Resource Stewardship in the National Parks

A Report
of the
National Park System Advisory Board
Science Committee

National Park System Advisory Board

Citizen advisors chartered by Congress to help the National Park Service save special places saved by the American people so that all may experience our heritage.

August 25, 2012

Director Jonathan Jarvis
National Park Service
1849 C Street NW
Washington, DC 20240

Dear Director Jarvis,

On behalf of the National Park System Advisory Board and its Science Committee, we present to you a report entitled *Revisiting Leopold: Resource Stewardship in the National Parks.*

The *Leopold Report* (officially *Wildlife Management in the National Parks*) was published in 1963. Its influence upon the philosophy, policies, and persons of the National Park Service has far exceeded that of numerous other studies, commission reports, advisory documents, and other attempts to guide and direct the NPS. Much has changed since 1963, and your charge to the present-day Science Committee to revisit the *Leopold Report* was an ambitious challenge. Specifically, you tasked the Science Committee with answering three critical questions: What should be the goals of resource management in the National Park System? What policies for resource management are necessary to achieve these goals? What actions are required to implement these policies? And while the *Leopold Report* focused on wildlife management, you charged the Science Committee with enlarging the scope of concern to include all natural and cultural resources for which the National Park Service has, as the current report notes, "an enduring responsibility."

Committee members met in several national parks and in Washington, DC. They consulted experts and familiarized

themselves with a wide range of documents, background papers, scientific studies, and other materials relevant to the task. The final report has the full endorsement of all members of the Science Committee and the NPS Advisory Board.

The report strives to provide general and conceptual answers to the questions posed to the Committee. Given the broad topic of park resources and the variety of situations facing National Park Service managers, general principles and guidance are emphasized rather than specific solutions to technical problems of resource management. The suggestions in *Revisiting Leopold* are intended to advance park stewardship during a time of unrelenting change. Committee members feel there is both opportunity and urgency in their recommendations. We hope you find this report useful, as the National Park Service approaches its 2016 Centennial year.

Sincerely,

Tony Knowles
Chair, National Park System Advisory Board

Dr. Rita Colwell
Science Committee Chair
Member, National Park System Advisory Board

Revisiting Leopold: Resource Stewardship in the National Parks

A Report
of the
National Park System Advisory Board
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August 25, 2012

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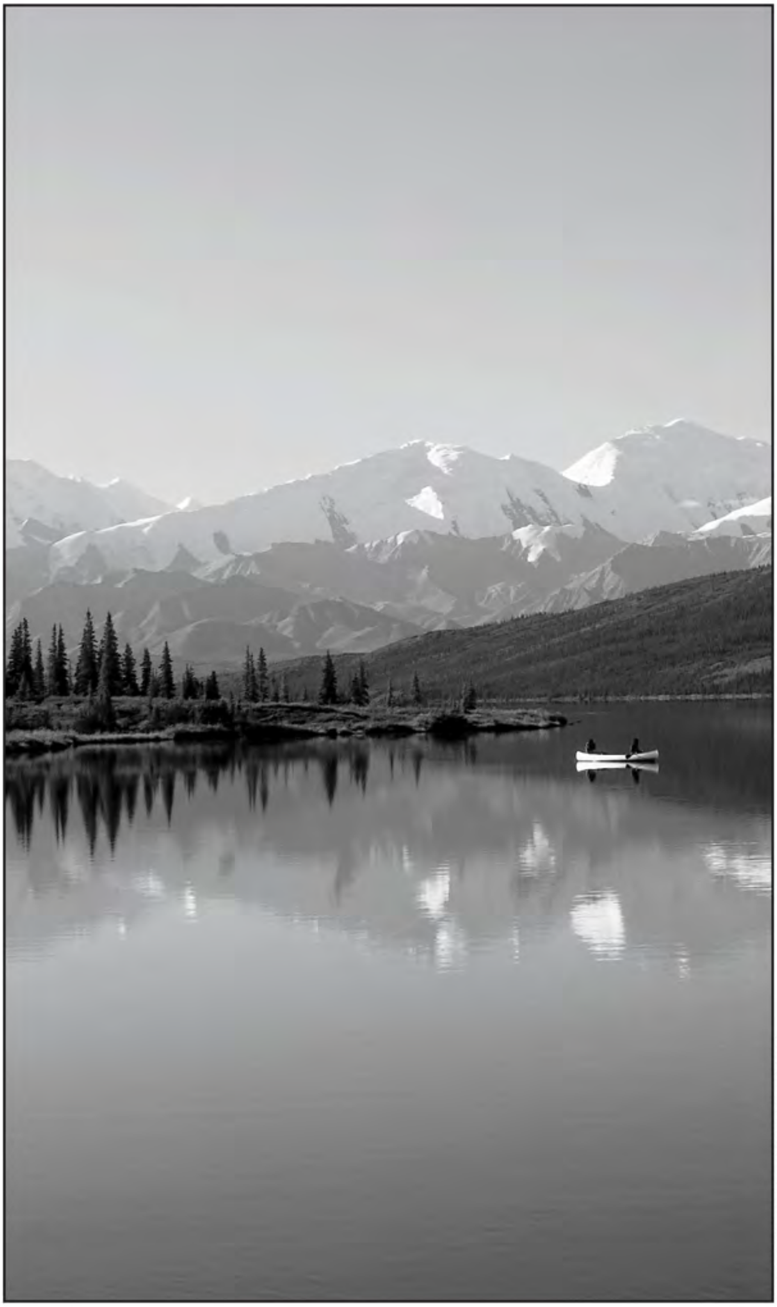


DENALI NATIONAL PARK AND PRESERVE / TREY SIMMONS

Prologue

It is an early summer morning in a western national park. A stream runs alongside a campground, cascading toward the old historic hotel. The campground is full and relatively quiet; the hotel is stirring as the staff prepares for breakfast service. Upstream, elk and deer graze on grasses, while a few early-rising visitors have stopped their cars to eagerly watch and photograph the wildlife. On the higher slopes, alpine flowers—columbine, Indian paintbrush, mountain bluebells—are in bloom, and pikas dart among them. Tent campers who had hiked up from the valley the day before are making coffee on small camp stoves. Higher above, a bighorn sheep stands alert on rock above the boundary of bare ground and the snow-covered slope. Still higher, a small glacier and its annual snowpack reflect the rising summer light. The scene stands as a portrait of a national park at a single moment in time.

But there is another window through which this scene can be viewed, one fitted with the lens of science. Monitoring stations show that the soil is warming earlier in the season. High temperatures and several years of low rainfall have caused the now widespread non-native grasses to dry into fire fuels more rapidly than in previous years. Wildlife studies document an elk herd increasing in number and exceeding estimates of what the valley can sustain. Surveys show early season visitation to the park at an all-time high due to changes in school calendars and an increased population of seniors. Educational programs on local history (based on new research) are attended by enthusiastic tourists. Field botanists have documented alpine flowers blooming days earlier than previously recorded, a trend that began over a decade ago. Ecologists note the pika population moving several hundred feet higher in elevation in response to increased summer temperatures. Glacial ice is declining, exposing new moraine. The scene shifts from just a moment in time or "portrait" to a moving record of a dynamic and continuously changing system. And it is one we do not yet fully understand.

Introduction

The national parks of the United States stand as a singular achievement of the nation. From the establishment of Yellowstone as the first national park in 1872, the National Park System has grown to include 397 national parks, historical sites, urban recreation areas, national monuments, wild and scenic rivers, and national trails, with more than 279 million visits each year. The character and importance of this precious heritage lies at the heart of the American experience, and stewardship of the national parks is an enduring responsibility shared by all Americans.

The extraordinary natural and cultural resources of the National Park System are the environmental, cultural, legal, political, and moral basis of the commitment of the American people to their national parks. The distinctive qualities and features of these resources are the ultimate source of public engagement with the National Park Service (NPS), and their protection, conservation, and restoration are essential elements of the NPS mission. This is not just the technical task of resource "management." The national parks require an ethic of stewardship that focuses on passing the parks unimpaired to future generations. As a result, *park stewardship* is a preeminent duty of the NPS.

This enduring responsibility has been examined previously. In 1963, the *Leopold Report* (officially titled *Wildlife Management in the National Parks*) was submitted to then Secretary of the Interior Stewart Udall by an advisory board of scientists chaired

by conservationist, author, and scientist A. Starker Leopold, son of ecologist Aldo Leopold. The report reviewed the management of wildlife in the national parks as practiced in the 1960s and proposed major recommendations. Since that time, the influence of the *Leopold Report*'s findings upon the philosophy, policies, and professionals of the National Park Service has proved lasting and significant.

Yet new knowledge and emerging conditions—including accelerating environmental change, a growing and more diverse population of Americans, and extraordinary advances in science—make it urgent to re-examine and if necessary revise the general principles of resource management and stewardship in the national parks as described in the *Leopold Report*. The current committee has endeavored to meet this challenge by providing the following conclusions and recommendations.

New conditions, new needs

Environmental changes confronting the National Park System are widespread, complex, accelerating, and volatile. These include biodiversity loss, climate change, habitat fragmentation, land use change, groundwater removal, invasive species, overdevelopment,

and air, noise, and light pollution. All of these changes impact park resources, from soil microbes to mountain lions and from historic objects to historic landscapes. Parks once isolated in a rural or wildland context are now surrounded by human development. Increasing pressures on public lands—from recreational use to energy development—amplify the importance of protected public lands and waters, creating challenges far more complex than in the Leopold era.

Cultural and socioeconomic changes confronting the National Park Service are difficult to overstate. These include an increasingly diversified, urbanized, and aging population, a transforming US economy, and constrained public funding for parks. The National Park System is significantly different—in scope, number of units, size, and complexity—than in the 1960s when the *Leopold Report* was released. Additions to the system include significant cultural, recreational, and urban resources. The cultural values and interests held by the American people have greatly broadened, generating pressing demands for diversity in the National Park Service and for relevancy of the National Park System to new generations of citizens.

Simultaneously, scientific understanding of natural and cultural resources has dramatically expanded, continues to grow at an accelerating pace, and is becoming more quantitative and technologically sophisticated. The conservation sciences have exponentially extended their theories, methods, and findings since the *Leopold Report* was issued (tellingly, the term "biodiversity"

had not yet been coined when Leopold's advisory board prepared its report). Systematic surveys of major organismic groups—not only for vertebrate wildlife but for plants, insects, fungi, and microbes—have expanded on both national and international fronts. Ecosystem management has matured into a science-based activity. There are new realizations of the profound risks human activities pose to oceans and the critical need to protect marine resources. Understanding of system complexity and interrelatedness has advanced along with recognition that this understanding is incomplete. The need for science—to understand how park ecosystems function, monitor impacts of change (even from afar), inform decision makers and their decisions, and enrich public appreciation of park values—has never been greater. In addition, the National Park System is an extraordinary national asset for advancing science and scholarship—from new discoveries of valuable genetic resources to monitoring benchmarks for environmental change and increasing knowledge of the impact of thousands of years of human history on the American landscape.

For all these reasons, revisiting the *Leopold Report*—which requires reexamining the core purposes of the National Park System and the stewardship responsibilities of the National Park Service—is both necessary and compelling as the NPS approaches 2016, the year of its centennial celebration.

The scope of this report

The 1963 *Leopold Report* addressed three basic questions:

1) What should be the goals of wildlife management in the national parks?
2) What general policies of management are best adapted to achieve the pre-determined goals?
3) What are some of the methods suitable for on-the-ground implementation of policies?

Leopold and his advisory board confronted the question of goals boldly and directly, recommending that "biotic associations within each park be maintained or where necessary recreated as nearly as possible in the condition that prevailed" before the arrival of Europeans on the continent. In a memorable phrase, the report declared, "A national park should present a vignette of primitive America." The authors also described implications of this goal as "not done easily nor can it be done completely." The report was adamant:

> *"Yet, if the goal cannot be fully achieved it can be approached. A reasonable illusion of primitive America could be recreated, using the utmost in skill, judgment, and ecologic sensitivity. This in our opinion should be the objective of every national park and monument."*

The current committee has responded to the charge given to it by the NPS and its National Park System Advisory Board—to revisit the *Leopold Report*—by answering three contemporary and expanded questions framed as in the original report:

1) What should be the goals of resource management in the National Park System?
2) What policies for resource management are necessary to achieve these goals?
3) What actions are required to implement these policies?

The current committee elected neither to offer an extended critique of the original *Leopold Report* nor to restrict its recommendations to the central topic that drew Leopold and his colleagues' attention—wildlife management. The committee has neither accepted all of Leopold's conclusions nor rejected them out of hand, and several of the *Leopold Report* findings remain valid and significant. These include:

- The need for the NPS to "recognize the enormous complexity of ecologic communities and the diversity of management procedures required to preserve them."
- The necessity that management "may involve active manipulation of the plant and animal communities, or protection from modification or external influences."
- The high importance of science to stewardship, such that the *Leopold Report* urged "the expansion of the research activity in the Service to prepare for future management and restoration programs."

Several key findings serve as the foundation of the current committee's recommendations. This report focuses on natural and cultural resource management for the units of the National Park System. Many if not most parks include both natural and cultural resources, and many park resources feature natural and cultural attributes—Yellowstone bison are both ecologically important and culturally significant. Parks exist as coupled natural-human systems. Natural and cultural resource management must occur simultaneously and, in general, interdependently. Such resource management when practiced holistically embodies the basis of sound park stewardship. Artificial division of the National Park System into "natural parks" and "cultural parks" is ineffective and a detriment to successful resource management.

While individual parks can be considered distinct units, they are—regardless of size—embedded in larger regional and continental landscapes influenced by adjacent land and water uses and regional cultures. Connectivity across these broader land- and seascapes is essential for system resilience over time to support animal movements, gene flow, and response to cycles of natural disturbance. Migration of aerial, terrestrial, and marine species like the wood thrush, pronghorn, and leatherback turtle routinely transcend park and even national boundaries. Resource stewardship requires land- and seascape strategies and tactics at larger regional scales. The same principle applies for cultural phenomena: scientific testing of drinking vessels from Chaco Canyon indicates the Chacoans drank chocolate beverages made with beans imported from Mesoamerica, linking Chaco

with civilizations to the south. Cultural history transcends park boundaries. Large-scale stewardship means that collaborations, partnerships, and networks are and will continue to be critical to preserve and protect resources.

In contemporary and future resource management, the functional qualities of biodiversity, evolutionary potential, and system resilience matter as much as observable features of iconic species and grand land- and seascapes. Iconic species (from wolves to whales) and grand land- and seascapes (from coral reefs to mountains) depend on the much more difficult to observe but essential characteristics and processes of healthy ecosystems, from decomposition by microorganisms to fixation and flow of nitrogen. Similarly, cultural resources extend beyond iconic buildings, historic sites, and landscapes to include indigenous values, sense of place, historical meaning, diverse forms of cultural knowledge, and the recent past.

Consequently, broad disciplinary and interdisciplinary scientific knowledge and scholarship are necessary to manage for change while confronting uncertainty. New and emerging scientific disciplines—including conservation biology, global change science, and genomics—along with new technological tools like high-resolution remote sensing can provide significant information for constructing contemporary tactics for NPS stewardship. This knowledge is essential to a National Park Service that is science-informed at all organizational levels and able to respond with

contemporary strategies for resource management and ultimately park stewardship.

In addition, the American people—including but not limited to visitors and residents of communities near parks—must be recruited as "co-stewards" of the national parks. The public must be made aware of the challenges facing the National Park System and urged and empowered to take action to preserve and protect these resources as part of their enduring responsibility as citizens.

What should be the goals of resource management in the National Park System?

The overarching goal of NPS resource management should be *to steward NPS resources for continuous change that is not yet fully understood, in order to preserve ecological integrity and cultural and historical authenticity, provide visitors with transformative experiences, and form the core of a national conservation land- and seascape.*

Continuous change is not merely constant or seasonal change; it is also the unrelenting and dynamic nature of the changes facing park systems expressed as extreme, volatile swings in conditions

(such as unexpected, severe wet seasons) within long-term trends of change (such as decadal droughts). Variations in environmental conditions, including extreme events like catastrophic wildland fires, hurricanes, and droughts increasingly exceed historic experiences. Significant uncertainty exists regarding responses of park ecosystems and historical resources to these conditions. It is an essential finding of this committee that given the dynamic and complex nature of this change, the manager and decision maker must rely on science for guidance in understanding novel conditions, threats, and risks to parks now and in the future.

Ecological integrity describes the quality of ecosystems that are largely self-sustaining and self-regulating. Such ecosystems may possess complete food webs, a full complement of native animal and plant species maintaining their populations, and naturally functioning ecological processes such as predation, nutrient cycling, disturbance and recovery, succession, and energy flow.

Cultural and historical authenticity describes the capacity of a historical object or setting to be an accurate representation of a specific cultural time and place, revealing meaning and relevance of the object to its "parent" culture or context, and displaying a genuine and realistic connection to factual historical events. Authenticity—of material objects or intangible heritage like traditional harvesting practices—is multidimensional and rarely absolute. Some attributes of authenticity might be intact (such as the materials in a historic building) while other attributes may

have been substantially altered (such as the functional use of the building or its community context).

Transformative experiences held by visitors to parks are of many kinds, and are based on interaction with natural and cultural resources. This interaction should both educate *and* inspire. Such experiences can be a weeklong, confidence-building wilderness adventure, a first encounter with a night sky free of artificial light, exploring a tidal pool with a park interpreter, or the emotional and patriotic response to standing on a historic battlefield or in an early Native American dwelling. A first, tentative nature walk for the city-raised child may prove as memorable as an exuberant hike by a seasoned park visitor. Distinctive and transformative experiences should be available to all Americans in all units of the National Park System. This requires expanding the relevance and benefits of parks to underrepresented minority groups and communities.

A coherent and sustainable *national conservation land- and seascape* recognizes that 21st-century conservation challenges require an expansion in the spatial, temporal, and social scales of resource stewardship. A comprehensive national conservation land- and seascape includes working lands and waters (for forestry, agriculture, and fishing), recreation areas, historical sites, wilderness areas, wild and scenic rivers, and marine protected areas. Connecting isolated and individual conservation sites into a network adds to their individual and collective resilience over time. The National Park System contains many of the land- and

seascapes most capable of sustaining ecological integrity and cultural and historical authenticity. It can and must be both core and essential to a larger national vision, with the national parks and historic sites serving as permanent anchors of conservation in a continuum of uses.

The contemporary strategies proposed by this committee (with their focus on coupled human-natural systems and connectivity across the larger land- and seascapes) require NPS resource management to embrace a holistic vision and design. This vision emphasizes the role of parks as spatially fixed, largely intact areas embedded in a matrix of adjacent lands and waters where use will change dynamically over time. The NPS should assume its responsibility for "life cycle stewardship" (the goal of managing resources such that species' full life cycles are sustainable over time) and collaborative resource management, whether resources are migratory species moving transiently within parks (such as spawning salmon in Olympic National Park) or co-managed sites important to indigenous communities and tribes (such as Chesapeake Bay or Devils Tower National Monument).

Confronted with continuous and dynamic change and the goal of preserving ecological integrity, NPS management strategies must be expanded to encompass a geographic scope beyond park boundaries to larger landscapes and to consider longer time horizons. Specific tactics include improving the representation of unique ecosystem types within the National Park System, prioritizing the protection of habitats that may serve as climate

refugia, ensuring the maintenance of critical migration and dispersal corridors, and strengthening the resilience of park ecosystems.

The National Park System should become the core element of a national (and with international collaboration, continental and oceanic) network of lands and waters proposed above. Where terrestrial and aquatic protected areas share borders, such as Point Reyes National Seashore and the Gulf of the Farallones Marine Sanctuary, or Olympic National Park and the Olympic Coast National Marine Sanctuary, unique opportunities exist to embrace this holistic vision across ecologically connected boundaries. This network should be managed for resiliency and connectivity, guided by scientific research, and responsible for life cycle stewardship, thereby fulfilling a conservation imperative of protecting the distinctive role and future of the National Park System within the broader American landscape and consciousness.

Because ecological and cultural systems are complex, continuously changing and not fully understood, NPS managers and decision makers will need to embrace more fully *the precautionary principle* as an operating guide. Its standard is conservative in allowing actions and activities that may heighten impairment of park resources and consistent in avoiding actions and activities that may irreversibly impact park resources and systems. The precautionary principle requires that stewardship decisions reflect science-informed prudence and restraint. This principle should be integrated into NPS decision making at all levels.

Contemporary understanding of environmental history and diverse American cultures has enriched our appreciation for the interaction between human and natural systems. The NPS should embrace continued traditional and sustainable use of natural and cultural resources by indigenous communities and tribes, within the broader goal of preserving ecological integrity and cultural authenticity.

What policies for resource management are necessary to achieve these goals?

The NPS should make as its central resource policy the stewardship of park resources to preserve ecological integrity and cultural and historical authenticity, provide transformative visitor experiences, and manage the National Park System as the core of a national conservation network of connected lands and waters. This policy should formally embrace the need to manage for change, the precautionary principle, and to the maximum extent possible, maintain or increase current restrictions on impairment of park resources.

The NPS and its stakeholders are uniquely positioned to propose specific revisions of technical policies for the organization. These

policies should define ecological integrity and cultural and historical authenticity and guide park stewardship over time. Such policies should clearly distinguish appropriate management actions and activities that preserve these qualities from those that can degrade or eliminate ecological integrity and/or cultural and historical authenticity. This will require concerted examination by NPS professionals and stakeholders, as well as the relevant scientific, legal, and policy analyses.

The NPS needs a specific and explicit policy for park stewardship and decision making based on *best available sound science*, *accurate fidelity to the law*, and *long-term public interest*. Best available sound science is relevant to the issue, delivered at the appropriate time in the decision-making process, up-to-date and rigorous in method, mindful of limitations, peer-reviewed, and delivered in ways that allow managers to apply its findings. Accurate fidelity to the law means that the NPS decision-making process must adhere with precision to law, be mindful of legislative intent, and consistently and transparently follow public policy and regulations. Long-term public interest emerges from the NPS mission, the expert judgment of park professionals, and an evolving understanding of public wants and needs. The key is "long-term," which is a necessary consequence of the NPS mission and reflects—at minimum—concern for multiple future generations in time.

While increased scientific capacity is an essential asset of a 21st-century National Park Service, scientific research findings

must be delivered to resource managers and decision makers in the form of usable knowledge. The NPS will require a broad technology innovation policy that encourages adoption of new technologies and establishes coherent strategies for data sharing and access that can be deployed in support of science, resource management, and park stewardship. Existing policies and procedures must be improved to encourage participation of external scientists, scholars, and students in scientific and scholarly research conducted in national parks, and expand the appropriate use of parks as national laboratories for science.

What actions are required to implement these policies?

The NPS should undertake a major, systematic, and comprehensive review of its policies, despite the risk and uncertainty that this effort may entail. The committee emphasizes that it is not recommending revision of the Organic Act, altering the mission of the NPS, or relaxation of restrictions on impairment of park resources. Rather, this review should explicitly focus on aligning policies with the goals for resource management recommended here, and streamlining, clarifying, and improving consistency

and coherence to provide guidance in resource management and decision making.

To implement the resource management goals and policies described in this report, the NPS will need to significantly expand the role of science in the agency. The committee has several recommendations. The NPS must materially invest in scientific capacity building by hiring a new and diverse cohort of scientists, adequately supporting their research, and applying the results. The NPS should train, equip, retain, and support the career advancement of these research scientists and scholars. They should be stationed in parks to provide place-based expertise and knowledge, long-term institutional memory, and technical support for resource management. NPS scientists (and the agency) would greatly benefit from strengthened and supportive supervision, increased opportunities to interact with the scientific community, including professional associations, and specific responsibility and opportunity for publishing their work in the scientific literature. Both NPS managers and scientists require training and requisite skills in communication, critical thinking, analysis, science, technology, and mathematics. The NPS should integrate scientific achievement into its evaluation and performance reward systems, providing incentives for scientists and managers who contribute to the advancement of science and stewardship within their park or region.

This expanded scientific capacity must be interdisciplinary as well as disciplinary, and leverage scientific partnerships with

academic institutions, other federal agencies, and both non-profit and private sectors. It should include well-established sciences such as wildlife ecology, botany, and anthropology. It should also incorporate the newer and increasingly relevant sciences such as genomics and climate change science, and innovative areas of research such as ecological economics, spatial modeling, and related methods.

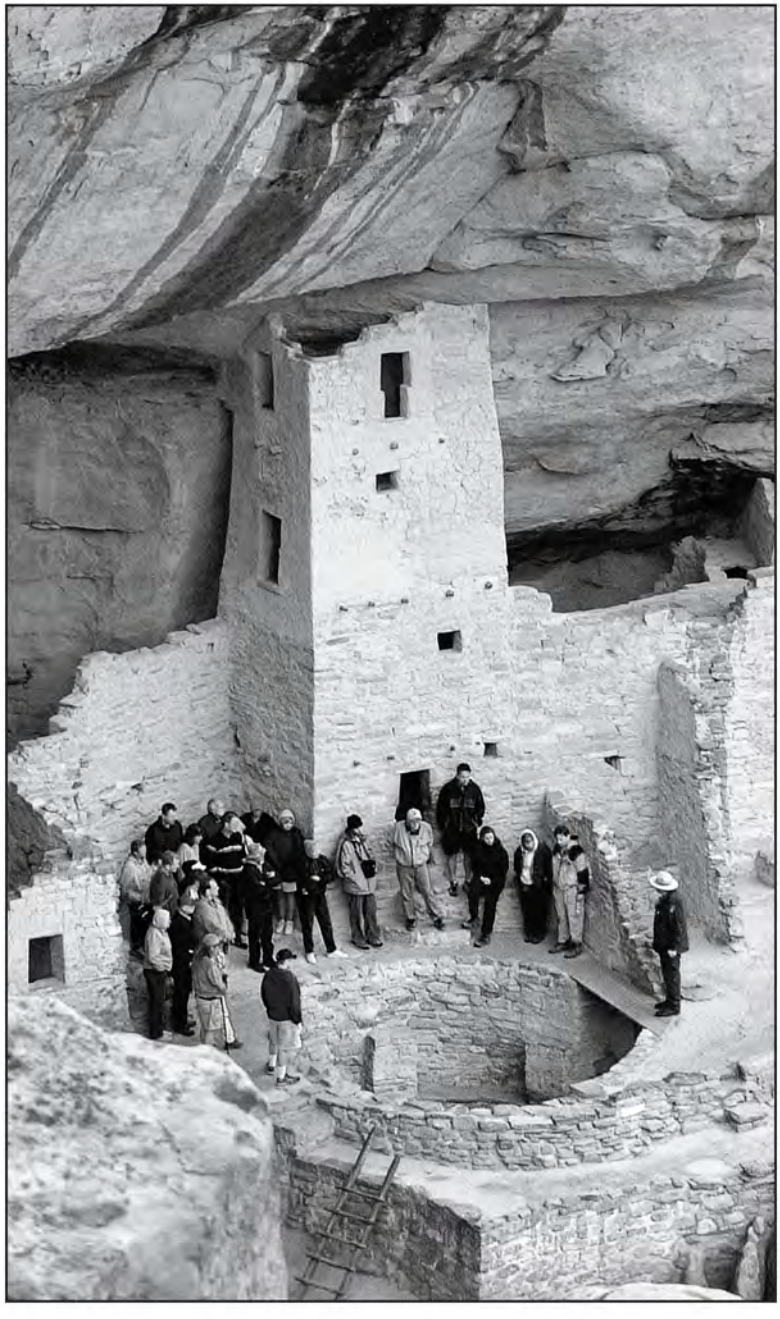
The NPS should establish a standing Science Advisory Board that includes representatives from a range of disciplines within the scientific community. The board would offer external perspectives on science in the parks, provide advice and guidance on science policy, priorities and controversies, and advocate on behalf of science within the agency. The board should be given specific responsibilities and appropriate resources in order to operate effectively.

Investing in science is essential, but it is only one element in preparing NPS stewardship for the future. The NPS must also expand its capacity to manage natural and cultural resources efficiently across large-scale landscapes, avoiding unnecessary bureaucracy while engaging networks, collaborations with academic institutions and other federal agencies (notably the U.S. Geological Survey), and partnerships with states, tribes, and the private sector.

An expanded role for monitoring is an essential component of managing for change. The NPS should function as a scientific

leader in documenting and monitoring the conditions of park systems, including inventories of biodiversity and cultural resources. Monitoring represents an important opportunity to engage the American public (particularly youth) in stewardship of park resources through outreach programs and emerging technologies that support citizen science. The NPS should also lead the way in establishing baseline environmental quality standards and benchmarks of ecological integrity and cultural and historical authenticity. It should invest in and apply analytic and decision-support tools systemwide. The agency should increase understanding of the natural and cultural resources under its care, improve linkages between its substantial current monitoring effort and research needs, and increase access to monitoring data by resource managers and the scientific community.

The NPS has an excellent corps of resource managers, but these managers must be supported with the necessary funds and personnel, as well as with training and professional development. NPS professionals, and especially park superintendents, should be required to possess and maintain significant scientific literacy that extends to an understanding of the strengths and limitations of scientific findings, appropriate application of scientific research to management and policy, and familiarity with key scientific concepts in both biophysical and sociocultural disciplines.



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Conclusion: Opportunity and urgency

Resource stewardship in the National Park Service owes a debt to Leopold's Advisory Board for the cogent principles, philosophy, and recommendations provided in its 1963 report. Now, almost 50 years later, revisiting the key questions raised by Leopold and his colleagues must be done in the context of a new century.

Resource stewardship within the National Park System of the future must be accomplished while addressing development pressures, pollution impacts, climate change, terrestrial and marine biodiversity loss, habitat fragmentation, and the loss of cultural resources. These challenges will only accelerate and intensify in the future. Future resource management based on historically successful practices cannot be assumed as effective park stewardship. Neither is crisis management a sufficient response. Structural changes and long-term investment are necessary to preserve the natural and cultural resources of the National Park System.

There is great urgency in the recommendations put forward in this report—accompanied with an exhortation to the NPS to act immediately, boldly, and decisively. The 2016 Centennial of the National Park Service offers an extraordinary opportunity for action and provides a critical benchmark for progress in meeting this enduring responsibility.

National Park System Advisory Board
Science Committee

Dr. Rita Colwell *(Committee Chair)*
Distinguished University Professor, University of Maryland College Park and Johns Hopkins University Bloomberg School of Public Health; Chairman and President, CosmosID, Inc., College Park, MD

Dr. Susan Avery
President and Director, Woods Hole Oceanographic Institution, Woods Hole, MA

Dr. Joel Berger
John J. Craighead Chair and Professor, Wildlife Biology Program, University of Montana, Missoula, MT; Senior Scientist, North American Program, Wildlife Conservation Society, Bronx, NY

Dr. Gary E. Davis
USNPS, Ret., President and Founder, GEDavis and Associates, Westlake Village, CA

Dr. Healy Hamilton
Senior Research Fellow, Marine Conservation Institute, Fairfax, CA

Dr. Thomas Lovejoy
University Professor, Environmental Science and Policy, George Mason University; Biodiversity Chair, The Heinz Center for Science, Economics and the Environment, Washington, DC

Dr. Shirley Malcom
Head, Directorate for Education and Human Resources Programs of the American Association for the Advancement of Science, Washington, DC

Dr. Ann McMullen
Curator and Head of Collections Research and Documentation, National Museum of the American Indian, Smithsonian Institution, Washington, DC

Dr. Michael Novacek
Senior Vice President, Provost of Science, Curator at the American Museum of Natural History, New York, NY

Sir Richard J. Roberts, Ph.D
1993 Nobel Laureate in Physiology or Medicine, Chief Scientific Officer, New England Biolabs, Ipswich, MA

Dr. Richard Tapia
University Professor, Director of the Center for Excellence and Equity in Education; Director of Alliances for Graduate Education and the Professoriate, Maxfield and Oshman Professor in Engineering, Rice University, Houston, TX

Dr. Gary Machlis (*Liaison to the Committee)* Science Advisor to the Director, National Park Service, Washington, DC

GEORGE
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SOCIETY

P.O. Box 65
Hancock, Michigan 49930-0065
USA

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