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RECREATIONAL CARRYING CAPACITY RESEARCH REVIEW

George H. Stankey
School of Applied Science
Canberra College of Advanced Education
Canberra, Australia

INTRODUCTION

Probably no other concept in the lexicon of recreation management has absorbed as much attention and effort as that of carrying capacity. Like the search by alchemists of old for the means to transmute base metals to gold, recreation managers have sought to discover the capacity of recreation resources, a figure seen as the critical requirement for the difficult decisions facing them.

But the search has been largely disappointing. Despite the concerted effort of many investigators and the expenditure of substantial amounts of money, the discovery of a formula or even well-prescribed procedure for determining capacity remains elusive. The lack of progress is, in many ways, puzzling, given the high level of interest and the extensive number of empirical investigations. In fact, the general lack of progress has led some observers to conclude that it is time to discard the carrying capacity concept altogether, in favour of other conceptual formulations that might offer greater utility to decision makers (Wagar, 1974; Bury, 1976).

Is it, in fact, time to turn away from the carrying capacity concept? Obviously, there is the question as to what alternative formulations might be utilised. However, despite the seemingly disappointing results, of capacity based investigations, it seems unnecessary to reject outright the carrying capacity model. In the following discussion, I would like to examine the issue in light of four questions:

1. What is the essence of criticisms of the carrying capacity model?
2. What is the basic purpose of the carrying capacity formulation process?
3. What are the main themes of evolution in the history of carrying capacity research?
4. What is the relationship between carrying capacity as an analytical-scientific concept and as a prescriptive decision making framework?

CRITICISMS OF THE CARRYING CAPACITY MODEL

A number of criticisms have been directed at the carrying capacity model; examples of some of the criticisms can be

found in papers by Wagar (1974) and Burch (1981). The following discussion is an effort to reflect the essence of some of the principal concerns reflected in these criticisms.

First, there is concern that the biological origins of the carrying capacity concept have promoted the notion of a fixed inherent capacity of a resource system for recreation use. This concern stems from a basic misunderstanding of the concept as used in range and wildlife management, a misunderstanding that rests on the notion that a single number regarding the number of livestock that can be accommodated per unit land can be prescribed. From such a perception, it is easy to understand the intuitive appeal of carrying capacity to recreation managers. However, it is a simplistic and mistaken conception; the carrying capacity of resources for wildlife or livestock is highly dependent upon a number of factors, including the type of animal, kind of vegetation, seasonality of use, soil, growing season, etc. Hence, even in range or wildlife management, there is no single number that prescribes capacity; it depends upon a number of environmental factors as well as on what objectives the manager chooses to pursue.

Thus, criticism that carrying capacity promotes the notion of a fixed and inherent number does not reflect a basic flaw of the concept as much as it does a fundamental misinterpretation of the concept as it has been applied to recreation management. Rather than rejecting carrying capacity as a basic model for management, it seems more appropriate to promote and gain a better understanding of its actual dimensions.

Second, the concept of recreational carrying capacity has been criticised on the grounds that it focusses undue attention on the physical-biological qualities of the site to the exclusion of social and psychological issues. This criticism stems from the deficiency discussed above, in which capacity was seen as an inherent and fixed quality of the biological regime. Such a perception of carrying capacity obscures considerations of how an individual area fits into a broader range of areas, what trade-offs and relationships exist among these areas, and what steps might be undertaken to contend with the problems brought on by use.

The substance of this concern is that the fixation on physical site factors hinders recognition that recreation is primarily a social-psychological experience and that the level of environmental deterioration may have little or nothing to do with the quality of that experience. As Davis (1963) 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'. Because much of the biological impact that inevitably accompanies recreation use typically occurs under fairly low use levels (Frissell & Duncan, 1965), the biologically-orientated recreation manager can easily be convinced that restriction on use is necessary

(Hendee & Pyle, 1971). This restrictive mentality, manifested in use regulations, rationing and the like is often noted as a product of the carrying capacity approach to management (Burch, 1981).

Third, there is concern that the carrying capacity model obscures the distinction between issues of a technical/scientific nature and those of a value or normative nature. For example, it is clear that recreation use does produce significant impacts on soils, vegetation, water quality, etc. Numerous empirical investigations of these effects have been conducted and their results are of importance and value to recreation managers in making decisions regarding the use of resources under their administration (Cole & Schreiner, 1981). However, such data are not deterministic; they do not, by themselves, prescribe how much impact is too much. This is a normative question - a value judgement - and while managers play a key role in resolving it, their technical expertise is no greater credential for settling what is fundamentally a value judgement that are the values, preferences and expectations of their clients, the recreationists (Socolow, 1976).

Again, the essence of concern here is that the carrying capacity model promotes the notion that the establishment of capacities is a deterministic, even mechanistic process when in fact, it involves a resolution of conflicting values over what is appropriate. Such resolution is further compounded when as noted earlier, decisions about capacity are made one area at a time rather than within a regional or systems context.

Fourth, the general conception that areas have a definable recreational capacity fosters the notion that the key issues in management is the number of persons involved, i.e., the maintenance of conditions within an area's carrying capacity is largely a matter of regulating use numbers. However, a growing body of research clearly indicates such is not the case.

Criticism of the capacity model with regard to this issue however, points to the fact that the amount of use might be and often is, of only minor importance. This is true whether one conceives of capacity in physical-biological terms or social terms. For example, studies of vegetative impact at campsites and trails reveal that use intensity is a less important variable of explanation than such measures as type of use or seasonal timing (LaPage, 1967; Helgath, 1975). Similar findings are reflected in the investigations of social capacity; what often matters most is not how many people are encountered, but how they behave (Stankey, 1972). A major research project of Grand Canyon river runners reported that neither the perception of crowding nor the level of reported satisfaction were related to contact levels (Shelby & Nielsen, 1976).

Recent research reported by Absher & Lee (1981) provides strong evidence that, in particular, experience motives intervene in the elementary bivariate density-crowding model to reduce the direct effect of social density on the perception of crowding to a statistically insignificant level. As they conclude: "In short, it seems that the common-sense notion of crowding in recreation settings as a phenomenon dependent upon sheer numbers of other people must be reassessed in favour of more complex formulations that incorporate motivation and individual characteristics" (p. 247).

Yet the numbers of persons walking across the vegetation or meeting others is not without importance. Social density appears to be a necessary but not sufficient variable in the explanation of impact. However, the general perception of carrying capacity as an index of 'what's the right amount' tends to overemphasise this element and exclude other possibly more significant measures.

Finally, there is concern that carrying capacity research has too often lacked sound theoretical formulation, resulting in a series of ad hoc, non-additive and generally atheoretic case studies. This seems especially true of those investigations of social capacity. As a result, data from many of the studies conducted lack a coherent framework within which they might be interpreted. The plethora of empirical studies have yielded a great deal of data about contact levels, visitor satisfaction and so forth, but whether they have provided much in the way of a clear understanding of the process of how people cope, react and adapt to changing use is another question.

In summary then, a number of criticisms have been directed at the carrying capacity model that has so long been a keystone in the recreation management literature. The remainder of this paper takes the position that somewhere between the extremes of, on one hand, proceeding on with the concept as though nothing has changed, and on the other, discarding it entirely lies an alternative perspective. This alternative rests on two elements:

1. a careful restatement of the underlying purpose of carrying capacity formulations; and
2. a critical analysis of the changes in the nature, direction and scope of carrying capacity research over the past 25 years.

Combined, these elements clarify what role carrying capacity should play in management decision making and what kinds of research activity needs attention to fully achieve this role.

THE RATIONALE OF CARRYING CAPACITY PRESCRIPTIONS

It is useful to consider what purposes underlie the efforts to estimate the carrying capacity of recreational resources. Numerous definitions are found in the literature; however, most have the following features in common:

1. capacity is seen as a function of both environmental and social effects;
2. the notion of sustained output is reflected; i.e., there is a concern with the environmental and social effects over time;
3. there is at least implicit recognition that carrying capacity levels will vary according to the type of recreational opportunity under consideration; i.e., the use level appropriate in one setting might not be appropriate in another;
4. that the formulation of a carrying capacity is dependent upon the establishment of clear management objectives for the area (Lime & Stankey, 1971).

From these general themes of commonality, we can infer that a basic objective of capacity investigations ought to be the definition of a desired relationship between the use of a resource system for recreational purposes, the physical-biological impacts on that system and the experiences derived from participation in that system. In this sense then, carrying capacity describes the resource and use conditions consistent with the management objectives prescribed for an area and helps to identify what actions might be needed to achieve, restore or protect these desired conditions.

Clearly, carrying capacity as defined in the above sense is not a mechanistic or deterministic procedural matter, but a judgemental process involving decisions as to what objectives are deemed appropriate for an area and what social and environmental effects are consistent with those objectives. Simply put, there is no straightforward answer to the question 'What is the carrying capacity of such-and-such an area?' Such a query can only be answered in the context of previously defined objectives specifying what kinds of end conditions are sought.

If this is the sense in which carrying capacity is of most utility, then we can begin to see why past investigations have encountered so much difficulty. As outlined above, recreational carrying capacity serves as a prescriptive or normative concept that can be used to aid the formulation of management decisions. Yet, when we review the history of recreational capacity, it is clear that the concept was conceived of as a predictive measure, the product of some equation. Such a perception helped promote the notion that the 'solution' was hampered only by the lack of data and that if sufficient personnel, financial and technical resources were brought to bear, the answer could be achieved.

However, like so many other issues we confront today, the carrying capacity question has proved to be largely resistant to a straightforward scientific solution. This is not to say that the capacity issue will not benefit from

further investigations of the association between recreational use, environmental consequences and social implications. However, it is an argument the capacity research will not produce answers as to what is right or wrong or what ought to be done. But utilised in a prescriptive management framework, it can serve a useful role as a source of feedback on the likely consequences and implications associated with alternative decisions. In the final section of this paper, I will review some of the major emerging dimensions of capacity research that appear to facilitate realisation of this role.

The notion that recreational resources have limitations to their ability to sustain continuous use has a long history of literature. The first reference apparently was contained in a 1936 discussion by Lowell Sumner, a National Park Service wildlife technician regarding the growing recreational use of the Sierra Range of California. "Park areas," he noted "cannot hope to accommodate unlimited numbers of people" (Sumner, 1936). Later, he urged that use of wild parks in the California Sierras be kept "within the carrying capacity or recreational saturation point ... the highest ... use ... consistent with its (wilderness) long-term preservation" (Sumner, 1942).

This early commentary took on added impact in the postwar period as use levels began to grow rapidly in response to the increasingly affluent conditions. Thus, in the late 1950s, the issue of carrying capacity became the focus of scientific investigation, a focus that swelled in scope, direction and orientation over the ensuing 25 years.

The period of research reflects a growing level of sophistication and is a case study of the evolution of a research endeavour in response to changing theoretical conceptualisations, methodological strategies and empirical outcomes. In reviewing this period, I have identified three dimensions or themes that have evolved in the thrust of the research. These themes, in general, reflect an increasingly sophisticated grasp of the concept and accordingly, the probability of a more relevant and applicable research programme.

The first feature we might note in the evolution of carrying capacity research is its increasingly integrative approach to the problem. The biological origins gave a predictably physical resource orientation to early studies. For example, the now classic studies of the effects of recreation use on the California Redwoods by Meinecke (1929) reflected a conception of the capacity problem as one largely of a biological nature.

By the early 1960s, increasing research attention was directed at the social aspects of capacity. That is, it was increasingly recognised that growing use levels would alter the nature of the recreational experience offered by a particular place to the point that it was different from that which originally attracted participants. Such research was

largely done in wilderness settings where it was hypothesised that increasing levels of contact could produce large reductions in visitor satisfaction (Lucas, 1964).

These two streams of research were substantially limited to a concern with the relationship between recreation use and their own particular functional concern; i.e., social or ecological. The complex interactions among the factors were often acknowledged, but because of the very complexity of the issue, not pursued. For example, the effects of recreation use on vegetation was a common focus of investigation, but the more complex interactions of how those changes affected other biological parameters or of how those biological changes affected users and their experiences was left largely alone.

The lack of this more integrative feature of research might represent one reason why carrying capacity research has not achieved the kind of results thought possible. As noted above, the lack of progress is not necessarily due to the fact that the biological/social interrelationships were not seen as important but simply that they were of such formidable proportions that they were nearly resistant to investigation. Nevertheless, there are now examples of such efforts to integrate the ecological and social aspects of capacity.

One such example, is the large interdisciplinary research effort conducted under sponsorship of the U.S. National Parks Service in the Grand Canyon of the Colorado River. Here, to assist the National Park Service in making decisions about appropriate use levels in the Canyon, a large number of studies were commissioned. These included investigations of biological effects (for example Carothers & Aitchison, 1976) as well as social effects (for example Shelby & Nielsen, 1976). Although no one study attempted to integrate data from these studies, managers were provided a comprehensive data set regarding carrying capacity from which they could approach the problem of establishing an overall capacity figure for the Canyon (Shelby, 1981). Interestingly, some basic findings were similar from both the biological and social studies; for example, the patterns of visitor use were more important in estimating impact than were the total number of people (Jensen, 1981).

A second integrative example involves the development of a framework for prescribing carrying capacities in the Yosemite Valley (Frissel et al., 1980). In this case, an interdisciplinary consulting group working in conjunction with National Park Planners, developed a methodology for integrating visitor effects on natural biotic communities and scenic values within the valley, thereby permitting decision makers to review how alternative use levels would alter these values and to judge how the maintenance of particular environmental conditions would affect the number and kind of recreation users. The approach developed in this study would appear applicable in many other recreational settings.

A second major feature of evolving capacity research has been the increasingly sound theoretical foundations underlying the work. This is especially true of work in the field of social capacity. Many of the early investigations were very empirically oriented and, although tied to some general notions of perception, lacked clear, or at least explicit, theoretical underpinnings.

One useful theoretical perspective that appears especially useful in the study of capacity comes from the writings of Altman (1975). In his book, The Environment and Social Behaviour, Altman discusses the need of people for privacy as a general need or goal but one without a specific fixed level. In this framework, crowding represents a condition where the privacy regulation mechanisms have failed to produce a match between desired and achieved levels of privacy. Such a conceptualisation clearly defines the situational nature of crowding: i.e., it is not an objective measure, but an evaluative interpretation of conditions in a particular circumstance. Conditions that are judged as desirable and non-stressful in one situation will likely be unacceptable in others. In other words, for any given circumstance, there will be a distribution regarding the approval or disapproval of that circumstance. The structural nature of this distribution can be illustrated by construction of a 'return potential curve' (Jackson, 1965), which reflects the range of conditions accepted as normatively acceptable, the intensity with which the norm is held, as well as other characteristics.

Heberlein (1977) has illustrated the application of Jackson's 'return potential curve' to the following hypothetical situation; individuals are asked to rate how they would feel seeing 1, 2, 3 ... other people in each of three situations: wilderness, a cocktail party and on a city side walk. Figure 1 indicates the hypothesised relationships. As it shows, conditions judged as crowded in one situation are clearly not so judged in another. Moreover, the curve representing wilderness is more intensely held than the others (i.e., it has a greater range on the vertical axis) and the norm for a cocktail party has a much broader range of acceptance (from 5 to 25 people) than that shown for wilderness (0 to 5). Finally, there are virtually no norms regarding side walk traffic, except at very low levels (a possible reflection of safety concerns) and at very high levels (reflecting the difficulty of movement).

Another example of an increasingly vigorous theoretic framework being applied to the issue of recreational carrying capacity is found in a recent paper by Absher & Lee (1981). Here, they introduce two important elaborations to the traditional bivariate model of capacity that linked social density to perceived crowding. The first addition to the model assumes that personal definitions of the recreation setting including expectations about the likely level of encounters,

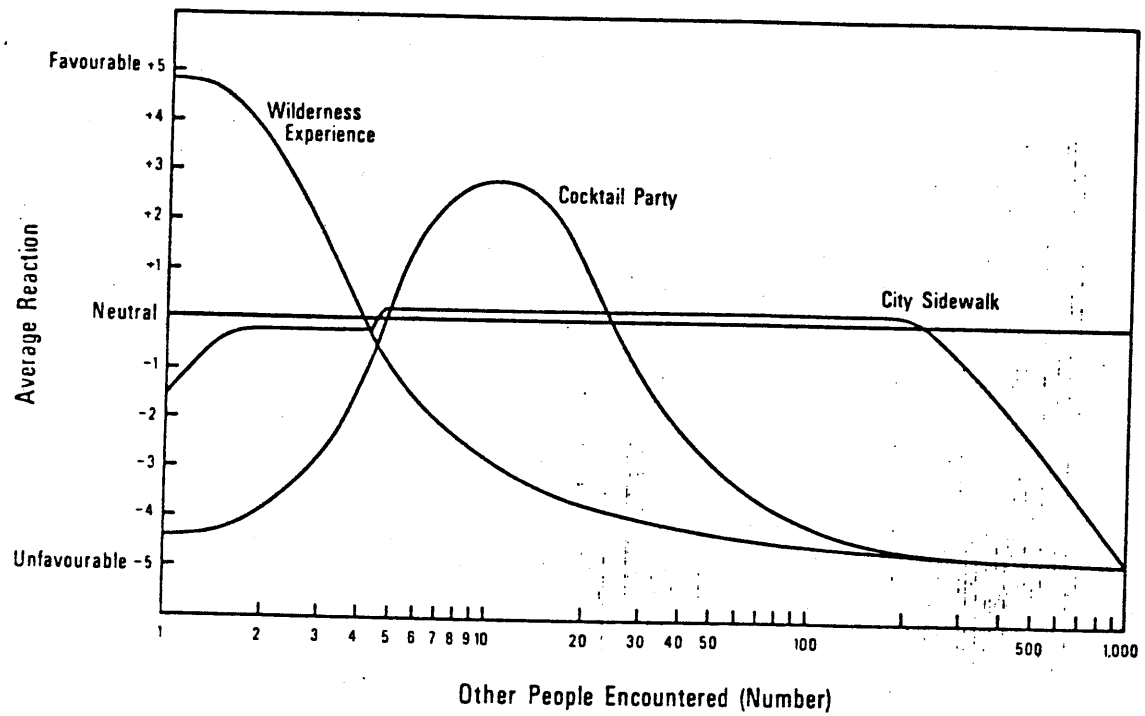

Figure 1. Return Potential Curves for Three Encounter Situations (from T. Heberlein 1977, p. 73).

are salient to outdoor recreation crowding theory. Secondly, the influences of social group membership and social status are introduced as likely influences on one's tolerance to crowding. Using path analysis, they demonstrate that social density contributes relatively little explanation in terms of perceived crowding, and that following introduction of the experimental factors, no effect of social density can be shown. The additional contribution of visitor characteristics is also low. The authors conclude: "In the end, crowding is less a response to social density than a product of the interaction setting, how it is defined, and the particular attributes, preferences and expectations of the people present" (Absher & Lee, 1981).

These theoretical perspectives provide clear evidence that recreational carrying capacity is situationally dependent and normatively prescribed. While sounding like the easy way out, the obvious answer to the question of 'What's the carrying capacity' is that 'it all depends'. Future research will be increasingly directed at controlling the various dependent factors so that its results will have greater application.

The increased theoretic orientation to carrying capacity research also carries with it the benefit of an improved and more precise set of concepts and terminology. Discussion of capacity invariably raises value-laden terms such as 'crowded'. But as the above discussion indicates, such terms have no universally accepted meaning and their use, unless accompanied by definition, leads to confusion. However, works by individuals such as Altman (1975) and Stokols (1972) have done much to provide order and consistency to the field. Such clarification should lead to sharpened definition of variables, to more rigorous measurement criteria and to a generally more sophisticated level of investigation.

Finally, a review of the extensive research on recreational carrying capacity suggests that progress has been hindered by the lack of a clear understanding as to what are the most critical dependent variables. The problem has plagued both social and ecological research; however, an example from studies of social carrying capacity illustrates the general problem.

Much of the social carrying capacity research has attempted to establish the relationship between increasing levels of contact and levels of satisfaction achieved by recreationists. The presumed relationship was that as use contact increased, satisfaction diminished. The satisfaction model of carrying capacity was intuitively appealing; moreover, its appeal was strengthened by its similarity to well-accepted economic notions diminishing marginal utility. In an early paper outlining this conceptualisation, Alldredge (1973) noted that with each additional visitor to an area, aggregate satisfaction would rise, until some point at which the last entry resulted in a net decline in aggregate

satisfaction. This general model received great attention in carrying capacity research (for example, Fisher & Krutilla, 1972; Price, 1977), for it clearly represented an opportunity to define an actual number at which capacity was reached.

The satisfaction model received additional support from some of the early investigations of wilderness recreationists. For example, Stankey (1972), found that in response to hypothetical changes in use levels, wilderness visitors showed a strong preference for contact between none and around three per day, with levels beyond these marked by rapid dimunition in reported satisfaction.

However, empirical studies generally did not reveal such a clear relationship between use and satisfaction.

In a study of beach users, McConnell (1977) reported significant partial correlations between density and willingness-to-pay. However, as Shelby & Heberlein (1980) have pointed out, this significant relationship was gained only through control of variables such as income, air temperature and number of visits per season. While such control is appropriate in a scientific investigation, it cannot be attained in the 'real world'.

Studies by Shelby & Nielsen (1976) of river runners on the Grand Canyon were unable to detect any significant relationship between levels of contact between parties and reported satisfaction. Such results have led some to a rejection of satisfaction as a criterion variable. In the extreme, the argument could be developed that because increasing use does not show any affects in reduced satisfaction, people simply adapt to increased levels.

The general lack of association between use and satisfaction is affected by several factors that require elaboration. First, as Shelby (1980) noted, encounters between people are only one element of the complex phenomena used called a 'recreational experience'. Because recreation behaviour is freely chosen, the tendency for participants is to seek consonance between what one did and what one got out of it. Hence, although people may have preferred less contact than they in fact encountered, they might still report high levels of satisfaction by giving priority in their evaluation to other aspects of their experiences, such as the pleasure visits they had with others they met.

Second, the recreation clientele of any area is constantly in flux. Those who are most sensitive to increasing use will likely be the first to move elsewhere, seeking the kind of experience they most desire. Their replacements will be those who seek, or are at least tolerant of, higher contact levels. Thus, the experience of recreationists can have great affect on the levels of reported satisfaction. The Grand Canyon river runners studied by Shelby & Nielsen (1976) reflect this problem well as some 90% were on their first visit and had little notion of what sorts of expectations

regarding contact levels might be realistic. Work by Schreyer & Roggenbuck (1978) clearly demonstrates that expectations greatly shape sensitivity to crowding in recreation settings.

Third, various factors can mediate the judgement as to whether crowding is perceived or not. For example, Shelby (1980) has shown that the actual level of contact one experiences is not a direct or uniform consequence of area-wide use. The discrepancy appears to be a function of situational factors, such as topographic variability or vegetation cover, temporal variations in use, or individual perceptual causes. Such problems have identified the need for more precise identification of social density variables; in this case, area-wide measures of density are replaced with measures of site-specific contact.

Fourth, the difficulty of demonstrating a clear and predictable relationship between use and satisfaction is confounded by the fact that as noted above, recreation is an experience, or more correctly, a collection or bundle of experiences. Some of these experiences are very much density dependent. For example, solitude, by definition, requires relatively little contact with others. On the other hand, socialisation is generally associated with frequent contact. However, even these experiences can be defined differently by people. Socialisation with others is generally not as important a type of experience for wilderness visitors, but these recreationists rate close contact with members of their own party - another kind of socialisation - very highly.

As the previously cited work of Absher & Lee (1981) demonstrates, it is only when the nature of the experiences sought by recreationists is taken into account that we begin to be able to specify the effects of changes in social interaction. Utilising motive constructs developed by Driver (1977), they were able to show that those who sought an experience of 'quietude' (defined as a desire to experience solitude or a quiet, tranquil place) were more likely to perceive a condition as crowded than those who sought 'shared experiences' (the desire for occasions to share with others, affiliate, feel camaraderie, or meet and socialise). Similarly, Brown & Haas (1980), utilising cluster analytic techniques, were able to sequent the clientele of a Colorado Wilderness into five distinct groups based on their scores with regard to the previously cited scales developed by Driver. Sensitivity and tolerance to other groups represented one of the important distinguishing factors in the typology of users that resulted.

Thus attempts to define the relationship between use and a general kind of recreational experience are almost doomed to fail. The perception of conditions as crowded is an experience-specific evaluation (Schreyer & Roggenbuck, 1978). Ironically, the need to specify the kind of experience prior to hypothesising its relation to use was clearly foreseen by Wagar (1964)

in his seminal paper on carrying capacity nearly 20 years ago. In that paper, Wagar sketched out the likely relationship between use and a number of experiences, such as skill, challenge and education, illustrating that the effects of use varied greatly for each. Current research in capacity increasingly reflects Wagar's early observation.

CONCLUSIONS

As noted at the outset of this paper, carrying capacity has a somewhat disappointing history. However, the disappointment may be more a function of unrealistic expectations than it is a reflection of any basic flaws in the general capacity model. Increasingly, the research effort directed at the capacity question is becoming more rigorous, well-funded and applicable to the decisions facing management.

From an early perspective that saw carrying capacity calculations as a mechanistic, almost arithmatic procedure, there has evolved an increasing recognition that capacity is a prescriptive process, with no obvious right answers. However, given basic decisions regarding the objectives of management, it represents a useful strategy for achieving a desired end.

The lack of any clear and obvious answer to the capacity issues also highlights the crucial need for management authorities to specify their management objectives in terms of kinds of experiences to be produced (Lime & Stankey, 1971; Driver & Brown, 1978; Absher & Lee, 1981). The business of recreation management is the business of producing desired human experiences. Without improved definitions of the product that is desired, useful formulations of carrying capacity will simply not be possible, and because of the great diversity in terms of what people seek and the frequent incompatibility among these desired experiences, it will be necessary that management ensures the provisions of a wide range of recreation settings where different capacity prescriptions prevail so that people with varying tastes, preferences and expectations can find a place that best suits their particular desires (Clark & Stankey, 1979). Only by ensuring such diversity in supply can we expect to cater adequately to the diversity in demand that exists.

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