

Carrying Capacity as “Informed Judgement”: The Values of Science And the Science of Values

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Carrying Capacity of Parks and Wilderness

Resource and social impacts of recreation use constitute long-standing issues in the field of park and wilderness management, and these issues are often addressed within the context of carrying capacity. In its most generic form, carrying capacity refers to the amount and type of visitor use that can be accommodated within a park or wilderness without unacceptable resource and social impacts. Recent experience with carrying capacity suggests that it can be applied most effectively through formulation of indicators and standards of quality for biophysical conditions (resource carrying capacity) and for the visitor experience (social carrying capacity) (Graefe et al. 1990; National Park Service 1997; Stankey et al. 1985; Stankey and Manning 1986; Manning 1999; Manning 2001). Analysis of carrying capacity focuses primarily on defining the level of resource protection and the type of visitor experience to be provided and maintained. Indicators of quality are measurable, manageable variables that define the quality of park and wilderness resources and the visitor experience. Standards of quality define the minimum acceptable condition of indicator variables.

By formulating indicators and standards of quality, parks and wilderness can be managed within a defined carrying capacity. Indicator variables are monitored over time, and if standards of quality are violated (or are in danger of being violated), management action

is required. This approach to carrying capacity is central to contemporary park and wilderness management frameworks, including Limits of Acceptable Change (Stankey et al. 1985), and Visitor Experience and Resource Protection (National Park Service 1997; Manning 2001).

“Informed Judgement”

The contemporary carrying capacity frameworks noted above rely (either explicitly or implicitly) on a foundation of “informed judgement.” That is, park and wilderness managers must ultimately render judgements about the level of impacts and related visitor use levels that are acceptable. A growing body of research illustrates that, while such relationships may be complex, increasing use levels of parks and wilderness may lead to increasing impacts to biophysical resources and the quality of the visitor experience (Hammit and Cole 1998; Manning 1999). To what degree are such impacts and associated visitor use levels acceptable?

This issue can be illustrated graphically as shown in Figure 1. In this figure, hypothetical relationships between visitor use and impacts to the biophysical and social environments are shown. This figure suggests that such relationships can take varying forms (e.g., linear or curvilinear), but that increasing visitor use can and often does cause increasing impacts in the form of damage to fragile soils and vegetation and crowding and conflicting uses. However, it is not clear from these relationships at what point carrying capacity has been reached. For example, for relationship A, X1 and X2 represent alternative levels of visitor use that result in corresponding levels of impact as defined by

points Y1 and Y2, respectively. But which of these points—Y1 or Y2, or some other point along the vertical axis—represents the maximum amount of impact that is acceptable?

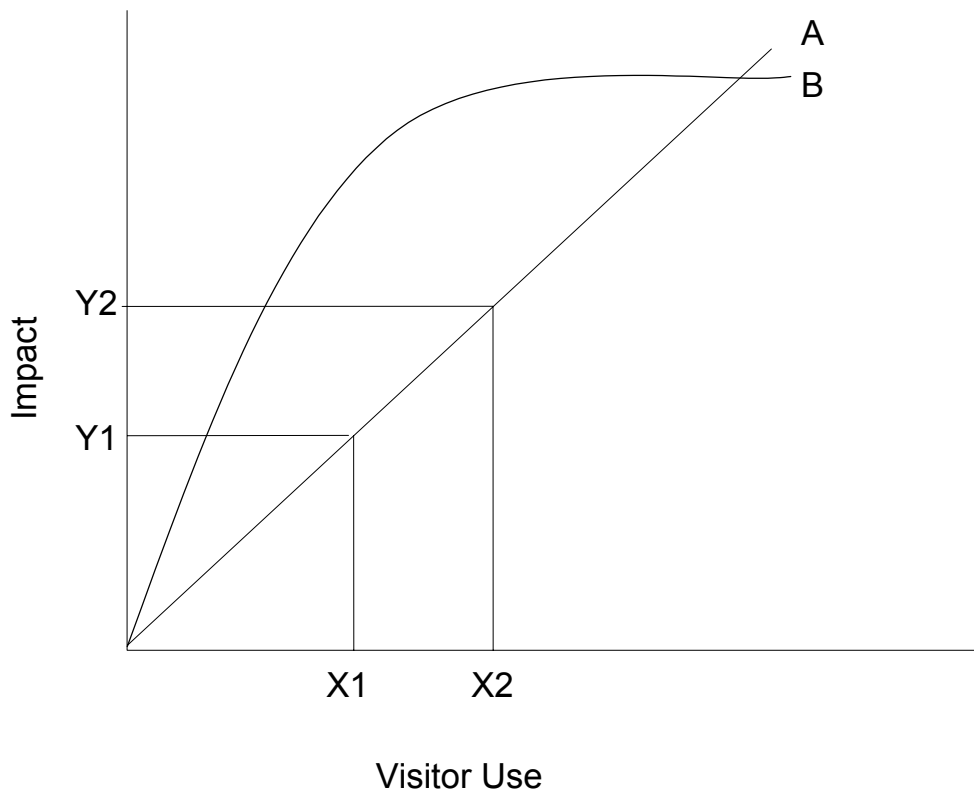


Figure 1. Hypothetical relationships between visitor use and impact to the recreation environment.

To emphasize and further clarify this issue, some studies have suggested distinguishing descriptive from evaluative and/or prescriptive components of carrying capacity (Shelby and Heberlein 1984, Shelby and Heberlein 1986). The descriptive component of carrying capacity focuses on factual, objective data such as the relationships in Figure 1. For example, what is the relationship between the amount of visitor use and perceived crowding? The evaluative/prescriptive components of carrying capacity determination

concern the seemingly more subjective issues of how changes in the recreation environment are judged and, ultimately, how much impact or change in the recreation environment is acceptable. For example, the evaluative component of carrying capacity might address the question of how visitors judge increasing levels of use, while the prescriptive component of carrying capacity might address the question of what level of perceived crowding should be allowed.

From this discussion, it is apparent that carrying capacity analysis and management require a strong element of “informed judgement.” Park and wilderness managers must ultimately render judgements about acceptable levels of biophysical and social impacts, and associated use levels, but such judgements should be as “informed” as possible. Findings from scientific studies represent an important approach to informing such judgements.

The Values of Science

Science can inform management judgements about carrying capacity in at least two ways. First, research findings should serve as the basis of the descriptive component of carrying capacity. As noted above, the descriptive component of carrying capacity concerns the relationships between visitor use and the biophysical and social impacts of such use. A substantial body of scientific literature has been developed on both the resource and social components of carrying capacity, and recent meta-analyses have begun to integrate and synthesize this growing body of knowledge (e.g., Hammitt and Cole 1998; Manning 1999).

Second, research findings can also help inform the evaluative/prescriptive components of carrying capacity. These components of carrying capacity ultimately concern the maximum acceptable level of biophysical and social impacts. Again, a substantial body of scientific literature has been developed on the degree to which park and wilderness visitors are perceptive of such impacts and their subjective evaluations of these impacts. This research explores the park and wilderness-related values of visitors, and can be used with other types of information (e.g., legal and administrative mandates, agency policy, historic precedent, interest group politics, personnel and financial resources) to help inform management judgements about standards of quality and, ultimately, carrying capacity.

The Science of Values

Within the context of carrying capacity, scientific approaches to park and wilderness-related values have been applied primarily to formulation of standards of quality. Earlier in this paper, standards of quality were defined as minimum acceptable levels of indicator variables. Standards of quality ultimately reflect the values that visitors place on parks and wilderness. Research on visitor-based standards of quality has conventionally focused on normative theory and techniques. For example, what is the maximum acceptable number of groups that visitors feel can be encountered per day along a wilderness trail? More recent research has begun to extend the normative approach by emphasizing the potential consequences or tradeoffs that may be inherent in normative research. For example, park and wilderness visitors may value both solitude and access,

but these values may ultimately conflict. How do concerns about maintaining reasonable public access to wilderness areas affect normative judgments about the maximum acceptable number of groups that can be encountered per day along wilderness trails? The following subsections briefly describe and illustrate this evolving research on alternative park and wilderness values and their relationship to formulating standards of quality.

The Normative Approach

Developed in the discipline of sociology, the concept of norms has attracted considerable attention as a theoretical and empirical framework in park and wilderness research and management. In particular, normative theory has special application in helping to formulate standards of quality for park and wilderness experiences. As applied in outdoor recreation, norms are generally defined as standards that individuals and groups use for evaluating behavior and social and environmental conditions (Donnelly et al. 1992; Shelby and Vaske 1991; Vaske et al. 1986). If visitors have normative standards concerning relevant aspects of recreation experiences, then such norms can be measured and used as a basis for formulating standards of quality. In this way, parks and wilderness areas can be managed within a more empirically informed carrying capacity. Application of the normative approach to formulating visitor-based standards of quality in park and wilderness management is most fully described in Shelby and Heberlein (1986), Vaske et al. (1986), Shelby et al. (1996), and Manning (1999). These applications have relied heavily on the work of Jackson (1965), who developed a methodology—return-potential curves or “norm curves”—to measure norms. Using

these methods, the personal norms of individuals can be aggregated to test for the existence of social norms or the degree to which norms are shared across groups. Normative research in outdoor recreation has focused largely on the issue of crowding (e.g., Heberlein et al. 1986; Manning et al. 1996a,b; Patterson and Hammitt 1990; Shelby, 1981; Vaske et al. 1996; Whittaker and Shelby 1988; Williams et al. 1991; Manning et al. 2002a; Manning et al. 2002b; Manning et al. 2000; Manning et al. 1999; Manning et al. 1996a), but also has been expanded to include other potential indicators of quality, including ecological impacts at wilderness campsites (Shelby et al. 1988), wildlife-management practices (Vaske and Donnelly 1988), and minimum stream flows (Shelby and Whittaker 1995). Research findings from published studies of recreation-related norms have recently been compiled in Manning (1999).

A hypothetical social norm curve is shown in Figure 2 to illustrate the methodology described above. The norm curve traces the average acceptability ratings of a sample of recreationists for encountering a range of groups of other visitors per day along a trail. The highest point on the norm curve might be considered the optimal or preferred condition. The range of acceptable conditions might include all points on the norm curve above the zero point of the acceptability scale. The minimum acceptable condition might be defined by the point at which the norm curve crosses the zero point of the acceptability scale. The degree of consensus among the sample is indicated by the dispersion or variance of individual responses around the means that define the norm curve. This issue often is referred to as “crystallization.” Finally, the distance of the norm curve above and below the zero point of the acceptability scale defines norm “intensity” (also called

“salience”) and is a measure of the degree to which the impact under study is important to respondents.

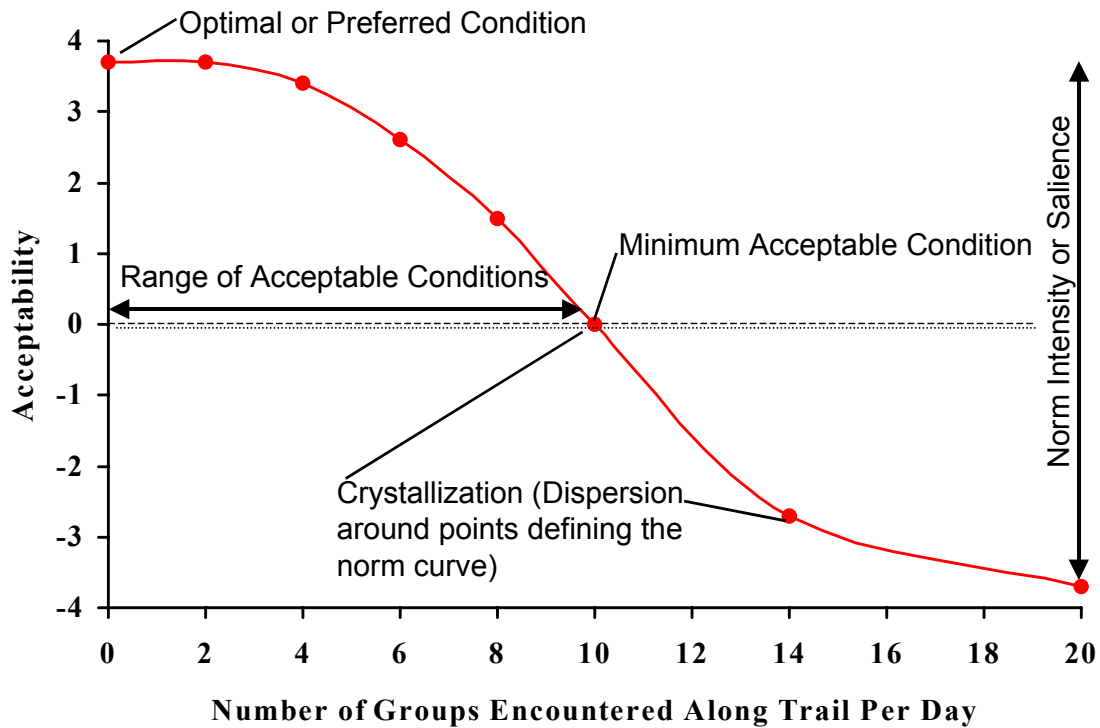


Figure 2. Hypothetical social norm curve

Extending the Normative Approach

As research on normative standards has proceeded, several approaches to measuring norms have evolved. Traditionally, outdoor recreation-related norms have been measured using a “numerical” or “narrative” approach. For example, respondents might be asked to evaluate a range of encounters (0, 5, 10, 15, etc.) with other groups per day along trails. The personal normative data derived are aggregated and graphed (as illustrated in Figure 2) to construct a “norm curve” from which social norms might be

identified. This numerical or narrative approach often is shortened to reduce respondent burden by simply asking respondents in an open-ended format to report the maximum acceptable number of encounters with other groups per day. These two approaches might be called the “long” and “short” versions of this measurement technique.

More recently, visual approaches to measuring crowding and other outdoor recreation-related norms have been developed. Two of these studies used photographs of wilderness campsites that illustrated a range of ecological impacts (Shelby and Harris 1985; Shelby and Shindler 1990). Two other studies have used artistic renderings of alternative use levels and related impacts (Heywood 1993a; Martin et al. 1989). More recently, computer software has been used to edit and produce photographs depicting a range of use levels and environmental impacts (Hof et al. 1994; Manning et al. 1995; Manning et al. 1996a; Manning et al. 1996b). As with the numerical/narrative approach described previously, long and short versions of this measurement technique can be used. The long version asks respondents to evaluate each image in a series of photographs. The short version asks respondents to select the photograph that illustrates the highest impact or use level acceptable.

An issue implicit in all of these measurement approaches concerns the evaluative dimension used in these questions. When respondents have been asked to evaluate a range of use levels and related impacts, the response scale has included terminology specifying a variety of evaluative dimensions, including “acceptability,” “preference,” “pleasantness,” “desirability,” “satisfaction,” and “tolerance”. These alternative

evaluative dimensions may have substantially different meanings to respondents, and may result in significantly different personal and social norms.

A related issue concerns the normative nature of evaluative dimensions. Application of normative theory and techniques to outdoor recreation has noted several important elements of norms as they traditionally are defined (Heywood 1993a, b; Heywood 1996a, b; McDonald 1996; Noe 1992; Roggenbuck et al. 1991; Shelby and Vaske 1991; Shelby et al. 1996; Williams et al. 1991). One of these elements suggests that norms have a strong obligatory nature; that is, norms define what “should” be. This suggests that norms might be measured by asking respondents about what recreation conditions or level of impacts they feel managers “should” maintain.

Recent studies of crowding-related norms for several national parks have allowed comparisons of findings among the norm measurement approaches described above (Manning et al., 1997a,b; Manning et al., 1998; Manning et al., 1999c,d; Manning et al., 2000). These comparisons suggest that alternative measurement approaches can affect resulting norms in a statistically significant and substantive way (Manning et al., 1999a). The most powerful effects concern the evaluative dimension used and more explicit introduction of the normative notion of the recreation conditions that managers should maintain.

These findings suggest three important points. First, a range of personal and social norms can be estimated using a spectrum of evaluative dimensions that range from “preference”

to “displacement” or “absolute tolerance”. Second, the “management action” evaluative dimension may be of special interest to park and wilderness managers because it more explicitly addresses tradeoffs inherent in crowding-related issues (i.e., a desire to avoid crowding while also maintaining reasonable public access), and therefore may more closely approximate the traditional prescriptive nature of norms. For example, the “management action” question for the carriage roads of Acadia National Park, Maine asked respondents “Which photograph shows the highest pattern of visitor use that the *National Park Service should allow* on this section of the carriage roads? In other words, at what point should visitors be restricted from using the carriage roads?” (Respondents were given options to report that visitor use should not be restricted at any point shown in the photographs, or that visitor use should not be restricted at all. To the extent that respondents select these options, resulting crowding-related norms are underestimated.) It is important to note that “management action”-related norms are consistently and often substantially higher than “preference” and “acceptability”-based norms. The magnitude of these differences is often underestimated because up to one third of respondents in some studies reported that visitor use should not be restricted at any point shown in the photographs, or that visitor use should not be restricted at all. Finally, the range of crowding-related norms developed in the literature based in alternative evaluative dimensions may be useful to researchers and managers as it facilitates a more comprehensive understanding of the evaluative and prescriptive components of carrying capacity.

Beyond the Normative Approach

Data derived from the normative approach can be useful in helping researchers and managers quantify the values of park and wilderness visitors and formulate crowding-related and other standards of quality. However, such studies have also illustrated the complex nature of this research, as well as the strengths and weaknesses of normative theory and empirical techniques. In particular, conventional studies designed to estimate crowding-related and other norms may substantially underestimate such norms because these studies fail to explicitly (or even implicitly) introduce tradeoffs between the desire to avoid crowding and other impacts of recreation and the desire to maintain reasonable public access to parks and wilderness.

Indifference Curve Analysis

Research on park and wilderness-related values might be strengthened through adaptation of alternative theoretical and empirical approaches, especially those that more explicitly address inherent tradeoffs in park and wilderness management. For example, indifference curve analysis developed in the discipline of economics, provides a model representing the tradeoff decisions an individual makes in allocating a fixed level of income between two consumer goods (Nicholson 1995). This approach has recently been adapted to examine the tradeoffs that visitors would prefer to make between solitude and access to Delicate Arch, a popular visitor attraction in Arches National Park (Lawson and Manning 2000; Lawson and Manning 2001b; Lawson and Manning 2002a). A representative sample of visitors was asked a series of questions regarding alternative combinations of solitude (number of people at Delicate Arch) and access (percentage

chance of receiving a permit to hike to the arch). Study findings provide potentially important insights into the appropriate balance between these two desirable attributes of the park experience, and can help inform management judgements about the carrying capacity of this site.

Indifference curve analysis may provide a useful tool for park and wilderness managers to evaluate trade-offs inherent in carrying-capacity decisions. This research approach gathers data concerning crowding-related norms of visitors, but places such norms within a more realistic and applied management context regarding the trade-offs inherent in such normative judgements.

Stated Choice Analysis

Stated choice analysis represents another research approach to quantifying carrying capacity-related values and tradeoffs inherent in park and wilderness management. Stated choice analysis models have been developed in the fields of psychometrics, econometrics, and consumer marketing to evaluate public preferences and related attitudes (Green and Srinivasan 1978). There is a growing body of literature describing the application of stated choice analysis to outdoor recreation management issues in parks and related areas (Louviere and Timmermans 1990b; Louviere and Woodworth 1985; Schroeder et al. 1990). In stated choice analysis, respondents are asked to make choices among alternative configurations of a multi-attribute good (Louviere and Timmermans 1990a). Each alternative configuration is called a profile, and is defined by varying levels of selected attributes of the good (Mackenzie 1993). For example, respondents may be

asked to choose between alternative recreation settings that vary in the number of other groups encountered, the quality of the natural environment, and the intensity of management regulations imposed on visitors. Respondents' choices among the alternatives are evaluated to estimate the relative importance of each attribute to the overall utility or satisfaction derived from the recreational setting. Further, stated choice analysis models are used to estimate public preferences or support for alternative combinations of the attribute levels (Dennis 1998).

Recent applications of stated choice modeling have been applied at Denali National Park (Lawson and Manning 2001a; Lawson and Manning 2002b) and Yosemite National Park (Newman et al. 2001; Newman et al. 2002). For example, wilderness visitors to Yosemite were asked their preferences between alternative wilderness scenarios that were described by a range of six attributes – campsite impacts, signs of stock use, trail encounters, campsite encounters, likelihood of receiving a wilderness permit, and regulation of campsite choice. Study findings suggest that campsite impacts are the most important attribute (or indicator of quality), and that most visitors would prefer to accept more management regulation to assure a minimum standard of quality for campsite conditions. Data also suggest that campsite condition three (on the park's five-level campsite monitoring system) may be an appropriate standard of quality.

Stated choice analysis provides a potential improvement over conventional normative research approaches to park and wilderness carrying capacity because resulting data are derived from a more holistic or contextual perspective. That is, visitors' normative judgements and the resulting multivariate statistical analysis explicitly consider the

inherent tradeoffs among the conditions of social, resource, and managerial attributes. Further, this expanded approach to normative research yields information to help formulate standards of quality for multiple and related park and wilderness attributes simultaneously.

Conclusions

Carrying capacity is an important issue in park and wilderness management, and is likely to increase in importance as the popularity of parks and wilderness continues to grow. Research on carrying capacity, along with management experience, has developed a number of planning and management frameworks and research approaches for addressing this issue. It is clear from the literature that management of carrying capacity involves matters of both science and values, and that both of these elements must be integrated into “informed judgements” on the part of park and wilderness managers. That is, managers must ultimately make value-based judgements about the maximum acceptable levels of visitor-caused impacts to the resource base and the quality of the visitor experience. However, such judgements should be informed to the extent possible by scientific data on the relationships between visitor use and resulting impacts, and the degree to which park and wilderness visitors and other interest groups judge such impacts to be acceptable. Such information represents the “values of science” to managing carrying capacity in parks and wilderness.

A growing body of literature has begun to address the corresponding “science of values,” and how this type of information might be integrated into park and wilderness

management. Visitor-based research has employed normative theory and techniques to explore the acceptability of a range of biophysical and social impacts related to visitor use, and findings from these studies are being integrated into a body of knowledge and applied in management decision-making. Conceptual and methodological extensions of the normative approach are currently being explored in a variety of park and wilderness contexts, and new theoretical and empirical approaches, including indifference curve and stated choice analysis, are being adapted to address tradeoffs inherent in carrying capacity management. In these ways, the science of values is progressing to meet the opportunities and challenges of the values of science to park and wilderness management.

While progress has been made in developing a more conceptually and empirically informed approach to the carrying capacity of park and wilderness, this research should be interpreted and applied carefully, and more research is clearly warranted. For example, normative theory and techniques borrowed from the discipline of sociology have proven useful in carrying capacity analysis, but such data derived in the context of park and wilderness management may lack the full prescriptive power of norms as they have traditionally been defined. As noted earlier in this paper, crowding-related and other norms in outdoor recreation have generally not included explicit consideration of tradeoffs that may be necessary to attain desired levels of solitude and other experiential and resource conditions. Additional conceptual and methodological approaches (such as indifference curve analysis and stated choice modeling, as described in this paper) may prove useful to supplement the normative approach. Moreover, the normative data described in this paper are often analyzed and presented using measures of central

tendency such as means and medians. Researchers and managers should be careful not to mask important variation that might exist among different types of park and wilderness visitors.

A related issue concerns the inherent complexity and diversity of carrying capacity and its application to parks and wilderness. Current visitors have been the subject of most carrying capacity research, but other interest groups may be considered legitimate stakeholders as well, including local residents, displaced visitors, and the general public. Research should be expanded to include a wider spectrum of interest groups. Carrying capacity research has also traditionally been conducted on a site-by-site basis. However, viewing individual parks and wilderness areas as parts of larger, regional or even national systems of outdoor recreation areas – and conducting research and management accordingly – may result in a more diverse system of park and wilderness opportunities that more fully serves the spectrum of public preferences. Such a “systems approach” may also help relieve some of the tension and confrontation often associated with the application of carrying capacity, as the preferences of multiple groups might be incorporated into larger scale research and management. It should also be noted that the types of data described in this paper are only one source of information on public values that might be incorporated into analyzing and applying carrying capacity to parks and wilderness areas. Other sources of information include legal and administrative mandates, agency policy, historic precedent, interest group politics, personnel and financial resources and – inescapably – management judgement, but judgement that is scientifically “informed” to the extent possible.

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