Chapter 11: A Systems Thinking Approach for Thinking and Reflecting on Sustainable Recreation on Public Lands in an Era of Complexity, Uncertainty, and Change

Stephen F. McCool and Jeffrey D. Kline[1]

> Systems thinking is a discipline for seeing wholes. It is a framework for seeing interrelationships rather than things, for seeing patterns of change rather than static snapshots…Today, systems thinking is needed more than ever because we are becoming overwhelmed by complexity.—
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> —Peter Senge, *The Fifth Discipline* (1990)

Purpose

The socioeconomic and biophysical contexts in which natural resource management takes place have been rapidly changing in recent decades. These changing contexts are bringing new complexity to the management of natural resources generally, and the question of how best to manage outdoor recreation specifically. We propose that this greater complexity is best addressed by research using a systems thinking approach able to account for the combined influence and interactions among relevant social, political, economic, and biophysical factors that influence recreation uses and values associated with public lands. We feel that this shift in research framing would offer greater opportunities for discovering new insights regarding people-landscape relationships that are central to outdoor recreation. This in turn would lead to greater potential for developing outdoor recreation policy and management approaches best suited to changing socioeconomic and biophysical contexts.

Problem Statement

Public lands are under more pressure than ever to provide ecosystem goods and services, including recreation opportunities, to a growing, ethnically diverse, and increasing population characterized by income inequality. These increasing demands coincide with generally declining land management capacity (e.g., budgets, staff, technical capital) of public land management agencies, increasing expenditures for fire management, and evolving relationships between people and their public lands generally.

[1] **Stephen F. McCool** is a professor emeritus, University of Montana, Wildland Recreation Management, 32 Campus Drive, Missoula, MT 59812; **Jeffrey D. Kline** is a research forester, U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, 3200 SW Jefferson Way, Corvallis, OR 97731.

Decisions about how much public land to allocate to different uses, which uses should have priority, how much of what ecosystem goods and services public lands managers should strive to provide, how to manage public access, and what kinds of recreation opportunities to provide and where to provide them are among the most persistent questions that public land managers and planners face. These are questions for which there are few simple answers. In fact, we suggest that often these questions cannot be answered in conventional ways, but rather they fall within a realm of what are called “wicked” problems or “messy situations” (Rittel and Weber 1973). Wicked problems involve situations in which cause-and-effect relationships are not clear and there are disagreements over management goals, which makes understanding of problems difficult. For example, temporal delays between causes, such as a redistribution of visitor use, may lead to affecting opportunities for solitude, but the delay that occurs may make it difficult to link causes with effects.

Wicked problems arise because the social, political, economic, and biophysical contexts of natural resource management have dramatically changed from the late 20th century, particularly when there are disputes about values. For example, while more people have moved their homes to the wildland-urban interface, making fire management much more difficult, and demands for recreation have grown and diversified, the public land base supplying recreation opportunities has largely remained fixed. Confusion or disagreement about resource management goals abound; uncertainty about the efficacy of management tools to address changing needs has increased; and the legacy of management institutions seems poorly equipped to address challenges that require interdisciplinary thinking and action.

These challenges arise from two principal sources. First, past approaches to recreation decisionmaking tend to narrowly bind analyses of resource management, in which recreation is embedded, thus limiting the consideration of important values and interactions that are not easily measured. These narrowly prescribed approaches often do not consider interactions and larger scale emergent properties, thereby leading to incomplete analyses, such as an area being viewed as a timber-producing one when its chief value is recreation. These biases can result in a false perception that an analysis used to support recreation decisionmaking is complete. Moreover, although recreation is often the most important value of U.S. public lands, valid measurements of its financial, health, and aesthetic benefits may be left out of the management process.

Second, these challenges arise because of “volatility, uncertainty, complexity, and change” (VUCA)[2] resulting from complex biophysical and socioeconomic processes occurring simultaneously at a variety of spatial and temporal scales. To

[2] This acronym was first used in the 1990s by the U.S. Army to describe the situation in the Balkan region, in which the Army was engaged.

some extent, VUCA conditions have existed for a long time in natural resources, but the dominant paradigm of decisionmaking, built upon rational-comprehensive planning, assumed that they did not. These same forces present new decisionmaking challenges to public lands managers. For example, decision processes need to be more inclusive of constituencies and focus on fostering trust and a sense of ownership while also building consensus (see discussion of "eudomonic" values in Blahna et al. 2020). Meeting these challenges calls on managers to find ways to efficiently and equitably manage public lands to meet growing public demands. We believe that this requires the development of conceptual frameworks and knowledge that acknowledge and account for current biophysical and socioeconomic complexity as well as institutional barriers, and that foster effective ways to use these frameworks and deliver this knowledge to public lands managers.

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These challenges suggest a need for the research community to identify ways to address the demands and opportunities that public land managers currently face. Prevailing paradigms about recreation and its management are based on assumptions about the world and perspectives that may not be as useful as they have been in the past. We believe that prevailing paradigms may need to be modified or replaced by paradigms of planning, management, and science more suited to the complex and temperamental world in which public land management now takes place. We propose that a systems-thinking approach to research and management will be better able to respond to challenges and opportunities that managers currently face and would best advance our understanding of recreation and its management on public lands.

Dimensions of the Problem

Whether from the viewpoint of a planner, manager, or visitor, relationships between public lands and people vary across space and time. Visitor expectations change, often quickly, or sometimes are seemingly static, depending upon the context and such other factors as information technology, changing visitor characteristics, print and social media, and so on. Also changing in an increasingly diverse population are the types of connections that people have or would like to have with their public lands. Aging of the population and internal migration are shifting demands for the many different activities in which people engage, and these changes cannot always be well anticipated. Managers and planners, acting in their roles as decisionmakers, are influenced substantially by the rules and regulations under which they operate and their perception of the circumstances of a given issue, problem, or opportunity before them. More fundamentally, managers and planners also are influenced by their own world views (Kohl and McCool 2016). We rarely explicitly recognize the influence of such personal characteristics and how they affect individual behavior.

Because of dramatic changes in the context in which natural resource management takes place, long-held assumptions often are no longer adequate or suitable for guiding management and policy affecting the future. Just as likely is for social and ecological change to lead to unexpected consequences or "surprises." Failure to adequately anticipate social and ecological change often leads to planning processes, management behaviors, and programs that either do not work or have unintended consequences (Allen and Gould 1986, Tallis and Polasky 2009). Imagine a public use plan that limits use in one area, only to see it rise in another. Such shortcomings arguably can arise from adherence to conceptual models of natural resource management and research that are inadequate for addressing the complexity and dynamics inherent in relationships between people and the natural resources being managed. As we consider the 21st century management context, our previous conceptual models of natural resource management and research appear to have favored linearly oriented systems of causality, within a context also of loosely coupled cause-effect relationships that often resulted in the misunderstanding or miscasting of key public land management problems and their broader contexts (Cilliers et al. 2013, Lachapelle et al. 2003). Resilience may be a goal of management of a system. Resilience is "a measure of the persistence of systems and of their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables" (Holling 1973). Resilience, then, as a goal functions at the systems level, and thus requires an understanding of the parts of a system and the relationship among its parts. More resilient systems can respond to disturbances emanating from larger systems, such as a landscape-level fire, in which case the system returns to its natural ability to respond from the fire. A resilient community can respond to a larger scale disturbance, such as a corporate board deciding to close a wood processing plant. The community would have excellent problem-solving skills and be able to lay out a path forward and retain its characteristics as a viable community.

For example, developing management plans based on conventional approaches, such as rational comprehensive planning, procedural orientations, and limiting public engagement to a few places in decisionmaking processes, have led to distrust, lack of implementation, and, in some cases, outright public opposition. Conventionally, values and uses for which explicit measurements, such as cultural and spiritual values, and some nonmarket values including nonuse values, may not be adequately represented in plans, resulting in suboptimal land use allocations. Although new requirements mandating that federal agencies now consider ecosystem services when evaluating management plans and other proposed actions attempt to ensure that these types of values are addressed, it remains uncertain whether such requirements will result in more meaningful analyses (Kline et al. 2013). National forest plans often have lacked detailed data on recreation use levels and the specific types of experiences that visitors desire, for example. Incomplete understanding of social-ecological systems has led to surprises involving increased impacts from management actions designed to reduce impacts.

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Social-ecological systems generally involve many interacting components and processes, with interactions occurring nonlinearly and at differing spatial and temporal scales and scopes. This complexity in natural resource issues calls for scientific inquiry focused on systems as a whole rather than their individual parts. Complex systems include emergent system properties that preclude understanding through examination of their parts. Thus, for example, studying the characteristics of any given individual will not necessarily help managers understand how much impact on a recreation resource that individual has and how it might be managed. Because emergence is a property of the system, examining the complex system by examining its individual components (such as an individual user or management rule or action) fails to account for the system's properties (e.g., Cilliers et al. 2013). Systems also can be loosely coupled, such that causes do not directly and immediately lead to effects, and effects may have multiple causes, can be nonlinear, and can be asymmetric in that small changes in one variable may lead to large changes in another.

Barriers and Challenges

Applying a systems thinking approach (a lens through which we can look) to natural resource management and recreation would involve challenges. First, moving to systems thinking is a change in paradigm (or conceptual model) for both research and management. Changing paradigms can be difficult, as it requires not only a change in how we assume the world "works," but also in the language we use to describe it, and the processes by which we manage. There will be people who do not want to change paradigms, simply because it is difficult, and because they believe the way they have been managing has been successful. As Sterman (2002: 513) noted, a sort of policy resistance develops, thus he affirmed "What prevents us from overcoming policy resistance is not a lack of resources, technical knowledge, or a genuine commitment to change. What thwarts us is our lack of a meaningful systems thinking capability." These barriers are applicable to both scientists and managers, as paradigm shifts require both groups to think significantly different than in the past.

For example, a concept about which there are varying perceptions regarding its usefulness in recreation management is carrying capacity. Although it has been the focus of numerous studies, to date no inherent carrying capacity for recreation has ever been proposed for a given area. That said, much of what has been learned about visitor experiences and biophysical impacts has been done so by attempting to establish carrying capacities. Many observers now feel that carrying capacity may be too reductionist and therefore a too simplistic view of recreation to be of value to management (e.g., McCool and Lime 2001). In its implementation in management contexts, analysts have often failed to consider that perceptions of carrying capacity among visitors (and managers) likely vary by individuals, as do the fundamental relationships between visitors (and managers) and their perceived impacts (Hammitt et al. 2015).

Implementing systems thinking approaches in natural resource management contexts is not without its own set of challenges, but guidelines for implementing such approaches are beginning to emerge.

Also, institutions such as the Forest Service that are charged with managing public lands typically are organized by specialties (e.g., recreation, wilderness, wildlife, watershed). These specialties can develop into "silos" (see fig. 5.2 in chapter 5), which isolate discipline-specific analyses from one another, and ultimately can lead to different specialties competing with each other for resources or attention. We feel that the use of systems thinking can be one approach to linking and ultimately removing such silos, because it calls for meaningful input from each discipline, and requires and brings about disciplinary integration to the process of resource management (Cerveny et al. 2019). Implementing systems thinking approaches in natural resource management contexts is not without its own set of challenges, but guidelines for implementing such approaches are beginning to emerge (Kline et al. 2017).

The second barrier is communicating and educating researchers and managers about what systems thinking involves and how it can help to resolve natural resource management issues by better addressing complexity. Systems thinking is not a scientific discipline in its own right, but rather an interdisciplinary approach that focuses on underlying relationships, actions, feedback loops, delays, and other factors. Systems thinking is an alternative to the largely disciplinary-centric analytical model of knowledge that had prevailed in modern education systems (Kay and Foster 1999). There has not been much research on how to teach systems thinking and what pedagogical approaches and skills work and which do not (Atwater et al. 2008). How do we teach about such questions as "what is a system?" How does systems thinking help us understand and function in a context of complexity? When is systems thinking appropriate? In addition, systems thinking may be influenced by the specific place and context confronting a planner, manager, or scientist because human experiences are embedded within them.

Related to communication and education will be the necessity for public land management agencies to overcome constraints on funding, time, and the availability of required expertise to actually implement the approach in management and planning contexts. Such institutional constraints, including declining staffing capacity, are noted as key challenges to implementing more integrated socioeconomic-ecological analysis to support public lands management in the United States (Kline et al. 2013: 151–152). Systems thinking, as a paradigm change, may lead to improved analysis and decisionmaking by improving understanding of how public land systems work.

Systems Thinking: A New Conceptual Approach

Applied in a public lands and recreation context, social-ecological systems thinking would explicitly recognize reciprocal connections and relationships between people and the landscapes they occupy, visit, and use. This would help managers and scientists to emphasize the system (e.g., a landscape providing high-quality recreation opportunities through the coordinated efforts of managers and their partners) and its function, rather than focus on specific components of the system (e.g., specific users or specific resources) via the lens of specific specialties or disciplines.

To use systems thinking, managers would need to consider for what purpose a recreation system exists, identify its components, describe the relationships among components, and indicate where characteristics about specific relationships create problems (or conflict) within the system. A relatively small-scale simple system whose purpose is to manage campsite impacts in a subalpine environment is displayed in figure 11.1. In this system, only management and campsites are shown as components, but such systems, even at the small scale, may have other components as well.

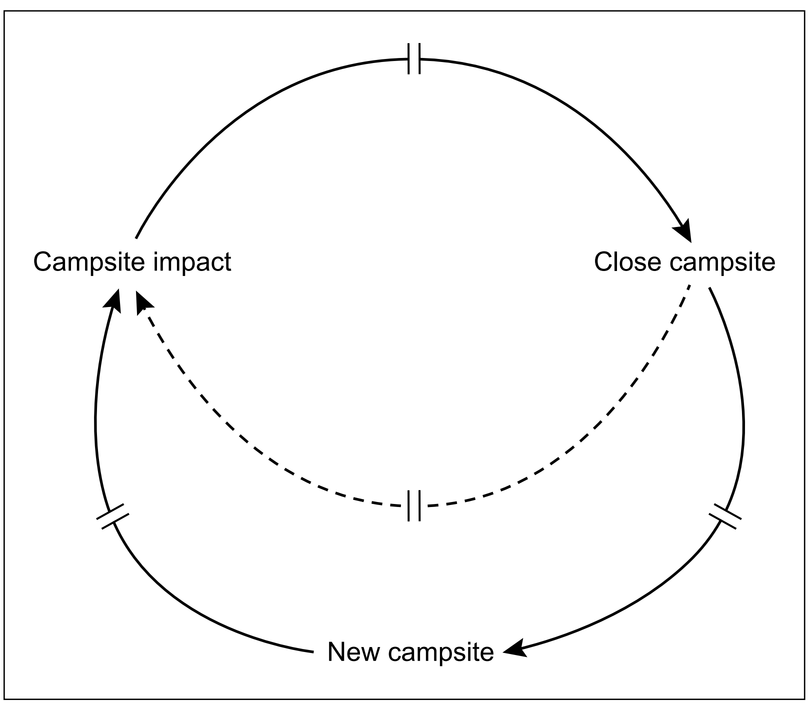

Figure 11.1—Causal loop diagram that shows how closing campsites in an alpine environment can lead to greater overall impact. When designated campsites are closed, visitors establish new campsites, causing additional impacts. These new impacts occur quickly, while recovery of closed campsites can take a long time, thus producing a total impact that is larger than the initial one. The diagram demonstrates the power of systems thinking in a complex system; this kind of situation is referred to as a "fixes that fail system."

A crucial point in applying systems thinking is bounding the system or describing the system components relevant to a particular purpose or decision.

A system has a specific function or purpose. That function may also be described as a goal. In figure 11.1, the goal may be returning the system to its preexisting condition and ecological functioning. In some social-ecological systems, the goal may be to distribute benefits from those systems in an equitable way.

A crucial point in applying systems thinking is bounding the system or describing the system components relevant to a particular purpose or decision. Recreation systems then will come at different spatial or functional scales, each embedded in the system that occurs at a larger scale. A larger scale system describing recreation policy, for example, may have the following components: suppliers (services, settings); policymakers, and visitors.

Each of these components is affected by decisions made by others within the system as well as "external" factors (which are simply components of systems existing at larger scales). For example, if policymakers reduce a given national forest's budget, it can lead to reductions in the supply of recreation opportunities, which in turn can affect visitors who formerly enjoyed an affected site. Of course, there are delays embedded in the system because these variables are loosely coupled in the short run. Alternatively, an increase in demand by visitors eventually affects the number of supplier services (e.g., tour operators or outfitters), which affects demand for settings, which then provides feedback to policymakers.

A more detailed example is a mid-scale depiction of a sustainable recreation system (fig. 11.2). It shows several linkages among components with their relationships and a few management actions. Of course, other authors may describe this system differently, but the point is if we take a systems perspective, we will increase our understanding of how we can better supply opportunities and better deliver the public land manager's components. In a very real sense, however, this system, in terms of its components, is similar to Fischer's (2018) description of forest landscape components of feedbacks, time lags, and cross-scale interactions.

Such systems are merely models or depictions that simplify a complex system. Their primary use is not prediction but understanding. As we gain understanding of a system, we add more components and connections. These systems, again, are mental models of how we see the world, how we see one thing connected to another. Such models are only descriptions; they do not imply a particular goal. However, systems generally have a function, and when they do, they become normative in the sense of a goal or function because they reflect value judgments. For example, the goal may be resilience, equity, or production of a certain ecosystem service. If a goal is equity, for example, we would design interventions in a system to achieve that. Figure 11.2 is an early attempt to depict a system whose function is sustainability, which is achieved by building a system that is resilient in the face of outside disturbance. In figure 11.2, the dashed lines show interventions in the system to move toward sustainability.

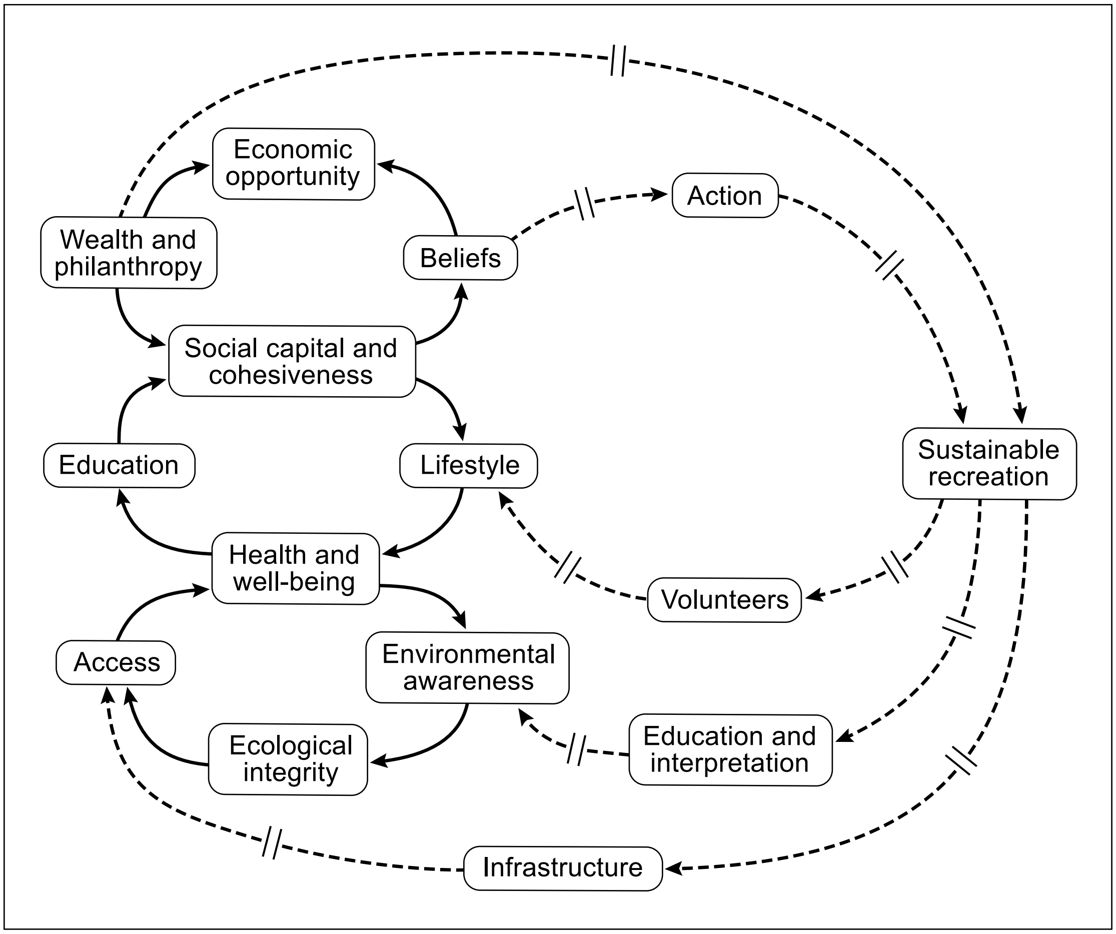

Figure 11.2—In this potential description of a sustainable recreation system, solid lines show the possible relationships among attributes that the literature commonly ascribes to sustainable recreation, and dashed lines show a few management actions and where they intersect. Gaps in the arrows indicate delays between one variable and another, while arrows show the direction of impact or influence. This relatively simple diagram is displayed only to represent how systems thinking is implemented through causal loop diagrams. Solid lines show the system, whereas dashed lines show potential interventions. Of course, the dashed lines in a real sense are part of the system.

Compelling Questions

Ideally, we feel that a shift to systems thinking as a research approach would enable greater discovery and more useful insights about the ways in which people connect to landscapes and how we might manage those connections. The very idea of "connections"—mentioned here and in the chapter 1—certainly imply a systems approach.

Key challenges to implementing a systems approach include:

1. Defining the relevant social-ecological system of interest in different contexts and different purposes when addressing issues regarding public lands management and recreation, including key human-biophysical connections and relationships.

2. Gaining useful knowledge about a relevant system and leverage points where managers have opportunities to influence the system and identify what work will be needed to use that knowledge to address issues.
3. Developing an understanding of the spatial and temporal relationships among system parts, including the nature and timing of various causes and effects.
4. Creating effective means for meeting challenges and taking advantage of opportunities in management contexts that are complex and uncertain.
5. Creating knowledge about the socioeconomic and ecological resilience of specific public lands recreation-based tourism systems, their vulnerabilities to various disturbances, and ways of retaining acceptable development trajectories.
6. Gaining an understanding of how to teach the importance of viewing the world as complex systems and how to use systems thinking as a way to function in complexity.
7. Overcoming analytical and institutional barriers to implementation.

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