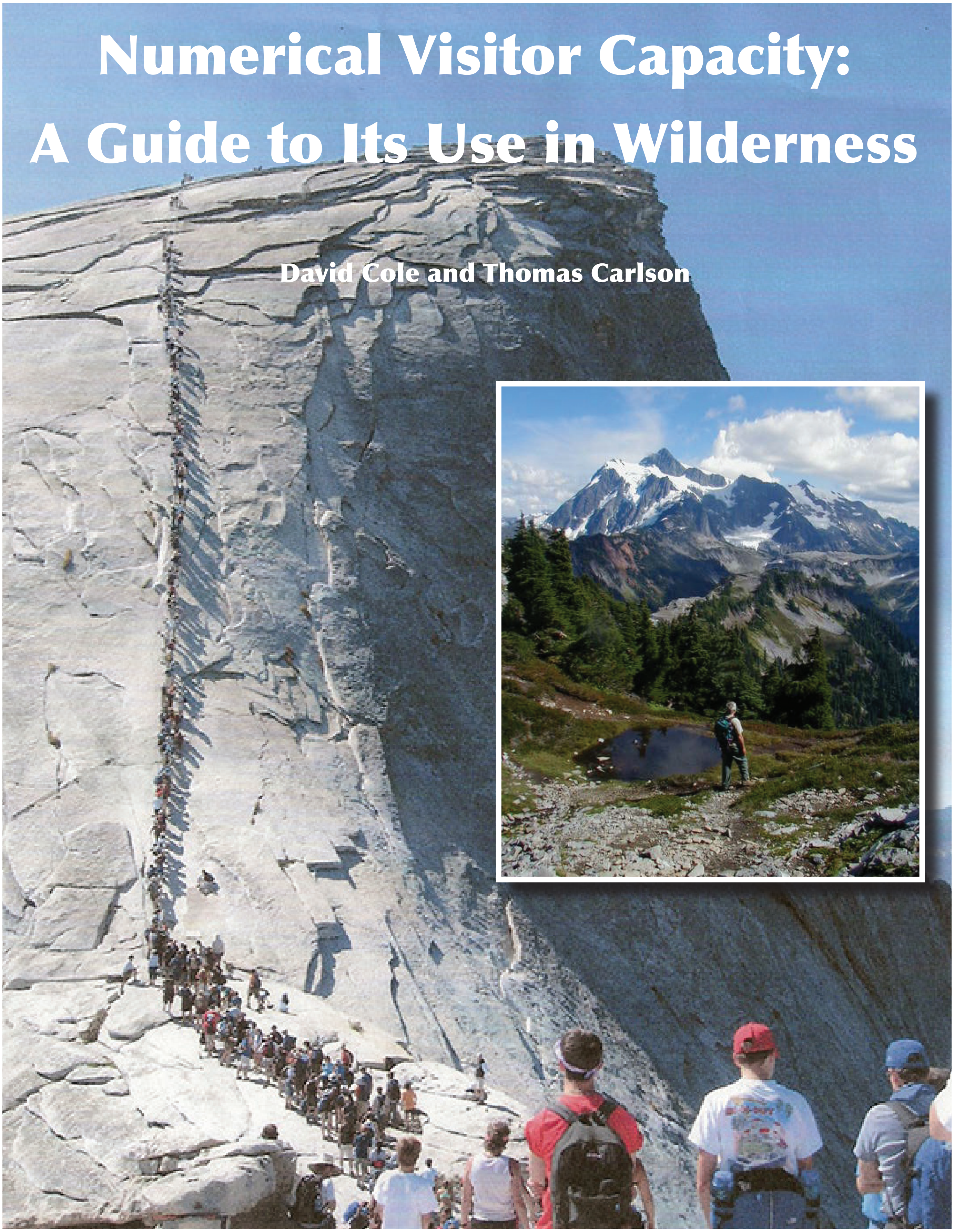
Numerical Visitor Capacity: A Guide to Its Use in Wilderness

David Cole and Thomas Carlson



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Abstract

Despite decades of academic work and practical management applications, the concept of visitor capacity remains controversial and inconsistently operationalized. Nevertheless, there are situations where development of a numerical estimate of capacity is important and where not doing so has resulted in land management agencies being successfully litigated. This report is a guide to developing estimates of numerical visitor capacity, with particular emphasis on wilderness. It reviews capacity concepts, surveys available approaches to capacity determination, and outlines a generic process. Appendices provide information on relevant legislation and policy, as well as detailed examples and templates.

Keywords: carrying capacity, indicators, recreation use, standards, visitor use management

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Cover: Hiker looks from the Mt. Baker Wilderness into the Stephen Mather Wilderness (inset photo by David Cole). Hikers use cables to ascend Half Dome in Yosemite Wilderness (photo courtesy of National Park Service).

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Introduction

The concept of recreational carrying capacity has been around since at least the 1930s, when National Park Service biologist Lowell Sumner wondered "how large a crowd can be turned loose in a wilderness without destroying its essential qualities." He went on to conclude that recreational use should be kept "within the carrying capacity" (Sumner 1936). The concept has been both the subject of academic studies (for example, Wagar 1964) and the basis for management decisions (Haas 2002). Interest in capacity has waxed and waned. The need to deal with capacity has been legislatively mandated and incorporated into policy. Recently, agencies have been successfully litigated because they have failed to address capacity issues (Haas 2004, Cole and others 2005). The concept remains controversial and poorly understood and it has never been operationalized in any consistent way. While this has led some to consider the concept a failure as a recreation planning framework and a term that should be banished (McCool and Lime 2001, McCool and others 2007), others have extolled the concept in books and reports devoted to the topic (Shelby and Heberlein 1986, Haas 2002, Manning 2007).

From the beginning, academic studies of the capacity concept have exposed its limitations. Al Wagar, the Forest Service scientist who first explored the concept systematically, noted that conceptually capacity "was a bad choice that has diverted attention from more promising approaches to effective management of recreation lands" (Wagar, 1974, p. 274) because it focused attention on limiting the number of people in an area and away from other management strategies. Recognizing these limitations and that the intent behind the capacity concept was to effectively sustain biophysical and experiential values threatened by recreation use, the notion of what carrying capacity means has often been enlarged to become an umbrella concept for visitor use management (Lime and Stankey 1971).

Numerical Visitor Capacity in Context

We share the view that capacity is more a topic and way of thinking (Lime 1976) than a metric and we strongly believe that addressing capacity is much more than managing the number of visitors. Therefore, before continuing with a guidebook on how to develop numerical visitor capacities, we must remind readers that deriving capacities is only one of many visitor use management tools. A large body of literature consistently concludes that amount of visitor use, the variable that capacity deals with, is often less important than such variables as the behavior of users or how and where use is distributed (Hammitt and Cole, 1998, Manning 1999, Cole 2009, Dawson and others 2009). Since impacts are most effectively managed by mitigating the factors that most influence amount of impact, managing use levels by setting capacities is seldom the most effective way to deal with most management problems (Cole and others 1987). **Setting a capacity should never be the first visitor use management approach to consider; rather, if used at all, it must be embedded in the context of a thorough analysis of the root cause of problems and a management prescription of diverse strategies and techniques.**

That said, there are issues and impacts that are directly related to use levels—crowding, for example (Shelby and Heberlein 1986, Manning 1999). Addressing capacity is an effective means of dealing with such issues. Perhaps more common are places where a myriad of impact issues can be effectively dealt with through means other than limiting use; but the result is a complex and onerous management regime of regulations, site hardening, channeling visitors, closures, and so on. The complexity and obtrusiveness of such a regime can often be reduced by also setting capacities and limiting use (Cole 1995).

Given that developing numerical capacities is sometimes necessary, this report will assist managers interested in developing estimates of numerical visitor capacity in wilderness. We use the term *numerical visitor capacity* because we believe, as do many other students of capacity concepts, that numbers are not always necessary when addressing capacity (Washburne 1982). However, the focus of this guide is on developing a numerical expression of capacity. We consider the concept of visitor capacity to be the same as user capacity or recreational carrying capacity and use the terms interchangeably, but we recognize that there are some who define these in different ways. Finally, although this guide is written for use in wilderness, with examples taken from wilderness, it should also be applicable on lands outside wilderness.

Using Numerical Visitor Capacity

Forest Service wilderness management regulations and policy do not require the establishment of a numerical visitor capacity, as long as visitor use can be managed in such a manner that wilderness character is not impaired by excessive recreational use (36 CFR 293.2 and FSM 2323.1). However, we believe that going through the process necessary to arrive at a numerical capacity (regardless of whether a specific number is derived) can be a useful tool in all wildernesses and likely is required, at least in some parts of many wildernesses. Refer to Appendix A for a review of the Wilderness Act, Forest Service regulations and policy, and their implications for capacity.

Addressing capacity is likely to be required in many situations where excessive visitor use has impaired wilderness character. Policy (Appendix A) suggests that (1) use should be limited if necessary to avoid impairment, (2) any limits on visitor use should be based on estimates of visitor capacity, and (3) capacity should be based on concerns regarding protection of both the biophysical resource and social conditions. Managers need to think carefully before deciding to limit use and should not overlook other more effective means of dealing with impacts (Hall 2001, McCool 2001). But where limits are deemed appropriate, capacity estimates are important inputs to decisions regarding use limits.

In addition, policy requires agencies to conduct a needs assessment to determine if outfitters and guides are appropriate and if so, how many, what type, and where they should operate. While there are a number of ways to determine how much commercial use should be allowed, a common approach is to establish a maximum level for all use (commercial and public) and then to allocate a portion of this to the commercial sector. With this approach, a numerical visitor capacity must be estimated.

As will be discussed in more detail below, the process of deriving a meaningful numerical capacity is useful for the entirety of visitor use management. It involves identifying goals, objectives, desired conditions, and what we refer to as thresholds (often called indicators and standards). It requires monitoring, evaluating the factors that influence impacts of concern, and identifying the entire suite of visitor management actions to be taken. Consequently, working through a capacity estimation process, regardless of whether limiting use is an important management tool, will benefit any recreation management program.

Using This Report

This report is an attempt to suggest how wilderness planners and managers, faced with one of these situations, might go about developing a numerical visitor capacity. These ideas are consistent with the intent of The Wilderness Act of 1964 and Forest Service regulations and policy. It does not represent new agency policy. Currently there is no established methodology in agency policy for developing a numerical visitor capacity; consequently, various approaches to addressing capacity have been taken.

In this report, we outline a very general approach to developing a numerical visitor capacity. The approach is consistent with the many planning frameworks that have been developed to address visitor capacity and visitor use management generally. Most of these take a management-by-objectives approach and build on the original ideas of Frissell and Stankey (1972) regarding developing management objectives that limit degradation and impairment. Conceptually, these frameworks are virtually identical (McCool and Cole 1997), although they differ in implementational detail. In order of their development, these frameworks include Limits of Acceptable Change (LAC) (Stankey and others 1985), Management Process for Visitor Activities (VAMP) (Parks Canada 1985), Visitor Impact Management (VIM) (Graefe and others 1990), Carrying Capacity Assessment Process (C-CAP) (Shelby and Heberlein 1986), Visitor Experience and Resource Protection (VERP) (USDI National Park Service 1993), Protected Areas Visitor Impact Management (PAVIM) (Farrell and Marion 2002), and Sustainable Visitor Capacity (SVC) (Queensland Environmental Protection Agency n.d.). Readers interested in more than numerical capacity—planning for visitor use management generally—would profit from reading more about these frameworks.

We suggest that planners and managers adopt an approach that meets their needs. Approaches will vary with available information, staff and resources and, particularly, with the likely consequences of prescriptive decisions based on capacity estimates. Where managers have little information and where the consequences of a capacity-based decision are not very controversial, rapid approaches may suffice. However, where the potential for resource degradation is significant or there is a high likelihood of the decision being challenged, a more involved, lengthy, collaborative, and precise approach is warranted. The keys to success are (1) employing the best available information; (2) basing an estimate on clear management objectives, logical thinking, sound science, and professional judgment (so it is not arbitrary); and (3) refining capacity estimates over time as new information becomes available. It is also important to think about implementation while developing capacities. There is little value to developing capacities if there is no will to implement the actions needed to avoid exceeding capacity.

What is Numerical Visitor Capacity?

The recommendations in this guidebook are consistent with early definitions of recreational carrying capacity, but not with some definitions of capacity that have been advanced more recently (Haas 2002, Whittaker and others 2010). Therefore, it is important to explore the capacity perspectives that are foundational to the basic assumptions of this guide. The original published definition of capacity was that it was "the maximum extent of the highest type of recreational use which a wilderness can receive, consistent with its long-term preservation" (Sumner 1942). Most definitions of capacity advanced since then are remarkably similar. For example, in their recent ruling on the Merced River capacity litigation, the United States Court of Appeals for the Ninth Circuit (Friends of Yosemite Valley v. Kempthorne, 520 F.3d 1024(9th Cir.2008)) noted the "plain meaning" of the mandate to "address…user capacities" was to "deal with or discuss the maximum number of people…which the river area can sustain without impact to the ORVs [outstandingly remarkable values]."

There are three things to note about these definitions. First, capacity is a maximum number of visitors. Second, it is the maximum number that is consistent with management objectives—the maximum number that can be accommodated without impairment of values. For wilderness, with its emphasis on protecting wilderness character, capacity is the maximum amount and type of use that can be sustained without causing unacceptable impact to the wilderness' ecological conditions or to the quality of visitor experiences.

The emphasis on sustaining values and avoiding unacceptable impact illustrate the importance of professional judgments and management objectives to identifying capacities. As McCool and others (2007) note, "Carrying capacity requires specific objectives" and because of this "each site has a whole range of potential capacities, each providing different consequences" (Wagar 1974, p. 275). Capacities cannot be identified until specific objectives or evaluative standards have been defined, leading Shelby and Heberlein (1986, p. 18) to define capacity as "the level of use beyond which impacts exceed levels specified by evaluative standards."

The third thing to note, not apparent in the capacity definition itself, is that capacity is an attribute that can be estimated. Capacity is not a value-free, inherent property of a place (Wagar 1964). It can only be estimated once decisions have been made about management objectives and other management actions to be taken in the area. But once these decisions have been made, analytical processes can be used to estimate what the capacity actually is. Such estimates might be imprecise, uncertain, and even inaccurate, depending on the situation and the quality and quantity of technical and experiential information available, but they are an attempt to get at a theoretically discoverable attribute. In other words, as originally conceived, capacities are based on decisions about management objectives and they inform decisions about actions such as use limits but are arrived at through a process of analysis and estimation, not a decision-making process.

To illustrate the distinction between descriptive estimates and prescriptive decisions, consider the capacity of a football stadium. A capacity cannot even be approximated until a prescriptive decision is made about whether spectators will be allowed to stand or must be seated. But once it is decided that there will be no standing, capacity can be estimated with a high degree of precision, certainty, and accuracy. The number of seats can simply be counted. This estimate of stadium capacity should certainly inform a decision about use limits—how many tickets to sell. But it is also possible to decide to sell more or less tickets than the stadium capacity. Prescriptive decisions about how much use will be accommodated or allowed can differ from the analytical estimates of capacity that should inform such decisions.

Capacity is also considered an estimate, arrived at through analytical processes, in the resource management disciplines from which the recreational capacity concept was borrowed. Dana (1957), for example, noted its equivalence to the concept of sustained yield in timber management. Sustained yields are estimated on the basis of research, monitoring, experience, and logical thinking. They inform decisions about timber supply, but supply is not synonymous with sustained yield. In range management, estimates of grazing capacity are developed, again based on monitoring, research, and experience. These estimates, in turn, inform decisions about stocking rates (how many animals can be grazed). In each case, capacities are estimates that inform decisions—not the decisions themselves. This distinction between estimation and decision was explicitly recognized in the regulations developed to implement the National Forest Management Act (NFMA). Section 219.18(a) stated that the portion of forest plans providing direction for wilderness management were to "provide for limiting and distributing visitor use of specific portions in accord with periodic *estimates* of the maximum levels of use" (emphasis added) that do not impair wilderness values (Federal Register 1982).

This differs from some more recent assertions that visitor capacity should be a prescriptive decision, arrived at through consideration and negotiation (Haas 2003) rather than analysis. Haas (2002), for example, defines visitor capacity as "the supply, or prescribed number, of appropriate visitor opportunities that will be accommodated in an area" (p. 10) and believes that "supply and capacity are synonymous" (p. 9). Traditionally, supply and capacity have not been considered to be synonymous. For example, Twiss (1971), in an early textbook discussion of recreational supply, notes that "capacity estimation" is one of the seven elements needed to make decisions about supply. This guide is intended to help managers make the prescriptive decisions and work through the analytical process that can produce descriptive estimates of numerical visitor capacity. These estimates should, among other things, inform decisions about supply or use limits.

A Procedure for Developing a Numerical Visitor Capacity

Given this definition, there are two major steps to developing a numerical capacity. First, one must establish thresholds. These thresholds represent the point at which impairment occurs or there is unacceptable impact to ecological conditions or the visitor experience. These biophysical and social thresholds are judgments, based on values—decisions that managers must make, with appropriate input from stakeholders. The implication of a threshold is that management will do whatever is necessary, even restrict access, to keep the threshold from being exceeded.

Second, one must estimate the maximum amount of visitor use that can be sustained without exceeding these thresholds. This is more of a science- and data-based step than the establishment of thresholds. Measures and monitoring data can be helpful, as can research. But, professional judgment and logical thinking will always be required and, in some cases, may be the primary basis for estimates. All processes for developing a numerical capacity have these two steps in common, but they vary considerably in detail.

Along with variation in the details of implementation, procedures for developing a numerical visitor capacity vary in the explicitness and objectiveness of thresholds, the accuracy of the numerical capacity estimates, and the time and resources required. It is important to understand the attributes of any capacity estimation process that is selected. Consequently, we review each of these characteristics.

Ideally, the thresholds of impairment and acceptable impact are made explicit, stated in precise and quantitative terms, and established through a process involving substantial input from an interdisciplinary team of agency officials, the public, and other stakeholders. This should maximize the validity of the thresholds and minimize subjectivity and bias in decisions about what the thresholds actually are and the conditions under which they might be exceeded. Less ideal options include establishing explicit, quantitative thresholds without much stakeholder input, using qualitative thresholds, and using thresholds that are implicit rather than explicit. An implicit threshold is one that has not been documented, leaving it unclear in the documentation of the process exactly what threshold was used. Sometimes the persons developing the capacity estimate may not even be able to articulate the threshold they are implicitly using. But any capacity estimate must be formulated with some threshold criterion in mind.

For any given threshold (or set of thresholds), there are many ways to estimate a numerical capacity. Some approaches use professional observation and experience, while others use research on the relationship between use and impact to arrive at an estimate; computer simulation modeling can sometimes be used as a way of further systematizing observation. Some approaches incorporate monitoring, while others do not. Some approaches are highly tailored to a specific area, while others rely on extrapolation and/or the use of generic coefficients. Accuracy is highest when systematic observation, monitoring, research, and professional judgment are all used and the process is tailored to a specific environmental, social, and managerial context, as opposed to being based solely on extrapolation from generic estimates.

Not surprisingly, time and resources are positively related to the quality of thresholds and the accuracy of capacity estimates. More accurate and defensible approaches are more costly, in time and resources. Capacity processes can generally be arrayed on a spectrum from (1) explicit thresholds, high accuracy approaches that require substantial time and resources to (2) implicit thresholds, low accuracy approaches that require little time and resources. The selection of a numerical estimation capacity process will largely be one of selecting an appropriate point on this spectrum, understanding the limitations of whatever process is undertaken, and striving to minimize those limitations. This is similar to the concept of a sliding scale described by Haas (2002, p. 29) in the following manner: "The sliding scale rule of analysis says that the level of analysis should be commensurate with the purpose or potential consequences." The greater the potential consequences, impacts or risks, the more certainty and precision are needed, with resultant implications for the amount and quality of science and information that is needed.

Summary of the Procedure

In short, estimating visitor capacity involves the following steps or decision points:

1. **Establish Thresholds.** These should be explicit and quantitative, although it is possible to work with qualitative and even implicit (see below) thresholds. They should address goals or desired conditions for the area—values and attributes you are trying to protect. Appendix C is an example, developed by the Northern Region of the Forest Service, of how to base thresholds and capacities on issues. Assuming the wilderness has zones with variable objectives regarding degree of impact and visitor experience, thresholds are likely to vary among zones.
2. **Define Analysis Areas.** These are areas (often watersheds) that (1) can be analyzed and managed as individual units and (2) have a common set of thresholds (i.e., the entire analysis area is in just one zone).
3. **Estimate Capacities for each Analysis Area.** Use professional judgment, logic, research, and/or monitoring data to estimate the maximum use each analysis area can receive without exceeding any of the thresholds. Assuming there are multiple thresholds (different indicators), only one will be the limiting factor in any analysis area. The limiting factor may vary among analysis areas.
4. **Convert and Aggregate Use Measures.** In some cases a numerical estimate of capacity for the entire wilderness may be necessary for programmatic planning purposes. If so, simply sum the capacity estimates for each analysis area. This may require some conversion among different use measures (e.g., RVDs, PAOT, groups entering per day, and groups per season). This wilderness-wide capacity may be of little value in implementing capacity on the ground, however. Capacity should be implemented for specific places (analysis areas perhaps) and for particular times, to ensure that capacity is not exceeded in any place or at any time.

Defining Thresholds

As noted above, ideally thresholds should be explicit and quantitative. To address the most important values at risk, it is best to develop thresholds for multiple attributes of concern. Explicit, quantitative thresholds are referred to as indicators and standards in capacity processes such as Limits of Acceptable Change (LAC) (Stankey and others 1985) and Visitor Experience and Resource Protection (VERP) (USDI National Park Service 1993), as well as in some more general planning processes and in Forest Service regulations and policy. In this document, we will at times use the terms "threshold" and "standard" interchangeably, although we use the generic term "threshold" most often. We recognize that the term "standard" is sometimes used in ways that differ from our use of the terms. As noted earlier, thresholds are not to be exceeded. They are requirements, not a suggestion.

Thresholds (or indicators and standards) can sometimes be found in existing plans, but in many cases they will need to be developed. Even thresholds in existing plans may need to be adapted or supplemented, because existing plans may not have identified some of the specific issues that are important in wilderness. Although the general issues which thresholds should address, such as preserving natural conditions, are similar across all wilderness areas, specific indicators will vary among areas. For example, in one wilderness the concern might be grizzly bears; in another it might be trampling of a rare plant.

To establish thresholds, first identify the wilderness values that are both most important and most likely to be at risk from high levels of visitor use; these are the indicators that are most relevant to capacity. Consider attributes of wilderness character and outstandingly remarkable values on rivers. Attributes that are unrelated to visitor use or that can be protected without limiting use are not needed for capacity estimates. However, these other indicators may be equally or more important to visitor use management generally; they should not be ignored. Decisions about indicators are best made on the basis of the experience of professionals and stakeholders. Lists of potential indicators that might be considered can be found in Manning (1999), Manning and Lime (2000), Lime and others (2004), National Park Service (n.d.) and on Wilderness.net (n.d.).

Once indicators have been developed, decisions will need to be made about the maximum level of impact to each of these attributes and values that will be tolerated; these are the standards or quantitative thresholds. Thresholds represent managers' decisions regarding the dividing line between impaired and unimpaired values, and between acceptable and unacceptable conditions. Thresholds may trigger management actions. There is no magic and little science in the establishment of quantitative thresholds, although it is helpful, when defining them, to have information on current conditions. Thresholds should be thought of as a balance between preserving desired conditions and avoiding excessive regulation and restriction on access. Thresholds should be set at the point where it would be generally acceptable to limit use in order to avoid exceeding that threshold. Visitor opinions captured in surveys, often referred to as norms (Vaske and others 1986, Manning 2007), provide one useful source of input, although some have questioned the sufficiency of such data for making prescriptive decisions (Stewart and Cole 2003).

Most wilderness areas are diverse in terms of how pristine they are and the wilderness experience they offer. This diversity should be maintained by providing several different wilderness zones (similar conceptually to ROS classes), each of which has different quantitative thresholds. For this purpose, managers will need to decide how many different zones to have (usually 2-4) and what the thresholds for each zone are. There may be some smaller wilderness areas that only have one zone, but this is likely the exception rather than the rule.

Then managers must allocate the zones to specific geographic areas. The entire wilderness must be zoned, with every specific place in the wilderness being assigned to only one zone. A typical wilderness will have multiple geographic areas assigned to the same zone, separated from each other by geographic areas assigned to different zones.

As an example, consider Inspiration Wilderness, a wilderness with four zones from most to least pristine. Managers there are most concerned about avoiding excessive crowding on trails, too many highly impacted campsites, and adverse effects of visitor use on populations of black bears. They decide to have three indicators, one for each of these concerns: a maximum number of encounters with other groups on trails per day, a maximum number of campsites per square mile with a condition class of 3 or more, and a maximum reduction in the population of black bears attributable to recreation use. For the maximum number of encounters per day, thresholds are 1, 2, 5, and 15 groups per day in the four zones. For campsites, thresholds are none, none, 2, and 5. For black bears, thresholds are none, none, 10%, and 10%.

As noted above, ideally thresholds should be carefully developed through a process of public and stakeholder involvement. Although often time-consuming and costly, this enhances the credibility of decisions. But a time-consuming public involvement process is not always necessary and may be wasteful of scarce resources in situations where important wilderness values are not substantially at risk and there is little controversy. In such a situation, a small interdisciplinary team or even a single individual could make these decisions in a single meeting.

Qualitative thresholds and even implicit thresholds are less desirable options. They should be avoided unless it is not possible to quantify critical attributes. In the example above, perhaps it is not possible to quantify impacts on black bears. Developing a qualitative threshold is better than ignoring an important issue. An example of a qualitative threshold for the issue of black bear impact might be "there will be negligible impact to populations in the more pristine zones and no more than moderate impact in the other zones." A team of bear experts might be convened to evaluate whether or not likely levels of impact exceed these thresholds. Implicit thresholds will be discussed more below.

Estimating Visitor Capacity on the Basis of Thresholds

The second step in arriving at a numerical visitor capacity is to estimate the maximum amount of use that can be sustained without exceeding *any* of the thresholds. As first noted by Frissell and Stankey (1972), this will involve deciding which threshold is the factor that ultimately limits capacity. The limiting factor is not the most important factor; all thresholds are important. The limiting factor is the one most sensitive to use, the threshold that is compromised at the lowest use level. But the limiting factor is likely to vary from place to place—between one trail and the next, between drainages, or between one bay and the next. Consequently, separate estimates will need to be developed for each of a number of individual analysis areas in the wilderness. There also may need to be coordination among adjacent wilderness units.

There is no simple rule to follow regarding how to divide a wilderness into analysis areas. Generally, an entire analysis area should be accessible from one or a few access points and it should be possible to manage it as a single unit. In mountainous wilderness, a watershed accessed by one main trail often makes a good analysis unit. But, an entire analysis area must be allocated to just one zone. If a watershed is long, with a popular section accessed by day users as well as a remote lake basin, it will usually be best to use more than one analysis area. Separate fjords or bays in an Alaskan wilderness, for example, should probably be separate analysis units and the popular shoreline locations should probably not be lumped with large tracts of unvisited interior lands for analysis purposes.

Estimates of capacity must be made for each individual analysis unit. Then these separate estimates can be summed to arrive at the capacity of the entire wilderness. Although a single overall capacity for the entire wilderness can be derived, capacities will usually need to be implemented at the scale of the individual analysis area, to avoid having over- and under-utilized management areas. For example, the entire wilderness might have a capacity of 10,000 groups, but this assumes that use will be distributed such that none of the analysis units exceeds capacity. If half the groups want to go to one place, either overall capacity will have to be reduced substantially or some system (e.g., a place-specific permit system) will have to be developed to ensure that use is more equitably distributed.

Professional judgment, logic, research, monitoring, and even tools like computer simulation modeling can all contribute to estimates of how much use can be accommodated without exceeding thresholds. The accuracy of estimates can be increased by using varied sources of information and tools and by periodically refining estimates on the basis of new and better information. Monitoring is not absolutely necessary to estimate capacity but, if done well, it always increases the accuracy of estimates. The importance of monitoring increases as the risk to valued resources increases and as the uncertainty associated with predictions based on professional judgment, logic, experience or research increases.

For example, consider the threshold of no more than one encounter with other groups per day in the most pristine zone of Inspiration Wilderness. For Analysis Area 1 in the Pristine zone, an estimate based on professional judgment could be that three groups per day could enter that area without exceeding the threshold of one encounter per day. Moreover, logic might suggest that with only three groups per day entering, there should be no campsites with a condition class of 3 or more and that impacts to black bears should be negligible. Thus the capacity estimate based on trail encounters appears to be the limiting factor. Similar analyses could be done for all analysis areas. These could be aggregated to provide an estimate of how many groups per day could enter the entire wilderness, assuming it was possible to distribute use in such a way that every analysis area is managed to capacity without exceeding capacity.

Note that estimates of maximum use, for a given analysis area, must be based on consideration of all other management actions being taken (or planned) in that area. This is critically important. Capacities can only be estimated in the context of the complete management prescription for each analysis area. Management actions, such as making trails more durable, teaching visitors Leave-No-Trace techniques, and designating campsites, will increase capacity if they are effective in reducing the per capita effects of use. All aspects of a management prescription affect capacity.

Monitoring data can be used to provide more accurate initial estimates of capacity. Assume monitoring data for Analysis Area 1 (from the example above) indicates that the threshold of one encounter per day is seldom exceeded until more than four groups per day enter. This monitoring-based estimate of four groups per day should be a more accurate estimate of capacity than the estimate of three groups based on logic and professional judgment. If there is a 100 day use season, total capacity would be about 400 groups per year. Or perhaps data show that encounters average about 0.5 encounter per day and total use is about 200 groups per year. This would suggest, as a starting estimate, that capacity might be about 400 groups per year. Computer simulation modeling, if available, can be a useful tool for estimating how much use can be sustained without exceeding established thresholds (Cole 2005, Lawson 2006). As noted earlier, although monitoring data and tools such as computer simulation increase the accuracy of estimates, they are not necessary. Estimates can be based on logic and professional judgment.

Once initial numerical capacity estimates are made, monitoring provides a means for adjusting estimates, resulting in increased accuracy over time. For example, it was assumed that number of encounters was the limiting factor. But if 400 groups per year are allowed into the area and bear populations seem to be adversely affected, this estimate might have to be lowered. Or perhaps, once use increases from 200 groups per year to 400 groups per year, data suggest encounter levels are still well below the threshold and that bear populations are not adversely affected. This would mean that capacity estimates were too low and use levels could be increased without exceeding any thresholds. Note that the numerical capacities are estimates not decisions. These estimates are likely to change over time, as conditions change and better information becomes available. In contrast, the thresholds should be stable at least through planning cycles.

As noted before, even if there is no monitoring data and uncertainty is high, capacities can still be estimated. It is not necessary to wait until research and monitoring data are available or to avoid making an estimate because there are insufficient resources for research and monitoring. However, as the likely level of controversy associated with a capacity estimate increases, so does the desirability of more information, research, and monitoring. This is the sliding scale principle (Haas 2002). As was done in the example above (three groups per day in Analysis Area 1), consider the threshold and make a professional judgment about the maximum use that would not exceed the threshold.

This is the approach to use with qualitative thresholds as well. In the absence of data, it is probably preferable to convene a group of knowledgeable people and/or stakeholders to make estimates. Moreover, in wilderness particularly, when uncertainty is high, it is important to use the precautionary principle to make conservative capacity estimates until monitoring data are available and more accurate predictions can be made. In wilderness, the provision of recreational opportunities is a management objective but one that is constrained by the need to protect wilderness character. So, where there is high uncertainty, lower the estimate somewhat to be precautionary. In addition, it is always easier politically and economically to increase capacity estimates than to lower them once use levels and patterns become established. This illustrates that one of the costs of not allocating sufficient resources to monitoring and research will be capacity estimates that are somewhat lower than perhaps they would need to be.

For some thresholds, estimating capacity is straightforward. For example, if there is a threshold for a use density measure like PAOT (persons at one time), such as no more than 200 PAOT, the capacity estimate would obviously be 200 PAOT. However, we do not advocate writing thresholds for use density itself because there is nothing good or bad about any particular use density. It is the effect of use density on the environment or the visitor experience that is a more legitimate concern.

Another example of a capacity that is easily estimated is a threshold such as no more than one campsite per square mile in a wilderness where camping is only allowed on designated campsites. In this case, the capacity estimate, in groups, would be the number of designated campsites (or more realistically some proportion of this number, if groups are not assigned to specific sites) plus an unlimited amount of day use. This latter example illustrates how capacities sometimes apply to only one recreational activity, in this case camping. It is quite common, for example, for there to be limits on river users but not other users. In this situation, capacities need only be estimated for river users—for the purpose of making decisions about maximum levels of river use.

Sometimes it will be necessary to translate between different measures of use. For example, estimates of groups per day or PAOT may need to be converted into recreation visitor days (RVDs) per year. Some procedures for converting use measures are included in the user's guide to the Recreational Opportunity Spectrum (USDA Forest Service 1982).

Other Numerical Capacity Estimation Procedures

As noted above, some capacity estimation processes rely on implicit thresholds. Two processes that have frequently been used, in which the thresholds are implicit, are (1) capacity estimates based on procedures described in the Recreation Opportunity Spectrum (ROS) handbook (USDA Forest Service 1982) and (2) capacity estimates based on a freeze on current use.

Capacity Estimation Based on ROS Coefficients

The process included in the handbook for implementing the Recreation Opportunity Spectrum (ROS) is as follows (USDA Forest Service 1982):

1. Map ROS classes in the wilderness.
2. Multiply the number of acres in each ROS class by capacity coefficients unique to each ROS class. Coefficients are maximum persons at one time (PAOT) per acre. These are most often taken from the table of coefficients in the ROS handbook, although that table has a footnote stating that coefficients should be developed specifically for local conditions. These coefficients are simply estimates of maximum use levels that will not exceed thresholds. The difference is that

these coefficients are someone else's estimates, developed for some place other than where you are, using thresholds that are implicit and not defined. Consequently, it is unclear what was assumed to be relevant or important.

3. Adjust capacities down to account for such variables as the proportion of acres that are useable, environmental screening, and so on. For example, if only 10% of acres are usable for recreation, capacity should be reduced 90%. If there is lots of screening by vegetation and local topographic variability, capacity might be higher because the environment can "absorb" more people. Again, it is up to local planners to decide which factors to consider and how to make adjustments.
4. Convert these adjusted PAOT/acre estimates to recreation visitor days (RVDs) using the formula in the guide (USDA Forest Service 1982).

There is an infinite number of ways that local managers can adjust their estimates to reflect local factors that managers feel should influence capacity levels. This is suggestive of the subjectivity inherent to this approach. Independent planners are likely to derive substantially different capacity estimates depending on the factors they judge to be important. The capacity coefficients published in the ROS handbook (USDA Forest Service 1982) were developed in the early 1980s by a small group of Forest Service planners in the Rocky Mountain Region, based on their best professional judgment. Coefficients were based on concern about impacts both to the environment and visitor experience, but exactly what thresholds these planners had in mind is not stated. The thresholds they used are implicit.

The low level of accuracy inherent to this process is reflected in the fact that the coefficients published in the handbook have wide ranges: from 0.002 to 0.025 PAOT/acre in the primitive zone and from 0.008 to 0.083 PAOT/acre in the semi-primitive non-motorized zone. Although selecting a coefficient at the high end of the range would result in a capacity estimate 10 times higher than selecting the low end coefficient, there is no guidance about how to select a precise coefficient within this range. Moreover, as noted above, there is a footnote on the table of coefficients noting that "specific ranges must be developed to meet regional or forest conditions."

This process is most commonly used in situations where capacity is much higher than current use, so there is no immediate need to limit use. Given the lack of explicit thresholds, high subjectivity and low accuracy, this approach is best suited to situations where only rough estimates of capacity are needed and where the "cost" of relatively inaccurate estimates is low. The primary advantage to this approach is that costs are relatively low. However, this approach still requires considerable field information, such as ROS zoning and information about the environment, facilities, and use that enable the coefficients to be adjusted. It also involves a large number of subjective judgments, many of which may not be apparent if one attempts to apply the ROS handbook in a routine manner.

Freezing Use at Current Levels

Another common approach to setting capacity in places where use limits are needed now is to set the capacity at the current level of use—to freeze use at current levels. This approach was taken on many rivers and in many national parks and wilderness areas, mostly in the 1970s and 1980s. With this approach, the implicit thresholds are the conditions that exist today. The current condition of resources is deemed acceptable because if they were not acceptable, capacity would have to be lower. But further deterioration would be deemed unacceptable; hence the need to limit use. Estimating capacity using this approach is extremely easy. It is simply the amount of use that exists today.

Although this is an inexpensive way to estimate numerical capacity and perhaps is politically expedient, it can be costly in terms of either allowing excessive use or not allowing as much use as might sustainably be accommodated. This follows from the fact that current conditions are unlikely to represent optimal thresholds. Indeed, many of the places that froze use in the 1970s and 1980s have tweaked their estimates as more information became available.

Conclusions

We want to close by rearticulating points made in the introduction to this guide. These suggestions are as applicable outside wilderness as they are inside wilderness. Although developing a numerical visitor capacity is worthwhile, addressing capacity is not primarily about managing the number of people. Many of the benefits of addressing capacity come from gathering information, monitoring, making decisions about thresholds, and prescribing the entire suite of management actions that are necessary to meet management objectives.

It is also important to remember that capacities can only be estimated in the context of all the other management actions that have been or will be taken in the area. Because these actions influence the relationship between amount of use and resource and social conditions, they affect capacity. Capacity will often change when new management actions are taken.

Consider the sliding scale principle and adjust the time and resources allocated to estimating capacity in relation to the resources at risk and the consequences of decisions. Think about implementation while developing capacities. There is little value to developing capacities if there is no will to implement the actions needed to avoid exceeding capacity. Similarly, it is important to implement capacities at appropriate spatial scales. Capacities are likely to be exceeded in local areas if a wilderness-wide capacity is employed without sufficient means for distributing use appropriately.

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Appendix A—Relevant Legislation and Policy

The Wilderness Act

The Wilderness Act does not direct wilderness managers to address visitor capacity. However, it does direct them to preserve wilderness character, protect natural conditions, and ensure that the benefits of wilderness (including outstanding opportunities for quality wilderness experiences) are available in an unimpaired condition for future generations. Since there are places where wilderness must be protected from excessive impacts of visitor use, the Wilderness Act implies a need to address capacity at least in some places. The following paragraphs highlight relevant excerpts from the Wilderness Act.

The Wilderness Act of 1964, in Section 2(a), established the National Wilderness Preservation System to provide *"… the benefits of an enduring resource of wilderness*." It requires that wilderness areas are to be *"… administered for the use and enjoyment of the American people in such a manner as will leave them unimpaired for future use and enjoyment as wilderness …"* while ensuring the *"… preservation of their wilderness character …"* The definition of wilderness, in Section 2(c), includes a mandate to *"… preserve its natural conditions …"* while providing *"… outstanding opportunities for solitude or a primitive and unconfined type of recreation …"*

In Section 4b of the Wilderness Act, visitor use (recreation) is included in a mandate that "*Except as otherwise provided in this Act, wilderness areas shall be devoted to the public purposes of recreational, scenic, scientific, educational, conservation, and historical use*." This means that visitor use is a public purpose of wilderness and opportunities should be provided as part of the benefits of wilderness. But note the phrase *"Except as otherwise provided in this Act …"* which constrains the public purposes, in part, by reference to other mandates of the law including the primary responsibility of managers to preserve wilderness character. The definition of wilderness character is derived from the four statutory qualities of: undeveloped, natural, untrammeled, and outstanding opportunities for solitude or a primitive and unconfined type of recreation found in Section 2c. All four qualities of wilderness character influence visitor experiences and are useful in setting thresholds for estimating visitor capacity.

Section 4d (6) contains a special provision that allows for commercial services (outfitters and guides) if they are needed to support recreation and other wilderness purposes. *"Commercial services may be performed within the wilderness areas designated by this Act to the extent necessary for activities which are proper for realizing the recreational or other wilderness purposes of the areas."* The language of the law uses the term *"may be performed*" and *"to the extent necessary"* to both allow and constrain these activities to match the wilderness purposes or to help provide the benefits of the wilderness resource. As with all other activities the primary mandate for administration (preservation of wilderness character) provides the guide for determining how much commercial visitor use is needed (the extent necessary) within the overall wilderness visitor capacity and the desired social, biological, and physical conditions.

Forest Service Regulations and Policy

Forest Service Wilderness Management Regulations and Policy do not define what is meant by visitor capacity or prescribe a specific method for estimating a numerical capacity. However, policy makes it clear that wilderness character must be protected from excessive use and that this may require limiting and distributing visitor use based on periodic estimates of capacity. Policy also makes it clear that any estimate of visitor capacity must be based on the capabilities of the social, biological, and physical components of the wilderness resource to accommodate use without impairment of wilderness character. Finally, policy requires a needs assessment for outfitter and guide operations that may include an estimate of visitor capacity. Listed below are the sections of federal regulations and Forest Service wilderness management policy most relevant to visitor capacity. Visitor capacity must always be done in compliance with NEPA analysis and forest planning regulations and policy, which are not shown here.

Regulations

36 CFR 293.2 Objectives:

(b) Wilderness shall be made available for human use to the optimum extent consistent with the maintenance of primitive conditions.

Forest Service Policy

FSM 2320.3: Policy

- Where there are alternatives among management decisions, wilderness values shall dominate over all other considerations except where limited by the Wilderness Act, subsequent legislation, or regulations.

FSM 2323.11 Management of Recreation Use in Wilderness:

- Provide, consistent with management of the area as wilderness, opportunities for public use, enjoyment, and understanding of the wilderness, through experiences that depend upon a wilderness setting.
- Provide outstanding opportunities for solitude or a primitive and unconfined type of recreation.

FSM 2323.14 Visitor Management:

- Plan and manage public use of wilderness in such a manner that preserves the wilderness character of the area.
- Provide for the limiting and distribution of visitor use according to periodic estimates of capacity in the forest plan.

FSM 2323.13g Outfitter and Guide Operations:

- Address the need for and role of outfitters in the forest plan.
- The plan must address the type, number, and amount of recreation use that is to be allocated to outfitters.
- Ensure that outfitters provide their service to the public in a manner that is compatible with use by other wilderness visitors and that maintains the wilderness resource.

FSH 2709.11 part 41.53e Needs Assessment, Resource Capacity Analysis, and Allocation of Use

- Allocate outfitting and guiding use in a project decision pursuant to 36 CFR Part 215 or in a programmatic decision pursuant to a wilderness plan, wild and scenic river plan, or plan for another type of congressionally designated area.
- Conduct a needs assessment to determine the public or agency need for authorized outfitting and guiding activities.
- When conducting a needs assessment for outfitting and guiding activities in a wilderness area, assess whether these activities are necessary for realizing the recreational or other wilderness purposes of the area and the extent to which the activities may be authorized consistent with maintaining the wilderness character of the area.

  Review previous needs assessments when reauthorizing use to ensure that they remain relevant to current and projected use trends, and update them if necessary.
- When monitoring demonstrates that impacts associated with use may exceed desired conditions, conduct a resource capacity analysis to assess the amount of use and types of activities that may be conducted without detrimental environmental and associated impacts. The resource capacity analysis may be conducted at a programmatic level or at a project level to address specific activities or geographical areas. In analyzing resource capacity, consider:

  a. The applicable land management plan and other applicable programmatic and project decisions.
  b. Inventoried conditions.
  c. Current visitor use and visitor use trends (amount, type, length of stay, and group size).
  d. Correlation of visitor use to plan guidance and inventoried conditions.
  e. The results of management actions, such as vegetation treatments, watershed rehabilitation, and findings from monitoring.

Wilderness Planning

Where there is no estimate of visitor capacity in the units' comprehensive plan, a subsequent wilderness planning process, supplemental to the comprehensive plan, *may* be necessary. Examples of situations that could trigger such additional planning could include deteriorating conditions that will exceed thresholds (standards) or a level of crowding that detracts from the wilderness experience, or as part of a needs assessment and allocation of use for commercial services. In these situations, if changes in management actions are anticipated, a NEPA-compliant planning process may be needed. In other situations, where no significant change in management actions are anticipated, or where it is simply desirable to identify current conditions or establish a baseline, an estimation of capacity may be determined without a lengthy planning process.

Appendix B—Examples

A Complete Example from the Hypothetical Imagination Wilderness

Consider the Imagination Wilderness, which consists of nine major drainages that vary substantially in recreation use and resultant impacts. Consequently, the wilderness has been divided into three distinct zones (using ROS or some similar framework): pristine, primitive, and semi-primitive. Three of the nine drainages are zoned pristine, three are zoned primitive, and three are zoned semi-primitive.

Step 1. Establish Thresholds. Some thresholds were available in the forest plan that has indicators and standards for each of the three zones. Two thresholds from the plan were considered applicable to capacity determination because too much use is likely to violate standards. Those indicators were the maximum number of other groups encountered per day and a reduction in the population of black bears attributable to recreation use. But wilderness managers were also concerned about campsite impacts. Consequently, they decided to also develop thresholds for both the density and condition of campsites. The thresholds applicable for each zone are shown in Table 1.

As noted before, the time, resources, and process of developing thresholds needs to be matched to the level of significance and potential controversy associated with capacity decisions. Where controversy is low, decisions can be made quickly without substantial input from diverse stakeholders, the public, and technical experts. At one extreme, thresholds might be defined in a few minutes, by a single individual, simply on the basis of professional judgment. At the other extreme, where the potential for controversy and the consequences of capacity decisions are high, it might be necessary to invest substantial periods of time in incorporating the input from diverse stakeholders in decisions. Regardless of process, the output is the same.

Step 2. Define Analysis Areas. Each of the drainages was considered a separate analysis area for analysis purposes. Our example is simplified by the fact that entire drainages are in the same zone. If a single drainage had been divided into more than one zone, it would have been necessary to divide the drainage into different analysis areas to reflect the zones.

Step 3. Estimate Capacities for Each Analysis Area. The outcome of this step is the maximum amount of use per unit of time that can be accommodated in each analysis area. In our example, it will be the maximum number of groups per day that can be allowed into each analysis area. Separate tables might be created for the analysis areas in each zone (as illustrated in tables 2-4). This maximum will be determined by the most limiting of the thresholds. Separate estimates must be made for each threshold. If it is suspected that one threshold is likely to be limiting, start with this one. For other thresholds, all that is needed is to conclude that capacity would be higher than would be allowed by the most limiting threshold.

In our example, assume that there are no monitoring data. Managers must use logic and their professional

Table 1. Thresholds (indicators and standards) for each zone.

Indicator	Pristine Zone	Primitive Zone	Semi-primitive Zone
Maximum number of groups encountered per day	0 groups on 90% of days in use season	5 groups on 90% of days in use season	15 groups on 90% of days in use season
Maximum number of campsites per square mile	2	5	10
Maximum number of campsites per square mile with condition class greater than 3	0	1	5
Effect of recreation on black bear populations	No adverse effect	No adverse effect	No more than 10% reduction

Table 2. Capacity estimates (maximum number of groups/day that can enter without exceeding thresholds) for the pristine analysis areas.

	Pristine Analysis Area		
Threshold	**1**	**2**	**3**
0 groups/day on 90% of days	2	2	4
≤ 2 campsites/square mile	Not the limiting factor		
0 campsites with condition class > 3	Not the limiting factor		
No adverse effect on bear populations	Not the limiting factor		
Capacity (entering groups/day)	2	2	4

judgment to estimate how many groups per day could enter the analysis area without violating any of the thresholds. In the pristine analysis areas (table 2), in Analysis Area 1, managers estimate that only two groups/day can enter without it being likely that groups would encounter each other. Considering their efforts to get groups in this area to camp on previously undisturbed sites and to leave no trace of their camp, they estimate that campsite thresholds are unlikely to be violated even if use was greater than two groups/day. In a similar manner, biologists conclude that black bears would also not be adversely impacted at these low levels of use. Consequently, managers conclude that capacity in these areas will be limited by number of encounters. Analysis Area 3 is twice as big as the other areas, so capacity estimates were twice as high.

In the primitive analysis areas (table 3), managers conclude that the limiting factor is a combination of two thresholds. They decide that to make certain that there will be no more than one highly impacted campsite per square mile, they will only allow camping on designated sites, will establish one designated site per square mile, and will manage for a 50% occupancy rate. Because Analysis Areas 4 and 5 have 10 designated campsites, they can accommodate no more than five overnight groups per night. Analysis Area 6, which is twice as large, can accommodate 10 overnight groups per night. This establishes a capacity for overnight users. Day use capacity is limited by encounters. In our example, managers estimate that another 10 day-use groups could enter each day (in addition to the five overnight groups in Analysis Areas 4 and 5 and the 10 overnight groups in Analysis Area 6) before the encounter threshold would likely be violated.

In the semi-primitive analysis areas (table 4), it was decided to limit the number of campsites by requiring people to camp in designated campsites. This makes it possible to accommodate large numbers of overnight groups and not exceed campsite thresholds. The encounter standards were also lax enough to allow many groups. Wildlife biologists estimated that the levels of use that would still not exceed the encounter and campsite thresholds would probably have unacceptable impacts on black bear populations. Consequently, capacity is limited by the black bear threshold. Their best estimate of the maximum number of groups that could

Table 3. Capacity estimates (maximum number of groups/day that can enter without exceeding thresholds) for the primitive analysis areas.

	Primitive Analysis Area		
Threshold	**4**	**5**	**6**
≤ 5 groups/day on 90% of days	15	15	20
≤ 5 campsites/square mile	Not the limiting factor		
≤ 1 campsite/square mile with condition class > 3	5[a]	5[a]	10[a]
No adverse effect on bear populations	Not the limiting factor		
Capacity (entering overnight groups/day)	5	5	10
Capacity (entering day groups/day)	10	10	10

[a]Maximum number of overnight groups.

Table 4. Capacity estimates (maximum number of groups/day that can enter without exceeding thresholds) for the semi-primitive analysis areas.

	Semi-primitive Analysis Area		
Threshold	7	8	9
≤ 15 groups/day on 90% of days	Not the limiting factor		
≤ 10 campsites/square mile	Not the limiting factor		
≤ 5 campsites/square mile with condition class > 3	25[a]	25[a]	40[a]
≤ 10% reduction in bear populations	40	40	60
Capacity (entering groups/day)	40	40	60

[a]Maximum number of overnight groups; there can be an unlimited number of day groups.

enter per day, without reducing bear populations by more than 10%, are 40, 40, and 60 in the three analysis areas. Obviously there is a high degree of uncertainty to such a professional judgment. Hopefully, such an estimate is conservative and can be refined over time with more information and data.

Step 4. Convert and Aggregate Use Measures. The total number of groups that can be allowed to enter per day is simply the sum of the capacities of the nine individual analysis areas—198 groups per day. To display this as an annual capacity, this number could be multiplied by the number of days in the use season. For a three-month use season, capacity could theoretically be as high as about 2000 entering groups. But the only way to accommodate the full capacity of 2000 groups per year, without exceeding thresholds, is to ensure that 198 groups enter each and every day. If it is likely that there are days when capacities will not be reached, capacity estimates must be reduced to account for this. This is similar to the approach described in the ROS handbook to reduce estimates by a factor (PU) related to the ratio between weekday and weekend use.

Capacities, expressed in terms of groups, can be converted to people by multiplying by mean group size (2.7 is typical of many wildernesses). This would suggest that the capacity of Inspiration Wilderness could be as high as 5400 people per year (if use was distributed evenly by day). This could be converted to recreation visitor days (RVDs) by multiplying capacity in people by average length of stay (in hours) and dividing by 12 hours. Average length of stay varies substantially among wildernesses, particularly with variation in the proportion of use that is day use. Recent data from the National Visitor Use Monitoring program suggest that mean length of stay in designated wilderness is about 15 hours. Using this figure, capacity of Inspiration Wilderness could be as high as 6750 RVDs. Again, this assumes that use can be distributed spatially such that use never exceeds capacity in any of the analysis areas.

Variations on Step 3, Estimating Capacities

There are many variations on Step 3 depending on the nature of the thresholds that have been established and the information (common sense, monitoring, research, and so on) that can be used to develop estimates. This makes it impossible to outline a standard method for making such estimates. The example above relied on logic and judgment. Below we outline other examples. If these do not work for your situation, use other estimation procedures. The critical point we are trying to make is that you must take the best available information and use that information in a logical manner to arrive at the best possible estimate of capacity, given available information. The keys are (1) to use whatever information is available and (2) to use it in a logical rather than arbitrary estimation process that draws on professional experience and judgment.

If monitoring data are available, either to develop or refine initial estimates, the process outlined above does not change. But there is a richer source of information available for making estimates. For example, consider the threshold of no more than five encounters per day in the primitive zone. If you have data on use levels and encounter levels and the monitoring data show that encounter levels currently average about 2.5 groups per day (half of the threshold), it would be reasonable to estimate that capacities could be approximately double the current use levels. This estimate may be misleading, however. To double use and stay within capacity, use would have to be distributed evenly across the days and across the trailheads. It is likely that this would require implementation of a permit system. If unwilling to do this, capacity would be lower and would have to be estimated using a more detailed analysis of individual analysis areas and daily use and encounter data. This is an illustration of how capacity is dependent on all the management actions that have been or will be taken.

As an example of a more detailed analysis, consider data that show that encounters are five or less per day on only 80% of days in the 100-day use season (violating the threshold of 90% of days). This suggests that current use exceeds capacity, but by how much? If daily use is arrayed from lowest to highest, unacceptable numbers of encounters typically occur when use exceeds the 80th percentile. For example, suppose that 7000 groups per season enter and that daily use levels range from 0 groups/day to a high of 150 groups/day. Assume that the 80th percentile use level is 100 groups/day (i.e., 80% of days have 100 groups or less). This suggests that there are currently 20 days when use exceeds 100 groups but that, to avoid exceeding capacity, use should exceed 100 groups on only10 days. That is, on 10 of the days when somewhere between 100 and 150 groups enter, only 100 should be allowed to enter. This suggests it might be reasonable to reduce current use by perhaps 25 groups on each of those 10 days. So capacity would be about 6750 (250 groups less than the current use level of 7000). Note, capacity could be maintained at 7000 or even increased if use was simply shifted from high-use days to low-use days.

In contrast, estimates are quite straightforward if thresholds are written in terms of allowable use per unit area. Perhaps black bear researchers estimate that the effect of recreation on bears is likely to be negligible if use density is no more than five persons at one time for every one thousand acres. For a 100,000 acre wilderness, capacity would be 500 people at one time. To derive an annual capacity, this could be multiplied by the length of the use season. If the season is 100 days, capacity would be 50,000 people per year. But this capacity would have to be reduced if use was unevenly distributed among days. For example, if there was four times as much use on weekends as on weekdays, capacity would be 22,500 people per year (50,000 x 0.45).

It is important to remember that this estimate of capacity can only be realized if use is fairly uniformly distributed among the analysis areas in the wilderness. Capacities need to be implemented on an analysis area basis to ensure that no analysis area exceeds the five persons at one time for every one thousand acres threshold.

Appendix C—An Issue-Based Numerical Visitor Capacity

The following guidelines were developed by recreation managers on the Lolo National Forest and staff from the Northern Region office during a workshop on April 6-7, 2010. The purpose of the workshop was to test the method described in an early version of this General Technical Report to assist managers in establishing capacities using available information. The group ran through several existing recreation management challenges on the Lolo NF using the outlined method. The method in the report was found to be useful, but participants suggested a few adjustments to make the process more applicable to specific place-based issues, both in wilderness and non-wilderness areas. The steps include:

- Identify the issue or management question
- Define the analysis area and existing condition
- Review existing guidance for the area and refine the desired condition
- Determine thresholds and the limiting factor
- Determine estimated capacity
- Identify management actions affecting capacity
- Identify additional information needs

Step 1. Identify the issue or management question that can be informed by developing visitor capacity. What is the issue or management question prompting staff to look at the amount or types of uses in an area? There are numerous and diverse issues that may force planners and managers to assess visitor use impacts in an area. Examples include perceived crowding, user conflicts, decline in the quality of hunting, receiving proposals for more or new commercial use, increase in number and/or size of dispersed campsites, overflowing parking lots, and pollution (human waste, litter, water pollution). In all of these cases, an understanding of visitor use in the area will be valuable.

Before jumping into the capacity analysis, it is useful to determine the extent to which a capacity will be helpful to decision-makers. In some cases, information provided by a capacity may not help decision-making, as the issue is not clearly tied to the amount of visitor use in an area. The important question to ask is: will a capacity help resolve the issue or provide useful information for a decision? A few examples where a capacity may not be very informative include: exceeding capacity to administer permits to standard, outfitter camps out of compliance, and illegal ATV use. Clearly identifying the issue or question will ensure that the analysis is focused. See Cole and others (1987) for common problems associated with recreational use.

Step 2. Define analysis areas and the existing condition. What area is impacted by the issue? This is the analysis area. Managers can also begin a capacity study by defining an analysis area, then identifying issues within that area. In other words, steps 1 and 2 can be switched depending on the reasons for developing a capacity. The boundaries of the analysis area can be based on terrain, access, or where certain activities are found. An analysis area should be possible to manage as a single unit and be allocated to one type of management area. For example, in one case study the group divided a large hunting area into drainages. In another example, hydrologic units were used as analysis area boundaries.

Once the analysis area(s) have been defined, provide a thorough description of what is occurring in that area. This should include a description of the types and timing of activities, amount of current commercial use, any signs of resource degradation, user conflicts and perceptions, and possible trends in use. The more accurate the description, the more accurate a capacity study can be. Use as many sources of information as possible to paint a picture of visitor behavior and use levels. Observations, database reports, resource conditions, information on the internet, applicable landscape-level assessments, volunteer registration at trailheads, visitor encounters, and any monitoring data are all excellent resources.

In some cases, once a clearer picture of the existing condition is developed, the issues identified for that area may change. If this is the case, make sure the issue or management question (step 1) is clearly understood before proceeding, as the rest of the process revolves around the issue(s).

Step 3. Review existing guidance for the area and refine the desired condition. Forest plans provide the most important guidance for management actions. In addition, Forest Service manuals and handbooks, forest-wide standards, and landscape-specific standards and guidelines may direct how an area, or a type of use, is to be managed. Other planning products such as travel plans, landscape assessments, and river management plans can also provide place-based recreation guidance to help describe the area's desired condition. In some plans, the Recreation Opportunity Spectrum (ROS) (USDA Forest Service 1982) for a given management area provides direction on the types of recreation opportunities the unit wants to provide.

In the capacity study, you are quantifying use in terms of the desired condition. Thus, there needs to be a clear picture as to what the desired condition for recreation is in that area. In plans, however, the desired condition is often very general and broad to allow for flexibility in implementing the plan. Take this opportunity to refine the desired condition for recreation in the area being analyzed. If the desired condition is left vague, it will be more difficult to complete the capacity and the unit will have a harder time selecting appropriate management actions.

Step 4. Develop threshholds and identify the limiting factor for use in each analysis area. Thresholds, for this process, are the point at which social or biophysical conditions will be unacceptably impacted by visitor use and serve as triggers for action. These are identified through indicators and standards. *Indicators* are the most important attributes of an area most likely to be at risk from high levels of visitor use. Attributes that are unrelated to visitor use or that can be protected without limiting use are not needed for capacity estimates. *Standards* are the maximum acceptable level of impact to the indicator. If these standards are exceeded (the threshold is crossed), different management actions may be necessary to prevent further resource degradation. Along with being directly linked to visitor use impacts, the best thresholds for determining numerical capacities are also quantitative, reliable, sensitive to change, and administratively feasible (see McCool and others 2007). Indicators and standards can be established for social or biophysical resources. For example, the indicator for a hunting area may be an opportunity for solitude for the visitor as described in the ROS class for that area. The standard might be that the visitor encounters no more than three other hunters in one day. Thus, the threshold is encountering three other hunters in one day. Other thresholds may deal with impacts to wildlife, vegetation, campsite occupancy, parking, space at a destination, or other attributes.

The limiting factor is the threshold that allows for the least amount of use. In one example, thresholds were established for encounters, parking spaces, and space for viewing a waterfall. Because visitors expect to see a lot of other people and can spread out along the trail to avoid congestion at the waterfall, the relatively small parking lot was the limiting factor. See the interagency strategy for wilderness monitoring (Landres and others 2008) for examples of indicators designed for wilderness, many of which can be applied to non-wilderness settings as well.

Step 5. Determine estimated capacity for the analysis area. Use the limiting factor to estimate the amount of use an analysis area can sustain. Along with the amount and location of visitor use, capacities should also be based on the type of use and the time when these uses occur. Capacities can be established for all types of use in an area at a given time, or for a single type of use; this should be determined by the issue, the desired condition, and the limiting factor. For instance, if the limiting factor for use in an area is parking lot size, then the capacity would be for all types of uses occuring at the same time, assuming that all visitors use that site for parking. On the other hand, if the limiting factor is number of campsites, then there may be a capacity for camping each night, but day use hiking might be unlimited.

Different capacities may also be established for different types of uses in an analysis area. If there is a need to establish a capacity for an area that includes more than one analysis area (district- or forest-wide), the estimates for each analysis area can be added together, according to the type and season of use. Large scale capacities can help inform programmatic planning efforts.

Step 6. Identify other management actions to manage visitor use impacts. The estimated capacity should be refined based on the potential influence of other planned projects or other management actions in the analysis area, since we are looking at impacts to the resource and not merely the number of people in the analysis area to achieve a defined desired condition. Also, an understanding of capacity can help determine appropriate management actions that need to be implemented. For example, a district is finding degraded conditions at a number of campsites in a backcountry area. They are planning to establish designated campsites along a popular trail to reduce this impact. This may result in a higher or lower estimated capacity for overnight use, depending on how many campsites are designated. Other actions such as increasing trail durability, educational outreach about LNT principles and techniques, increasing parking lots, or restricting certain uses may also have an impact. Cole and others (1987) provide a number of actions to help mitigate common problems associated with recreation use.

Step 7. Identify additional information needs. While developing an estimated capacity, managers may find significant gaps in their understanding of recreational use and impacts in an area. First, clearly define the questions that need to be answered or studied and the types of information that will be useful. How can this information be gathered efficiently? Most likely, other districts or forests have dealt with this same issue and can provide suggestions for actions that worked for them. Receiving input from outfitters and guides, other interested groups, and other individuals is extremely valuable and will help increase awareness and transparency in the capacity analysis process. If use levels are high and there is evidence of user conflicts, public participation is highly recommended, even if the unit is not planning to immediately develop a specific proposed action based on the estimated capacity.

Once actions are implemented regarding visitor use, monitoring is essential to allow the unit to refine the estimated capacity. Evaluate whether the action has resolved the issue or if other issues have arisen in the area. If there are still issues, reassess the estimated capacity and management actions being used. Thus, this process is intended to be cyclical, with each iteration offering a more refined capacity.

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