Spring/Summer 2012 • Volume 29 • Number 1 www.nature.nps.gov/ParkScience

PARKScience

Integrating Research and Resource Management in the National Parks

National Park Service
U.S. Department of the Interior

Natural Resource Stewardship and Science
Office of Education and Outreach

SAFETY AND THE VISITOR EXPERIENCE ON HALF DOME TRAIL

- Cave discovery at Grand Canyon
- Climate research at Rocky Mountain
- Science partnerships at Golden Gate
- Sustainable tourism in gateway communities
- NPScape: Case study at Saguaro
- International park assistance: Taiwan

ON THE COVER

 Visitors ascend the Half Dome cables in Yosemite National Park, California, during a busy summer day. The photo illustrates crowded conditions on the cables, which were common prior to the park implementing its interim day use permit system in 2010.

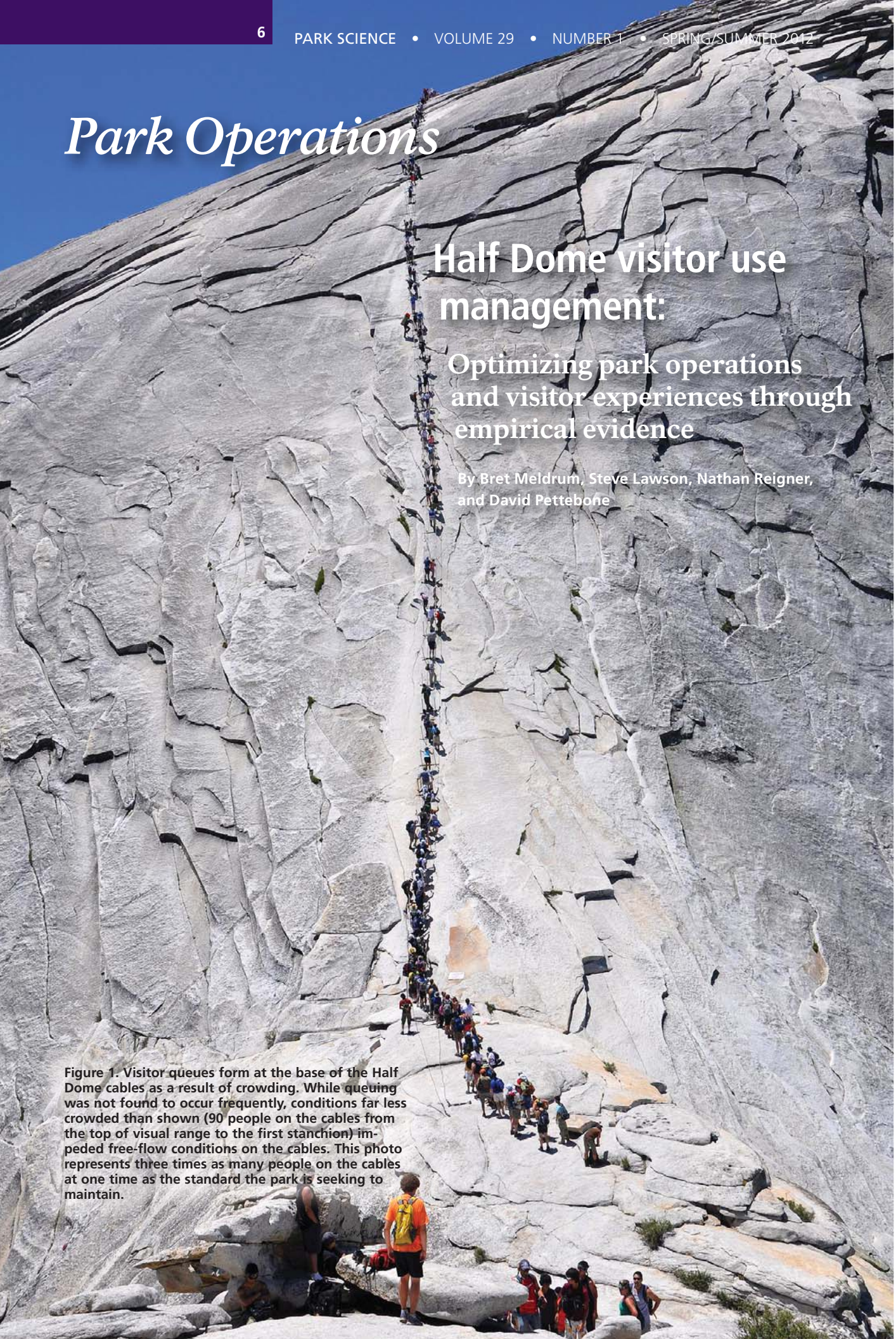
NPS PHOTO

Park Operations

Half Dome visitor use management:

Optimizing park operations and visitor experiences through empirical evidence

By Bret Meldrum, Steve Lawson, Nathan Reigner, and David Pettebone



NPS PHOTO

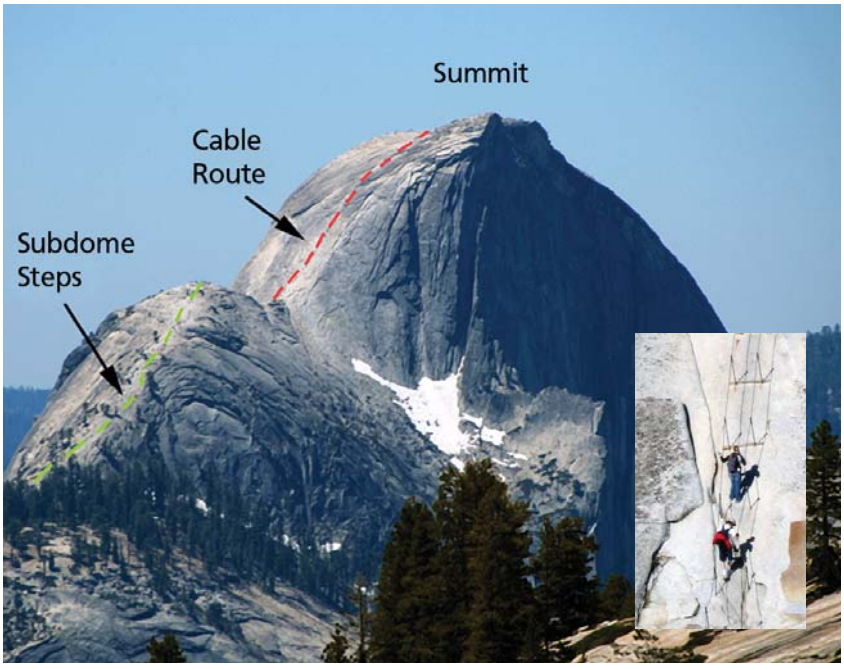
Figure 1. Visitor queues form at the base of the Half Dome cables as a result of crowding. While queuing was not found to occur frequently, conditions far less crowded than shown (90 people on the cables from the top of visual range to the first stanchion) impeded free-flow conditions on the cables. This photo represents three times as many people on the cables at one time as the standard the park is seeking to maintain.

Abstract

The Half Dome Trail (HDT) hike has long been the setting of an iconic experience in Yosemite National Park. The trail takes visitors up the only route accessing the summit without technical climbing. Over time, it has transformed from a historic multiday wilderness experience to an ambitious, and frequently epic, day hike. This 16-mile (26 km) hike ascending 4,000 ft. (1,219 m) is a significant undertaking that ends with the last 400 ft (122 m) of the ascent exposed and on a cables structure. In recent years as visitation has increased, numerous search-and-rescue incidents have taken place on and around the cables. This trend led park management to investigate visitor use on the trail system leading to Half Dome, including behaviors on the cables. This article describes a series of scientific investigations applied to inform and further frame management of visitor use along the HDT. Notably, results from visitor use measurement, simulation modeling, and monitoring of visitor movements provide a basis for standards that frame acceptable conditions.

Key words

day use permits, recreation allocation, recreation carrying capacity, safety, science-based decision making, simulation modeling, social science, visitor experience, visitor use management



NPS PHOTO

Figure 2. The exposed section of the Half Dome Trail leads from the subdome to the summit. This route consists of pairs of heavy-gauge cables approximately 32 inches apart secured to the rock surface at varying intervals.

YOSEMITE NATIONAL PARK IS RECOGNIZED for its towering granite cliffs and surreal waterfalls. Located in the Sierra Nevada of California, the park is also renowned as a popular recreation destination that at times experiences high levels of visitation. While the experiences of most visitors are concentrated in the easily accessible areas of Yosemite Valley, high levels of visitor use are also documented on wilderness trails (Broom and Hall 2010), including the Half Dome Trail (HDT) (fig. 1, facing page).

The HDT hike has long been the setting of an iconic experience in Yosemite National Park. The trail leads visitors up the only route accessing the summit without technical climbing. The hike is 16 miles (26 km) round-trip ascending 4,000 ft (1,219 m), and is an undertaking that culminates with the last 400 ft (122 m) of the ascent exposed and on the Half Dome cables (figs. 1 and 2). This structure consists of pairs of heavy-gauge cables approximately 32 inches apart secured to the rock surface at varying intervals of 82 to 296 feet (25–90 m) in length. The cables are suspended by stanchions that vary from waist to shoulder height and provide handholds, while boards anchored to the stanchions afford footing (fig. 2 inset). The cables form a corridor that facilitates travel to the summit of Half Dome. The structure is typically installed by the trail crew in mid-May and available for use through mid-October, dependent upon weather.

In recent years this hike has transformed from what was historically thought to be a multiday wilderness experience to an epic day hike for most visitors, with an increasing number of search-and-rescue incidents. Fourteen falls and four deaths have been recorded in the vicinity of the Half Dome cables since 1969, with eight incidents occurring since 2006. Most of these falls were caused by weather events resulting from wet surfaces, but three falls occurred when the cables were down while one happened under crowded conditions.

Iconic park destinations can require extensive operations to minimize the effects of crowding, manage traffic, improve safety, protect wilderness values, and provide search-and-rescue services. This article illustrates and outlines a process in support of science-based decision making to manage visitor

Providing for free-flow conditions along the cables route is within the control of park management and is beneficial for maintaining quality visitor experiences. Freedom of movement on the cables reduces unnecessary fatigue and allows visitors better control over their own adventure and risk.

use on the Half Dome Trail. The cables section of this trail does present an additional opportunity to frame visitor experience with safety as the biggest driver in determining daily use levels. This investigative process provides rationale for decision making that maintains high-quality visitor experiences and is designed to withstand public scrutiny. The defining elements of this process are issue identification, scientific investigation, interim management measures, park planning commitments, monitoring, and operational refinements.

Visitor use research

In 2008, we established descriptive and evaluative research components to better understand visitor use and experience on the HDT. The descriptive component quantifies spatial and temporal characteristics of visitor use on the trail. These characteristics include trail use levels in terms of hikers, people at one time (PAOT) using the Half Dome cables, travel times for visitors ascending and descending the cables, and visitor densities on the Half Dome summit and subdome area (see fig. 2). The evaluative component focuses on visitors' perceptions of crowding, risk, and safety on the cables (Manning 2011; Graefe et al. 2011). These data were collected via surveys administered on-site after visitors descended from the Half Dome summit area using a combination of written descriptions and visual simulations of a range of conditions on the cables route.

An initial focus of the research was to determine experiential and use conditions on the cables associated with various daily trail use levels. Results of the evaluative survey using visual simulations of PAOT on the cables suggest visitors were willing to tolerate up to 70 people on the cables at one time. This could be called the "visitor informed crowding standard." The descriptive component of the study identifies distinct patterns between PAOT on the cables and the amount of time visitors took to ascend the cables. When more than 30 PAOT were observed on the cables route, visitors began taking significantly longer to ascend and descend the cables, often as a result of being delayed by others. This could be called the "travel time standard" (Lawson et al. 2009). Increasing time spent on the cables, particularly caused by crowding, reflects the visitor safety and experiential quality concerns that underlie this study and the subsequent park management actions. To facilitate free-flow conditions for safety and experiential qualities, the travel time standard was selected by park management. Using the relationship between PAOT on the cables and counts of hikers on the HDT, a range of daily use levels for various PAOT amounts can be estimated.

We developed a pedestrian simulation model to better understand the issue of visitor movement and the result of a few key variables of interest collected through direct observation, repeat photography, automated trail counter equipment, and survey research. This planning tool allows for a greater degree of management understanding of operational and environmental scenarios. Simulation models are flexible, responsive, and predictive planning tools that can inform decision making more than purely statistical models do (Cole 2005). Simulated use scenarios by the model explain issues that cannot be directly observed in real life, under current management. A range of daily use levels were simulated for various management scenarios, including open use, permit systems, evacuation scenarios, and special equipment requirements. Model outputs provide system measures comparable to management objectives, the 30 PAOT travel time standard in this case. Results of the simulation modeling scenarios provide additional insight into the managerial feasibility of a variety of operational considerations pertaining to field staffing, reservation system capabilities, and emergency evacuation scenarios. Through the simulations, park management decision makers were able to better under-

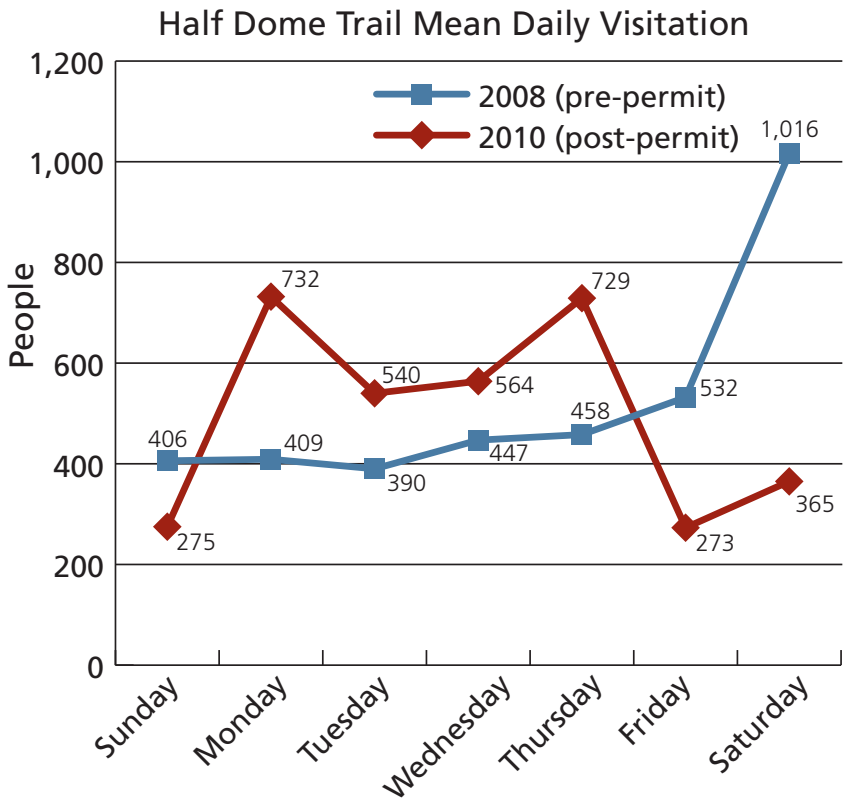


Figure 3. Mean daily visitation over study years 2008 and 2010 (applicable federal holidays removed).

stand the likely implications associated with any alternative before making a selection.

Management action

Results from the descriptive research and simulation modeling suggest that a range of 300–400 people per day could hike the HDT while maintaining park management objectives associated with freedom of movement on the cables. Park managers instituted an interim daily use limit of 400 people under the Superintendent's Compendium for Fridays, Saturdays, Sundays, and federal holidays in 2010. Initial regulations sought to minimize the burden on visitors as much as possible through the permit process. Concurrently the park committed to an environmental assessment under the National Environmental Policy Act and to monitor visitor use on the Half Dome cables with the new daily visitor use limit. The decision to implement these regulations was publicly contentious, but communicating the findings of crowding conditions from the 2008 (Lawson et al. 2009) study and the recent series of falls on the cables helped the decision withstand public scrutiny.

To allocate the 2010 daily limit, Yosemite developed a permit system on the Web site recreation.gov, the same contracted provider that allocates campground reservations for the Department of the Interior. Though establishing use limits for each day of the week was considered, park management decided instead to limit access only on known high-use days of the week and monitor the results. This strategy allowed for a communication emphasis on the pragmatism of visitor use management while recognizing the importance of recreation access. It also allowed the 2010 visitor use monitoring efforts to document the extent of visitor displacement from weekends to weekdays resulting from the new permit system.

Follow-up monitoring of visitor use conditions on the HDT in 2010 revealed that while use declined significantly from Friday to Sunday, it increased from Monday through Thursday (fig. 3). In light of these results, we concluded that visitor demand for Half Dome is certainly flexible enough to accommodate weekday travel, and in 2011, managers applied a seven-day interim permit system allowing 400 people per day to address this documented recreation displacement with the three-day/week permit system.

This incremental modification in the permit process serves as an example of and argues a need for adaptive management. Visitor use response to management actions cannot always be known before such decisions occur. Instituting a weekend and holiday permit system was thought to be the least disruptive to visitors as we sought to understand effects from the new management actions (fig. 4, next page). Without documenting changes in visitor use across years, park management cannot assess the efficacy of their actions in maintaining standards and achieving safety and experiential quality.

Conclusions

Half Dome visitor use research conducted in 2008 (Lawson et al. 2009) and replicated via monitoring in 2010 (Pettebone et al. 2011) has provided a clearer

Figure 4. A park ranger checks permits at the base of the subdome to enforce the daily recreation allocation.

understanding of visitor use, experience, and safety issues at an iconic and complex recreation setting. This approach establishes a basis for visitor use management decision making through examining and simulating relationships between visitor use levels and variables relevant to visitor experience and management operations. The investigation allows crowding to be addressed through scientifically defensible means, a practice becoming increasingly prudent in high-visibility parks. Providing for free-flow conditions along the cables route is within the control of park management and is beneficial for maintaining quality visitor experiences. Freedom of movement on the cables reduces unnecessary fatigue and allows visitors better control over their own adventure and risk. The known increases in daily use levels have been positively correlated with delays in travel times on the cables. This research development through statistical regression and simulation modeling allows the park to consider a range of daily visitor use levels that ensure freedom of movement on the most constraining experiential aspect of the HDT, the cables.

While this visitor use research approach does apply to other parks and protected area landscapes, the HDT application contains unique descriptive considerations for the development of management objectives, notably the physical performance of the cables as a system that provides for freedom of movement. The travel time standard of no more than 30 PAOT on the Half Dome cables was a more salient capacity driver than the crowding standard of 70 PAOT, because it focuses on preventing visitors from being forced to spend more time on the cables than expected. Unlike many other locations both within Yosemite and throughout the National Park System that have developed crowding standards for attraction sites and trails, the cables provide a visitor movement consideration similar to transportation service measures (i.e., number of people, travel time, and level of service). This occurrence provides a unique ability to use recreation-based simulation modeling software to understand how physical system–like characteristics of visitor use change across levels of use, space, and time. The HDT system also allows park managers to explore for a more diverse set of standards on which to base visitor use management actions.

This pressing issue for Yosemite has emphasized the complex nuances of visitor use and the need for addressing them through planning, management, and operations scenarios. It also serves as a strong argument for why visitor use and social science research is needed in the National Park Service. Equally, management actions in many cases require monitoring to understand resultant effects and necessary refinements. Though the visitor use research outlined in this article supports active visitor use management on the HDT, discretion is needed to develop operations that provide the optimal conditions for visitor movement and experiential conditions. The HDT context outlines a progression of management issue identification, research, planning, and monitoring that is useful for science-based decision making and may lead to appropriate long-term visitor use management solutions.

Acknowledgments

The authors would like to acknowledge Dr. Peter Newman, Dr. Adam Gibson, and the Warner College of Natural Resources at Colorado State University for their contributing research in establishing visitor-informed standards on the Half Dome cables.

References

Broom, T. J., and T. E. Hall. 2010. An assessment of indirect measures for the social indicator of encounters in the Tuolumne Meadows area of Yosemite National Park. Report for Yosemite National Park. University of Idaho, Moscow, Idaho, USA.

Cole, D. N., editor. 2005. Computer simulation monitoring of recreation use: Current status, case studies, and future direction. General Technical Report RMRS-GTR-143. USDA Forest Service, Fort Collins, Colorado, USA.

Graefe, A. R., K. Cahill, and J. Bacon. 2011. Putting visitor capacity in perspective: A response to the capacity work group. Journal of Park and Recreation Administration 29(1):21–37.

Lawson, S., P. Newman, N. Reigner, A. Gibson, and J. Choi. 2009. Half Dome cables modeling and visitor use estimation final report. Resource Systems Group Report to Yosemite National Park. White River Junction, Vermont, USA.

Manning, R. E. 2011. Studies in outdoor recreation: Search and research for satisfaction. Third edition. Oregon State University Press, Corvallis, Oregon, USA.

Pettebone, D., B. Meldrum, C. Leslie., K. King, and J. Meath. 2011. Half Dome Trail visitor use monitoring report. Yosemite National Park, El Portal, California, USA.

About the authors

Bret Meldrum *(bret_meldrum@nps.gov) is chief, Visitor Use and Social Science Branch, Yosemite National Park, El Portal, California, and a PhD student, University of Arizona, Tucson, Arizona.* ***Steve Lawson****, PhD (steve.lawson@rsginc.com), is director, Public Lands Planning and Management, Resource Systems Group, White River Junction, Vermont.* ***Nathan Reigner*** *(nreigner@uvm.edu) is a PhD student, University of Vermont, Burlington, Vermont.* ***David Pettebone****, PhD (david_pettebone@nps.gov), is wilderness coordinator, Visitor and Resource Protection Division, Rocky Mountain National Park, Estes Park, Colorado.*