

# A Literature Review



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**CARRYING-CAPACITY OF RECREATIONAL SETTINGS**

## CARRYING CAPACITY OF RECREATIONAL SETTINGS

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### INTRODUCTION

Few concepts within the field of outdoor recreation management have attracted as much attention and persisted as long as that of carrying capacity. As a recreation management idea, carrying capacity can be traced as far back as the mid-1930's. But interest in it peaked during the 1960's and 1970's as burgeoning recreational use raised concerns about appropriate amounts and types of use in the Nation's outdoor recreational areas.

That carrying capacity would gain prominence in outdoor recreation management was logical enough. Most managers were trained in the biological sciences and therefore were familiar with the concept as it had been applied to management of wildlife and livestock. As used in these fields, the term referred to the number of animals of any one species that could be supported in a given habitat (Dasmann 1964). The analogy in the management of outdoor recreation was difficult to resist. Determining how many people could use a given recreational setting before unacceptable impact set in became critically important to many managers.

Over the years, many studies have focused on the notion of recreational carrying capacity (for examples of bibliographies on carrying capacity, see Stankey and Lime 1973; Cole and Schreiner 1981; Vaske and others 1984). Considerable experience has been accumulated in applying the concept. Some authorities charge that the concept has not provided the kind of information that was needed or anticipated; some even have argued that the term should be dropped altogether (Wagar 1974; Bury 1976). Dissatisfaction with the concept might lie more with unrealistic expectations about what carrying capacity could provide rather than any inherent weakness in the concept itself (Stankey 1982). Nonetheless, it is clear that many managers find the concept difficult to grasp and to implement. Washburne and Cole (1983) found that while managers of two-thirds of the areas in the National Wilderness Preservation System (NWPS) believed that use exceeded capacity at least some of the time, only one-half of the managers reported any progress in establishing capacities.

Despite the many difficulties of defining and measuring carrying capacity, the concept persists in both the popular and professional literature. We believe it represents an important conceptual framework within which to view recreation management. The carrying capacity model provides a basis for examining several important interactions: between supply and demand considerations, between

concerns about resource conditions and perceived recreational quality, and between the quantity of recreational opportunities supplied and the quality of experiences derived from them.

## RECOMMENDATIONS

1. Management objectives should be developed for all recreational areas. Management objectives should be as explicit and quantitative as possible and should address natural resource, social, and managerial factors. Without such objectives, the concept of carrying capacity will remain a contentious issue with no basis for resolution. Moreover, management objectives are essential guides in formulating appropriate programs of management.
2. Managers should monitor recreational areas to ensure that management objectives are met. Managers need to develop and implement reliable yet cost-effective monitoring systems. In many recreational areas, there is a serious lack of basic descriptive information about existing conditions and an even greater absence of information about trends in these conditions.
3. Recreation management should be considered within a broad approach that considers each recreational area as part of a larger system of areas. Research indicates that there is a wide diversity of tastes for outdoor recreation. Management should provide a corresponding diversity of opportunities. A range of carrying capacities should be developed and implemented to meet recreation demands now and in the future.

## ISSUES AND PROBLEMS

Based on the following review, the following issues and problems seem especially important.

1. Management objectives play a critical role in establishing carrying capacities. Carrying capacities cannot be established until objective, quantifiable management objectives have been written. There is a need to initiate an aggressive program of formulating management objectives for all recreational areas so that carrying capacity can become a management tool.
2. Research should play an enhanced role in helping establish management objectives. The consequences and implications of alternative use levels in recreational areas is only now beginning to be understood. Improved knowledge of the effects of recreational use, as well as the effectiveness of management actions in controlling such effects, is a necessary component of recreation management planning.
3. Public input needs to be formally and systematically incorporated into the process of establishing management objectives to guide carrying capacity decisions. Research has shown that important differences exist between the perceptions and opinions of managers and those of visitors. These differences often relate to such things as appropriate levels of use and impact. Because carrying capacity involves personal and normative judgments, the views of users need to be incorporated into the process.

4. There is need for an integrated approach to the study of carrying capacity, involving ecological, social, and managerial factors. No single discipline holds the answer to establishing carrying capacity. Moreover, there are important interrelationships among these factors. Changes in use based on social considerations can lead to changes in ecological conditions and can require certain management actions. Conversely, managing an area to preserve certain ecological conditions has direct implications for the type and level of use permitted. An integrated approach to implementing carrying capacity is needed.

## SUMMARY OF FINDINGS

Over the past 20 years carrying capacity research, coupled with extensive management experience with the concept, has produced many findings that can be drawn into six basic conclusions.

1. Whereas carrying capacity as applied to management of wildlife or range has been focused on ecological considerations, its application to outdoor recreation requires consideration of other factors, too. Particularly important are the following (Manning 1986):

a. Natural resource factors. The physical and biological characteristics of the natural resource base greatly influence the degree of change in the environment that results from recreational use. Although recreational use inevitably causes change in the environment, some resource bases are inherently more fragile than others.

b. Social factors. The needs and wants of people are important in determining appropriate uses of natural resources. User perceptions and opinions of what types and level of use are appropriate are an essential element of carrying capacity prescriptions. As one author has noted "The question of carrying capacities too often sounds like a physical problem when its heart is really a matter of inter-personal quality effects" (Davis 1963).

c. Managerial factors. Legal directives and agency missions often play a major role in determining appropriate resource, social, and management conditions. These factors prescribe what conditions should be maintained and what actions are needed to achieve those conditions.

2. With any recreational use of an area, natural resource factors, social factors, and managerial factors will inevitably change. Because some level of impact will occur, a major management responsibility is to help establish appropriate limits to this change. A promising new approach to the carrying capacity concept (The Limits of Acceptable Change, or LAC, see Stankey and others 1984, 1985) focuses explicitly on the need to make decisions that identify the levels of change that are acceptable in different recreation settings.

3. Limits of acceptable change should be developed and expressed as management objectives. Management objectives should identify and describe, explicitly and quantitatively, the natural resource, social, and managerial conditions to be maintained or restored. Management objectives should be based on research findings, public input, and managerial judgments.

4. Because any one recreational area can have many different capacities, depending on the objectives set for it, there is a need to consider carrying

capacity decisions within a regional (or large) planning framework. No one recreational area should be considered as an isolated entity; each is part of a larger system of areas and opportunities. Decisions regarding the carrying capacity of any one recreational area will affect others in that system.

5. Although the term carrying capacity suggests that the number of users is the main concern, carrying capacity can also be a function of other use conditions, such as type of use, timing and location of encounters between visitors, and visitor behavior. As a result, limiting numbers might have negligible effect on controlling overuse problems and is only one of many management options that might be implemented.

6. Carrying capacity is a management concept, not a scientific theory. Scientific research can play an important role in the process of establishing carrying capacities. For example, research can help describe and predict the social and ecological consequences of alternative types and levels of recreational use, and it can evaluate the relative effectiveness of different management strategies such as site closure or rehabilitation. But ultimately, managers must decide the uses that are appropriate and acceptable and the kinds and amounts of impact that are tolerable. Moreover, these management decisions will require value judgment that cannot be derived from scientific research (Stankey 1979).

#### Research on Natural Resource Factors

Much research has been completed on natural resource, social, and managerial factors. A synopsis of this research follows.

The report submitted to the Commission by Dr. David Cole, entitled \*‘Resource Impacts Caused by Recreation,’ provides considerable detail on this topic. Several conclusions, however, merit special attention.

1. Virtually all ecological studies of carrying capacity report a curvilinear relationship between recreational use and impact. Typically, most environmental impact occurs under light levels of recreational use, and additional recreational use causes relatively little additional impact. Cole (1982), for example, found that recreation sites receiving light levels of use sustained a median loss of 71 percent of original vegetational ground cover, while similar sites receiving heavy recreational use sustained a 94 percent median ground cover loss. Thus, a relatively large increase in recreational use resulted in a relatively small increase in environmental impact.

2. Complex interactions exist between the various physical parameters that compose the environment; these can be altered by recreational use. Manning (1979), for example, has traced a seven-step soil impact cycle in which the initial scuffing away of leaf litter and other surface organic material caused by recreation leads to increased soil compaction which in turn reduces water infiltration rates, leading to increased runoff, soil erosion, and sedimentation. Increased sedimentation can lead to environmental impacts in adjacent waterways. Thus, the direct impacts associated with recreation need to be considered in light of the secondary effects they might have in order to assess their full consequences.

3. In assessing ecological impact associated with recreation, it can be difficult to determine the most appropriate indicator of that impact. For example, many early studies of impacts on water quality focused on threats to human health, such as coliform counts. Most studies revealed only minor problems, typically highly localized and transitory effects. But more recent studies of high mountain lakes in the Sierra Nevada mountains (Taylor and Erman 1979) indicate that recreational impacts are inducing subtle changes in water chemistry that will eventually affect their long-term biological productivity.

4. Many ecological impacts are subject to some degree of management control. Techniques such as site rehabilitation, fertilization, and planting have been tested and found effective (Beardsley and others 1974). Management activities can also affect the timing and location of impacts. The location of trails, for instance, is a powerful influence on where people go and, by implication, the nature and location of impacts. Poor design of recreational areas contributes to many ecological problems.

5. Most of the research done on resource impact problems has focused on vegetation and soils. Studies on water, air quality, and wildlife are much less abundant. Also, much of the research is descriptive and site specific. Hence, an understanding of the full range of impacts associated with recreational use is limited, as is an understanding of the dynamics of the impact process. These shortcomings limit the ability of managers to minimize environmental impacts.

### Research on Social Factors

There has been increasing recognition that use of a recreational area-- amount, type, timing, distribution, and behavior--can be a major influence on the quality of the recreational experience. Concerns about crowding and related issues are common in the professional and popular publications. Several major conclusions can be drawn from the literature.

1. It is important to distinguish the concept of crowding from the more simple concept of amount of use. Many recreational areas are used intensively, but this does not necessarily mean they are crowded. Crowding is a normative concept based on the personal judgment that a particular situation has attracted too many people (Stokols 1972). For example, in wilderness settings the generally accepted norm is that few if any others should be present (Stankey 1973). But in a different recreational setting--a popular beach in the summer, for example--the presence of many others might not only be acceptable but desirable (McConnell 1977). Crowding norms appear to be widely shared by different users. Shelby (1981), for example, has demonstrated how visitors interviewed on three different rivers were able to specify appropriate use levels for different types of experiences.

2. Crowding norms are a function of more than just the number of other users. A variety of use characteristics as well as situational variables affect personal judgments about crowding (Manning 1985). The motivations underlying recreation participation and the preferences and expectations visitors hold are powerful determinants of whether a situation is defined as crowded or not. Ditton and others (1983), for example, found that river runners responded to the presence of others according to how they had rated different motives for

their visit. Users who gave high ratings to “getting away from others” tended to report crowding, while those who gave relatively high ratings to “being part of a group” found the same use levels satisfactory. Moreover, Stankey (1973) reported that wilderness users were more tolerant of others, when contacts occurred while on the trail or near the periphery of the area as opposed to contacts at campsites or in the area’s interior. The notion of crowding can also be influenced by the activities in which users engage (snowmobilers versus cross-country skiers, Jackson and Wong 1982), method of travel (hikers versus horseback riders, Stankey 1973), or other perceived conflicts in behavior (West 1982). The central factor in all these studies seems to relate to perceived likeness; when others are seen as sharing the same values as oneself, conflict is unlikely. When differences are seen, however, conflict can develop, often manifesting itself in judgments that the area is crowded or overused (Manning 1985).

3. There appears to be considerable consensus on what constitutes crowding among like-minded groups, but not necessarily between groups or across the population as a whole. Several studies have found that selected groups of recreationists share personal, attitudinal, and behavioral characteristics that lead to shared norms regarding crowding (Shelby 1981; Shelby and Heberlein 1984).

4. In assessing the effects of crowding, researchers and managers have difficulty selecting an appropriate criterion measure. Early studies focused principally on user satisfaction and hypothesized that as use levels in wilderness rose, individual satisfaction declined (Stankey 1973). If this were actually true, managers could have used such data to establish appropriate capacities. But studies of visitor reactions to actual use conditions generally have failed to demonstrate such a clear relationship. For example, in an analysis of over 50 studies, Graefe and others (1984) found no relationship between satisfaction and visitor density. They also found no significant relationship between numbers of contacts among recreationists and satisfaction. They did, however, find positive and significant relationships between the number of encounters between user groups and perceived crowding; that is, as encounters between user groups increased, recreationists were more likely to report the situation as being crowded. Their review concludes that although the perception of crowding is influenced by use level, its influence is mediated by a variety of situational and subjective variables.

Many of the studies reviewed by Graefe and others involved river users. Studies of trail-oriented use, primarily in wilderness, have shown stronger associations between the number of others encountered and satisfaction. For example, studies by Lucas (1980, 1985) reveal a negative relationship between satisfaction and a variety of measures of solitude, such as the number of other recreationists encountered, the number of horse parties encountered, and success in finding campsite solitude.

5. The above findings lead to the conclusion that satisfaction is a complex, multifaceted concept. Because recreation is a self-selected, voluntary form of behavior, visitors will employ a wide range of mechanisms that allow them to accept the situation, even when it is not preferred (Schreyer 1979). Measures of overall satisfaction therefore provide little evidence of visitor concern with crowding. Problems such as crowding can only be assessed with specific measures addressing these problems.

For density-dependent experiences, such as desire for solitude, satisfaction is closely associated with visitor perceptions of crowding (Gramann 1982). The importance of the experience greatly influences attitudes toward encounters with others and measures of satisfaction (Stankey and McCool 1984). When McCool (1983) compared satisfaction ratings for wilderness visitors who reported that meeting more than 10 others was "too many." Respondents who scored in the upper quartile on a solitude/stress-release scale reported trip quality as "poor" 2.5 times more often than those scoring in the lower quartile.

### Research on Managerial Factors

Many studies have focused on management actions, particularly the variety of management actions available and their effectiveness. Several conclusions are noteworthy.

1. Many techniques are available for maintaining outdoor recreational areas within their carrying capacities. At the broadest level, management has four basic strategies: reduce the amount of use through restrictions, accommodate more use by supplying additional opportunities, modify the character of use to reduce its impact, or harden the resource base to increase its resiliency (Manning 1979). These broad strategies embrace many specific actions, including mandatory permits, user fees, information and education programs, regulations, and zoning (Lime 1979).
2. Management actions are often categorized as being either direct or indirect (Peterson and Lime 1979). Direct management actions focus on visitor behavior, offering little or no freedom of choice. Mandatory permits and regulations are examples. Indirect- management actions attempt to influence visitor behavior while preserving some freedom of choice. Information and education programs and user fees are examples. It is generally agreed that indirect management actions are to be favored whenever possible (Lucas 1983).
3. Research to date indicates that a variety of management actions can be effective in implementing carrying capacity. Evaluations have been based on effectiveness in influencing visitor behavior, acceptability to visitors, fairness, and practicality. The number of such studies are limited and have focused particularly on information and education programs and control techniques such as reservation systems, lotteries, and fees (Lime and Lucas 1977; Roggenbuck and Berrier 1981; Krumpel and Brown 1982; Stankey and Baden 1977; Manning and others 1984).

### CASE STUDIES

There have been many efforts to apply carrying capacity. Most, however, are poorly documented and lack formal evaluation. One major exception is a current project underway in the 1.5-million-acre Bob Marshall Wilderness complex in western Montana. Here Forest Service administrators and researchers, educators, and citizens are applying the Limits of Acceptable Change concept (Stankey and others 1984, 1985). The project emphasizes development of management objectives that define, in measurable terms, the desired social and resource conditions. The intent is to incorporate carrying capacity into the



area's management. The public has played a major role in setting objectives and determining the management activities necessary to achieve them. Similar work is being undertaken in selected National Parks by researchers from the University of Maryland (Graefe and others 1985) under sponsorship of the National Recreation and Parks Association.

## KNOWLEDGE GAPS

Several important gaps in knowledge exist. A better understanding is needed of the interrelationships between ecological and social factors in setting carrying capacities. This would include the relationship between use, including amount, type, timing and distribution, and the social and ecological impacts that result. Also needed is improved understanding of the social and ecological consequences that result when carrying capacities are exceeded. What happens, for example, to users who are displaced from one area as use exceeds tolerable limits for them? Where do they go, what do they do, and what effects do they have on other recreational areas and users? Particular attention needs to be given to development of management actions to prevent or mitigate unacceptable impacts. We need to improve our knowledge of how a given management action will affect recreational use and the environment. And finally, we need to develop better understanding of 'what constitutes compatibility among different groups in outdoor settings in order that crowding and conflict can be minimized.

## RESEARCH ASSESSMENT

The concept of carrying capacity is large, involving a variety of disciplines. Many studies have been completed, but much of what has been done is descriptive, focused on a single aspect of the problem, and often conducted in a hypothetical setting. Much of the research lacks a theoretical base. Overall the utility for management is limited.

Most ecological studies attempt to assess the use-impact relationship after much of the impact has occurred, and with only limited knowledge of the specific amount and type of use that produced it. Few experimental studies or studies of trends have been attempted. Social studies are heavily based on cross-sectional surveys; few behaviorally based studies exist. And like ecological research, few experimental studies or trend studies have been done.

Perhaps the greatest shortcoming in the research on carrying capacity is the lack of holistic, integrative studies that combine natural resource, social, and managerial perspectives. Such studies would produce much more relevant information for decisionmaking needs; findings would also more likely be applied.

## KEYWORDS

Recreational carrying capacity, management objectives, recreational planning, visitor management, recreation impacts

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