# Historical Development of Limits of Acceptable Change: Conceptual Clarifications and Possible Extensions

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**Abstract**—The Limits of Acceptable Change (LAC) process was developed to deal with the issue of recreational carrying capacity. For that purpose, the LAC process sought to explicitly define a compromise between resource/visitor experience protection and recreation use goals. The most critical and unique element of the process is the specification of LAC standards that define minimally acceptable conditions. This paper identifies the antecedents of LAC, describes the rationale behind its formulation, and attempts to clarify LAC terminology and concepts. It assesses the extent to which a more generic LAC process might be applied to issues beyond recreation management in wilderness.

In January 1985, "The Limits of Acceptable Change (LAC) System for Wilderness Planning" was published by the Forest Service (Stankey and others 1985). In April 1987, the first application of the LAC process—to the Bob Marshall Wilderness Complex—was documented within a Forest Plan amendment. This report and plan were the culmination of an effort, begun in early 1980, to develop and implement a process for dealing with the issue of recreational carrying capacity in wilderness. The antecedents of this effort extend back at least to the 1930's when managers first stated the need to keep recreation use levels below an area's "carrying capacity" or "saturation point" (Stankey and others 1990). Since 1985, a number of related processes for addressing recreation carrying capacity have been developed—for example, the Carrying Capacity Assessment (Shelby and Heberlein 1986), Visitor Impact Management (Graefe and others 1990), and Visitor Experience and Resource Protection (National Park Service 1993) processes. Since 1985, LAC and these related processes have had a pronounced effect on recreation management planning in the United States (McCoy and others 1995) and, increasingly, around the world. Enthusiasm about these processes has resulted in calls to apply them to a broad spectrum of natural resource management issues (for example, Brunson 1995; Cole 1995).

In this paper we review the earlier work that influenced why and how LAC was developed, as well as the aspects of the process that were most controversial during its formative stages. We present this perspective partially for its historical interest but primarily to help focus attempts to (1) clarify and resolve aspects of the LAC process that remain controversial and (2) assess the extent to which LAC concepts can be applied to a wider range of natural resource management issues.

## Reasons for Developing the LAC Process

During the late 1970's, we (scientists with the Forest Service's Wilderness Management Research Unit, Missoula, MT) were being asked with increasing frequency to help parks and wildernesses develop carrying capacity plans. Two events convinced us that we would shortly be deluged with such requests and that it would be more efficient to develop a process and procedural manual than to continue to deal with each request individually. In 1978, the General Authorities Act (U.S. Public Law 95-625) required each National Park to develop "visitor carrying capacities." In 1979, regulations implementing the 1976 National Forest Management Act (NFMA) specified that each National Forest wilderness would "provide for limiting and distributing visitor use of specific portions in accord with periodic estimates of the maximum levels of use that allow natural processes to operate freely and that do not impair the values for which wildernesses were created" (Federal Register 1979). Because attempts to develop carrying capacities would absorb substantial portions of the resources available for wilderness management, we were also concerned that capacities would be developed in places they were not needed and in ways that were neither productive nor defensible (Washburne 1982). The limitations of the carrying capacity concept were becoming increasingly apparent.

Another inspiration for developing LAC was our concern that recreation use was constantly growing, resulting in increasing impact and other management problems. We were concerned about the incremental nature of human-induced change in wilderness and felt that inadequate attention to management planning was a poor way to protect the investment American society had made in wilderness, through the designation process. We were particularly concerned that problems were expanding into parts of wilderness that had been relatively unused and undisturbed. This led us to attempt to isolate weaknesses in existing wilderness management planning and to devise a process that would overcome many of these weaknesses.

Perhaps our foremost concern with existing wilderness plans was the absence of specific, achievable management

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objectives for wilderness conditions. The descriptions of desired conditions found in most management plans were so general (for example, "maintain natural conditions" and "provide solitude") as to be of no use in distinguishing problem situations, identifying promising management strategies, or evaluating management success. Only when describing desired management actions and programs were plans specific. One of the shared beliefs among those of us who developed LAC was that objectives need to be specific and achievable and that they should describe ends rather than means—conditions rather than management actions.

Other concerns included (1) lack of accountability for quality wilderness management, (2) management programs that appeared arbitrary and capricious, and (3) inadequate knowledge of both existing conditions and trends, a lack made more problematic by the frequent turnover of personnel. Without either objectives or monitoring data, the strength of management was entirely dependent on the perceptiveness and intuition of the individuals charged with wilderness management. Without either continuity of personnel or focused attention from line officers, wilderness management was typically a rudderless ship. Hence, our second shared belief was that wilderness plans should be trackable and traceable. Plans needed to provide accountability, through the specification of explicit and visible objectives that were essentially contracts, with success at meeting objectives evaluated with objective monitoring data.

## Antecedents to the LAC Process

Formal development of the recreational carrying capacity concept began with Wagar's (1964) monograph on the topic. Although primarily hypothetical, Wagar's treatise forecast the two principal conclusions of the empirical research on carrying capacity that followed.

The first conclusion was that different recreationists seek different experiences in wilderness, and the relationship between amount of use and experience quality varies with the experience being sought. Similarly, the relationship between amount of use and environmental quality varies with the degree of environmental change deemed appropriate. Thus, carrying capacity could only be defined within the context of specific management objectives. Moreover, the emphasis of these management objectives should be on outputs—the experiences and environmental conditions desired—not on inputs such as use levels (Stankey and McCool 1984).

The second conclusion was that amount of use is only one of many variables that influence the quality of visitor experiences and environmental conditions. Other use-related variables (mode of travel, group size, behavior, timing of use) and environmental variables also influence quality, as does management. Management strategies can be devised that manipulate each of the variables that affect quality—not just amount of use (Cole and others 1987). Consequently, management actions other than limiting use are an equally and often more effective means of dealing with recreation management problems.

The direction we took in developing LAC, then, was largely determined by our awareness of the conceptual and empirical work on recreational carrying capacity, along with our shared belief in the need for accountable management, based on monitoring data that can be used to assess achievement of specific objectives, defined as ends rather than means. This led us to focus most of our efforts on developing a practical way to write specific objectives.

For this purpose, we again shared a belief in the concept of limits of acceptable change, first articulated by Frissell in 1963. In his masters thesis on campsites in the Boundary Waters Canoe Area, Frissell (1963) concluded that if recreation use is to be allowed, deterioration is inevitable and must be accepted. Even low levels of recreation use will cause some impact. Impact must be accepted, but "a limit should be placed on the amount of change to be tolerated. When a site has reached this predetermined limit of deterioration, steps should be taken to prevent further adverse change."

This "limits of acceptable change" concept was developed further and proposed as an alternative model for making decisions about carrying capacity (Frissell and Stankey 1972). The fundamental approach was to focus management on achieving specific objectives, defined as staying within maximum acceptable deviations from (1) the "natural range of variation" in ecological conditions and (2) a "pristine wilderness experience."

## Core Elements of the LAC Process

Certain elements of the LAC process, as published in 1985, were present at the start of our deliberations and were conceptually noncontroversial; other elements were added along the way or debated extensively. We do not mean to imply that conceptually noncontroversial elements are necessarily easy to implement, however. The core, noncontroversial elements of the LAC process were the development of standards, the assessment of current conditions (inventory/monitoring) in relation to standards, and the formulation and implementation of management prescriptions to bring conditions into compliance with standards. Moreover, we always asserted that standards should refer to outputs rather than inputs. Specifically, they should define maximum acceptable deviations from absolute protection of resources (environmental conditions and visitor experiences).

We believed that the goal of carrying capacity planning was to develop a compromise between resource/visitor experience protection and access to recreational opportunities—goals that are virtually codified in the Wilderness Act and the National Park Service Organic Act. Recreation use has to be allowed, but only to the extent that is consistent with a high degree of resource protection. We also believed that the key to ensuring consistent and defensible compromises lay in formally defining those compromises as measurable, achievable standards.

Implicitly, we adopted one of many potential means of defining a compromise between these conflicting goals. The LAC process involves developing standards for only one of the goals—for protection of resources and the visitor experience but not for access to recreational opportunities. Where compromise is necessary, the goal for which standards are developed is compromised first, until the standard is reached. In the application of LAC to wilderness recreation, for example, resource conditions are compromised before recreation use is restricted—but only until standards are threatened. Thereafter, the other goal is compromised—and there is no limit to the extent it can be compromised. In the recreation application, when the maximum acceptable limit of resource degradation is reached, no more degradation is allowed and recreation use is restricted as much as necessary.

Curiously, we never debated other means of achieving compromise (such as using an iterative process—first compromise one goal a little, then the other, then the first, and so on). We also never questioned for which goal standards should be written. For example, we could have written standards for the extent to which recreation use could be restricted—rather than the extent to which resource and experiential quality could be compromised. This would have led managers to first restrict use—in an attempt to protect quality—but, once the restriction limit was reached, to not allow any further restriction of use, regardless of the implications for resource impact and experience quality. Our shared vision in these regards was probably derived from implicitly embracing the concept proposed by Frissell and Stankey (1972), as well as agency policy and much of the writing about wilderness, which generally expressed the belief that wilderness conditions should provide the "bottom-line"—not recreation use. We were also aware of a similar approach, included in the 1977 amendments to the Clean Air Act (Public Law 95-95), in which air quality was to be maintained by not allowing the violation of "standards," defined as maximum allowable incremental deviations from established baselines for "clean" air.

We conclude, then, that the most unique aspect of the LAC approach (the element that most succinctly distinguishes it from other processes and defines what LAC is) is the method used to define compromise between goals. Compromise is accomplished through the specification of LAC standards, limits of acceptable change—the LAC equivalent of attainable management objectives. Moreover, it is highly desirable that this compromise be developed through a collaborative process in which the resultant decisions reflect the input of numerous stakeholders. To be called LAC, therefore, a process must (1) contain standards that express minimally acceptable conditions, (2) require monitoring capable of determining whether or not standards have been met, and (3) base management prescriptions on evaluations of whether or not standards have been met.

## Elements of LAC That Were Controversial

The elements of LAC that were debated and changed during the developmental process were zoning (the description and allocation of opportunity classes) and the identification and selection of alternatives. Neither of these elements is absolutely critical to the fundamental LAC framework. We knew that zoning was controversial. Ultimately, however, we concluded that zoning was useful in most wilderness situations, particularly as a means of guarding against the incremental degradation of conditions in the more remote and pristine portions of wilderness. Conditions will vary spatially regardless of what management does, and legitimate differences of opinion about acceptable impact levels exist. Therefore, we decided that zoning should be included as an integral part of the LAC process.

Alternatives were an attempt, added relatively late in the developmental process, to increase compatibility between the LAC process and agency land management planning processes. In addition, early versions of the process included a step in which the wilderness was divided into management areas or compartments. Ultimately we decided that this step was unnecessary; managers could add the step if it seemed useful.

There was also substantial debate about terminology. Zoning wilderness, still a controversial subject today (Haas and others 1987), was officially unacceptable in the early 1980's. Consequently, we were forced to use the terminology of opportunity classes—derived from the Recreation Opportunity Spectrum (Clark and Stankey 1979)—rather than zones. This was unfortunate because it gave greater emphasis than we intended to visitor experiences, as opposed to environmental preservation. We also added the term "indicator," well along in the process, to refer to the social or environmental variable for which standards need to be developed. The term was selected to conform with existing planning jargon. The term does not imply that the variable should be an indicator of some other variable of concern, rather than being the variable of concern iteself. Finally, the term "standard" has a different meaning than it has when used in Forest Plans.

Another controversial issue concerned whether standards could be qualitative rather than quantitative. We were unable to resolve this issue definitively. We felt that qualitative standards were vastly inferior when it came to consistently evaluating whether or not standards were violated. Conversely, we recognized that there may be extremely important variables that are impossible to quantify. We ultimately stated that standards should be quantitative wherever possible, but we have no experience in evaluating how well qualitative standards would work.

## Current Controversies and Issues

The preceding discussion is germane to a number of questions about LAC. Most questions about the LAC process itself revolve around indicators and standards—what they represent, what they should include, what should happen if they are violated, and what should not happen when they are not violated. Other questions are concerned with where the concept of desirability fits in the LAC process. Finally, many questions have been raised about the applicability of LAC to a broad range of resource management issues. Many of these issues are discussed in depth in the workshop synthesis papers included in this proceedings (see papers by Cole and McCool). In this paper, we briefly address these questions from the perspective of the intent and shared belief system of those of us who originally developed LAC. This does not imply that alternative formulations are wrong. Alternatives may prove better; however, substantially different formulations might best be considered a different process.

### Indicators and Standards

First, LAC standards are statements of minimally acceptable conditions. They do not define desired conditions, nor do they define unacceptable conditions. We would rather have no campsite impact, no social trailing, and virtually no interparty encounters. This is not possible, however, without restriciting use to an unacceptable degree. What is optimal about the conditions defined by standards is the compromise between opposing objectives. Given the need to

compromise between resource protection and access to recreational opportunities, standards define the *compromise* that we desire—not the *conditions* that we desire.

In wilderness, LAC standards are written for setting attributes that reflect degree of naturalness or that influence experience quality. They are not written for management actions—which are means rather than ends. They also are not written for direct attributes of the experience, because experiences are not subject to direct management control. For example, LAC standards might be written for encounter rates, a setting attribute that is subject to management control and that influences opportunities to achieve solitude (Hammitt and Rutlin 1995). Standards would not be written for solitude achievement itself (Hollenhorst and others 1994), which is determined more by personal characteristics that cannot be controlled by management.

Finally, standards are absolute limits—not just warnings. Violation of standards should not be tolerated. Tolerances can be written into standards, however. For example, encounter standards often incorporate probabilities (such as, no more than one encounter per day on 90 percent of the days during the main use season). This standard allows the one encounter per day condition to be exceeded a few times during the season—perhaps on holidays and popular weekends—without the need to invoke highly restrictive actions.

Conversely, recreation opportunities should not be restricted *to any substantial degree* unless restrictions are necessary to keep conditions within standards. This does not imply that nonrestrictive actions (such as visitor education) should not be taken at any time or that restrictive actions should not be taken when it is clear that conditions are deteriorating and standards will soon be violated if nothing is done. It does imply that managers should not implement highly restrictive actions to maintain conditions that are substantially within standards. The fact that conditions are deteriorating, but still well within standards, is not sufficient cause to restrict use substantially—although recognition of deterioration should be cause for concern and a trigger for less onerous actions. As Cole and McCool (this proceedings) note, it would be useful to explicitly list the sorts of management actions that are relatively nonrestrictive and, therefore, legitimate to implement even if standards are not threatened. A similar list of more restrictive actions would illustrate the types of actions management is committed to implementing as a means of keeping conditions within standards.

## Desirability

Some have suggested that the lack of attention to desired conditions is a shortcoming of LAC. We did not include desired conditions because those desired conditions seemed so self-evident. From the Wilderness Act, conditions in wilderness should ideally include no recreation impact, settings that optimize opportunities for quality primitive experiences, and no restrictions on recreation use. With the benefit of hindsight, we agree that more explicit statements of desired conditions—for all goals, not just those we write standards for—would be a worthwhile addition to the process. These statements would help (1) with the identification of indicators, (2) with the identification and implementation of management strategies, and (3) with guidance for dealing with situations where conditions are better than acceptable but worse than desired (Cole 1995). These could easily be incorporated into the LAC process by including a section on wilderness wide goals—a proposed modification to the process discussed by Cole and McCool (this proceedings).

## A Generic LAC Process

It is impossible to define the range of situations LAC can be applied to without agreement on what the LAC process is. Unfortunately, as we initially developed LAC, we decribed the LAC process entirely within the context and terminology of the issue we were concerned with—the carrying capacity problem. We never explicitly defined the process in terms that were not issue specific. This lack of explicit definition of a generic process becomes a problem when we attempt to assess the range of situations to which LAC can be applied.

Building on an effort first described in Cole (1995), the conceptual core of LAC—stated in generic rather than issue-specific terms, using the recreational carrying capacity issue as an example—is as follows:

1. Agree that two or more goals are in conflict. In the original LAC example, the two goals are to protect wilderness conditions (natural conditions and quality experiences) and to allow recreation use with as little restriction on access and freedom as possible. Other sets of conflicting goals might be allowing livestock grazing versus preserving natural conditions, minimizing property loss from fire versus allowing fire to play its natural role, and keeping air from being polluted versus allowing industrial development.

2. Establish that all goals must be compromised to some extent. LAC—a process for arriving at compromise—is unnecessary in situations where one goal cannot be compromised, such as where no compromise of the integrity of cultural sites will be tolerated. In the original example, both wilderness character and recreation use are compromised to some extent.

3. Decide which conflicting goal will ultimately constrain the other goal. Call this the *ultimate constraining goal*. The other goal is the *initial constraining goal* (because it constrains the first goal, but only initially). In the original LAC process, protection of wilderness character is the ultimate constraining goal, and recreation use is the initial constraining goal. Multiple goals can be compromised simultaneously. The only requirement is that if two or more goals are considered ultimately constraining, either these goals cannot conflict with each other or it must be possible to establish a hierarchy among these goals.

4. Write indicators and LAC standards, as well as monitor the ultimate constraining goals. In our example, this involved writing standards for such wilderness conditions as campsite impacts and visitor encounter rates. No standards are written for degree of restriction to either recreational access or freedom of behavior.

5. Allow the ultimate constraining goal to be compromised by the initial constraining goal until a "bottom line" (the limit of acceptable change) is reached. In our example, recreation use is initially allowed to compromise wilderness

conditions. Some degree of degraded wilderness condition is accepted without imposing strict restrictions on use. Use is not restricted substantially until conditions approach standards. Wilderness conditions are allowed to be degraded, as long as they are not below standard.

6. Finally, compromise the initial constraining goal so the ultimate constraining goal's minimally acceptable condition is never violated. In our example, restrict recreation use as much as needed to keep conditions from falling below standard.

### Applications of LAC Beyond Wilderness Recreation Problems

If this is accepted as the generic LAC process, it suggests that LAC can be applied to any situation where (1) goals are in conflict and all goals must be compromised, (2) a hierarchy of goals exists such that one or more goals can be considered to ultimately constrain the other goals, and (3) it is possible to develop measureable standards. So the process can be applied outside wilderness and even outside protected areas. It can be applied to issues other than recreation, such as grazing, mining, water flow regulation, and emission of pollutants, as long as there is a conflict between use and resource impacts.

LAC is of little value, however, if there is no conflict between goals. If there is no conflict, one should strive for desired conditions rather than acceptable conditions. Similarly, it is of little value if managers are unwilling to compromise one of the goals. Simply strive for desired conditions for the uncompromisable goal. LAC is also unworkable—as currently formulated—if both goals are considered equally important. Finally, LAC will not work for issues where desirable or acceptable future conditions are a chaotic, moving target. This is a critical limitation where the concern is ecosystem change, where we consider natural change to be desirable, and where impacts are pervasive, leaving no undisturbed reference areas.

This discussion leads us to conclude that the LAC process—as originally formulated—can be applied much more widely than it has been. However, there are limits to its usefulness. It is not even useful for dealing with all recreation management issues in wilderness, let alone all wilderness management issues. This suggests that we should view LAC as a framework that is embedded within the larger comprehensive planning process—a framework that is extremely useful for dealing with problems such as carrying capacity that are characterised by conflict and the need for compromise.

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## References

Brunson, Mark W. 1995. The changing role of wilderness in ecosystem management. International Journal of Wilderness. 1(1): 12-15.

Clark, Roger N.; Stankey, George H. 1979. The recreation opportunity spectrum: a framework for planning, management, and research. Gen. Tech. Rep. PNW-98. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 32 p.

Cole, David N. 1995. Defining fire and wilderness objectives: applying limits of acceptable change. In: Brown, James K.; Mutch, Robert W.; Spoon, Charles W.; Wakimoto, Ronald H., tech. coords. Proceedings: symposium on fire in wilderness and park management; 1993 March 30-April 1; Missoula, MT. Gen. Tech. Rep. INT-GTR-320. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station: 42-47.

Cole, David N.; Petersen, Margaret E.; Lucas, Robert C. 1987. Managing wilderness recreation use: common problems and potential solutions. Gen. Tech. Rep. INT-GTR-230. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 60 p.

Frissell, Sidney S., Jr. 1963. Recreational use of campsites in the Quetico-Superior canoe country. St. Paul, MN: University of Minnesota. 66 p. Thesis.

Frissell, Sidney S., Jr.; Stankey, George H. 1972. Wilderness environmental quality: search for social and ecological harmony. In: Proceedings of the 1972 national convention; 1972 October 1-5; Hot Springs, AR. Washington, DC: Society of American Foresters: 170-183.

Graefe, Alan R.; Kuss, Fred R.; Vaske, Jerry J. 1990. Visitor impact management: a planning framework. Washington, DC: National Parks and Conservation Association. 105 p.

Haas, Glenn E.; Driver, B.L.; Brown, Perry J.; Lucas, Robert C. 1987. Wilderness management zoning. Journal of Forestry. 85: 17-21.

Hammitt, William E.; Rutlin, William M. 1995. Use encounter standards and curves for achieved privacy in wilderness. Leisure Sciences. 17: 245-262.

Hollenhorst, Steve; Frank, Ernest, III; Watson, Alan. 1994. The capacity to be alone: wilderness solitude and growth of the self. In: Hendee, John C.; Martin, Vance G., eds. International wilderness allocation, management, and research. Fort Collins, CO: International Wilderness Leadership Foundation: 234-239.

McCoy, K. Lynn; Krumpe, Edwin E.; Allen, Stewart. 1995. Limits of acceptable change: evaluating implementation by the U.S. Forest Service. International Journal of Wilderness. 1(2): 18-22.

National Park Service. 1993. Special report—VERP: a process for addressing visitor carrying capacity in the National Park System. [Unpublished report]. Denver, CO: U.S. Department of the Interior, National Park Service, Denver Service Center. 20 p.

Shelby, Bo; Heberlein, Thomas A. 1986. Carrying capacity in recreation settings. Corvallis, OR: Oregon State University Press. 164p.

Stankey, George H.; Cole, David N.; Lucas, Robert C.; Petersen, Margaret E.; Frissell, Sidney S. 1985. The limits of acceptable change (LAC) system for wilderness planning. Gen. Tech. Rep. INT-176. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 37 p.

Stankey, George H.; McCool, Stephen F. 1984. Carrying capacity in recreational settings: evolution, appraisal, and application. Leisure Sciences. 6: 453-473.

Stankey, George H.; McCool, Stephen F.; Stokes, Gerald L. 1990. Managing for appropriate wilderness conditions: the carrying capacity issue. In: Hendee, John C.; Stankey, George H.; Lucas, Robert C. 1990. Wilderness management, 2d ed. Golden, CO: Fulcrum Publishing: 215-239.

Wagar, J. Alan. 1964. The carrying capacity of wild lands for recreation. Forest Science Monograph 7. Washington, DC: Society of American Foresters. 24 p.

Washburne, Randel F. 1982. Wilderness recreational carrying capacity: are numbers necessary? Journal of Forestry. 80: 726-728.