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Integrating Resource, Social, and Managerial Indicators of Quality into Carrying Capacity Decision-Making

As use of national parks, wilderness, and related areas continues to rise and visitors and types of activities continue to diversify, we are challenged to balance recreation use and preservation. 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 addresses the challenges we face in integrating social and resource data and describes a current study in Yosemite National Park designed to accomplish such an objective. This study will develop and apply conjoint, or "tradeoff," analysis that quantitatively integrates resource, social, and managerial indicators of quality. The study will also utilize a GIS framework to integrate resource, social, and managerial indicators of quality into carrying capacity decision-making. The capabilities and advantages of these integrative techniques are outlined.

Conceptual Background

When facing management challenges, we look to planning and management decision-making frameworks to help organize our priorities and choose from competing alternatives. Two prominent management frameworks in the recreation management literature are the recreation opportunity spectrum (ROS) and carrying capacity.

ROS is a land classification and recreation management framework developed during the late 1970s (Clark and Stankey 1979; Brown et al. 1978; Brown et al. 1979). It has generally been applied to inventory and allocate recreation opportunities through zoning in agency management plans. ROS comprises land classification categories that describe an array of recreation opportunities ranging from primitive to urban (Clark and Stankey 1979). Recreation opportunities are defined by linear relationships among three characteristics: the resource setting, the social setting, and the managerial setting. ROS facilitates the integration of alternative combinations of these attributes to define and manage for different recreation opportunities. For example, primitive recreation opportunities are defined by "natural" resource conditions, "low-density" social conditions, and "undeveloped" managerial conditions (Figure 1).

Carrying capacity is a more prevalent framework employed to address management concerns of increasing recreation use and associated deterioration in resource and social conditions. In its most generic form, carrying capacity refers to the amount and type of recreation use that can be sustained in a protected area (Stankey and Manning 1986; Shelby and Heberlein 1986; Graefe et al. 1984; Manning 1997). Carrying capacity literature, like that of ROS, relates recreation management to resource, social, and managerial attributes. For example, there are inherent tradeoffs between the resistance and resilience of the resource, the amount and type of recreation activities, and the intensity of visitor and site management. Thus, carrying capacity has also been used to integrate resource and social considerations in recreation management decision-making. The most widely used contemporary carrying capacity frameworks in the USA include limits of acceptable change (LAC; Stankey et al. 1985) and visitor experience and resource protection (VERP; NPS 1997).

Research and management expe-

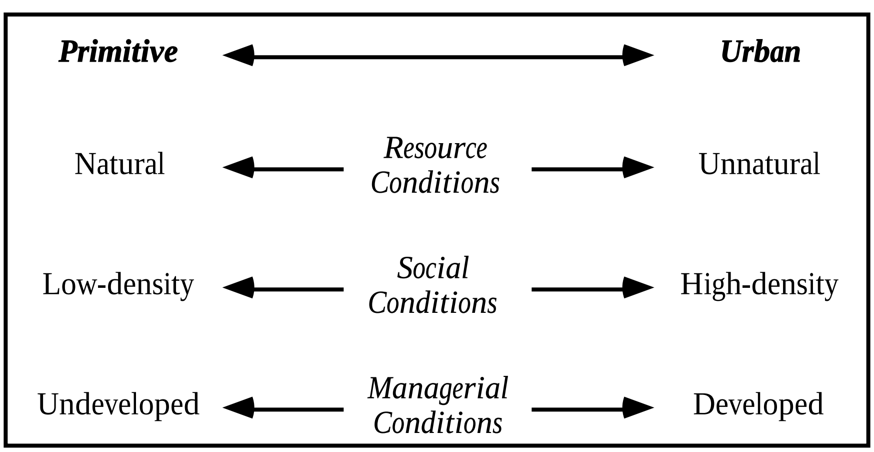

Figure 1. Linear relationships between the resource, social, and managerial conditions as suggested by the ROS (Manning 1985).

rience reveals that carrying capacity can be determined only when prescriptive management objectives are explicitly defined, and that management objectives should be formulated and expressed in terms of indicators and standards of quality (Frissell and Stankey 1972; Manning et al. 1996; Manning 1998; Manning 1999). Indicators of quality are measurable, manageable variables that define the desired future conditions for resource, social, and managerial settings (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."

These management frameworks provide a conceptual foundation for research to support an integrative approach to protected area planning and management. They suggest that planning and management of recreation must consider resource, social, and managerial attributes, and that indicators and standards of quality should be developed for these attributes. When standards of quality are violated, managers must act to manipulate elements of the resource, social, or managerial setting through management actions affecting visitors or the site.

Related Literature

Recreation experiences are composed of the resource, social, and managerial settings in which they take place. This threefold concept intertwines ecological issues with social issues, making recreation management inherently integrative. However, integrating resource and social data into carrying capacity decision-making continues to challenge managers and researchers.

Although great strides have been made to increase and diversify public participation in park and wilderness planning and management, there remains room for improvement. Understanding the dynamics of the total system is often constrained by a lack of coordination among experts and the public. Emphasis should be placed on facilitated negotiation and consensus-building to develop a common vision and resolve conflicts (Stein and Gelburd 1998). Early and continuous public input will help incorporate the social dimensions of ecological issues into an integrative approach. Other important elements of successful public participation are using a variety of involvement approaches and giving constant feedback (Stein and Gelburd 1998). There is an on-going need to define mutual goals that integrate the social, ecological, and managerial systems in concert with those portions of the public involved with a particular project.

Public participation in park and wilderness planning and management will not be the cure for eliminating uncertainty; rather, it will help clarify points of dispute and identify knowledge gaps. The role of the public also helps clarify if there is some level of consensus on the "right" course of action, even in the face of uncertainty. Ultimately, considering "all relevant facts, knowledge, values and social interests" greatly improves the foundation for rational and integrative decision-making (Hennen 1999, 304).

Adaptive management is a way to address the "staggering information requirements" that stem from an integrative approach to wilderness planning and management (Cortner and Moote 1999). Adaptive management is an action-based process where information is continually collected and desired goals and outcomes are evaluated and adjusted—otherwise known as "learning by doing." Management prescriptions are considered working hypotheses that are tested through management activities (Cortner and Moote 1999). Management efforts are designed as experiments, with monitoring (either in the field or through simulation modeling) being a key component to allow for redirection of strategies as quickly as possible. This type of strategy provides for "decisions that are informed; that gain understanding, acceptance and support by a wide audience; that recognize the uncertainty inherent in those decisions; and, that are adjustable in the face of surprise" (Lessard 1998). The iterative nature of hypothesis-testing through monitoring and evaluation procedures leads to a proactive rather than reactive approach to planning and management.

Clark et al. (2000) suggest that integration is a good example of a "policy myth." A policy myth tends to garner support and enthusiasm at the abstract level, but loses support when further definition is needed. Integration in protected area management illustrates such a dilemma. While at the theoretical level we understand the complexities involved in the human relationship with protected environments, we continue to be challenged to make integrative management tools operational in the field.

The concept of integration is neither new nor limited to the study of natural resource management. Clark et al. (2000) traced the routes of integration to the concept of holisms. Holisms address functional relationships between parts and whole systems and the idea that the "whole is greater than the sum of the parts." The idea of holisms is an inherent part of science from ecology to medicine (Clark et al. 2000). The concept of managing a system holistically by integrating and defining relationships between social systems and ecological systems has a long history, dating back to Aldo Leopold's "land ethic" (1949).

The resource management literature suggests several frameworks that begin to address these issues.

Ecosystem management (EM), integrated environmental management (IEM; Rabe 1986; Bartlett 1990; Born and Sonzogni 1995) and integrated resource management (IRM) (Yin and Pierce 1993) are a few of the frameworks that begin to address the maintenance of processes and functions that preserve whole systems for ecological integrity and for human cultural and economic benefits (Grumbine 1998). These frameworks include aspects of protecting ecosystems, maintaining biological diversity, protecting ecological processes and integrity, and accommodating human use (Brussard et al. 1998; Christensen et al. 1996; Grumbine 1994; Francis 1993; Lackey 1998; Yaffee 1999). Key elements include analyses on multiple spatial and temporal scales, disturbance regimes, and adaptive management (Boyce and Haney 1997; Grumbine1994).

Analytical Integrative Models

Several models have emerged from the resource management literature that might help to make protected area management and research more integrative. For example, an environmental impact statement (EIS), mandated under the National Environmental Policy Act (NEPA, enacted 1968), combines social and ecological analyses to assess the potential impact of certain federal agency management actions. NEPA compliance has encouraged increased public involvement in early stages of decision-making and development of multiple alternatives for management actions. These occurrences have fostered a more comprehensive consideration of ecological, social, and economic elements. Although this approach is integrative in nature, it is more multidisciplinary than interdisciplinary. EIS models generally lack the analytical power needed to fully address interrelationships between social and ecological conditions.

Spatial analyses conducted using geographic information systems (GIS) provide another tool for analyzing and visualizing relationships between biophysical resource characteristics and various social attributes. Traditionally, only resource data have been georeferenced within GIS systems. However, GIS has the capability to incorporate social data as well, thereby facilitating a more integrative analysis.

Conjoint analysis, also called trade-off or stated choice analysis, is used in marketing research to measure consumer preferences (Louviere 1988; Green et al. 1988), and has also been applied in non-market and environmental policy contexts (Opaluch et al. 1993; Dennis 1998). In recreation management decision-making, conjoint analysis can be employed to evaluate visitor preferences for trade-offs between various levels of access to protected areas, resource impacts, crowding, and conflicts, and site development or visitor regulation. Respondents are asked to choose between alternative scenarios that vary in their attributes (e.g., resource, social, and managerial conditions). Data are analyzed to determine the partial utilities for each attribute imputed from the overall trade-offs. Partial utilities can also be combined to estimate the relative preferences for any combination of attribute levels, thus providing an objective, quantitative mechanism for integrating resource-, social-, and managerial-setting elements.

Carrying Capacity of Yosemite National Park Wilderness: An Integrated Approach

An integrated approach to carrying capacity analysis is now being undertaken in the wilderness portion of Yosemite National Park. This study has two specific objectives. First, selected ecological-, social-, and managerial-setting attributes that define the quality of wilderness experiences in Yosemite 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, park visitors will be surveyed to evaluate relative tradeoffs among the wilderness-setting attributes. 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. Analysis of visitor preferences regarding these tradeoffs will be used to inform wilderness planning and management decisions.

Study Methods

This study is being conducted for the wilderness portion of the park. The principal research method is a survey of wilderness users. Sampling for the visitor survey portion of this study is being conducted in and around the wilderness permit stations in Yosemite Valley, Tuolumne, Wawona, and Hodgdon Meadows. The sampling universe includes 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 research is being conducted in two phases corresponding to the study objectives. The first phase of research will inventory and map selected setting attributes of wilderness experiences 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.

Workshops were held in Yosemite during fall 2000 with researchers

Table 1. Indicators selected for the study.

Component of Wilderness Experience	***Indicator of Quality***
Ecological	· Signs of human use at campsites (e.g., size of barren core, root exposure). · Signs of stock or stock use (e.g., trail impacts, tree scars, manure).
Social	· Encounters with other groups along trails. · Encounters with other groups at campsites.
Managerial	· Camping regulation (e.g., designated campsites vs. freedom to camp anywhere). · Availability of permits.

and over a dozen park managers and rangers. Over 30 potential indicators were discussed, covering resource, social, and managerial dimensions. 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 park managers, six indicators were chosen to represent the social, resource, and managerial conditions of Yosemite wilderness (Table 1).

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. A diary approach permits data to be spatially referenced. Respondents will be asked to report the existing conditions of selected indicators and to report their desired standards of quality. For example, a standard of quality for trail encounters could be a maximum of three other groups per day. Subsequent GIS analysis will permit development of maps displaying the current and desired condition of all indicators.

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 conjoint analyses. The questionnaire will contain factorially arranged sets of questions specifically designed to enable the conjoint statistical analyses. A range of three standards of quality will be assigned to the six indicators (Table 2), followed by development of alternative scenarios representing all permuta-

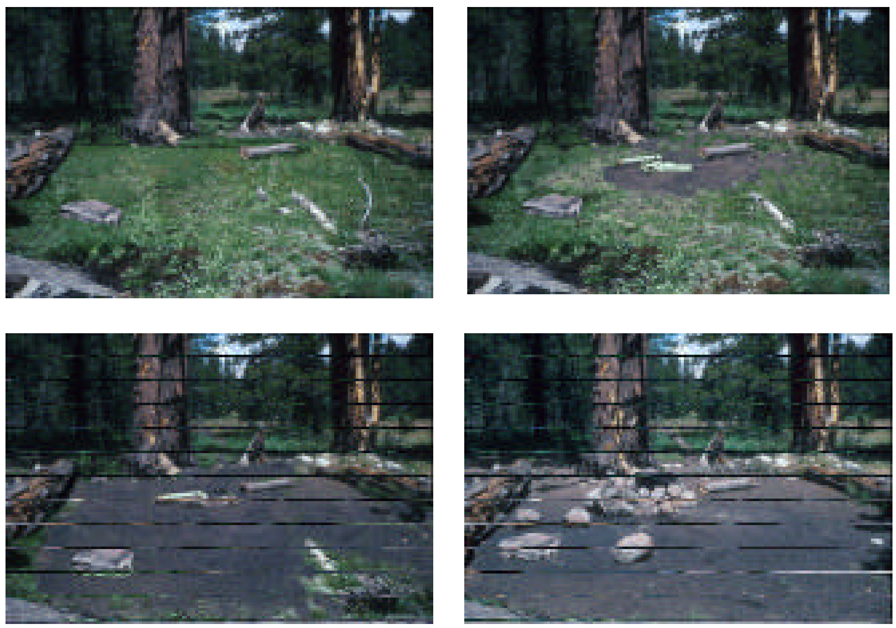

Figure 2. As part of a 'diary' survey, wilderness visitors will use these computer-generated photographs showing increasing amounts of impact to assess the current conditions of campsites as well as minimum acceptable conditions of campsite impacts.

tions of such attribute levels. Respondents will be asked to rate the desirability of a subset of scenarios representing the full universe of possible permutations. The resulting data, through application of conjoint analysis, will be used to estimate the relative importance of each indicator and standard of quality.

Several conceptual and analytical frameworks will be used to integrate the data collected in this study. Importance–performance analysis is a framework that can be used to help formulate indicators and standards of quality (Martilla and James 1977; Hollenhorst and Gardner 1994). Data can be graphically represented by plotting the importance that visitors place on indicators of quality against the perceived or preferred condition of each indicator relative to its current condition (i.e., its performance). Such plots reveal the relationships between importance and performance of indicator variables, and where management action might be focused (i.e., where importance is high and performance is low). Study data from the stated choice model will be used as the measure of the indicator importance, while diary

Table 2. Yosemite wilderness-setting attributes and levels.

Resource conditions

Signs of human use at camping sites:

- Photograph depicting low impact.
- Photograph depicting moderate impact.
- Photograph depicting high impact.

Encountering stock or signs of stock use:

- Never encounter stock groups or signs of stock use.
- Encounter stock groups or signs of stock 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 wilderness permit:

- Most visitors are able to get a permit for their preferred trip.
- Most visitors are able to get a permit for at least their second-choice trip.
- Only a minority of visitors are able to get a permit.

data will provide the preferred condition or standard of quality for each indicator variable. Data from the importance–performance analysis will generate an overall condition score that can be analyzed and reported within a GIS framework for all geographic areas within the wilderness portion of the park.

Conclusion

As park and wilderness planning and management address more complex carrying capacity issues due to the growing popularity of these protected environments, a broader domain of information needs to be considered. There is also a corresponding increase in the need for greater management expertise to make use of this expanded range of information. The increase in complexity of management issues places a greater demand on managers, planners, and researchers to take a more integrated view to effectively meet the needs of agency missions and stakeholders (Walker 2001). This paper reviewed some of the traditional methods used to integrate data and outlined a current study at Yosemite National Park that employs some additional quantitative methods.

Conjoint analysis is well suited for soliciting and analyzing the preferences of stakeholders in environmental decisions that involve the achievement of numerous objectives (Dennis 1998). Conjoint ranking surveys can be employed to solicit and analyze public preferences for alternative resource, social, and managerial settings, permitting direct integration of their preferences into statistical models that can aid in management decision-making. Two principle uses include aiding managers in formulating indicators and standards of quality and in gauging public preferences when selecting from among competing management interventions. The surveys employed in the current study at Yosemite National Park will provide an inventory of indicator conditions, information on the relative importance of alternative indicators and indicator conditions, and visitor preferences for standards of quality.

As suggested in this paper and illustrated by the Yosemite case study, several issues must be addressed to effectively combine and integrate various types of information critical to carrying capacity decision-making:

1. A collaborative scoping process to identify resource, social, and managerial issues by management zone.
2. A baseline map and georeferenced database of prioritized areas in need of resource or social mitigation.
3. Data on existing and preferred conditions derived from ecological assessments and visitor surveys, and an effective method for integrating such information.
4. Well-defined resource and social management prescriptions for each management zone.
5. Indicators and standards of quality for each management zone.
6. Monitoring protocols that encourage adaptive management through the testing of management prescriptions as hypotheses

7. Models that link management activities with changes in selected indicators.

Key features of the integrative approach include broad and diverse public involvement, scale-relevant assessments for social, economic, and biological components of the management area, development of maps and databases (both spatial and non-spatial), and long-term performance indicators and monitoring protocols that facilitate learning from experience. The results of this approach are improved data quality and access, more informed decisions in planning and management, improved collaboration, and more effective evaluation of decisions. The challenge for integration is to develop and refine tools that allow scientific data, professional expertise, and public perceptions to be integrated into a negotiation process that acknowledges the uncertainty, values, and assumptions that ultimately guide decision-making.

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