

PRINCIPLES OF CARRYING CAPACITY FOR PARKS AND OUTDOOR RECREATION AREAS¹

David W. Lime

Senior Research Associate, University of Minnesota
Department of Forest Resources, 155 Green Hall
St. Paul, Minnesota 55108, USA

ABSTRACT: Lime D. W., *Principles of Carrying Capacity for Parks and Outdoor Recreation Areas*, ACTA ENVIR. UNIV. COMENIANAE, 4-5: 21-28, 1995

Park and recreation managers increasingly are challenged to deal with growing numbers of outdoor recreationists. Many areas, both public and private, are threatened by congestion, crowding and overuse. For some managers the situation is reaching crisis proportions - the physical environment is being damaged beyond acceptable limits and the people visiting these areas are no longer receiving high quality or enjoyable outdoor experiences.

Over the past 30-40 years in North America, determining carrying capacity frequently was voiced as a manager's answer to solving the problem of overused and impacted recreation areas. Carrying capacity as applied to the management of recreation use and impacts is a complex and troublesome concept that incorporates principles of the social as well as the physical and biological sciences.

WHAT IS CARRYING CAPACITY ?

Carrying capacity as applied to park and outdoor recreation management had its beginnings in the field of wildlife and range management where capacity concerned the number of animals of a particular species that could be maintained in a given habitat (Dassmann 1964). When applied to park and recreation conditions, early discussions addressed the relationship between visitor use and physical resource conditions. The idea was that as visitor use increases, it results in increased environmental impact as measured by soil compaction, vegetation damage, water quality change and related variables.

Further discussions of carrying capacity and its application to park and recreation revealed that another important dimension of carrying capacity dealt with the quality of the visitor experience. That is, in the absence of compensatory management, as visitor use intensity increases, it causes greater social impacts as measured by crowding, congestion, loss of enjoyment and related variables.

From a park management perspective, carrying capacity is a planning concept, a framework or way of thinking about how to plan and manage a particular recreation resource. It is *not* the basis for some magic formula that gives the manager the answer to the continuing

¹This paper builds on earlier writings of the author on carrying capacity (e.g., Lime 1970, Lime and Stankey 1971, Lime 1976, Lime 1979, Manning et al. 1995).

question, "How much use is too much?" Deciding how much and what kind of use is appropriate and acceptable for an area must be based on managerial judgment and experience.

The published literature on carrying capacity spans a wide range of topics focusing on both environmental and social aspects of parks and outdoor recreation (e.g., Wagar 1964, Lime and Stankey 1971, Stankey and Lime 1973, Wagar 1974, Graefe et al. 1984, Manning 1986, Shelby and Heberlein 1986, Cole 1987, Hammitt and Cole 1987, Graefe et al. 1990, Kuss et al. 1990, Manning et al. 1995).

In spite of an impressive amount of literature related to carrying capacity, attempts to apply the concept to park and recreation settings often have resulted in frustration because of limited success in deciding how much impact (bio-physical and social) was too much. While human use of any resource results in some change, managers continue to debate how much change is acceptable or can be tolerated. That is, at what point is carrying capacity reached and management intervention required?

In defining carrying capacity as it applies to the management of park and outdoor recreation use and impacts, I assume that the primary goal of management is to provide enjoyment and benefits for people as well as to protect the environmental integrity of the area in question. There are certain constraints in doing this, of course—budgetary, administrative, legal and the capabilities of the physical environment. Thus, managers are challenged to determine the amount and *type of visitor use an area can sustain over a specified period without causing unacceptable change to the bio-physical environment or to the quality of the experience for the user.*

BASIC PRINCIPLES

Following are some basic principles related to the concept of outdoor recreation carrying capacity.

- 1. Carrying capacity can be defined only in light of management objectives for the area in question. Monitoring conditions over time helps assess whether or not acceptable conditions have been exceeded.**

Almost any site can be "hardened" to accommodate the type of recreational opportunity or opportunities called for by management. Therefore, management objectives should define, as specifically as possible, the kind of recreational opportunities or benefits the area is to provide.

At least two types of management objectives can be differentiated:

1. Broad objectives influenced or controlled by enabling legislation and general administrative policy.
2. Explicit objectives that delineate the appropriate and desired environmental setting or conditions to be sustained and the user opportunities or benefits the area is to provide.

Broad, general objectives can identify:

1. The kinds of activities that might be provided (e.g., camping, picnicking, fishing, sightseeing, wildlife watching and hunting).
2. Whether consideration will be given to the protection of natural features.
3. Whether the area should be developed to serve as many people as possible or should be limited to specific kinds of users, such as campers, anglers or hikers.

Explicit objectives are more difficult to define because they must identify *the kinds of opportunities or benefits* to be provided, and *how* and *where* these opportunities will be managed and sustained. Here, the manager must be concerned with such issues as:

1. General use intensity or appropriate level of solitude.
2. Appropriate level of development and accessibility of recreation facilities.
3. General degree of naturalness desired.

Defining these more specific objectives calls for the identification of *indicators* and *standards* of quality. Indicators reflect the type of conditions meant to be provided, such as general use intensity. Standards reflect the quantitative and measurable conditions of each indicator variable, such as the number of other parties a person would encounter while hiking each day in a backcountry setting and not adversely impact the quality of the visitor experience.

Through a process of specifying indicators and standards of quality, carrying capacity can be determined and managed by monitoring conditions over time. Indicator variables are monitored at periodic intervals and once standards are reached or exceeded, carrying capacity has been reached as well (Cole 1989, Marion 1991, Manning et al. 1995).

Management objectives should be realistic and attainable. Establishing objectives must be modified if they are not working and/or if they are no longer relevant. The potential for evaluating whether or not objectives have been achieved is increased when objectives have been quantified and are specific rather than ambiguous. Achieving explicit objectives may be influenced by administrative and policy constraints. And, financial, personnel and technical limitations can inhibit certain objectives as well.

2. A variety of carrying capacity planning frameworks have been applied to park and outdoor recreation settings, and all are grounded in the specification of indicators and standards, as well as in monitoring to assess whether or not acceptable conditions have been exceeded.

In the United States during the past 10-15 years, several planning frameworks have been proposed to address questions of carrying capacity, acceptable and appropriate visitor use, and environmental impacts caused by recreation use. These frameworks include Limits of Acceptable Change (LAC) (Stankey et al. 1985, Marion et al. 1985), Visitor Impact Management (VIM) (Graefe et al. 1990), Carrying Capacity Assessment Process (CCAP) (Shelby and Heberlein 1986) and the Visitor Experience and Resource Protection (VERP) program currently being developed by the National Park Service (National Park Service 1993, Hof et al. 1994).

While each framework calls for its own steps and general procedures, conceptually they are more similar than different. All of them address both environmental resource impacts resulting from visitor use and experiential (social) aspects of the visitor experience. They also call for the formulation of management objectives by specifying indicators and standards. And, monitoring activities are required to assess when carrying capacity has been reached or exceeded.

Implementing such planning frameworks can be complicated and costly for agencies and institutions. They require substantial investments in employee training as well as in data collection to specify indicators and standards, and to develop long-term monitoring activities. In sum, implementation requires significant commitment by all levels of the management system.

3. Obtaining attitudes and preferences of recreation users and nonusers can help administrators set objectives (indicators and standards) and suggest needed changes in current policy.

Usually there is more than one solution to a given management problem. Soliciting public opinion allows the manager to review the mix of attitudes that exists regarding a specific issue.

Frequently, users and potential users disagree about what they want—a quality experience to one person may be altogether unacceptable to someone else. Furthermore, user preferences often are different from manager preferences and from what managers believe the user wants.

Gathering data on public attitudes can be especially useful in identifying the range and mix of public desires for a given recreation site or geographic region. Such information can help managers define *specific* conditions or actions necessary to achieve management objectives.

For example, an agency might decide to provide basic camping facilities in relatively remote locations that are accessible by automobile. Studies of attitudes could provide indices of how visitors might respond to different sizes of campgrounds; the type of setting in which individual camp units are located; spacing between units; the kind and spacing of toilets, water facilities, trails, playground equipment, etc.; design of access roads; and various interpretive materials and services.

The results of such attitude surveys are not substitutes for management experience and good judgment. Nor do such studies make decisions easier for managers. On the contrary, they may increase the number of alternatives that must be considered.

Knowing who may oppose various management actions also is important. Once management decisions are made, especially on controversial issues, it is as important to explain why users' preferences cannot be met as it was to learn what their opinions were.

4. A full range of recreation opportunities within a region are desirable to satisfy the diversity of recreation tastes.

Managers should set objectives and standards for an area that will result in a balanced system or spectrum of recreation opportunities within a region. These should include not only a variety of activities (hiking, swimming, hunting, boating, etc.) but also an assortment of different kinds of opportunities for each activity (auto-access camping, remote area camping, etc.). No one manager or agency need feel obligated to meet the demands of *all* recreation users. Each public agency, for example, could aim at providing one or more *specific* types of recreation opportunities and refer those wanting something different elsewhere.

Obviously, regionwide collaboration among private and public managers is mandatory if a full and appropriate mix of opportunities and benefits is to be provided. There does seem to be good progress in meeting this objective among managers of developed campgrounds, for example. Some federal and state agencies in the United States, for example, have indicated they plan to take a major role in providing low-density, simple campground development and encourage the private sector to take the lead in providing more intensively developed facilities.

5. Many techniques are available to manage an area for its carrying capacity; the techniques selected, however, should depend on the management objectives, purpose and significance of the area.

Unfortunately, the capacity concept has always implied the use of limits on numbers of visitors as a primary mechanism for dealing with management of visitor use and impacts. In reality, however, management strategies developed from carrying capacity research and experience suggest that limiting use is only *one* of many possible techniques to address capacity questions. Progress has been slow to eliminate such confusion and broaden the management implications and understanding of carrying capacity concepts.

More than two decades ago, USDA Forest Service researchers in the United States developed a framework for discussing ways to manage both natural resources and visitors for carrying capacity (Gilbert et al. 1972, Peterson and Lime 1979). They emphasized that the selection of a technique or combination of techniques to control the character and amount of use largely depended on the specific management objectives for the area. Further, in selecting techniques managers should seek to: (1) reduce conflicts among competitive uses, (2) reduce the destructiveness of some users, (3) increase the durability of the physical resource, and (4) provide increased opportunities and benefits for visitor enjoyment. These goals can be achieved by the three overlapping types of control measures - site management, direct regulation of use, and indirect regulation of use (table 1).

Recognizing that site management techniques can have an immediate and significant effect on the character of the area and the kind of recreational opportunity or benefit offered is important. Hence, drastic or even seemingly subtle changes in the design and type of facilities can alter the character of the site to the point that it may no longer be satisfactory to many current users. This transition often has been observed in small, informal campgrounds that have been closed or have evolved into large, modern, intensively developed camping areas. The resulting process of "creeping campground development" forces out those campers who seek solitude and contact with nature.

Many direct and indirect ways are available to the manager to modify or control the recreational behavior of users (e.g., Peterson and Lime 1979, Brown et al. 1987, Cole et al. 1987). Direct controls often regulate when visitors can use the area, what area they can use, how long they can stay, and in which activities they can engage. Some of these measures greatly restrict the user's freedom of choice.

Indirect controls, on the other hand, are more subtle and less obtrusive. They generally do not interfere directly with an individual's freedom of choice. In essence, with indirect controls the manager seeks to modify user behavior without the user being aware of this influence. For instance, reducing trail maintenance in certain areas might convince some hikers to use other trails that are better maintained. As another example, hikers seeking solitude could be informed specifically where use is lightest. In both examples, such actions could help redistribute use and might also help more people increase their enjoyment.

The indirect, more subtle types of controls should be tried and evaluated before the more authoritarian, heavy-handed kinds of action are pressed into service. In particular, do not apply heavy-handed use restrictions because they appear cheapest or administratively convenient. When more regulatory types of measures are necessary, they should be applied as far in advance of the visitor's arrival at the site as possible.

Table 1 Some measures to control the character and intensity of recreational use to meet desired management objectives

Type of control	Method	Specific control techniques
Site Management (Emphasis on site design, landscaping, and engineering)	Harden site	Install durable surface (native, nonnative, synthetic) Irrigate Fertilize Revegetate Convert to more hardy species Thin ground cover and overstory
	Channel use	Erect barriers (rocks, logs, posts, fences, guardrails) Construct paths, roads, trails, walkways, bridges, etc. Landscape (vegetations patterns)
	Develop facilities	Provide access to underused and/or unused areas Provide sanitation facilities Provide overnight accommodations Provide coessionare facilities Provide activity-oriented facilities (camping, picknicking, boating docks, other platforms, playground equipment, etc.) Provide interpretive facilities
Direct Regulation of Use (Emphasis on regulation of behavior; individual choice restricted; high degree of control)	Increase policy enforcement	Impose fines Increase surveillance of area
	Zone use	Zone incompatible uses spatially (hiker only zones, prohibit motor use, etc.) Zone uses over time Limit camping in some campsites to one night, or some other limit
	Resctrict use intensity	Rotate use (open or close roads, access point, trails, campsites, etc.) Require reservations Assign campsites and/or travel routes to each camper group in backcountry Limit usage via access point Limit size of groups, number of horses, vehicles, etc. Limit camping to designated campsite only Limit length of stay in area (max./min.)
	Restrict activities	Restrict buiding campfires Restrict fishing or hunting
Indirect Regulation of Use (Emphasis on influencing or modifying behavior; individual retains freedom to choose; control less complete, more variation in use possible)	Alter physical facilities	Improve (or not) access roads, trails Improve (or not) campsites and other concetrated use areas Improve (or not) fish or wildlife populations (stock, allow to die out, etc.)
	Inform users	Advertise specific attributes of the area Identify the range of recreation opportunities in surrounding area Educate users to basic concept of ecology Advertise underused areas and general patterns of use
	Set eligibility requirements	Charge constant entrance fee Charge differential fees by trail, zone, season, etc. Require proof of ecological knowledge and recreations activity skills

6. Ultimately, the park and outdoor recreation manager is left with the difficult decision of deciding how much and what kinds of use are acceptable for a given area, and how and where such uses are to be managed and sustained.

For some decisions, the appropriate course of action is rather clear because there are few alternatives. In others, information necessary to decide may be meager or conflicting. Further, political, administrative, legal, budgetary and resource constraints may influence decisions.

Researchers can help managers by finding out what people want from a recreation experience and what they think about alternative actions. Researchers also can help by determining how various kinds and levels of use will affect the environment. However, such information only reduces the range of uncertainty associated with a given decision; it does not eliminate the uncertainty. As stressed earlier, there is *no magic formula* for carrying capacity and there is *no magic number* that is the capacity for an area.

Without a marriage of managerial judgment and facts, the quest for quality park and outdoor recreation management appears destined for "rougher days." Some warn that without adequate public participation in resource decision making "... resource managers will find themselves in the backwash of the environmental movement, serving as mere resource custodians with most decision making in other hands" (Hansen 1970).

Reviewed by Ján Drdoš

REFERENCES

- Brown, P. J., S. F. McCool, and M. J. Manfredo. 1987. Evolving concepts and tools for recreation user management in wilderness: A state-of-knowledge review. Proceedings: National Wilderness Research Conference: Issues, State-of-Knowledge, Future Directions. USDA Forest Service General Technical Report INT-220, pp. 320-346.
- Cole, D. N. 1987. Research on soil and vegetation in wilderness: A state-of-knowledge review. Proceedings: National Wilderness Research Conference: Issues, State-of-Knowledge, Future Directions. USDA Forest Service General Technical Report INT-220, pp. 135-177.
- Cole, D. N. 1989. Wilderness campsite monitoring methods: A sourcebook. USDA Forest Service General Technical Report INT-259.
- Cole, D. N., M. E. Peterson, and R. C. Lucas. 1987. Managing wilderness recreation use: Common problems and potential solutions. USDA Forest Service General Technical Report INT-230.
- Dassmann, R. F. 1964. Wildlife Biology. New York: John Wiley and Sons.
- Gilbert, C. G., G. L. Peterson, and D. W. Lime. 1972. Toward a model of travel behavior in the Boundary Waters Canoe Area. *Environment and Behavior* 4(2): 131-157.
- Graefe, A. R., F. R. Kuss, and J. J. Vaske. 1990. Visitor impact management: The planning framework. Washington, D. C.: National Parks and Conservation Association.
- Graefe, A. R., J. J. Vaske, and F. R. Kuss. 1984. Social carrying capacity: An integration and synthesis of twenty years of research. *Leisure Sciences* 6(4): 395-431.
- Hammit, W. E. and D. N. Cole. 1987. *Wildland Recreation: Ecology and Management*. New York: John Wiley and Sons.
- Hansen, R. P. 1970. The resource manager and environmental quality: Problems and opportunities. (Abstract) Society of American Foresters Annual Meeting Proceedings. Las Vegas, Nevada, pp. 13-15.
- Hof, M., J. Hammett, M. Rees, J. Belnap, N. Poe, D. W. Lime, and R. E. Manning. 1994. Getting a handle on visitor carrying capacity: A pilot project at Arches National Park. *Park Science* 14(1): 11-12.
- Kuss, F. R., A. R. Graefe, and J. J. Vaske. 1990. Visitor impact management: A Review of Research. Washington, D. C.: National Parks and Conservation Association.
- Lime, D. W. 1970. Research for determining use capacities of the Boundary Waters Canoe Area. *Naturalist* 21(4): 9-13.

- Lime, D. W. 1976. Principles of recreational carrying capacity. Proceedings of the Southern States Recreation Research Applications Workshop, USDA Forest Service General Technical Report SE-9, pp. 122-134.
- Lime, D. W. 1979. Carrying capacity. Trends 16(2): 24-27.
- Lime, D. W. and G. H. Stankey. 1971. Carrying capacity: Maintaining outdoor recreation quality. Recreation Symposium Proceedings, USDA Forest Service, pp. 174-184.
- Manning, R. E. 1986. Studies in Outdoor Recreation. Corvallis, Oregon: Oregon State University Press.
- Manning, R. E., D. W. Lime, and R. F. McMonagle. 1995. Indicators and standards of the quality of the visitor experience at a heavily-used national park. Proceedings of the 1994 Northeastern Recreation Research Symposium. USDA Forest Service General Technical Report NE-198, pp. 24-32.
- Marion, J. L. 1991. Developing a natural resource inventory and monitoring program for visitor impacts on recreation sites: A procedural manual. National Park Service, Natural Resources Report NPS/NRVT/NRR-91-06. Denver, Colorado: National Park Service.
- Marion, J. L., D. N. Cole, and D. Reynolds. 1985. Limits of acceptable change: A framework for assessing carrying capacity. Park Science 6(1): 9-11.
- Peterson, G. L. and D. W. Lime. 1979. People and their behavior: A challenge for recreation management. Journal of Forestry 77(6): 343-346.
- National Park Service. 1993. VERP: A process for addressing visitor carrying capacity in the National Park System. Denver, Colorado: Denver Service Center.
- Shelby, B. and T. A. Heberlein. 1986. Carrying Capacity in Recreation Settings. Corvallis, Oregon: Oregon State University Press.
- Stankey, G. H., D. N. Cole, R. C. Lucas, M. E. Peterson, S. S. Frissell, and R. F. Washburn. 1985. The Limits of Acceptable Change (LAC) system for wilderness planning. USDA Forest Service General Technical Report INT-176.
- Stankey, G. H. and D. W. Lime. 1973. Recreational carrying capacity: An annotated bibliography. USDA Forest Service General Technical Report INT-3.
- Wagar, J. A. 1964. The carrying capacity of wildlands for recreation. Forest Science Monograph 7, Society of American Foresters, Washington, D. C.
- Wagar, J. A. 1974. Recreational carrying capacity reconsidered. Journal of Forestry 72(5): 274-278.

SÚHRN

V uplynulých 30 rokoch v severnej Amerike bolo riešenie únosnosti reakciou manažerov na predimenzovanú návštevnosť a s ňou spojené znehodnocovanie parkov a rekreačných priestorov. Únosnosť, používaná v riešení rekreačného využívania a jeho vplyv na životné prostredie je komplexným a obťažným problémom, zahrňujúcim princípy sociálnych, prírodných a biologických vied.

Analýza literatúry o únosnosti ukazuje, že témy riešenia sa sústreďujú na dva aspekty rekreačných aktivít, a to na environmentálne a sociálne. Ide z jednej strany o uspokojenie návštevníka v rekreačnom priestore, z druhej o ochranu environmentálnej integrity územia. Cieľom je preto určiť veľkosť a typ návštevníckeho využívania, ktoré môže uniesť rekreačný priestor v určitom čase bez toho, aby sa neprijateľne zmenilo prírodné prostredie, alebo znížila kvalita zážitkov návštevníka.

Princípy koncepcie únosnosti sú nasledovné:

1. Únosnosť možno definovať len vo svetle cieľov riadenia daného územia. Monitorovanie podmienok pomáha zistiť, či sa prekračuje únosná miera zmien.

2. Celý rad rôznych plánovacích projektov stanovenia únosnosti bol založený na špecifikácii indikátorov a prípustných mier znečistenia, ako aj monitoringu, aby sa zistilo, či bola prekročená únosná miera zmien.

3. Získanie údajov o postojoch a preferenciách užívateľov i neužívateľov môže manažerovi pomôcť zostaviť súbor indikátorov a prípustných mier znečistenia a navrhnúť zmeny v riadení.

4. Je žiadateľné celé spektrum možností rekreačných aktivít v území, aby sa uspokojili rôznorodé rekreačné požiadavky.

5. Je množstvo spôsobov a technik, ako riadiť územie ak sa neprekračuje prah únosnosti, závisia však od cieľov riadenia, účelu a významu územia.

6. Konečne, manažer parku alebo rekreačného priestoru musí sám rozhodnúť, aké množstvo a aké druhy využívania sú prijateľné pre dané územie a ako a kde tieto využívania treba regulovať a udržiavať v súlade so zásadami trvalej udržateľnosti.