

# Measuring and Managing the Quality of Transportation at Acadia National Park

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**EXECUTIVE SUMMARY:** In response to increased use of parks and outdoor recreation related areas, transportation legislation passed in 1998 required the Departments of Transportation and Interior to assess transportation needs and develop planning procedures for congestion management in parks and on public lands. One year later, the National Park Service responded by publishing its *Transportation Planning Guidebook*. This publication used a number of case studies to illustrate a range of park management strategies for addressing traffic congestion. A common theme throughout the guidebook was implementation of alternative transportation systems, including shuttle buses and bicycle/pedestrian facilities, in addition to roads. Together, this integrated infrastructure and the forms of transportation accommodated are known as multimodal transportation networks. These networks provide managers opportunities to disperse visitor use over space and time, a strategy for addressing congestion and crowding. As this strategy is more widely used, multimodal transportation is an increasingly important component of the experience of visitors to national parks and related areas. While conventional transportation planning uses a levels of service (LOS) framework to measure and manage many modes of transportation, it lacks measures of visitor experience critical in park and outdoor recreation contexts. Indicators and standards of quality, a framework widely used in the field of park and outdoor recreation management, give explicit consideration to visitor perspectives and incorporate them into management. Using Acadia National Park as a study site, this paper illustrates that LOS and indicators and standards of quality can be integrated to provide a more holistic approach to transportation management in park and outdoor recreation contexts. Furthermore it develops a series of potential standards for density of use on roads, in shuttle buses, and along shared-use paths. These standards provide a rational basis for informed planning and management of alternative transportation in parks and outdoor recreation.

**KEYWORDS:** Indicators and standards of quality, transportation, levels of service, multimodal transportation, quality of service

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Transportation is fundamental to parks and outdoor recreation. For example, every year, millions of visitors travel to, from, and within national parks. But transportation can be more than this—it is often a form of recreation itself, offering most visitors their primary opportunities to experience and enjoy the natural and cultural landscapes embodied by national parks. The iconic roads of many of the crown jewel national parks—Going-to-the-Sun Highway in Glacier National Park, Tioga Road in Yosemite National Park, and the Park Loop Road in Acadia National Park—were designed to allow visitors to experience the parks in their cars (Carr, 2007). In fact, entire units of the national park system, such as Blue Ridge Parkway, have been designed specifically for this purpose. All of these roads were a response to demand for what is historically one of America's most popular recreation activities, "driving for pleasure" (Manning, 2011). Today, bicycling and public transit have begun to offer additional transportation options in a growing number of national parks.

Funding to support these alternative modes of transportation in national parks and other public lands has increased. This includes funding for transit, bicycle, and intermodal facilities (119 Stat. 1144, 23 U.S.C. 202, 203, 204). The Federal Transit Administration continues to assist in planning and managing transit systems for national parks through its Paul S. Sarbanes Transit in Parks Technical Assistance Center (formerly the Alternative Transportation in Parks and Public Lands Program), and the Federal Highways Administration recently published *Guide to Promoting Bicycling on Federal Lands* (Gleason, 2008). With multimodal transportation systems on the rise in parks, it is evident that the means to measure and manage their quality is important in shaping the experience of visitors.

### Research on Transportation in the National Parks

One of the earliest academic treatments of the contemporary field of outdoor recreation suggested that recreation experiences occur in five phases, two of which are travel to and from parks and related areas (Clawson & Knetsch, 1966). Of course, the on-site experience of outdoor recreation also involves some form of transportation (e.g., car, foot) in almost all cases. Thus, a strong linkage between outdoor recreation and transportation has been recognized for some time. Unfortunately, relatively little empirical work has been conducted on the relationship between transportation and outdoor recreation. However, this is beginning to change. A recent analysis of research needs concludes that transportation in the context of outdoor recreation is "much more than getting from point A to B" (Daigle, 2008, p. 62). In other words, transportation can be an important part of the outdoor recreation experience and warrants more attention.

Historically, transportation has been integrated into the context of parks and outdoor recreation through the aesthetic sensibilities of the field of landscape architecture, and this

history has been well documented as it applies to the National Park Service (Carr, 1998). For example, the natural look of many of the scenic roads in the national parks has been attributed to careful planning, design, and construction by landscape architects (Louter, 2006). Stephen Mather, the first director of the National Park Service, even established a landscape engineering department charged with naturalizing park roads and trails (Sutter, 2002). However, only recently has research turned to empirical studies of park visitors and how they view roads and other forms of transportation in parks and outdoor recreation.

For instance, an interpretive study of visitors' perspectives of alternative transportation in Yosemite Valley used semistructured interviews to identify psychological factors and situational influences that affect visitors' perceptions of the park shuttle bus system (White, 2007). The study concluded that psychological factors influencing visitors' perspectives of alternative transportation included "perceived freedom, environmental values and beliefs, prior experience with Yosemite National Park and other national parks, and sensitivity to subjective perceptions of crowding" (p. 50). A need for additional crowding and capacity research for park shuttle bus systems was also noted. A follow-up study of visitor experiences of transportation in Yosemite National Park included multiple forms of transportation including walking, bicycling, park shuttles, and private vehicles (White, 2011). This research documented visitors' transportation mode choices, identified their satisfaction with each mode, explored perceptions of experiential dimensions of these modes, and examined visitors' preferences concerning transportation management. Findings established that all modes of transportation were important in influencing the visitor experience with some differences in levels of satisfaction between traditional and alternative modes of transportation. Traffic congestion was suggested as a potential indicator for measuring the quality of the visitor experience. Furthermore, the study suggests development of transportation-based indicators and standards for measuring and managing the quality of travel in parks.

Precedents for using indicators and standards based frameworks for managing park roads and scenic driving have been set in recent studies (Hallo & Manning, 2009, 2011; Manning & Hallo, 2010). These studies have been conducted in a number of national parks, including Acadia National Park, Cape Cod National Seashore, Blue Ridge Parkway, and Denali National Park and Preserve. As a first phase of these studies, qualitative interviews were used to elicit potential indicators of quality. Respondents across all settings frequently cited congestion and crowding as having an impact on the quality of the visitor experience. The second phase of these studies used visual simulations to illustrate varying numbers of vehicles along park roads. Respondents were asked to rate the acceptability of the conditions in each of the photos on a 9-point scale (ranging from -4 [very unacceptable] to +4 [very acceptable]). These studies suggest thresholds for the maximum acceptable density levels on park roads.

The studies described above suggest integrating indicators and standards into the more conventional transportation concept of "levels of service" as used by the Transportation Research Board (TRB) and its *Highway Capacity Manual (HCM)* (Transportation Research Board, 2010). Defining an "appropriate level of service" has been an important element of transportation planning in the national parks for several decades (National Park Service, 1984, p. 12), but these standards have lacked a strong basis in empirical research. The most recent edition of the *HCM* adopts a perspective that is more in keeping with defining standards based on empirical studies of drivers and other transportation users when it states that levels of service describe "how well a transportation facility or service operates from the travelers' perspective" (Transportation Research Board, 2010, p. 1-2). However, the *HCM* is not written within the context of parks and outdoor recreation.

### **Conceptual Frameworks to Define Quality in Transportation in National Parks Levels of Service**

Current U.S. policy and regulation describes levels of service (LOS) as a conceptual framework that may be used to measure the quality of travel experiences in national parks

(119 Stat. 1144, 23 U.S.C. 204, 23 C.F.R. 970.214). LOS is a highway capacity framework that has guided transportation management across the United States and is reflective of the broader management objectives of the Department of Transportation: “[to] Serve the United States by ensuring a fast, safe, efficient, accessible and convenient transportation system” (80 Stat. 931, 49 U.S.C. 101). It is derived from the TRB’s *HCM* and describes operational conditions within a traffic stream using variables such as speed, travel time, freedom to maneuver, comfort, and convenience (Transportation Research Board, 2000). It defines a range of traffic conditions based upon a letter system (A through F) where A represents the best operating conditions and F the worst. However, this grade system has been critiqued for lacking empirical links to user perceptions (Flannery, Wochinger, & Martin, 2004). While recent research has undertaken a more comprehensive view of factors important to users and has led to a number of explanatory variables that have been used to help develop LOS models, including pavement quality and presence of trees (Transportation Research Board, 2008), they may not fully reflect experiential components of travel, especially in the context of national parks and related areas. Other conceptual frameworks that incorporate experiential elements more explicitly exist in the field of park and outdoor recreation management.

### **Indicators and Standards of Quality**

Conventional transportation management lacks a strong normative component (Kane & Del Mistro, 2003; Manheim, 1973). Norms have been defined broadly as “standards that individuals use for evaluating behavior, activities, environments, or management proposals as good or bad, better or worse” (Shelby, Vaske, & Donnelly, 1996, p. 116). More concisely, social norms, or the use of normative theory to derive social norms, describe what “ought” to be (Manning, 2011). Indicators and standards of quality employ a normative approach and are widely used in outdoor recreation management (Graefe, Kuss, & Vaske, 1990; Manning, 2001, 2007; National Park Service, 1997; Stankey et al., 1985). Indicators are “measureable, manageable variables that help define the quality of parks and outdoor recreation areas and opportunities,” and standards define “the minimum acceptable condition of indicator variables” (Manning, 2007, p. 86). Through use of normative theory and associated empirical methods, standards of quality may be derived in the form of social norm curves (Manning & Krymkowski, 2010; Vaske & Whittaker, 2004). Methods to develop norm curves were initially advanced in the field of social psychology (Jackson, 1966), but have been adapted and applied in research on outdoor recreation and natural resources more broadly (Manning, 2007; Vaske & Whittaker, 2004).

### **The Relationship between Service and Quality**

The relationship between LOS and indicators and standards of quality is expressed by the *HCM*’s interpretation of quality of service. As noted above, the 2010 *HCM* states that quality of service “describes how well a transportation facility or service operates from the traveler’s perspective” (Transportation Research Board, 2010, p. 1–2). While the quality of service concept was also included in the previous edition of the *HCM* in 2000, its definition focused primarily on “quantitative measures to characterize operational conditions” (Transportation Research Board, 2000, pp. 2-2) rather than the traveler’s perceptions of those conditions. The LOS concept has always been represented in the *HCM* as the A to F stratification of quality of service, but only in its most recent edition is the emphasis on including user perceptions for defining LOS made clear. The introduction of numerous traveler perception-based models for describing LOS in the 2010 manual further highlights the importance of this evolution of the LOS concept.

Similar to an indicators and standards based approach, these traveler perception based models set thresholds derived from user perceptions of quality. Furthermore, both LOS and indicators and standards of quality present a continuum of conditions that represent a range of service quality. Indicators and standards of quality define a minimum acceptable condition, and most transportation planning efforts typically use LOS C or D to ensure an “acceptable operating service” (Transportation Research Board, 2000, pp. 2–3). Therefore, it follows that the integration of these frameworks be anchored around

a minimum acceptable condition of quality equivalent to the hard line standard between LOS *D* and *E*. That is to say, any of the conditions deemed acceptable by travelers would be represented by LOS *A–D*, while any of the conditions rated as unacceptable by travelers would be represented by LOS *E–F*. The strict standard between LOS *D* and *E* indicates both a minimum level of acceptability from a traveler's perspective and a level of service that transportation planners aim to exceed. Furthermore, standards for capacities not only distinguish "red light" thresholds, but also establish "yellow light" warnings or cautionary standards (Whittaker, Shelby, Manning, Cole, & Hass, 2011, p. 13). The nexus between indicators and standards of quality and quality of service provides another means of incorporating user perceptions into LOS.

### **Purpose of the Study**

The purpose of this research is to explore the relationship between LOS as used in the field of transportation and indicators and standards as used in the field of parks and outdoor recreation. Conventionally, LOS measures variables such as speed and travel time, which are pertinent to most transportation experiences. However, transportation in the context of parks is often a more recreational experience and therefore demands a more expansive approach to management that also encompasses travelers' perspectives, especially as they relate to enjoyment and appreciation of parks and related areas. Indicators and standards of quality are designed to incorporate experiential variables into the management process and thus provide a means of bridging the theoretical gap between the fields of transportation and outdoor recreation. The study addresses three modes of transportation at Acadia National Park: cars on the Park Loop Road; bicycle/pedestrian travel on the carriage roads; and buses on the park's transit system, the Island Explorer. The research design employs surveys of users of these three modes of transportation to identify indicators of quality, measure normative standards for density of use, and integrate study findings into a comparable LOS framework.

### **Method**

#### **Study Location**

Acadia National Park was established in 1916 in recognition of its scenic beauty, rich history, and recreational values (Manning, 2009). Acadia is arguably the most intensively used national park with over 2 million annual visits on only 47 thousand acres. Nearly all visitors travel through the park by car, bicycle, and/or shuttle bus.

The Acadia Park Loop Road provides visitors an opportunity to drive for pleasure and see many of the iconic features of the park. It is one segment of the All-American Road referred to as the Acadia Byway. An All-American Road is the highest scenic designation a road may receive and requires recognition of at least two intrinsic qualities (National Park Service Management Systems, 2011). The Acadia Byway received recognition for both its recreational and scenic qualities (National Scenic Byways Online, 2010).

Acadia's 50-mile system of carriage roads is one of the park's principal recreation assets. Originally built for horse and carriage use in the first half of the 20th century, the system today serves primarily as a bicycle/pedestrian facility (Thayer, 2002) and provides not only a form of recreation, but also a means of traveling from one point in the park to another. For instance, while the carriage roads themselves incorporate scenic vistas for an enjoyable journey, they also allow visitors to reach quintessential park destinations such as the visitor center and historic Jordan Pond House.

The Island Explorer is a shuttle bus system that delivers visitors to, from, and around Acadia National Park. The bus service utilizes intelligent transportation systems technology to provide real-time information to visitors and also incorporates the use of alternative fuels. Subsidized by the L.L. Bean Corporation, bus service is provided free of charge to visitors and has been in operation at the park since 1999. It was one of the National Park Service's first alternative transportation pilot projects and has reduced congestion and

greenhouse gas emissions within the park (National Park Service, 1999). Together, the Park Loop Road, carriage road system, and Island Explorer provided the opportunity to collect qualitative and quantitative data on travelers' perspectives of quality across three primary modes of transportation in one national park.

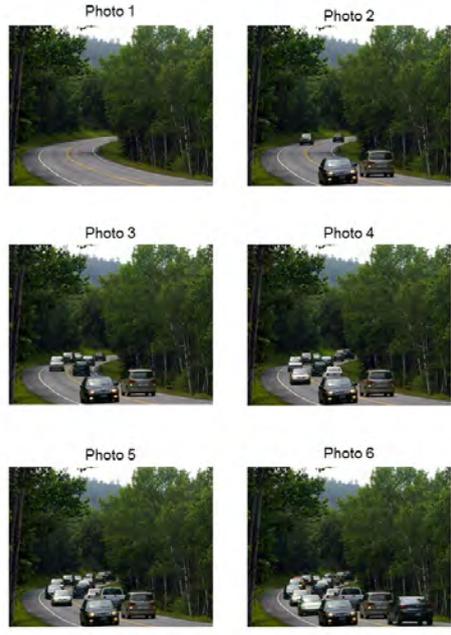
### Sampling Sites

Travelers using multiple modes of transportation were surveyed during July 2009. A purposive sampling approach was designed to target users of each mode of transportation. For cars, survey administrators were based at three locations along the Park Loop Road. The survey sites were located in parking areas that allow access to a number of park attractions including a historic site and trailheads. Surveyors collected data during the daylight hours and were asked to approach each group as they entered the survey site. The same approach to survey administration was applied to the carriage roads. Sampling locations were also chosen to survey transit users, including an intermodal facility located in the gateway community of Bar Harbor, a historic site and a natural attraction site.

### Survey Instrument

Three versions of the study questionnaire were developed to measure indicators and standards of quality for the three modes of transportation in Acadia. All three questionnaires included a section of open- and close-ended questions including a list of items that might be considered by respondents as desirable or undesirable components of a transportation system. The open-ended questions were designed to identify indicators that have an impact on visitors' travel experience. Specifically, they asked respondents what they most and least enjoyed about their travel by car, bus, or along the carriage roads. The close-ended sections of the questionnaires asked respondents to rate the desirability of a list of attributes for transportation systems. These batteries of questions were structured similarly, but included different potentially desirable items that were tailored to each of the three modes of transportation. These items were selected based upon a combination of literature review and brainstorming by researchers and park staff. Respondents were asked to rate the degree to which each item was considered desirable or undesirable using a scale that ranged from -2 (*very undesirable*) to +2 (*very desirable*).

The survey was also designed to measure normative standards of respondents for density of use for all three modes of transportation. Normative research methods as described earlier were used for this purpose. A series of visual simulations was used to present visitors with a range of density conditions on the Park Loop Road and the carriage roads. Prior studies validate visual simulation as an effective means of measuring crowding related standards (Manning, 2007; Manning & Freimund, 2004). For the Island Explorer, narrative and numerical descriptions of a range of density-related conditions were used based on measures taken from the *HCM* (Transportation Research Board, 2000). For the Park Loop Road, a series of six photographs was constructed for a 125-meter section of road, and these photographs showed a range of zero to 20 cars (Figure 1). For the carriage roads, a series of seven photographs was constructed of a 125-meter section of trail, and these photographs showed a range of zero to 36 users, with equal proportions of walkers and bikers (Figure 2). For the Island Explorer, short narrative statements were used to present six density of use levels on buses that ranged from 2.0 seats per rider to .5 seat per rider (Table 1). Respondents were asked to evaluate the acceptability of each photograph or description on a scale bounded by -4 (*very unacceptable*) to +4 (*very acceptable*).



*Figure 1.* Visual Simulation of Park Loop Road Traffic



*Figure 2.* Visual Simulation of Carriage Road Use

**Table 1***Narrative and Numerical Descriptions of Use Density on Island Explorer*

Level of Service (LOS)	Narrative and Numerical Description
A	No rider needs to sit next to another. There are more than two seats for each rider.
B	Riders can choose where to sit. There are three seats for every two riders.
C	All riders can sit. There is one seat for each rider.
D	All seats are occupied and a few riders must stand. There are five riders for every four seats.
E	All seats are occupied and many riders must stand. There are three riders for every two seats.
F	All seats are occupied and half of all riders must stand. There are two riders for every seat.

**Data Analysis**

Data analysis was conducted to identify indicators and standards of quality for the three modes of transportation included in the study. This included three principal steps. First, open-ended responses to the questions about what was enjoyed most and least about each of the three modes of transportation were read and transcribed verbatim into a dataset using SPSS v.19. Responses were coded based upon recurring themes throughout the data, and multiple coders were used to ensure reliability. This process for coding open-ended responses is in keeping with qualitative research and evaluation methods (Maxwell, 2005; Patton, 2002). Codes encompassed the majority of responses, and any outlying responses were coded as miscellaneous. The total number of responses for each code was recorded and then divided by the sum of overall responses to provide a rank-ordering of indicators based upon which codes were most frequently cited. The second step in the analysis was a simple mean score evaluation of the desirability of the potential attributes (or indicators of quality) included in the close-ended question. Third, social norm curves were derived from the question addressing crowding-related standards of quality. Average acceptability ratings for each point along the range of conditions presented to respondents was calculated and plotted.

It should be noted that Park Loop Road users, carriage road users, and Island Explorer users are not necessarily mutually exclusive. For example, a park visitor may use all three modes of transportation at some point during the stay in the park. However, the surveys in this study engaged visitors in situ and asked them about the travel activity in which they were currently participating. For example, the survey designed to develop indicators and standards for carriage road travel was administered only at sites along the carriage roads, and asked questions specifically and singularly about the respondents' use of the carriage roads on that day.

## Results

### Park Loop Road Indicators

A total of 252 completed questionnaires were collected along the Park Loop Road (87% response rate). Responses to open-ended questions asking visitors what they enjoyed most and least about their trip along the Loop Road revealed several potential indicators of quality for recreational driving. One indicator that arose from the study was density of use. Responses related to “traffic,” “congestion,” and “crowds” were coded together, and this was most frequently cited as what visitors enjoyed least about their trip (20% of respondents). This was followed by “parking” (lack of parking, unauthorized parking) (19%), another manifestation of vehicular density levels. Density of use is a potentially good indicator because it is both measurable and manageable; it can be measured, as in this study, by the number of vehicles using a predetermined length of road at any one time, and it can also be managed using a variety of outdoor recreation management practices. For example use of the Loop Road could be limited, or use could be dispersed over space and time via alternative modes of transportation such as transit or cycling.

Analysis of the close-ended questions regarding potential indicators of quality included three items related to density of use, including “few vehicles on the road,” “adequate spacing between vehicles,” and “ability to maneuver as you drive (change lanes, slow/stop).” Average respondent ratings on the desirability scale (ranging from -2 to +2) were 1.11, .95, and .95, respectively, and this corroborates density of use as an important indicator of quality to the recreational driving experience.

A second indicator that arose from the study was related to characteristics of the landscape. For instance “scenery” and “views” were most frequently reported as what visitors enjoyed most about their trip (39% of respondents). Prior research on the Park Loop Road measured visual preferences of drivers and offered management strategies such as opening views and increasing visual screening (Steinitz, 1990); therefore, scenery and views also make potentially good indicators of quality for recreational driving. In response to the list of attributes that could be desirable to their park road experience, visitors evaluated three items related to scenery including “scenic views,” “limited development (houses, businesses) along the road,” and “scenic overlooks/pull-offs.” Average respondent ratings on the desirability scale (ranging from -2 to +2) were 1.85, 1.72, and 1.63, respectively, and this confirms scenery and views as potentially important indicators of quality for the recreational driving experience.

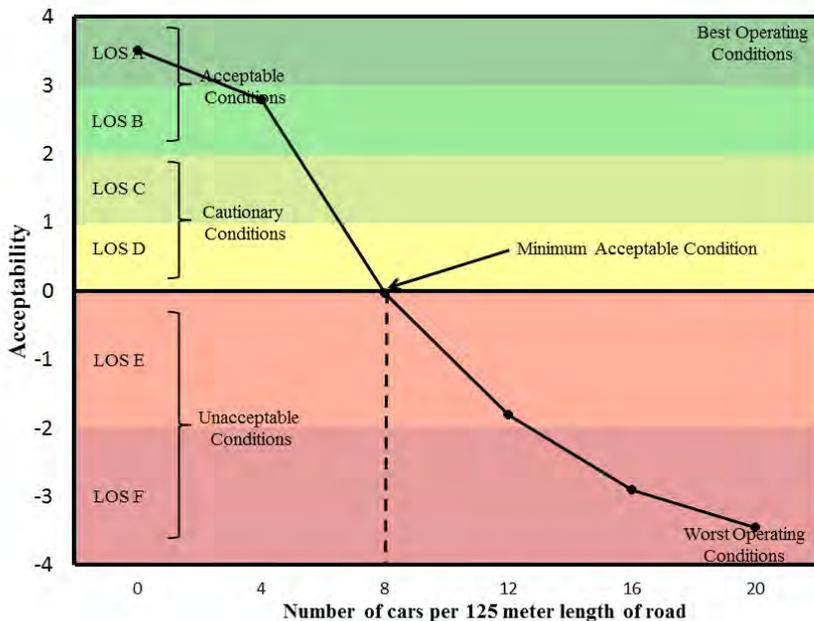
### Park Loop Road Standards

Average visitor acceptability ratings for the visual simulations showing a range of cars per 125-meter length of road are plotted to form the social norm curve in Figure 3. The LOS conceptual framework has been overlaid to portray the relationship between LOS and normative standards of quality. The overlay was anchored around a minimum acceptable condition, or hard line standard between LOS *D* and *E*, in keeping with the language of the *HCM* described earlier. The norm curve shows that as the number of cars on the road increases, acceptability decreases. Average respondent ratings fall out of the acceptable range and into the unacceptable range at approximately eight cars per 125 meters of road.

### Carriage Road Indicators

A total of 249 completed questionnaires were collected along the carriage roads (94% response rate). Responses to open-ended questions asking visitors what they enjoyed most and least about their trip on the carriage road revealed several potential indicators of quality for recreation on a shared use path. One indicator that arose from the study was density of use. “Crowds,” “traffic,” and “too many people” were coded together, and this was frequently cited as what visitors enjoyed least about their trip (12% of respondents) second only to “poor route quality,” “condition,” and “design” (14%), which were also coded together. Density of use is a potentially good indicator because it is both measurable and manageable. It can be measured, as in this study, by the number of users walking or biking on a predetermined length of path at any one time. It can also be managed using

a variety of outdoor recreation management practices. For example, managers at Acadia National Park have established two crowding-related standards for two types of recreation opportunity “zones” on the carriage roads (Manning, 2009). Establishing similar density of use standards for these zones, and carefully monitoring them through the use of electronic trail counters, observations by park staff, and visitor surveys could reveal excess capacity in one zone or the other. Park managers could then promote use in under capacity areas, thereby reducing congestion through the dispersal of use over space and time.



**Figure 3.** Social Norm Curve for Traffic Congestion on the Acadia Park Loop Road

Analysis of the close-ended question regarding density of use asked respondents how desirable they found having “few people on the greenway.” The average respondent rating on the desirability scale for this item was .82, and this corroborates density of use as an important indicator of quality to the carriage road experience.

Like the Park Loop Road, a second indicator that arose from the study was related to characteristics of the landscape. For instance in the open-ended questions, “scenery” and “views” were most frequently cited as what visitors enjoyed most about their trip (35% of respondents). And in the close-ended questions respondents evaluated two items related to scenery, including “scenic views” and “scenic overlooks/pull-offs.” Average respondent ratings on the desirability scale (ranging from -2 to +2) were 1.88 and 1.44, respectively, and this confirms scenery and views as potentially important indicators of quality to the carriage road experience.

### Carriage Road Standards

Average visitor acceptability ratings for the visual simulations showing a range of users per 125-meter length of carriage road are plotted to form the social norm curve in Figure 4. The LOS conceptual framework has been overlaid to portray the relationship between LOS and normative standards of quality. The overlay was anchored around a minimum acceptable condition, or threshold between LOS *D* and *E*, in keeping with the language of the *HCM* described earlier. The norm curve shows that as the number of users on the carriage road increases, acceptability decreases. Average respondent ratings fall out of the acceptable range and into the unacceptable range at approximately 21 users per 125 meters of trail.

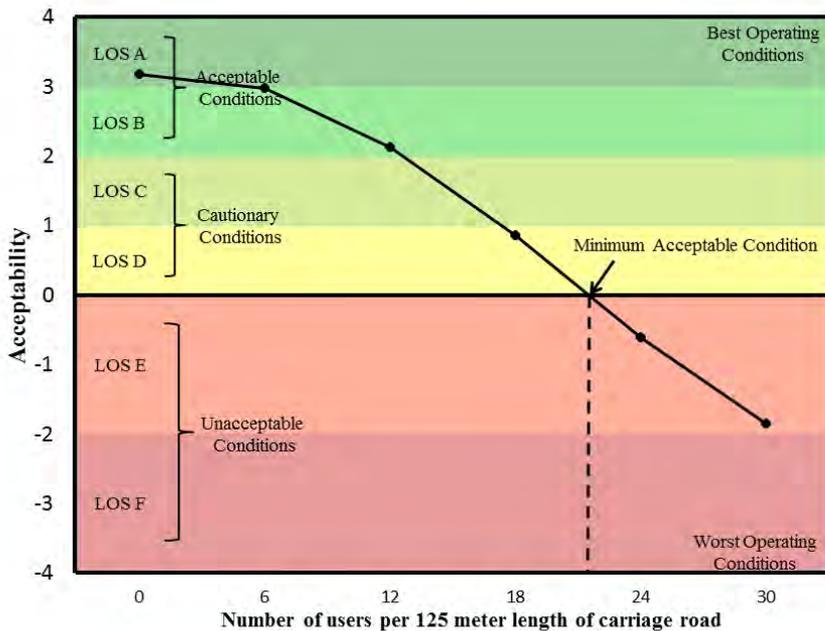


Figure 4. Social Norm Curve for Use on the Acadia Carriage Roads

### Island Explorer Indicators

A total of 249 completed questionnaires were collected among riders of the Island Explorer (79%). Responses to open-ended questions asking visitors what they enjoyed most and least about their trip on the Island Explorer revealed several potential indicators of quality for shuttle-based transportation. As with the Park Loop Road and carriage roads surveys, one indicator that arose from the study was density of use. For instance, “having to stand” and “crowds” were coded together, and this was cited as what visitors enjoyed least about their trip (8% of respondents). In this case, however, density of use ranked third as an indicator of quality after “frequency of trips”/“wait times” (25%) and “poor route quality”/“condition”/“design” (11%). Density of use is a potentially good indicator because it is both measurable and manageable. It can be measured, as in this study, by the number of seats available for riders. It can also be managed using a variety of outdoor recreation management practices. For example, use of the Island Explorer could be limited or dispersed over space and time via alternative modes of transportation such as driving or cycling.

Analysis of the close-ended questions regarding potential indicators of quality included two items related to density of use, including “having plenty of room” and “ability to move around freely within the bus.” Average respondent ratings on the desirability scale (ranging from -2 to +2) were 1.06 and .24, respectively. This corroborates density of use as an important indicator of quality to the Island Explorer experience.

As noted above, the second indicator that arose from the study was related to convenience. “Frequency of trips”/“wait times” was most frequently cited as what visitors enjoyed most about their trip (i.e., respondents were reporting that they found buses to be scheduled frequently and that this resulted in short wait times) (21% of respondents). Trip frequency is a good indicator because it is both measurable and manageable. Acceptability of varying wait times may be measured, and managers may alter bus schedules to satisfy visitor demand.

In response to the list of attributes that could be desirable to their shuttle bus experience, visitors evaluated two items related to convenience including “the bus arrives at stops frequently” and “the bus arrives at stops on schedule.” Average respondent ratings on the desirability scale (ranging from -2 to +2) were 1.22 and 1.47, respectively. This confirms trip frequency and scheduling are potentially important indicators of quality to the Island Explorer experience.

### Island Explorer Standards

Average visitor acceptability ratings for the narrative descriptions illustrating a range of seats available for riders are plotted to form the social norm curve in Figure 5. The LOS conceptual framework has been overlaid to portray the relationship between LOS and normative standards of quality. The overlay was anchored around a minimum acceptable condition, as with the other transportation modes, and in keeping with the language of the *HCM* described earlier. The norm curve shows that the most acceptable condition is about one seat per rider and that acceptability falls as the number of seats per rider increases and decreases from that point.

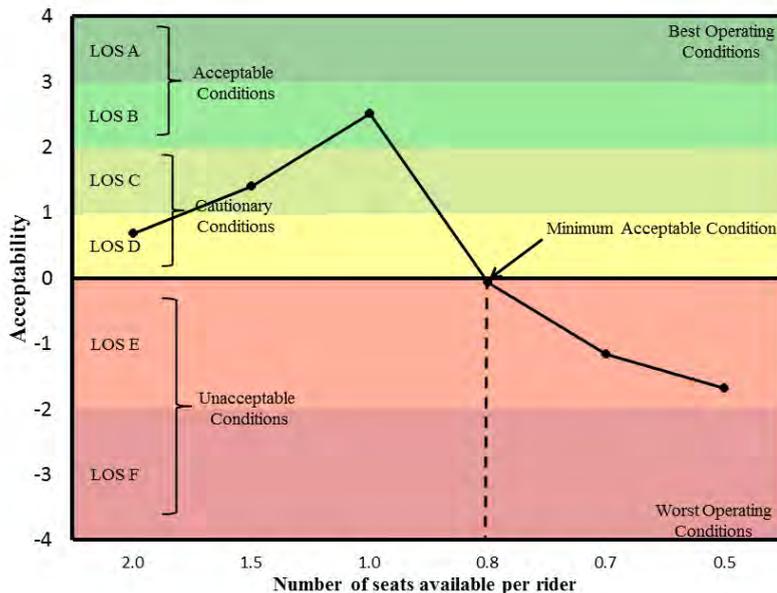


Figure 5. Social Norm Curve for Congestion on the Island Explorer

## Discussion

Responses to the open-ended and close-ended questions in this study identify several potential indicators of quality for transportation in parks and outdoor recreation and suggest how the relative importance of these indicators may vary across multiple modes of transportation at Acadia National Park. Density of use appears to be an important indication of the visitor experience for all modes of transportation studied: foot, car, shuttle bus, and bicycle. In the open-ended questions for Island Explorer riders, density of use was the third most important indicator after frequency of service and route quality. For carriage road users, density of use was the second most important indicator after route quality. For visitors traveling by car on the Park Loop Road, density of use was the most important indicator. Close-ended questions asked respondents to rate the desirability of a list of transportation-related attributes. Each set of attributes was tailored to each mode of transportation, and these items varied across surveys. Therefore, it is difficult to directly compare and draw conclusions related to the relative importance of density of use across the three modes of transportation. However, low density-related attributes were rated as highly desirable for all three transportation contexts included in the study. While more research is needed to further explore the relative importance of indicator variables to the park travel experience, a principal finding of this study is that density of use is an important element of multiple modes of travel in Acadia National Park.

The importance of density as an indicator for all three modes of transportation is in keeping with the literature on both transportation (Transportation Research Board, 2000, 2008) and parks and outdoor recreation (Manning, 2007, 2009). However, the way in which density is manifested varies by mode of transportation; density for a park road may be expressed as the number of cars per length of road; density on greenways may be the number of users per length of trail; and density of use for transit may be the number of riders on a shuttle bus. Relevant measures of density are potentially important indicators of quality for managing transportation in parks and related areas. Study findings also suggest that normative research can be used to derive standards of quality for density related indicators as applied to multiple modes of transportation.

Study findings also illustrate the ways in which the two conceptual frameworks used in the study are compatible. LOS implicitly uses indicators and standards by suggesting that issues such as density of use (i.e., indicators of quality) are important to travelers and that there is a wide range of conditions (i.e., standards of quality) for these indicators that spans conditions from *very acceptable* (LOS *A*) to *very unacceptable* (LOS *F*). The normative data on standards of quality offer a more empirical approach to informing LOS, including identifying a threshold of acceptability—the minimum level of an indicator of quality that is acceptable to visitors. As evidenced by language in the *HCM* described earlier, this minimum level of acceptability coincides with the threshold between LOS *D* and *E* for conventional transportation planning and provides a rational anchor for overlaying the rest of the LOS conceptual framework.

Building on the nexus between these conceptual frameworks, LOS may need to be extended and revised in the context of parks and outdoor recreation to include more indicators of quality that address the experiential component of such use. For example, LOS conventionally addresses the issue of efficiency in transportation (i.e., the shortest travel time), but in the context of parks and outdoor recreation it has been suggested that additional variables may need to be included when managing for high quality transportation experiences (Hallo & Manning, 2009). For instance, opportunities to drive or ride slowly, to stop when wanted, and to travel under low levels of use so that visitors are able to see and experience the landscape may be more important than traditional measures of efficiency. Findings from this study corroborate this research and extend it across multiple modes of transportation in park settings. As illustrated in the qualitative component of this study, other potential indicators of quality for transportation in parks and outdoor recreation might address issues such as character of surrounding landscape and condition

and design of the transportation facility. Moreover, standards of quality may have to be reregistered from conventional *HCM*/LOS guidelines to ensure they are appropriate in the context of parks and outdoor recreation. For example, a comparison of the *HCM*'s LOS guidelines for shuttle buses (see Table 1) and the social norm curve for the same descriptions in Figure 5 illustrate incongruence between frameworks. Conventional LOS guidelines in the *HCM* suggest that decreasing numbers of seats per rider are increasingly unacceptable. But the standards of quality data in this study found that the most desirable situation for park visitors is having one seat available for every rider. This may suggest that there is a "social" component to transit in parks; that is, visitors may wish to share the ride with similarly minded other riders, as long as all riders have a seat. Or, perhaps visitors perceive a half empty bus as inefficient and ineffective as an environmentally friendly mode of transport. This would be in keeping with past studies that link the use of alternative transportation with proenvironmental attitudes (White, 2007).

### **Implications for Managers**

The LOS-related standards of quality derived from travelers' perspectives developed in this study have direct implications for park and public land managers. For instance, park management objectives include providing enjoyable visitor experiences, and this should include the important travel component of the recreation experience. The indicators and standards identified in this study provide an empirical basis for managing transportation in the context of parks and outdoor recreation. Indicators and standards are a vital component of contemporary park and outdoor recreation management frameworks (Manning, 2001, 2007; National Park Service, 1997; Stankey et al., 1985). Once indicators and standards are formulated, indicators are monitored and management actions taken to ensure that standards are maintained.

Transportation-related indicators and standards also offer park managers insight about managing alternative forms of transportation. For example, visitors to Acadia National Park can travel to Jordan Pond House, one of the park's iconic attractions, by car or shuttle bus on the Park Loop Road, or they can walk or bike there on the carriage roads. Formulating and monitoring indicators and standards for each of these forms of transportation would help inform park managers about which forms of transportation should be promoted. For example, if automobile traffic on the Park Loop Road is in danger of violating standards of quality, then managers may want to encourage use of the Island Explorer (e.g., provide more frequent service) or the carriage roads (e.g., offer guided interpretive walks or bike rides).

Transportation-related indicators and standards might also be used to help design Intelligent Transportation Systems (ITS) in parks. For example, automated traffic counters on the Park Loop Road and carriage roads, along with monitoring of ridership by drivers on Island Explorer buses, could provide real-time information to visitors about when and where transportation-related conditions are not meeting visitor-based standards of quality, offering visitors a chance to adjust their use of the park accordingly. Acadia National Park has already experimented with ITS related to conditions at parking lots (Daigle & Zimmerman, 2004), and Yosemite National Park uses computer models to estimate crowding-related conditions at key park attraction sites based on counts of inbound vehicle traffic (Lawson, Newman, Choi, Pettebone, & Meldrum, 2009).

### **Study Limitations and Future Research**

While this study was conducted across multiple transportation facilities and incorporated perspectives of multiple user types, it was limited to a single scenic road corridor, greenway, and shuttle system. Given these limitations, the site-specific standards derived may not be generalized to all park transportation modes or facilities.

Clearly, more research is needed to further test and develop the relationships between the LOS framework as used in the *HCM* and indicators and standards of quality as used in the park and outdoor recreation literature. For example, more study is needed of the

potential indicators of quality for the many modes of travel that can be used in parks. For instance, results from this study found that density of use on shuttle buses is a prominent element of travelers' experience. However, study results also suggested that convenience might play an equally important role in measuring the quality of service for transit. Further research could determine another set of standards for the convenience of bus service (e.g., frequency of service). Moreover, researching the relative importance of transportation-related indicators, such as density of use and convenience, is pertinent for park and outdoor recreation managers. For instance, if park managers want to promote alternative forms of transportation and convenience is more relevant to the park travel experience than conditions of density, park managers might influence visitor travel choices more effectively by making some modes of transportation more convenient than others (e.g., providing more frequent bus service while limiting the availability of parking). Standards of quality may also vary substantially depending on the types of users on roads (e.g., cars, trucks, buses, RVs) and trails (e.g., hikers, bikers, equestrians). Engaging these diverse travelers and their perspectives on quality also warrants further research. Moreover, using the language of the *HCM* as a rationale, the integrated framework presented in this study identifies a minimum acceptable condition anchored at the margin between LOS *D* and *E*. However, LOS *A–D* and *E–F* present a range of acceptable and unacceptable conditions with no empirically discernible boundaries. Further research using alternative evaluative dimensions in addition to “acceptability” could potentially aid in refining these boundaries. For example, research on normative standards in parks and outdoor recreation has used the concepts of “preference” (the condition respondents prefer) and “displacement” (the condition that would drive visitors away from the park) to identify a broad range of conditions in parks based on the quality of visitor experience (Manning, Valliere, Wang, & Jacobi, 1999).

### Conclusion

Multimodal transportation is an important but understudied component of the visitor experience in national parks and related areas. The conceptual frameworks of LOS and indicators and standards of quality can be integrated to measure and manage transportation in the context of parks and outdoor recreation. This study illustrates this approach through research on three modes of transportation at Acadia National Park. More research is needed to identify additional indicators and standards of quality for transportation in parks and outdoor recreation, and to extend and reregister conventional LOS guidelines in this new context.

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