TRANSPORTATION PLANNING AND SOCIAL CARRYING CAPACITY IN THE NATIONAL PARKS

William Valliere

Researcher, University of Vermont, School of Natural Resources, Burlington, VT 05405

Robert Manning

Professor, University of Vermont, School of Natural Resources, Burlington, VT 05405

Megha Budruk

Graduate Research Assistant, University of Vermont, School of Natural Resources, Burlington, VT 05405

Steven Lawson

Graduate Research Assistant, University of Vermont, School of Natural Resources, Burlington, VT 05405

Benjamin Wang

Researcher, University of Vermont, School of Natural Resources, Burlington, VT 05405

Abstract: The U.S. national park system accommodates nearly 300 million visits annually. Most visitors come to the national parks in automobiles, and this poses several management challenges. Delays at national park entrances caused by traffic congestion detract from the visitor experience. Inadequate parking facilities further compromise the visitor experience and lead people to park along roadsides, damaging park resources and causing traffic hazards. At times, visitors must be turned away from some national park areas because transportation infrastructure is not sufficient to meet visitor demand.

National Park Service transportation planning has focused on addressing these issues through development of alternative public transportation systems. A number of national parks are planning and operating public transportation and shuttle systems to reduce visitors' reliance on personal transportation. While new transportation systems may mitigate traffic congestion and parking problems, these systems could potentially cause other problems. For example, the fleet size, scheduling, and routing of transportation systems can directly affect the number and distribution of visitors in a national park. Efforts to design transportation systems that protect and enhance the quality of the visitor experience in national parks can be improved with information about the social carrying capacity of these areas.

This paper presents carrying capacity research conducted to support planning in Yosemite National Park. Crowding-related standards of quality were formulated in heavily visited areas of this national park. A simulation model was developed to estimate the relationship between crowding-related standards of quality and visitor use levels and distribution. This information can be used to assist national park managers to design and operate transportation systems that integrate considerations of social carrying capacity.

Introduction

Our national parks contain important natural, cultural, and historical resources. Their importance is reflected in the fact that they currently receive nearly 300 million visits per year (National Park Service, 2001b). With increasing visitor use comes potential impacts to park resources and the visitor experience. Most visitors to national parks come via private automobile. Reliance on the automobile challenges park managers with a host of management issues that include traffic congestion, insufficient or inadequately managed parking, noise, and limited opportunities to use non-motorized travel or alternative transportation modes. The interaction between impacts created by automobile traffic, park resources and the visitor experience is the focus of this paper. Changes to transportation systems within national parks can potentially affect the visitor experience. These effects can be positive, or as we will demonstrate, potentially negative, depending on how alternative transportation systems are designed and developed.

In this paper, we will:

- Demonstrate the historic connection between transportation and the national parks
- Outline current thinking about transportation planning in the parks
- Describe management challenges associated with transportation planning
- Demonstrate linkages between transportation and social carrying capacity
- Provide demonstrations of different transportation scenarios as they relate to social carrying capacity
- Demonstrate how transportation planning can be informed by carrying capacity research and vice versa

The Historic Roots of Transportation in the National Parks

Transportation to and in national parks has not always been considered a problem by national park officials. In fact, mechanized transportation was important to the growth and success of the national park system. Early efforts by railroad operators to bring visitors to national parks brought political and economic support to the fledgling park movement. While the motivations of early railroad barons nay not have been fully altruistic, their support of the preservation movement lent a utilitarian air to an argument that was passionate, but otherwise lacking in pragmatic basis. In fact, support by railroads may have helped with the creation of the National Park Service. With the Union Pacific railroad's "See America First" campaign, growing numbers of tourists were encouraged to visit the national parks, thus giving the national park movement national recognition (Runte, 1997).

With the advent of the mass produced automobile, the popularity of national parks blossomed. Many early preservationists embraced the presence of automobiles in the national parks. The growing availability of automobiles to the middle class helped the national parks capture even greater public support. The few "purists" or as Edward H. Hamilton , correspondent for *Cosmopolitan* magazine dubbed them, "nature cranks," were outvoted by the large majority of preservationists who initially embraced the automobile as an opportunity to increase public popularity of the national parks (Runte, 1997). In fact, even John Muir accepted automobiles into his beloved Yosemite to increase public support for preservation of the parks. In a letter to Howard Palmer, Secretary of the American Alpine Club, Muir wrote "all signs indicate automobile victory, and doubtless, under certain precautionary restrictions, these useful, progressive, blunt-nosed mechanical beetles 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, and, from the mountaineer's standpoint, with but little harm or good" (Bade, 1924).

The popularity of visiting national parks by automobile grew quickly. For example, in Yosemite National Park, by 1916, more visitors entered the park by automobile than by train. The following season, the ratio was nearly three to one, and by 1918, the ratio was almost seven to one (Lillard, 1968). By the mid 1950s only 1 to 2 percent of all park visitors entered by public transportation (Long, 1956). This trend has continued through present times.

Current Thinking and Challenges Facing Transportation Planning in the Parks

In recent years, the National Park Service has taken notice of the deleterious effects of automobiles on both park resources and the visitor experience. According to the National Park Service Transportation Planning Workbook (1999), "much has changed in the past 80 years. Parks have become so popular and so readily accessible that many park roads are inundated with increasingly long lines of vehicles. Many NPS facilities and infrastructure are stretched to their limits. Congestion and its accompanying pollution threatens to degrade the visitor experience as well as the priceless natural and cultural resources that have been so carefully preserved."

In response to the challenges facing park managers, the Department of Interior and the Department of Transportation began working together in 1997 to formulate solutions to park transportation issues. The Department of Interior and the Department of Transportation entered into a Memorandum of Understanding in November of 1997 to respond to high visitation levels and the corresponding problems that result from growing volumes of traffic and spiraling demands for visitor parking. The challenge of balancing stewardship of park resources against the pressure for more public access has become increasingly difficult in recent years. The Memorandum of Understanding lays the foundation for developing more comprehensive, intermodal, and financially efficient transportation systems while addressing the National Park Service's dual mandate of preserving natural and cultural resources and providing for a meaningful, pleasant visitor experience (National Park Service, 2001c).

In 1999, when unveiling Acadia National Park's new alternative transportation system, then Secretary of Interior Bruce Babbit remarked "Our parks don't have too many people, but they can, and often do, have too many cars. There is almost a tyranny of the automobile, where honking, fumes and hectic search for parking actually limits and inhibits our experience of nature. Two years ago, we sought a better way. Today I'm proud to announce that we've found it." Secretary Babbit continued "From Yosemite to Yellowstone, to the Grand Canyon and Zion, the Park Service is looking at emerging technology to help fulfill our 83-year-old mandate to provide access to, and preserve unimpaired, our greatest natural resources" (National Park Service, 2001a).

The emerging technologies former secretary Babbit spoke of were intelligent transportation systems (ITS), and alternative transportation systems (ATS). Some of the strategies and tools used by these systems include:

- Enhanced roadways
- Provision for non-vehicular travel modes
- Enhanced visitor information
- Encouragement of use of alternate travel modes
- Improved "way-finding" signage (ITS)
- Restricted access to roadways
- lternative Transportation Systems (e.g., buses, light rail)

One of the primary strategies employed by transportation planners thus far in the national parks has been the use of ATS. In a number of parks, including Grand Canyon, Acadia and Zion, plans for ATS have been created, and in some cases, implemented. These systems offer potential solutions to some of the transportation problems that many parks face. For example, by introducing ATS, the number of private automobiles entering parks will be reduced thereby reducing traffic congestion, alleviating parking problems, and reducing adverse impacts created by noise and air pollution. Additionally, opportunities for further interpretation may become available when groups of people are together on a public transportation system.

Linkages between Transportation and Social Carrying Capacity

Since alternative transportation systems can directly affect the number and distribution of park visitors at various attraction sites within a park, implementation of ATS can potentially affect the carrying capacity of parks. Carrying capacity is generally defined as the maximum number of visitors that can be accommodated in a park or related area without unacceptable impacts on park resources or the quality of the visitor experience (Manning, 1999). Contemporary approaches to managing carrying capacity, including Limits of Acceptable Change (LAC) (Stankey et al., 1985) and Visitor Experience and Resource Protection

(VERP) (National Park Service, 1997; Manning, 2001), rely on formulation of indicators and standards of quality. Indicators of quality are measurable, manageable variables that reflect management objectives for resource protection and the quality of the visitor experience. Standards of quality define the minimum acceptable condition of indicator variables. ATS can potentially affect indicators and standards of quality, and ultimately carrying capacity through variations in fleet size (number of vehicles in fleet and capacity of each vehicle), scheduling and routing.

Case Study: Yosmite National Park

In a study of carrying capacity in Yosemite Valley, visitors at the base of Bridalveil Fall were asked questions regarding park conditions that added to or detracted from the quality of the visitor experience (Manning, Valliere, Lawson, Wang & Newman, 1999). The number of persons at one time (PAOT) at the fall emerged as an important indicator of experiential quality. Visitors were also asked to rate the acceptability of a series of computer-generated photographs showing a range of people at the base of the fall. These data provide a basis for helping formulate a standard of quality for PAOT at this site.

A computer simulation model of visitor use of Bridalveil Fall was also developed (Manning et al., 1999). This model was used to estimate PAOT at the base of the fall. Figure 1 traces PAOT over the minutes of a simulated day. Average daily use at Bridalveil Fall is approximately 3,500 visitors, and the simulated day ran from 7:00am (0 minutes) to 8:00pm (780 minutes). The mean PAOT (69) is represented by a horizontal line.

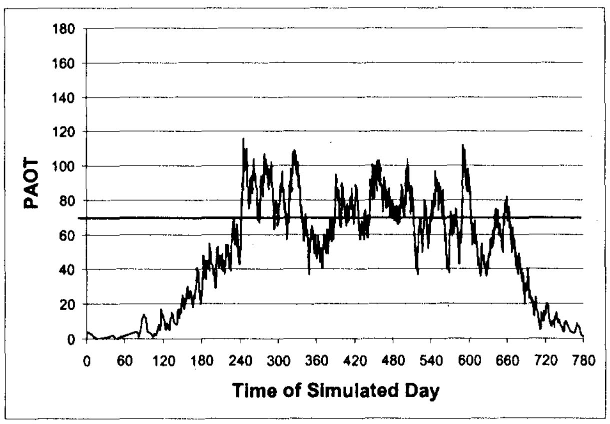

Figure 1. Simulation of Current Conditions at the Base of Bridalveil Fall

Two alternative scenarios were then developed and run using the computer simulation model. These scenarios were designed to simulate visitor use under an ATS. Both scenarios held total daily use of Bridalveil Fall constant at 3,500 visitors, but varied arrival schedules. In the first scenario, visitors arrived in groups of 180 every 30 minutes, and findings from this scenario are plotted in Figure 2. In this scenario, mean PAOT, represented by the higher horizontal line, increased dramatically to 98. In the second scenario, visitors arrived in groups of 45 every 7.5 minutes, and findings from this scenario are plotted in Figure 3. In this scenario, mean PAOT, represented by the lower horizontal line, decreased to 62.

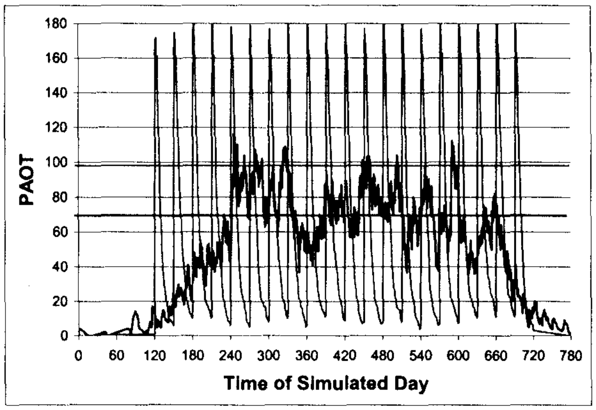

Figure 2. Simulation of Current Conditions and 30 Minute Scheduled ATS at the Base of Bridalveil Fall

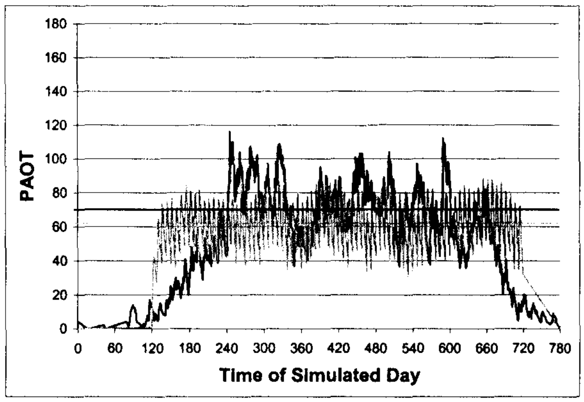

Figure 3. Simulation of Current Conditions and 7.5 Minute Scheduled ATS at the Base of Bridalveil Fall

These results suggest that PAOT, which is a salient indicator of the quality of visitor experience is transportation dependent. Infrequent, large groups can increase average PAOT, thereby effectively decreasing carrying capacity. Further, more frequent, moderately sized groups, can decrease average PAOT, thereby effectively increasing carrying capacity.

Conclusions

Instituting ATS may improve conditions on park roads, but has the potential to both improve and degrade social conditions at park attraction sites. In general, small groups delivered frequently at regular intervals tend to decrease PAOT, while large groups, delivered less frequently, will tend to increase PAOT.

Transportation systems can affect social carrying capacity as measured by indicators of visitor experiential quality. Transportation planners therefore need to carefully consider carrying capacity issues. Integration of transportation planning and social carrying capacity is necessary to institute park planning that does not degrade the quality of the visitor experience. By doing so, park managers can address issues of transportation capacity and social carrying capacity within a single framework. Computer simulation modeling allows manipulation of several dynamic variables at one time (e.g., rate of delivery, group size, scheduling, routing) offering a more comprehensive assessment of potential transportation alternatives, and can be an effective tool integrating transportation planning and social carrying capacity research.

Potential exists for future research into the integration of social carrying capacity and transportation planning. First, applying a variety of transportation scenarios to a park-wide computer simulation model could provide a more complete picture of the interaction between social carrying capacity and transportations systems. Second, inclusion of indicator variables that apply to both transportation planning and social carrying capacity into studies and planning could give managers a broader understanding of how park systems function.

Integration of transportation planning and carrying capacity offers potentially important mutual benefits. Carrying capacity can provide estimates of appropriate use levels at strategic sites within a park, and these data can be used to help design the routing and scheduling of a transportation network. Moreover, an appropriately designed transportation network can be a vital tool in implementing a carrying capacity plan.

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