# ENVIRONMENTAL AUDITING

# Capabilities and Management Utility of Recreation Impact Monitoring Programs

**JEFFREY L. MARION**
USDI National Biological Service
Virginia Tech/Department of Forestry
Cooperative Park Studies Unit
Blacksburg, Virginia 24061-0324, USA

ABSTRACT / A recreation impact monitoring system was developed and applied in 1984–1986 and in 1991 to all backcountry river-accessed campsites within Delaware Water Gap National Recreation Area, Pennsylvania and New Jersey. Results suggest that actions implemented by park managers in response to problems identified by the initial survey were highly effective in reducing resource degradation caused by camping. In particular, the elimination of some designated campsites and installation of anchored firegrates reduced the total area of disturbance by 50%. Firegrate installation provided a focal point that increased the concentration of camping activities, allowing peripheral areas to recover. As suggested by predictive models, additional resource degradation caused by increased camping intensities is more than offset by improvements in the condition of areas where use is eliminated. The capabilities and management utility of recreation impact monitoring programs, illustrated by the Delaware Water Gap monitoring program, are also presented and discussed.

For the first European settlers, the immense wilderness of the North American continent was both an obstacle to be overcome and an asset to be developed. Island remnants of those pristine natural landscapes are today preserved primarily in national parks, forests, and wilderness areas. Coinciding with this loss of naturalness has been an evolving public opinion: today we speak of preserving natural environments from civilization. With effective management, the value of preserved natural environments will continue to expand as surrounding lands become increasingly modified. A common goal for protected areas, permitting the free play of natural processes unaffected by human influence, presents managers with a difficult, perhaps impossible, challenge. Human activities occurring within, adjacent to, and at great distances from protected area boundaries present pervasive and intractable threats to these areas.

Natural resource monitoring programs offer managers the most objective tool for documenting natural conditions, processes, and the extent of human influence. Through monitoring, managers can evaluate human-induced changes and the effectiveness of their efforts in minimizing such changes. This paper presents selected results highlighting these capabilities as applied to an important internal threat to protected areas: recreation use. Specifically, results are presented from two monitoring assessments of backcountry campsite conditions at Delaware Water Gap National Recreation Area (DWGNRA), a unit of the US National Park Service.

The Organic Act of 1916 established the National Park Service (NPS), directing it to "promote and regulate" the use of the parks in a manner that "will leave them unimpaired for the enjoyment of future generations." This mandate, which is similar to those of most protected areas, presents managers with a paradox. Recreation ecology research has shown that even very light use can alter resource conditions (Cole 1982, 1993, Marion and Merriam 1985). Current resource protection policies and management frameworks recognize the inevitability of at least some degree of human influence. For example, the NPS Management Policies state that managers should "identify acceptable limits of impacts, monitor backcountry use levels and resource conditions, and take prompt corrective action when unacceptable impacts occur" (USDI 1988). Management frameworks such as the limits of acceptable change (LAC) (Stankey and others 1985) and visitor impact management (VIM) (Graefe and others 1990) provide the means for defining and managing conditions within such limits.

The capability to monitor the conditions of resources altered by recreation use is essential to effective protected area management. Monitoring can be defined as the systematic collection and analysis of data at regular intervals, in perpetuity (USDI 1991). Recreation impact

KEY WORDS: Recreation impacts; Campsites; Recreation management

monitoring programs provide data to document the condition of trails and campsites, evaluate human impacts, suggest effective management interventions, and evaluate the subsequent success of implemented actions (Cole 1983, 1989, Marion 1991). The capabilities and management utility of such programs are receiving increased international attention due to dramatic expansions in ecotourism worldwide.

## Study Area

Delaware Water Gap NRA encompasses 70,000 acres in northeastern Pennsylvania and northwestern New Jersey approximately 60 miles northwest of New York City. The park includes a 40-mile segment of the Delaware River, flowing through a semideveloped valley with forested river banks often bordered by agricultural fields. River valley soils consist of glacial till and alluvium. Common tree species along river banks are *Acer saccharinum* (silver maple), *Fraxinus americana* (white ash), and *Betula nigra* (river birch). Intensive flooding and ice damage during spring thaws eliminate woody vegetation in low-lying areas, which become dominated by grasses.

The river is a primary recreation attraction, receiving approximately 300,000 visits annually. Principal river activities include canoeing, swimming, and fishing. River use is concentrated within the warmer months of May through September and is predominantly day oriented. Approximately 31,000 canoeists camp along the river annually, as determined by aerial overflights and verified with early morning ranger patrols.

Managers permitted unrestricted camping along the river from establishment in 1965 until 1983, when a designated site camping policy was implemented. Most campsites selected for designation were user-developed sites; sites too close to roads or river accesses were not selected. Camping areas were designated by placing steel campsite signs on trees visible from the river. Camping, restricted to one night per site, was permitted anywhere in the vicinity of these signs. In 1989, managers further restricted camping to the immediate vicinity of permanently anchored steel firegrates, on a reduced number of the existing campsites.

## Methods

In 1984, a multiparameter campsite condition assessment system was developed for monitoring the resource conditions on river-accessed backcountry campsites at DWGNRA. The monitoring system was developed to accommodate park management information needs and constraints on personnel. Procedures for assessing 29 site inventory and resource condition parameters were developed so that two trained workers could assess a typical campsite in approximately 10–15 min. Resource condition parameters (e.g., campsite size and exposed soil) document site conditions, while inventory parameters (e.g., distance from river and tree canopy cover) document site location or resource attributes. All river campsites (N = 179) were assessed by trained seasonal park staff during the summers of 1984–1986 (hereafter referred to as the 1986 survey).

Table 1. Condition class rating system applied at DWGNRA

| Condition class definitions | |
|---|---|
| Class 1: | Campsite barely distinguishable; slight loss of vegetation cover and/or minimal disturbance of organic litter. |
| Class 2: | Campsite obvious; vegetation cover lost and/or organic litter pulverized in primary-use areas. No bare soil other than fire scars. |
| Class 3: | Vegetation cover lost and/or organic litter pulverized on much of the site; some bare soil exposed in primary-use areas. |
| Class 4: | Nearly complete or total loss of vegetation cover and organic litter; bare soil widespread. |
| Class 5: | Soil erosion obvious, as indicated by exposed tree roots and rocks and/or gullying. |

In 1991, field procedures were revised to incorporate improved assessment methods, while maintaining comparability with the earlier survey. Photographs from permanently referenced photopoints and a condition class assessment (Table 1) were added. Campsites rated a condition class of three or above were assessed with 12 resource condition parameters and 15 inventory parameters. These procedures required approximately 15–20 min for two traind workers to complete for each campsite. Less disturbed campsites were assessed with fewer procedures that required 5–10 min per campsite. This dual approach was designed to reduce field assessment time, as comprehensive data on less-disturbed campsites are not essential to park managers. Excluding training, ten days were required to assess all river campsites (N = 110). Staff conducted this survey during extended overnight trips while working 10-h days.

### Field Techniques

Measurement accuracy and precision were enhanced through the development and use of a comprehensive procedural manual and the hiring, training, and supervision of qualified field staff. Campsite boundaries were defined by pronounced changes in vegetation cover, vegetation height/disturbance, vegetation composition, surface organic litter, or, more rarely, topography. In the 1986 survey, campsite sizes were determined

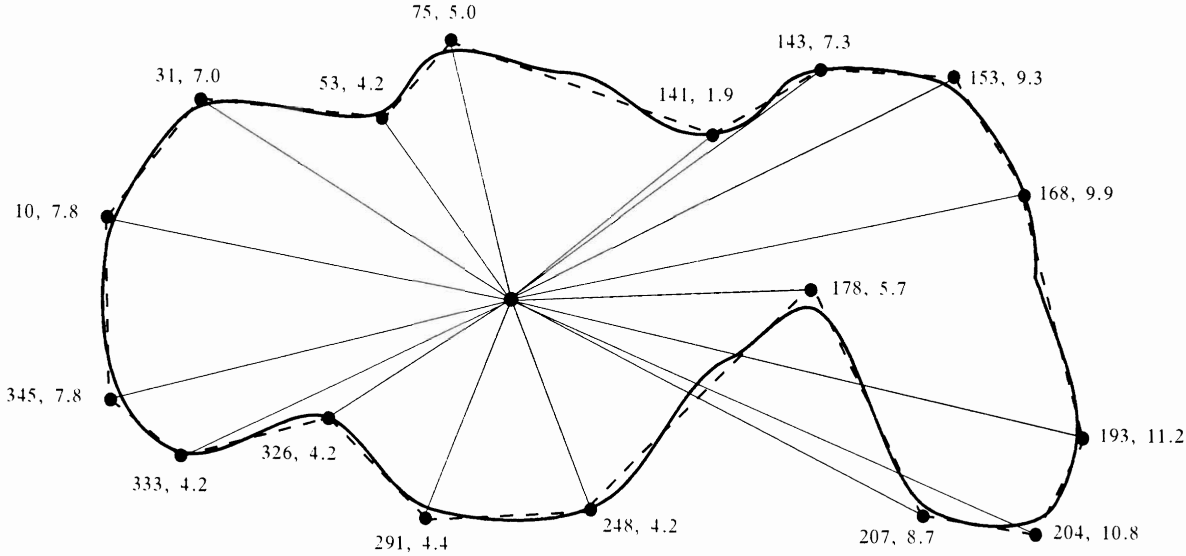


**Figure 1.** The variable radial transect method used for determining campsite size. The campsite boundary is flagged at locations which, when connected with straight lines, characterize the campsite's area. The distance and compass bearing from a campsite centerpoint to each flagged location are assessed and input to a computer program, which arithmetically calculates campsite area.

**Figure 2.** Two workers determining distance and azimuth from a campsite centerpoint to the boundary to determine campsite area using the variable radial transect method.

by measuring the dimensions of one or more geometric figures that closely matched campsite boundaries. In the 1991 survey, a newly developed variable radial transect method (Figures 1 and 2) was used to assess campsite sizes (Marion 1991). With this method, wire pin flags are placed along the campsite boundary at locations that, when connected by straight lines, define a polygon whose area closely approximates the campsite area. Distance and compass bearing from a permanently located centerpoint to each flag are recorded. Using the campsite boundary definitions, any untrampled islands of vegetation within campsite boundaries and any trampled satellite areas outside campsite boundaries are measured using the geometric figure method.

Within campsite boundaries, including satellites and excluding islands, staff estimated the percentage of live nonwoody vegetation cover and exposed soil using six and four classes in 1991 and 1986, respectively. Vegetation cover was also estimated for an adjacent, environmentally similar but undisturbed control area, selected to represent campsite conditions in the absence of camping. The number of trees with obvious human-caused damage and the number of felled trees (stumps) were also counted. The lineal distance of shoreline where vegetation was absent or obviously disturbed from trampling was measured. Inventory parameters were also assessed.

### Data Analysis

In 1986, the areas of each geometric figure were calculated and summed to obtain an estimate of each campsite's size. In 1991, a computer program was used to arithmetically calculate campsite sizes from transect data, subtracting the areas of untrampled islands of vegetation and adding the areas of satellite use areas. For vegetation cover, the midpoints of onsite coverage classes were subtracted from the midpoints of offsite classes to estimate the percentage of campsite vegetation cover lost due to human trampling. An estimate of the area of vegetation loss was calculated by multiplying percentage loss by campsite size. As mineral soil was never exposed on undisturbed controls, the area of exposed soil was calculated by multiplying the midpoint of campsite soil exposure classes by campsite size.

The numbers of damaged trees and felled trees per campsite were converted to a number per 100 $m^2$, a value somewhat smaller than the typical campsite. This conversion improves comparability, as these parameters were assessed only within campsite boundaries, which can change between surveys.

Median values are reported to characterize conditions on the typical campsite; mean values were affected by skewed distributions and outliers. The range and sum for resource condition parameters are reported to characterize the distribution of values and cumulative impact.

Experimental measurement error assessments were conducted in 1990 in Shenandoah National Park using similar field procedures. These results, as interpreted through professional judgment and consultation with field staff, were used to derive measurement error estimates for each campsite condition parameter. These estimates are 30% for tree damage and 20% for the remaining parameters. To illustrate the use of measurement error estimates, consider a 100-$m^2$ campsite. Based on a 20% error estimate, the true campsite size is inferred to be between 80 and 120 $m^2$. When comparing to an earlier or later survey, the campsite would have to increase or decrease in size more than 20 $m^2$ for one to conclude that a real change has occurred.

## Results

### Survey Results, 1986

Survey staff located 179 campsites in 1986, 116 (65%) were designated and 63 were undesignated or illegal. For the entire river corridor, there were an average of 1.8 designated and 1.0 undesignated campsites per kilometer of river. However, campsite density was quite variable, ranging from 1.2 to 4.0 campsites/κ for five river segments. Campsite numbers were highest on the New Jersey shore (83, 46%), followed by the Pennsylvania shore (55, 31%) and islands (41, 23%). Legal campsites were often located in clusters; 60% of the legal campsites occurred in groups of more than five campsites.

The median designated campsite was approximately 127 $m^2$ in size, affecting a cumulative area of nearly 3 ha (28,140 $m^2$) (Table 2). Intensive trampling within campsite boundaries reduces and eliminates vegetative groundcover; the median area of vegetation loss was 66 $m^2$. Campsites at DWGNRA often lack organic litter and soil horizons due to periodic flooding. Even on upland campsites not subject to flooding, organic materials are quickly pulverized and eroded in core use areas. Subsequently, mineral soil exposure on campsites was substantial, with an area of 43 $m^2$ on the median campsite. Activity at boat landings also leads to the loss or disturbance of vegetation along the shoreline, a lineal distance of 5 m on the median campsite. In addition to groundcover changes, camping activities have caused the loss and damage of trees. The median campsite lost one tree (0.3/100 $m^2$) and had four damaged trees (2.2/100 $m^2$), defined by broken or cut limbs, knife and axe scars, or nails.

### Management Response

Managers found the large number of undesignated campsites and the high density and close spacing of designated campsites to be unacceptable. In particular, many areas resembled highly degraded backcountry "campgrounds" that restricted visitor solitude.

Several actions recommended for reducing camping impacts (Marion 1988) were implemented in 1988–1989. Existing campsites were reviewed to select those with the best potential for resisting the effects of camping and for maximizing visitor solitude. Specific campsites were designated by permanently anchoring steel firegrates at the center of each selected campsite. Previously, individual campsite locations resulted from un-

Table 2. Conditions on all designated campsites assessed in 1986 (N = 116)

| Resource parameters | Conditions | | |
|---|---|---|---|
| | Median | Range | Cumulative impact[a] |
| Campsite size ($m^2$) | 127 | 10–3072 | 28,140 |
| Vegetation loss ($m^2$) | 66 | 0–2319 | 12,687 |
| Exposed soil ($m^2$) | 43 | 0–1042 | 11,146 |
| Shoreline disturbance (m) | 5 | 0–57 | 944 |
| Damaged trees (N/100 $m^2$) | 2.2 | 0–16 | 349 |
| Felled trees (N/100 $m^2$) | 0.3 | 0–8 | 95 |

[a]Cumulative impact is the sum of campsite condition values for all campsites.

structured camping within designated camping areas. This led to a proliferation of campsites and firescars at the more popular locations. Furthermore, prior to the installation of anchored firegrates, both fire sites and campsites tended to migrate over time, creating unnecessarily large areas of disturbance.

An improved "River Guide" pamphlet was also developed and its distribution by all commercial canoe outfitters was required. The pamphlet includes a map showing campsite locations and describing camping regulations, including a requirement that visitors camp only on campsites with steel firegrates. Finally, river rangers initiated efforts to reduce illegal camping through increased visitor contacts, placement of "No Camping" signs on sites receiving repeated use, and early morning enforcement patrols.

## Survey Results, 1991

Survey staff located 110 campsites in 1991, 87 (79%) were designated and 23 were undesignated. Riverwide, campsite densities declined from 1.8 to 1.4 designated campsites/km of river and from 1.0 to 0.4 undesignated campsites/km. Of the 87 designated campsites, 81 had been designated campsites in 1986, two had been undesignated, and four were newly created campsites. Thirty-five (30%) of the campsites within the former designated camping areas were eliminated. This action improved campsite solitude; in 1986 two or more campsites were visible from one third of the designated campsites, in 1991 this degree of campsite intervisibility existed for less than one quarter of the designated campsites.

The reduced number of undesignated campsites, from 63 to 23, occurred in spite of the addition, in 1989, of 35 former designated campsites that did not receive firegrates. Of the 23 undesignated campsites, 15 were also undesignated in 1986, 5 were new campsites, and 3 had been designated campsites in 1986. Survey staff could discern the locations of some former designated campsites and reported that they had undisturbed ground vegetation and/or leaf litter. The apparent rapid recovery of vegetation on these campsites is attributed to the moist and nutrient-rich riparian soils, long growing season, and lack of continued trampling.

In 1991, the median designated campsite was 121 $m^2$ in size, essentially unchanged from the median size in 1986 (Table 3). The total area of camping disturbance (sum of all campsite areas) was reduced by 50%, from 28,140 $m^2$ to 14,020 $m^2$. The median and cumulative campsite sizes were also reduced for the large subset of campsites common to both surveys (N = 73). For these sites, the median relative change was −18% (Table 4) and the cumulative area of disturbance was reduced by 37%.

Median vegetation cover was 15% on campsites and 98% in adjacent undisturbed control areas; the typical campsite lost about four fifths of its vegetation cover. Median area of vegetation loss increased 27% between 1986 and 1991 (Table 3). However, the relative change for this measure declined 28% for campsites common to both surveys (Table 4). Furthermore, the cumulative area of vegetation loss declined by 21% for all campsites and by 4% for those common to both surveys, indicating a general improvement in conditions.

Due to absence of organic litter on most campsites, changes in the exposure of soil typically mirror changes in loss of vegetation cover. For all designated campsites, amount of bare soil on the median campsite nearly doubled from 43 $m^2$ in 1986 to 85 $m^2$ (Tables 2 and 3). However, the cumulative area of bare soil decreased by 10%, and data on campsites common to both studies also show improved conditions (Table 4). The median shoreline disturbance in 1991 was only 1 m while cumulative lineal disturbance was 205 m, a 78% reduction from 1986 (Table 3). For campsites common to both surveys, relative change was −70% and cumulative shoreline disturbance declined by 71% (Table 4). Also for this group, shoreline disturbance increased on 11 campsites and decreased on 55 campsites (Table 4).

Damaged and felled trees per 100 $m^2$ were 2.5 and

Table 3. Conditions on all designated campsites assessed in 1991 (N = 77) and comparisons to 1986 survey (N = 116)

| Resource parameters | Conditions in 1991 | | | Percent change from 1986[b] | |
|---|---|---|---|---|---|
| | Median | Range | Cumulative change[a] | Median | Cumulative |
| Campsite size ($m^2$) | 121[c] | 11–773[c] | 14,020[c] | −5 | −50 |
| Vegetation loss ($m^2$) | 84 | 5–738 | 9,986 | 27 | −21 |
| Exposed soil ($m^2$) | 85 | 1–757 | 10,067 | 98 | −10 |
| Shoreline disturbance (m) | 1 | 0–15 | 205 | −82 | −78 |
| Damaged trees (N/100 $m^2$) | 2.5 | 0–7 | 206 | 14 | −41 |
| Felled Trees (N/100 $m^2$) | 0.3 | 0–5 | 45 | 0 | −53 |

[a]Cumulative change is the sum of campsite condition values for all campsites.

[b]Percent change values are the 1991 median or cumulative values minus their respective 1986 values as a percentage of the 1986 values.

[c]N = 85.

Table 4. Median conditions and changes on 73 designated campsites common to 1986 and 1991 surveys[a]

| Statistic | Campsite size ($m^2$) | Vegetation loss ($m^2$) | Exposed soil ($m^2$) | Shoreline disturbance (m) | Trees (N/100 $m^2$) Damaged | Trees (N/100 $m^2$) Felled |
|---|---|---|---|---|---|---|
| Condition | | | | | | |
| 1986 | 147 | 86 | 80 | 7 | 2.2 | 0.2 |
| 1991 | 130 | 75 | 76 | 1 | 2.4 | <0.1 |
| Change | | | | | | |
| Absolute | −27 | −8 | 1 | −4 | −0.04 | 0 |
| Relative (%) | −18 | −28 | −11 | −70 | −21 | −42 |
| Cumulative | −6686 | −795 | −834 | −513 | −32 | −5 |
| No. of sites | | | | | | |
| Increase | 21 | 24 | 31 | 11 | 30 | 29 |
| Decrease | 35 | 32 | 30 | 55 | 28 | 20 |
| Unchanged | 17 | 14 | 12 | 7 | 14 | 24 |
| Significance | 0.003 | 0.357 | 0.891 | 0.000 | 0.594 | 0.975 |

[a]Absolute change is the condition in 1991 minus the condition in 1986 (on a case-by-case basis). Relative change is absolute change as a percentage of the condition in 1986. Cumulative change is the sum of condition values for all campsites in 1991 minus the sum of condition values for all campsites in 1986. The number of sites unchanged includes those with identical values for both surveys as well as sites with changes less than the estimated measurement error (see Methods section). The significance of differences between 1986 and 1991 was tested with the Wilcoxon matched-pairs, signed ranks test.

0.3 on the median campsite. Although tree damage was not assessed in offsite areas, these data suggest that permitting campfires has not resulted in the significant loss of or damage to trees. Furthermore, the cumulative number of damaged and felled trees per 100 $m^2$ declined with respect to all campsites surveyed and those common to both surveys (Tables 3 and 4).

## Discussion

### Survey Results

The park's reported overnight visitation along the river has remained relatively stable between surveys, averaging approximately 31,000 campers annually. However, due to the reduction in campsite numbers, visitation per designated campsite increased approximately 28%, from 268 nights/site annually in 1984–1986 to 344 nights/site in 1989–1991. River rangers report that instances of campsite demand exceeding supply, typically on only two weekends each year, have been no more frequent with the reduction in campsite numbers.

With an increased intensity of use, conditions on individual campsites would be expected to deteriorate. For example, according to campsite impact models developed by Cole (1992), campsite area and area of vegetation loss changes as the square of any change in amount of use. Thus, if designated campsite visitation increased by 28%, campsite sizes and vegetation loss should increase by approximately two thirds

($128\%^2 = 164\%$). However, empirical research at DWGNRA (Cole and Marion 1988) and elsewhere (Cole 1982, Marion and Merriam 1985) has documented a curvilinear relationship between amount of recreational use and most forms of campsite degradation. The most significant changes occur with initial use and at low to moderate use intensities; well-established campsites accrue little additional change as the frequency of camping increases. The influence of activity concentration provides one important explanation for this apparent discrepancy. Coincident with campsite expansion is an increasing tendency for visitors to spend more time in specific activity areas, such as cooking and tenting locations. Such spatial concentration of activities increases trampling intensities within primary-use areas while decreasing trampling in peripheral areas, resulting in less campsite expansion than would otherwise be predicted (Cole 1992).

Monitoring results at DWGNRA support these described relationships. In spite of increased use intensities, campsite conditions substantially improved, as reflected by absolute, relative, and cumulative change values for campsites common to both surveys (Table 4). For example, the total area affected by camping declined 37%, by 6686 $m^2$, and the area of vegetation loss declined by 28%. A lack of pronounced deterioration was expected, given the curvilinear use–impact relationship. The improvement in campsite conditions suggests the influence of additional factors.

The management actions implemented in 1988–1989 are considered the most likely cause for the improved campsite conditions. In particular, increased campsite spacing and firegrate installation more clearly defined discrete campsites, altering visitor behavior by attracting and concentrating camping activities near the firegrate. The largest campsite size reductions occurred in the most popular designated camping areas. As illustrated in Figure 3, 13 campsites decreased by more than 200 $m^2$, while none of the campsites increased by this amount. The reduction in area of vegetation loss is also attributed to increased activity concentration. Due to the fragility of broad-leafed ground vegetation, most DWGNRA campsites have little vegetation to lose. Thus, the area of vegetation loss is reduced through reductions in campsite area. These findings support the prediction that increased activity concentration can reduce the area of campsite disturbance and vegetation loss.

Other aspects of visitor behavior may also have been affected by the management actions. The widely distributed "River Guide" likely reduced illegal camping by informing more visitors of the park's camping policies. The guide's river map also helps visitors to find and use all available campsites during peak use periods. Low-impact practices recommended in the pamphlet may also have been adopted by some visitors, resulting in fewer damaged and felled trees. "No Camping" signs posted on the most persistent illegal campsites and increased ranger patrols reinforced the revised camping policies and low-impact messages.

Environmental conditions, including rainfall, were fairly uniform between the two monitoring assessments. Environmental attributes relating to the relative resistance and resilience of campsites to trampling disturbance were incorporated into campsite selection criteria employed in 1988–1989 (Marion 1988). However, few campsites were converted from fragile to resistant settings.

DWGNRA campsite monitoring results illustrate the capabilities of resource monitoring programs and the effectiveness of management efforts in limiting visitor impacts. Initial monitoring results, an understanding of recreation ecology principles, and management experience guided the identification and selection of management actions. Monitoring results lend support to the confinement strategy for minimizing the effects of camping. Results and observations suggest that the reduction in campsite numbers and firegrate installation were the most critical determinants of the general improvement in campsite conditions. Undoubtedly both actions significantly increased use intensities within the boundaries of the remaining campsites. However, monitoring results and Cole's predictive impact models suggest that degradation caused by increased use intensities is small in comparison to improvement caused by the elimination of use in other areas. Important management implications are that aggregate change can be held to a minimum by: (1) confining camping to the smallest number of campsites necessary to accommodate near-peak use, and (2) encouraging the spatial concentration of activities on campsites.

## Monitoring Capabilities

Recreation activities are a traditional and appropriate use of most protected natural areas. A challenge for managers is to facilitate and regulate such use while minimizing the associated resource degradation. The recurring question, "are we loving our parks to death?" increasingly challenges managers to develop and implement management policies, strategies, and actions that permit recreation without compromising ecological and aesthetic integrity. Recreation impact monitoring should be an essential element of any management program seeking to balance these dual objectives.

As with other prominent and critical resource threats, managers can no longer afford a wait-and-see attitude or rely on subjective impressions of deterioration in

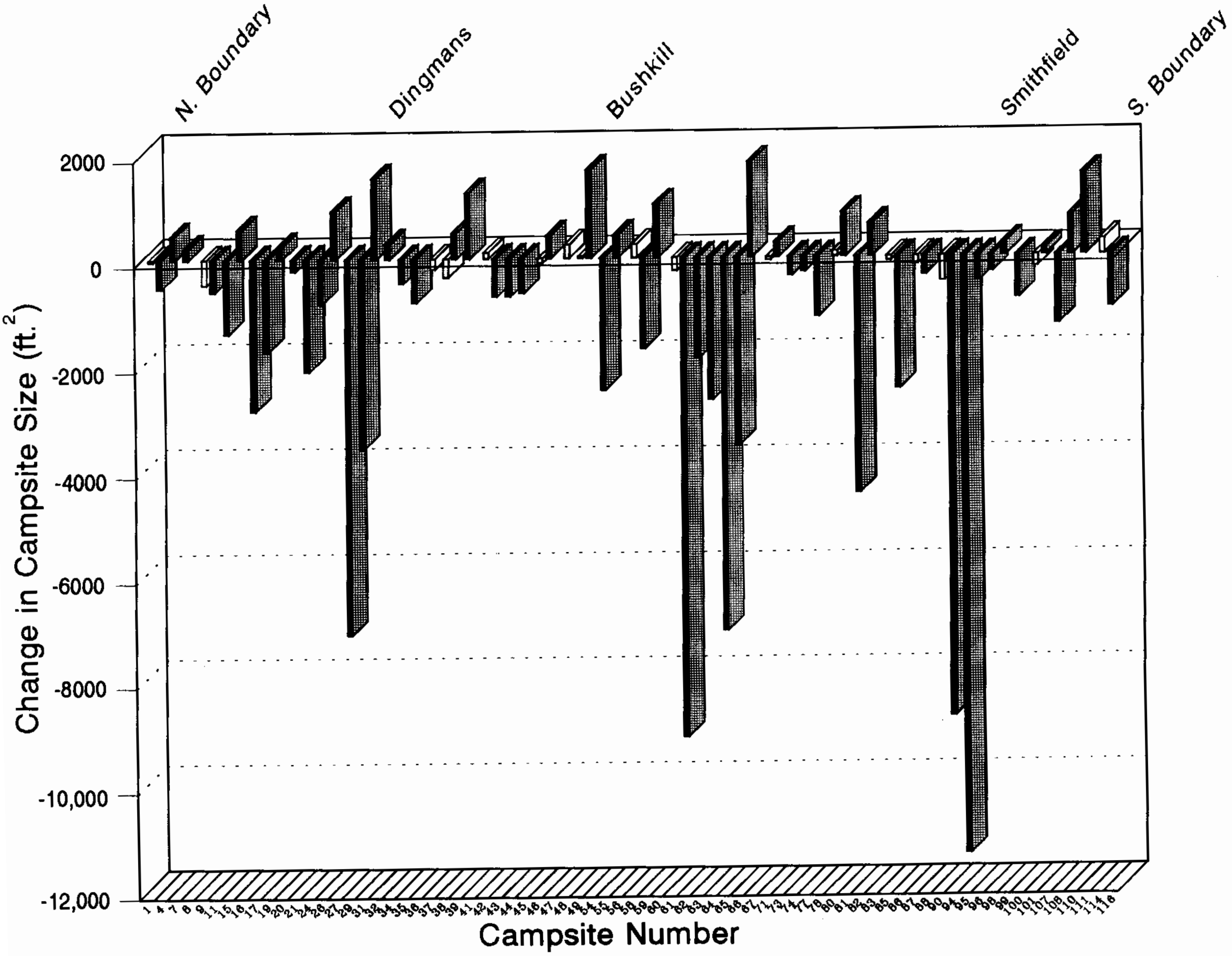


**Figure 3.** Change in campsite size from 1986 to 1991 for designated campsites common to both surveys. Campsites with positive bar values increased in size, those with negative values decreased in size. Bars that are not shaded represent values that are less than the 20% estimated measurement error.

resource conditions. Expanding popularity of wildland recreation, greater public scrutiny, and widening demands for participatory public land management have driven an increasing need for more objective information. Managers require recreation impact monitoring systems that can efficiently produce reliable data describing the types and extent of resource changes attributable to recreation. Quantitative documentation of site-specific conditions provide a permanent and impartial record, although individual managers may come and go.

Properly implemented recreation impact monitoring programs provide a standard approach for collecting and analyzing resource condition data over time. Analysis of data from periodic reassessments enables managers to detect and evaluate changes in resource conditions. Deteriorating conditions can be discovered before severe or irreversible changes occur, allowing time to implement corrective actions.

Analysis of recreation impact monitoring data can also describe relationships between resource conditions and influential use-related and environmental factors. An improved understanding of the influence of type and amount of use, or the relative trampling resistance of vegetation and soil types, can aid managers in selecting effective visitor and resource management actions. As demonstrated by the DWGNRA campsite monitoring program, the effectiveness of implemented actions can also be evaluated. This capability facilitates use of less restrictive actions initially, while justifying regulatory or controversial actions when truly necessary.

Finally, a recreation impact monitoring program is indispensable to the newer protected area planning and management frameworks, including the limits of acceptable change (LAC) (Stankey and others 1985), visitor impact management (VIM) (Graefe and others 1990), and visitor experience and resource protection (VERP) (USDI 1993). These frameworks evolved from and are currently replacing management approaches based on the more traditional carrying capacity model (Marion and others 1993).

Under the new frameworks, numerical standards are established for selected resource condition indicators. Standards specify the limits of acceptable change, as established by managers and the public. These limits establish a measurable reference point defining the critical boundary line between acceptable and unacceptable conditions. Monitoring programs can provide valuable information for the selection of indicators and standards by identifying resource indicators that can be efficiently and reliably assessed and by presenting data that describe the range of current conditions for each indicator. Most important, the monitoring component of these new frameworks allow periodic comparisons of resource conditions to the established standards.

In conclusion, external land use practices, internal management activities, and recreation use increasingly threaten protected natural areas. The values of these areas are inextricably linked to their naturalness. Polluted waters, trampled vegetation, and the proliferation of trails, campsites, and fire rings have the potential to impair ecosystem function and the quality of visitor experiences. Recreation impact monitoring programs offer managers a tool for assessing such changes and provide an essential basis for making resource protection decisions.

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