

COGNITIVE MAPPING: AN APPLICATION FOR TRAIL MANAGEMENT

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Abstract

Outdoor recreation managers and planners need to use effective and efficient methods to monitor environmental impacts and degradation in areas under their jurisdiction. Traditional methods used to accomplish these tasks generally rely on managerial assessments or other techniques that are monitored over time. These methods generally focus on the resource itself, not the visitor to the resource, and are usually implemented after impacts have become evident. One method that may allow recreation managers and planners an earlier opportunity at intervention is to assess the perceptions of resource visitors through the use of cognitive mapping methodology. This paper explores the use of cognitive mapping methodology to assess hikers' perceptions of trails and trail conditions on the island of Oahu, Hawaii. Visitors to established trail systems on Oahu were randomly intercepted and asked to participate in a survey that employed cognitive mapping methodology in conjunction with more traditional survey methods. Specifically, respondents were asked to mark on maps of Oahu the hiking trails that they perceived to be the most popular, the perceived trail conditions / impacts on trails, and to indicate the variables that were associated with their own satisfaction levels. This study suggests that cognitive mapping can be used, in addition to more established methods, as an outdoor recreation management tool.

1.0 Introduction

This paper explores the use of cognitive mapping as a means of gathering data related to recreational use patterns (RUP) and impacts on hiking trail systems on the Island of Oahu, Hawaii. Further, it suggests ways that such data might be used by managers to mitigate

recreational impacts that may occur from those RUP's. Recreational use is destroying and disrupting the biological diversity and site amenities of many recreation areas in Hawaii. Subsequently, it is important for managers to use methods that allow for the measurement of recreational impacts. Data of this type can then be used to help maintain the integrity of a given resource. Most traditional recreational impact studies focus on visitors / users after they have visited a recreation resource area, or rely on managerial judgment that is based on data gathered from techniques such as milacre plots or photo file inventories. Unfortunately, this information is not necessarily conducive to designing management and maintenance programs to mitigate impact until the damage has already occurred. Another method of gathering data related to impacts is to have users identify popular areas and conditions using cognitive mapping techniques. This data provides a spatial map of current recreation use, the most significant biophysical attractors, and an approximate number of visitations to these areas.

The hiking trails on the island of Oahu are considered a major asset in terms of tourism and leisure opportunities for resident and visitor populations (Lankford et al. 1994). The Hawaiian words, *Na Ala Hele*, mean "hiking trails," or literally, "trails for walking." This system of trails is prevalent on all the Hawaiian islands. Many of the trail systems encompass shoreline and mountain trails built and used by the old Hawaiians. Unique to this system is the presence of many *makahas* (water circulation channels from the ocean or fresh water sources) which allow hikers to cool off in the arid regions of the islands. In addition, many of the trails connect various parts of the island's parks, open spaces, and beaches.

As a consequence, the State Department of Business and Economic Development promotes these trail systems as an "eco-tourism" resource. Unfortunately, the State Division of Forestry & Wildlife employs only one specialist to manage the trail systems on each of the islands. Consequently, the management and monitoring of the trail system is inadequate. This study was designed to help the Wildlife Trail and Access System managers make decisions concerning existing trail conditions in areas that are being used frequently. Secondly, the study identified general characteristics of hikers for use in the development of eco-tourism management strategies.

1.1 Cognitive Mapping

Cognitive mapping alludes to an individual's ability to construct a mental representation of the geographical environment (Blades et al. 1999). This representation can be formed in more than one way. For example, an individual may cognitively form a mental representation through direct experience with the environment. In this process an individual visits an area and gradually builds up a knowledge base of places and routes in that environment. Jacob and Luloff (1995) term this process as "existential experience." Individuals may also develop cognitive maps through indirect means. Examples would include assimilating geographical information from verbal descriptions (personal communication), written descriptions (guide books, etc.), and graphic materials (maps, etc.). Despite the means used to construct these cognitive maps, the end result is a compendium of the larger environment that may include information and knowledge of areas and distances not actually visited or experienced. According to Gilmartin (1985), cognitive maps have the potential to significantly impact an individual's behavior, beliefs, and attitudes regarding places.

Cognitive mapping also speaks to an individual's sense of place. As noted by Downs and Stea (1977), sense of place relates to a broad based awareness of a geographical place and its attributes. This sense of place is often widely held by the local population or users of a particular area. Jacob and Luloff (1995) suggest that these individuals may form cognitive maps that serve as representations of the spatial environment. These representations serve to index assorted reference information related to a particular environment. These representations, or cognitive maps, are considered accurate in that they serve as: (a) a means for an individual to share information with others; (b) help an individual navigate between places; and (c) may serve as a means of recall allowing an individual to recollect important information about a specific geographical area.

The application of cognitive mapping procedures to the study of recreation and tourism activities has been limited (Britton 1979; Fridgen 1987; Guy et al. 1990; Jacob & Luloff 1995; Pearce 1981; Walmsley & Jenkins 1992). Yet as noted by Downs and Stea (1977) and Fridgen (1987) recreation and cognitive maps are inseparable. This is due to the connection between cognitive mapping and spatial behavior. Spatial behavior refers to patterns

of movement that can be characterized by its origins, distances, destinations, directions, and frequencies of occurrence. In an outdoor recreation context for example, an individual is constantly making decisions about places to visit and how to get there. The tourism and recreation industry therefore works hard to produce marketing materials that will manipulate and favorably influence an individual's cognitive representation of place. All forms of recreation and travel have some form of environmental cognition because people must orient, traverse, and locate recreation destinations and attractions. Cognitive mapping allows recreation resource managers the opportunity to identify where users perceive the best recreation areas are located. It is important to understand these perceptions in order to manage intensive use areas appropriately in terms of maintenance, supervision, budgeting, and planning.

As noted earlier cognitive mapping has been used to study recreation and tourism related issues. Fridgen (1987) used cognitive mapping to help research individual's perceptions of tourism regions in the state of Michigan. Using a random traveler intercept methodology, Fridgen surveyed travelers that had stopped at Travel Information Centers in Michigan. Respondents were asked to indicate on a map which areas of Michigan they perceived to be recreation and tourism regions. Data from the survey were collapsed into a Tourism Location Score. These scores were then used to compare tourism locations and establish which areas of the state were most popular. Fridgen's findings indicated that most travelers rated coastal areas as being most popular and were most likely to provide excellent tourism and recreation opportunities.

In a study related to tourism issues, Jacob and Luloff (1995) used cognitive mapping to research residents' perceptions of rural areas in the state of Pennsylvania. Using a total design method mail survey (Dillman 1978), the researchers asked respondents to indicate on a blank map of Pennsylvania those areas they perceived to be most rural. Results indicated that most respondents could indicate rural areas on the map. There were however differences with respect to the population density of the respondents' place of residence. Urban respondents reported a larger percent of rural area than did those who lived in less populated areas. The authors also noted the incongruities between so called "objective" (road) and "subjective" (tourism promotion) maps. Discussed

was the Amish Country located in Lancaster County, Pennsylvania. Long marketed as a rural “eden,” this area is one of the most popular tourist destinations in Pennsylvania. This county benefits from its rural image despite having a population that exceeds 400,000. This example shows that cognitive maps and imagery can be a powerful marketing tool for tourism based agencies.

Walmsley and Jenkins (1992) used cognitive mapping to research tourists attitudes and behaviors in Coffs Harbour Australia. The researchers were interested in how tourists experience “environmental learning” (or understanding) about an areas new and unfamiliar attributes. They believed that an understanding of this process would be of value to those concerned with the promotion and commercial viability of tourist attractions. Respondents were selected at random and asked to complete a sketch map of the Coffs Harbour area. Respondents were also asked to complete a questionnaire designed to elicit information about other factors that might influence their cognitive mapping experience or perceptions. Walmsley and Jenkins concluded that cognitive maps were a useful means of exploring how tourists come to know the environment of a resort area. They found that environmental learning occurs quickly and is influenced by a number of variables. Specifically they found that length of stay prior to the mapping activity and being the driver of a motor vehicle (as opposed to being a passenger) positively impacted the quality of the cognitive maps. Individuals from urban areas were also more likely to produce a quality map than were those from rural areas. It is believed that individuals who are familiar with complex urban environments are better at interpreting new environments.

1.2 Cognitive Mapping Analysis Issues and Methods

The analysis of cognitive maps can present problems. As noted by Walmsley and Jenkins (1992), every cognitive map is somewhat idiosyncratic as each contains perceptions of information that are of particular significance to the maps author. The end result then is the potential for a series of maps with a high degree of variability. This is due to the fact that each map is an individual’s attempt to externalize a cognitive image. Although there is no way to ascertain how well each map represents its creator’s cognitive imagery, the research suggests that such maps do provide valuable data into the ways that individuals develop environmental knowledge (Downs & Stea 1977). The technique used by most

researchers for this purpose is to analyze cognitive maps in terms of Lynch’s (1960) typology of map features. This approach filters out idiosyncratic elements by focusing on the main items recorded. Maps are then analyzed in the aggregate to bring out the generality and quantity of recorded items (landmarks, paths, topographical features, etc.).

2.0 Methods of Present Study

The following research questions were proposed for this study: (a) which areas of Oahu are perceived as the most popular hiking areas?; (b) are hikers primarily drawn to popular accessible areas?; (c) does a relationship exist between familiarity and use levels with the trails on Oahu and cognitive maps of the hiking resources?; and (d) once cognitive mapping information is collected, what factors can be identified with visitor satisfaction to a particular trail?

Cognitive maps were prepared by gridding the Island of Oahu into distinct hiking zones (see Map 1). These zones took into consideration existing geographic regions, climatic conditions, landscape features, marine resources, and recreation sites. The grids allowed respondents to indicate primary hiking sites and the resulting composite maps allowed the researchers to identify high impact areas. In cooperation with the State Division of Forestry, and Wildlife Trail and Access System managers, researchers collected data at specified trail heads around the island (four trailheads, which included leeward, windward, northshore and southshore). Random sites, days, times, and respondents were chosen for data collection. Surveys were collected from 100 hikers (N=100, of which 25 surveys were collected at each of the trailheads).

Respondents were asked to answer various questions and mark maps which addressed the objectives of the study. In addition socio-demographic information and data related to the management and use of the areas were collected. Following the methods of Fridgen (1987), respondents were asked to indicate the top three hiking zones on the map (by circling the three most important recreational hiking trails on the island; and then indicate which zone was best for their own recreational hiking (by placing an X in the circle of their choice). Subsequently a recreation hiking location score (RHLS) was calculated for various hiking locations on the island of Oahu as follows:

Table 1.—Recreation Hiking Location Score Indicating Most Popular Hiking Trails and Respondent’s Ratings of Single Best Trail and Most Frequently Visited Trail as Validation of Cognitive Mapping

Area of Island	Recreation Hiking Location Score (RHLS)	Single Best Trail (%) As Validation	Most Frequently Visited (%) As Validation
Honolulu (urban)	38.8	39	49
Koolaupoko (windward, south)	20.6	9	9
Koolauloa (windward, north)	19.0	12	8
Waianae (leeward, western)	12.6	6	3
Waialua (north shore)	12.2	4	1
Ewa/Pearl City (leeward)	12.0	10	8

A = A tally of circles for each part of the island was made to represent the three most important hiking areas on the island;

B = A tally of partial circles for each part of the island was made to account for overlap between boundaries/zones on the map; and

C= A tally of X’s (representing their own “best” hiking trail)

As a result of this formula, the calculation of the RHLS was: $RHLS = (.4A + .4C + .2B)$. Therefore, each respondents cognitive mapping was worth one point, with .4 points given to full circles, .4 points to the X’s which represented their best/favorite hiking area; and .2 points for the partial circles (the researchers determined which zones these partial circles would fall). This RHLS score allowed researchers to determine which areas of the island had the most relative use. In addition respondents were asked to indicate their own most frequently used hiking trail and to indicate the single best hiking trail on the island. Results from these two questions were used to validate the RHLS procedure.

3.0 Findings

Analysis of the sample indicated that males comprised 62% of the sample, while females represented 38%. Almost one third (27%) of the hikers had graduate degrees and third (34%) had four year degrees. Residents of Oahu comprised 64% of the sample, while tourists

comprised 28%. Residents of neighboring islands comprised the remaining 8% of respondents who completed the cognitive mapping task.

Results indicate that the cognitive mapping and resulting recreation hiking location scores (RHLS) helped to identify the most heavily impacted hiking areas on the island of Oahu. Honolulu does receive the largest impact in terms of users to its extensive trail systems on the mountain side (mauka) of the urban area. The windward south (Koolaupoko) and windward north (Koolauloa) were the next most popular hiking spots (see Table 1).

Analysis of the questions used to validate the RLS scores verified that these three areas were the most popular hiking destinations on the island. These findings also indicate that the Honolulu trail system is the most popular hiking area on Oahu. This is not surprising given that 68% of the island’s population lives in Honolulu. This finding suggests that hikers are primarily attracted to accessible hiking areas. The findings also indicate there is some relationship between the visitation and perception of the island trail systems and the recreational hiking areas as noted on the cognitive maps. For example, when examining the respondents (grouped by area of island according to the map responses) by the “trail they most visited/best trail” all the indicated they were at least somewhat familiar with the hiking trails on the island. There were no significant differences observed by these

respondent groups. Pearson correlation coefficients were generated to determine which variables were related to overall satisfaction of the respondents. Satisfaction with that day of hiking was significantly correlated ($p=.05$) with: (a) condition of the trail ($r=.52$); (b) ability of other hikers ($r=.45$); (c) damage caused by overuse ($r=.59$); and (d) the need for a reservation system in high use areas ($r=.59$).

A one-way ANOVA was used to identify specific issues (5 = added great satisfaction, 1= detracted greatly from satisfaction) for each area of Oahu that was "most visited/best trail" by the respondents. The hikers to the trail systems indicated a significant difference ($p=.05$) with respect to parking issues. Specifically, visitors to Koolaupoko ($M = 4.11$) and Ewa / Pearl City ($M = 4$) trail systems indicated that availability of parking added greatly to their hiking satisfaction, which differed significantly from visitors to the other areas. The presence of litter negatively impacted visitors to all trail systems. Finally, with the exception of visitors to Koolaupoko, respondents in all areas felt that the existing trail systems were being damaged by overuse.

4.0 Discussion of the Use of Cognitive Mapping for Assessing Trail Use

The cognitive mapping process outlined in this study appears to have usefulness in identifying popular and potentially impacted hiking areas on the island of Oahu. The findings also indicate that self reported familiarity with the existing trail systems, current visitations, and recreational use patterns can help validate the findings of the cognitive mapping process (Table 1).

Not surprisingly it appears that hiking trail systems adjacent to urban areas receive the most use and account for the most perceived impacts. More importantly, respondents indicated that these areas were overused, littered, and should be managed through some type of reservation system. Finally, the findings relative to satisfaction with hiking are important in that appropriate management action can be implemented before both residents and tourists become disenchanted with hiking on Oahu. Hiking is an important aspect of the State of Hawaii's eco-tourism promotion.

It is expected that information gathered using a cognitive mapping methodology will assist recreation managers in managing trail resources under their jurisdiction. By

identifying high impact sites, adjustments can be made to current management, maintenance, and law enforcement activities. This process can then take place before further environmental degradation occurs in areas that are not currently given priority. Refinement of the cognitive mapping procedures will enable future researchers to use the technique for recreation and tourism management and planning.

4.1 Implications for Professional Practice

It is important to note that cognitive mapping is useful in survey research studies designed to assist the recreation resource manager. No attempt is being made to suggest that cognitive mapping should replace any other monitoring technique or research methodology. Rather, it is suggested that cognitive mapping be used to supplement or strengthen existing monitoring efforts. The strength of the technique is that it allows the resource manager an opportunity to identify locations and areas (spatial aspects) of potential impact and high use from the perception of the resource visitor. High scores on the RHLS may suggest attachment to a trail or system of trails. Moore and Graefe (1994) noted that managers need to be aware that visitors attachment to areas may be an important factor to take into consideration during the area planning process. They suggested that understanding place attachment (of which the RHLS may be one minor indicator) is important if managers are to be able to effectively maximize public benefits. In fact, when public hearings are proposed or considered relative to management actions on the trail systems, the trail managers on the Island of Oahu may have an idea of the issues, viewpoints, and behaviors of the trails users by site or area due to the data provided by the RHLS. In fact, Lloyd and Steinke (1986), and Raitz and Ulack (1981) argued in support of this statement in that cognitive maps and images should be similar for groups that share similar knowledge, beliefs, and experiences about places.

Cognitive mapping methodology may also prove useful in monitoring recreational user conflicts. It is important for land managers to be aware of the issues and differing goal orientations of hikers and other trail users. Ruddell and Hendricks (1995) noted that land managers and trail users are increasingly concerned about conflicts associated with the popularity of mountain biking. In Hawaii, there have been many instances of hiker and mountain bike conflicts on the trails. Some studies suggest that

maintenance problems and lowered hiker satisfaction with the trail systems in Hawaii are increasing (Lankford and Knowles-Lankford, 1993; Lankford, Kipling, & Mood, 1994; Lankford, Silva, Kowalski, 1996). Given the survey data and identification of popular hiking areas, Ruddell and Hendricks suggested that an educational system that identifies rules of etiquette associated with conflict be used, rather than enforcing prohibitive codes. Moore and Scott (1995) recommended that targeted educational efforts designed to expose users to the rationale / purposes of different activities may be effective in reducing conflicts on suburban trails. Cognitive mapping may allow the trail managers to identify the exact trails where these conflicts are emerging. In addition, the trail manager should integrate behavioral data with the cognitive maps to better understand specialization, goal orientation of users, perceived satisfaction and conflicts. Hase et al. (1996) noted that specialization can be a useful indicator for understanding motivations, perceived conflicts and management preferences.

According to Freundschuh and Kitchin (1999) cognitive mapping has evolved into a rich multi-disciplinary field, with a broad range of topical interests, in which geography is a key component. Through this collaborative process cognitive mapping research has provided insights into many theoretical issues concerning how individuals learn, comprehend, and behave in geographic space. Cognitive mapping research also provides for real world spatial applications. These include the development of search and rescue technology, map design, implementation of geographic information systems, and the development of mobility and navigation aids for visually impaired people (Jackson & Kitchin 1998). Kitchin (1997) noted that cognitive mapping research has theoretical utility in understanding spatial decision making, especially as it relates to way finding ability, migration choices, consumer behavior, and recreation decisions and behaviors.

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