

Traveler Perspectives of Greenway Quality in Northern New England

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ABSTRACT

Greenways exist across a range of landscapes from urban to natural and serve society as transportation corridors as well as recreational pathways. Due to these dual functions, they warrant an interdisciplinary approach to planning and management that incorporates frameworks from both the fields of transportation and outdoor recreation. The intent of this research was therefore to: (1) investigate the relationship between transportation and recreation from a greenway user's perspective; (2) consider and integrate transportation and recreation frameworks that measure quality of greenway travel; and (3) determine the significance of settings in users' perceptions of quality. On-site surveys of users across three greenways in northern New England (n=841) were administered to solicit knowledge of how travelers use and perceive the quality of these facilities. Findings suggest greenways are used primarily for recreation, but often incorporate varying elements of transportation. Furthermore, travelers' perceptions of quality differ across settings. This paper also illustrates that transportation and recreation planning frameworks may be integrated to provide a more holistic approach to greenway planning and management.

INTRODUCTION

Greenways can serve society in numerous ways, including as conduits for non-motorized transportation and as recreation opportunities. They have been defined as “any natural or landscaped course for pedestrian or bicycle passage” (1, pg. 1), classified as “shared pedestrian-bicycle facilities” by transportation engineers (2, pg. 18-6), and referred to as “bicycle and pedestrian pathways” by outdoor recreation planners (3, pg. 72). They may be found from Manhattan’s Central Park to the rim of Grand Canyon National Park. Spanning a spectrum of urban, suburban, rural, and natural settings, their users may ride horseback, cross-country ski, rollerblade, or skateboard. With concrete, asphalt, gravel, or natural surfaces, they have been called many names; from multi-use pathways and esplanades to towpaths and trails. Regardless of nomenclature, greenways as a rule are non-motorized corridors separated from all motor-vehicle traffic. However, exceptions may be made for emergency services, maintenance, and other case-by-case permitted access. As pertains to this paper, they provide opportunities to walk and bike for both pleasure and practical ends.

In the interest of promoting walking and biking, funding opportunities for greenway development have increased in recent years. In 1991, passage of the Intermodal Surface Transportation Efficiency Act (ISTEA) unlocked new funding sources for bicycle and pedestrian facilities. The Transportation Equity Act for the 21st Century (TEA-21) further increased this funding in 1998, and most recently the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) continued the trend in 2005. This funding has led to greenway growth in urban and natural settings and has enhanced both transportation and recreation opportunities. As greenways expand across landscapes, it is evident that the means to measure and manage their quality is important.

PRIOR GREENWAY RESEARCH

A number of studies have begun to consider greenways. They have been discussed as an evolving landscape form dating back over 2000 years (4), classified into three distinct historic ‘generations’ (5), and considered a landscape planning tool of substantial potential for the future (6). They have been the focus of multi-objective planning scenarios in Concord, North Carolina (7), and a continuing challenge in collaborative planning and regional coordination in New England (8, 9). Yet, studies of user perceptions of greenway travel remain relatively limited.

One study of user perceptions utilized on-site surveys at 13 greenway trails in metropolitan Chicago. The study focused on perceived trail preferences and problems and findings suggested how factors such as vegetation management and trail surfacing can affect user preferences (10). Another study, related to user perceptions and quality of life, focused on three urban settings in Texas (11). This study distinguished travelers based upon if they used the greenway for commuting only, recreation only, or mixed uses. Findings suggested that recreationists believed greenways contributed to their quality of life most through health/fitness and the natural areas they offer, while commuters valued reduced pollution and transportation costs most. While both of these studies help guide this paper, they focus primarily on urban contexts. Furthermore, they tend to dichotomize trip purpose into transportation or recreation rather than considering the inherent relationship between the two (12).

While prior studies have considered user perceptions of greenway travel, this study distinguishes itself in a number of ways. First, rather than dichotomizing trip purpose as either transportation or recreation, it considers the relationship between the two and illustrates the oftentimes mixed nature of greenway use. Thus, the study begins to justify the incorporation of more experiential elements of transportation rather than just travel time, speed, etc. Second, rather than focusing on a single location or even a number of locations within a similar context, this study encompasses a wider range of greenway opportunities. In this way, a comparative analysis between city (urban), village (rural), and national park (natural) contexts could be made. Third, while prior studies have begun to develop user-perception based models for greenway travel this is the first to utilize a framework from the field of outdoor recreation management. This indicator and standard based framework is focused on user perceptions of quality and therefore provides an apt integration in the LOS framework widely used in the field of transportation.

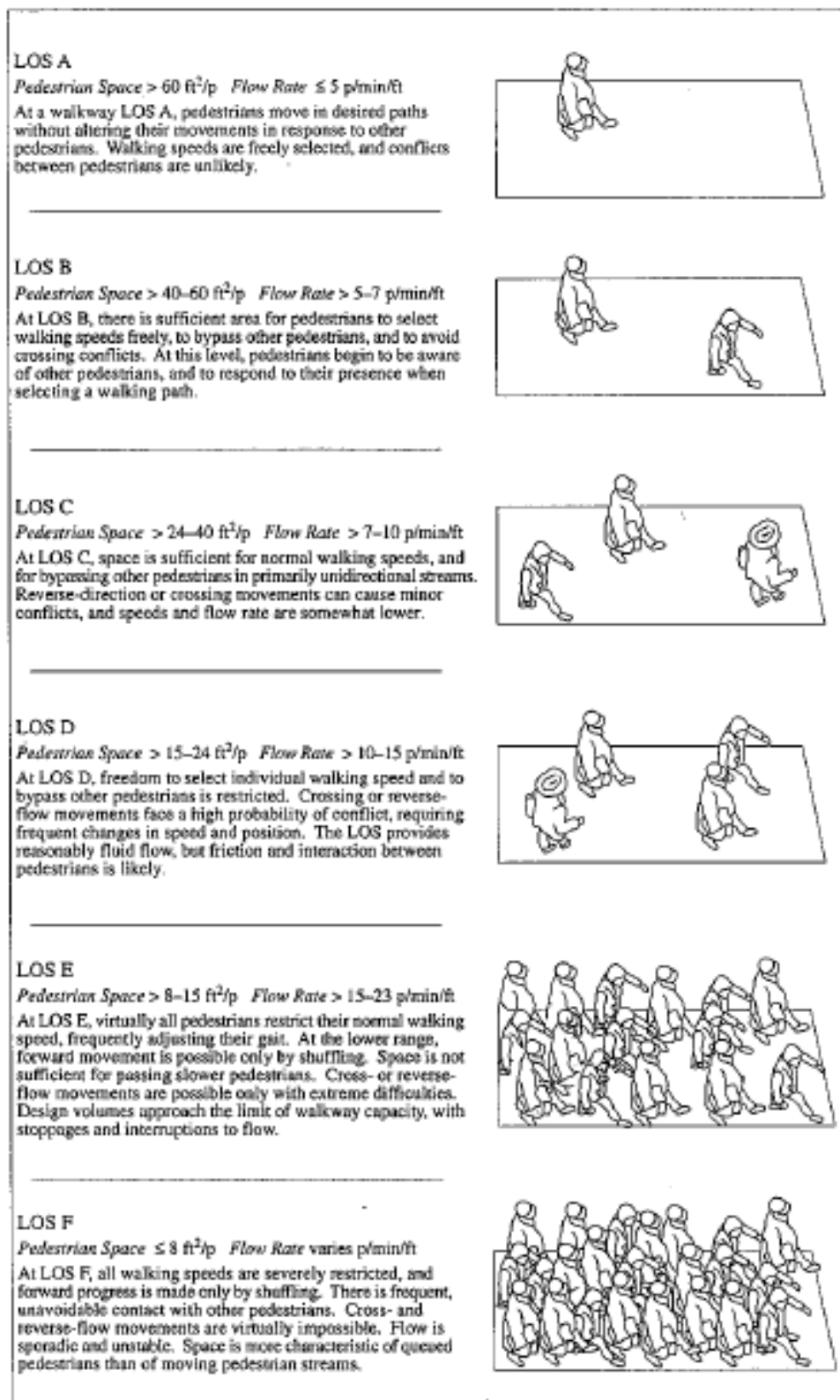
As greenways continue to develop and expand across landscapes, the relationship between contextual settings, transportation, and recreation warrants further examination. Information regarding user perceptions of greenway travel will lead to improved planning and management of greenways, and by investigating a wider spectrum of greenway opportunities, a systematic approach to planning and managing for a range of diverse travel preferences may be achieved. Therefore, the purpose of this study was to: 1) investigate the relationship between transportation and recreation from a greenway user's perspective, 2) consider and integrate transportation and recreation frameworks that measure quality of greenway travel, and 3) determine the significance of settings in users' perceptions of quality.

CONCEPTUAL FRAMEWORKS FOR MEASURING THE QUALITY OF GREENWAY TRAVEL

Level of Service

Level of service (LOS) is a conceptual framework that has guided transportation planning 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" (Department of Transportation Act). It is derived from the Transportation Research Board's Highway Capacity Manual (HCM) and describes operational conditions within a traffic stream using variables such as speed, travel time, freedom to maneuver, comfort, and convenience (2, 13). It defines a range of traffic conditions based upon a letter grade system (A through F); where 'A' represents the best operating conditions and 'F' the worst. Figure 1 is one representation of this organizational framework in the HCM for a pedestrian walkway facility. The LOS framework is operationalized for numerous types of transportation facilities, but may utilize different conventions in doing so. For example, some freeway segments may use speed and intersections may use time delay. Regardless, the intent of LOS was to create a familiar and widely understood tool for presenting transportation plans to the public (2, 13). However, this grade system has been critiqued for lacking empirical links to user perceptions (14). 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 develop LOS models (15), it may not fully reflect experiential components of travel, especially in the context of greenways.

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FIGURE 1 An organizational framework for LOS in the HCM (2, pg. 11-9).

For instance, attempts to describe the quality of bicycle and pedestrian travel have focused primarily on user interactions rather than a more holistic set of experiential factors. The HCM defines LOS for shared-use paths based upon hindrance, or the number of events (meetings or passings of users) a pedestrian or cyclist experiences while traveling on a greenway (2). Models incorporating this concept have been developed to incorporate hikers, bikers, and joggers but remain reliant primarily upon the number of overtakings between users (16). While some studies have begun to incorporate real-time human perceptions into a bicycle level of service (17), they too have focused primarily upon impacts from other road users rather than elements such as the surrounding environment. Furthermore, it has been suggested that some modes of transportation, such as pedestrian activity, include a ‘breadth of experience’ (18) that has not yet been included in LOS measures. Conceptual frameworks from the field of park and outdoor recreation management help identify these experiential elements and incorporate them into management.

Indicators and Standards of Quality

Transportation management lacks, and could benefit from, the incorporation of a normative component (19, 20). *Indicators and standards of quality* utilize a normative approach and are widely used in outdoor recreation management (21, 22, 23, 24, 25, pg. 28). Indicators are “measurable, 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” (26). Through the use of normative theory and associated empirical methods, standards of quality may be derived from social norm curves (27, 28). Methods to derive norm curves were initially advanced in the field of social psychology (29), but have been adapted and applied in research on outdoor recreation and natural resources more broadly (30, 25).

For example, a hypothetical social norm curve could be developed to define the acceptability of encountering other groups along a hiking trail. Respondents could be presented with a range of hypothetical conditions of the indicator variable (e.g., number of groups encountered along a trail per day), and asked to evaluate their acceptability on a scale of -4 to +4 (-4 being “very unacceptable” and +4 being “very acceptable”). The mean visitor evaluation ratings for the varying levels of the indicator variable may then be plotted to form a social norm curve. The hypothetical norm curve described is illustrated in Figure 2, and suggests a range of acceptable conditions as well as a minimum acceptable condition or standard.

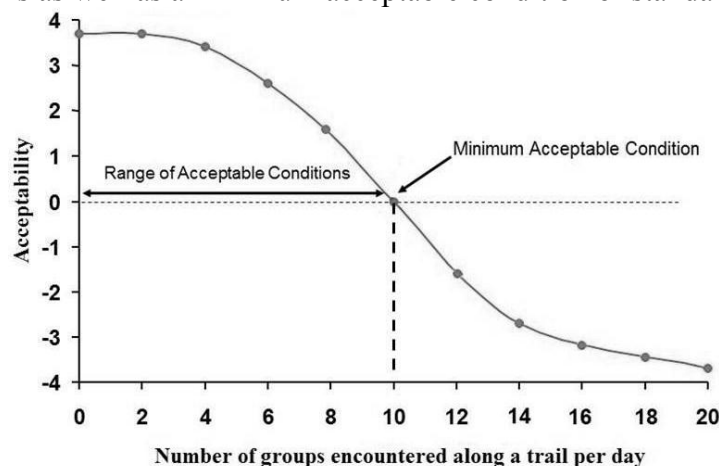


FIGURE 2 Hypothetical social norm curve.

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” (13, pg. 5-1). 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” (2, pg. 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” (2, pg. 2-3). Therefore, it follows that the integration of these frameworks be anchored around a minimum acceptable condition of quality equivalent to the 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 (31). A graphic representation of this relationship is illustrated in Figure 3. This nexus between indicators and standards of quality and quality of service provides another means of incorporating user perceptions into LOS.

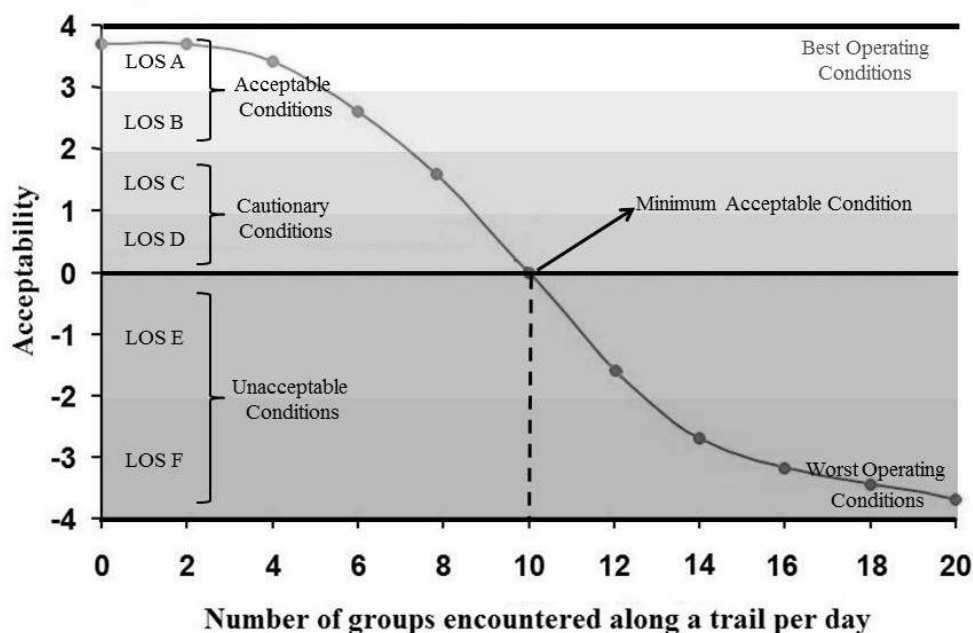


FIGURE 3 Model for an integrated framework.

METHODS

Study Overview

This study utilized on-site surveys across three greenways located in New England. The surveys were designed to measure greenway users' trip purpose, indicators of quality, and standards of quality for density of use along each greenway. Preferences for landscape character were also measured. Each survey utilized open- and close-ended questions in addition to a series of visual simulations designed to elicit respondents' perceptions of travel quality.

Study Locations

Greenway planning and development in New England exemplifies the potential for a system of non-motorized travel networks capable of satisfying both transportation and recreation demand. This was recognized by the 2007 Fabos Landscape Planning and Greenway Symposium which outlined a cohesive network of greenways as part of a multi-state regional system (9). The plan identified both current greenways as well as proposed critical connections. While it lacks regional governance and requires inter-governmental coordination, there still remains a concerted effort to maintain a "New England Greenway Vision Plan" (8). This study considered the northern New England region (spanning the states of Vermont, New Hampshire, and Maine), and chose to focus on three sites within the "Vision Plan" that represent greenways across a continuum of landscape development from natural to urban.

Acadia National Park was established in 1916 in recognition of its scenic beauty, rich history, and recreational values. Located on the southeast coast of Maine, it is arguably the most intensively used national park in the United States with over two million annual visits on only 35 thousand acres (32). It also maintains a 50-mile system of carriage roads. Originally built for horse and carriage use in the first half of the twentieth century, today the system serves primarily as a bicycle/pedestrian facility (33) and provides not only recreational opportunities, but also 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 Stowe Recreation Path was completed in 1989 and extends 5.3 miles from the village center to a mountain resort and spa. Located in the tourism-based community of Stowe, Vermont, it traverses agricultural land, connects to occasional commercial services, and is the culmination of donated easements and town acquired private lands (1). The recreation path provides not only a pastoral setting for visitors, but also serves the community in aspects of both recreation and transportation (34).

The Burlington Bike Path has been called the city's crown jewel (35). It connects the downtown of Vermont's largest city to other communities in the county, has been estimated to generate \$4.5 million dollars in tourism revenue per year, and has its own 13 member task force devoted to planning and managing its future for both transportation and recreation (36). Furthermore it is a major feature of a regional bicycle and pedestrian plan for Vermont's only metropolitan planning organization (37).

1 **Sampling Sites**

2 Greenway users across the three study locations were surveyed during the summer of 2009.
3 Sampling locations were chosen based upon their relative ease of access to visitors. Surveyors
4 collected data during the daylight hours and were asked to approach each group as they passed
5 the survey site. Signs indicating that a research study was in progress were located
6 approximately 50 yards along the trail before the survey site, and incentives of cold drinks and
7 small candies were offered. A total of 249 questionnaires (94% response rate) were collected at
8 the Acadia carriage roads, another 274 (94% response rate) were collected at the Stowe
9 Recreation Path, and 318 (88% response rate) were collected at the Burlington Bike Path.

11 **Survey Instrument**

13 *Measuring Trip Purpose*

14 The survey instrument was designed to measure greenways users' trip purpose. Respondents
15 were asked to use a nine-point scale to rate the purpose of their trip ranging from 1 ("purely
16 transportation") to 9 ("purely recreation"). A statement preceding the question read: "the
17 purpose of using a greenway can range from purely 'transportation' (for example, to get from
18 one place to another) to purely 'recreation' (e.g., to enjoy the journey), or it can be some
19 combination of these purposes. Using the scale below, please indicate the purpose of your use of
20 the greenway today." Rather than dichotomizing trip purpose, this scale provided an opportunity
21 for respondents to consider their trips as both functional and fun.

23 *Measuring Indicators and Standards of Quality*

24 The survey instrument was also designed to measure indicators and standards of quality for each
25 of the three greenways. The questionnaire included a section of open- and close-ended questions
26 as well as a list of items that might be considered by respondents as desirable or undesirable
27 components of a greenway. The open-ended questions were designed to identify indicators that
28 have an impact on users travel experience. Specifically, these questions asked respondents what
29 they most and least enjoyed about their travel along the greenway. The close-ended section
30 included items that may be considered potentially desirable or undesirable components of a
31 greenway. Respondents were asked to rate the degree to which each item was considered
32 desirable or undesirable using a scale that ranged from -2 ("very undesirable") to +2 ("very
33 desirable").

34
35 The survey was also designed to measure normative standards of respondents for density
36 of use along the greenway. Normative research methods as described earlier were used for this
37 purpose. A series of visual simulations was used to present visitors with a range of density
38 conditions on each of the greenways. Prior studies validate visual simulation as an effective
39 means of measuring crowding related standards (38, 25). Each series of simulations was created
40 specifically for their site (i.e., a series of photos of the Burlington Bike Path, a series of photos of
41 the Stowe Recreation Path, and a series of photos of the Acadia carriage roads). For the
42 Burlington Bike Path and Stowe Recreation Path, a series of five photographs was constructed of
43 a 125 meter length of path, and these photographs showed a range of 0 to 24 users (Figure 3). As
44 the carriage roads are wider than the other greenways, a series of six photographs was
45 constructed of a 125 meter length of the path, and these photographs showed a range of 0 to 36
46 travelers in order to populate trail space with a comparable amount of use. Each series of visual

- 1 simulations illustrated half pedestrian use and half cyclist use. Respondents were asked to
- 2 evaluate the acceptability of each photograph on a scale bounded by -4 (“very unacceptable”) to
- 3 +4 (“very acceptable”).

Photo 1=0 Users



Photo 2=6 Users



Photo 4=18 Users



Photo 3=12 Users



Photo 5=24 Users



FIGURE 3 Visual simulations of Burlington Bike Path users.

Measuring Preferences for Landscape Character

The survey was also designed to measure normative standards for the desirability of passing through different types of landscape while traveling along the greenway. Landscape character was described as urban, suburban, rural, and natural (meanings of these terms were left to the interpretation of respondents) and respondents were asked to evaluate the desirability of each type of landscape on a scale ranging from -4 (“very undesirable”) to +4 (“very desirable”). The intent of this segment of the survey was not to exclude greenway development from certain

settings, but rather to consider attributes of a greenway that may be measured, planned, and managed for in a way that incorporates user preferences.

Data Analysis

Standards of quality for each site were derived using mean evaluations of respondents. Social norm curves were developed using the mean evaluations for each photograph and description of landscape character. Comparisons across greenway contexts were made using a one-way ANOVA analysis of variance, and post-hoc Tukey tests. Given the modest sample size for each context, a probability value of .05 was utilized to report significant differences between greenways.

RESULTS

Greenway Users' Trip Purpose

Consistent with prior studies, most travelers used greenways for recreational purposes. However, this was less true in the urban context of the Burlington Bike Path. Figure 4 illustrates the relationship between transportation and recreation across greenway contexts. Those who responded 1 on the nine-point scale were considered to have a purely transportation purpose, while those who responded 9, a purely recreation trip purpose. Respondents ranking themselves from 2 to 8 were grouped as having a mixed use. After calculating the mean score of users' trip purpose ratings of the nine-point scale, a significant difference between Burlington Bike Path users and users of the other contexts was found. The mean values for the mixed use travel groups were 5.76 for the Burlington Bike Path, 6.26 for the Stowe Recreation Path, and 7.15 for the Acadia Carriage Roads.

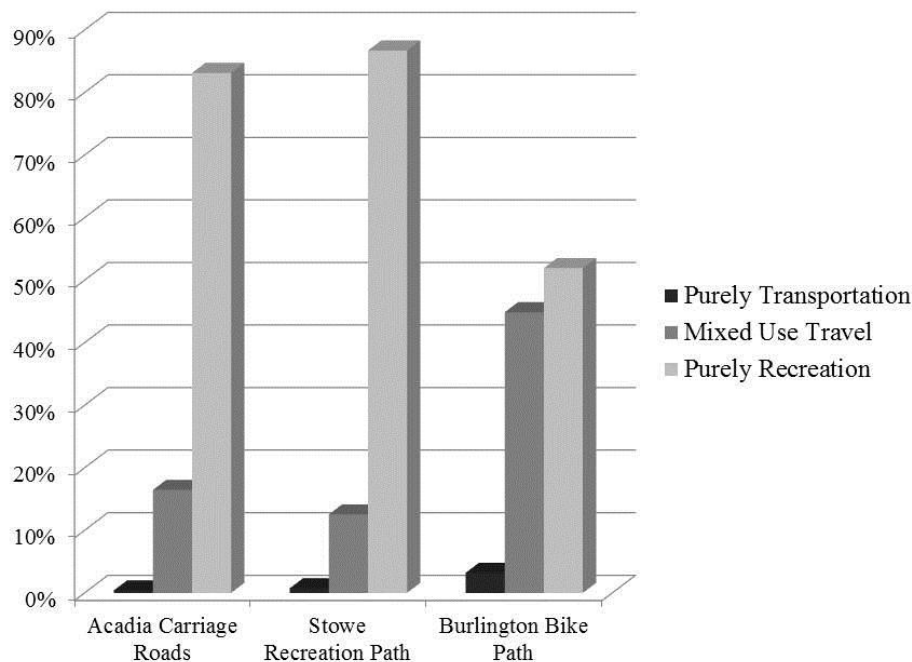


FIGURE 4 Trip purpose across greenway contexts.

Greenway Users' Perceptions of Quality

Responses to open-ended questions asking visitors what they enjoyed most and least about their greenway travel revealed several potential indicators of quality for greenway planning and management. For instance, scenery and views was most frequently cited as what greenway users enjoyed most about their trip (34% for the Acadia carriage roads, 35% for the Stowe Recreation Path, and 31% for the Burlington Bike path). Prior research has measured visual preferences and offered management strategies such as opening views and increasing visual screening to maintain scenic viewing opportunities (39). Therefore, because landscape character and scenic views are measurable and manageable, they make potentially good indicators of quality for greenway design. Furthermore, when given a list of attributes that could be desirable to their greenway experience, visitors evaluated "scenic views" as one of the items. Average respondent ratings on a five-point desirability scale (ranging -2 to +2) were 4.88 for the Acadia carriage road and 4.81 for both the Stowe Recreation Path and Burlington Bike Path. This confirms scenery and views as an important indicator of quality for greenway travel.

A second indicator that arose from the study was related to the physical quality/condition/design of the greenway itself. For instance, good path quality was frequently cited as what users enjoyed most (18% for the Acadia carriage roads, 17% for the Stowe Recreation Path, and 8% for the Burlington Bike Path). Poor path quality was also frequently cited as what users least enjoyed (14% for the Acadia carriage roads, 28% for the Stowe Recreation Path, and 27% for the Burlington Bike Path). Many strategies could be used to measure and manage the quality of pavement, surface type, lane widths, etc. These results reinforce that the physical quality, condition, and design of greenways are important indicators of travel quality. While this study focused on deriving standards of quality for greenways, it did not consider these physical aspects of travel experience. Further research is needed to develop standards for this indicator.

A third indicator that was established based upon responses to the open-ended questions was related to the density of use along the greenway. For instance, crowding and other users along the greenway were frequently cited as what respondents enjoyed least (22% for the Acadia Carriage Roads, 26% for the Stowe Recreation Path, and 32% for the Burlington Bike Path). Density of use is a potentially good indicator because it is both measurable and manageable. It may be measured, as in this study, by the number of users along a pre-determined length of path at any one time. It may also be managed using a variety of strategies. For example a greenway could be widened, extended, or incorporated into other greenway networks to distribute use over space and time, thereby, alleviating congestion or crowding effects. Furthermore, when given a list of attributes that could be desirable to their greenway experience, visitors evaluated "few people on the greenway" as one of the items. Average respondent ratings on a five-point desirability scale (ranging -2 to +2) were 3.82 for the Acadia carriage road and 3.69 for the Stowe Recreation Path and 3.47 for the Burlington Bike Path. This confirms density of use as an important indicator of quality for greenway travel.

Greenway Standards/Levels of Quality

Traveler acceptability ratings for the visual simulations showing a range of users per 125 meter length of greenway are shown in the social norm curves in Figure 5. The LOS conceptual framework has been overlaid to portray the relationship between LOS and normative standards of quality. The norm curves show that as the number of users on each greenway increases,

acceptability decreases. Average respondent ratings fall out of the acceptable range and into the unacceptable range at approximately 20 users per 300m² of path for the Burlington Bike Path, 15 users per 300m² of path for the Stowe Recreation Path, and 10 users per 300m² for the Acadia carriage roads. It is also worth noting that the most acceptable condition varies across greenway contexts. For instance, in the more urban context of the Burlington Bike Path, having other users along the greenway (6 per 300² meters) is perceived by travelers as being more acceptable than sharing the path with no other users. This is in contrast to the other greenway contexts where the zero condition was considered optimal.

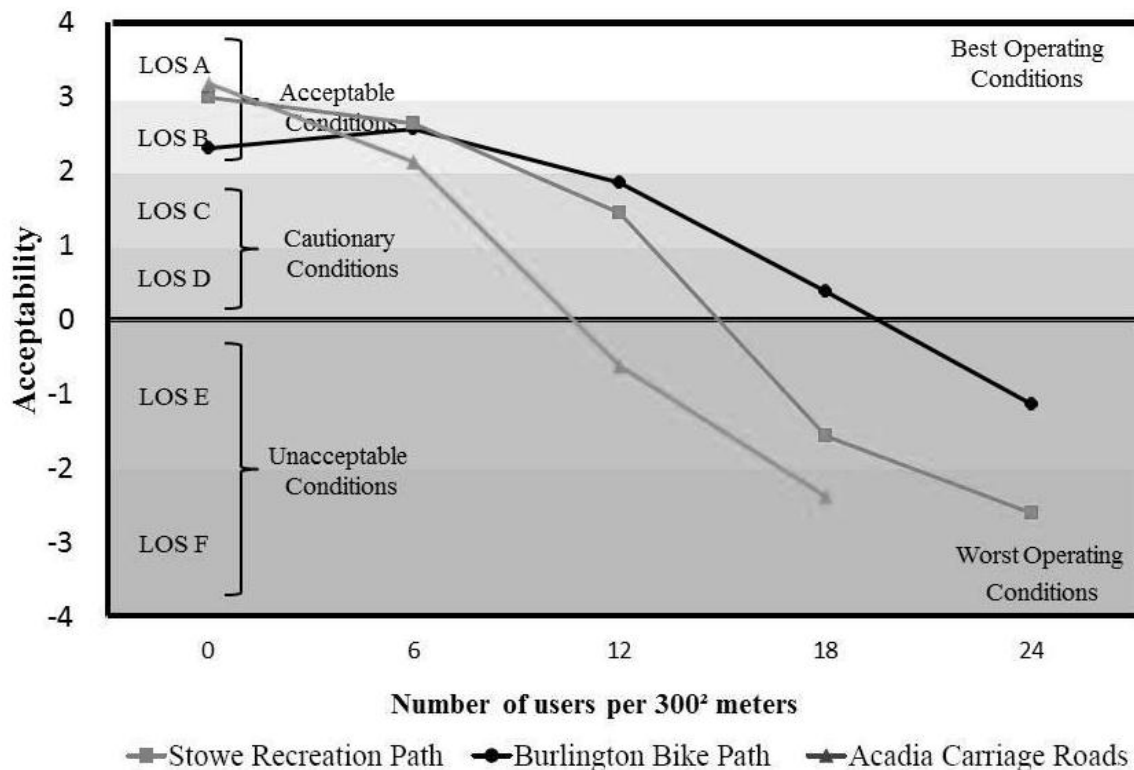


FIGURE 5 Social norm curves for density of use across greenway contexts.

Travelers' Preferences for Landscape Character

Traveler ratings of the desirability of various landscapes along a greenway are illustrated in the social norm curves in Figure 6. The norm curves show that as the level of development increases, acceptability decreases. Average respondent ratings for the Acadia carriage roads and Stowe recreation path fall out of the acceptable range and into the unacceptable range as the landscape character changes from rural to suburban. Users of the Burlington Bike Path approach the threshold of acceptability in the urban context, but ultimately find all types of landscapes acceptable within the context of their greenway experience. Furthermore, significant differences were found among the greenways when evaluating both the suburban and urban landscape types.

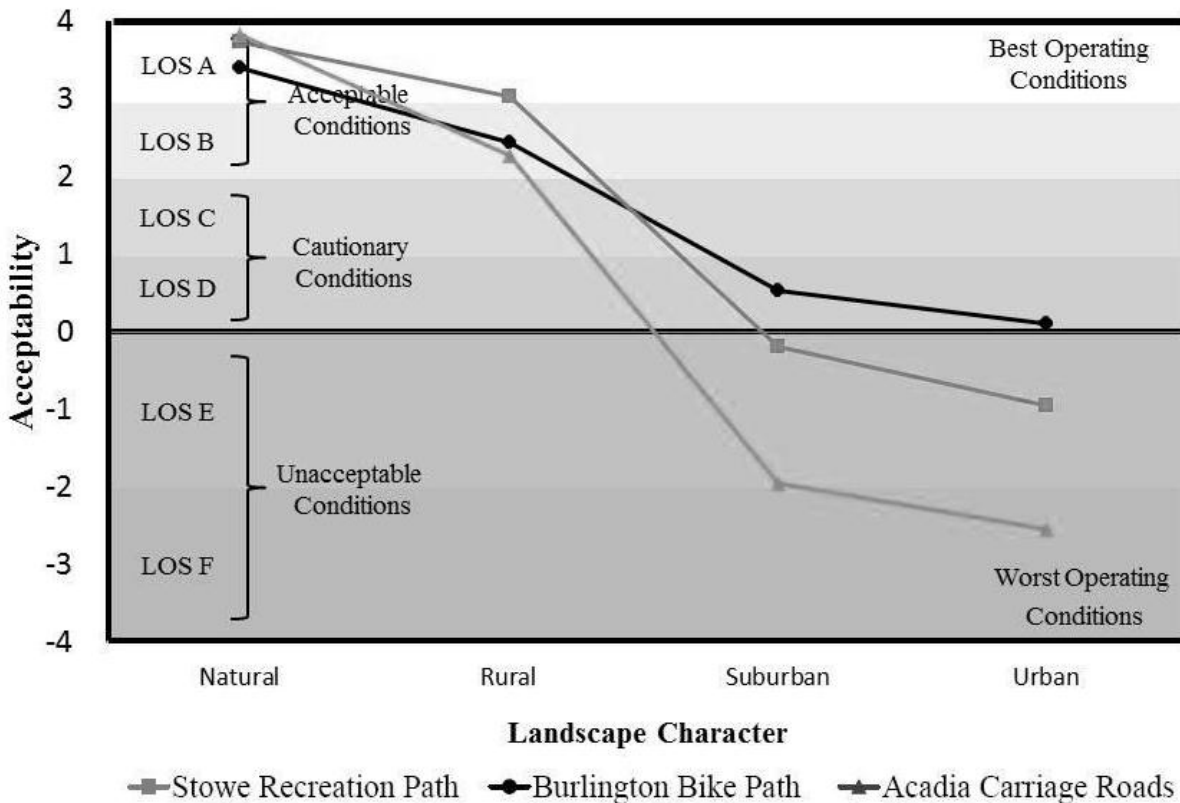


FIGURE 6 Social norm curves for landscape character.

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2 DISCUSSION

3 Study findings corroborate prior greenway research. For instance, as in past studies (11), this
 4 research found that greenways are used primarily for recreation. This research considered a
 5 broader spectrum of greenway opportunities however, and revealed that greenway users' trip
 6 purpose may be context sensitive. For instance, the more urbanized setting of the Burlington
 7 Bike Path revealed a significantly higher proportion of users engaging in greenway activities that
 8 were not purely recreational, but included at least some element of transportation. This
 9 relationship between recreation, transportation, and contextual settings is also in keeping with
 10 past research (40). Furthermore, the recreational nature of greenways suggests that their
 11 planning may benefit from conceptual frameworks developed in the field of parks and outdoor
 12 recreation management.

13 This study adapted a widely-used framework from the field of parks and outdoor
 14 recreation management to seek potential indicators of quality for greenway travel. Findings
 15 suggest that density of use is important to greenway travelers and this is in keeping with the
 16 literature on both transportation (2, 13, 15) and parks and outdoor recreation (25). Moreover,
 17 findings illustrate that measures of density are relevant indicators of quality for managing
 18 transportation across a number of greenway contexts, and that normative research can be used to
 19 derive standards of quality for density related indicators.

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 concerns 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. The normative data on standards of quality offer an empirical approach to informing LOS, including identifying a threshold of acceptability – the minimum level of an indicator of quality that is acceptable to travelers. Building on the nexus between these conceptual frameworks, and given the often recreational purpose of greenway travelers, LOS may benefit from being extended and revised to include indicators of quality that incorporate experiential components of travel.

For example, LOS conventionally addresses the issues of efficiency in transportation (i.e., travel delays), 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 (40). This study corroborates prior research and extends it to greenways across a range of contextual settings. For instance, opportunities to walk or ride slowly, to stop when wanted, and to travel under low levels of use so that travelers are able to see and experience the landscape may be more important than traditional measures of efficiency. Other potential indicators of quality for transportation in parks and outdoor recreation might address issues such as character of surrounding landscape, types of vehicles allowed, and litter. Moreover, standards of quality may be integrated into conventional HCM/LOS guidelines to ensure they are appropriate in a variety of contexts. For example, Figure 5 indicates that the maximum acceptable number of users on the Burlington Bike Path is approximately 20 users per 300² meters. Yet, for the Stowe Recreation Path, LOS E is approximately 15 users per 300² meters. Another example of this context sensitivity is represented by the social norm curve for the Acadia carriage roads. As noted previously, the Acadia carriage roads are twice as wide as the other study greenways. After re-registering the LOS overlay for this spatial differential, approximately 10 users per 300² meters is the maximum acceptable condition for density of use. While a constant relationship of density was held for this study, width could be another important variable in measuring acceptability rating and warrants further research. Regardless, it is clear that greenway users' perceptions of acceptable conditions vary across contexts. Additional research is needed to continue testing 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. The standards of quality explored in this study might vary substantially depending on the types of users on greenways (e.g., pedestrians, joggers, cyclists, equestrians).

IMPLICATIONS AND LIMITATIONS

This study has a number of implications for greenway planning and management. For instance, it offers planners a methodology for creating a user-based LOS that incorporates important elements of greenway facilities that may have previously been overlooked. These experiential components may then be integrated into planning to enhance and improve greenway users travel experiences. For example, since greenway users indicate a preference for natural surroundings, planners may zone or manage greenway corridors to preserve rather than develop them. This is not to say that greenways are only appropriate in natural settings, but that even in urbanized settings natural landscaping and design is preferred. Planners could encourage the development

1 of these natural attributes regardless of the setting, thereby, providing an overall higher level of
2 quality for greenway travelers. If demands for facility improvement, including paving and
3 signage, arise from survey responses, planners will have established a rational basis for investing
4 in them as well. However, these conclusions should not be drawn hastily. Further research
5 (including viewshed analysis) that engages both transportation and recreation-oriented users
6 could further elucidate travelers' preferences for greenway design.

7 This study also illustrated that the minimum acceptable condition for density of use along
8 a greenway can vary across contextual settings. While the three study sites from this research
9 represent a spectrum of greenway opportunities, they are limited to a narrow region of the
10 country and do not reflect a full range of urban to natural environments. In this way, they only
11 begin to suggest appropriate standards for other greenways. To create a more generalizable set
12 of standards, further research will be needed to more fully flesh out a spectrum of contexts. This
13 paper offers planners an indicator- and standards-based methodology for developing their own
14 context-sensitive series of LOS standards appropriate for their location. However, as more
15 results are compiled using this methodology a finer grain of generalizability may be established
16 through comparative analysis across sites.

17 Finally, the traveler-perception-based framework developed by this study is in keeping
18 with the intent of the HCM. "The LOS concept was created, in part, to make presentation of
19 results easier than if numerical values of service measures were reported directly" (13, pg. 17-
20 38). While the letter grade system has been used effectively to demonstrate results to the public,
21 this methodology adds an additional element of transparency in conveying results. For instance,
22 visual simulations of travel conditions may be used in conjunction with their corresponding LOS
23 grades to clarify the quality of service concept to affected communities and constituents.
24 Furthermore, visual simulations may be used to address a number of other considerations related
25 to greenway planning and management. For example, the visual simulations in this study were
26 populated with small group sizes and an equal number of cyclists and pedestrians. This may not
27 be representative of realistic conditions, such as large platoons of pedestrians taking up more
28 space or making up the majority of greenway users. Greenway monitoring prior to developing
29 the simulations could help create more realistic conditions, and survey results may then elucidate
30 perceived conflicts between user types. Moreover, the potential for addressing conflict between
31 user types may also be guided by visual research methods. For instance, the acceptability of
32 different management techniques, such as separating uses through striping and signage, could
33 also be tested.

34 35 **CONCLUSION**

36 Greenways are an increasingly important component of transportation networks. The conceptual
37 frameworks of LOS and indicators and standards of quality can be integrated to measure and
38 manage transportation and recreation for these dual purpose facilities. This approach is
39 illustrated through application to three greenways across two states in northern New England.
40 More research is needed to identify additional indicators and standards of quality for greenway
41 travel, and to extend and register LOS guidelines in this new context.

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