INTEGRATING RESOURCE, SOCIAL AND MANAGERIAL INDICATORS OF QUALITY INTO CARRYING CAPACITY DECISION MAKING

Peter Newman

Robert Manning

Bill Valliere

School of Natural Resources, University of Vermont, 361 Aiken Center, Burlington, VT 05405, USA

Abstract: As use in national parks and related areas continues to rise and visitors and types of activities continue to diversify, we are challenged to balance use and preservation in parks, wilderness and related areas. Faced with these challenges, integrative approaches to defining, monitoring and managing ecological, social and managerial setting attributes is crucial. This research outlined in this paper has two objectives. The first objective is to inventory and map selected ecological, social and managerial setting attributes that define wilderness quality in Yosemite National Park. Using GIS technology, overlay maps of these setting attributes will assist in determining the types and distribution of wilderness experiences, associated ecological impacts and concomitant opportunity zones for the wilderness portion of the park. The second objective is to evaluate relative tradeoffs among wilderness setting attributes. Evaluations of these tradeoffs will be analyzed and will allow management to decide how to best mitigate recreational impacts while not hindering, to an unacceptable degree, the freedoms and other qualities often associated with wilderness experiences.

Problem Statement

As use in national parks and related areas continues to rise and visitors and types of activities continue to diversify, we are challenged to balance use and preservation in parks, wilderness and related areas. This challenge forces managers and researchers to address both ecological and social issues when making management decisions. In park and wilderness management, integrating social and resource indicators is essential to meet park mandates that require the protection of both experiential and resource conditions. This paper will address the challenges we face in integrating social and resource data and outline a study in progress in Yosemite National Park. This study will develop and apply a management model that integrates resource, social and managerial indicators of quality into carrying capacity decision-making.

Historical Background

Yosemite National Park is in the Sierra Nevada mountain range of California. The Park is approximately 1200 square miles and is known for the sheer cliffs of Yosemite Valley, its rugged snowy mountain peaks and its high mountain meadows. Inspired by the writing of John Muir, the painting of Albert Bierstadt and the photographs of Ansel Adams, visitation to the park has been on the rise since its inception. In Yosemite National Park wilderness use peaked in the early 1970s at approximately 200,000 visitor nights per year. Use quotas established in the mid-1970s helped to reduce that number to approximately 120,000 visitor nights through the 1980s and into the 1990s (van Wagtendonk, 1979; Boyers, 1999). However, use is currently on the rise again (Cole, 1996; Boyers, 1999). Along with increasing use trends come associated ecological and social impacts. Management decisions must now be made about the number of visitors and associated impacts that can ultimately be accommodated within Yosemite National Park wilderness.

Conceptual Background

When facing these management challenges we look to frameworks to help organize our thoughts and set management objectives. Two prominent management frameworks in the recreation management literature are the Recreation Opportunity Spectrum (ROS) and carrying capacity.

ROS is a land classification framework developed during the late 1970s (Clark & Stankey, 1979; Brown, Driver, & McConnell, 1978; Brown, Driver, Burns, & McConnell, 1979). ROS is comprised of land classification categories that describe an array of recreation opportunities ranging from primitive to developed (Clark & Stankey, 1979). Within the ROS framework, recreation opportunities are defined by three characteristics: the resource setting, the social setting, and the managerial setting.

ROS can be a powerful allocation and planning tool that facilitates the inventory of diverse recreation opportunities. It is assumes that linear relationships exist between each of its three setting attributes: resource, social and managerial. Alternative combinations of these setting attributes define recreation opportunities that range from primitive to urban. For example, primitive recreation opportunities are defined by natural resource conditions low density social conditions, and undeveloped managerial conditions (Figure 1). ROS has been adopted by federal land management agencies and is used in the planning and management of wilderness and related outdoor recreation (Buist & Hoots, 1982).

Traditional concern over the impacts of increasing recreation use has given rise to the concept of carrying capacity. In its most generic form, carrying capacity refers to the amount and type of recreation use that can be sustained in a park, wilderness or related area (Stankey & Manning, 1986; Shelby & Heberlein, 1986; Graefe et al., 1984; Manning, 1997). The literature on carrying capacity – like ROS – suggests that recreation experiences be considered within a three-fold framework of concerns: resource, social, and managerial. For example, the number of visitors that an area can accommodate is dependent on the resistance and resilience of the resource, the type of recreation activity taking place and the intensity with by which an area is managed.

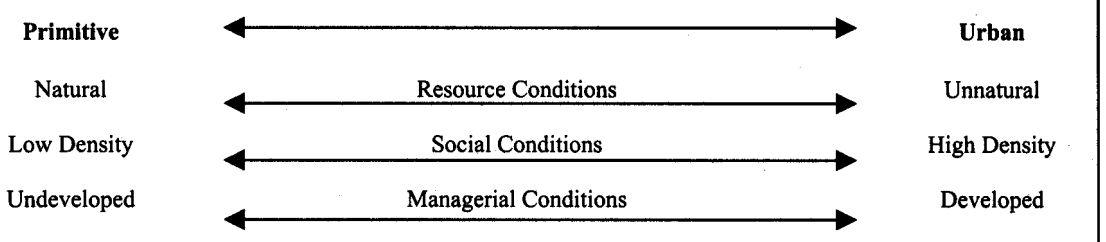

Figure 1. Linear Relationships between the Environmental, Social and Managerial Conditions as Suggested by the ROS (Manning 1985)

Research and management experience suggests that carrying capacity can be determined only when management objectives are defined, and that management objectives should be formulated and expressed in terms of indicators and standards of quality (Frissell & Stankey, 1972; Manning et al., 1996; Manning, 1998; Manning, 1999). Indicators of quality are measurable, manageable variables that define the quality of resource conditions and the visitor experience (Manning, 1999, Merigliano, 1990). Standards of quality define the minimum acceptable condition of indicator variables, or what is often termed the "limits of acceptable change."

The above frameworks provide a conceptual foundation for research to support an integrative approach to wilderness planning and management in Yosemite National Park. They suggest that planning and management of wilderness recreation must consider resource, social and managerial attributes, and that indicators and standards of quality should be developed for these attributes.

Analytical Integrative Models

Several models have emerged from the resource management literature that might help to make wilderness management and research more integrative in nature. For example, environmental impact statements (EIS) are used to assess the potential impact a management action may. An EIS mandated through the National Environmental Policy Act (NEPA 1968) combines social and ecological analyses, and findings are displayed within one report. Although this approach is integrative in nature, it is more multi-disciplinary than inter-disciplinary. An EIS model lacks the analytical power needed to fully address the relationships between social and ecological conditions.

Spatial analysis conducted using geographic information systems (GIS) gives us a tool in which we can begin to consider relationships between biophysical characteristics of a resource and a variety of social information. Traditionally, only resource data have been geo-referenced within GIS systems. However, GIS has the capability to incorporate social data as well, thereby facilitating a more integrative analysis.

Tradeoff analysis is another approach to integration. It is likely that most visitors want as unimpeded access to the wilderness as possible, but also want such areas protected from excessive resource impacts, want to avoid undesirable levels of crowding and congestion, and want minimal management restrictions. However, these conditions often conflict, and tradeoffs must be made among these conditions. Such tradeoffs can be explored through a number of empirical approaches, such as stated choice models. Stated choice models allows us to understand the relative importance of resource, social and managerial condition/ attributes from the standpoint of the visitor. Stated choice models have been developed in marketing research to measure consumer preferences and tradeoffs among such preferences (Louviere, 1988; Green et al., 1988), and have recently been extended to applications in non-market and environmental policy contexts (Opaluch et al., 1993; Dennis, 1998). A trade-off analysis is an integrative approach that focuses on the cognitive relationships among resource, social, and management conditions.

GIS and stated choice analysis will be used as integrative frameworks in this study. Stated choice analysis will be used to determine preferred tradeoffs among resource, social and managerial attributes of the wilderness experience and these and other study data will be analyzed and reported using a GIS framework.

Study Objectives

The purpose of this research is to develop and apply a management model that integrates resource, social and managerial indicators of quality. More specifically, the study has two objectives. First selected ecological, social, and managerial setting attributes that define the quality of wilderness experiences in Yosemite National Park will be inventoried and mapped. Using GIS technology, overlay maps of these setting attributes will assist in determining the types and distribution of wilderness experiences and concomitant opportunity zones for the wilderness portion of the park. Second, relative tradeoffs among wilderness setting attributes will be evaluated. Optimum levels of ecological, social, and managerial setting attributes may not be able to be achieved simultaneously. In such cases, tradeoffs must be made among these attributes. Visitor-based evaluations of these tradeoffs will be analyzed and will inform wilderness planning and management decisions.

Study Methods

This study will be conducted in the wilderness portion of Yosemite National Park. A principal research method will be a survey of wilderness users. Sampling for the visitor survey portion of this study will be conducted in and around the wilderness permit stations in Yosemite Valley, Tuolumne, Wawona and Hodgdon Meadows. The sampling universe will include all persons receiving a wilderness permit during the summer use season of 2001. A stratified random sample will be selected from the sampling universe. The sampling season will begin on June 26, 2001, and end on Labor Day weekend 2001.

The research will be conducted in two phases corresponding to the two study objectives described above. The first phase of research will inventory and map selected setting attributes of wilderness experiences in Yosemite National Park using GIS. Setting attributes will be defined in terms of indicators and standards of quality, and will address ecological, social, and managerial components of wilderness experiences. Examples of indicators and standards of quality to be included in the study are shown in Table 1.

The indicators were chosen using a modified delphi design (Sackman, 1975). Workshops were held in Yosemite National Park during the fall 2000 with researchers and over a dozen park managers and rangers. Over 30 potential indicators were discussed covering resource, social and managerial dimensions and managers were asked to vote for the indicators they believed were the most pertinent and feasible. Based on a literature review and continued discussion with management in Yosemite National Park, six indicators were chosen to represent the social, resource and managerial conditions of Yosemite wilderness (Table 1).

Table 1. Indicators to Be Utilized in the Study

Component of Wilderness Experience	Indicator of Quality
Ecological	1. Signs of human use at campsite (e.g, size of barren core, root exposure). 2. Signs of stock or stock use (e.g., trail impacts, tree scars, manure).
Social	3. Trail encounters. 4. Camp encounters.
Managerial	5. Availability of permits. 6. Camping regulation (e.g., designated campsites to freedom to camp anywhere).

Data on these indicators will be obtained through a visitor survey. This survey will be conducted as a "diary" where respondents will be asked to trace their daily route of travel and report and evaluate aspects of their wilderness trip as it is experienced on site. In this way, resulting data will be spatially referenced. Respondents will be asked to judge the existing quality or standards of selected indicator variables and to report the desired standard of quality as well. Resulting data will be coded into a GIS database that will allow development of coverages displaying the current and desired condition of all indicator variables.

The second phase of research will address visitor evaluations of tradeoffs among competing setting attributes or indicators and standards of quality. These tradeoffs will be explored through a visitor survey and application of stated choice models. The questionnaire will contain batteries of questions designed to enable the application of the statistical procedure of stated choice analysis. A standard research design involves assigning a range of performance levels to selected product or service attributes, then developing alternative scenarios that represent permutations of such attribute levels. Respondents then rate their preferences among scenarios and resulting data indicate which attributes are most important. In the context of wilderness recreation, indicators and standards of quality can be substituted for performance levels of product or service attributes as shown in Table 2. In this example, a range of three standards of quality have been specified for each of six indicators of quality representing the resource, social, and managerial components of wilderness recreation experiences. Respondents will be asked to rate the desirability of a subset of scenarios representing the full universe of possible permutations, and resulting data, through application of stated choice analysis, will be used to estimate the relative importance of each indicator and standard of quality. Study findings can inform management decisions concerning appropriate tradeoffs among the setting attributes of wilderness experiences.

Integrating Study Findings

Several conceptual and analytical frameworks will be used to integrate the resource and social data collected in this study. Importance-performance analysis is a framework that can be used to help formulate indicators and standards of quality (Martilla & James, 1977; Hollenhorst & Gardner, 1994). The framework is illustrated in Figure 2.

Table 2. Yosemite Wilderness Setting Attributes and Levels

Resource conditions
Signs of human use at camping sites:
Photograph 1 (low impact)
Photograph 3 (medium impact)
Photograph 5 (high impact)
Encountering stock or signs of stock use:
Never encounter stock groups or signs of stock use.
Encounter stock groups or signs of a minority of days.
Encounter stock group or signs of stock a majority of days.
Social conditions
Number of other groups encountered per day while hiking:
Encounter fewer than 5 other groups a day while hiking.
Encounter 5 –15 other groups a day while hiking.
Encounter more than 15 other groups a day while hiking.
Opportunity to camp out of sight and sound of other groups:
Able to camp out of sight and sound of other groups all nights
Able to camp out of sight and sound of other groups most nights
Able to camp out of sight and sound of other groups a minority of nights
Management conditions
Regulation of camping:
Allowed to camp anywhere.
Allowed to camp anywhere in a specified zone.
Required to camp in an assigned site in a specified zone.
Chance of receiving an overnight back-country permit:
Most visitors are able to get a permit for their preferred trip.
Most visitors are able to get a permit for at least there second choice trip.
Only a minority of visitors are able to get a back-country permit.

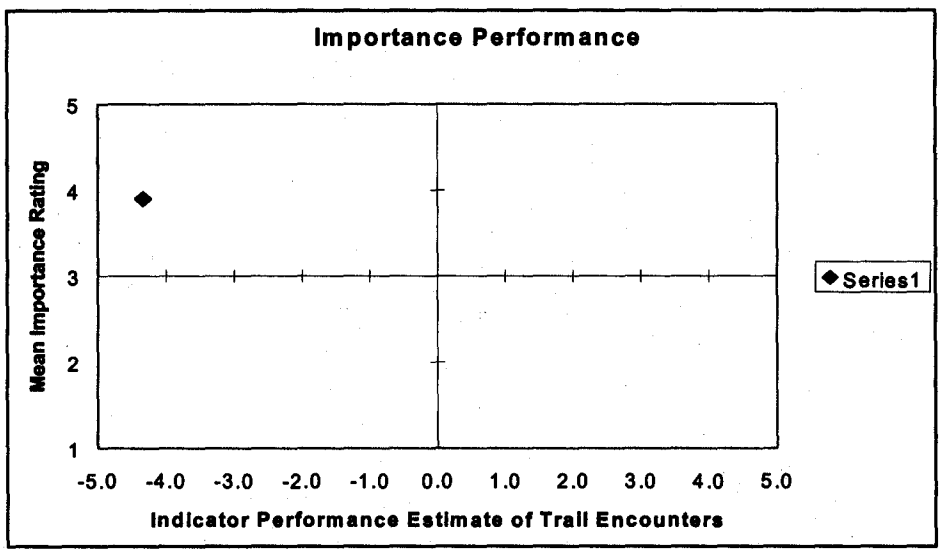

Figure 2. Example of Importance-Performance Framework

The vertical axis plots the importance that visitors place on resource, social and managerial indicators of quality and the horizontal axis plots the perceived or preferred condition of each indicator relative to its current condition. The resulting data provide a graphic representation of the relationships between importance and performance of indicator variables, and where management action is needed. Study data derived from the stated choice model will be used as the measure of the importance of indicator variables and study data derived from the visitor diary will provide data on the preferred condition or standard of quality for the indicator variables. The algorithm shown in Figure 3 will then be used to integrate importance-performance measures for all resource, social and managerial indicators of quality.

$$\sum I_{1\,IPE}(w) + I_{2\,IPE}(w) + I_{3\,IPE}(w) + I_{n\,IPE}(w)$$

W= importance weight from stated choice model.
Indicator Performance Estimate (IPE) = Actual – Preferred/ Standard Deviation of Preferred

Figure 3. Algorithm Used to Estimate the Overall Condition on an Area Using Social and Resource Indicators

This algorithm will generate an overall condition score for any geographic area within the wilderness portion of the park, and these data can be analyzed and reported within a GIS framework. Study data and the GIS framework will 1) allow for the creation of a map of priority areas in need of resource and/or social mitigation, 2) provide an informed basis for formulation of indicators and standards of quality for all wilderness zones, 3) inform selection of wilderness management prescriptions of highest utility to wilderness visitors, and 4) provide a tool for monitoring resource, social and managerial indicators of quality.

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