Principles of Sustainable Transportation in the National Parks

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The historic and contemporary relationships between transportation and the national parks have given rise to a growing body of scientific and professional literature on this topic. Based on this literature, we develop and present a set of principles for managing sustainable transportation in the national parks. These principles address sustainability by reducing the environmental impact of transportation, enhancing the quality of the transportation-related visitor experience, and using transportation as a tool to achieve park management objectives.
INTRODUCTION
Transportation and national parks are intimately linked. For example, nearly 300 million visitors per year travel to and within the U.S. national parks. Moreover, American national parks comprise over 80 million acres of public land and include extensive networks of transportation corridors—roads, trails, bike paths, waterways, public transit—that link a vast array of iconic attraction sites—viewpoints, historical and cultural sites, visitors centers, campgrounds, gateway communities. The inherent complexities of this intersection between transportation and national parks demand more explicit research and management attention.

But transportation is more than a means of access to national parks—it can be a form of recreation itself, offering most visitors their primary opportunities to experience and appreciate the natural and cultural landscapes embodied by national parks. For example, the iconic roads of many of the “crown jewel” national parks—Going-to-the-Sun Road in Glacier National Park, Tioga Road in Yosemite National Park (Yosemite), Trail Ridge Road in Rocky Mountain National Park (Rocky Mountain), and the Park Loop Road in Acadia National Park (Acadia), for example—were designed for visitors to experience the parks in their cars and are important manifestations of the historic and contemporary linkages between transportation and national parks (1, 2). 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 “driving for pleasure”, what is historically one of America’s most popular recreation activities (3).

And transportation can be even more than this; it is also a potentially powerful tool for managing the national parks. The transportation networks and linkages in parks help determine where park visitors travel (and where they don’t) and can be used by park managers to help deliver the “right” number of visitors to the “right” places at the “right” times (4, 5, 6). In this way, transportation can be used to manage national parks in a sustainable way by protecting park resources and the quality of the visitor experience.

Interest in these linkages between transportation and national parks has led to a growing body of scientific and professional literature on this topic. The studies referenced in this paper are representative of a growing body of knowledge. These studies address the interface between transportation and a diverse group of national parks, they use natural and social science methods, and address a range of transportation systems and issues. They draw on the scientific and professional literature in the fields of transportation and parks and outdoor recreation. While study of transportation in the context of national parks is in its early stages, a set of principles to help guide transportation management in national parks is beginning to emerge. Based on our review of the scientific and professional literature, we develop and present a set of principles for sustainable transportation in the national parks.

Principles of Managing Sustainable Transportation in the National Parks

Principle 1. Transportation and national parks are inextricably linked. This was the initial premise of this paper, and the growing scientific and professional literature bears this out in multiple ways. In their early history, transportation—by horse, stagecoach, and railroad at first and later and more generally by automobile—provided public access to the parks that was needed to build widespread societal appreciation and support for national parks (1,2). Even today, roads and to a lesser extent trails are the primary ways in which the vast majority of visitors experience and enjoy the national parks. But ease of access has led to a number of contemporary issues regarding the impacts of large and growing use of the parks, as well as the impacts of conventional transportation itself, primarily in the form of automobiles. (These issues
are described more fully in Principles 2 and 3 as well as subsequent related principles). National parks have entered a new era in which transportation management is evolving to address these issues; examples include many forms and innovative applications of ATS and more deliberative and purposeful management of transportation to more fully meet the array of issues associated with contemporary park management. Examples include recent programs of interdisciplinary research at Yosemite (7,8,9) and Denali (10,11,12,13).

**Principle 2. Transportation is central to the foundational two-fold mission of the NPS.** National parks are to be managed in ways that protect park resources and the quality of the visitor experience while providing public access for enjoyment and appreciation. But under conditions of high and growing demand, these objectives can often conflict with one another. There was little concern over road building in the early history of the national parks because use levels were low and parks were primarily considered to be monumental scenery (2). However, as use of the national park system now approaches 300 million visits annually, transportation is an increasingly vital manifestation of the tension between use and preservation. Roads and other components of park transportation systems largely dictate the levels and types of uses the national parks accommodate. Moreover, these roads and other elements of the transportation systems in parks can themselves impact park resources and the quality of the visitor experience (these resource and experiential impacts are addressed more fully in Principles 5 and 6, respectively). A growing number of studies of transportation in the national parks describe these issues and how they are playing out across the landscape of the national park system. Yosemite is often considered the poster child for the issue of use versus preservation, and the defining role of transportation in Yosemite is described in several recent studies and papers (14,7,8,9). Similarly, a number of studies have addressed the role of transportation in meeting the two-fold mission of national parks at a diversity of other parks, including Denali (10,11,12,13), Rocky Mountain (15,16,17,18), Acadia (19,20,21,22), and Zion National Park (Zion) (19,23).

**Principle 3. Transportation is central to the foundational issue of carrying capacity of the national parks.** This principle follows directly from Principle 2. Carrying capacity is a long-term and increasingly urgent issue in the national parks and is generally defined as the amount and type of use that can be accommodated in parks without unacceptable impacts to park resources and the quality of the visitor experience (4). Principle 2 suggests that transportation plays a vital role in mediating and managing the inherent tension between use and preservation that is at the heart of the carrying capacity concept. Transportation networks (e.g., roads) and services (e.g., ATS) dictate the amount and distribution of park use and thus the impacts of this use. As noted in Principle 2, several studies have been conducted on the relationship between transportation and carrying capacity in Yosemite, the park that is often thought of as most representative of the carrying capacity issue (14,7,8,9). Contemporary management of the park aspires to use the transportation network to deliver the “right” number of visitors to the “right” places at the “right” times as informed by a program of research. Likewise, studies of the role of transportation in the carrying capacity of national parks have been conducted on the Denali Park Road (24,10,11,12,13). In this case, it’s the carrying capacity of the road itself that’s an important part of the issue: how many vehicles can use the road without unacceptable levels of disturbance to the park’s iconic wildlife and while maintaining the wilderness character of the road experience? These and related issues permeate the scientific and professional literature.

**Principle 4. Transportation management in the national parks should be guided by a management-by-objectives framework that incorporates formulation of indicators and standards of quality.** Several conceptual and organizational frameworks have evolved in the
scientific and professional literature on parks and outdoor recreation and transportation (3, 25).

Examples include the concept of carrying capacity, indicators and standards of quality, and levels of service (LOS). These frameworks have contributed to development of a broader, management-by-objectives framework to guide transportation management in the national parks. This framework is comprised of three primary steps: 1) formulation of management objectives and associated indicators and standards of quality, 2) monitoring indicator variables, and 3) taking management actions to ensure that standards of quality are maintained (4). A growing number of papers incorporate this approach to transportation management in the national parks and support formulation of transportation-related indicators and standards of quality. Examples include studies at Denali (10,11,12,13), Yosemite (7,8,9), Acadia (19,20,21,22) and Rocky Mountain (15,16,17,18), and all contribute to transportation-related programs of research aimed at supporting and implementing the management-by-objectives framework described above, including formulation of indicators and standards of quality.

**Principle 5. Transportation in the national parks can have important environmental implications.** Transportation, primarily in the conventional form of private automobiles, can have important environmental impacts to park resources. For example, an NPS-wide survey estimates well over 10,000 vehicle-wildlife collisions over a recent 18-year period (26). And research at Denali has documented changes in wildlife behavior related to traffic on the Denali Park Road (24,11). Impacts to soil and vegetation caused by unauthorized parking, along with other traffic-related issues, led the NPS to close the road in Zion Canyon to private autos and institute a shuttle bus system (23). Studies at Rocky, Zion, and Acadia document the noise generated by transportation which can impact animals and detract from the quality of the visitor experience (17,19). And, of course, there are substantial air pollution problems associated with the cars and other vehicles visitors use in national parks (19).

But more sustainable transportation, primarily in the form of ATS, can lead to substantial environmental benefits. For example, the shuttle bus system in Denali has been designed to limit the number of vehicles on the park road, reducing the chance of collisions with and disturbance of wildlife (11). In particular, the scheduling of shuttle bus service allows for the vehicle-free intervals needed by Dall sheep to safely cross the road corridor. A sophisticated modeling approach which demonstrates the substantial reductions in both air pollution and human-caused noise that have been gained by use of shuttle bus systems at Zion and Acadia (19).

However, poorly planned ATS can lead to unanticipated environmental impacts (or “downstream effects”) as described in studies at Rocky Mountain (15,17). In this case, the shuttle bus system delivered more visitors to sites in the Bear Lake area of Rocky Mountain than these areas could accommodate, and this has resulted in substantive impacts to soils and vegetation along trails and at attraction sites.

**Principle 6. Transportation in the national parks can have important experiential implications.** Given the strong historic and contemporary linkages between transportation and the national park experience as described in Principle 1, transportation can affect the quality of the visitor experience in many ways. When visitor use levels are relatively low, visitors can leisurely drive uncongested park roads, stopping and parking at iconic park attractions, hiking uncrowded trails, and experiencing park resources that are protected in their natural condition. However, when visitor use levels are high, park roads can become congested, visitors can have difficulty finding a place to park, and park resources can become degraded, particularly at iconic park attractions and trails. These kinds of traffic conditions and associated impacts to the quality of the visitor experience are characteristic of a growing number of national parks. ATS can help
maintain high quality visitor experiences by substantially reducing traffic congestion and parking problems. But even ATS can be subject to crowding, can be inconvenient or otherwise stressful (e.g., run on an infrequent schedule), and can deliver too many visitors to selected locations, causing crowding and resource impacts and degrading the quality of the visitor experience (as described at Rocky Mountain in Principle 5). Transportation must be planned and managed in ways that create and maintain high quality visitor experiences.

Principle 7. Transportation is an important form of recreation in the national parks. Following on Principle 6 and emphasizing its importance, transportation is a form of recreation for the vast majority of national park visitors. As described earlier, the iconic roads of many of the national parks were designed to facilitate enjoyment and appreciation of the parks. Driving for pleasure has long been a favorite American pastime, and nowhere is this more true than in the national parks. And, of course, ATS can be added to the list of transportation networks that are vital to shaping the quality of the visitor experience. A growing number of studies illustrate ways in which transportation can be planned and managed to help ensure high quality visitor experiences. For example, several studies suggest standards of quality for traffic congestion on roads in Acadia, Denali, and Yosemite (20,21,12,8). These studies also suggest standards of quality for trail use in these parks. Other studies suggest standards of quality for ATS at Acadia (20), and illustrate the extent to which ATS has (or can) reduce air and noise pollution at Zion, Acadia, and Rocky Mountain (17,19). These and related studies offer guidance on planning and managing transportation to help ensure the quality of the visitor experience.

Principle 8. Transportation can be an effective management tool in national parks. Given the linkages between transportation and visitor use in the national parks, as described above, transportation can and should be used as a potentially powerful park management tool. Several studies offer good examples of the ways in which this can be done. For example, the ATS program at Denali has been designed to limit the impacts of vehicles on wildlife along the Denali Park Road (10,11,12,13). ATS is also effective at reducing air pollution and greenhouse gas emissions at Zion, Acadia, and Rocky Mountain (16,19), and reducing noise pollution at Rocky Mountain (17). Simulation modeling at Acadia suggests that traffic congestion on the Park Loop Road could be substantially mitigated by eliminating parking in the right-hand lane (though this would also reduce availability of parking at several key attraction sites) (21). Research programs at Rocky Mountain and Yosemite illustrate the way in which transportation can and probably should be used to help manage the carrying capacity of national parks by delivering the “right” number of visitors to the “right” places at the “right” times (7,8,9,15,16,17).

This is in contrast to the more conventional “demand-driven” approach to transportation management as illustrated in a study at Grand Canyon (27). At Grand Canyon, parking facilities were developed at the park’s new visitor center based on estimates from a robust statistical model of the number of parking spaces needed to accommodate visitor demand. This study was well designed and executed and has helped solve the parking problem. However, it is unknown whether the new parking lot is sized to accommodate the “right” number of visitors (i.e., a sustainable level of visitation), or results in levels of visitor use that cause unacceptable impacts to park resources and/or the quality of visitors’ experiences at nearby attraction sites and trails.

Other studies illustrate a more deliberative and ultimately informed management approach by using transportation to help achieve park management objectives. For example, studies at Rocky Mountain, Denali, and Yosemite, have identified standards of quality for traffic congestion on key park roads, the number of hikers on key trails, and the number of people-at-one-time at iconic attraction sites (8,9,12,16,21). In this way, park transportation infrastructure
and programs – amount and location of parking, design and scheduling of ATS, hiking permit systems – can be planned and managed to help meet park management objectives related to minimizing impacts to park resources and the quality of the visitor experience. This approach to using transportation as a park management tool, in contrast to a conventional demand-driven approach, is illustrated graphically in Figure 1.

**Principle 9. There is growing use and support for ATS in the national parks.** Several studies describe early and relatively large ATS programs at Acadia (19,20,22), Rocky Mountain (15,16,17,18), Denali (10), and Zion (19,23). These are widely regarded as successful models for the national park system. Beyond these high-profile examples, many other units of the national park system have adopted large and small ATS programs that involve shuttle buses, ferries, and historic and specialized vehicles. Some of the ATS programs are voluntary and others are mandatory, while some charge a fee and others are “free” (though, of course, all must be paid for in some way). There is a growing body of evidence that ATS is well-received by most visitors and that ATS can be designed to serve the needs of both park management and visitors. For example, visitors overwhelmingly support the mandatory shuttle bus system at Zion (23). At Grand Canyon, more visitors are choosing to use the voluntary shuttle bus system than expected (27). At Great Smoky Mountains, a general population survey found that 75% of respondents supported a mandatory (but free) shuttle bus system at iconic Cades Cove, and over 50% reported they would pay a fee for this service (28). Moreover, the value of the improved services to visitors (e.g., reduced traffic congestion) was estimated to be $32 million.

Several studies identify desirable properties of ATS that encourage visitors to choose ATS over private autos. For example, a study at Yosemite (14) found that ease of use (e.g., frequent scheduling), perceived freedom (e.g., ability to reach desired destinations), and stress reduction (e.g., less concern over issues such as parking) were highly desirable characteristics of ATS and would help persuade visitors to choose ATS over their cars. Another study at Rocky Mountain found that visitors were more inclined to use ATS when they were aware of the ways ATS would improve the quality of the visitor experience: less traffic congestion, less crowding on trails, and no parking problems (18). Day visitors to Acadia suggested that desirable qualities of ATS include frequent service (intervals of 15-to-25-minutes between buses), perceived freedom (convenient stops), knowledge of the environmental benefits of ATS, and availability of educational/interpretive programming on shuttle buses (22).
Finally, successful use of ATS seems to lead to a reinforcing cycle of more support of ATS. For example, at Zion, 98% of visitors who rode the park’s shuttle bus system reported that they would use ATS programs at other parks as well (23). And the study at Yosemite described above also found that experience with ATS in parks leads to greater support for and use of ATS (14).

**Principle 10. Conventional guidelines for managing transportation may need to be re-registered in the context of national parks.** Transportation is generally managed according to guidance contained in the Highway Capacity Manual (HCM) (25). Research underlying the HCM has been conducted primarily in the context of “utility” trips where the primary objective is to provide the most efficient way to travel from origin to destination. However, these guidelines will often need to be re-registered in the context of national parks and related areas where driving, walking, biking, public transit and other forms of transportation are designed to offer a more leisured experience to allow greater enjoyment and appreciation of the landscape and associated park attractions and features. A study at Acadia is especially instructive by developing density-related standards of quality for three modes of transportation in the park:
driving on the Park Loop Road, hiking and biking on the park’s carriage roads, and riding the
park’s Island Explorer shuttle bus system (20). Study findings were overlayed with a
conventional HCM LOS framework, and results suggest that for driving and hiking/biking, LOS
A and B define a high quality experience in the park context, LOS C and D define cautionary or
“yellow light” conditions, and LOS D and E are unacceptable to visitors in the context of the
national park. Results are similar but more complex for public transit. Moreover, findings from a
study of the social carrying capacity of the Acadia Park Loop Road also provide compelling
evidence that LOS needs to be registered in the context of national parks (21).

Principle 11. Transportation research and management in the national parks should be as
integrative as possible. Carrying capacity in the context of national parks has both
environmental and experiential components and these components are often interrelated.
Moreover, the scientific and professional literature on transportation and parks and outdoor
recreation should be integrated where possible. And Principle 8 suggests that transportation can
(and often should) be an important management tool. Finally, research methods can be integrated
in ways that complement one another and offer synergistic advantages. Several studies offer
illustrations of all these integrative approaches. For example, as described in Principle 10, the
framework of indicators and standards of quality from the park and outdoor recreation literature
was combined with the LOS framework from the transportation literature to develop insights into
the quality of transportation in the context of national parks (20). And as described in Principle 8,
park transportation has been integrated with park and outdoor recreation management objectives
and associated indicators and standards of quality in a coordinated program of research designed
to use transportation as a park management tool at Yosemite (7,8,9), Denali (10,11,12,13), and
Rocky Mountain (16). All of these programs of research incorporate both resource (e.g., impacts
to soil, vegetation, and wildlife) and experiential (e.g., crowding) components.

Principle 12. Transportation management in the national parks should be conducted at a
park-wide, regional, or landscape scale where appropriate. Impacts to parks from outdoor
recreation often manifest themselves first at selected sites – such as iconic attractions and
popular roads and trails. However, these areas and issues should be studied and managed in a
more geographically inclusive way to help prevent problems from arising elsewhere. In fact,
“fixing” a problem in one area can sometimes simply shift the problem to another area. Several
of the research and management programs described in the scientific and professional literature
offer good examples of more geographically expansive approaches. For example, research at
Rocky Mountain illustrates how the ATS system in the Bear Lake corridor has helped solve the
road congestion and parking problems in this area, but has caused “downstream” problems of
resource and experiential impacts at selected attraction sites and trails served by the transit
system (15,16). Research and management attention at the park has now shifted to identifying
other sites in the park (and perhaps sites on public lands outside the park) where some park
visitors might be diverted from the Bear Lake area. Transportation management at a larger,
regional scale is illustrated in studies at Zion (23,29) and Cape Cod (30). At Zion, the park’s
shuttle bus system serves both the park and the gateway town of Springdale, offering
convenience and “connectivity” for both visitors and residents who are employed in the park.
And at Cape Cod, all regional transportation providers cooperate and coordinate their schedules
and services to offer the possibility of “car-free” vacations to the park and the surrounding
region.

Principle 13. Transportation should be incorporated into comprehensive park management
plans. Following on several of the above principles, transportation is an integral and vital
component of national parks: it is an important form of recreation and park appreciation, and transportation can be an effective park management tool. Moreover, there are important environmental and experiential implications of transportation. Given the centrality of transportation to park management, transportation should be given explicit consideration in park planning and management. The NPS has recently begun a program of preparing long-range transportation plans and this has the potential of being a very constructive initiative.

Principle 14. Transportation offers important opportunities to deliver information, education, and interpretive programs to park visitors. Visitors use many forms of transportation to travel to and through national parks, and information, education, and interpretive programming can be used to reach visitors during all phases and modes of transportation. Conventionally, visitor centers and wayside exhibits are used to communicate with visitors as they travel by personal vehicle through the park, and they can be effective. However, ATS offers opportunities that may be especially efficient and effective in communicating with visitors. Public transit, by definition, gathers groups of visitors who may then be reached very efficiently. Moreover, a study of a proposed extension of the Island Explorer shuttle bus system to parking areas outside the Mount Desert Island section of Acadia found that many potential transit riders placed a high value on interpretive services designed to inform and enhance the quality of their park visit (22). The highly successful ATS program at Zion has made the shuttle bus system an important visitor attraction in and of itself, in part due to the audio and personal interpretive programming delivered to visitors on the buses (23).

Principle 15. Transportation management in the national parks should be conducted in a proactive manner. Like all good planning and management, transportation should be used to avoid problems before they arise. Perhaps the best example of this is management of the Denali Park Road (10). With construction of a new highway in Alaska in the early 1970s that would make Denali much more accessible, park staff instituted a limit on the annual number of vehicle trips that could be taken on the Denali Park Road, the principal means of visitor access to the park. This limit was instituted to protect park wildlife and the quality of the visitor experience. This proactive approach to transportation planning has been a cornerstone and effective component of park management as use has increased dramatically over the past several decades.

Principle 16. Transportation management in the national parks should be as informed as possible. The management-by-objectives framework described in Principle 4 is fundamentally adaptive; that is, it encourages managers to make decisions based on the best information available. Moreover, through long-term monitoring of indicators of quality, the framework allows managers to update, revise, and refine management as new information becomes available. However, this shouldn’t be used as an excuse not to seek out the best information possible. The growing number of studies on transportation in the national parks represent good-faith efforts on the part of park and transportation planners, managers, and scientists to help create a foundation of knowledge about managing transportation in national parks. The emerging set of principles presented in this paper is an effort to further this process.

Principle 17. Transportation management in the national parks can draw on an array of research methods and approaches. The studies described in this paper use highly diverse research methods to address a range of transportation-related problems and issues. These research approaches employ natural science methods when assessing environmental impacts of park use and use social science methods to address human dimensions-related issues. Methods common to many studies include qualitative and quantitative surveys of park visitors, park managers, and the general public; visual simulations of a range of park conditions; GPS-based...
tracking of visitor travel patterns; GPS-based tracking of park wildlife; traffic and parking data
collection and analysis; computer simulation models of visitor travel patterns; acoustic modeling;
and sophisticated statistical analyses. These and other research methods can be productively used
to better inform transportation management in the national parks.

Principle 18. Transportation management in the national parks should be based on
partnerships with important stakeholders. Transportation management at Cape Cod is an
excellent example of this principle (30). The park is deeply embedded in the surrounding towns
of the Outer Cape and it has successfully partnered with all levels of government, a variety of
non-governmental organizations, regional planning commissions, the local Congressional
delegation, a local university, and several businesses to create an increasingly coordinated
transportation network that serves the needs of park management, park visitors, and local
residents. Similarly, the public transit systems at Zion (23,29) and Acadia (20,22) have worked
closely with gateway communities to build strong elements of connectivity that serve the needs
of park visitors and surrounding towns.

Principle 19. Transportation management in the national parks needs strong leadership.
Strong leadership is a prerequisite of most successful planning and management projects, and
transportation is no exception. Though this leadership is not always obvious in the papers that
comprise the scientific and professional literature, it is more evident to those who have been
involved in these efforts and understand and appreciate the vital role of key individuals and
organizations; national park superintendents, planners, resource managers, program directors;
community leaders; non-profit groups; Congressional delegations. For example, at Cape Cod,
Clay Schofield and U.S. Representative William Delahunt have been instrumental in building
and supporting the coalition of park-related transportation partners on the Outer Cape (30).

Principle 20. Transportation management in the national parks should address
traditionally underserved populations. National parks are important symbols of our nation’s
commitment to democracy; they are icons of our shared natural and cultural history, and they
should be accessible to all people. Transportation management at Cape Cod represents one
manifestation of this issue (30). In this case, the park is using beach wheelchairs and wheelchair
accessible beach paths to help ensure access to mobility impaired visitors. However, there are
other groups in society, particularly racial and ethnic minorities, who are substantially
underrepresented in the national parks (31). Research suggests that transportation to national
parks may be a barrier to visitation, and more research and planning are needed to help ensure
equal opportunities to visit the national parks (32). Transportation management has an important
role to play in this issue.

Principle 21. Transportation in the national parks should be managed by design, not by
default. The growing scientific and professional literature illustrates ways in which resource and
experiential conditions in national parks are related to transportation. Transportation can
exacerbate or help mitigate these impacts depending on how transportation systems are designed
and managed. Transportation management can be guided in many ways, including the types of
studies noted in this paper. However, management will often require exercise of professional
judgment. As described in Principle 16, management should be as informed as possible, but there
are inherent limits to our knowledge base at any point in time.

After attempting in good faith to inform themselves of the problems and issues facing
parks and outdoor recreation areas, park and transportation managers must ultimately exercise
their professional judgment. Unfortunately, there will rarely be perfect knowledge about the
types of problems that exist in parks and their seriousness, the causes of these problems, and the
effectiveness of alternative management practices. Nevertheless, park and transportation managers should find courage in their knowledge of the burgeoning scientific and professional literature, the conceptual and management frameworks that have emerged from this literature, the inherently adaptive nature of park and transportation management, and in the responsibilities with which they have been entrusted. Management programs can (and should) be revisited and revised based on monitoring and advances in scientific and professional knowledge. But the seriousness of transportation and related park and outdoor recreation issues in the national parks – the tension inherent in two-fold mission of the national parks, the growing urgency of carrying capacity, the need to formulate indicators and standards of quality – will require strong and deliberate management action.

**Sustainable Transportation in the National Parks**

Sustainability has emerged as a vital concept for the contemporary world, and for good reason; we must learn to live within the constraints posed by our environment or face the possibility of grave consequences in the form of a degraded planet and diminished quality of life. What better place to address this issue than the national parks, iconic symbols of our commitment to protecting the environment? And what better issue than transportation, one of the world’s greatest consumers of fossil fuels and contributors to air and noise pollution and greenhouse gases? Sustainable transportation in the national parks makes good, common sense.

In important ways, the national parks have been at the forefront of sustainability for decades. National park management has been historically based on its foundational two-fold mission: to foster public use and appreciation of the parks while protecting their environmental and experiential integrity. This is at the heart of sustainability. In the context of the national parks, this issue is often called carrying capacity – how much and what kinds of use can be accommodated in the national parks without unacceptable impacts to park resources and the quality of the visitor experience? With annual visitation to the national parks nearing 300 million, this is an increasingly urgent question.

In the context of national parks, carrying capacity/sustainability has multiple dimensions: concern for the quality of the environment, concern for the quality of the visitor experience, and attention to the opportunities and constraints of management. This multidimensional framework is in keeping with the emerging body of scientific and professional literature on sustainability more broadly. For example, the earliest expression of sustainability in the contemporary environmental literature suggested that it had two important dimensions: ecological and social (33). More recent treatments of sustainability are based on what are often called the “three pillars” of sustainability, or the “three E’s”, or the “triple bottom line” (34). All of these frameworks suggest that comprehensive consideration of sustainability must address matters of environment, society, and economy. In the case of transportation in the national parks, the scientific and professional literature is beginning to address all of these dimensions. Most studies address the relationship between transportation and the environment and the quality of the visitor experience. However, less is known about the economic dimension of sustainable transportation. Long-term funding of public transit in the national parks is likely to be challenging, although research at Great Smokey Mountains found substantial willingness to pay for the benefits of ATS (28), and Acadia’s Island Explorer shuttle bus system is heavily subsidized by philanthropic giving, a model that might be more broadly used across the national park system.

One of the most promising manifestations of sustainable transportation in the national parks is ATS. The national parks feature many innovative and prominent forms of ATS – Acadia’s Island Explorer, the Yosemite Valley Shuttle, the shuttle bus system in the Bear Lake...
Corridor of Rocky, the 90-mile Visitor Transportation System on the Denali Park Road. Other national park ATS programs use ferries, trains, vans, historic vehicles, and other conveyances. Many of these ATS vehicles use alternative, less polluting, fuels. And, of course, ATS can mean pedestrian and bicycle travel as well. Properly planned and managed, ATS can reduce many of the environmental impacts of private automobiles while maintaining and even enhancing the quality of the visitor experience. And many visitors will take these positive experiences with more sustainable transportation back home with them, more prepared to support sustainability in all forms, and this will be good for national parks and the greater world.

This paper illustrates ways in which transportation management in the national parks is becoming more sustainable and can become even more so. There is greater understanding of the potential impacts of transportation on park resources and the quality of the visitor experience. Programs of natural and social science research in the national parks are providing a stronger theoretical and empirical foundation for formulating indicators and standards of quality for defining and measuring the sustainability of transportation in the national parks. And this research is also testing the effectiveness of a range of management actions designed to maintain standards of quality. This growing body of work draws on the literature in the fields of both parks and outdoor recreation and transportation, and integrates this work where possible. In particular, the conventional paradigm of demand-driven transportation is being revolutionized by a more sustainable approach in which management objectives for park resources and visitor experiences serve as the foundation upon which transportation systems are designed and managed (see Figure 1). While a great deal more research on sustainable transportation in the national parks is warranted, the scientific and professional literature on this topic is beginning to reach a critical mass as reflected in the emerging principles described above.
REFERENCES


