

WILDERNESS ENVIRONMENTAL QUALITY:  
SEARCH FOR SOCIAL AND ECOLOGICAL HARMONY

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One of the hallmarks of the 1960's was the increased use of the legislative process by conservationists to achieve desired goals. Certainly one of the major achievements accomplished by this means was the passage of the Wilderness Act in 1964 (Public Law 88-577). The Act brought statutory recognition and protection to areas managed primarily to ensure the uninterrupted flow of natural events and processes. It also recognized the value of these areas as the source of certain human experiences; experiences such as solitude and interaction with the natural environment.

Achieving these goals is another matter. Increasing levels of use on wilderness are creating pressures that make the environmental preservation and primitive recreation objectives of the Act difficult to meet. Since 1946, recreational use of wilderness has grown about 10 percent per annum and in some areas, the growth rate is closer to 25 percent a year. Projections of future use suggest similar rates of growth will continue (ORRRC, 1962; Cicchetti et. al., 1969), at least for the period within which crucial management decisions will need to be made.

The resource base to meet this increasing demand is dwindling. At present, approximately 10 million acres of designated Wilderness exists. The Wilderness Act calls for the Forest Service, National Park Service, and Bureau of Sports Fisheries and Wildlife to study their holdings and recommend additional areas suitable for classification. Estimates as to the potential size of the National Wilderness Preservation System vary considerably, but the maximum figure appears on the order of 70 million acres (Stankey, 1971). However, the additional acres will do little to reduce use pressures in a net sense, because areas presently in a de facto wilderness status are probably already supporting a considerable level of use.

The outcome of these two factors, increasing use and a static resource base, is apparent. It will become increasingly difficult to meet the objectives established by the Wilderness Act. Eventually, there will be a loss of those environmental qualities that originally prompted the designation of the area as Wilderness.

Because the possibility of a wilderness system overrun by excess use is unpalatable to managers and visitors alike, we are led to a consideration of the establishment of so-called "carrying capacities."

## CARRYING CAPACITY--A REVIEW AND AN EVALUATION

In the literature of recreation research needs, carrying capacity stands as one of the major issues. Several problem analyses over the past 15 years have cited the need to determine the impact of recreational use on both the resource and the experience (Dana, 1957; Clawson and Knetsch, 1963; NAS, 1969).

In response to these calls for carrying capacity research, a considerable body of published studies has developed. In a recent bibliography, Stankey and Lime (1972) list over 200 published pieces related to carrying capacity decisionmaking. This includes papers dealing with the physical-biological dimensions of the carrying capacity problem as well as studies focusing on the social interaction of recreationists. The bibliography is by no means exhaustive. Numerous other studies whose principal focus is on concerns other than carrying capacity undoubtedly have relevance to the capacity problem (e.g., the considerable body of literature in range management).

Along with the increasing information on the specifics of carrying capacity has also come a growing understanding of the concept itself. The bivariate nature of carrying capacity has become generally recognized; both ecological and social inputs are integral. Most definitions of capacity call for use limitations at some point that will not adversely affect either the physical resource or the recreational experience of the user (LaPage, 1963; Chubb, 1964; Chubb and Ashton, 1969; Lime and Stankey, 1971; Stankey, 1971). Moreover, the time horizon has been recognized as a crucial element (Chubb, 1964). Specifying a time constraint in capacity definitions has helped draw our attention from questions of "how many people can this area absorb?"<sup>11</sup> to "what are the environmental and social consequences of a given level of use over a certain period of time?"<sup>11</sup>

However, despite the growing abundance of empirical data relative to carrying capacity and the increasing sophistication in our understanding of the concept, it is our considered judgment that progress toward grasping this urgent research need leaves much to be desired. There are probably a variety of reasons for this shortcoming. But in our estimation, the most significant factor has been the lack of a systematic, conceptual framework within which the major issues of carrying capacity could be defined and the research necessary to enlighten these issues designed. While the body of literature related to carrying capacity is substantial, it must also be described as being comprised primarily of a series of individual and non-accumulative efforts. Certain aspects of carrying capacity have been studied in some detail. Other areas have been almost entirely neglected (e.g., the impact of recreationists on wildlife behavior). Moreover, the lack of a conceptual framework stressing the interrelationship of the various parameters has led many studies to a single-causation explanation of capacity. One of the problems of capacity definitions that focus only on the physical or social parameters is they lead us to view these parameters as separate considerations when, in fact, they are inextricably linked. The soil compaction and dying vegetation that accompanies excessive use of a site is of significance not only to the ecologist, but also to the social scientist, for the perception of declining esthetic quality might well be a more important constraint than reduced soil pore space.

## TRADITIONAL CAPACITY MODELS

In some ways, the estimation of Wilderness capacity poses fewer problems than do other environmental opportunities along the recreation spectrum, for the management objectives have been relatively clearly defined within the Wilderness Act. Broadly speaking, the Act addresses itself to accomplishing two major objectives; (1) the preservation of some areas where ecological processes can operate as freely as possible from the influences of man's activities; and (2) the provision of a recreational opportunity that we typically describe as "primitive."

The almost mutually exclusive nature of the objectives of resource preservation and human use lends both challenge and urgency to the issue of Wilderness carrying capacity. But our efforts to match resource preservation with increasing use pressures have not been particularly successful. As previously noted, we see this slow progress a function of the lack of a conceptual framework for studies to be developed and conducted. We also see problems in the traditional view of the relationship between use and change. Typically, we have operated on the tacit assumption that increasing use results in a declining quality of output, whether it be a recreational experience or ecological conditions. This over-simplified model of capacity has all too often led to the conclusion that restriction on use numbers was the only effective solution.

We have both conceptual and empirical reasons to doubt this model. In studies of the biological impact of recreationists on sites, investigators have found that simple numerical measures of recreation use were inadequate predictors of change. For example, in a study of campground trampling, LaPage noted "trampling, expressed simply as man-days of use, is not an adequate measure of the impact of camping on vegetation. Some measure of the quality or character of recreation use is needed that will explain the destruction of ground cover more realistically than simple use intensity does"(LaPage, 1967).

Similarly, when we examine the social side of carrying capacity, we find that user definitions of recreational quality do not subscribe to the simple linear relationship between use and satisfaction the traditional model of carrying capacity describes. To the contrary, in a conceptual monograph, Wagar pointed out the various needs that motivate people to recreate might be enhanced by increasing intensities of use (Wagar, 1964). Also, empirical studies have demonstrated that characteristics of use other than simple numbers are very often more important to recreationists' satisfaction. Method of travel (Lucas, 1964) and party size (Stankey, 1971) both appear more critical dimensions of use than simple numbers.

What these findings suggest is the need to develop a model of carrying capacity that incorporates and weighs an assortment of inputs in addition to use levels. We propose, in the following discussion, an analytical framework for decisionmaking that provides for the integration of several use-related influences on both the social and ecological dimensions of wilderness.

## A MULTI-DIMENSIONAL MODEL OF CAPACITY

Ecosystems by definition are dynamic and changing. It is not a static picture of wilderness at a particular point in time we are striving to

preserve. Rather, these reserves should present examples of naturally functioning ecosystems, fluctuating in an unrestrained manner.

This preservation objective is at the heart of the Wilderness Act. However, a realistic assessment of our undeveloped lands will quickly show that we no longer have absolutely pristine natural systems surviving anywhere on earth (Figure 1). All potential and existing Wilderness areas have been somehow influenced by man.

Airborne materials such as pesticides, smog, and radiation have had a worldwide influence. Even the Antarctic is not free from these evidences of modern man.

Many Wilderness areas had been influenced and changed by modern man prior to the time when they were officially designated as Wilderness. Evidence exists throughout many designated Wildernesses of early logging, mining, and homesteading activities (Gilligan, 1955).

Most Wilderness reserves are affected by external management activities such as water-level controls and the introduction of exotic plants, mammals, birds, insects, and disease pathogens.

Natural Wilderness communities are also influenced by the management policies and programs we apply within these reserves. A prime example is the unnatural modification that has occurred as a result of effective fire suppression.

Finally, recreational use of Wilderness has been a major (and often the principal) source of modification. Even very low levels of human use result in change in natural ecosystems. It is this change initiated by recreational use which we will focus upon in the following discussion.

Identifying, establishing and maintaining absolutely pristine ecosystems is impossible in the face of these various influences. But this is fully recognized by the Wilderness Act which defines Wilderness as an area which "generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable" (emphasis added). By law, some latitude or variation from pristine is acceptable. The pristine condition might never be attained but nevertheless, it is a goal which we strive to achieve.

A basic question facing Wilderness managers, then, is the degree to which variation from the pristine will be permitted. What are the "limits of acceptable change" beyond that variation expected in a natural system?<sup>1/</sup>

### Acceptable Changes in Wilderness Ecology

Figure 2 depicts a hypothetical model of the concept of the "limits of acceptable change" in wilderness ecology. The influence of man on Wilderness

1/

For an earlier discussion of estimating acceptable change, see David W. Lime, "Research for determining use capacities of the Boundary Waters Canoe Area" *Naturalist* 21(4): 8-13. 1970.

**WORLD-WIDE POLLUTION**

**Air  
Water  
Radiation**

**RECREATION USE**

**Campsites  
Trails  
Recreation stock grazing**



**PRE-ESTABLISHMENT CHANGES**

**Logging  
Mining  
Introduction of exotics**

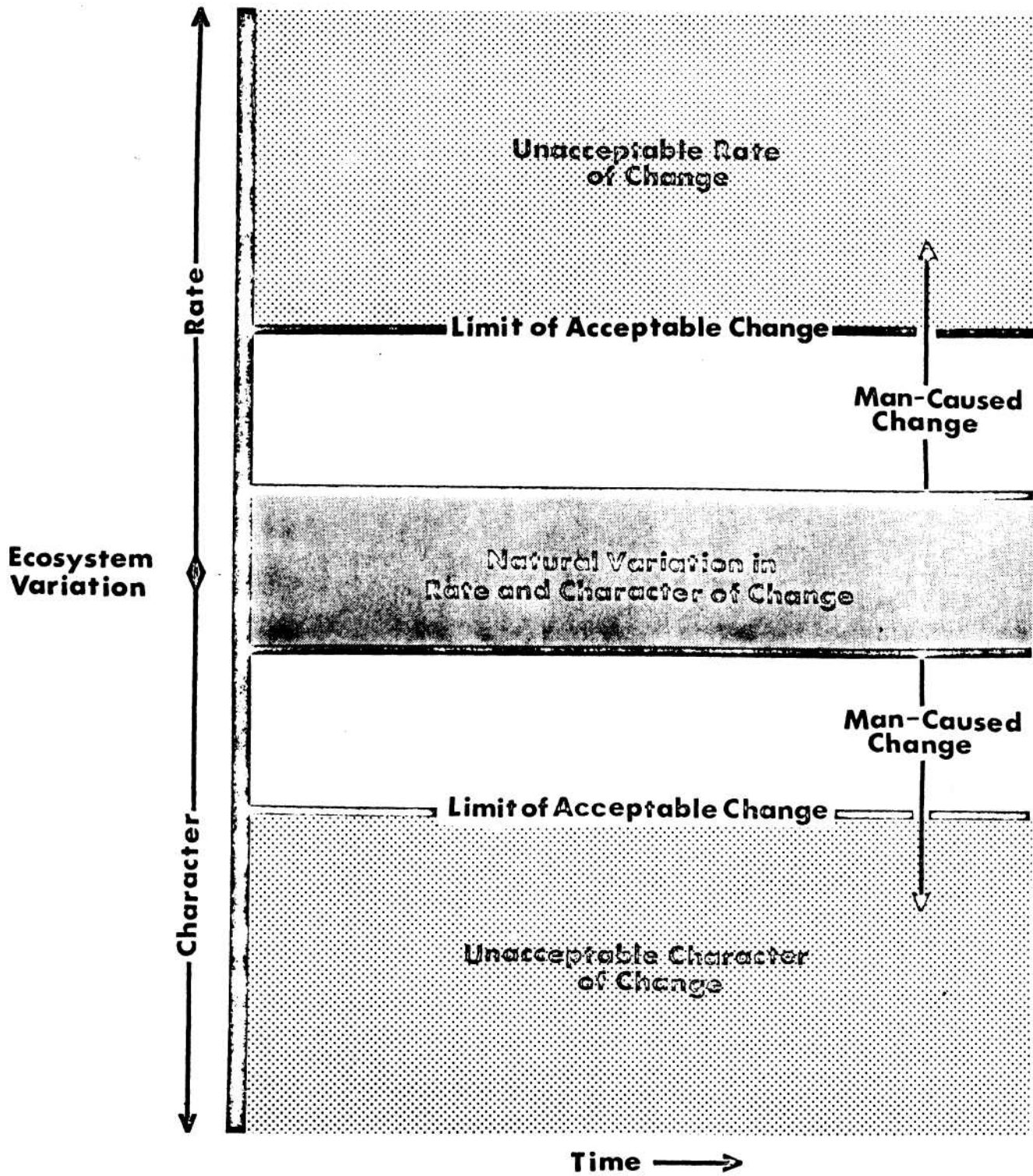
**MANAGEMENT POLICIES**

**Fire Control  
Administrative structures**

**EXTERNAL INFLUENCES**

**Water-level controls  
Predator control  
Introduction of exotics**

**FIGURE 1. Factors Influencing Natural Biotic Communities**



**Figure 2. Model of Acceptable Ecological Variation in Wilderness.**

will eventually cause the rate and character of the variations in the system to exceed the natural condition. Thus, the decisionmaking criteria becomes that point where man-caused change exceeds the limit of acceptable change (LAC)

The limits of acceptable change describe that range of environmental conditions society decides it will call "Wilderness." Areas in which man's influence results in changes beyond those limits will be in danger of losing the ecological or social qualities that led us to define them as Wilderness.

What determines the location of the "Limits of Acceptable Change"? The Wilderness Act does not provide precise information on this point. However, wording such as "generally," "primarily," and "substantially" suggest some limits should be set. We believe the intent of the Act was to have these limits as close as possible to the natural conditions. But still, the Act does not provide the manager with the specific criteria he needs to set limits.

For illustrative purposes, our hypothetical model simplifies the issue and shows only that a change from natural conditions occurs when man uses Wilderness. In actuality, we are dealing with changes in a great number of individual resource elements. The introduction of a particular use configuration<sup>2/</sup> into Wilderness results in changes in soil bulk density, amount and variety of ground cover on campsites, vigor of tree growth, rate of soil erosion, and many other elements. Several criteria could be used to determine at what point further change in a particular resource element is unacceptable.

In some situations, it might be decided we can not accept any change that exceeds the natural range of variation.' This option is, in most cases, an impossibility.

A second alternative would keep man-caused change sufficiently limited that a return to a point within the natural range of variation is possible within some predetermined time period, such as the following use season.

The limit of acceptable change might be set as that point where a sudden departure from a natural rate of change occurs. A marked increase in the rate of soil erosion provides an example.

A fourth possibility is limiting change to the point at which it becomes obvious and objectionable to the user. This alternative, however, requires an input that we have not yet discussed; the role of user perception in setting the LAC. User definitions of acceptability must also be recognized as important constraints on decisions taken to insure Wilderness preservation.

#### Acceptable Changes in the Wilderness Experience

In Figure 3 we posit that a "pristine wilderness experience" can be defined. Such an experience could be characterized as involving such things as

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A use configuration is comprised of some specific combination of use level, type, distribution (spatial and temporal), and user behavior patterns.



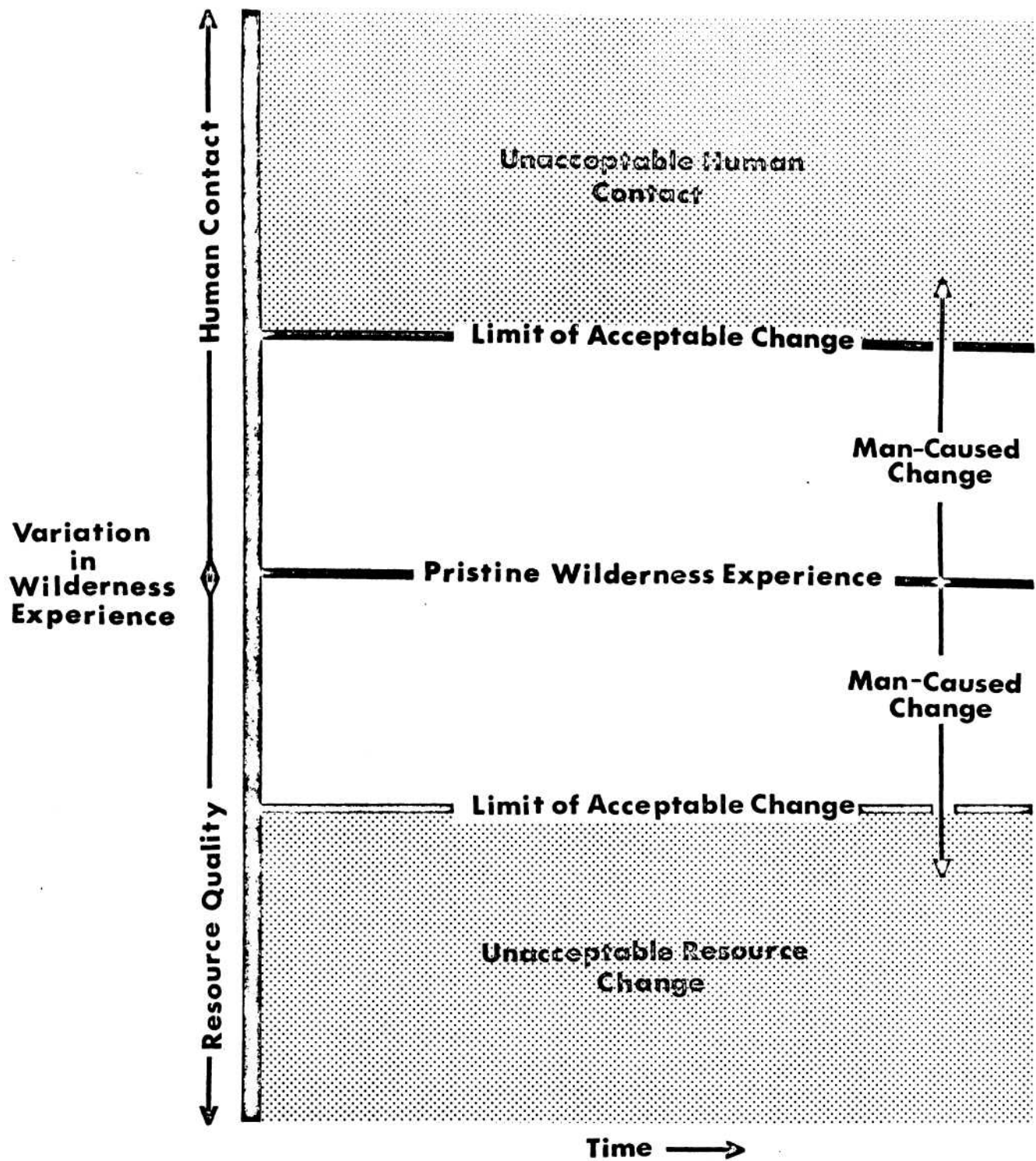


Figure 3. Model of Acceptable Variation in Wilderness Experience.

encountering no other people on a visit, the opportunity to witness completely undisturbed ecosystems, and so forth. This is, of course, a purely hypothetical construct. However, it provides us with the base measurement from which we are able to discuss what constitutes acceptable levels of change in the Wilderness experience.

In reality, present use conditions in Wilderness depart from this hypothetical construct. However, although the Wilderness Act is imprecise on the magnitude of allowable change, it also has provided some gross guidelines. The opportunity for solitude in Wilderness is an important part of the wilderness definition and use configurations that result in the loss of this quality are not to be tolerated. Similarly, the natural landscape is an important part of wilderness and while most users probably will not recognize minor deviations from the natural, campsites that are bare and dusty and surrounded by dying vegetation will generally not be recognized as any semblance of Wilderness. So, we can probably find agreement at the gross and general level as to what constitutes unacceptable change. The difficult issue, however, is defining the difference between acceptable and unacceptable.

Some major methodological and philosophical considerations confound the problem. For example, whose definition of acceptable change do we rely upon, the user's or the manager's? And, if we should decide to rely upon user definitions of change, which user's value system do we turn to? Finally, doesn't the continuing evolution of cultural perception make human definitions of acceptability realistic for only one point in time?

Obviously, there are not clear unequivocal answers to these questions. However, we can provide some insight regarding them that should help managers (who hold decisionmaking responsibility) make defensible considered judgments.

Resource managers might feel their professional background and training permits them to make accurate estimates of what constitutes an acceptable wilderness experience. Their judgments, however, will generally reflect a biological bias in terms of what is or is not acceptable. In Wilderness, this bias may not be entirely inappropriate because primary management emphasis is on resource preservation. Nevertheless, these judgments could at times seriously overestimate user tolerance to change; that is to say, what the manager defines as acceptable change could very well be judged to be excessive change by the user. Professional estimations as to what constitutes a desirable norm for recreationists have a generally poor track record for accuracy (Lucas, 1970). The result of relying upon technical judgments of the social dimension of Wilderness capacity could lead to a significant loss in quality for the visitor.

Wilderness users are not by any means a homogeneous social unit. We have substantial documentation at hand that illustrates the variety of benefits, values, and characteristics users ascribe to Wilderness (Stone and Taves, 1956; Lucas, 1964; Burch and Wenger, 1967; Hendee et al., 1968; Stankey, 1971). Typically, these studies describe a gradient of users ranging from the inveterate wilderness enthusiast to the incidental, casual visitor. However, all these visitors hold attitudes as to what constitutes wilderness and a desirable wilderness experience. Attempting to accommodate the standards of all these persons is both theoretically and pragmatically impossible. Decisions will have to be made to utilize visitor input in some selective but systematic manner. One simple way would be to make decisions at the 50 percent point: that is, any time more than half of the users object

to some situation, (for example, the condition of campsites), management would consider the LAC for resource quality had been exceeded and some decision would be called for.

A second alternative we might suggest would relate visitor objectives to management objectives. Through survey research, those visitors whose personal objectives and definitions of Wilderness most nearly mesh with those of the Wilderness Act can be defined. In turn, these users<sup>1</sup> perception of what constitutes acceptable human contact or resource quality can serve as a useful indicator for managers in deciding when action is needed. Although this alternative would require considerable additional research, it would make the incorporation of visitor input into decisionmaking a more sophisticated process.<sup>1/</sup>

The concern that visitor definitions of acceptable limits of change will gradually become less rigorous over time is a difficult problem. We lack the type of longitudinal studies necessary to determine whether or not such definitions are becoming progressively more diluted. However, conventional wisdom has certainly led many to assume this is the case.

One must understand that the quality of supply will affect the nature of demand. The quality of the Wilderness System in the future will be subject to the control of the managing agencies. If the quality is permitted to change substantively away from natural conditions (whether purposely or through the lack of adequate decisions) then future definitions of acceptable change can likewise be expected to shift. However, this change in attitude might not necessarily be the result of individual shifts in opinion, but rather might be the result of some major shifts in the clientele utilizing the area. Those visitors whose personal LAC has been exceeded have left and their replacements would be those who readily accept the changes. This process of displacement as a result of various congestion costs is almost certainly already in progress and could be the reason many have assumed that visitor definitions of Wilderness are shifting.

#### MAKING DECISIONS ABOUT CARRYING CAPACITY

At some point in the operation of the system we have outlined, the change in one of the elements reaches the critical point, defined herein as the limit of acceptable change. In one case, the coliform count in a stream might reach this crucial level first; in another, the probability of encountering a certain number of other parties might be the constraint. The point is, the system is designed to respond to the minimum limit of acceptable change set by the decisionmaker. This "minimum-value" concept of carrying capacity, then, focuses management decision needs on halting that character and rate of change that would lead to conditions unacceptable to our institutionalized definition of Wilderness.

1/ For further discussion on the alternative, see Hendee et. al., 1968; Stankey, 1971 and 1972.

Moreover, by focusing research on estimating the limits of acceptable change, we can halt the generally unproductive expenditure of resources trying to measure "the" carrying capacity of an area and begin to focus our attention on some of the fundamental underlying issues that make carrying capacity a crucial management need. What are the relative fluctuations we can anticipate in visitor experiences and wilderness ecology under different use configurations? What trade-offs are involved when we establish the limits of acceptable change at some particular level--what would be the costs and benefits of setting the LAC at another point? Answers to such issues as these will then permit us to make decisions regarding such measures as use limitations in light of the influence of such actions on keeping use consistent with the LAC. Rather than making the determination of carrying capacity the end, it becomes, as it should, a means to an end.

### The Role of Management Objectives

Management objectives play two important functions in this model. First, they play a prescriptive function by defining what it is we should be providing in an area. Thus, they are the criteria against which decisions regarding the LAC for each dimension are ultimately judged. Unless the objectives are relatively clear, efforts to establish some "carrying capacity" will be futile (Lime and Stankey, 1971). All too often, objectives are either lacking, contradictory, or of such diffuse character that any effort to arrive at an estimation of capacity becomes impossible. In the case of Wilderness, the objectives have been spelled out broadly, and although there is considerable latitude in these objectives, it is probably purposeful and the overall intent still is clear.

A second function management objectives play is in defining the kinds of alternatives available to the manager as he attempts to satisfy those objectives. For example, in an attempt to reduce ground cover loss at wilderness campsites, a manager might consider "hardening" the site; that is, establishing some exotic, more hardy species or in some other way altering the site to enhance its ability to withstand use. However, this is not a viable alternative, for the constraints of the Wilderness Act would prohibit it.

It is our judgment that efforts to manage Wilderness within the limits of acceptable change will have to be directed along the lines of use control. Within this broad scope of managerial action, we would include such measures as limits on total use, restriction on certain types of use (e.g., the use of stock), party size limitations, use distributions (both in space and time), and efforts to reduce visitor impact through the input of information and education. Adjustments in these various use configurations represents a difficult task. Regulating and modifying the human use of Wilderness will require considerable expertise and sensitivity, so as not to simply replace the problem of excessive change with the problems associated with excessive regimentation.

We do see a role for the limited application of ecological manipulation as an alternative to maintain conditions within the LAC. For example, a heavily impacted campsite might recover in two years under a program of natural restoration. The careful application of fertilizer, however, could reduce the period required for restoration to one year.

Knowledge is a major constraint and there will be situations where the appropriate course of action to remedy a problem is not known. Such a condition would place considerable responsibility on research but would also require the manager to utilize considered judgment to contend with the problem until such time as facts become available.

### The Role of Simulation Modeling

Computer simulation offers a particularly sophisticated and useful tool in the application of the model we have been discussing. The ecological and social sub-systems we are dealing with contain numerous elements each of which responds in a certain manner and rate to the input of some particular use configuration. The complex interrelated nature of these elements introduces the possibility that slow, perhaps almost imperceptible change in one component of a sub-system might initiate sudden and rapid change in another. Thus, it is necessary that change throughout both sub-systems be monitored continuously and simultaneously. This need to simultaneously consider the complex, interwoven mesh of ecological and social variables makes the application of computer technology and simulation modeling virtually a necessity.

Other valuable sources of information could be derived from simulation. It would be the principal tool for estimating change in response to some particular use configuration, thus serving as a predictive tool for determining when the LAC would be reached. Simulation would also be useful in estimating where some particular LAC might lie, but the actual decision to designate some point of change as the LAC will still remain a responsibility of the administrator.

Simulation will serve a major role in defining research needs and the relative priorities of these needs. Some areas currently have a relatively good base of support for decisionmaking; other areas have been virtually untouched. As efforts to simulate the various impacts on wilderness proceed, the major weak points in the information system will become evident.

Finally, simulation will permit managers to display various alternative solutions to problems and assess the costs and benefits associated with each of them, prior to making the actual decision. With the increased interest in public involvement, such ability could prove to be a useful technique in displaying both the problems and possible solutions to the public. Accurate predictions of the potential consequences of any given alternative could lead to both reduced levels of conflict with the public and an increased probability of fulfilling the objectives of the Wilderness Act.

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