Monitoring and Management of Visitor Flows in Recreational and Protected Areas
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Modelling Visitor Flow from the Visitor Perspective: The Psychology of Landscape Navigation

Terry C. Daniel

Department of Psychology and School for Renewable Natural Resources
University of Arizona, Tucson, AZ 85718, USA
Email: tdaniel@U.Arizona.edu

Abstract: This paper reviews basic issues underlying the monitoring and modeling of the movements of visitors in large-scale natural parks and recreation areas. Modeling of "visitor flow" is related to research and methods in associated fields, including environmental preference, environmental values/attitudes and wayfinding. Relevant psychophysiological and neurological research and theory is also reviewed to reveal the fundamental basis of dissociations between verbal reports and actions. It is argued that traditional verbal survey methods cannot in principle provide an adequate basis for models of human landscape navigation.

The need for "visitor management" at the world's major natural parks and protected areas is obvious to everyone. Certainly those charged with the management of such areas recognize that the "human dimension" is at once the most potent and the most problematic of the forces with which they must contend. The physical and biological forces of wind, fire, flood, insects and drought can be overwhelming and catastrophic, but natural systems have evolved in the context of just such disturbances, and generally adapt to them rather well. The onslaught of increasing multitudes of adoring human tourists, recreationists and seasonal residents, while perhaps not as dramatic as a hurricane or a flood, has proven much more relentless. Natural systems have not had the millennia required to evolve suitable adaptive responses to this very recent and sometimes erratic disturbance agent.

How can natural parks and protected areas be saved from being loved to death?

One obvious answer is to close the gate and keep people out altogether. But this policy is likely to be very unpopular when it is the public that is being kept out of public lands, and public support (financial and political) is essential for providing the resources required to maintain and protect these areas. Moreover, there are substantial benefits to individuals and to society of having people visit and recreate in these special natural places, benefits that can not be readily replaced by other experiences and activities. But unbridled access could degrade or destroy the natural environmental settings that are essential to these desired experiences. Clearly, as generations of park managers and the participants at this conference realize, a balance between public use and environmental protection is needed.

In the face of increasing populations and increasing demands on natural parks and protected areas, protection of threatened plants and wildlife species, sensitive ecosystems, and biodiversity on the planet justifies limitations of human access and use. The question is, how much limitation? In recent years policy has tended toward *providing acceptable (satisfactory) visitor benefits, so long as it does not threaten the long-term sustainability of sensitive environmental/ecological resources*. Visitor numbers are limited by the estimated "carrying capacity" of the park environment. The visitor is placed in the position of being guilty until proven innocent—that is, excluded unless it can be shown that his/her admission would not harm the environment. In contrast, a policy that leans more in the direction of meeting visitor wants and needs might be *providing the maximum visitor benefits consistent with conserving the sustainability of essential environmental/ecological resources and systems*. By this policy the visitor is innocent until proven guilty—that is, admitted unless it can be shown that doing so would injure the environment.

There is considerable room for reasoned debate about where on the environmental protection-visitor satisfaction dimension public park management policies should stand in the 21st Century, both in general terms and on a place by place basis. Wherever one may chose to draw that line, however, rational policy development and implementation requires some fundamental information about visitors, about their needs and wants from the park environment, and about the impacts of their visits/uses on that environment. Following the well established lead of the physical and biological dimensions of park management, these human dimension/visitor management information needs should be met through the application of careful and rigorous science. This must entail a thorough investigation and analysis of past visitor-environment interactions, an appropriately detailed inventory of current visitor-environment conditions, and the development of scientific theory and models sufficient to make precise and reliable predictions of the outcomes of future visitor-environment interactions for a range of relevant park policy and management scenarios. The conveners and participants at this conference are demonstrably dedicated to just such a cause.

There is, of course, already a considerable history of recreation and tourism research that can, and has, advised visitor management policies. The best developed areas of park visitor science have focused on the visitor. Much is known about visitor demographics, perceptions, attitudes, expectations and beliefs, reflecting the interests and perspectives of the social scientists that have been drawn to this field of research. There is also considerable knowledge about visitors' general satisfaction with park visits, and growing understanding of how that is affected by various biological, social and managerial features of parks and recreation areas. Less is known about how specific park features affect particular individual and social benefits of visitation, and less still is known about specific and cumulative impacts of individual and collective visitor activities on park environments, especially where complex ecosystem disturbances are of concern.

In short, while there is considerable knowledge about park visitors and park environments in general, and about some important interactions, much less is known about specific visitor-environment relationships. Visitor demand for the experiences and activities that natural parks and protected areas provide continues to increase. At the same time, the supply and resilience of quality park environments remains mostly fixed or declines. In this context, information about specific visitor-environment relationships will be essential to achieving balanced park management policies that are biologically and socially sustainable. For example, general carrying capacity concepts (number of visitors per park) are not sufficient for attaining balanced allocations of visitor access to parks and protected areas. Many heavily used parks already apply spatially and temporally specific limits on visitation, restricting specific uses in designated areas at particular times to control both environmental impacts (as on nesting birds) and social conflicts (as between snowmobiles and cross country skiers). When successfully applied, such temporal-spatial zoning can enable parks to meet increasing visitor demand while at the same time reducing adverse impacts on sensitive environmental resources and enhancing the quality of visitor experience. But this level of specificity in park management demands the support of more precise and more detailed park visitor science. Gross tallies of visitors and general characterizations of visitor-environment interactions will not be sufficient. Meeting these needs will require answers to a chain of W questions that are near to the heart of this conference on Visitor Flow.

WHO/WHERE/WHEN/WHAT?

Who is Where When, doing What? Answering this question correctly and with sufficient precision is essential to effective park visitor management. Knowing W/W/W/W, between and within parks and protected areas is the most basic data required for the development of a valid and useful park visitor science, and for more effective visitor management. W/W/W/W data is prerequisite to understanding visitor-environment relationships (from quality of visitor experience/satisfaction to visitor impacts on the park environment) and visitor-visitor relationships (from solitude to crowding). Knowing W/W/W/W now and in the past provides the building blocks for models and theories that enable predicting changes in W/W/W/W in the future, and for understanding *Why* those changes occur. Yet surprisingly few parks and protected areas can answer the W/W/W/W question with any precision or certainty in either the past or the present, and far fewer have any scientific basis for predicting the W/W/W/W implications for the alternative futures among which they must be prepared to choose.

Answering W/W/W/W is the goal of the Visitor Flow monitoring and modeling efforts represented at this conference. The papers presented here represent some of the world's most imaginative and innovative approaches to this question. Advanced monitoring and remote sensing, geo-referencing and geographic information processing, and computer simulation and modeling technologies have been enlisted, adapted and combined to locate visitors in time and space and to track their movements and actions with unprecedented precision. But this has not been the traditional approach to visitor research. More often, when managers and investigators wanted to answer the W/W/W/W question (or, more correctly, subsets of that question), they have just asked, and in more or less sophisticated ways, written down what visitors said. That is, the vast majority of W/W/W/W data has been collected using one form or another of the verbal survey.

Verbal surveys have been and will continue to be an essential tool for park visitor science. Many important questions can most efficiently and effectively be addressed by posing questions and obtaining answers in words. Some important questions can only be addressed this way. Moreover, in some venues (especially politics and public relations), what people say can be more important than what they do. But the verbal survey has become so ubiquitous that "human dimensions" research (and much of social science in general) has acquired a reputation as "paper and pencil science" (with commensurate expectations about equipment budgets). However, for answering the more basic W/W/W/W question for actual visitors in actual natural (park) environments, verbal surveys may be particularly inappropriate.

The empirical data base indicating that people do not always do what they say or say what they do, is large and venerable. The dissociation between verbally expressed "attitudes" and overt behavior is legendary in the social and behavioral sciences (Nisbitt and Wilson, 1977). Indeed, this observation has achieved recognition at the most basic levels in the colloquial distinction between "talk'n the talk" and "walk'n the walk."

Park visitor/recreator research is not immune from this general pattern of dissociation between what people say and what they do. The mismatch between words and deeds can at times be due to genuine failures of perception and/or memory (visitors don't always accurately know where they are or remember later what they did there), and at times it may derive from intentional deceit (e.g., "we did not go into the restricted area"). Recent psychophysiological and neurological research, however, provides evidence that word-action dissociations may be characteristic of humans, a result of the fundamental "modular" architecture of the mind/brain. Little or none of this basic research has involved visitors in natural parks or protected areas, of course. Indeed much of the work has used animals or human subjects manifesting specific neurological disorders. Healthy human subjects have been studied, but mostly in very constrained laboratory situations designed to identify the neurological substrates of perceptions, thoughts, feelings and actions. Still, this research potentially has important implications for determining the necessary and sufficient conditions for answering the W/W/W/W question that is basic to Visitor Flow. The brief (and superficial) review of research below argues for shifting park visitor research beyond verbal surveys to include greater use of more direct spatially and temporally precise monitoring and modeling of visitor behavior, i.e. to increase emphasis on Visitor Flow. At the very least, this research provides support for expanding park visitor-research equipment budgets beyond paper and pencils.

WORDS VERSUS ENVIRONMENTS

It is not uncommon for assessments of public responses to different environments or environmental conditions to be based on verbal descriptions of (or just labels for) those environments or conditions. Is there any evidence that such verbal descriptions are capable of supporting valid assessments? That is, are answers to such questions consistent with responses based on direct experience of the actual environments (or conditions) the questions intend to represent?

Environmental preference--Few studies have directly compared environmental preferences based on verbal descriptions with preferences based on direct experience (Daniel & Ittelson, 1981, provides an indirect comparison). In fact the environmental perception/environmental preference literature seems to have bypassed this question entirely on the way to asking whether photographs are a sufficient representation for obtaining valid responses to such questions (Daniel & Boster, 1976; Shutleworth, 1980; Sheppard, 1989; Stamps, 1990; Zube, et al, 1987).

For many relevant environmental preference questions, the weight of the evidence is that obtaining valid answers requires highly realistic visual representations (e.g., photographs) of the environments/conditions at issue. Even then, important limitations have been noted. For example, environments with significant dynamic elements (e.g., flowing rivers) may require dynamic (animated/motion) representations (Brown & Daniel, 1991). If sensory modalities other than vision are important in the environments (or conditions) being assessed, additional features (e.g., the sound of flowing water) may need to be added to the representation as well (Hetherington, et al 1994). More recent environmental representation studies have focused on the sufficiency of emerging computer-graphic/computer-simulation techniques. Environmental preferences (and other perceptual judgments) have been studied for computer representations ranging from still video images/montages to interactive virtual reality systems (Bergen et al, 1995; Bishop & Leahy, 1989; Daniel & Meitner, 2001; Oh, 1994; Orland, 1993; Vining & Orland, 1989). The indications are that very high levels of color and texture fidelity (viz the environments represented) are needed to achieve valid responses.

Wayfinding-- Going beyond assessments of passive environmental experiences to address questions about navigation through, and destination selection within the three-dimensional environment (issues much closer to Visitor Flow), the environmental representation standards would appear to increase. Verbal versus "pictorial" representations have been studied directly in the context of wayfinding, especially studies comparing the effectiveness of verbally presented directions (route descriptions) versus maps as aides to learning and navigating spaces. Studies have compared verbal and map-directed route navigation in real and simulated environments, with the general finding that both can lead to successful performance (e.g., Evans & Pezdek, 1980; Franklin & Tversky, 1990; Thorndike & Hayes-Roth, 1982). However, map representations are generally superior in supporting configural knowledge, as indicated by superior performance when the navigator is required to go off the primary route to avoid a roadblock, to get back on track after a navigational error, to find a successful shortcut, or to reverse the route.

Of course, both maps and verbal descriptions are abstractions of the environment, and learning routes by either of these means is not the same process, and often does not produce the same outcomes as learning by direct exploration of the environment.

This difference, between secondary (from maps and words) and primary (direct experience) spatial learning (Presson & Hazelrigg, 1984), affects knowledge of the space and performance on a number of navigation-related tasks. Learning from both verbal and map representations, for example, tends to distort actual spaces toward a more Cartesian reference system and to shift perception/memory of oblique intersections and curved paths toward right angles and straight paths (e.g., Evans & Pezdek, 1980).

The great majority of outdoor way-finding studies have been conducted in built environments (especially in and around college campuses), where streets (sidewalks) provide primary routes and buildings and other architectural features are the principal landmarks. Fewer studies address navigation in natural environmental settings where trails or passage ways would be less regular and changes in topography and/or vegetation would be principal landmarks. An exception is the small set of studies on “orienteering” (e.g., Malinowski & Gellespie, 2001), but subjects in these studies typically have access to verbal descriptions, maps and compasses, and they are trained in the use of navigational aides.

A number of investigators have noted the potential advantages of using virtual environments to study wayfinding (e.g., Bishop, 2001; Rohrmann & Bishop, in press). Computer simulation/VR research, like the preference research discussed above, has apparently by-passed the question of whether verbal descriptions would suffice to represent the virtual environments with which their subjects interact. As in the preference literature, texture and color fidelity/realism in environmental representations have been found (or assumed) to be important. In addition, studies using “walk-through” (or "drive-through") simulations have been especially concerned about motion parameters, both the depiction of movement of the navigator/viewer through the environment and the motion of dynamic elements in the environments represented. Indications are that, in addition to rather high levels of form and color realism, realistic movement/motion is also necessary for valid environmental responses. In particular, interactive capabilities must be sufficient to allow the subject to explore visually, and in depth, the environment represented (Bishop, 2001; Bishop et al, 2001). Moreover, efforts are increasing to develop more natural response options for VR systems. Based more on intuitions than on actual empirical study, verbal responses, and even mouse or joy stick systems, have apparently been judged inadequate to support valid conclusions about human navigation in three-dimensional environments.

Psychophysiological-neurological research— There is wide spread belief that exposure to natural environments, in either active or passive pursuits, is psychologically and physically beneficial, especially for highly stressed, urbanized humans (e.g., Parsons, 1991; Ulrich, 1983). Consistent with this belief, it has been shown that viewing natural environments (directly, in photographs or in video) can produce rapid and substantial physiological recovery from stress (e.g., Hartig et al, 1991; Parsons et al, 1998). As for the environmental preference research described above, there do not appear to be any studies that have directly investigated whether verbal descriptions (read or heard) of these environments would have similar effects. A recent review, however, suggests that concern about environmental representation in this context has instead focused on whether even high quality visual representations (photographs, video tapes and high-realism computer simulations) are sufficient to support the restoration effects of direct environmental experience (Parsons & Hartig, 2001).

There is long-standing evidence that visual/perceptual and verbal processing systems may be supported by somewhat independent brain/neurological systems in humans (e.g., Gazzaniga, 1985). Perhaps the most popular version of this distinction has been the notion that the left and right hemispheres of the brain are differentially specialized for verbal (left hemisphere, for right handed people) and visual/perceptual (right hemisphere, for right handed persons) processing. Fascinating studies with “split brain” subjects (persons whose left and right hemispheres have been separated by accidents or as a surgical treatment for severe epilepsy, for example) have revealed astonishing differences in the capabilities of the two sides of the brain (e.g., Gazzaniga, 1984; Sperry, 1968). For example, words presented only to the left side of the visual field (and thus only activating the right side of the brain in split brain subjects) can neither be read nor (in the case of instructions for action) responded to appropriately (such as selecting the named object from a set of objects). In contrast, when pictures of objects are exposed in the left visual field the subject can not name the object, but can accurately select the depicted object with the left hand (the hand primarily controlled by the right hemisphere). In normal (intact) brains stimulation from both sides of the visual field is neurologically simultaneously transmitted to both hemispheres, but careful experiments have revealed that the separation in verbal versus visual/perceptual function persists, and has important implications for normal cognition and behavior.

Studies of the neurological substrates of spatial learning and navigation in three-dimensional environments also indicate that only rather high-realism environmental representations are sufficient to produce neurological activation patterns that are similar to those that would be expected to occur in actual environmental encounters. For example, brain scans of subjects learning relatively abstract virtual mazes or towns differ from those of subjects learning from richer, more realistically depicted environments, and it is the latter representations that produce patterns of neural activity most consistent with those expected for direct spatial learning (Parsons & Hartig, 2001). One possible counter example cited by Parsons and Hartig was a study of experienced London taxi drivers who were instructed to imagine driving familiar routes through the city. Brain scans of the drivers showed patterns of neural activity substantially similar to those expected for navigation in actual environments. Whether novice drivers less familiar with the environment in question would produce similar results is not known.

The simple two-hemisphere, visual-versus-verbal dichotomy is no longer held, as recent work has indicated considerably more complex patterns of separation and sharing of verbal and perceptual and other functions between the hemispheres. Perhaps more importantly, neurological research has identified a much larger number of autonomous or semi-autonomous anatomical/functional distinctions. One such distinction that may be significant for understanding aspects of Visitor Flow is the separation of neurological systems for perception-for-representation (as for encoding objects into memory or for verbally describing a perceived object) versus perception-for-action (as for avoiding a collision or for grasping an object).

WORDS VERSUS ACTIONS

In some circumstances asking people verbally to report where they have been and what they did there may be sufficient. But there are many circumstances where this would not be an appropriate procedure. For an obvious example, while lost persons do exhibit consistent and predictable navigational patterns (Malinkowski & Gillespie, 2001), it would seem on the face of it to be inappropriate to ask them where they have been. Young children are quite capable of navigating though complex environments, but they are unlikely to have the verbal skills to describe sufficiently where they have gone/would go or how they would get there. In fact, there is some evidence that young children may only be able to indicate the extent of their spatial understanding through responses that are basically similar to actual navigation. In one study (Lehnung, et al 2001) preschool children performed significantly below older elementary school children on a spatial learning task when configural knowledge was assessed by moving a compass-like pointer to indicate the direction of a learned landmark (not in sight). However, when the same children were allowed to indicate the direction by orienting their body and pointing with an extended arm, the young children preformed as well as the older children. This finding is consistent with the fact that implied spatial learning and navigational ability for adult subjects can depend considerably on the tasks/responses used to assess that ability (e.g., Kitchin, 1996).

Saying versus doing the "right" thing--There are many contexts in which verbal reports and actions are inconsistent. Dissociations between self-reports of attitudes and behavioral intentions versus behavior have been the subject of a large number of psychological and social experiments. Studies of health promoting/protecting behaviors are one important example where stated intentions versus actions inconsistencies are notorious, especially with respect to diet, exercise, smoking and unprotected sexual behavior. In the environmental domain pervasive discrepancies have been reported between self-reports and actions regarding energy conservation and recycling (e.g., Ebreo & Vining, 1994; Corral-Verdugo, 1997). In the Corral-Verdugo study if was found that self reports of recycling were associated with reported agreement with conventional beliefs about the value of conservation and recycling practices, but self reports were not significantly correlated with behaviorally assessed personal motivations or competencies required for recycling behaviors. In contrast, recycling behavior (confirmed by direct observations) for the same respondents depended upon personal motivations and competencies, but was independent of expressed beliefs about the value of conservation and recycling.

It is tempting to attribute the above discrepancies between words and actions to insincere subjects, i.e., subjects strategically saying what they believe the experimenter (and society more generally) wants to hear. Such "task demand" effects are very likely important in many situations characteristic of verbal attitude surveys. But there is evidence that similar dissociations between words and actions may be much more fundamental.

Environmental affordances--No hiker would be surprised that people routinely overestimate the steepness of a hill they are about to climb, especially when burdened by a backpack. What may be more surprising is the finding that such exaggerations, consistently found in verbal reports, are not found when people indicate estimated steepness by their actions. For example, when people estimate the steepness of a hill by adjusting an unseen platform with their hand, the exaggeration goes away and slope estimates are much more accurate (e.g., Bhalla & Proffitt, 1997; Crème & Proffitt, 1998; Proffitt, et al 1995). A related experiment (Wraga, et al 2000) used an environmental-scale representation of the Muller-Lyer illusion, in which a line segment extending between two circles is consistently judged to be shorter than it is. When this illusion was arranged so that the line (between the circles) extended in front of the observer as a "path," verbal estimates of the length of the path showed the expected underestimation. When subjects were blindfolded and asked to walk to the end of the path, however, the bias in length estimation did not occur. These findings are consistent with the view that mental representations of environmental objects that support explicit memory or verbal reports are anatomically and functionally separate from the implicit representations that guide actions toward those objects (Milner & Goodale, 1995).

Psychophysiological and neurological bases—Consider the following observation: a woman is shown two objects, one a tall thin vertical rectangle and the other a much shorter-wider cube. When asked about the objects, she is unable to consistently tell the experimenter whether the two objects are the same or different. On the other hand, when asked to reach out and pick up one of the objects, she does so quickly and with ease. Further, video tape recordings of her action reveals that both the orientation and the extent (width) of her grasp were appropriately adjusted to fit the object being picked up well before her hand came in contact with the object (Milner & Goodale, 1995).

The behavior in the study described above is, of course, not normal. The subject in the experiment suffers from a particular neurological disorder caused by brain injury. But a large body of related studies with both brain damaged and normal subjects has lead psychologists and neuroscientists to make important distinctions between the processes of cognition and action. The perceptual and cognitive processes for representing objects for the purposes of remembering them and/or reporting about them versus the processes that direct actions toward the same objects appear to be associated with distinct and substantially independent underlying neurological systems in the brain. As the studies by Proffitt and his associates described above reveal, such dissociations between words and actions are not restricted to people with brain damage. Indeed, such word-action dissociations are very likely characteristic of many environmental perceptions and judgments that underlie the W/W/W/W questions that are central to understanding Visitor Flow.

IMPLICATIONS FOR VISITOR FLOW

The research outlined above indicates that it is very unlikely that verbal descriptions can provide valid environmental representations for the study of Visitor Flow. Indications are that for assessing visitor's aesthetic and other environmental preferences, only high fidelity, realistic environmental representations will suffice. For questions regarding visitor's navigation through the environment, representational standards are likely to be even higher, including high fidelity representations of movement parameters (for both the visitor and dynamic environmental components) and high levels of interactivity to support active exploration of the environments represented. The pervasive dissociations between words and actions that have generally plagued verbal surveys of attitudes, beliefs and intentions are increasingly believed to be a reflection of the fundamental architecture of the human mind/brain. Thus, verbal reports alone are unlikely ever to provide a valid basis for ascertaining visitor's preferences for and/or reactions to environmental conditions in parks and protected areas. At a minimum, the research outlined above strongly affirms the need for thorough empirical confirmation of the validity of any study that purports to answer the W/W/W/W questions that are most basic to understanding Visitor Flow. That is, it must be demonstrated that answers to W/W/W/W questions based on the environmental representations used and the responses obtained in the assessment are consistent with W/W/W/W answers for actual visitors in actual parks. Of course, making this comparison requires information about the actual behavior of visitors in actual parks and protected areas--that is information about Vistor Flow.

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