A REVIEW OF CARRYING CAPACITY AND A FIELD STUDY OF PARK MANAGERS' TECHNIQUES TO MINIMIZE THE IMPACTS OF RECREATION USE AND OVERUSE ON SOILS RESOURCES

SPECIAL PROBLEM

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ABSTRACT

A REVIEW OF CARRYING CAPACITY AND A FIELD STUDY OF PARK MANAGERS' TECHNIQUES TO MINIMIZE THE IMPACTS OF RECREATION USE AND OVERUSE ON SOILS RESOURCES

The purpose of this study was to investigate if and how carrying capacity is determined by park managers at various parks visited during the summer and fall of 2005. The study further investigated how park resources such as soils are impacted when carrying capacity is reached or exceeded, and examined the maintenance and management techniques used by park managers to lessen impacts of recreation use to these resources. Recreation managers from various agencies were interviewed, including the Corps of Engineers (COE), U.S. Forest Service (USFS), Kentucky Department of Parks (KDP), and Louisville Metro Parks (LMP).

Trails, particularly in areas where equestrian use is allowed, was the most often mentioned area of concern for soils resources. One pattern that emerged in the interviews was not so much concern for the amount of use, but the timing of the use, particularly the horseback riders who persist in continuing with scheduled trail rides no matter how wet the trail.

The managers interviewed demonstrated that they conscientiously and creatively manage the natural resources at their park, using to the best of their ability the management techniques they have available to them within the constraints of (1) manpower and budget, and (2) the properties of the soils and other natural features on the properties they manage. The managers demonstrated techniques that managed both the resources and the visitors. None of the managers used formal recreational carrying capacity reference materials, but generally because they were not aware of them or they considered their agency's work out of date. They left the definite impression that they would welcome such documentation to help them manage their properties if it was developed and provided to them, but they do not have the time or inclination to seek out such information out on their own. It follows that any improved soils resources information that could be easily accessed by managers would be a welcome addition to their toolbox.

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Introduction

The trend toward overuse and overcrowding of outdoor recreation areas has gained recognition as a major problem facing administering agencies and the visiting public. Greater numbers of visitors use these areas each year, creating challenges that must be faced if these sites are to be left for the enjoyment of future generations.

American's affection for "the Great Outdoors" has been traced to this country's frontier heritage (President's Commission on American Outdoors, 1986, p. 3). Each year, millions of Americans head to the outdoors in search of a satisfying recreational experience. Unfortunately, the words "loving them to death" have been used to describe the impacts of heavy visitation on the more popular national parks (National Parks, 1982).

Two key terms describe these undesirable impacts. A *Recreation Carrying Capacity Handbook* developed for the Corps of Engineers (Urban Research and Development Corporation, 1980) describes overcrowding as "a condition in which the user does not achieve a satisfactory recreational experience because of too many people or inadequate spacing between users." That same document defines overuse as "a condition in which (during the course of a season/year) degradation of the physical environment makes the resource no longer suitable or attractive for recreation use" (p. 4). This paper will attempt to describe some of these problems and challenges facing managers of public lands and some of the approaches being used to control the negative physical environmental effects, particularly on soils.

Patmore describes part of the problems faced when administering the recreational use of these lands in his book *Land and Leisure* (1970). Although much of that text is devoted to land uses in England and Wales, his observations concerning the amount of lands truly available to the public certainly apply to America's situation. He writes that

> *"…this abundance is illusory. The matching of supply and demand is no simple equation. The problem lies not in the number of acres which have been conserved or in the total area nominally available for public access, but in the effectiveness of both conservation and access and in the location of the land concerned."* (p. 221).

Patmore describes recreation lands as falling into two broad categories, (1) *user-oriented* which are more important for their location than for their unique feature or quality; and (2) *resource-based*, in

which the land's quality is the more important factor, regardless of its location. Patmore makes several excellent points, such as that "land is most scarce where cars are most abundant", and that the recreation pressure which these lands receive are "characterized by extreme seasonality and periodicity." (p. 174-175).

Lavery discusses the demand/supply concept of outdoor recreation in the book *Recreational Geography* (1974). Lavery identifies three types of capacity in relation to outdoor recreation areas: physical, environmental, and ecological. He asserts that *physical capacity* is the simplest to understand, i.e., the parking lot becomes filled before a popular beach has reached its capacity to accommodate more users. *Environmental capacity* is the optimum level of recreational use that can be achieved before the users perceive a reduced level of attraction to that site. The concept of environmental capacity is the most abstract, and often deals with intangibles, such as individual perceptions which are influenced by the season, their mood, and a variety of other factors. Studies have produced some estimates for environmental capacities, (i.e., 100 persons per square miles in wood land areas, and 400 persons per mile in accessible coastal beach areas), but these are very general and may be influenced by any number of factors.

Ecological capacity refers to the highest level of recreational use that can occur before damage to the ecological features of the area results. This capacity is influenced by the soils, vegetation, seasonal impacts of the use, and other related factors. For instance, the automobiles used to reach the area may cause more damage than the visitors themselves. It is usually not difficult to recognize when a site has been overused to the point that erosion has begun and vegetative cover is no longer continuous. The difficulty is in determining at what point that deterioration begins. It is similarly difficult to determine if changes in wildlife populations, for instance are due to recreational pressures, or instead the result of weather or other factors. Many different philosophies of ecological capacity may emerge when determining acceptable limits. A recreation site's vegetative cover may endure extended periods of heavy visitation before showing signs of deterioration. Yet much lower levels of recreational pressure may adversely affect the birds and mammals in the area (Lavery, 1974).

The physical, environmental, and ecological capacities described above can be combined under the heading of *resource capacity*. Another interesting recreational capacity that has been identified is social capacity. The Corps of Engineers *Recreation Carrying Capacity Handbook* defines *social capacity*

as “the level of use of a recreation resource beyond which the user’s expectation of the experience is not realized and the user does not achieve a reasonable level of satisfaction” (p. 4). Social capacity can be nearly impossible to determine since visitor satisfaction is such an individual perception, based on value judgments which defy precise measurement. Each visitor has a different definition of “crowding”, and a different level of tolerance to that condition (Urban Research and Development Corporation, 1977, p. 1-3).

Various management approaches have been used to limit the negative effects. In *Recreational Geography*, a chapter authored by Goldsmith and Munton asserts that there are two basic strategies available to the park manager: (1) manage the resource, and/or (2) manage the visitor. They contend that traditionally natural resource management practices have not occurred until after a myriad of visitor management practices have been tried and the site still shows unattractive evidence of overuse. Visitor management techniques include the use of physical barriers such as ditches and fences, and more “subtle” approaches such as signs, alternating access points, and providing facilities to attract people to other sites (Lavery, pp. 267-269).

One thing on which many park managers would agree is that visitors traditionally resist most methods of limiting visitor use of public lands, regardless of the rationale behind such limits. The typical park visitor’s attitude, certainly understandable, is that his tax dollars support the area, and he therefore has certain rights to enjoy it. Yet if this attitude is not tempered with a concern for the resource, and for other park users, conflicts among users as well as negative impacts on the environmental quality of the park are inevitable. In an article discussing such problems, Frome describes visitors who view parks as “fixtures, as thoroughly indestructible entertainment” (p. 16).

While he sees such attitudes as problematic, Frome views rules and regulations as “abhorrent”, and states that they should be kept to a minimum. He suggests that the more efficient means would be voluntary compliance with “unwritten rules…based on common sense”. Frome calls for a “park ethic” which recognizes federal areas as “special places – to visit for lasting inspiration, rather than entertainment of the moment.” (p. 16). Likewise, an entire chapter of the report compiled by the President’s Commission on Americans Outdoors is devoted to the need for an “outdoor ethic”. That report defines the outdoor ethics as “personal involvement in the outdoors as an essential part of life. It means a sense of appreciation for, and obligation toward the air, land, water, and living things on earth. It includes statesmanship:

courtesy for other using the outdoors; and stewardship: our obligation to ensure future generations' enjoyment of our natural heritage" (p. 55).

Given that the trend toward overuse and overcrowding of outdoor recreation areas will continue, the challenge for park managers is to understand and use the available research on the optimum level of use. On the ground, they must incorporate these findings and as they use available techniques to protect the resource, yet provide a satisfying experience for the park visitor. Techniques may include resource manipulation, limiting access, segregating conflicting activities, sound administrative policies, and the effective use of manpower and financial resources (Lavery). Interpretive techniques can also be used to nurture the "park ethic" and "outdoor ethic" of recreationists. These are all accepted methods of addressing the concerns of diminishing resources and reduced visitor appreciation, so that federal outdoor recreation areas can be enjoyed by the generations which follow.

A classic approach to determining optimum levels of recreation use has been the development of "recreational carrying capacities." The U.S. Department of the Interior (DOI) (under which the National Park Service, Bureau of Land Management, and the Fish and Wildlife Service operate) took the lead in this task. In 1977, a document titled *Guidelines for Understanding and Determining Optimum Recreation Carrying Capacity* was developed for the Bureau of Outdoor Recreation (now BLM) by the Urban Research Development Corporation under a contract with the DOI. Likewise, the establishment of carrying capacities was legislated through an amendment to the 1978 National Park Service General Authorities Act. The National Parks Conservation Association studied carrying capacities in the National Parks with the help of researchers from the University of Maryland (Urban Research Development Corporation, 1980). The U.S. Army Corps of Engineers also utilized the services of the Urban Research Development Corporation to develop their 1980 *Recreation Carrying Capacity Handbook*. Meanwhile, at the state level, The Florida Division of Recreation and Parks, for instance, has developed *Visitor Carrying Capacity Guidelines* with optimum capacity requirements for land-based activities indicating "people/unit of facility" which is available online.

More recent work in the carrying capacity field includes the U.S. Forest Service's *Limits of Acceptable Change (LAC) System for Wilderness Planning* (Stankey, Cole, Lucas, Petersen & Frissell, 1985), and the National Park Service's *Visitor Experience and Resource Protection (VERP) Framework*

(U.S. Department of the Interior [DOI], 1997). LAC moves the emphasis from "how much use an area can tolerate" to "primary emphasis …on the conditions desired in the area" (Stankey et al, p. iii). VERP is "planning and management framework that focuses on visitor use impacts on the visitor experience and the park resources. These impacts are primarily attributable to visitor behavior, use levels, types of use, and location of use" (DOI, p. 9). During the decade of the 1990's the focus in the area of recreational carrying capacity was on *"capacity decision making"* rather than *"capacity planning"* (Chilman, Titre, Vogel & Brown [online], 2005).

Guidelines such as those discussed above can provide valuable input for recreation professionals making decisions involving planning, site design and development, and administration and operation of recreation sites (Urban Research and Development Corporation, 1980). Managers should also utilize other tools available to them such as U.S. Department of Agriculture county soil surveys that help land managers identify the suitability of existing soils to the uses (U.S. Department of Agriculture [USDA], 1994). Typical surveys include information on recreational development, and a chart showing predicted limitations for specific types of facilities. For instance, recreational information contained in the 1986 Soil Survey of Bullitt and Spencer Counties, KY includes:

> *"Paths and trails" for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface…"Severe" means that soil properties are generally unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures" (USDA,1986, p. 71).*

Purpose of the Study

The purpose of this study was to investigate if and how carrying capacity is determined by park managers at various parks visited during the summer and fall of 2005. The study further investigated how park resources such as soils are impacted when carrying capacity is reached or exceeded, and examined the maintenance and management techniques used by park managers to lessen impacts of recreation use to these resources. Recreation managers from various agencies were interviewed, including the Corps of Engineers (COE), U.S. Forest Service (USFS), Kentucky Department of Parks (KDP), and Louisville

Metro Parks (LMP). Selected portions of the information gathered will be shared on the COE's Natural Resources Management (NRM) Gateway website (http://CorpsLakes.us.army.mil), which is open to park managers from all agencies as well as to academia so that they can learn from the challenges and techniques documented by this study.

Methods

The purpose of this study was to interview park managers to determine how they address issues related to carrying capacity and see how they protect the natural resources from overuse and/or degradation of the resources.

Procedures

During the period June through September 2005, the researcher conducted a total of six personal interviews with park managers from various agencies. Five of the interviews were with managers within the Commonwealth of Kentucky and also included site visits to selected recreation areas they manage. The sixth interview was with a park manager in Texas, and was conducted over the telephone. Each participant was asked an informal series of open ended questions related to the topic. Interviews and site visits were conducted at Taylorsville Lake, KY with both the COE and the KDP managers; at Otter Creek Park with a representative of LMP; and at Cave Run Lake with both the COE and USFS representatives.

Findings - Interviews and Site Visits

Taylorsville Lake, KY

Taylorsville Lake is located in Spencer, Nelson and Anderson counties in central Kentucky. The 3,050 acre Taylorsville Lake is located on the Salt River near Taylorsville, about 25 miles southeast of Louisville. The COE cooperates with the Commonwealth of Kentucky to manage Taylorsville Lake's lands and water.

Taylorsville Lake Area Soils and Recreation Limitations

The General Soil Map for Spencer County, KY shows Taylorsville Lake to be in the Eden map unit, described as "steep to sloping, moderately deep, well drained, flaggy soils that have a clayey subsoil; on hillsides and narrow ridgetops". Besides the primarily Eden soils, there are also some minor occurrences of other soils such as Lowell, Fatwood and Nicholson (ridge tops) and Nolan and Boonsboro within the unit (USDA, 1986, p. 22-23). The Recreational Development table warns of moderate to severe

limitations for all types of recreational facilities on Eden, Faywood, and Nicholson soils due to factors such as slope, slow percolation, and the amount of clay. The Lob Lowell soils' recreational development limitations range from slight limitations on paths and golf fairways to moderate on all other facilities. The Loc and LsC3 Lowell soils limitations range from moderate (slope, percolation) on campgrounds, picnic areas and golf fairways to severe on trails (erodability) (pp. 123-131).

In addition, the Kentucky Geological Survey 2005 Land-Use Planning map for Spencer County, KY offers planning guidance according to the type of rock unit. The Taylorsville Lake area is shown as shale and limestone, with limitations ranging from severe to slight for both the intensive (i.e., ball fields) and extensive (i.e., camping and picnicking) recreation categories (Greb, Davidson & Carey, 2005).

Corps of Engineers Management

The initial interview was conducted with the Corps of Engineers Park Manager Keith Richardson at Taylorsville Lake, KY. Richardson indicated that he does not consult carrying capacity guidelines in the management of his areas, because the COE has not published recent guidance covering the types of day-use areas he manages. He is very familiar with the county soil surveys.

There was a lengthy discussion about the Spencer County soils survey and the predicted limitations on recreational development. This author was the park manager at Taylorsville in 1991 and Richardson was the park ranger when the KDP proposed a horse trail at the Possum Ridge Recreation Area. Since the KDP leases lands from the COE, as park manager this author initiated a recommendation on whether or not to allow this development in a memo to higher authority, an excerpt of which follows:

> *There is some concern that a horse trail anywhere in the TAL [Taylorsville Lake] area could lead to erosion problems. Reference the attachments from the "Soil Survey of Bullitt and Spencer Counties" which indicate that the entire project area consists of Eden soils. According to Table 9 of that document, Eden soils have potential for severe erosion in conjunction with <u>any</u> recreational development, to include paths and trails…The document does go on to say that this limitation can be offset by design and maintenance, etc…*
>
> *Field personnel do not believe that the soils factor should be reason to deny horseback usage, but it does make the proper initial construction of the trail and continued maintenance*

critical…Corps field personnel have provided TAL State Park Manager…with some specific information on trail construction and maintenance…(Department of the Army, 1991)

By 1993, Richardson was the COE park manager at Taylorsville and recommended approval for a KDP request for a 15 mile extension of the initial trail. In his April 27, 1993 memo, he noted "Soils…limitations for recreational development due to their tendency to erode easily…can however be offset by proper design and maintenance…Based on observations by project personnel these practices were implemented and have been successful in keeping erosion to a minimum…" (Department of the Army, 1993).

It was humbling for this author to return in 2005 and hear about areas of waist deep erosion on the horse trails. In fact, the book *Hiking Kentucky* published in 1998 has a bullet at the top of the Taylorsville Lake State Park page saying, "Learn firsthand why horses and hikers shouldn't mix on the same trails," and further says about the trails at Taylorsville Lake State Park, "…because they are used heavily by horses, they are unsuitable for hiking – being rutted and torn up almost as if a plow had chattered down them…" (Elliott & Elliott, p. 149). While the COE manages the KDP lease, KDP directly manages the trail and further discussion of it will be found in a later section titled "KDP Management."

The COE directly manages facilities immediately adjacent to the dam. This includes several picnic sites. A common issue with camping and picnic sites is that heavy foot traffic results in soil compaction, loss of vegetation, and muddy areas during periods of rainfall. A common practice to address this is to create an impact zone. The Corps of Engineers Recreation Facilities and Customer Services Standards (U.S. Army Corps of Engineers, 2004) require a hardened pad for campsites and picnic sites, which is traditionally made of fine gravel (Figure 1). Concrete pads are optional, particularly when universal accessibility for persons with disabilities is an issue. At Taylorsville, the impact area for picnic sites near the heavily used visitor center and the overlook on the dam's right abutment have been converted from gravel to concrete (Figure 2).

Maintenance of trails for pedestrian access to the shoreline is a challenge that Richardson mentioned. Taylorsville does not offer many good locations for bank fishing access. A heavily traveled area is just upstream from the right abutment of the dam. Budget packages have been requested for several years to install metal steps to assist fishermen climb the steep bank, and to help with the erosion that has

resulted from the informal trails they use there (Figure 3). It does appear that the soil on these trails is currently packed with no evidence of deep ruts that would signify that significant new erosion is taking place.

The interpretive trail Richardson manages has a steep section that does not seem to have an erosion problem, but gets slick when muddy creating a safety issue. Installation of a hand rail in this section is the proposed solution (Figure 4).

The other challenge on trail construction and maintenance is the financial one. In an era of declining manpower and budgets, the maintenance of interpretive and hiking trails generally becomes low priority. Richardson has been successful in using volunteers such as Boy Scout troops and the general public on National Public Lands Day activities to accomplish an estimated 90% of the approximately 3-mile interpretive trail's construction (Figure 5).

Figure 1. Typical hardened pad provided for COE campsites and picnic areas, with a fine crushed stone surface. This campsite at Moutardier Campground, Nolin River Lake, KY also has a riprap border to prevent erosion when the lake level rises

Figure 2. Taylorsville Lake, KY. COE picnic sites with concrete impact zone. This option provides access for persons with disabilities.

Figure 3. Taylorsville Lake, KY. Erosion on trail created by bank fishermen just upstream of the right abutment of Taylorsville dam.

Figure 4. Taylorsville Lake, KY. This steep section of interpretive trail does not have erosion problems, but safety issues arise due to being very slick when wet. Installation of a hand rail is recommended.

Figure 5. Taylorsville Lake, KY. These signs indicate the level of success the COE park manager has achieved in using volunteers to construct and maintain the interpretive trail.

Figure 6. Taylorsville Lake, KY. This Taylorsville Lake State Park campsite is classified as a “primitive” site at Possum Ridge Campground and does not have a hardened impact pad. Note the soil compaction and loss of vegetation.

KDP Management

The second interview was conducted with the KDP Park Manager at Taylorsville Lake, Brian Pharis. Pharis is in his first full season as Taylorsville Lake State Park Manager, and previously was Recreation Director at another Kentucky state park. Pharis was not aware of any KDP carrying capacity guidelines. While he did not mention using soil surveys specifically, he did indicate that he is up to date on trails construction and maintenance techniques. He regularly attends International Mountain Biking Association (IMBA) and Kentucky Mountain Biking Association (KMBA) training.

Pharis has the luxury of managing a new campground completed in 2000 with hardened impact areas, so he has not experienced problems with those sites. He did mention that the only impacts that he could envision to date would be on the few primitive sites they have. Indeed, during the site visit it was noted that soil compaction and loss of vegetation have occurred on those sites (Figure 6).

Pharis indicated that his major challenges on recreation impact on natural resources are the trails previously discussed in the interview with COE park manager Richardson. These trails are multi-use. He indicated that due to deterioration of the resource, they are not as heavily used since recreationists are going elsewhere. Even with the reduced usage, there is still a lot of horse pressure. For instance, weekend benefit rides for St. Jude Children Fund bring out 40-50 horses at a time, three times per year. On a typical weekend during the recreation season, the 10 horse camp sites (maximum 4 horses/site) are generally half filled with seven or eight horse trailers in the day use lots.

Pharis said that the main impacts on the trail have resulted from horse use in damp conditions (Figures 7-10). He also noted that severe erosion has occurred in several locations where the trails may have up to a 60% slope. He indicated that in some areas it is currently difficult to distinguish the original trail from new trails that users created to bypass deteriorated trail sections.

Pharis has major plans to address the trail problems. Over the next eighteen months he hopes to resurface and rejuvenate the trail and change routes to make them more user friendly. This includes additions of berms and water bars to control water flow, incorporating winding descents with a maximum 15 % slope. He intends to mulch the surfaces. He has access to KY Department of Transportation surplus telephone poles to use for trail construction materials. Pharis also hopes to establish access trails

Figure 7. Taylorsville Lake, KY. Erosion on portion of the trails at Taylorsville Lake State Park, Possum Ridge area. This trail has been heavily impacted by horses.

Figure 8. Taylorsville Lake, KY. View of a section of trail at Taylorsville Lake State Park, Possum Ridge area, which has been heavily impacted by horses. Although this appears to be a road for vehicle traffic, it is actually the original trail with a parallel new trail created beside it to avoid ruts in the original.

Figure 9. Taylorsville Lake, KY. Section of the trail at Taylorsville Lake State Park, Possum Ridge area. This view of standing water in hoof prints is typical of wet section of the trail, and predicted by the USDA soil survey for Spencer County's Recreational Development table that warns of moderate to severe limitations for all types of recreational facilities on Eden, Faywood, and Nicholson soils due to factors such of slope, slow percolation, and the amount of clay (USDA, 1986)

Figure 10. Taylorsville Lake, KY. Section of the trail at Taylorsville Lake State Park, Possum Ridge area. This portion of the trail stays wet – note standing water in hoof prints in the foreground. Also note that many of the hoof prints are to the left of the established trail, presumably created by riders trying to bypass the mud of the original trail. This photo was taken on June 14, 2005, when there had been only 1.34 inches of rain in the previous 24 days (0.80 inches of rain had fallen on June 12)

leading to other trails, where for instance Spencer County High School cross country team wants to use the Taylorsville Lake trails for training purposes. Pharis intends to widen the trails to a standard five foot width so that two horses can pass, and make an eight foot width on access trails for running events.

Pharis described a progressive approach to management, including his plans to add park furniture made from natural materials he wants to add at trail rest stops. He plans to move a $9,000 bridge that was initially installed in the wrong place.

When asked if he would consider limiting horse use on trails in wet times, he said he would be interested in that, but does not plan to pursue it because he has too small a staff to police it. As far as social issues, he indicated that spooking of horses by other trail users was the main user conflict of which he was aware.

Otter Creek Park, KY

Otter Creek Park covers 3,000 acres in northern Meade County. This public park is owned and operated by the City of Louisville. Recreational facilities provided include campgrounds, picnic areas, trails, and a nature center (USDA, 1999).

Otter Creek Park Area Soils and Recreation Limitations

The General Soil Map for Meade County, KY shows Otter Creek to be in the Baxter-Hammack-Crider map unit, described as "undulating to steep, very deep, well drained, clayey and loamy soils on karst ridges and side slopes". There are also some minor occurrences of other soils such as Nolin within the unit (USDA, 1999, p. 29). The Recreational Development table warns of some limitations ("restrictive soil features" (p. 211) due to slope and small stones for Baxter, Hammack, and Crider soils. Flooding potential creates severe limitations on Nolin soils for campgrounds and golf fairways, moderate limitations for playgrounds, and slight limitations for picnic areas and trails (p. 214).

LMP Management

This interview was conducted with Bryan Lewis, Park Naturalist at Otter Creek Park. Lewis was not aware of any carrying capacity documents for his park. He also said that he rarely consulted a soil survey in the course of his duties. He mentioned awareness for an erosion problem off the park that affected it: the nearby Ft. Knox tank training area drains into Otter Creek Park.

Unlike the hardened impact pads typically seen at a COE park, the picnic area at Otter Creek was completely grassed. Lewis said that their tables are not anchored and the mowers continuously move them around to mow, so the grass is never impacted in one place for very long. Their 200-site campground did have gravel pads at each site.

Lewis pointed out an unusual management issue not seen at any of the other locations: "mudslides." People dig out a trench in the bank along Otter Creek in the Garnettsville Picnic Area, add water with a five-gallon bucket, slide down and splash into creek (Figures 11-12). Where there was once a proliferation of mudslides along the bank, only one active one was there in July 2005. Lewis credited this to education of administrators of the YMCA camp that had a tradition of creating these in years past, and surmised that the active mudslide had been built by alumni of one of the earlier camps.

Along with education, Lewis said that his philosophy is to "redirect" rather than "prohibit" activities to protect the resources and showed several examples. First, he showed an area where cars used to pull off and create problems with soil compaction and killing the grass. Lewis added trees to this area which did not block the view but effectively stopped the parking of vehicles there (see Figure 13). Another technique to keep vehicle traffic out of the grassy picnic area was placement of large rocks around the parking lot. These natural materials were stockpiled when a nearby Dixie Highway cut was improved a few years ago (Figure 14). He also mentioned a cut-through trail that users had created where he was having difficulty getting vegetation established where he plans to try a cedar fence to block foot traffic.

Lewis used the terms "social" or "rogue" or "volunteer" trails to describe trails that users created on their own. An example was the trail developed to the inside of the original trail along Otter Creek because the original one was in danger of falling into the creek.

Lewis was knowledgeable in trails construction and maintenance, and recommended IMBA's trail manual (IMBA, 2004) as the best resource he had used. He noted that he harvest cedars off the park for use in trail construction such as handrails and steps. He made the point that an important key in trail construction is to drain the trail to the outside (down the slope). He also showed us timbers used in old trail construction that were rotting after maybe only five years, because they were in shady locations.

Figure 11. Otter Creek Park, KY. "Mudslide" cut into the bank along Otter Creek. Users splash a bucket of water in the cut to make it slick enough to slide down it into the creek

Figure 12. Otter Creek Park, KY. View of a mudslide created as access to the creek. The park naturalist has used education to slow the former proliferation of mudslides, and only one was active in July 2005

Figure 13. Otter Creek Park, KY. Small trees planted between the guardrail and the roadway have effectively stopped cars from pulling into the grassy area, where soil compaction and loss of vegetation due to the vehicles had been a problem

Figure 14. Otter Creek Park, KY. Large rocks from a nearby road cut used as natural barriers to keep vehicles out of the grassy picnic area

Figure 15. Otter Creek Park, KY. Steps placed on steep sections of trail can prevent erosion problems and provide a safer tread for hikers. This section of trail has steps made from rocks placed approximately seven years ago

Figure 16. Otter Creek Park, KY. Steps on this section of trail were jack-hammered from an existing boulder in the trail's path about 15 years previously

Figure 17. Otter Creek Park, KY. An old section of trail with steps made from cedar trees

Figure 18. Otter Creek Park, KY. Steps newer than in Figure 17, placed using sections of tree trunks and gravel treads that have been in place for about five years

Figure 19. Otter Creek Park, KY. Trail steps made with timbers that have been in place for approximately 15 years. Since this is a dry section of trail and receives some sunlight, the timbers have lasted much longer that a typical five-year life expectancy in shaded, damp conditions

Figure 20. Otter Creek Park, KY. Visitors create new trails for their convenience which the park naturalist described as “social”, “rogue”, or “volunteer” trails. Examples are social trails established because visitors are determined to get to the top of the mouth of Morgan’s Cave, a significant geological feature in this park. This photo shows where Mother Nature succeeded where the park naturalist could not to close traffic on a social trail -- a fallen tree blocked the path

Lewis had several examples of trails step construction on the trail to Morgan's Cave. A segment of the stairs was constructed with rocks approximately seven years ago (Figure 15). Another section was jack-hammered out of a large boulder about 15-20 yrs ago, which he said would probably never be done today due to fiscal constraints (Figure 16). Another type of step was constructed from cedar tree trunks (Figure 17), while the newest section of steps was made about five years ago with cedar tree sections and white gravel treads (Figure 18). An old timber section was still in good condition after nearly 15 yrs old because it was in a dry portion of the trail that receives partial sunlight (Figure 19). Besides the trail steps, along this trail Lewis pointed out some social trails. A persistent area of social trails is that leading to the top of Morgan's Cave, where the public wants to get on top of the cave to see this geologic feature from another angle (Figure 20).

Otter Creek Park also has issues with horseback riding on wet trails. Red Cedar is an approximately eight mile equestrian trail, and a new section will be multi-use combined mountain bike and hiking. Lewis cited instances where horses damaged trails riding when wet.

Lewis observed that mountain bikers are very organized and they help with trails construction and maintenance. Horse back riders tend not to be organized, and therefore do not have as much voice regarding the trails they can use, for instance.

Cave Run Lake, KY

Cave Run Lake, KY is almost completely surrounded by a portion of the Daniel Boone National Forest. The COE and the USFS jointly operate and manage this 8,270-acre lake near Morehead, KY.

Cave Run Lake Area Soils and Recreation Limitations

Although Cave Run Lake lies in more than one county (Bath, Rowan, Morgan and Menifee), for the scope of this paper only the Bath County soils will be addressed since that is where most of the recreation areas visited and discussed with managers were located. The General Soil Map for Bath County, KY shows areas visited to be in the Colyer-Rockcastle map unit, described as "moderately steep to steep, somewhat excessively drained, shallow soils of dissected uplands" (USDA, 1963). Since the Bath County is an older survey, issued 1963, it does not contain a Recreational Development table.

COE Management

An interview was conducted with the COE Park Manager at Cave Run Lake, KY. Mark Barnum. The COE directly manages recreation areas immediately adjacent to the dam. Barnum indicated that he does not consult carrying capacity guidelines in the management of his areas, because the COE has not published recent guidance covering the types of day-use areas he manages. He is very familiar with the county soil surveys, but noted that they were not particularly useful since soils in his recreation areas were significantly disturbed during construction of dam, so he is left with subsoil or fill. His outlook is that a manager is dealt certain cards and must simply use appropriate techniques for the situation. "Most of the developed recreation areas and associated facilities were constructed during the initial development of the lake projects. Seemingly there was little consideration given to the carrying capacity or limitations of the soils and other natural resources" during the site selection for recreational development, Barnum stated. He noted that regardless of the most elaborate planning, managers ultimately have to adjust to what is actually on the ground and make those "inherited facilities work with the site's existing resources – in spite of their limitations."

A problem area for Barnum is the Stoney Cove Recreation Area, where overuse and lake fluctuations erode picnic sites. He uses crushed stone on trails leading to the site, sized to fit the need. Trails originally constructed in some locations go straight down the hill, so he uses water bars and crushed stone (#57) or Class I sand (gravel chips which pack good) (Figure 21). Barnum uses concrete caps at heads of trails to keep shallow culverts in place (Figure 22).

A common problem for recreation areas that Barnum addressed is that soils around playground equipment often gets compacted, lose vegetation, and have mud puddles after periods of rain. Barnum has created sand-filled impact zones around the playground equipment that addresses soils issues as well as safety issues by providing a cushion for falls (Figure 23). Even with this remedy, the area directly under swings pack and get "dips". He has installed heavy rubber pads that are buried semi-flush with the ground (Figure 24). These pads offer fall-protection as well as scuff protection, and can also be used to construct accessible routes for persons with disabilities.

Barnum also commented on some USFS trails issues that affected the COE's Stoney Cove area visitation since it is a parking and staging area for users of the USFS trails system. He has noticed a

decrease in horse trailer parking at Stoney Cove due to construction of White Sulphur Horse Camp which gave access to Buckskin and other trails not used much before. Barnum also noted that other loops that the USFS developed subsequently helped reduce COE problems with off-road vehicles.

Figure 21. Cave Run Lake, KY. This trail to picnic sites in the COE's Stoney Cove Recreation Area utilizes timber water bars and gravel to slow erosion. Park Manager Barnum notes that "the selection of crushed stone sizes to harden problem areas along trails depends upon the gradient of the trail segment and underlying soils. Class I sand (limestone chips) is far superior as a walking surface (packs well, lays flat and is quiet); however, it is unsuitable as a hardening material along steeper sections of a trail. Larger stone, such as No. 57 or No. 610 are heavier and resist erosion better. But the angular pieces of larger stone do not pack well, are noisy to walk over and tend to roll under foot"

Figure 22. Cave Run Lake, KY. The COE manager uses concrete caps to keep shallow trailhead culverts from floating out of place since it sits on solid bedrock due to shallow soils in the area. The concrete cap provides a resilient walking surface and keeps the culvert covered and in place

Figure 23. Cave Run Lake, KY. Playground equipment in the COE's Tailwater Recreation Area has a sand-filled impact zone that reduces soils compaction and muddy conditions, and also provides fall-protection for users. Commercially available heavy rubber pads made of shredded tires are provided at selected locations within the impact zone to prevent depressions in the soil that would hold water, and to provide protection in possible fall zones

Figure 24. Cave Run Lake, KY. The COE manager uses commercially available rubber pads, buried semi-flush with the ground, to prevent "dips" of compacted soil that hold water directly underneath swings. A specially formulated 2-part glue is used to fasten the pads to a treated wood base that is imbedded in the sand. This installation method keeps the rubber pads in place, and avoids use of metal fasteners that could create a safety hazard

USFS Management

The second interview at Cave Run Lake was conducted with Carey Loomis, Forestry Technician with the Morehead Ranger District, USFS. Loomis has been in this position since 1991, and trails construction and maintenance is 40 % of his job.

Loomis indicated that he does not consult carrying capacity materials, but he does use soils maps. He also mentioned that he follows National Environmental Policy Act (NEPA) guidelines and looks at cultural and biological aspects on new trails as well as soil conditions. He noted that a new trail is planned to go all the way around the lake that will be for horses, so it will have to build it with heavy equipment. The trail will begin with a six to eight foot tread width initially (dozer blade width). For this project he is consulting with others to include a biologist, hydrologist, geologist, soil scientist, and archeologist.

Loomis also noted that he is using an engineering plan for the first time on the Caney Loop restoration, instead of the usual method of just flagging the trail and getting a dozer operator. He hopes the Caney loop in the future can be dedicated to bikers. This work was started as a test to get the cost/mile estimate to apply to the new-round-the-lake trail.

Similar to the comments made by Barnum, Loomis noted that our site visit would look at a section of the Sheltowee Trace trail near the dam, where nearly the whole section is clay -- no topsoil left because of dam construction. However, in the Pioneer Weapons Area, soils are very different (until get into riparian areas), where they have lots of single track trails that get very heavy use and stay in great shape.

Loomis gave an example of how trails conditions are weather dependent. The same day this author was there for the site visit, a bike concessionaire had told Loomis how well the trails were looking this year. However, Loomis noted that receipt of this compliment was strictly a function of a dry year compared to the past three wet years when the trails looked bad.

Loomis has a lot of experience with trail erosion, and noted that “ruts become little canyons.” Where lots of horse traffic will occur, wet areas need underdrain. During the site visit Loomis discussed several techniques he would use during trail upgrade, to include use of geosynthetic materials such as Tri-lock block and geocell. He told about using two or three 12-inch culverts in one area the previous year and rains popped them right out, so Tri-lock block will be used this time instead. He noted that Tri-lock with riprap on the ends of drain crossings will last a lifetime (Figure 25-26). This author was able to return two

months after the initial interview for follow up photographs to see how those materials were used to address erosion problems (Figures 26-30, 32). Gabions were used in some locations to keep drainage off the trail (Figures 31-32). Other techniques on the Sheltowee include use of French drains or perforated pipe, covered with #4 rock on the Sheltowee (#2 rock on the Caney side) and then topped with dense grade aggregate (DGA).

Loomis noted that the initial trail construction and renovation looks like a road, but showed areas on the Caney loop that were built with a dozer in 1991 but have grown in to look very natural (Figures 33-34). On the Caney loop he also pointed out some log water bars put in by mountain bikers as he directed, but now people are going around them instead of over them.

Loomis discussed some social issues with multi-use trails. He noted that mountain bikers tend to seek a political solution to trail problems more quickly than horseback riders. IMBA and KMBA project work fizzled because of shared use with horses -- horses tear up what biker volunteers fixed so they are reluctant to continue. He mentioned one incident this year where a frustrated mountain biker slugged a horse who would not move out of the way.

When asked if it would be feasible to keep horses out during wet conditions, Loomis noted that if such a voluntary policy were invoked it could be followed by administrative regulatory enforcement if need be. Violators could be cited on a degradation of the resource statute, but such cases are very difficult to prove and he does not have enough people to patrol and monitor the activity in this manner.

Loomis said that the only attempts he had made to monitor trail usage in terms of numbers of users was the installation of commercially available trail counters, but they also counted leaves, deer, etc. so were very unreliable. In his experience, the best way to monitor trail usage is using a person to survey users. He used a volunteer for such a survey for approximately six to eight weeks a few years ago. Of the approximately 200 persons surveyed, 99 % said they would support fees if the trails would be maintained.

Figure 25. Cave Run Lake, KY. USFS's Sheltowee Trace Trail, July 2005. Culvert placed, with riprap on both sides of the trail where trail crosses drain

Figure 26. Cave Run Lake, KY. September 2005, view of finished section of trail that crosses drain shown in Figure 25. Tri-lock block has been placed, topped with gravel. USFS representative Loomis indicates this type of repair incorporating Tri-lock block and riprap "will last a lifetime"

Figure 27. Cave Run Lake, KY. September 2005, view of rehabilitated section of Sheltowee Trace trail. The exposed trail edge shows materials used in the rehab: geotextile fabric underneath a layer of Tri-lock block, with top layer of gravel

Figure 28. Cave Run Lake, KY. Close up view of Tri-lock block placed on the trail. "Tri-lock is a system of pre-cast concrete blocks made up of two components: a 'lock block' and a 'key block'. Each is keyed into two other components for stability and integrity. For ease of installation, the blocks are typically installed in dry conditions by hand on a specially engineered filter fabric" (Hanson,)

Figure 29. Cave Run Lake, KY. View of geocell – a flexible geosynthetic mat – before placement on the Sheltowee Trace trail for erosion control

Figure 30. Cave Run Lake, KY. View of geocell after placement on the edge of a Sheltowee Trace section for erosion control

Figure 31. Cave Run Lake, KY. July 2005, Sheltowee Trace Trail. View looking south. Note the bank on the left side of the trail

Figure 32. Cave Run Lake, KY. View looking north. Note the gabion placed for erosion control of the bank shown in Figure 27 (right side of the trail in this photo)

Figure 33. Cave Run Lake, KY. July 2005, Sheltowee Trace Trail rehabilitation. Note dozer tracks. Because hand labor is so slow and cost prohibitive, the USFS uses small dozer for initial construction and major trail rehab to clear and level trails. The addition of gravel to the tread gives an initial appearance of "a small road" in the word of USFS representative Loomis

Figure 34. Cave Run Lake, KY. July 2005, view of a section of Caney Trail that was initially cleared by the USFS with a small dozer in 1991. In 1991 this trail looked similar to the view in Figure 29, but vegetation has grown into restore the natural look

Cooper Lake State Park, TX

Located in northeast Texas, Cooper Lake State Park is operated by the Texas Department of Parks through a lease agreement with the COE. The South Sulphur Unit at Cooper Lake has equestrian trails.

An abbreviated interview by phone with South Sulphur Unit Manager Rodney Franklin was conducted for the specific purpose of hearing about his success in closing horse trails in wet conditions. Franklin noted that they have highly erodable soils at Cooper Lake. When the trails first opened there were no restrictions, resulting in lots of damage to the resource ("the horses' hooves take the mud with them"). There are also some safety issues if users ride horses when the trails are wet. Now he closes trails whenever there is enough rain to cause significant impact by horses. If users have reservations and have not arrived yet, the park calls the visitors and reschedules. If the visitors are already there, then park personnel let them know they can continue to camp but not ride. Cooper Lake also has a brochure that explains the policy.

When told he was the first manager spoken with that restricts use in wet conditions, Franklin said that at his park users have to check in at headquarters on way into the park, so he can monitor use. Sometimes people come in at night, but in wet conditions park employees catch these new arrivals first thing in the morning and tell them the trail is closed, or leave a note on their equipment if they not at their site during the morning site check. Previous trail users know to call before they come to check on trail conditions.

Franklin also mentioned closing sections of trails to allow them to heal. He said his staff have done all they can do to educate riders. While the riders were at first not happy about closures, once they understood that they may lose the use of the resource, the message was better received.

Discussion

The managers interviewed demonstrated that they conscientiously and creatively manage the natural resources at their park, using to the best of their ability the management techniques they have available to them within the constraints of (1) manpower and budget, and (2) the properties of the soils and other natural features on the properties they manage . The managers demonstrated techniques that managed both the resources and the visitors, the two basic strategies identified by Goldsmith and Munton

(Lavery). None of the managers used formal recreational carrying capacity reference materials, but generally that was because they were not aware of them or they considered their agency's work out of date. They left the definite impression that they would welcome such documentation to help them manage their properties if it was developed and provided to them, but they do not have the time or inclination to seek out such information out on their own. It follows that any improved soils resources information that could be easily accessed by managers would be a welcome addition to their toolbox.

Trails, particularly in areas where equestrian use is allowed, was the most often mentioned area of concern for soils resources. Taylorsville Lake presents a classic case study of an area that was overwhelmed by a specific use, made worse by the fact that the entire park area has soils that are predictably unable to withstand such use. The horse trails developed there served as one of the very few locations offering such opportunities on public lands in the vicinity of the Louisville metropolitan area. The horseback riders that were so pleased to have this opportunity rode in great numbers in all weather conditions, and within a period of only a few years had contributed to the deterioration of the trails to the point that they began to look for other places to go, leaving behind a trail system that was unsuitable for hikers and even mountain bikers in some locations.

One pattern that emerged in the interviews was not so much concern for the amount of use, but the timing of the use, particularly the horseback riders who persist in continuing with scheduled trail rides no matter how wet the trail. The manager at Cooper Lake, TX demonstrated a successful program that limited horseback riding on his park's trails to when dry conditions exist. This example shows that other locations should consider implementing a similar approach where manpower exists to monitor and manage such a program. Managers should also consider this option when developing new facilities, as building in the ability to monitor trails access is a key factor in the long term success of such a policy.

Education appears to be another major key to enlightening visitors to ways they can protect the resource and to reduce user conflicts. Outreach to those the managers affectionately called "horse people" should be considered to help them understand the impacts of riding on wet trails, and to develop an understanding of how the potential positive impact of volunteer work on their part could help them

politically to have a voice in trails management and development, similar to the success currently enjoyed by mountain bikers in the IMBA organization and their local affiliates.

Fees for trails use should not be overlooked as an option to give users an opportunity to contribute to resource protection and to provide funds for managers to better maintain recreational facilities. This would particularly be recommended for special users who most heavily impact the trails, such as ATVs users and horseback riders, and especially in areas such as Taylorsville Lake where the inherent soil properties require more careful and expensive construction, maintenance and management techniques. The overwhelmingly positive response of the Cave Run Lake trail user survey Loomis mentioned is an indication of willingness to pay fees if the money would result in well maintained trails. When faced with the loss of use of the resource, both fees and restraint on times of use become more attractive to the users.

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