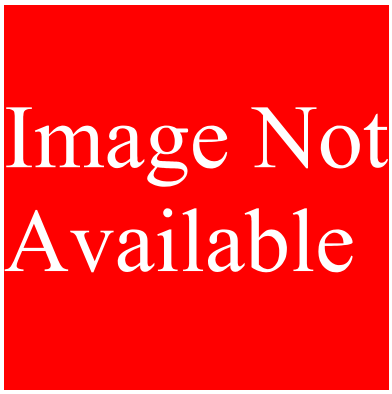
**NATIONAL PARK SERVICE**

RESEARCH/RESOURCES MANAGEMENT REPORT

# AN EVALUATION OF CAMPING IMPACTS AND THEIR MANAGEMENT AT ISLE ROYALE NATIONAL PARK

Final Report




United States Department of the Interior

National Park Service
Isle Royale National Park

# AN EVALUATION OF CAMPING IMPACTS AND THEIR MANAGEMENT AT ISLE ROYALE NATIONAL PARK

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*by:* Tracy A. Farrell and Jeffrey L. Marion

Doctoral Student and Research Scientist/Unit Leader
USGS Patuxent Wildlife Research Center
304 Cheatham Hall (0324)
Cooperative Park Studies Unit
Virginia Tech/Department of Forestry
Blacksburg, VA 24061

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NATIONAL PARK SERVICE - ISLE ROYALE NATIONAL PARK

Research/Resources Management Report

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800 East Lakeshore Dr.
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# EXECUTIVE SUMMARY

National Park Service legal mandates and administrative policies prescribe a management paradox for administering recreational use in backcountry and wilderness areas. Park staff are charged with managing naturally functioning ecosystems and processes substantially free from human influence, yet these protected areas must also be managed for recreational visitation. Research investigating the environmental impacts associated with recreational visitation indicate that substantial changes can occur even at low levels of camping and hiking activity. Managers therefore require objective information that describes resource changes, their relationships to influential factors, and how they vary over time. Such information is essential to determinations of acceptability, identification of corrective actions, and evaluations of management effectiveness.

This research effort applied knowledge from the discipline of recreation ecology to design and implement a backcountry campsite monitoring program for Isle Royale National Park (ISRO). Staff affiliated with the Virginia Tech Cooperative Park Studies Unit collaborated with park staff in the development of this program, including the selection of indicators, specification of measurement procedures, and administration of field work. This report describes these efforts, presents results from the first monitoring cycle, evaluates current park camping management policies, and provides recommendations for reducing camping-related visitor impacts.

Legal mandates, management policies and guidelines, and park planning documents are examined to describe legislative and management intent relating to visitor impact management and monitoring. This review provides justification for implementing a campsite monitoring program and may be useful in enlisting organizational support to sustain the program over time. Management planning and decision making frameworks are described and recommended for adoption. These frameworks can aid managers in the difficult task of balancing resource protection and recreation provision objectives. The critical role of monitoring and its continuation at ISRO is also discussed.

Alternative campsite impact assessment approaches are described. Elements of photographic, condition class, and multi-indicator measurement-based approaches were combined for application at ISRO. This approach emphasizes field procedures that are efficiently applied yet yield reliable campsite condition measurements for a variety of campsite attributes, including area of disturbance, vegetation loss, soil exposure, tree damage, root exposure, and development of informal trails. A comprehensive procedural manual was developed (Appendix 1) to guide present and future field staff in taking consistent measurements.

Following staff training, field work was conducted during the summer of 1996. Field staff assessed all designated backcountry campsites and shelters and conducted limited searches for non-designated campsites. Within the park's 36 campgrounds, survey staff located and assessed 244 sites, including 113 individual campsites, 43 group campsites, and 88 shelters. Site distribution between wilderness and non-wilderness is approximately equal: 116 (47.5%) campsites and shelters are in wilderness and 128 (52.5%) are in non-wilderness.

The conditions on ISRO backcountry sites are generally quite good. Conditions on 211 sites (86%) are quite acceptable, with condition class ratings of 1, 2, or 3. The majority of sites are rated class 3, characterized by extensive organic litter and/or vegetation disturbance but with soil exposed only in primary use areas. Soil is exposed more extensively on only 33 sites (14%) and no sites are rated class 5, characterized by obvious soil erosion.

Site sizes are extremely small, with two-thirds of the sites under 751 $ft^2$. However, at least seven sites might be considered unacceptably large at more than 2000 $ft^2$. The typical site has about 16% vegetation groundcover and has lost an estimated 60% of its pre-construction vegetative cover. While soil exposure is evident on all sites, the typical site has 38% exposed soil over an area of just 159 $ft^2$. Exceptions include 26 sites with vegetation loss greater than 1000 $ft^2$ and nine sites with exposed soil greater than 1000 $ft^2$.

The majority of trees were removed from sites during construction so on-site tree damage (median = 0) is lower than off-site measures (median = 4). Of the 362 on-site trees assessed, 281 (78%) are damaged. An additional 1,029 damaged trees occur in adjacent off-site areas. Root exposure is generally not a problem, almost two-thirds of the sites (160, 66%) have no trees with exposed roots. Of the 362 on-site trees assessed, 174 (48%) have root exposure. The number of tree stumps is also low; 89 occur within site boundaries and 300 occur in adjacent off-site areas.

The development of off-site trailing appears to be a problem in some campgrounds. The typical site has 3 trails leading away from its boundaries, 61% have 3 or more trails and 10% have 5 or more. The construction of illegal fire sites may also be an issue. Illegal fire sites occur on 22 sites. Litter, while present on most sites, occurs in small quantities. Improperly disposed human waste is rare as all campgrounds have at least one pit toilet.

The size and condition of shoreline landing areas may be one of the more significant issues for management consideration. While the majority of landings are less than 500 $ft^2$ (76%), 6 exceed 2000 $ft^2$. The total area of disturbance associated with boat landings (81,695 $ft^2$) is 46% as large as the total area of disturbance associated with all camping sites (177,964 $ft^2$). Furthermore, while soil erosion is rare on camping sites it is much more common at landings and on landing access trails.

Relational analyses were conducted to investigate the influence of environmental, use-related, and managerial factors. Campsites located in evergreen forests (spruce and fir) and under more open forest canopies are significantly smaller in size and in area of vegetation loss and soil exposure. Evergreen branches typically extend to the ground providing a vegetative wall that inhibits site expansion. Open forest canopies permit the growth of shade-intolerant grasses and sedges, which are highly trampling resistant.

Campsite location and design at Isle Royale have been highly successful in limiting the area of disturbance associated with camping. Campgrounds are commonly located in sloping terrain which acts to spatially concentrate camping activities and inhibit site expansion. The design of campsites provides the minimum space needed for tents, cooking, and socializing. Campsite construction practices, including cut and fill work and placement of embedded logs, provide strong visual cues that clearly identify campsite boundaries. The median site size at ISRO (554 $ft^2$) is exceptionally

small, as are area of vegetation loss and exposed soil. We know of no other backcountry or wilderness areas in the United States that have achieved this degree of camping impact containment.

While many would maintain that camping shelters are primarily a visitor amenity or convenience, our analyses clearly demonstrate that they also provide a resource protection function. The median area of disturbance for shelters, including both their "footprint" and associated external disturbance, is 377 $ft^2$, in comparison to 572 $ft^2$ for individual campsites and 1496 $ft^2$ for group campsites. Shelter visitors likely spend a greater proportion of their time within the structure or immediately in front of it. Similar findings reveal small but statistically significant reductions in areal measures of disturbance for campsites with picnic tables in comparison to campsites that lack them. In spite of this finding the presence of picnic tables in backcountry zones is uncommon and their presence in wilderness is considered inappropriate under the “minimum tool” principle (Hendee and others 1990). We recommend removal of these facilities from the 33 wilderness sites where they are currently found. Analyses related to the presence of fire sites provide no compelling evidence for restricting the current policy of allowing campfires at backcountry sites.

The number, distribution, and arrangement of sites are also discussed. We recommend an initial primary reliance on altering visitor distribution patterns to address current and future camping capacity problems. Entry point quotas may be needed to redistribute use in time and space. Limited construction of additional campgrounds and/or sites may also be needed to eliminate bottlenecks in visitor distribution patterns or to address the social issues of visitor crowding and conflict. Site clustering in backcountry campgrounds is beneficial to wildlife by reducing habitat fragmentation. However, survey data show that campsite and shelter spacing within campgrounds also limit the potential for camping solitude. Only 22 (9%) of the sites have no other sites visible and mean inter-site distance is only 76 ft. Crowding and conflict issues at campgrounds were highly ranked from among an extensive list of potential issues provided for visitor comment in a recent backcountry visitor survey.

The potential for camping solitude, as reflected by campsite locational attributes, and site conditions are not always consistent with the proposed General Management Plan backcountry and wilderness zoning. For example, mean inter-site distances for sites within the backcountry and primitive zones (83 and 76 ft respectively) are equivalent to those for sites in the frontcountry and portal zones (82 and 78 ft respectively). Planners and managers may wish to consider setting standards for such indicators so that these physical attributes can be managed to achieve differing recreation experience objectives.

Finally, we discuss and make recommendations for the park’s campsite maintenance and monitoring programs and for enhancing *Leave No Trace* education. Regarding monitoring, we have provided a comprehensive procedural manual and a database to guide future efforts. We recommend a monitoring cycle of approximately every five years, though timing can be altered to accommodate management needs and constraints.

# INTRODUCTION

This report describes results from the development and application of a backcountry campsite, shelter, and shoreline access monitoring program for Isle Royale National Park (ISRO). This effort was initiated in response to current development of a General Management Plan (GMP) for the park. This study provides data describing campsite, shelter site, and shoreline access conditions, and use-related and environmental factors that influence those conditions. Study implications and recommendations for park planning and management are discussed. A separate but similar concurrent research effort on ISRO social conditions (visitor satisfaction, crowding, and conflict) and visitor campsite impact perceptions is also underway at the University of Minnesota Cooperative Park Studies Unit.

Park and wilderness managers must maintain a balance between resource protection and recreation provision mandates. Though a central purpose for the creation and management of parks, visitation has the potential to degrade park resources and the experiences of other visitors. This is particularly true along trails, at overnight campsites, and at day-use recreation sites like shoreline landing areas, where visitation and its effects are concentrated.

Potential consequences of visitation include the trampling and subsequent loss of ground vegetation, shrubs, and tree seedlings; felling of saplings; erosion of surface litter and humus; exposure, erosion, and compaction of mineral soil; and exposure of tree roots and damage to tree trunks (Table 1) (Cole 1987, Cole and Marion 1988, Hammitt and Cole 1987, Marion 1984a). Visitors also notice and are affected by these resource impacts (Lucas 1979, Shelby and Shindler 1992). A recent survey of visitors to three eastern wilderness areas found that littering and human damage to campsite trees were among the most highly rated indicators affecting the quality of recreational experiences (Roggenbuck et al. 1993). These and other resource impact indicators, such as the amount of vegetation loss and bare ground around a campsite, were rated above many social indicators, including the number of people seen while hiking and encounters with other groups at campsites.

**Table 1.** Resource impacts caused by hiking, boating, and camping activities.

| Vegetation Changes | Soil Changes | Additional Concerns |
|---|---|---|
| ● Loss of Vegetation Cover<br>● Alteration of Composition<br>● Loss of Species<br>● Damage to Trees<br>● Exposure of Tree Roots<br>● Loss of Tree Regeneration | ● Loss of Organic Matter<br>● Erosion<br>● Compaction<br>● Reduction in Soil Moisture | ● Littering<br>● Threats to Water Quality<br>● Threats to Human Health<br>● Threats to Wildlife |

The National Park Service recognizes the need for effective visitor management and resource protection programs to balance visitation with its associated resource impacts. The recurring question, "Are we loving our parks to death?" challenges managers to develop and implement management policies, strategies, and actions that permit recreation without compromising ecological and aesthetic integrity. Furthermore, managers are frequently forced to engage in this balancing act under the close scrutiny of the public, competing interest groups, and the courts.

Managers can no longer afford a wait-and-see attitude or rely on subjective impressions of deterioration in resource conditions. Managers require scientifically valid research and monitoring data. Such data should describe the nature and severity of resource changes and the relationships between controlling visitor use and biophysical factors. Research has revealed that these relationships are complex and not always intuitive. A reliable information base is therefore essential to managers seeking to develop and implement effective visitor and resource management programs.

Legislative, administrative, and park resource protection mandates and objectives are reviewed to provide justification for the initiation and continuance of a visitor impact monitoring program. New comprehensive carrying capacity planning and management frameworks such as the Limits of Acceptable Change (LAC) and Visitor Experience and Resource Protection (VERP) are described and recommended for managing visitor impacts. Monitoring program objectives and capabilities are also described, as is the importance of integrating monitoring data into resource protection decision making.

Although numerous reasons for implementing a visitor impact monitoring program are described in the following sections, the actual value of these programs is entirely dependent upon the park staff who manage them. Programs developed with little regard to data quality assurance or operated in isolation from resource protection decision making will be short-lived. In contrast, programs that provide managers with reliable information necessary for developing and evaluating resource protection policies, strategies, and actions can be of significant value. Only through the implementation of objective management frameworks that integrate defensible monitoring programs can we hope to provide legitimate answers to the question, "Are we loving our parks to death?"

## Research Objectives

The principal goal of this research is to design and apply a monitoring system for documenting the conditions of backcountry campsites within Isle Royale National Park. Specific research objectives are listed in Figure 1.

1. Construct, refine, and apply a backcountry campsite monitoring program for Isle Royale National Park that addresses all relevant park information needs with flexible, cost effective, scientifically defensible procedures.

2. Assemble a comprehensive monitoring program manual describing all procedures including those necessary for repeating the assessment.

3. Prepare a report that summarizes and analyzes data from the monitoring assessment.

4. Evaluate and recommend modifications to existing backcountry management policies, camping regulations, and visitor information literature.

**Figure 1.** Research objectives.

## Monitoring Program Objectives

The principal goal for the backcountry camping and shoreline access monitoring program is to provide a reliable, cost-effective, and tested method for gathering data that document backcountry campsite and shoreline access conditions. Specific objectives for the monitoring program are listed in Figure 2.

1. Obtain quantified measurements of managerially relevant campsite condition indicators using scientifically valid and cost-effective procedures.

2. Provide campsite condition information in a format conducive to making and evaluating decisions for managing backcountry camping resources and visitor experiences.

3. Maintain flexibility in the design and application of monitoring procedures to accommodate changes in management needs, constraints, and directions.

4. Improve data accuracy and precision by developing and documenting standardized monitoring procedures and quality assurance protocols.

**Figure 2.** Campsite monitoring program objectives.

## Justification for Monitoring

This section reviews legislative mandates, management policies and guidelines, park resource protection objectives, and visitor perceptions of recreation resource impacts. The purpose of this review is to describe legislative and management intent regarding the need to balance visitor use with resource protection objectives, and additionally, why visitor impact monitoring is essential to

this endeavor. This review is included both to justify the implementation of a campsite and shoreline access monitoring program and to enlist organizational support for sustaining such a program over time.

## Legislative Mandates

Current legislation and agency documents establish mandates for monitoring (Marion 1991). Recent legislative mandates allow managers more latitude to make proactive decisions that can be defended in court if necessary. Managers who make proactive decisions should be prepared to prove the viability of their strategies, or risk public disapproval or even legal action against the agency. Survey and monitoring programs provide the means for such demonstrations.

### Agency Organic Act

The National Park Service Organic Act of 1916 (16 *United States Code* (USC) 1) established the National Park Service, directing it to:

> "promote and regulate the use of the Federal areas known as National Parks, Monuments, and Reservations . . . by such means and measures as conform to the fundamental purpose of the said Parks, Monuments, and Reservations, which purpose is to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."

National Park Service general authorities were amended in 1978 by the act expanding Redwood National Park (16 USC 1a-1) mandating that all parks be managed and protected "in light of the high public value and integrity of the National Park System" and that no activities should be undertaken "in derogation of the values and purposes for which these various areas have been established."

Congress intended park visitation to be contingent upon the National Park Service's ability to preserve park environments in an unimpaired condition. However, unimpaired does not mean unaltered or unchanged (USDI 1988). Any recreational activity, no matter how infrequent, will cause changes or impacts lasting for some period of time. What constitutes an impaired resource is ultimately a management decision, a judgement. The Organic Act's mandate presents the agency with a management challenge since research demonstrates that resources are inevitably changed by recreational activities, even with infrequent recreation by conscientious visitors (Cole 1982 1985, Marion 1984a). If interpreted overly strictly, the legal mandate of unimpaired preservation may not be achievable, yet it serves as a useful goal for managers in balancing these two competing objectives.

### External Mandating Documents

Park Service backcountry management policies are guided by external documents as well. For Isle Royale National Park, relevant external documents include the Wilderness Act of 1964 (PL. 88-577) and the National Environmental Policy Act of 1969 (42 USC 4321 *et seq*). These acts overlay park designation and are intended by Congress to protect certain areas of the park singled out for exceptional ecological or social value.

With the federal designation of the park in 1931, a mandate was given to preserve wilderness and the plants and animals in a primeval manner, which was further supported when 99% of the park was designated as federal wilderness in 1976. The wilderness areas are managed under the Wilderness Act of 1964 (Public law 88-5) so as to protect their natural resources and processes and to provide visitors with high quality wilderness experiences. In 1981, the park was also designated a Biosphere Reserve by the United Nations, increasing its worldwide recognition as the largest island park in a fresh water lake.

Wilderness, as defined in the Wilderness Act of 1964 (16 USC 1131-1136), is:

> "an area where the earth and its community of life are untrammeled by man . . . which is protected and managed so as to preserve its natural conditions and which generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable. . . ."

The Wilderness Act established the same use and preservation management paradox implied by the Organic Act. Wilderness areas:

> "shall be administered for the use and enjoyment of the American people in such manner as will leave them unimpaired for future use and enjoyment as wilderness and so as to provide for the protection of these areas, the preservation of their wilderness character, and for the gathering and dissemination of information regarding their use and enjoyment as wilderness. . . ."

Finally, the National Environmental Policy Act of 1969 (42 USC 4321 *et seq*) directs federal agencies to use all practicable means to "attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences. . . ." Title I of the act requires that federal agencies "monitor, evaluate, and control on a continuing basis their agency's activities so as to protect and enhance the quality of the environment." This amendment also directs agencies to "promote the development and use of indices and monitoring systems (1) to assess environmental conditions and trends, (2) to predict the environmental impact of proposed public and private actions and (3) to determine the effectiveness of programs for protecting and enhancing environmental quality."

## Management Policies and Guidelines

Authority to implement congressional legislation is delegated to agencies who identify and interpret all relevant laws and formulate management policies to guide implementation. For the National Park Service, these policies are set forth in *Management Policies*, revised in 1988. This document provides direction for management decisions. Adherence to the procedures within *Management Policies* is "mandatory unless waived or modified by an appropriate authority." More specific procedures for implementing service-wide policy are described in *NPS-75: Natural Resources Inventory and Monitoring Guideline* (USDI 1992) and *NPS-77: Natural Resources Management Guideline* (USDI 1991) of the NPS Guideline Series.

Several statements in *Management Policies* specifically require resource condition assessments:

> "The National Park Service will assemble baseline inventory data describing the natural resources under its stewardship and will monitor those resources at regular intervals to detect or predict changes. The resulting information will be analyzed to detect changes that may require intervention and to provide reference points for comparison with other, more [human-]altered environments." (Chapter 4:4)

> "Backcountry use will be managed to avoid unacceptable impacts on park resources or adverse effects on visitor enjoyment of appropriate recreational experiences. The National Park Service will identify acceptable limits of impacts, monitor backcountry use levels and resource conditions, and take prompt corrective action when unacceptable impacts occur." (Chapter 8:3)

> "Potential impacts on soil resources will be routinely monitored." (Chapter 4:20)

Resource inventory and monitoring are also recommended when administering parks where policy imposes restrictions on visitor autonomy, as in Isle Royale National Park where camping is restricted to designated campsites :

> "Any restrictions on recreational use will be limited to the minimum necessary to protect park resources and values and to promote visitor safety and enjoyment. To the extent practicable, public use limits established by the National Park Service will be based on the results of scientific research and other available support data". (Chapter 8:2)

Two NPS natural resource management guidelines, NPS-75, *Natural Resources Inventory and Monitoring Guideline* (USDI 1992), and NPS-77, *Natural Resources Management Guideline* (USDI 1991), also have relevance to monitoring conditions of backcountry campsites. NPS-75 states:

> "It is the policy of the National Park Service to assemble baseline inventory data describing the natural resources under its stewardship, and to monitor those resources forever; to detect or predict changes that may require intervention … and with growing awareness of the effects of human activities within the parks, natural resource baseline inventories and subsequent monitoring are an essential basis for park management." (Chapter 1:1)

NPS-77 also addresses resource inventory and monitoring programs:

> "To fulfill the NPS mission of conserving parks, it is essential that park managers know the nature and condition of the resources in their stewardship, have the means to detect and document changes in those resources, and understand the forces driving the changes." (Chapter 5:20)

A subchapter of NPS-77 entitled "Backcountry Recreation Management" notes that park Superintendents are responsible for producing and implementing management strategies to address backcountry recreation. Restrictions on visitors are to be the minimum necessary:

> "Any restrictions on use should directly relate to the accomplishment of specific management objectives identified in the plan, or resolve specific, documented impacts." (Chapter 3:73)

## Monitoring in Support of Park Administration

Isle Royal National Park is currently developing a General Management Plan to provide a framework for management decisions over the next 15 to 20 years. The purpose of the plan is to protect natural and cultural park resources and to offer diverse recreation opportunities for visitors. During the first few stages of the GMP process, several **Park Purpose Statements** were developed (USDI 1996a: p.3):

1) Maintain the wilderness character of the park for visitor use and enjoyment for current and future generations.
2) Protect park cultural and natural resources.
3) Offer recreation opportunities and experiences harmonious with wilderness values and the preservation of park resources.
4) Offer educational and interpretive programs for visitors.
5) Promote scientific research of visitor impacts and ecosystem processes.

**Park Significance Statements** were also developed during the GMP planning process to identify the international, national, and regional values of ISRO (USDI 1997: p.2), including:

1) The island is a remote and primitive wilderness archipelago isolated by Lake Superior.
2) Research opportunities are abundant in this undisturbed and relatively simple ecosystem.
3) Park waters support native fisheries and the most genetically diverse lake trout populations in Lake Superior.

The park is currently zoned as wilderness or non-wilderness although little distinction is currently made between these zones for managing backcountry recreation use or facilities. During the GMP planning process, nine potential management zones have been proposed with guidelines to determine appropriate types and intensities of recreational use and development. The purpose of these zones is to further classify areas based on physical, biological, social, and management conditions to guide the appropriate type and amount of use and facilities in these areas.

The preferred GMP alternative emphasizes separating motorized and non-motorized uses to reduce user conflicts and distribute use types across the island. For example, paddler campgrounds and non-motorized water zones are proposed in areas with no trail access for canoeists and kayakers. This alternative suggests four zones that would permit camping in designated areas: frontcountry, wilderness portal, backcountry, and primitive (USDI 1997, USDI 1996a: p.5):

**Frontcountry** - visitor experiences emphasize high social contact and moderate convenience and access to developed facilities. Campgrounds may be large, with hardened trails and interpretive facilities and signs.

**Wilderness Portal** - transition area between other zones, offering a mixture of use types and varying potential for solitude. Facilities in this zone could include moderate-sized campgrounds with shelters and/or campsites, and may include constructed docks.

**Backcountry** - facilities are remote and opportunities for adventure and solitude are available. Facilities could include small campgrounds and docks.

**Primitive** - full immersion into nature is promoted with frequent opportunities for independence and solitude. Facilities in this zone would be limited to primitive trails and small campsites with no docks.

Off-trail hiking and camping would also be permitted within a wilderness **Pristine** zone by special permission, emphasizing greater opportunities for solitude and containing no facilities. The GMP is addressing the management of camping and related visitor use activities. These management actions include offering greater accessibility to some outhouses and shelters, removing facilities from other areas, and conducting research of current visitor impacts on natural and cultural resources and visitor crowding and conflict issues (USDI 1997: p. 8).

The following camping management concerns have been raised during the GMP planning process:

> "Visitors with different recreational objectives often find themselves in conflict, primarily at campgrounds. Increasing visitation is resulting in resource impacts and in crowding of some campgrounds, docks and trails...some visitors complain that there are too few backcountry campsites on the island, and they are concerned about having to share campsites." (USDI 1996a)

Several management activities described in the park's Resource Management Plan (USDI 1994) are also applicable to backcountry camping management and impact monitoring:

**Project Statement: ISRO-N-180 (Wilderness/Backcountry Management)**
This statement describes the need for completing wilderness and backcountry planning and management programs using the Visitor Experience and Resource Protection (VERP) planning model.

**Project Statement: ISRO-N-181 (Develop/Implement Backcountry Campsite I&M Program)**

This statement describes the need for a monitoring system to measure resource impacts at campgrounds and on trails to inform managers of changing conditions and to support objective decision making.

**Project Statement: ISRO-N185 (Develop Wilderness Management Plan)**
This statement describes the need for a Wilderness Management Plan to guide NPS and visitor use actions relative to Wilderness Act mandates.

## Visitor Perceptions of Resource Conditions

Visitors to wildland environments are aware of resource conditions, just as are managers (Lucas 1979, Marion and Lime 1986). Physical conditions of campsites affect visitors' experiences and the perceived aesthetics of a campsite. Indeed, visitors are quite sensitive to overt effects of other visitors (such as the occurrence of litter, horse manure, malicious damage to vegetation) and particularly obtrusive examples of tree root exposure and soil erosion. A recent survey of visitors to four wilderness areas, three in southeastern states and another in Montana, found that littering and human damage to campsite trees were among the most highly rated indicators affecting the quality of wilderness experiences (Roggenbuck and others 1993). Amount of vegetation loss and exposed soil around a campsite were rated as more important than many social indicators, including number of people seen while hiking and encounters with other groups at campsites. Hollenhorst and Gardner (1994) also found vegetation loss and bare ground on campsites to be important determinants of satisfaction by wilderness visitors.

## Monitoring Program Capabilities

Managers require scientifically valid campsite research and monitoring data. As with other prominent and critical resource issues, managers can no longer afford a wait-and-see attitude or rely upon subjective impressions of deteriorating resource conditions. When establishing policy for backcountry camping, such data should describe the condition of campsites, relationships between campsite condition and visitor use or environmental attributes, and the likely effects that visitor activities have on biophysical, social, and managerial environments. These relationships are complex and not always intuitive. A reliable information base, therefore, is essential for managers who seek to develop and implement effective visitor and resource management policy.

Monitoring programs can be of significant value when providing managers with reliable information necessary for establishing and evaluating resource protection policies, strategies, and actions. When implemented properly and with periodic reassessments, these programs produce a data base with significant benefits to wilderness managers (Figure 3). Monitoring programs provide an objective record of resource conditions, even though individual managers come and go. A monitoring program may help detect and evaluate trends when data are compared between present and past resource assessments. It may detect deteriorating conditions before severe or irreversible changes

occur, allowing time to implement corrective actions. Analysis of monitoring data may assist in the selection of appropriate management actions and reveal their effectiveness over time.

Finally, a campsite and shoreline access condition monitoring program provides an essential component of recreation resource planning and management frameworks such as the *Limits of Acceptable Change* (LAC) (Stankey and others 1985) and *Visitor Impact Management* (VIM) (Graefe and others 1990) (Figure 4). The National Park Service's Denver Service Center has combined elements from these approaches in developing a model known as *Visitor Experience and Resource Protection* (VERP) to guide the future development of park General Management Plans (USDI 1993). These frameworks evolved from, and are currently replacing, management approaches based on the more traditional carrying capacity model (Marion and others 1985). As previously noted, the National Park Service *Management Policies* requires approaches that identify and monitor acceptable limits of change in backcountry settings.

Under these new frameworks numerical standards are set for individual biophysical or social condition indicators. These limits define the critical boundary line between acceptable and unacceptable conditions, establishing a measurable reference point against which future conditions can be compared. The utility of specific indicators and the process of selecting standards are discussed later in this report.

As we shall see, the monitoring program assembled and implemented during this research provides information necessary for identifying applicable biophysical

- Identify and quantify site-specific resource impacts.
- Summarize impacts by environmental or use-related factors to evaluate relationships.
- Aid in setting and monitoring management standards for resource conditions.
- Evaluate deterioration to suggest potential causes and effective management actions.
- Evaluate the effectiveness of resource protection measures.
- Identify and assign priorities to maintenance needs.

**Figure 3.** Capabilities of visitor impact monitoring programs.

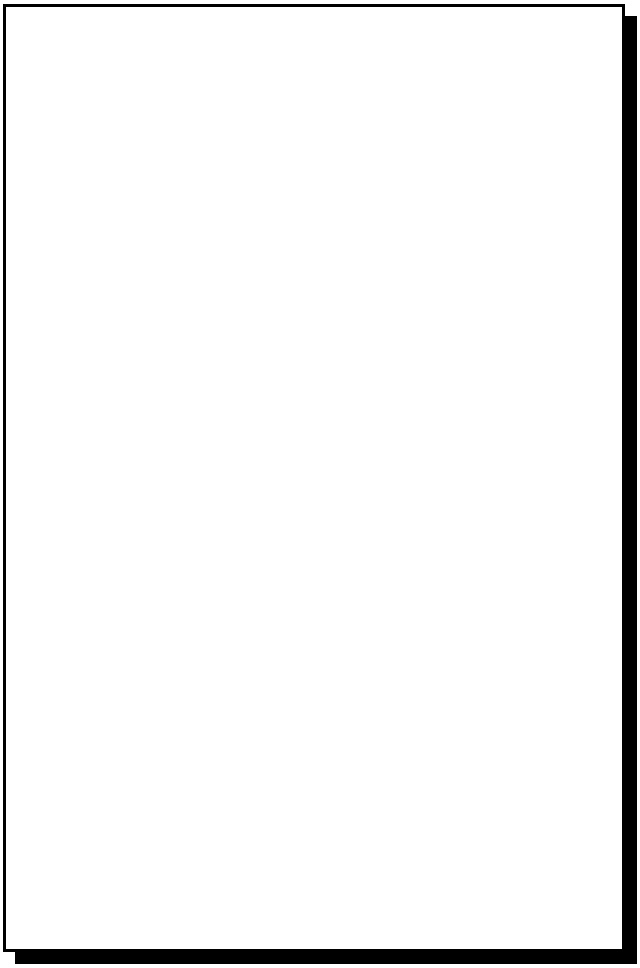

**Figure 4.** Schematic illustrating contemporary planning and management frameworks.

indicators, formulating realistic standards for those indicators, and periodically evaluating resource conditions in relation to those standards. When coupled with the participation of managers and other stakeholders, that information can form the basis for decisions about managing backcountry camping within Isle Royale National Park.

# LITERATURE REVIEW

This section briefly reviews the history of camping impact research and monitoring within the park and region and describes alternative approaches for assessing campsite conditions. As incorporated into an LAC/VERP management process, specific indicators of resource conditions must be identified and monitored. Therefore, criteria for selecting appropriate indicators are presented and discussed.

## Park and Regional Campsite Impact Research and Monitoring

Some limited campsite inventory work was conducted at ISRO in the early 1980's. However, this data could not be located and a formal report was never produced.

Considerable work has been conducted at the Boundary Waters Canoe Area Wilderness (BWCAW) of northeastern Minnesota, and findings are generally applicable to ISRO. University of Minnesota faculty and graduate students have conducted pioneering campsite impact research at the BWCAW, beginning with a study by Frissell and Duncan (1965). Frissell (1978) later developed the widely adopted condition class rating system based on this work. This was followed by an intensive five-year study of changing conditions on 33 newly established wilderness campsites (Merriam and others 1973) with limited measurements continued over a 15-year period (Merriam and Peterson 1983). This work was continued by a comprehensive assessment and evaluation of impacts on 96 well-established campsites (Marion 1984a, Marion and Merriam 1985a,b). A monitoring program based on this work (Marion 1984a,b) was initiated by Forest Service staff in 1985 and has been continued to the present. The monitoring manual was substantially revised in 1995 to incorporate improved procedures included within Marion (1991). A review of campsite management within the area, including a description of the BWCAW campsite maintenance program, is provided by Marion and Sober (1987).

The second author has also consulted in the development of a monitoring program at Voyageurs National Park of north central Minnesota. Applicable documents describing this program and campsite management at Voyageurs include Reume (1983a,b) and USDI (1985).

## Types of Campsite Impact Assessment Systems

Systems for assessing campsite and shoreline access conditions differ significantly in the type of information collected, assessment methods, and assessment time. Three general approaches can be been applied:

1) **photographic systems** - based on repeat photographs from permanent photo points;
2) **condition class systems** - based on descriptive visual criteria of general site conditions; and
3) **multi-indicator systems** - based on individual measurements and appraisals of many specific indicators of resource condition.

A brief summary of these approaches and systems follows. Cole (1989) and Marion (1991) contain comprehensive reviews of these systems.

Photographic systems were among the first applied to document the effects of backcountry visitors (Magill and Twiss 1965). Photographic methods are generally easy to establish, require little time for repeat photographs, and yield easily understandable visual records of campsite conditions. Disadvantages include poor comparability due to inconsistent photographic quality, lack of quantitative measurements for specific types of changes, and changes that are missed in areas hidden from view or not photographed. Additionally, assessment of photographic data requires extensive investment of time to handle and compare individual photographs.

Condition class systems have been described by Frissell (1978) and Marion (1991). Such systems consist of a set of statements describing increasing levels of resource change. Observers compare site conditions to these descriptive condition classes and record the class that most closely matches the conditions of the site being assessed. This type of system is easy and quick to apply and provides a useful summary measure of resource condition. However, as with photographic systems, this approach does not provide quantitative measurements of specific resource changes. Furthermore, the visual criteria used in these systems are subjective and require careful training of personnel to achieve consistent results. Perhaps most importantly, the data collected allow for only limited analysis because the differences between condition classes are not related linearly. Instead, they are ordinally related. An ordinal relationship means that a condition class 2 site is not necessarily twice as degraded as a condition class 1 site.

Multi-indicator systems are based upon independent assessments of several inventory variables and condition indicators. Rapid estimation systems designed by Parsons and MacLeod (1980), Cole (1983), and Marion (1984b) consist of 6 to 10 variables, each with 3 to 5 quantitatively defined rating categories reflecting the degree of change in a particular indicator. This is accomplished by having surveyors compare the indicator's condition on the campsite with its condition in similar but undisturbed areas adjacent to the site. Again, however, an investigator's selection of a measurement scale to reflect indicator conditions limits the types of analysis appropriate for the data.

More recently, Marion (1991) has formulated and refined multi-indicator systems that emphasize more accurate area measurements and assessments of campsite condition. This approach requires greater observer training and often takes two observers 15 minutes to complete. These procedures adopt elements of photographic, condition class, and multi-indicator systems to measure visitor impacts as effectively and efficiently as possible.

## Indicators of Backcountry Campsite Condition

Before monitoring can be initiated, appropriate resource indicators must be selected. A single, direct measurement of a campsite's condition is inappropriate because the overall condition is an aggregate of many components. Typically, then, monitoring evaluates various soil, vegetation, or aesthetic elements of a campsite that serve as indicators of that site's condition. An indicator is any setting element that changes in response to a process or activity of interest (Merigliano 1990a,b). An indicator's condition provides a gauge of how recreation has changed a setting. Monitoring programs provide reliable data on indicator conditions that permit comparisons across time to document and evaluate trends in campsite conditions. Comparison to management objectives or indicator standards reveals the acceptability of any resource changes. Similarly, monitoring assessments that follow the implementation of corrective management actions permit evaluations that reveal the effectiveness of those actions.

## Criteria for Selecting Indicators

Selection of indicators appropriate for a particular setting is one of the first judgements that must be made during a monitoring process. Cole (1989), Marion (1991), and Williams and Marion (1995) review criteria for their selection, which is summarized here. Potential indicators of resource condition are numerous and there is great variation in our ability to measure them with accuracy, precision, and efficiency. Accuracy refers to how close a measurement is to the true value, provided it could be measured without error. Precision refers to how close independent indicator measurements are to a common value. Both are important: accurate measures correctly describe how much change has occurred while precise measures permit objective comparisons of change over time. Comprehensive procedural manuals, staff training, and program supervision stressing quality control are necessary to produce objective data that support management decision making. Poorly managed monitoring efforts may result in measurement error that at best confounds data interpretation and at worst exceeds the magnitude of change attributable to recreational activities. Efficiency refers to the time, expertise, and equipment needed to measure the indicator's condition. Even the best measures are not feasible if managers lack available staff or time necessary to perform them.

Preferred indicators should also reflect campsite attributes that have ecological and/or aesthetic significance. Recreational trampling sufficient to expose a campsite's soil, for example, is aesthetically unappealing and renders the site vulnerable to soil compaction and erosion. Similarly, indicator measures should primarily reflect changes caused by the recreational activity of interest. For example, measures of tree damage should exclude damage caused by lightning strikes. However, soil erosion along the shorelines of campsites may be attributable to a combination of recreation use and natural forces, suggesting it would make a poor indicator in this particular setting. Indicators should be measurable, preferably at an interval or ratio scale where the distances between numeric values are meaningful i.e. a campsite with 100 $ft^2$ of exposed soil has twice as much as one with 50 $ft^2$. In comparison, condition class ratings are based on subjective assessments rather than quantitative measures, providing data at an ordinal scale. Distance between numeric values are not meaningful: as previously noted, a condition class 2 site is not necessarily twice as degraded as a condition class 1 site.

Preferred indicators are sensitive to change. Measurement techniques must be capable of reliably documenting change occurring over one monitoring cycle. Measures of soil erosion accurate to the nearest two inches would be unacceptable if soil loss is typically less than one-half inch per year. Indicators must also measure site condition attributes that are temporally stable on at least a weekly basis. Assessing the amount of trash on campsites every year or five years would not characterize the extent of this problem on individual sites, though an average for all sites measured throughout a summer may acceptably characterize this problem for the entire area. Research has documented an annual cycle of impact that increases in areal extent and severity over the use season followed by recovery during off-seasons (Marion and Cole 1996). Progressive phenological and recreation use season related changes, such as the annual cycle of on-site vegetation loss and recovery, can be addressed by completing future assessments within a two week window of time established by the date of the initial site assessment.

And finally, indicators that reflect depreciative behavior can be problematic when interpreting and applying results. Littering and damage or felling of trees have high ecological and social significance but their cause is often attributable only to a small number of visitors whose actions may be unresponsive to traditional management actions. Preferred indicators should also be responsive to management interventions. Indicators such as soil erosion and tree damage are difficult to correct or rehabilitate and exhibit slow recovery. Thus, monitoring such indicators may provide poor data with which to gauge the success of management interventions.

In summary, managers must consider and integrate a diverse array of issues and criteria in selecting indicators for monitoring impacts on campsites. Indicators will rarely score high on all criteria requiring good judgement as well as area-specific field trials and direct experience. Indicators that score high on some criteria but low on others may be retained in some instances or omitted in others. Tradeoffs are also required, such as a necessary reduction in accuracy so that precision and efficiency may be increased.

# STUDY AREA

## Park Resources and Visitation

Isle Royale National Park, established in 1940, is located in the northwest corner of Lake Superior, 73 miles from Houghton, Michigan, and 22 miles from Grand Portage, Minnesota. The park's terrain was formed by glaciers and includes exposed rocky ridges, numerous ponds, streams, and adjacent parts of Lake Superior. The park is particularly known for its moose and wolf populations but many other wildlife and fish species are also present. The approximate mean lake elevation is 601 ft with the highest elevation on the main island at approximately 1377 ft. In addition to the one large island, ISRO includes some 400 smaller islands and includes (USDI 1994). Approximately 99% of the park's land area is designated as wilderness. Because ISRO is managed as a wilderness area, pets and wheeled vehicles are prohibited in the park and no motorized vessels can travel on the inland lakes. The area was designated as an International Biosphere Reserve in 1980.

The park is open from April 16 until October 31 with transportation from the mainland to the park by boat or floatplane. There are 36 campgrounds with 244 camping and shelter sites, 165 miles of foot trails for hiking, and several inland lakes used for canoeing and kayaking. Primary recreation activities include hiking, fishing, camping, and boating, including motorboats of all sizes, sailboats, canoes, and sea kayaks. Visitor use statistics from 1996 permit data by type of recreational activity are presented in Table 2. Hiking and power boating are the predominant activities. Backcountry visitation from 1979 to 1996 is presented in Figure 5. Visitation has been gaining steadily at a 4-5% growth rate over the previous eight years, exceeding prior maximum use levels reached in the 1970's. While overall visitation is low compared to many other NPS units, the number of backcountry overnight stays ranked 10$^{th}$ in 1996 (USDI 1996b). More significantly, when figured on a per acre basis, ISRO has the highest number of backcountry overnights of all NPS units and the park is closed half of each year.

## Camping Policies

All visitors must obtain a permit for camping which describes their itinerary, party size, and types of activities they will engage in during their visit to the island. The park has also developed camping rules and regulations which govern camping location, group sizes, fires, sanitation, and visitor behavior to minimize resource impacts and reduce conflict between user groups. Special permits are also available, though rarely requested, for off-trail hiking and camping. Additional regulations apply to larger visitor groups (parties of 7-10 people), they must obtain camping reservations in advance of their trip, follow their established itinerary, and camp only within group campsites provided at many of the campgrounds. Most visitors camp within the 36 designated backcountry campgrounds (Figure 6) which contain a combination of group campsites and individual sites, the latter including campsites and/or three-sided wooden camping shelters (Figure 7, Table 3). The term backcountry campground is used because campsites and shelters are clustered together and often include other facilities such as docks, outhouses, and campfire rings.

**Table 2.** Backcountry visitor use, party size, and average length of stay by type of use.

| Visitor Statistics[1] | Hiking | Sailing | Power Boating | Canoeing | Kayaking | Total |
|---|---|---|---|---|---|---|
| **Visitors (#)** | 6,884 | 442 | 3,969 | 1,173 | 340 | 12,808 |
| **Parties (#)** | 2,312 | 151 | 1,169 | 404 | 107 | 4,143 |
| **Visitor Nights (#)** | 34,843 | 1,870 | 13,780 | 6,857 | 1,845 | 59,195 |
| **Party Nights (#)** | 11,138 | 660 | 4,188 | 2,353 | 631 | 18,970 |
| **Party Size (Avg.)** | 3.0 | 2.9 | 3.4 | 2.9 | 3.2 | 3.1 |
| **Nights Per Site (Avg.)** | 1.1 | 1.3 | 1.6 | 1.3 | 1.4 | 1.3 |
| **Nights Per Trip (Avg.)** | 4.8 | 4.4 | 3.6 | 5.8 | 5.9 | 4.9 |
| **Use Type (%)** | 54 | 3 | 31 | 9 | 3 | 100 |

1- 1996 data provided by ISRO from permit data, numbers are mutually exclusive and do not include non-recreation and concession lodging stays.

**Figure 5.** Isle Royale National Park backcountry visitation for 1979-96. Source: ISRO permit data.

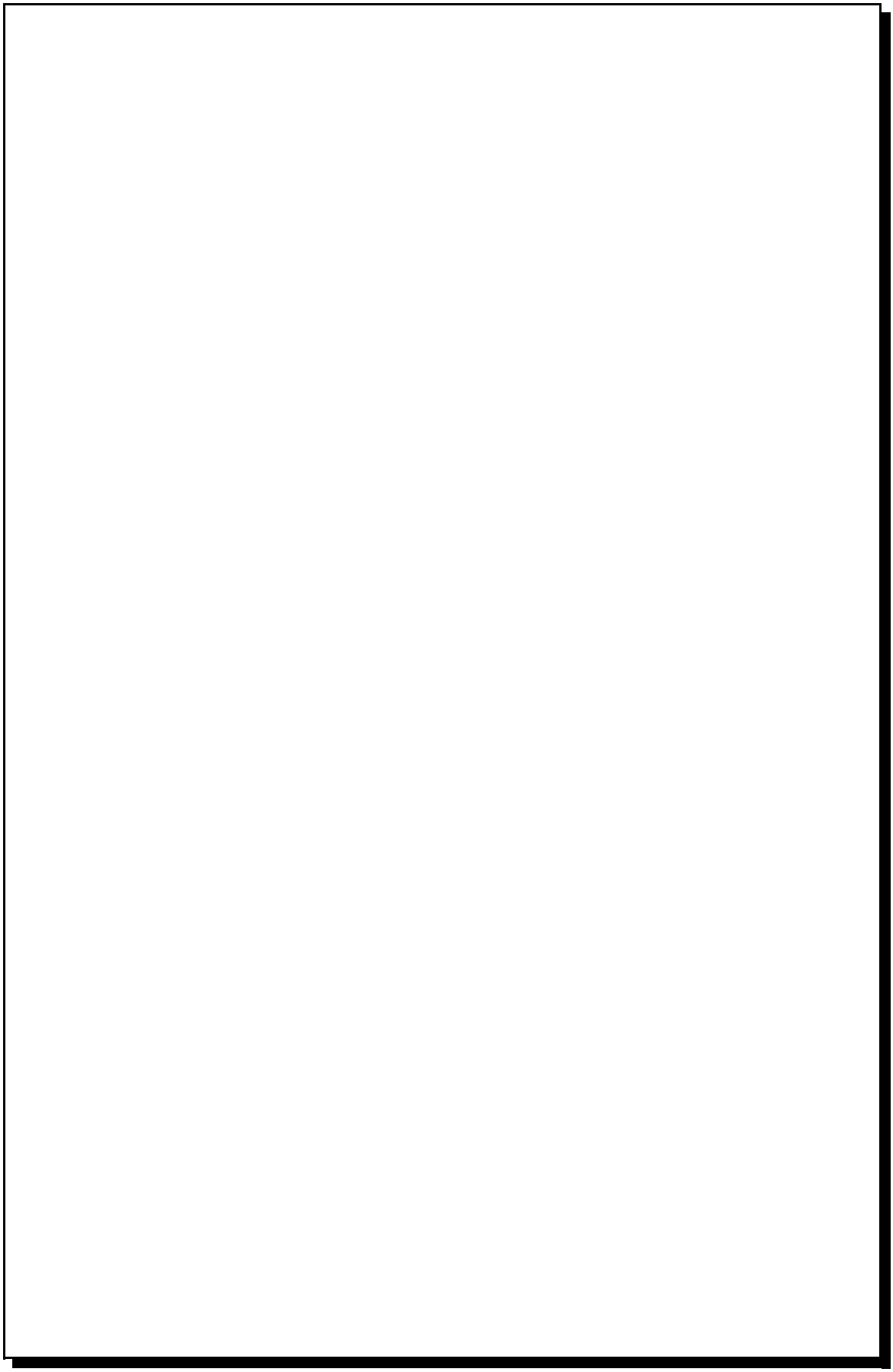

**Figure 6.** Isle Royale National Park including distribution of 36 backcountry campgrounds. Source: Isle Royale National Park.

**Figure 7.** Schematic diagram of the McCargoe Cove campground illustrating a typical arrangement of group campsites (triangles) and individual sites, including campsites (circles) and shelters.

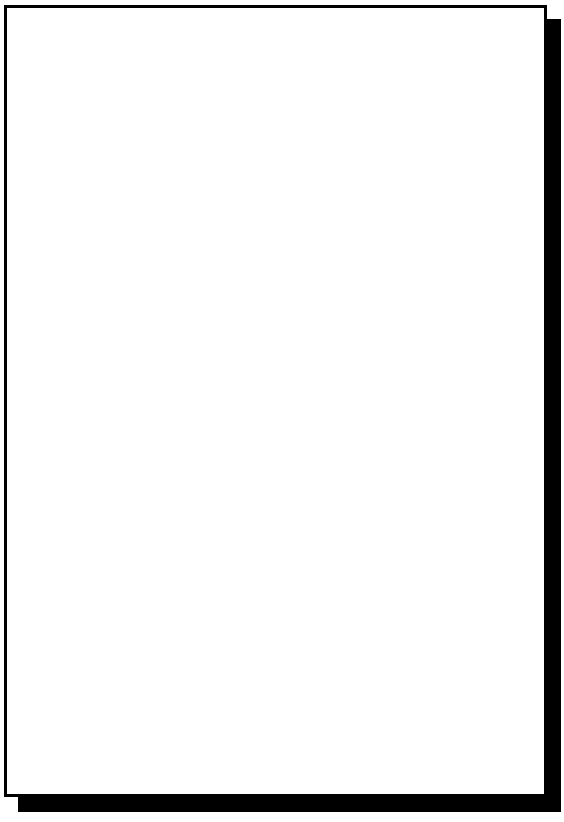

**Figure 8.** Diagram illustrating the arrangement of a typical group campsite and including a cross-sectional view showing cut and fill technique to create tent pads in sloped terrain.

**Table 3.** Campground characteristics: number of sites by site type, stay limits ,access, and fire policies.

| Campground Name | Individual Sites | Group Sites | Shelter Sites | Stay Limit in Days | Access /Fires[1] |
|---|---|---|---|---|---|
| **Beaver Island** | 0 | 0 | 3 | 3 | B-C-S |
| **Belle Isle** | 1 | 0 | 6 | 5 | B-C-F |
| **Birch Island** | 1 | 0 | 1 | 3 | B-C-S |
| **Caribou Island** | 1 | 0 | 2 | 3 | B-C-CR |
| **Chickenbone E.** | 3 | 1 | 0 | 2 | T-S-C |
| **Chickenbone W.** | 6 | 3 | 0 | 2 | C-S-T |
| **Chippewa Harbor** | 2 | 1 | 4 | 3 | B-C-F-T |
| **Daisy Farm** | 6 | 3 | 16 | 3 | B-C-S-T |
| **Desor N.** | 3 | 0 | 0 | 2 | S-T |
| **Desor S.** | 7 | 3 | 0 | 2 | S-T |
| **Duncan Bay** | 1 | 0 | 2 | 3 | B-C-F |
| **Duncan Narrows** | 1 | 0 | 2 | 3 | B-C-F |
| **Feldtmann Lake** | 5 | 2 | 0 | 2 | S-T |
| **Grace Island** | 0 | 0 | 2 | 3 | B-C-S |
| **Hatchet Lake** | 5 | 3 | 0 | 2 | S-T |
| **Hay Bay** | 1 | 0 | 0 | 3 | B-C-S |
| **Huginnin Cove** | 5 | 0 | 0 | 3 | S-T |
| **Intermediate Lake** | 3 | 0 | 0 | 2 | C-S |
| **Island Mine** | 4 | 2 | 0 | 3 | F-T |
| **Lake Richie/Hike** | 4 | 2 | 0 | 2 | C-S-T |
| **Lake Richie/Canoe** | 3 | 0 | 0 | 2 | C-S |
| **Lake Whittlesey** | 3 | 0 | 0 | 2 | C-S |
| **Lane Cove** | 5 | 0 | 0 | 3 | C-S-T |
| **Little Todd** | 4 | 0 | 0 | 2 | F-T-C |
| **Malone Bay** | 0 | 2 | 5 | 3 | B-C-F-T |
| **McCargoe Cove** | 3 | 3 | 6 | 3 | B-C-CR-T |
| **Merritt Lane** | 1 | 0 | 1 | 3 | B-C-S |
| **Moskey Basin** | 2 | 2 | 6 | 3 | B-C-S-T |
| **Pickerel Cove** | 1 | 0 | 0 | 2 | C-S |
| **Rock Harbor** | 11 | 3 | 9 | 1 | B-C-T-S |
| **Siskiwit Bay** | 4 | 3 | 2 | 3 | B-T-CR-F |
| **Three Mile** | 4 | 3 | 8 | 1 | B-C-S-T |
| **Todd Harbor** | 5 | 3 | 1 | 3 | B-T-CR |
| **Tookers Island** | 0 | 0 | 2 | 3 | B-C-S |
| **Washington Creek** | 5 | 4 | 10 | 3 | C-S-T |
| **Wood Lake** | 3 | 0 | 0 | 2 | C-S |

**1 - B**-Boat access. **C**-Canoe/kayak access. **CR**-Fires in community ring only. **F**- Campfires allowed or standing grills provided. **S**- Self contained stoves only. **T**-Trail access (USDI 1995).

Campgrounds at ISRO are frequently located within sloping terrain (5-12%). The construction of campsites typically involves cut and fill work, excavating upslope soils which are deposited downslope to create slightly sloped benches. This work is most frequently done for individual tent pads which adjoin each other or are linked by very short paths (Figure 8). Campsites generally consist of clusters of tent pads rather than a single larger site as is common in most other parks and wildernesses. Cooking activities also generally take place on an unused tent pad or at the edge of one of the larger tent pads. Tent pads are most commonly in the 12 by 12 foot range for individual sites and 14 by 14 foot for group sites. Their numbers vary, typically 1-3 (most commonly 2) for individual campsites and 3-5 (most commonly 5) for group campsites. All woody vegetation, rocks and stumps are removed within these tenting areas and the ground is smoothed and generally outsloped for drainage (3 inches in 12 feet, Doug Boose, personal communication). Rocks or logs are often embedded in the ground on the downslope sides to retain the fill material and prevent its erosion. Though tent pads in flatter terrain lack the cut and fill work that make them visually obvious, one or two logs are often embedded in the ground to aid in identifying the desired locations. The work to create a smooth surface and the impact of subsequent use also serves to visually identify tent pads in these settings.

Camping shelters and campsites cannot be reserved, they are available on a first-come, first-served basis. The number of sites are limited (Table 3) so visitors are advised to be prepared to travel to an alternate campground in case the one where they planned to stay is full. Alternately, visitors may double up with other parties as long as they do not exceed the site capacities. These limits include 6 people/night at shelter sites, 6 people/night and 3 tents at individual campsites, and 10 people/night at group campsites. Larger groups, 7-10 people, may only camp at group campsites and must follow their approved itinerary. Length of stay limits are also imposed for all campgrounds, ranging from one to three days (Table 3).

Campgrounds where shelters outnumber campsites generally receive heavy boater use. Campgrounds comprised predominantly of individual and group campsites are used more commonly by hikers. Campground use data are presented in Table 4. Average site occupancy for 1996 ranges from 62 visitors/site (Intermediate Lake) to 540 visitors/site (Grace Island). The majority of campgrounds received 200-299 visitors/site and only one exceeded two exceeded 300 visitors/site (Caribou Island and Grace Island) (Table 4). More importantly, campground capacities (number of groups vs. number of campground sites) were exceeded on two or more nights in 1995 for all but one campground (Table 4). Ten campgrounds exceeded their capacities (according to permit data) on more than 20 nights in 1995.

Waste disposal regulations stipulate that visitors use pit toilets where provided or the “cat-hole” method of burial in locations greater than 100 ft from trails, streams, lakes, or dry stream beds. Trash is to be packed out and feeding or intentional disturbance of wildlife is prohibited. Camping stoves are strongly encouraged but fires may be built in community fire rings, standing grills, or metal campfire rings where provided (Table 3).

**Table 4.** Campground overnight stays, average annual site occupancy, and nights/season over capacity.

| Campground Name | Total Overnight Stays (# visitors)[1] | Average Site Occupancy[1] (# visitors/site) | Nights/Season Over Capacity (#)[2] |
|---|---|---|---|
| **Intermediate Lake** | 185 | 62 | 0 |
| **Todd Harbor** | 1,559 | 173 | 2 |
| **Lake Whittlesey** | 344 | 115 | 3 |
| **Huginnin Cove** | 713 | 143 | 4 |
| **Little Todd** | 481 | 120 | 4 |
| **Washington Creek** | 3,829 | 202 | 4 |
| **South Desor** | 1,637 | 164 | 5 |
| **Malone Bay** | 1,242 | 177 | 7 |
| **Rock Harbor** | 3,738 | 163 | 7 |
| **Desor North** | 578 | 193 | 8 |
| **Hatchet Lake** | 1,630 | 204 | 9 |
| **Island Mine** | 1,532 | 255 | 9 |
| **Pickerel Cove** | 158 | 158 | 9 |
| **Daisy Farm** | 5,457 | 219 | 10 |
| **Three Mile** | 3,529 | 235 | 10 |
| **Wood Lake** | 542 | 181 | 12 |
| **Belle Isle** | 1,248 | 178 | 14 |
| **Birch Island** | 428 | 214 | 14 |
| **Chickenbone West** | 2,556 | 284 | 15 |
| **Duncan Bay** | 749 | 250 | 15 |
| **McCargoe Cove** | 3,157 | 263 | 15 |
| **Siskiwit Bay** | 2,456 | 273 | 15 |
| **Lake Richie / Canoe** | 698 | 233 | 16 |
| **Lake Richie / Hike** | 1,608 | 268 | 16 |
| **Feldtman Lake** | 1,787 | 255 | 18 |
| **Hay Bay** | 248 | 248 | 18 |
| **Merritt Lane** | 552 | 276 | 24 |
| **Duncan Narrows** | 678 | 226 | 25 |
| **Tookers Island** | 503 | 252 | 28 |
| **Lane Cove** | 1,099 | 220 | 29 |
| **Chippewa Harbor** | 1,846 | 264 | 30 |
| **Moskey Basin** | 2,766 | 277 | 32 |
| **Chickenbone East** | 899 | 225 | 34 |
| **Beaver Island** | 884 | 295 | 40 |
| **Caribou Island** | 1,101 | 367 | 45 |
| **Grace Island** | 1,079 | 540 | 51 |

**1** - 1996 data. Average site occupancy was calculated by dividing a campground's total overnight stays in 1996 by its number of sites.

**2 -** Nights/season over capacity is the number of nights in 1995 that each campground exceeded its capacity (nights when the number of groups, according to permit data, exceed the total number of campground sites) (1996 data was unavailable).

Educational approaches are also employed to encourage minimum impact camping practices. For example, visitor brochures suggest that visitors use equipment with natural colors to avoid visual impacts, and that visitors walk in the middle of trails and follow switchbacks to prevent trail erosion. Visitors are also asked to avoid making unnecessary noise and engaging in other disruptive activities to promote solitude.

## Historical Perspective

This section, contributed by Doug Boose with our editing, describes the history of ISRO campground construction and camping management based on his memory and that of Hal Hoenig, the current campground maintenance leader.

Shelter camping at ISRO has a long tradition with several pre-1950 log shelters surviving into the 70's at West Chickenbone Lake, Hatchet Lake, and north of Carnelian Beach. The present day shelters were built starting in the mid-1950's. The last two new shelters in the park were installed at Three Mile campground in 1972, though shelter maintenance and replacement are ongoing activities. Campgrounds with shelters had at least one privy and prior to 1973 designated tent sites did not exist, although informal overflow tenting areas were beginning to develop within the environs of many of the campgrounds with shelters. De facto, but undesignated camping areas at locations lacking shelters also existed. These locations included Lane Cove, Lake Richie, Little Todd, North Desor. There were also numerous well-used tent spots along park trails. Some of the most noticeable ones were along the Greenstone Ridge Trail four to nine miles out of Windigo. These tenting areas lacked privies. Camping and fires were permitted at all locations. However, most visitors preferred and spent the majority of their nights in shelters. Shelters at three locations [West Chickenbone Lake (1), Hatchet Lake (2), and south Lake Desor (1)] were removed upon passage of the ISRO Wilderness designation in 1976.

In 1973, the park formalized some of the informal camping locations. Tent sites were cleared where necessary and privies were installed at Lane Cove, East Chickenbone, Lake Richie, Little Todd, North Desor, Huginnin Cove, Island Mine, and Feldtmann Lake. Some of the canoe campgrounds were developed at this time or soon thereafter. This expansion of campgrounds and sites was in response to rapid increases in backcountry use occurring during the early 1970's. By 1974, camping outside of the designated campgrounds was by special permit only. From 1974 through 1982 tent sites were added sporadically in response to overcrowding at selected campgrounds. By the early 80's campfires had been eliminated at most of the busiest campgrounds.

Under the guidance of the Backcountry Management Group campground rehabilitation and maintenance work began in 1983. These efforts focused on creating inviting tent pads, separation of sites, and sometimes additional sites and privies. The absolute capacity of a campground was nearly always increased during this work (by providing more usable tent pads) even if the number of sites did not increase.

# RESEARCH METHODS

Research objectives called for the development of a standardized impact assessment system to monitor resource conditions on backcountry campsites and shelter sites and at shoreline accesses. The monitoring procedures emphasize the multiparameter measurement-based approach but incorporate condition class assessments and photographs from permanent photopoints. The condition class rating provides a quick assessment of general site conditions (Figure 9). The multiparameter assessment procedures provide more quantitative information on twelve shelter site and campsite impact indicators, and for three shoreline access impact indicators (Appendix 1). Photographs provide for visual comparisons of changes on individual sites over time.

**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.

**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.

**Figure 9.** Shelter site and campsite condition class definitions.

The survey's primary objective was to locate and assess all shelter sites and individual and group campsites within the park's 36 campgrounds. A census was viewed as necessary to provide comprehensive baseline information on the number, distribution, and condition of these sites for planning purposes and as a comprehensive baseline for future comparisons. A secondary objective was to locate and assess all shoreline access areas within the campgrounds. While future monitoring could use a sampling approach to increase efficiency, obtaining comprehensive data at the outset of the monitoring program permits greater flexibility in conducting future analyses. Census data also permit greater flexibility in selecting and evaluating management standards employed by management frameworks such as VERP (Figure 4).

Monitoring procedures were developed by Dr. Jeff Marion in consultation with ISRO resource manager Jack Oelfke and review by other park staff. Procedures were adapted from those applied in other campsite monitoring studies (Marion and Leung 1997, Williams and Marion 1995) and more fully described in Marion (1991). Procedures were field tested and further revised during a three-day pre-assessment staff training visit. Staff training emphasized the development of good judgement

in applying procedures and the importance of measurement accuracy, precision, and efficiency in all field assessments.

Field work was conducted by ISRO seasonal field staff provided and supervised by Jack Oelfke, ISRO Resource Management Specialist. Survey staff included two summer NPS park natural resource interns, Meghan Wendt and Mark Romanski, college students with majors in the natural sciences and experienced in backcountry camping. Tracy Farrell (first author of this report) also assisted with fieldwork for a two week period. Survey staff worked together, dividing assessment procedures among them. Field work, including staff training, was conducted from June 15 to August 30, 1996 (two staff, 10 weeks).

Campsites and shelter sites were located using a variety of information and approaches. Designated campsites were located by reviewing ISRO site maps for each campground. During their travels to assess designated sites, survey staff also searched for illegal campsites. However, time was unavailable to conduct extensive searches so this report does not reflect the number, distribution, or conditions on these illegal sites. Shoreline accesses were located by walking campground and formal park trails and by following access trails from the sites toward the lakeshore. Shoreline access landing areas were recorded as either site specific or as serving multiple sites. In instances where more than one shoreline access landing area served a single site (N=8) their areas were combined.

Sites, which include individual and group campsites and shelters, were defined as areas of obvious vegetative or organic litter disturbance that in the judgement of survey staff was caused by camping activities. Furthermore, the disturbance had to be of such extent to produce a discernable boundary between disturbed and undisturbed areas. Site size was measured using the variable radial transect method (Appendix 1). The size of satellite tent sites, those separate from the main site, and of shoreline access landing areas were measured using the geometric figure method (Appendix 1).

Indicator conditions were typically assessed only within the established boundary of the site, with additional procedures to allow for assessments of "satellite" use areas and tree damage in adjacent off-site areas (Appendix 1). Fixing the area of interest within campsite boundaries increases the precision of assessments, however, this approach reduces measurement accuracy. For example, counts of damaged trees and stumps conducted only within campsite boundaries increase the efficiency and precision of these assessments for future monitoring efforts but decrease the accuracy of assessing total or aggregate tree damage and felled trees. At ISRO, site construction techniques leave few trees within site boundaries so damaged and felled trees are most prevalent in adjacent off-site areas. For this reason these two indicators were also assessed within 50 ft of site boundaries, acknowledging that such measures will likely be less precise than on-site measures. On-site measures are emphasized in this report because experimental trials have shown that surveyors conducting off-site assessments vary in their thoroughness, and problems are encountered when assigning damaged trees that are mid-way between two sites.

In summary, for monitoring purposes it is critical that managers recognize the trade-offs between measurement accuracy and precision for future monitoring purposes. Precision is typically favored

over accuracy because a standards-based management framework requires a high degree of precision for reliable comparisons of data to standards and to data of other monitoring cycles.

Site and shoreline access impact indicators were selected on the basis of earlier recreation ecology and visitor impact perception studies, indicator selection criteria, and discussions with park staff. For soil, the percentage of exposed soil was assessed according to a six-category cover-class scale (Appendix 1). The number of trees with moderate to severe root exposure were counted within delineated site boundaries as an indication of soil compaction and erosion. For vegetation, the percentage of ground covered by non-woody vegetation on-site and off-site was estimated according to the six-category cover-class scale. Number and degree of damaged trees and number of tree stumps were also assessed separately both on- and off-site. To evaluate camping solitude, a number of indicators of site density and intervisibility were included at the request of park staff. These and other aesthetic indicators included the number of trails extending from a site, distance from the site to lakeshore and formal park and campground trails, distance to nearest other site, number of other sites visible, number of fire scars or fire rings, presence of litter, and presence of improperly disposed human waste. For shoreline accesses, landing area size, erosion, and associated trail erosion were assessed.

## Data Analysis and Statistical Testing

A challenge associated with all resource inventory and monitoring programs is efficient storage and evaluation of collected data. Occasionally, because of the extensive time required for data input and analysis, monitoring data may not be interpreted or used in the planning and management process as originally intended. To alleviate this problem, a database was produced using dBASE III+, a database management package, and exported into SPSS for Windows vers. 7.5.1, a statistical analysis package allowing a full range of standardized analyses (SPSS, Inc. 1997).

Study results are presented in both tabular and graphical formats to facilitate interpretation and application of the data. Both the mean (arithmetic average) and median (value above and below which half of the measurements fall) are reported. The mean is not always the best measure of central tendency due to the effect of outlier data (values that are far removed from the rest) and distributions which are highly skewed (not distributed in the form of a bell-shaped curve). In these instances the median provides a better estimate of central tendency and is emphasized in discussions for those indicators. The standard deviation is reported as well as the minimum and maximum values, which serve as evidence of the range of conditions and of data variability.

Statistical testing is used to evaluate the influence of various factors on extent of site impact. Two statistical tests employed include the independent samples t-test and the Analysis of Variance (ANOVA) General Linear Model (GLM) General Factorial procedure (SPSS, Inc. 1997). The t-test compares the mean, or average, value of an indicator between two different groupings of records. Specifically, it tests the null hypothesis that the two groups are samples from populations that have the same mean value. For example, testing to see if high use campsites have significantly more exposed soil than low use sites.

The ANOVA GLM General Factorial procedure provides regression analysis and analysis of variance for one dependent variable by one or more independent factors. For example, testing to see if exposed soil (the dependent variable) is influenced by forest cover type and/or site type (the independent factors). The factor variables divide the population into groups. The GLM procedure tests null hypotheses about the effects of independent factors on the means of various groupings of the dependent variable. The GLM procedure can also provide means for one factor that are adjusted to account for the influence of another factor. For example, means can be calculated for amount of exposed soil under different forest cover types that are "adjusted" to account for and reflect the potentially confounding influence of site type. Interactions between factors can also be investigated; when significant these can complicate interpretation of the main effects. The t values and F ratios generated by these tests are compared to table values to determine their significance, or probability value (p value). For this report, p values less than 0.05 are considered statistically significant and appear in bold in table listings.

## Measurement Error

Readers are cautioned to consider measurement error when reviewing the study results. Every measurement of an indicator consists of two components: (1) a component reflecting an accurate assessment of true conditions, and (2) a component reflecting measurement error. Ideally, indicator measures should be both accurate (closely approximating the true value) and precise (multiple raters should yield similar values). Efforts were made to minimize measurement error through the development of detailed measurement procedures and the hiring, training, and supervision of capable field staff.

Experimental assessments of measurement error were conducted in 1990 (unpublished) and 1993 (Williams and Marion 1995) in Shenandoah National Park using procedures similar to those applied in this study. Results from these exercises have been used to improve the assessment procedures employed in this survey. Regardless, measurement error remains a component of all measures which managers must consider when making decisions based on monitoring data. Further discussion on this issue is provided in Williams and Marion (1995).

# SURVEY RESULTS

Survey results describe findings from evaluations of a census of the park's backcountry campsites, shelter sites, and associated shoreline accesses. Throughout this report the term "site" refers collectively to shelters and campsites (both individual or group). Survey results describe: (1) site numbers and distribution, (2) site inventory indicators, (3) site impact indicators, (4) comparisons by wilderness designation, site type and management zone, and (5) relational analyses to investigate how various environmental, use-related, and management factors influence site conditions.

## Number and Distribution of Campgrounds, Campsites, and Shelter Sites

Within the park's 36 campgrounds survey staff located and assessed 244 sites, including 113 individual campsites, 43 group campsites, and 88 shelters (Table 5). The number of sites per designated campground, including individual and group campsites and shelters, ranges from 1 to 25 with a mean of 6.8. Of the 36 campgrounds, 14 have between one and three sites, seven campgrounds have between four and six sites, eight have between seven and nine sites, and seven have ten or more sites.

Site distribution between wilderness and non-wilderness is approximately equal: 116 (47.5%) campsites and shelters are in wilderness and 128 (53%) are in non-wilderness. Site distribution by type of site varies: there are more individual sites (76 sites, 67%), about equal numbers of group sites (20 sites, 47%), and fewer shelters (20 sites, 23%) in wilderness (Table 5).

Park literature states that visitors must camp only at "designated sites and shelters"and also must obtain a permit. During field work survey, staff examined likely places to camp visible from campground and park trails. Only two illegal campsites were found. While this search was not thorough, the small number of "illegal" campsites suggests that visitors are in substantial compliance with the designated site camping policy.

**Table 5.** Distribution of individual and group campsites, and shelters in wilderness and non-wilderness areas.

| Wilderness Designation | Individual Campsites | Group Campsites | Shelter Sites | Totals |
|---|---|---|---|---|
| **Non-Wilderness (#)** | 37 | 23 | 68 | 128 |
| ***(Column %)*** | *33* | *54* | *77* | *53* |
| **Wilderness (#)** | 76 | 20 | 20 | 116 |
| ***(Column %)*** | *67* | *46* | *23* | *47* |
| **Parkwide Totals (#)** | 113 | 43 | 88 | 244 |
| ***(Row %)*** | *46* | *18* | *36* | *100* |

## Site Inventory Indicators

Information on a number of campsite inventory indicators was collected to characterize site locations with respect to physical and social characteristics. Social characteristics, such as distance between sites, are presented separately to facilitate discussion of social indicators and their implications for managing visitor crowding or conflict. Data for physical and social characteristics are presented separately by site type, including individual campsites (N=113), group campsites (N=43), and shelters (N=88).

### Physical Characteristics

Inventory indicators of physical characteristics include distance to lakeshore, dominant vegetation type, whether or not fires are permitted, whether or not picnic tables are provided, number of tent pads, and shoreline substrate type.

#### Distance to Lakeshore

The majority of sites (141, 58%) is within 26-300 ft of a lakeshore; only 31 sites are more than 500 ft from a lakeshore (Table 6). Half of the individual campsites (56, 50%) and shelter sites (49, 56%) are within 100 ft of the lakeshore. The medians for both of these site types fall into the second category of 26-100. Group campsites are furthest from the lakeshore with sixteen (37%) located more than 500 ft inland. The shelters are closest to lakeshores with 26 (30%) within 25 ft. Individual campsites are more evenly distributed, with 16 (14%) within 25 ft and 14 (12%) greater than 500 ft from the lakeshore.

#### Forest Cover Type

Ten species of dominant and co-dominant trees were recorded. The most common tree species on campsites are white spruce (84 sites, 34%), white birch (56 sites, 23%) and balsam fir (54 sites, 22%) (Table 6). The category "Other" includes balsam poplar, black spruce, sugar maple, tag alder, and white cedar.

#### Campfires

Campfires are not permitted on the majority of sites (206, 84%) (Table 6). Fires are not permitted at 99 (88%) of the individual campsites, at 38 (88%) of the group campsites, or at 69 (78%) of the shelter sites. However, four of the 36 campgrounds have group fire sites located in a central "commons" area. In nine of the campgrounds, campfires are allowed or standing grills are provided. Fires are more commonly permitted in wilderness (24 sites) than non-wilderness (14 sites).

#### Picnic Tables

Picnic tables are provided at 156 (64%) of the sites (Table 6). The provision of picnic tables differs by site type. Nearly all shelter sites 85 (97%) have picnic tables. Most shelters are in the more accessible areas. For group campsites, the majority (26 sites, 61%) also has picnic tables. Conversely, the majority of individual campsites (68, 60%) lacks picnic tables. Picnic tables are provided on 33 (28%) of the wilderness sites, including 19 shelters, 11 individual campsites, and 3 group campsites.

**Table 6.** Number and percent of individual and group campsites and shelters for selected inventory indicators of physical characteristics.

| Inventory Indicators | Individual Campsites (N=113) | | Group Campsites (N=43) | | Shelter Sites (N=88) | |
|---|---|---|---|---|---|---|
| | Number | Percent | Number | Percent | Number | Percent |
| **Distance to Lakeshore** | | | | | | |
| **#25 ft** | 16 | 14 | 1 | 2 | 26 | 30 |
| **26-100 ft** | 41 | 36 | 12 | 28 | 23 | 26 |
| **101-300 ft** | 31 | 27 | 11 | 26 | 23 | 26 |
| **301-500 ft** | 11 | 10 | 3 | 7 | 15 | 17 |
| **>500 ft** | 14 | 12 | 16 | 37 | 1 | 1 |
| **Forest Cover Type** | | | | | | |
| **Balsam Fir** | 21 | 19 | 5 | 12 | 28 | 32 |
| **Quaking Aspen** | 7 | 6 | 12 | 28 | 10 | 11 |
| **White Birch** | 40 | 35 | 11 | 25 | 5 | 6 |
| **White Spruce** | 35 | 31 | 10 | 23 | 39 | 44 |
| **Other Trees** | 10 | 9 | 5 | 12 | 6 | 7 |
| **Campfires Permitted** | | | | | | |
| **Yes** | 14 | 12 | 5 | 12 | 19 | 22 |
| **No** | 99 | 88 | 38 | 88 | 69 | 78 |
| **Picnic Tables** | | | | | | |
| **Yes** | 45 | 40 | 26 | 61 | 85 | 97 |
| **No** | 68 | 60 | 17 | 39 | 3 | 3 |
| **Tent Pads** | | | | | | |
| **1-2** | 84 | 74 | 0 | 0 | | |
| **3-4** | 28 | 25 | 16 | 37 | NA | NA |
| **5-6** | 1 | 1 | 27 | 63 | | |
| **Shoreline Substrate[1]** | | | | | | |
| **Bedrock** | 7 | 25 | 3 | 60 | 7 | 29 |
| **Cobble** | 3 | 11 | 0 | 0 | 6 | 25 |
| **Dirt/Soil** | 18 | 64 | 2 | 40 | 10 | 42 |
| **Sand** | 0 | 0 | 0 | 0 | 1 | 4 |

1-Sites numbers are reduced as some sites lack shoreline access.

**Tent Pads**

Tent pads, including both management constructed and visitor created, were also counted and measured at each site. The number of tent pads per site ranges from 0 to 6 with a mean of 1.8. At individual campsites, the majority (84 sites, 74%) has one to two tent pads (Table 6). Visitors do not appear to be creating additional tent pads at these sites. Group campsites do not have less than three tent pads on any site, with the majority (27 sites, 63%) having five or six tent pads. Mean tent pad size is 131 $ft^2$ with a range of 74-223 $ft^2$. Additional data for this indicator are presented in the Site Impact Indicators section under Site Size.

### Shoreline Substrate Type

Substrate type was recorded at shoreline access points affiliated with 57 campsites and shelters. The remaining campsites and shelters (N=187) either did not have shoreline access or they shared a common access with other campground sites: a total of 60 of these multiple shoreline accesses were measured. Of the 57 sites with their own shoreline access points, half have soil substrates, less preferred due to the potential for erosion (Table 6). However, 17 site accesses have resistant bedrock substrates and nine have cobble. The shoreline substrate types of the 60 campground accesses were also recorded: 20 (33%) are cobble, 18 (30%) are dirt or soil, 15 (25%) are bedrock, and 5 (8%) are sand.

## Social Characteristics

A variety of site location and visibility indicators were included to permit evaluations of the potential for solitude, primarily for campers but also for hikers on park trails. Inventory indicators of social characteristics include means of visitor access, distance to the nearest other campsite and to campground trail, number of other sites visible, and whether or not the campsite or shelter is visible from the campground trail and from the nearest formal hiking trail.

### Means of Access

Visitors have different expectations and behaviors which may lead to conflict between user groups, such as kayakers and motorboat users. A common method for addressing the problem of conflicting uses is to spatially separate different user groups. Isle Royale campgrounds may be accessed by water using canoes, kayaks, and motorized boats and by land via hiking trails. The survey staff determined means of access based on park rules and regulations, presence of trails, and consideration of other factors like water depth and characteristics of shoreline accesses.

Regardless of site type, multiple access by boats and by trail is the most common access category (136 sites, 56%) (Table 7). Shelter sites most strongly demonstrate this trend, 67 (76%) are accessible by all forms of access. The only other type of access for the remaining 21 shelter sites is by non-motorized and motorized boats. Primary access for 27 (63%) of the group campsites is also by non-motorized and motorized boats and trails. The means of access for individual campsites is the most diverse, including 30 sites (27%) accessible only by trail. Of all of the campsite types, the individual campsites best separate different user groups. Wilderness boundaries stop at the shoreline so visitors traveling by motorboat can access wilderness campsites. One-quarter of the wilderness sites (N=30) are accessible by motorboats.

**Table 7.** Number and percent of individual and group campsites and shelters for selected inventory indicators of social characteristics.

| Inventory Indicators | | Individual Campsites (N=113) | | Group Campsites (N=43) | | Shelter Sites (N=88) | |
|---|---|---|---|---|---|---|---|
| | | Number | Percent | Number | Percent | Number | Percent |
| **Means of Access[1]** | | | | | | | |
| | **NM Boats/Trail** | 28 | 24 | 6 | 14 | 0 | 0 |
| | **NM/M Boats** | 13 | 12 | 0 | 0 | 21 | 24 |
| | **Trail Only** | 30 | 27 | 10 | 23 | 0 | 0 |
| | **NM/M Boats/Trail** | 42 | 37 | 27 | 63 | 67 | 76 |
| **Number of Other Sites Visible** | **0** | 13 | 12 | 6 | 14 | 3 | 3 |
| | **1** | 37 | 33 | 23 | 54 | 26 | 30 |
| | **2** | 45 | 40 | 13 | 30 | 24 | 27 |
| | **3** | 13 | 12 | 1 | 2 | 21 | 24 |
| | **$4** | 5 | 3 | 0 | 0 | 14 | 16 |
| **Distance to Nearest Other Site** | **0-50 ft** | 40 | 35 | 5 | 12 | 37 | 42 |
| | **51-100 ft** | 48 | 43 | 20 | 47 | 40 | 46 |
| | **101-150 ft** | 17 | 15 | 9 | 21 | 8 | 9 |
| | **151-200 ft** | 7 | 6 | 2 | 5 | 2 | 2 |
| | **>200 ft** | 1 | 1 | 7 | 16 | 1 | 1 |
| **Distance to Campground Trail** | **0-50 ft** | 58 | 51 | 13 | 30 | 63 | 72 |
| | **51-100 ft** | 36 | 32 | 14 | 33 | 19 | 22 |
| | **101-150 ft** | 9 | 8 | 4 | 9 | 5 | 6 |
| | **151-200 ft** | 5 | 4 | 4 | 9 | 0 | 0 |
| | **>200 ft** | 5 | 4 | 8 | 19 | 1 | 1 |
| **Site Visibility from Campground Trail** | **Yes** | 98 | 88 | 32 | 74 | 88 | 100 |
| | **No** | 12 | 12 | 11 | 26 | 0 | 0 |
| **Site Visibility from Formal Trail** | **Yes** | 32 | 28 | 13 | 30 | 50 | 57 |
| | **No** | 68 | 60 | 30 | 70 | 25 | 28 |
| | **Missing Data** | 13 | 12 | 0 | 0 | 13 | 15 |

1 - NM=nonmotorized, M=motorized

**Number of Other Sites Visible**

The number of other sites that are visible from each campsite or shelter, a measure of site inter-visibility, was assessed to evaluate the potential for solitude while camping. The number of other sites visible ranged from zero to six with a mean of 1.8. Overall potential for solitude is low. Only 22 (9%) of the sites have no other sites visible while 19 sites (8%) have four or more other visible sites (Table 7). Based on this indicator the potential for solitude is highest at group campsites: one or fewer sites are visible from 29 (60%) of group sites, compared to 45% of the individual campsites and 33% of the shelter sites. As large groups are often comprised of youth the issue of noise remains a threat to solitude within the group camping areas. The potential for solitude is higher in wilderness than in non-wilderness areas: three or more sites are visible from 42 (36%) of the non-wilderness sites compared to only 8 (6%) of the wilderness sites. For more than one-half of the wilderness sites, one or no sites are visible compared to one-third of the non-wilderness sites.

**Distance to Nearest Other Site**

Potential for visitor solitude while camping was also assessed by measuring the distance from each site to its nearest neighboring site (between site boundaries). Inter-site distance ranged from 0 to 334 ft with a mean of 76 ft. Data are presented in 50 ft categories in Table 7. In agreement with inter-site visibility findings, the overall potential for solitude is low and group campsites offer the greatest opportunities for solitude (notwithstanding noise-related issues). Twenty-five (59%) of the group sites are within 100 ft of another site, compared to 78% of individual sites and 88% of shelters. In particular, a large proportion of shelters (37 sites, 42%) are within 50 ft of other sites. Inter-site distances in wilderness areas range from 0 to 334 ft with a mean of 82 ft. In non-wilderness areas, sites are somewhat closer together: distance to nearest other site ranges from 3 to 322 ft with a mean of 71 ft.

**Distance to Campground Trail**

The shortest distance from site boundaries to the campground trail was also measured to evaluate the potential for visitor solitude while camping and to characterize the location of sites within campgrounds. Distance to campground trail ranges from 0 to 352 ft with a mean of 64. The majority of sites (83%) are within 100 ft of a campground trail (Table 7). Shelters are the most densely clustered sites and are also closest to campground trails: 63 (72%) are within 50 ft of trails. Half of the individual campsites (58, 51%) are within 50 ft compared to less than one-third of the group campsites (13, 30%). In non-wilderness, campground trail distance is shorter (0 to 42 ft with a mean of 55 ft) than in wilderness (0 to 352 ft with a mean of 73 ft).

**Site Visibility from Campground Trail**

Site visibility from the campground trail was also assessed. Most sites (218, 89%) are visible from the campground trail (Table 7). All shelters are visible from campground trails, compared to 88% of individual campsites and 74% of group campsites. Of the 116 wilderness sites, 98 (84%) are visible from campground trails. Of the 128 non-wilderness sites, 120 (94%) are visible.

**Site Visibility from Formal Trail**

Site visibility from a formal park trail was assessed; park trails often have higher traffic and site visibility also affects the perception of solitude for hikers. A majority of sites are not visible from formal park trails (123 sites, 56%) (Table 7). Though some missing data complicates interpretation, about one-third of the individual and group campsites and just over one-half of the shelter sites are

visible from formal trails. In wilderness, 38 sites (37%) are visible from formal park trails compared to 57 sites (45%) in non-wilderness.

## Site Impact Indicators

Assessment methods and parkwide results are described for 13 impact indicators to characterize the condition of campsites and shelters (collectively referred to as sites), and shoreline accesses. Data are presented in a following section by wilderness status and by site type.

### Campsites and Shelter Sites

#### Condition Class

A descriptive condition class system (Figure 8, Methods section) was applied to all surveyed campsites and shelter sites. Only one site is lightly altered (condition class 1), characterized by minimal vegetation disturbance and generally small size (Table 8). About one-tenth of the sites (31, 13%) are rated condition class 2, with vegetation cover lost and/or organic litter pulverized in primary use areas (Table 8). The most common condition class rating, class 3, was assigned to 179 sites (72%). These sites have substantial organic litter disturbance and vegetation loss (mean vegetation loss = 66%), with bare soil exposed in primary use areas (mean exposure = 34%). Fewer sites (33, 14%) are rated condition class 4, characterized primarily by their substantial soil exposure (mean exposure = 72%). Finally, none of the sites have obvious soil erosion (condition class 5). It is interesting to note that site size is not strongly related to condition class. Condition class 4 sites are not substantially larger than class 2 or 3 sites.

Condition class does not differ greatly by wilderness designation or site type. The majority of non-wilderness sites (96, 75%) and wilderness sites (83, 72%) are rated condition class 3. However, 22 (19%) of the wilderness sites are rated condition class 4 compared to 11(8%)of the non-wilderness sites. Among site types: 20 individual campsites (18%), 8 group campsites (19%), and 5 shelter sites (6%) are rated condition class 4.

**Table 8.** Number, percent, size, vegetation cover, and exposed soil of legal campsites and shelter sites by condition class (N=244).

| Condition Class | Sites | | Average Site Size ($ft^2$) | Avg. Vegetation Cover (%) | Avg. Exposed Soil (%) |
|---|---|---|---|---|---|
| | Number | Percent | | | |
| **1** | 1 | 1 | 419 | 98 | 0 |
| **2** | 31 | 13 | 741 | 62 | 5 |
| **3** | 179 | 72 | 720 | 26 | 34 |
| **4** | 33 | 14 | 776 | 8 | 72 |

### Site Size

Site boundaries were defined by pronounced changes in either vegetation cover, vegetation height or disturbance, vegetation composition, surface organic litter, or topography (Appendix 1). Site size was assessed by measuring the length and azimuth of transects radiating from a center point to site boundaries (see Variable Radial Transect Method, Appendix 1). Areas were computed from transect measurements. The area occupied by the "footprint" of shelters (150 $ft^2$) is included in areal measures of site size.

Sites range in size from 132 to 2,571 $ft^2$ with a median size of 554 $ft^2$ (Figure 10). Many sites are extremely small. For example, 102 sites (42%) are less than 501 $ft^2$ and approximately two-thirds of the sites are under 751 $ft^2$. Seven sites are greater than 2000 $ft^2$ in size. The total area of disturbance from camping (sum of areas for all sites) is 177,964 $ft^2$, equivalent to 4.09 acres.

For monitoring purposes, managers are most interested in the increase in site sizes beyond that accounted for by the constructed tent pads. Therefore, we subtracted from site size measures the areas of constructed tent pads. For individual campsites, the recalculated site size ranges from 30-1183 $ft^2$, with a mean of 408 and a total area of disturbance of 46,155 $ft^2$. For group campsites, the recalculated site size ranges from 0-1759 $ft^2$, with a mean of 847 and a total area of disturbance of 36,429 $ft^2$.

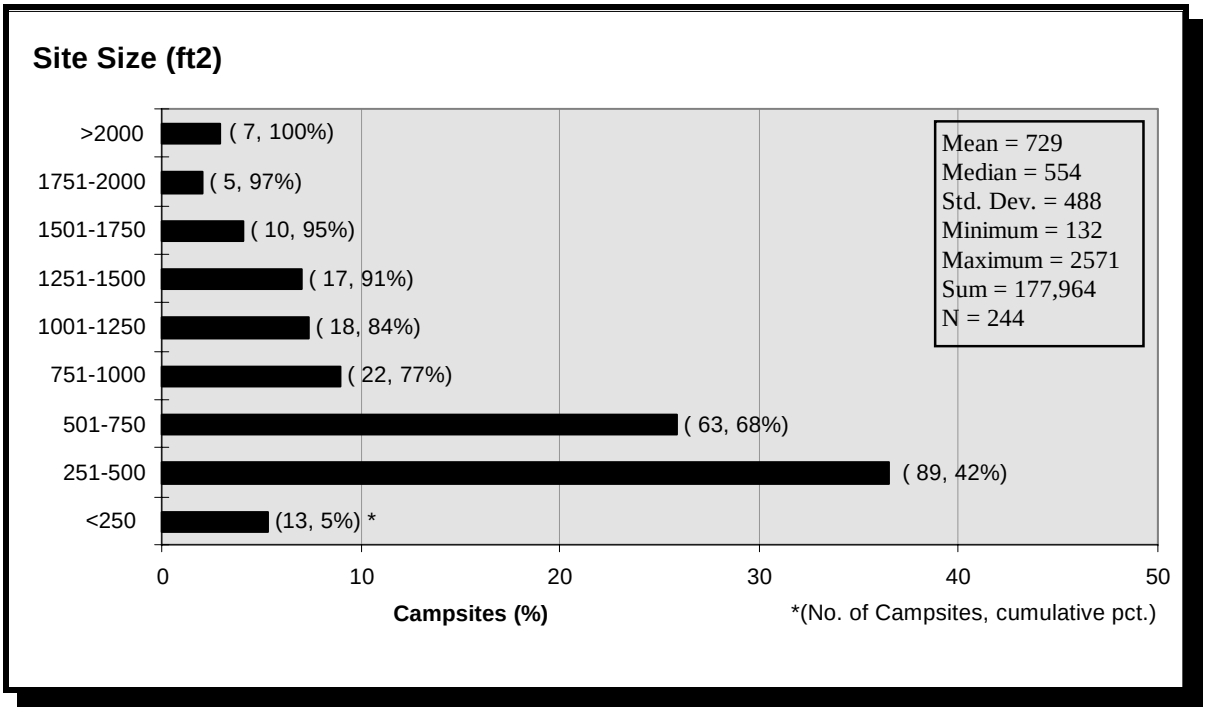


**Figure 10.** Frequency distribution and descriptive statistics for site size

### Vegetation Loss

Vegetative groundcover was assessed both within site boundaries and in adjacent undisturbed off-site areas with similar environmental attributes. Surveyors estimated the percent of live non-woody vegetative ground cover (herbs, grasses, and mosses) in each location and recorded the most appropriate vegetation coverage class from pre-defined categories (Appendix 1). Coverage class midpoints were used to estimate the percentage of vegetation groundcover lost on sites by subtracting on-site values from off-site values. The area of ground vegetation loss was then calculated by multiplying percentage of vegetation groundcover loss by site size. This measure emphasizes the areal extent of vegetation loss. A 50% loss of vegetation on a 2000 $ft^2$ site should be viewed more critically than a 50% loss on a 100 $ft^2$ site.

Median percent vegetation groundcover on sites is 16% (mean = 29%). Vegetation cover is quite sparse on more than half of the sites: 66 sites (27%) have 0-5% vegetation cover and another 74 sites (30%) have 6-25% cover. In contrast, median percent vegetation groundcover in undisturbed off-site areas is 98% (mean = 91%), which describes 173 (71%) of the sites.

Median percent vegetation loss on sites is 61% (mean = 62%). Nearly 80% of the sites lost more than 80% of their estimated original cover. Vegetation loss of this extent is not uncommon on heavily used designated sites. Two sites have more vegetation groundcover than environmentally similar, adjacent off-site areas. Most often this occurrence results from the growth of moss or trampling resistant groundcover. Moss is often able to colonize peripheral portions of sites due to reduced ground vegetation and organic litter; the cover of resistant species can increase when tree loss opens the forest overstory.

The area over which vegetation groundcover changed ranges from a gain of 189 $ft^2$ to a loss of 2085 $ft^2$ with a median loss of 343 $ft^2$ (Figure 11). The areal extent of vegetation loss is relatively small. For sites estimated to have lost vegetation cover (N=238), 170 (70%) lost less than 500 $ft^2$. Many sites have lost only small areas of vegetation, e.g. 88 sites (36%) have lost less than 250 $ft^2$.

### Exposed Soil

Exposed soil was assessed using the same predefined categories and mid-point transformations as vegetation loss (Appendix 1). Exposed soil was defined as areas with very little or no organic litter or vegetation cover. Exposed soil in undisturbed areas is extremely rare, so the area of exposed soil ($ft^2$) was computed by multiplying percent exposed soil on sites by site size.

Exposed soil occurs on all sites and is distributed over a broad range. As estimated by mid-point values for the six coverage class categories, percent soil exposure is 2.5% on 44 sites, 15% on 64 sites, 38% on 64 sites, 63% on 46 sites, 85% on 25 sites. Median percent soil exposure is 38% (mean = 36%).

The area of exposed soil ranges from 6 to 1,906 $ft^2$ with a median of 159 $ft^2$ (Figure 12). However, nearly two-thirds of the sites (65%) have less than 250 $ft^2$ of exposed soil, with the majority (82%) under 500 $ft^2$. Only nine sites have exposed soil areas of over 1000 $ft^2$.

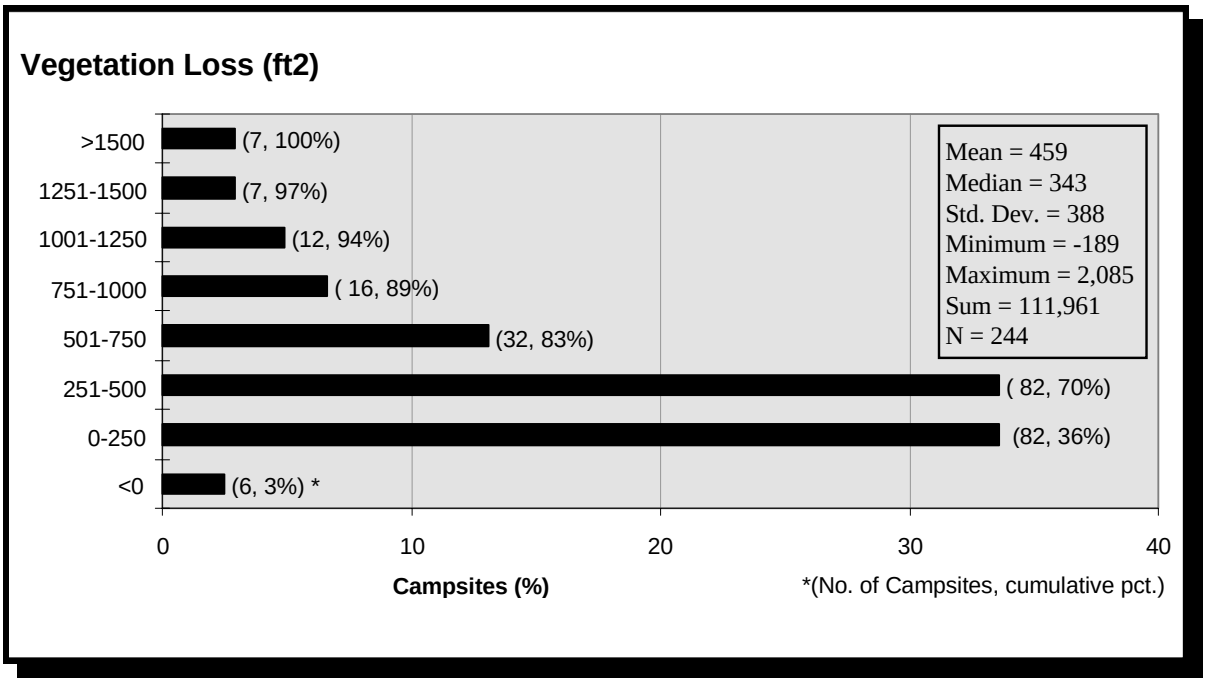


**Figure 11.** Frequency distribution and descriptive statistics for vegetation loss.

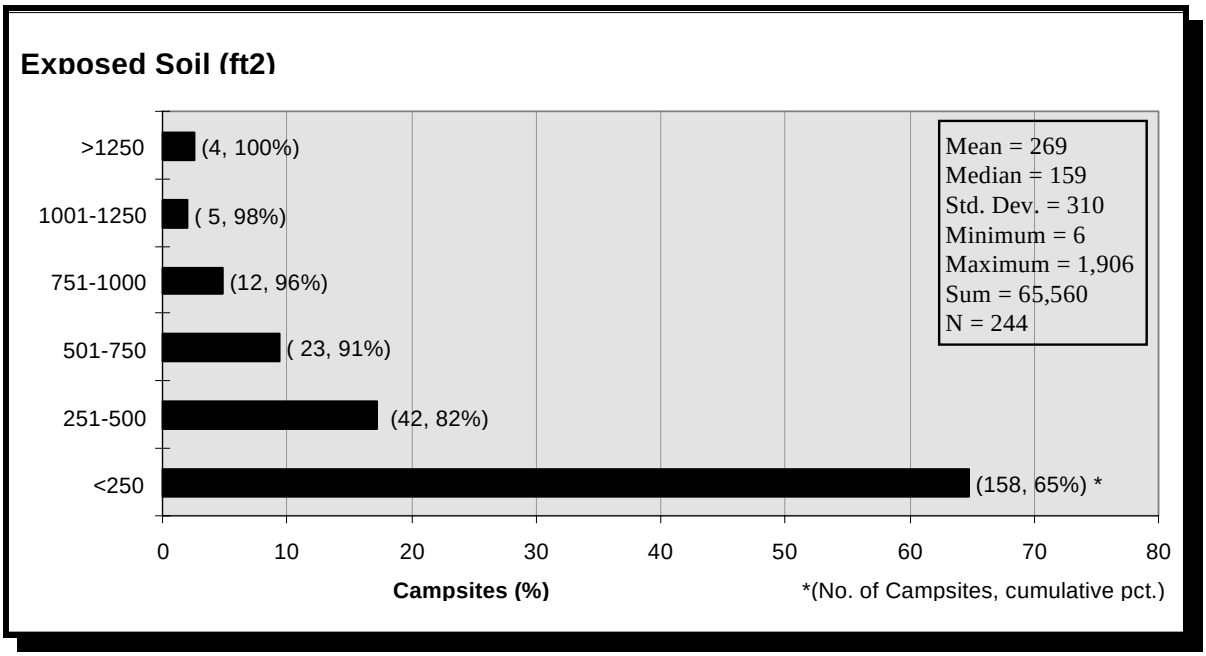


**Figure 12.** Frequency distribution and descriptive statistics for exposed soil.

**Damaged Trees**

Live trees within site boundaries were assessed for human-caused damage. Surveyors assigned one of three discrete damage rating categories to each tree: none/slight, moderate, or severe (Appendix 1). Moderate and severe damage categories are combined for presentation purposes. Trees with moderate and severe damage were also tallied in adjacent off-site areas for each designated site. Both the number and percent of damaged trees are presented. The number of damaged trees is emphasized because damage to 20 of 40 trees present on one site should be viewed more critically than damage to 2 of 4 trees present on another site. The number of damaged trees, 20 vs. 2, conveys this difference; the percentage of damaged trees, 50 vs. 50, does not.

No trees occur within the boundaries of 131 (54%) of the sites. No damaged trees occur on an additional 11 sites (5%) that have trees (N=113). However, for sites with trees, an average of 78% of the trees are damaged (median = 100%). For all sites, the number of damaged trees per site ranges from 0 to 21 with a median of 0 (mean = 1.2) (Figure 13). Approximately three-quarters of the sites have one or no damaged trees. However, 10% of the sites have four or more damaged trees. All trees are damaged on 71 sites. Of the total 362 trees counted on sites, 281 (78%) are moderately or severely damaged.

In adjacent off-site areas, surveyors found *an additional* 1,029 damaged trees, more than tripling, to 1,310, the assessment of damaged trees associated with camping activities. The number of damaged trees per off site area ranges from 0 to 24 with a median of 4 (mean = 4.2). Approximately one-half of the off-site areas have three or fewer damaged trees, and another one-quarter of the sites have five or more damaged trees in off-site areas.

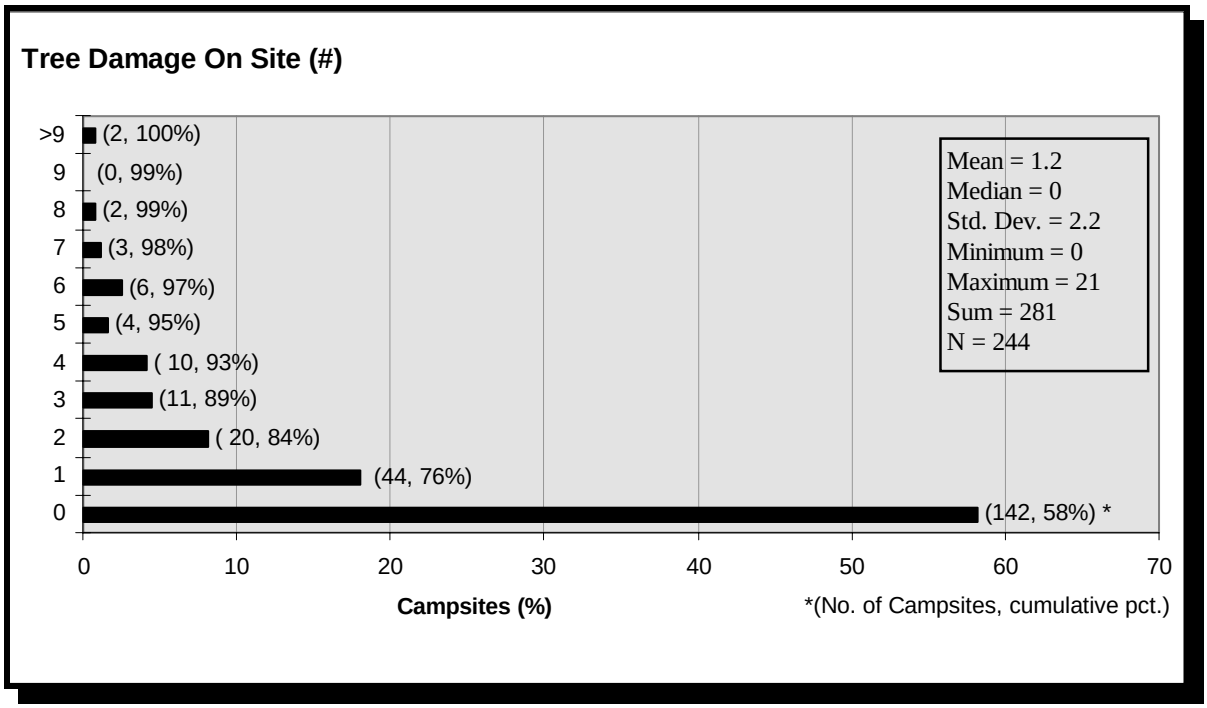


**Figure 13.** Frequency distribution and descriptive statistics for damaged trees on-site.

### Root Exposure

Root exposure was assessed in three categories: none/slight, moderate, and severe (Appendix 1). All other procedures and comments described for the tree damage indicator are applicable to this indicator as well.

For those sites with trees (N=113), 29 (27%) have no trees with exposed roots. For sites with trees, an average of 59% of the trees have exposed roots (median = 67%). For all sites, the number of trees per site with exposed roots ranges from 0 to 8 with a median of 0 (mean = 0.7) (Figure 14). Almost two-thirds of sites (160, 66%) have no trees with exposed roots. Of the trees assessed for exposed roots (N=362), 174 (48%) have moderate or severe root exposure. Only seven sites have five or more trees with exposed roots.

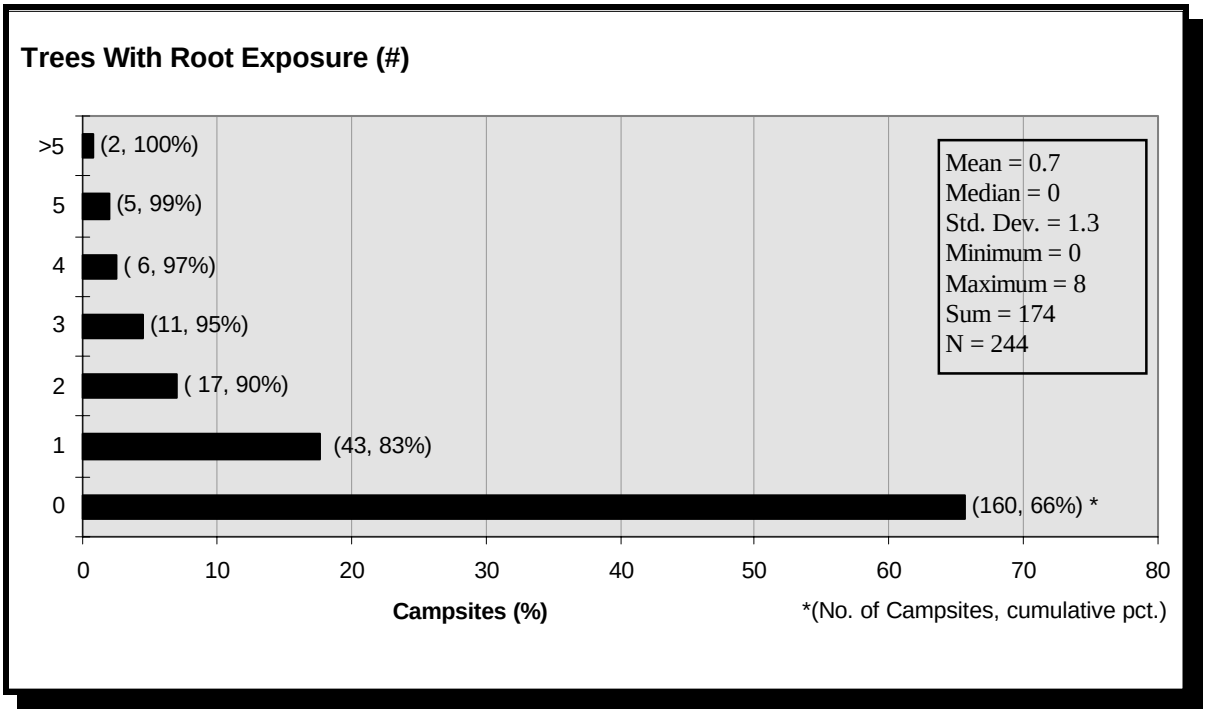


**Figure 14.** Frequency distribution and descriptive statistics for trees with root exposure.

### Tree Stumps

Tree stumps within site boundaries were counted (Appendix 1). Tree stumps were also counted in adjacent off-site areas for each designated site.

Stumps occur on 56 (23%) of the 244 surveyed sites. Number of stumps per site ranges from 0 to 5 with a median of 0 (mean = 0.4) (Figure 15). Most sites (223,91%) have one or no stumps and only 4 sites (1%) have 4 or more stumps. A total of 89 stumps occur within site boundaries.

In adjacent off-site areas, surveyors found an additional 300 tree stumps. The number of stumps per site ranges from 0 to 10 with a median of 1 (mean = 1.2). Nearly one-half of the sites have no tree stumps in adjacent off-site areas and 91% of the sites have three or fewer stumps in these areas. Tree stumps are not always an indication of use related impact as NPS staff frequently remove dead, dying, or hazardous trees.

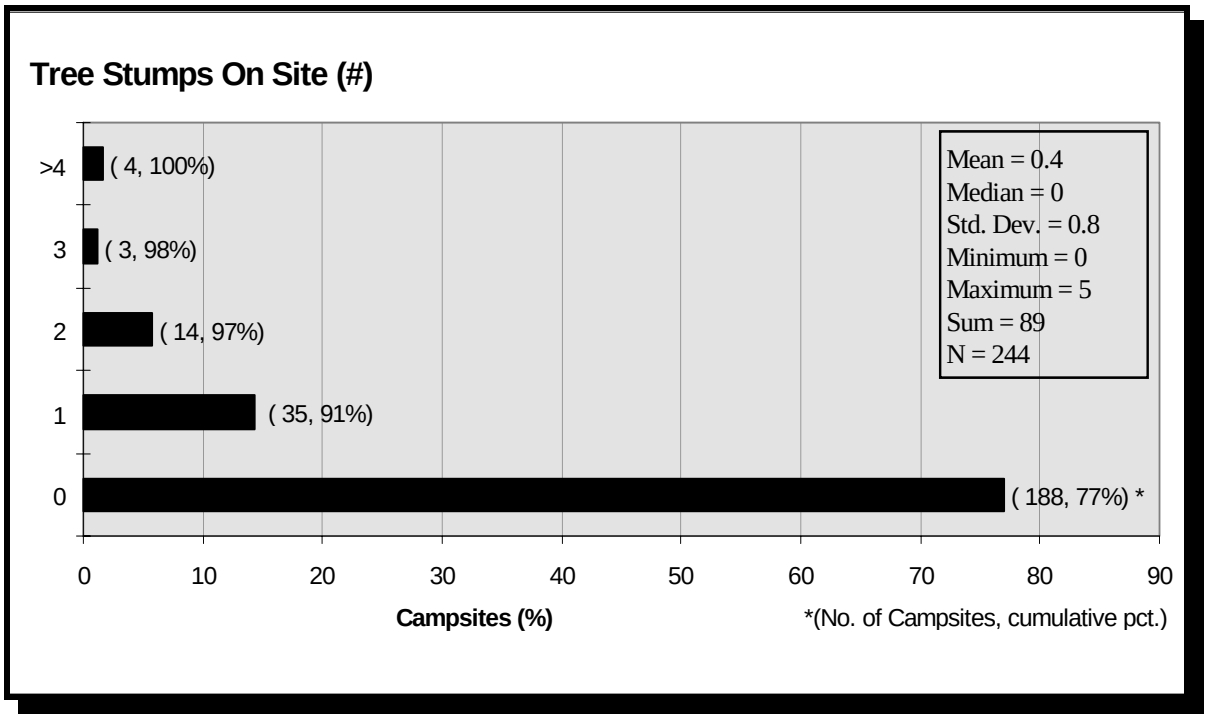


**Figure 15.** Frequency distribution and descriptive statistics for tree stumps on-site.

### Trails

All trails leading away from the outer site boundary were counted to assess the general density of related off-site trails (Appendix 1).

The number of trails ranges from 1 to 10 with a median of 3 (Figure 16). All of the sites have at least one easily discernable trail leading to the site. Occasionally a second trail to access an outhouse or water is necessary and appropriate. However, 61% of the sites have 3 or more trails and 24 sites (10%) have 5 or more trails. Trail proliferation in campgrounds appears to be a problem for some sites.

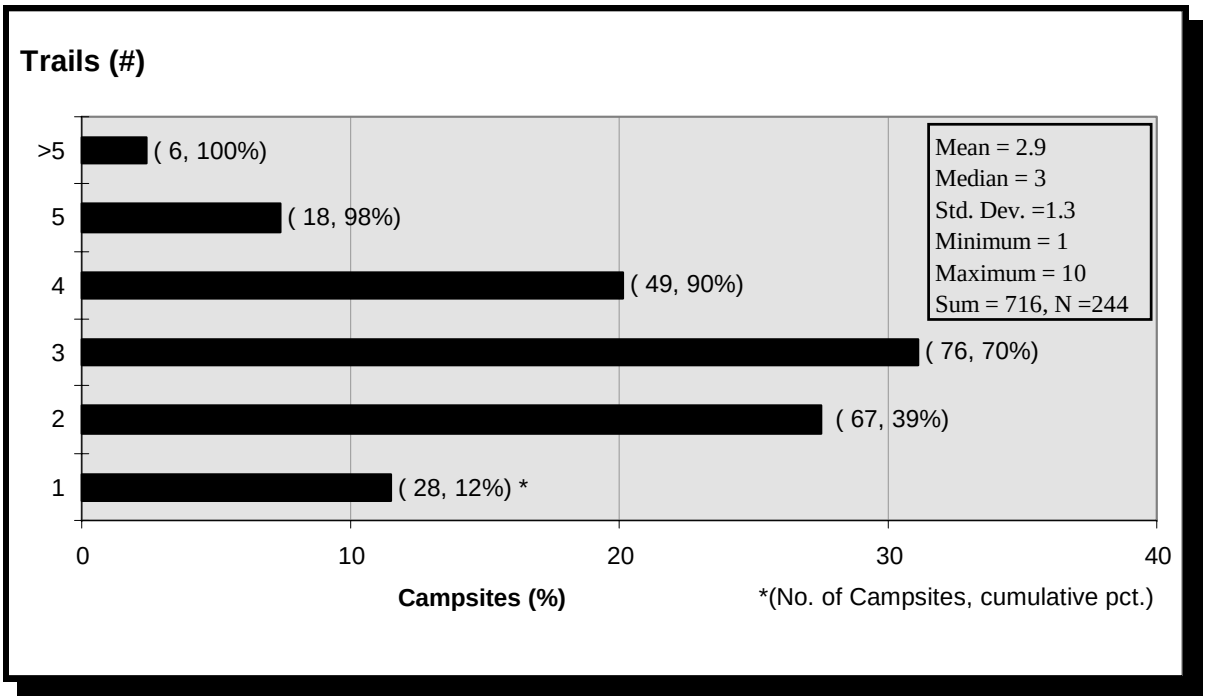


**Figure 16.** Frequency distribution and descriptive statistics for trails accessing sites.

### Fire Sites

Fire sites of any type, current or inactive, within site boundaries were counted (Appendix). Legal fire sites were found on 38 sites, with only one fire site on each site. Fires are not permitted on 206 sites, however, 22 have illegal fire sites, one/site on 20 sites and two/site on two sites. A total of 62 fire sites occur on these 60 sites.

### Litter

The amount of litter or trash present on each site was assessed as the percentage of a 40 gallon garbage bag that could be filled (Appendix 1). The majority of sites are relatively clean; 41 sites were substantially free of litter while 234 sites (96%) have one-tenth of a bag or less. The worst occurrences of litter included one site with a full bag of litter and another with a quarter of a bag.

### Human Waste

The number of instances of improperly disposed human waste in the vicinity of each site was also assessed (Appendix 1). All of the 36 campgrounds have at least one and as many as six privies so improper human waste disposal is not a problem. Rapid searches of likely toilet locations around each site revealed that 237 sites (97%) lack evidence of improperly disposed human waste, 5 sites had one instance each, and 2 sites had 2 instances each.

## Shoreline Accesses

### Shoreline Landing Area

The area of each shoreline landing access or boat docking location was measured. These sites may serve an entire campground or specific sites. The landing area was defined as any human-disturbed area along the shoreline created by recreational activities such as landing, unloading and loading, boating, or fishing. The geometric figure method was applied to determine the total area of disturbance associated with the landing area, excluding the dock surface, which was recorded separately (Appendix 1).

For all shoreline landing areas measured (N=100), about one half (N=52) serve more than one site. Eight sites have multiple landing areas which are not shared with other sites so the sizes of these multiple landings were summed for these sites. The size of landing areas ranges from 6 to 27,052 $ft^2$ with a median of 145 $ft^2$ (Figure 17). The majority of the landing areas are small, less than 500 $ft^2$ (77%), but six of the landing areas are excessively large, more than 2000 $ft^2$.

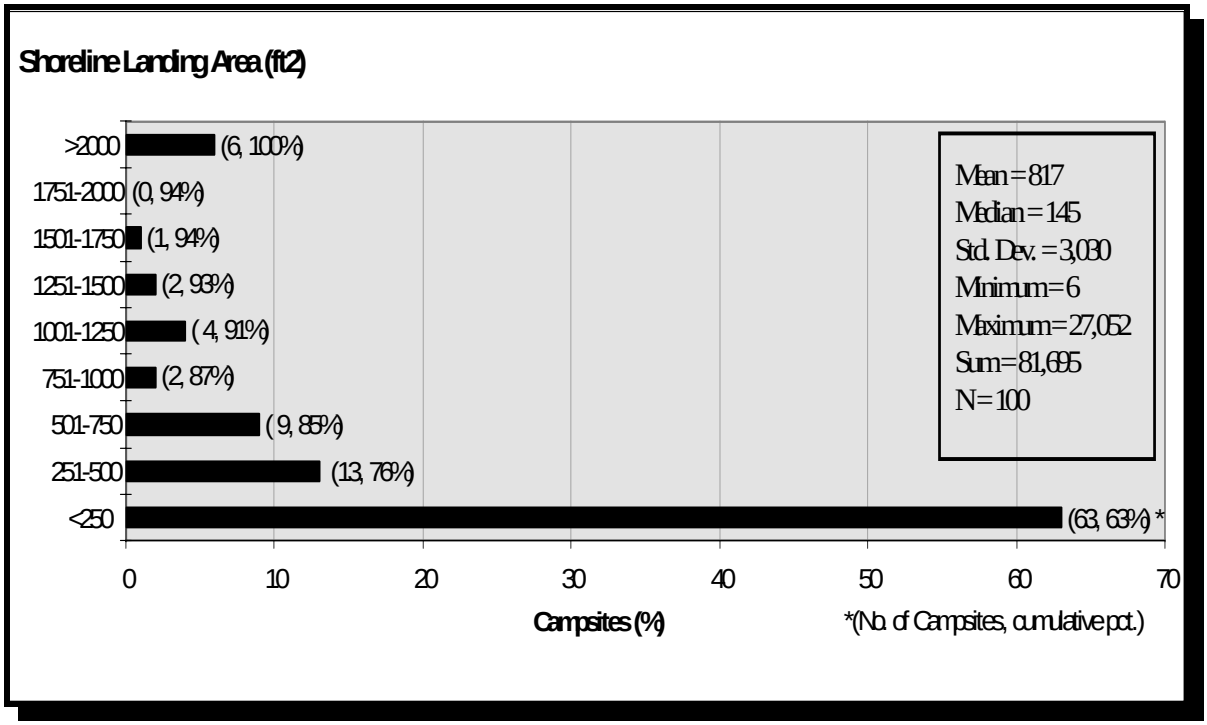


**Figure 17.** Frequency distribution and descriptive statistics for shoreline landing area.

### Landing Area Erosion

Soil erosion was assessed at each landing area (N=100) using a four-class quantitatively based rating from none to severe (Appendix 1). While one-fourth of the landings have no evident erosion (25, 25%), erosion is severe (> 4 inches deep over 25% of the area) at 15 sites (15%) (Table 9). Erosion is primarily a problem at sites with soil substrates.

### Trail Erosion

Soil erosion was also assessed on landing area access trails using the same four-class rating scale (Appendix 1). Very few landings have trails lacking soil erosion (5, 5%) (Table 9). The majority of landings (86, 86%) have trails with erosion rated as infrequent or common; only nine have trails are rated as severely eroded.

**Table 9.** Number and percent of landing areas (N=100) by categories of landing area and access trail erosion.

| Impact Indicator | Number | Percent |
|---|---|---|
| **Landing Area Erosion** | | |
| **None** | 25 | 25 |
| **Infrequent** | 34 | 34 |
| **Common** | 26 | 26 |
| **Severe** | 15 | 15 |
| **Trail Erosion** | | |
| **None** | 5 | 5 |
| **Infrequent** | 48 | 48 |
| **Common** | 38 | 38 |
| **Severe** | 9 | 9 |

## Comparisons by Wilderness Designation, Site Type, and Management Zone

This section presents findings organized by wilderness designation, site type, and park management zone, as currently proposed in the General Management Plan (GMP) process. The GMP preferred alternative contains the following zones that contain campgrounds: backcountry, frontcountry, primitive, and wilderness portal. As in previous sections, the term site refers collectively to campsites and shelters.

### Wilderness Designation

Conditions for nearly all impact indicators are more degraded on wilderness sites than on non-wilderness sites (Table 10). For example, comparison of data from wilderness to non-wilderness reveals higher median values for site size (674 $ft^2$ vs. 465 $ft^2$ respectively), area of vegetation loss

(525 $ft^2$ vs. 270 $ft^2$ respectively), and area of exposed soil ( 243 $ft^2$ vs. 104 $ft^2$ respectively) (Table 10). In spite of the fact that there are fewer wilderness than non-wilderness sites (116 vs. 128), the aggregate measures of disturbance for all three parameters are higher for wilderness sites.

There are more than three times as many damaged trees on wilderness sites (218) than on non-wilderness sites (63) (Table 10). Differences in off-site tree damage are less dramatic: 540 damaged trees (median = 4) in wilderness and 489 damaged trees (median = 4) in non-wilderness. Trees with root exposure, tree stumps on- and off-site, and access trails are only slightly more frequent in wilderness areas.

In contrast with these findings, the area of landings is substantially less on wilderness sites. The average size of landing areas in non-wilderness (mean = 1,564 $ft^2$) is over six times as large as those in wilderness (mean = 229 $ft^2$) (Table 10). The total area of disturbance for 44 non-wilderness landing areas is 68,833 $ft^2$ compared to 12,862 $ft^2$ for 56 wilderness landing areas. However, the extremely large size of a few of the landing areas greatly affects these numbers as indicated by the much smaller medians (non-wilderness median = 223 $ft^2$ and wilderness median = 97 $ft^2$).

**Site Type**

Site conditions are strongly influenced by site type. For example, group campsite sizes (median = 1496 $ft^2$) are nearly four times larger than shelter sites (median = 377 $ft^2$), and about two and one-half times larger than individual sites (median = 572 $ft^2$) (Table 11). Area of vegetation loss is also largest for group campsites (median = 986 $ft^2$), smallest for shelter sites (median = 208 $ft^2$), and intermediate for individual campsites (median = 397 $ft^2$). Area of exposed soil follows the same trend. Group campsites are developed to be used by larger parties with more constructed tent pads. Furthermore, shelters more effectively concentrate visitor activity, resulting in a smaller total area of disturbance. Areal measures of disturbance for the shelter sites are so small that aggregate sums for vegetation loss and exposed soil are less than half the total area of disturbance for group campsites, even though there are more than twice as many shelters (N=88) as group campsites (N=43) (Table 11).

On-site and off-site tree damage is also greatest for group campsites, followed by individual campsites (Table 11). Though shelter sites have few damaged trees on-site (median = 0 and mean = 0.2), there are only 30 trees within the boundaries of shelter sites and off-site tree damage is considerably higher (median = 4). Shelter sites are often centrally located in high traffic campground areas so tree damage may not always be attributable to shelter site visitors. The shelter sites also have very few stumps on- or off-site; stumps are more prevalent on or around group campsites (Table 11). The number of trails are relatively similar across site types (Table 11), as are values for litter, fire sites, and improperly disposed human waste (not shown in Table 11).

**Table 10.** Campsite and shelter conditions by wilderness area designation.

| Impact Indicator | | Non-Wilderness Areas (N=128) | Wilderness Areas (N=116) |
|---|---|---|---|
| Site Size ($ft^2$) | Mean | 643 | 825 |
| | Median | 465 | 674 |
| | Sum | 82,288 | 95,676 |
| Vegetation Loss ($ft^2$) | Mean | 399 | 525 |
| | Median | 270 | 454 |
| | Sum | 51,119 | 60,842 |
| Exposed Soil ($ft^2$) | Mean | 218 | 325 |
| | Median | 104 | 243 |
| | Sum | 27,850 | 37,710 |
| Damaged Trees, On-Site (#) | Mean | 0.5 | 1.9 |
| | Median | 0 | 1 |
| | Sum | 63 | 218 |
| Damaged Trees, Off-Site (#) | Mean | 3.8 | 4.7 |
| | Median | 4 | 4 |
| | Sum | 489 | 540 |
| Trees w/Root Exposure (#) | Mean | 0.4 | 0.9 |
| | Median | 0 | 0 |
| | Sum | 48 | 108 |
| Stumps, On-Site (#) | Mean | 0.3 | 0.4 |
| | Median | 0 | 0 |
| | Sum | 38 | 51 |
| Stumps, Off-Site (#) | Mean | 1.2 | 1.3 |
| | Median | 1 | 1 |
| | Sum | 155 | 145 |
| Trails (#) | Mean | 2.9 | 3 |
| | Median | 3 | 3 |
| | Sum | 372 | 344 |
| Landing Area ($ft^2$) | Mean | 1564 | 229 |
| | Median | 223 | 97 |
| | Sum | 68,833 | 12,862 |
| | N | 44 | 56 |

**Table 11.** Campsite and shelter conditions by site type.

| Impact Indicator | | Individual Campsites (N=113) | Group Campsites (N=43) | Shelter Sites (N=88) |
|---|---|---|---|---|
| Site Size ($ft^2$) | Mean | 650 | 1570 | 421 |
| | Median | 572 | 1496 | 377 |
| | Sum | 73,440 | 67,496 | 37,028 |
| Vegetation Loss ($ft^2$) | Mean | 425 | 997 | 240 |
| | Median | 397 | 986 | 208 |
| | Sum | 48,013 | 42,863 | 21,084 |
| Exposed Soil ($ft^2$) | Mean | 246 | 620 | 126 |
| | Median | 177 | 631 | 85 |
| | Sum | 27,780 | 26,679 | 11,100 |
| Damaged Trees, On-Site (#) | Mean | 1.4 | 2.4 | 0.2 |
| | Median | 1 | 1 | 0 |
| | Sum | 162 | 103 | 16 |
| Damaged Trees, Off-Site (#) | Mean | 4.1 | 5.4 | 3.8 |
| | Median | 3 | 5 | 4 |
| | Sum | 460 | 234 | 335 |
| Trees w/Root Exposure (#) | Mean | 0.6 | 1.7 | 0.2 |
| | Median | 0 | 1 | 0 |
| | Sum | 66 | 72 | 18 |
| Stumps, On-Site (#) | Mean | 0.3 | 0.9 | 0.1 |
| | Median | 0 | 1 | 0 |
| | Sum | 38 | 39 | 12 |
| Stumps, Off-Site (#) | Mean | 1.0 | 2.2 | 1.0 |
| | Median | 1 | 2 | 0 |
| | Sum | 118 | 93 | 89 |
| Trails (#) | Mean | 2.6 | 3.1 | 3.4 |
| | Median | 2 | 3 | 3 |
| | Sum | 288 | 131 | 297 |
| Landing Area ($ft^2$)[1] | Mean | 170 | 279 | 230 |
| | Median | 80 | 305 | 125 |
| | Sum | 4098 | 1395 | 4376 |
| | N | 24 | 5 | 19 |

1 - Fifty-two additional landing areas provided access to multiple sites. Statistics for these include: mean = 1381 median = 222, and sum = 71,826.

As previously noted, many campsites lack individual shoreline landing areas so the sample sizes (N values) for this indicator differ from other indicators. The landing areas associated with group sites are typically largest (median = 305 $ft^2$)(Table 11). Approximately one-half of the landings (N=52) serve multiple sites within campgrounds. These multiple site accesses have the largest median and mean size and total area of disturbance (71,826 $ft^2$) (see footnote, Table 11).

## GMP Proposed Zoning

The preliminary preferred alternative of the GMP proposes nine park management zones, four of which would allow for camping in designated areas: backcountry, frontcountry, primitive, and wilderness portal. The descriptions of these zones in the Study Area section illustrates intended future conditions (as opposed to current conditions). Campground data arrayed by proposed zone are presented here to inform planning participants of situations where existing social and resource conditions match or contrast with intended future conditions.

The proposed frontcountry zone includes only two campgrounds with a total of 42 sites. Given that this zone is intended as a threshold zone able to accommodate high visitation the low number of campgrounds and sites is currently inconsistent with zone objectives. However, existing sites in this zone do have many other sites visible (median = 2), are very close to campground trails (median = 34 ft), and support very high levels of visitation (median = 3532) (Table 12). Conversely, the 28 primitive zone sites (including 9 campgrounds), have the least number of other sites visible (median = 1), the longest distance to campground trail (median = 72 ft), and the fewest number of overnight stays per year (median = 542). This zone is intended as the most protected of these four zones, accommodating the lowest visitation. Social conditions for the wilderness portal zone (5 campgrounds, 58 sites) and the backcountry zone (20 campgrounds, 116 sites) are intermediate (Table 12).

Data characterizing site conditions as stratified by these four proposed zones are presented in Table 13. Sites in the wilderness portal zone have the least impact, another inconsistency given that this zone is intended as a gateway zone to the more protected backcountry and primitive zones. For example, median site size in this zone is just 425 $ft^2$, in comparison to sites in the backcountry and primitive zones whose median sizes are 705 $ft^2$ and 528 $ft^2$ respectively (Table 13). Median area of exposed soil, perhaps the best indicator of severe impact, is lowest on sites in the frontcountry zone (another inconsistency) though it is second lowest on the backcountry zone sites. On- and off-site tree damage is also more pronounced for backcountry and primitive zone sites. There is relatively little variability across zones for tree stumps. Frontcountry sites have the largest number of trails (median = 65) and primitive sites have the least (median = 10). Landing areas for wilderness portal sites are the largest although this is likely due to a small number of very large areas which increases the mean (mean = 18,419 $ft^2$ compared to median = 4,682). Landing areas are smallest for primitive zone sites (median = 140 $ft^2$) (Table 13).

**Table 12.** Campsite and shelter social attributes by proposed General Management Plan zone.

| Social Attributes | | Proposed GMP Zone[1] | | | |
|---|---|---|---|---|---|
| | | Frontcountry (N=42) | Wilderness Portal (N=58) | Backcountry (N=116) | Primitive (N=28) |
| **Other Sites Visible (#)** | | | | | |
| | **Mean** | 2.6 | 2.5 | 1.3 | 1.3 |
| | **Median** | 2 | 3 | 1 | 1 |
| | **Minimum** | 1 | 0 | 0 | 0 |
| | **Maximum** | 6 | 5 | 3 | 3 |
| **Distance to Nearest Other Site ($ft^2$)** | **Mean** | 82 | 78 | 83 | 76 |
| | **Median** | 66 | 65 | 66 | 75 |
| | **Minimum** | 3 | 14 | 0 | 0 |
| | **Maximum** | 222 | 322 | 334 | 160 |
| **Distance to Campground Trail ($ft^2$)** | **Mean** | 40 | 54 | 74 | 77 |
| | **Median** | 34 | 38 | 54 | 72 |
| | **Minimum** | 0 | 0 | 0 | 0 |
| | **Maximum** | 239 | 257 | 352 | 225 |
| **Overnight Use (# visitors/yr)** | **Mean** | 3532 | 2590 | 1407 | 537 |
| | **Median** | 3532 | 1846 | 1317 | 542 |
| | **Minimum** | 3326 | 1242 | 248 | 158 |
| | **Maximum** | 3728 | 5457 | 3529 | 1099 |
| | **Sum** | 7064 | 12,950 | 28,145 | 4834 |
| | **Campgrounds (#)** | 2 | 5 | 20 | 9 |

1 - Only proposed zones that contain campgrounds are included.

**Table 13.** Campsite and shelter conditions by proposed General Management Plan zone.

| Impact Indicator | | Proposed GMP Zone[1] | | | |
|---|---|---|---|---|---|
| | | Frontcountry (N=42) | Wilderness Portal (N=58) | Backcountry (N=116) | Primitive (N=28) |
| Site Size ( $ft^2$) | | 631 | 589 | 872 | 576 |
| | Mean | 465 | 425 | 705 | 528 |
| | Median | 265,001 | 34,157 | 101,171 | 16,136 |
| | Sum | | | | |
| Vegetation Loss ($ft^2$) | | 378 | 365 | 548 | 404 |
| | Mean | 263 | 249 | 455 | 390 |
| | Median | 15,857 | 21,195 | 63,597 | 11,312 |
| | Sum | | | | |
| Exposed Soil ($ft^2$) | Mean | 200 | 365 | 300 | 256 |
| | Median | 104 | 249 | 183 | 224 |
| | Sum | 8387 | 21195 | 34824 | 7157 |
| Damaged Trees, On-Site (#) | Mean | 0.5 | 0.6 | 1.9 | 2.1 |
| | Median | 0 | 0 | 1 | 1 |
| | Sum | 23 | 33 | 216 | 59 |
| Damaged Trees, Off-Site (#) | Mean | 4.0 | 3.4 | 4.6 | 4.8 |
| | Median | 3 | 4 | 4 | 5 |
| | Sum | 169 | 198 | 528 | 134 |
| Stumps, On-Site (#) | Mean | 0.4 | 0.2 | 0.5 | 0.3 |
| | Median | 0 | 0 | 0 | 0 |
| | Sum | 17 | 9 | 56 | 7 |
| Stumps, Off-Site (#) | Mean | 1.1 | 1.1 | 1.4 | 0.9 |
| | Median | 1 | 1 | 1 | 0 |
| | Sum | 48 | 61 | 165 | 26 |
| Trails (#) | | 65 | 34 | 16 | 10 |
| | Mean | 65 | 27 | 16 | 10 |
| | Median | 130 | 172 | 324 | 90 |
| | Sum | | | | |
| Landing Area ($ft^2$) | Mean | 15,505 | 4,041 | 1680 | 444 |
| | Median | 15,505 | 4,682 | 868 | 140 |
| | Sum | 31,010 | 20,207 | 26,883 | 3,550 |
| Campgrounds (#) | | 2 | 5 | 16 | 8 |

1 - Only proposed zones that contain campgrounds are included.

## Relational Analyses: Influence of Environmental, Use-Related, and Managerial Attributes

Relational analyses were conducted to investigate the influence of selected environmental, use-related, and managerial factors. Environmental attributes include forest cover type and canopy cover type. Use-related attributes include amount of overnight use. Managerial attributes include presence of picnic tables and whether or not fires are permitted. Knowledge of these relationships can assist managers in selecting sites that are more resistant to recreation-related resource degradation and managing sites and visitor use and behavior to minimize impacts.

### Influence of Environmental Attributes

#### Forest Cover Type

Site conditions were compared among individual campsites (N=103) and group campsites (N=38) which had one of the four dominant forest cover types: balsam fir (N=26), quaking aspen (N=19), white birch (N=51), and white spruce (N=45). Shelter sites were removed from this analysis because individual and group sites are most affected by forest canopy cover and shelter sites are least affected. Data were also stratified by site type (individual and group) in the statistical analysis (two-way ANOVA, General Linear Model) because site type significantly affected some impact indicators. Statistical testing reveals that site type was significant for all of the areal measures of impacts including site size, vegetation loss, and soil exposure (Table 14).

**Table 14.** Mean site conditions as influenced by forest cover type and site type.

| Impact Indicator | Forest Cover Type | | | | ANOVA, GLM[1] | | |
|---|---|---|---|---|---|---|---|
| | Balsam Fir (N=26) | Quaking Aspen (N=19) | White Birch (N=51) | White Spruce (N=45) | Veg. Type F Ratio/Sig. | Site Type F Ratio/Sig. | Interaction F Ratio/Sig. |
| **Site Size ($ft^2$)** | 1080 | 1043 | 1196 | 1023 | 2.04/.111 | **210/.000** | 0.27/.847 |
| **Vegetation Cover On-Site (%)** | 39 | 26 | 22 | 42 | **3.87/.011** | 1.85/.176 | 1.38/.250 |
| **Vegetation Cover Off-Site (%)** | 92 | 98 | 96 | 96 | 1.58/.196 | 1.99/.161 | 0.87/.459 |
| **Vegetation Loss (%)** | 54 | 72 | 74 | 55 | **4.91/.003** | 0.96/.335 | 1.09/.357 |
| **Vegetation Loss ($ft^2$)** | 536 | 758 | 895 | 564 | **7.76/.000** | **63.3/.000** | 1.19/.315 |
| **Soil Exposure (%)** | 22 | 57 | 44 | 29 | **7.15/.000** | 0.21/.644 | 1.16/.328 |
| **Soil Exposure ($ft^2$)** | 192 | 596 | 525 | 313 | **8.51/.000** | **27.5/.000** | 2.52/.061 |

1- Two-way ANOVA, General Linear Model results describing the forest cover type and site type factor effects, and their interaction effects. Condition indicators that exhibit significant differences ($p<.05$) are in bold. Impact indicator means for forest cover types have been adjusted to account for the influence of site type.

Statistical testing also reveals that the percentage measures of vegetation cover on-site, vegetation loss and soil exposure vary significantly across forest cover types. Among these statistically significant indicators across forest cover types, the areal and percentage measures are smallest for the balsam fir and white spruce species with one exception. These evergreen species have branches extending to the ground and likely resist the site expansion that is more common in the open park-like stands of quaking aspen and white birch.

### Forest Canopy Cover

The response of site impact indicators to canopy cover was evaluated to determine its effect on vegetation growth. Studies have shown that sites in heavily forested areas often have substantially reduced vegetation groundcover both on- and off-site due to reduced sunlight and the finding that trampling resistant species are generally shade intolerant. Data for forest canopy cover over sites was classified into four 25% coverage classes. Shelters were not included in this analysis because two-way ANOVA's with forest canopy cover and site type revealed significant interaction effects for these factors, complicating the interpretation of results. By removing the shelter sites, only one interaction effect occurs for the area of vegetation loss (Table 15).

**Table 15.** Mean site conditions as influenced by forest canopy cover and site type.

| Impact Indicator | Forest Canopy Cover | | | | ANOVA, GLM[1] | | |
|---|---|---|---|---|---|---|---|
| | 0-25% (N=75) | 26-50% (N=29) | 51-75% (N=29) | 76-100% (N=20) | Forest Cov. F Ratio/Sig. | Site Type F Ratio/Sig. | Interaction F Ratio/Sig. |
| **Site Size ($ft^2$)** | 1028 | 1092 | 1235 | 1221 | **3.37/.020** | **212/.000** | 0.53/.662 |
| **Vegetation Cover On-Site (%)** | 41 | 29 | 17 | 14 | **7.86/.000** | 0.41/.522 | 0.38/.765 |
| **Vegetation Cover Off-Site (%)** | 96 | 97 | 91 | 81 | **6.22/.001** | 0.52/.472 | 1.83/.145 |
| **Vegetation Loss (%)** | 55 | 68 | 74 | 67 | **4.01/.009** | 0.08/.777 | 1.04/.379 |
| **Vegetation Loss ($ft^2$)** | 550 | 768 | 956 | 750 | **11.0/.000** | **85.4/.000** | **2.86/.039** |
| **Soil Exposure (%)** | 33 | 41 | 42 | 41 | 1.03/.383 | 0.07/.799 | 0.71/.548 |
| **Soil Exposure ($ft^2$)** | 325 | 479 | 520 | 498 | **3.74/.013** | **40.9/.000** | 1.90/.132 |

1-Two-way ANOVA, General Linear Model results describing the forest canopy cover and site type factor effects, and their interaction effects. Condition indicators that exhibit significant differences ($p<.05$) are in bold. Impact indicator means for forest canopy cover categories have been adjusted to account for the influence of site type.

The mean site conditions of the individual and group sites were compared among four levels of canopy cover because they demonstrated the greatest significance among the site types. Vegetation cover on-site and off-site is less on sites with greater canopy cover. Dense forests tend to support

more fragile broad-leafed herbaceous cover that is not resistant to trampling. Open forest canopies support the growth of more trampling resistant but shade-intolerant grasses, along with some trampling resistant herbs. Studies have also shown that sun-loving groundcover vegetation has higher resiliency, ability to recover from damage. These findings explain why sites under open canopies are notably smaller (Table 15).

## Influence of Use-Related Attributes

### Amount of Use

Use data from park camping permits are recorded by campground so the use/impact relationship may only be examined using indicator data aggregated by campground. Use data from June to December of 1996 (see Table 4) was categorized in two classes of approximately equal numbers of campgrounds: #1000 (N= 16) and >1000 overnights (N=20). Independent sample t-tests were used to evaluate the effect of use level on the sums of site condition indicators within each campground, averaged across the campgrounds in each use class. Total area, area of vegetation loss, and area of soil exposure all increase significantly with increasing use (Table 16).

A potential limitation of this analysis is that other factors, most notably site type, influence site conditions and thus may confound interpretation of these use effect analyses. The smaller number of cases (N=36) resulting from site data aggregated by campground prevents analyses with further stratification by site type.

**Table 16.** Selected site condition indicators as influenced by amount of campground use (nights/season).

| Impact Indicator | Campground Use (nights/season) | | T-Test[1] |
|---|---|---|---|
| | #1000 (N=16) | >1000 (N=20) | t value/Sig. |
| **Sum of Site Size ($ft^2$)** | 1755 | 7494 | **5.66/.000** |
| **Sum of Vegetation Loss ($ft^2$)** | 1166 | 4665 | **4.43/.000** |
| **Sum of Soil Exposure ($ft^2$)** | 759 | 2671 | **3.11/.004** |
| **Sum of Landing Area Size ($ft^2$)[2]** | 572 | 4594 | **2.13/.013** |

1-Independent sample t-test results. Condition indicators that exhibit significant differences ($p<.05$) are in bold.
2-Sample sizes differ from other indicators: N=15 and 16 respectively.

A second approach to investigate the influence of amount of use involved dividing campground use data by the number of sites in each campground to obtain mean use per site (see Table 4). Two classes of amount of use per site were evaluated (number of average overnights per site: #250 and >250). The means of site condition indicators within each campground, averaged across the campgrounds in each use class, were statistically tested. Although the means of three impact indicators are larger at the higher site use level, none are statistically significant (Table 17).

**Table 17.** Selected site condition indicators as influenced by amount of campground use (mean values).

| Impact Indicator | Campground Use (nights/season/site) | | T-Test[1] |
|---|---|---|---|
| | 0-250 (N=23) | >250 (N=13) | t value/Sig. |
| **Mean Site Size ($ft^2$)** | 691 | 734 | 0.49/.627 |
| **Mean Vegetation Loss ($ft^2$)** | 439 | 420 | 0.24/.811 |
| **Mean Soil Exposure ($ft^2$)** | 242 | 274 | 0.47/.641 |
| **Mean Landing Area Size ($ft^2$) [2]** | 1256 | 1743 | 0.87/.358 |

1- Independent sample t-test results. Condition indicators that exhibit significant differences ($p<.05$) are in bold.
2- Sample sizes differ from other indicators: N=19 and 11, respectively.

Finally, the effect of campground over-capacity use was investigated by examining mean impact indicator values stratified by three categories of campground nights/season over capacity (see Table 4). The number of nights/season (1995 data) that campgrounds exceeded their capacity was divided by the number of sites in each campground to convert this factor to a per site basis. The means of site condition indicators within each campground, averaged across the campgrounds in each over capacity class, were statistically tested. The means of all impact indicators actually decrease with increasing site over capacity, though these differences are not statistically significant (Table 18).

These analyses indicate that campgrounds receiving high use have greater areal measures of disturbance than those receiving low use. For example, the total area of disturbance (sum of site sizes) is significantly greater on the highest use campgrounds. However, these campgrounds have larger numbers of sites (compare values in Tables 3 and 4) so this finding is to be expected. When differences in campsite numbers are taken into account through analyses on a per site basis (Table 17) there are no statistically significant differences. Similarly, when impact indicator values on a per site basis are compared between campgrounds at differing levels of over capacity camping there are also no statistically significant differences. Our interpretation of these findings is that amount of site use is a far less important factor than some other factors, such as site type and particularly site location and design, presented in the following section.

**Table 18.** Selected site condition indicators as influenced by number of nights/season over capacity (per site basis).

| Impact Indicator | Nights/Season Over Capacity (per site basis) | | | ANOVA[1] |
|---|---|---|---|---|
| | #1 (N=11) | 1.1 - 5 (N=13) | >5 (N=12) | F ratio/Sig. |
| **Mean Site Size ($ft^2$)** | 710 | 781 | 622 | 1.25/.300 |
| **Mean Vegetation Loss ($ft^2$)** | 455 | 508 | 330 | 2.20/.127 |
| **Mean Soil Exposure ($ft^2$)** | 227 | 337 | 187 | 2.10/.139 |
| **Mean Landing Area Size ($ft^2$)[2]** | 2244 | 2223 | 235 | 1.31/.286 |

1-One-way ANOVA results. Condition indicators that exhibit significant differences ($p<.05$) are in bold.
2-Sample sizes differ from other indicators: N=9, 9, and 12 respectively.

## Influence of Management Actions

### Campsite Location and Design

Managers can influence the size and expansion potential of campsites through their location and design. ISRO's campsite location, design, and construction work (described in the Study Area section) appears to be highly successful in promoting use of the constructed tent pads and avoiding site expansion or creation of new "satellite" tenting areas. In the judgement of field staff 420 of the identified tent pads appeared to be "management constructed" and only 22 tenting sites were either "natural" (no construction needed) or "visitor-created", the latter defined as additional tent pads developed by visitors generally as overflow sites and considered illegal. Constructed tent pads are always more attractive than alternative unprepared locations, particularly when adjacent off-site areas are sloped as is frequently the case at ISRO. The sloping off-site terrain, generally in the range of 7-12%, is often sufficient to constrain visitor activities to the prepared surfaces. Many of the sites have been colonized by grasses in peripheral use areas, in contrast to mostly herbs offsite. These resistant grasses provide another visual cue to the intended use areas.

The combination of these management actions have resulted in campsite sizes that have considerably less area of disturbance on a per capita basis than any other park or wilderness assessed using comparable techniques (Table 19). The median site size at ISRO (554 $ft^2$) is quite small in comparison to most other areas studied. Site sizes at Shenandoah National Park are smaller due to their dispersal policy and on Jefferson National Forest Wilderness campsites due to their low use levels (though data on overnight stays is unavailable). The most appropriate comparison, however, may be made by dividing the total area of disturbance resulting from camping activities by the total overnight visitation to obtain a measure of disturbed area per visitor (column 3 in Table 19). Values in this column reveal that camping management at ISRO has achieved a high degree of success in minimizing the area of disturbance, only 3.8 $ft^2$ of disturbed area per overnight stay.

**Table 19.** Campsite size and use statistics for selected park and wilderness areas.

| Area Name and State | Campsite Size ($ft^2$) [median/ sum] | Disturbed Area / Overnight Stay ($ft^2$) | Total Backcountry Overnights (visitors/yr) | Camping Policy | Citation |
|---|---|---|---|---|---|
| **Isle Royale National Park, MI** | 554<br>177,964 | 3.8 | 46,625 | Designated Sites | Farrell and Marion, 1997 |
| **Delaware Water Gap National Recreation Area, PA/NJ - 1986** | 1,362<br>302,784 | 9.3 | 32,399 | Designated Areas | Marion, 1994 |
| **Delaware Water Gap National Recreation Area, PA/NJ - 1991** | 1,302<br>150,859 | 4.6 | 33,184 | Designated Sites | Marion, 1994 |
| **Shenandoah National Park, VA** | 253<br>284,176 | 7.1 | 40,000 | Dispersal | Williams and Marion 1995 |
| **New River Gorge National River, WV[1]** | 3,100<br>904,736 | 23.0 | 39,410 | Unregulated | Marion, 1990 |
| **Great Smoky Mountains National Park, TN/NC** | 1,039<br>550,824 | 5.7 | 96,459 | Designated Areas | Marion and Leung, 1997 |
| **Jefferson National Forest Wildernesses, VA[2]** | 335<br>66,035 | N.A. | Unknown | Unregulated | Leung and Marion, 1995 |
| **Mount Rogers National Recreation Area, VA** | 707<br>85,284 | N.A. | Unknown | Unregulated | Leung and Marion, 1995 |

1 - Sites also receive substantial but unknown amounts of day-use.

2 - Including 11 wilderness areas, all of which receive relatively little use.

### Shelters

Managers can influence site conditions through the facilities they provide, as clearly demonstrated by the smaller area of disturbance present at shelter sites. Shelters serve to spatially concentrate camping activities to wooden shelter floor and to the area immediately in front of the shelter. Median site size for shelters is 377 $ft^2$, compared to 572 $ft^2$ for individual campsites and 1496 $ft^2$ for group campsites (note: the area occupied by each shelter is included within site size measures). Similar findings were documented at Great Smoky Mountains National Park (Marion and Leung 1997). The mean area of disturbance for shelters (3,218 $ft^2$) is smaller than for either rationed campgrounds (12,143 $ft^2$) or unrationed campgrounds (4,638 $ft^2$), and shelters account for 37% of the overnight visitation but only 10% of the total area of disturbance from camping. Hitching post areas for horses and tenting areas to accommodate overflow use (long-distance hikers on the Appalachian Trail) account for their larger sizes in comparison to ISRO shelters.

### Picnic Tables

Other facilities such as picnic tables might also serve to spatially concentrate visitor activities and reduce site sizes. Facilities in backcountry and wilderness settings are generally provided only as needed for resource or visitor protection. From a philosophical perspective facilities such as picnic tables are generally considered to be inappropriate in backcountry and wilderness settings because they are provided primarily as a visitor amenity rather than a resource protection facility. Some facilities can serve both functions; fire grates help prevent forest fires and concentrate visitor activity yet they also facilitate visitor needs for cooking food. To address this issue at ISRO, analyses were conducted to determine if picnic tables provide any resource protection function. Of specific interest was whether picnic tables encouraged activity concentration and reduced areal measures of disturbance.

One-way ANOVA's were run to examine the effect of picnic tables, stratified by the three site types, on site size, vegetation loss, and exposed soil. Only three shelter sites lack picnic tables and mean values indicate that their presence slightly increases areal measures of disturbance. However, for campsites areal measures for all three indicators are greater for the sites that lack picnic tables. The small sample size for shelters that lack picnic tables and a significant interaction effect (due to the differences across site types) led us to run the analysis again omitting the shelter sites (Table 20). These results reveal small but statistically significant reductions in areal measures of disturbance for individual and group campsites. Campsites of both types that have picnic tables are smaller in size and have less vegetation loss and exposed soil. These results suggest that picnic tables also serve a resource protection function on campsites (not shelters) by spatially concentrating activities that would normally be dispersed over wider areas. Regardless of this finding, their appropriateness in backcountry and wilderness remain an issue deserving of further management discussion.

**Table 20.** Mean campsite conditions as influenced by the provision of picnic tables and site type.

| Campsite Type and Presence of Picnic Tables | Impact Indicator | | |
|---|---|---|---|
| | Campsite Size ($ft^2$) | Vegetation Loss ($ft^2$) | Soil Exposure ($ft^2$) |
| **Individual Campsites** | | | |
| **Picnic Tables (N=45)** | 549 | 315 | 123 |
| **No Picnic Tables (N=68)** | 717 | 497 | 327 |
| **Group Campsites** | | | |
| **Picnic Tables (N=26)** | 1522 | 919 | 531 |
| **No Picnic Tables (N=17)** | 1643 | 1116 | 757 |
| **F Ratio and Sig. [1]** | | | |
| **Campsite Type Effect** | **285/.000** | **104.0/.000** | **59.4/.000** |
| **Picnic Table Effect** | **6.58/.011** | **9.97/.002** | **15.7/.000** |
| **Interaction Effect** | 0.17/.677 | 0.02/.900 | 0.05/.833 |

1-ANOVA, General Linear Model results. Means are unadjusted.

**Fire Sites**

Fire sites can concentrate visitor activity and reduce areal measures of site disturbance but they can also increase several forms of site impact, particularly tree damage and proliferation of firewood gathering trails. Site conditions of campsites and shelters with legal firesites (N=38) are compared to site conditions where fires are not permitted or present (N=184). The twenty-two sites with illegal firesites were omitted from this analysis. There are significantly fewer damaged trees on sites where fires are permitted (mean = 0.6) than on sites where fires are prohibited (mean = 1.2) (Table 21). However, only 12 of the 38 sites where fires are permitted have trees within site boundaries so an examination of off-site tree damage would be more appropriate. Numbers of off-site damaged trees are significantly more numerous for sites where fires are permitted (mean = 5.0) than for sites where fires are prohibited (mean = 3.9). Similar findings were documented for tree stumps on- and off-site (Table 21). These findings indicate that permitting fires does increase damage to trees, though the increase is quite marginal, about one damaged tree per site.

While there is no difference in the size of sites between sites where fires are permitted or not permitted, the area of vegetation loss and exposed soil is less on those that permit fires (Table 21). Particularly for exposed soil these findings suggest that fire sites may cause greater activity concentration within site boundaries. Intensive activity in the vicinity of the fire site does create soil exposure there but less activity elsewhere on the site means that there is less exposed soil overall. Finally, there are significantly more trails on sites where fires are permitted (mean = 3.5) than on sites where they are prohibited (mean = 2.8). This increase, while small, is attributed to the creation of additional fire wood gathering trails.

**Table 21.** Mean site conditions as influenced by fires permitted.

| Impact Indicator | Fires Permitted | | T-test (t / sig.) |
|---|---|---|---|
| | Yes (N=38) (mean) | No (N=184) (mean) | |
| **Tree Damage, On-Site (#)** | 0.6 | 1.2 | **-2.3 / .024** |
| **Tree Damage, Off-Site (#)** | 5.0 | 3.9 | **2.0 / .048** |
| **Tree Stumps, On-Site (#)** | 0.1 | 0.4 | **-2.5 / .015** |
| **Tree Stumps, Off-Site (#)** | 1.4 | 1.2 | 0.7 / .476 |
| **Site Size ($ft^2$)** | 719 | 713 | 0.1 / .945 |
| **Vegetation Loss ($ft^2$)** | 349 | 473 | -1.8 / .068 |
| **Exposure Soil ($ft^2$)** | 162 | 290 | **-2.3 / .003** |
| **Trails (#)** | 3.5 | 2.8 | **3.1 / .002** |

# DISCUSSION AND RECOMMENDATIONS

## Camping Capacity

Backcountry visitation at ISRO has risen by 37% over the previous decade (based on three-year averages, 1984-86 vs. 1994-96) with 54,968 overnight stays reported for 1996 (Figure 5). Campground occupancy data reveals that the capacity of most campgrounds is currently exceeded on one or more nights each year (Table 4) and that 10 campgrounds exceeded their capacities by more than 20 nights in 1995. Few campgrounds appear to be underutilized; only one campground did not exceed its capacity in 1995 and only seven campgrounds exceeded their capacities by five or fewer nights (Table 4).

High campground occupancy rates suggest that a number of problems could be occurring. Visitors who arrive at a full campground may be tempted to camp illegally if they are unable or unwilling to share a campsite or travel to the nearest other campground. Those who share campsites, as recommended by the NPS, may unnecessarily enlarge a site that lacks sufficient space. Visitors camping in full campgrounds may feel crowded or experience greater conflict. Interactions with others and noise levels are generally higher and the sense of being on a remote wilderness island is diminished. These site capacity issues could be addressed through a number of alternative options:

**Option 1 - Construct Additional Sites:** Additional campsites could be constructed at campgrounds experiencing chronic over-capacity conditions. Alternately, new campgrounds could be established in the vicinity of overcrowded campgrounds. The construction of new campsites or campgrounds would alleviate current and future overcrowding but would increase the area of disturbance associated with camping activities and might further fragment wildlife habitat.

**Option 2 - Alter Visitor Distribution:** Backcountry visitation could be shifted in time or space. For example, in the Boundary Waters Canoe Area Wilderness (BWCAW) entry point quotas based on visitor travel models are used to match visitor entry to the number of campsites within travel zones ( Gilbert and others 1972, Hulbert and Higgins 1977, Lime 1970, 1977, Peterson 1977, Peterson and deBettencourt 1979). The quotas restrict or shift use in time or space so that campsite occupancy rates for each travel zone remain in the range of 60-85%. Visitors may be forced to select a less visited entry point or a less popular time of year but they retain the flexibility to travel where and when they want once they gain entry. Visitor distribution might also be altered by advertising or encouraging the use of less visited access points. ISRO has relatively few backcountry entry points and access to some is more difficult due to constraints on the frequency and timing of ferry boats. However, the BWCAW approach may still be workable as boating schedules and access points could be altered to improve visitor distribution patterns relative to available campsites. Site occupancy rates of 60-85% could be achieved by altering visitor distribution patterns, reducing use, or constructing additional sites in areas with rates exceeding 85%. This option allows visitors wide latitude in their freedom to travel, a benefit which is offset by the "cost" of a greater area of disturbance associated with the larger number of campground sites that are necessary but that go unused each night in order to maintain a 60-85% occupancy rate.

**Option 3 - Establish a Site Reservation System:** A more restrictive option is to establish a reservation system where visitors must define and follow an itinerary based on campsite availability. Specific sites are reserved for each night's stay, allowing up to 100% booking of sites in popular campgrounds. The curvilinear relationship between amount of overnight visitation and most forms of camping impacts (Cole 1987, Marion and Merriam 1985a, Marion and Cole 1996) indicate that aggregate measures of disturbance would be held to the absolute minimum by this option. The majority of impact occurs with site creation and initial camping use, with impact increasing more gradually as site visitation rises from moderate to high levels. This relationship suggests that aggregate impact can be minimized by concentrating visitation on a limited number of sites.

For example, the number of sites could be limited to that necessary to accommodate demand during a typical high use (not peak use) time period. Further increases in visitation could be accommodated only by using the site reservation system to force visitors to shift the timing or location of their backcountry travel to match the availability of campsites. Site occupancies of 90-100% parkwide can often be achieved under this option, effectively limiting site numbers and the total area of disturbance to the absolute minimum. Under this option some existing areas may have more campsites than are currently needed, allowing for future expansion in use or removal of sites with reductions in total area of disturbance. However, the "cost" of achieving this degree of resource protection is born by the visitors, who lose their freedom to plan trips when and where they want, and when in the backcountry, lose their freedom to adjust daily schedules to their changing desires or needs. Experience in parks that operate such systems (e.g., Everglades, Grand Canyon, Mount Rainier) reveals that visitors rarely remain on their itineraries due to a variety of factors, many of which may be beyond their control (blisters, weather, weaker party members). Visitors may also risk their safety in attempting to remain on schedule or are forced to camp illegally if they cannot find a ranger to radio in a request to revise their itinerary. Such systems are also more expensive to develop and operate.

**Recommendations:** We recommend a primary reliance on option two, altering visitor distribution patterns. In our opinion this option represents the most appropriate balance between the park's recreation provision and resource protection objectives (for reasons previously discussed). Informational efforts and changes in ferry schedules offer indirect and low-cost approaches to improve the match between visitor and campsite distribution patterns. Entry point quotas may also be needed to redistribute use in time and space and to address future increases in visitation.

Limited construction of additional sites may also be needed in some instances to eliminate existing bottlenecks in the most common travel routes. As will be discussed in a following section, limited construction of additional sites also allows managers to address other issues related to visitor crowding and conflicts. However, we note that restricting site occupancy rates to a maximum of 85% also addresses these social issues. Furthermore, ISRO already has the highest number of backcountry overnights per acre of any NPS unit and has limited ability to redistribute use temporally because the park is closed for half of each year. Reservation systems (option 3) pose a substantially greater threat to visitor freedom, a critical element in high quality wilderness recreation experiences. We recommend their use only if option two is demonstrated to be impractical or ineffective.

## Distribution and Arrangement of Sites

There are currently 156 campsites and 88 shelters grouped together in 36 backcountry campgrounds located primarily around the island's perimeter. A principal advantage of this spatial arrangement is that it concentrates visitor activities, reducing human presence in large areas of the island's interior. This reduces the fragmentation of wildlife habitat so that interference with wolves and other wildlife is minimized. Site clustering also increases the efficiency of maintenance and visitor contact/enforcement activities and the provision of facilities such as boat docks. However, site clustering also has negative aspects. While the majority of campgrounds have fewer than 10 sites, 5 campgrounds have 12 or more sites, including 2 with more than 20 sites. Visitors have ample opportunities for experiencing solitude while hiking but the large number of sites in some campgrounds reduces their solitude while camping. Site clustering may also exacerbate problems with the feeding and attraction of wildlife, which learn that larger campgrounds can be a dependable source of food. Finally, site clustering provides fewer options to visitors in designing alternative itineraries and less flexibility in altering travel plans while in the backcountry.

Data from this survey indicate that campsite and shelter spacing or densities within campgrounds also limits the potential for camping solitude. Only 22 (9%) of the sites have no other sites visible while 54 (22%) have 3 or more other sites visible (Table 7). Mean inter-site distance is 76 ft and 190 sites (78%) are within 100 ft of their nearest neighbor (Table 7). Based on these indicators the potential for camping solitude is greatest for group campsites and lowest for shelter sites. Noise, which is more commonly associated with the larger youth-related groups, also negatively affects solitude. The importance of this factor is acknowledged but was not evaluated by this survey.

The potential for solitude is somewhat greater in wilderness campgrounds than in non-wilderness campgrounds. In wilderness, mean inter-site distance is 82 ft and more than one-half of these sites have one or no other sites visible. In non-wilderness, mean inter-site distance is 71 ft and one-third of these sites have one or no other sites visible. The potential for camping solitude also varies by proposed GMP zone, as indicated by inter-site visibility and distances (Table 12). For example, mean inter-site visibility is 2.6 sites for the frontcountry zone, 2.5 for the wilderness portal zone, 1.3 for the backcountry zone, and 1.3 for the primitive zone. Inter-site distances for these zones are less variable (82, 78, 83, and 76 ft, respectively) but should be greater in the backcountry and primitive zones in comparison to the frontcountry and portal zones.

A visitor survey recently conducted by the University of Minnesota Cooperative Park Studies Unit (Pierskalla and others 1996) reveals that ISRO backcountry visitors perceive both crowding and conflict at campgrounds to be salient issues. Crowding-related problems included "Seeing too many other hikers in the campgrounds" (ranked 2 out of 64 items), "Being able to find a vacant shelter" (ranked 4/64), "Seeing too many other watercraft on Lake Superior" (ranked 5/64), "Finding an available campsite" (ranked 6/64), and "Campsites or shelters too close together in campgrounds" (ranked 13/64). Conflict-related problems included "Too much motorboat noise" (ranked 1/64), "Motorboat noise in narrow harbors and bays" (ranked 3/64), and "Noisy people at campgrounds with docks" (ranked 9/64). While the majority of visitors did not find these issues to be a problem they remain highly ranked among the extensive list of potential issues provided for visitor comment.

**Recommendations:** Park managers and planners should reexamine the current distribution of campgrounds and site numbers relative to current or desired visitor distribution patterns and management zones. Minimum standards for camping solitude indicators (inter-site distance and visibility) to reduce the potential for crowding and conflict might also be established. Redistribution of use through education, changes in boat scheduling and routes, and/or entry point quotas may resolve these issues. For example, restricting campground occupancy rates to a maximum of 85% may resolve some of the social crowding and conflict issues.

If use redistribution is ineffective then use reduction or limited construction of new campgrounds or sites may be necessary. Park staff who write backcountry permits may suggest geographic areas where additional camping capacity is needed to facilitate circuit hikes or cross-island treks. Development of new campgrounds, particularly in the vicinity of those with larger numbers of existing sites, could allow closure of some existing sites to enhance camping solitude and separate conflicting use types. For example, a campground developed within a few miles of the McCargoe Cove campground might permit the closure of some centrally located McCargoe Cove sites to both increase inter-site distances and reduce the number of visitors staying overnight. The new campground could also be situated away from Lake Superior or restricted to non-boaters to reduce the potential for visitor conflicts. Site occupancy rates would be reduced if the number of sites created in the new campground exceeded the number closed at McCargoe Cove..

Additional campsites located out of sight and at least 150 ft from existing sites could be added to existing campgrounds to allow closure of an equal number of higher density centrally located sites. This action would reduce the potential for both crowding and conflicts. Additionally, conflict problems at some existing campgrounds could be resolved by designating them for specific user types, such as campgrounds restricted to hikers or powerboaters.

## Campsite Location and Design

Campsite location and design, described in the Results section under Influence of Management Actions, has been highly successful in limiting the area of disturbance associated with camping. Campgrounds are commonly located in sloping terrain which acts to spatially concentrate camping activities and inhibit site expansion. The design of campsites (Figure 8) provides the minimum space needed for tents, cooking, and socializing. Campsite construction practices, including cut and fill work and placement of embedded logs provide strong visual cues to visitors identifying campsite boundaries. The median site size at ISRO (554 $ft^2$) is exceptionally small, particularly when evaluated as area of disturbance per annual overnight stay (3.8 $ft^2$)(Table 19). Other areal measures of disturbance, area of vegetation loss and exposed soil area, are also exceptionally low. We know of no other backcountry or wilderness areas in the United States that have achieved this degree of camping impact containment.

Nevertheless, we do offer some critique and recommendations regarding campsite construction practices. Constructed tent pads are highly artificial in appearance. At ISRO they are typically constructed as angular geometric shapes, squares or rectangles, rather than circles or ovals that

would appear more natural in backcountry and wilderness settings. Soil removal along the upper slope of tent pads sometimes terminates abruptly, leaving a straight 4 to 8 inch wall of eroding soil.

**Recommendations:** We recommend that subsequent site construction and maintenance work strive to create sites with a more natural looking appearance. Such work should be substantially unnoticeable to backcountry visitors, particularly in wilderness (Marion and Sober 1987). In our opinion the cut and fill practices used to create campsites in sloping terrain comply with the "minimum action required" policy of wilderness management (Hendee and others 1990). The high degree of success at ISRO in limiting the size and impact of campsites attests to the effectiveness of this practice. However, such work can and should be visually and ecologically less obtrusive than the impacts they aim to prevent or minimize (Marion and Sober 1987). Tent pad boundaries can be made more rounded and irregular and cuts can be more gradual and natural in appearance. While such actions would make the intended use areas less obvious to visitors we believe that their flat and unobstructed surfaces, combined with the evidence of prior use, will provide the visual clues necessary to attract and restrict use to these sites.

The selection of any future campsites should favor sloping terrains and additionally take into account forest cover type and canopy cover. Relational analyses revealed that sites located in balsam fir and white spruce cover types have smaller areal measures of disturbance and less vegetation loss. The branches of evergreen species extend to the ground, acting as a wall that inhibits site expansion and increases camping solitude. The loss of vegetation ground cover can be minimized by selecting sites with more open overstories. The greater sunlight penetration supports trampling resistant and resilient grasses and herbs. Alternately, sites could be located in very dense forests that support little ground vegetation and therefore have little cover to lose.

## Site Conditions

The condition of ISRO backcountry sites is generally quite good. Conditions on 211 sites (86%) are quite acceptable, with condition class ratings of 1, 2, or 3 (Table 8). The majority of sites are rated class 3, characterized by extensive organic litter and/or vegetation disturbance but with soil exposed only in primary use areas. Soil is exposed more extensively on only 33 sites (14%) and no sites were rated class 5, characterized by obvious soil erosion.

As previously noted, site sizes are extremely small, with two-thirds of the sites under 751 $ft^2$ (Figure 10). However, at least seven sites might be considered unacceptably large at more than 2000 $ft^2$. The typical site has about 16% vegetation groundcover and has lost an estimated 60% of its pre-construction vegetative cover. Nearly 80% of the sites have lost more than 80% of their estimated original cover. Due to the small size of these sites the areas contained within their boundaries sustain intensive traffic which tramples and removes the majority of vegetation cover. Areal measures of vegetation loss are small, however, with a median loss of 343 $ft^2$. Similarly, while soil exposure was evident on all sites, the typical site has 38% exposed soil over an area of just 159 $ft^2$. Exceptions include 26 sites with vegetation loss greater than 1000 $ft^2$ and nine sites with exposed soil greater than 1000 $ft^2$.

The majority of trees are removed from sites during construction so on-site tree damage (median = 0) is lower than off-site measures (median = 4). Of the 362 on-site trees assessed, 281 (78%) are damaged. An additional 1,029 damaged trees occur in adjacent off-site areas. Root exposure is generally not a problem; almost two-thirds of the sites (160, 66%) have no trees with exposed roots. The number of tree stumps is also low; 89 were found within site boundaries and 300 were found in adjacent off-site areas.

The development of off-site trailing appears to be a problem in some campgrounds. The typical site has 3 trails leading away from its boundaries, 61% have 3 or more trails, and 10% have 5 or more. The construction of illegal fire sites may also be an issue. Illegal fire sites were found on 22 sites. Litter, while present on most sites, occurs in small quantities (< $1/10^{th}$ of a 40 gallon bag on 96% of the sites). Improperly disposed human waste is rare, as all campgrounds have at least one pit toilet. Searches of likely off-site toilet areas revealed only seven sites with improperly disposed human waste.

The size and condition of shoreline landing areas may be one of the more significant issues for managers to consider. While the majority of landings are less than 500 $ft^2$ (76%), 6 exceed 2000 $ft^2$. The total area of disturbance associated with boat landings (81,695 $ft^2$) is 46% as large as the total area of disturbance associated with all camping sites (177,964 $ft^2$). While ISRO staff have achieved a high degree of success in containing impacts on camping sites, landing areas have not received the same attention. Furthermore, while soil erosion is rare on camping sites it is much more common at landings. Clearly some of these landings, or the large areas of disturbance associated with them, are unnecessary. Soil erosion was rated as common at 33 landings and severe at 16 landings. Soil erosion is also a problem on landing access trails, rated as common on trails leading to 43 landings and severe on trails leading to 10 landings.

## Recommendations for Minimizing Impacts

### Campsite Maintenance

An ongoing program of campsite maintenance can provide an effective option for improving conditions on campsites that receive intensive visitation. Marion and Sober (1987) describe maintenance practices developed for BWCAW campsites that are readily applicable to ISRO sites. Several practices are recommended for management consideration, including site restoration techniques applied to nonessential use areas, tree planting, and grass seeding.

Some campsites are excessively large in size. When located in flat terrain and open vegetation the potential for site expansion will always be high. Site closure should only be considered when use can be shifted to a more resistant site, such as one with a low potential for site expansion. Alternately, site restoration techniques may be applied to nonessential site use areas, such as visitor-created tent pads, site use areas, or shoreline landings. Restoration of organic litter, woody debris, and vegetative groundcover is typically ineffective in preventing re-use of such disturbed areas. An additional and more effective practice is to bury large rocks that cannot be moved ("ice-berging") or to dig shallow pits and mound soil to create an uneven land surface inhospitable to tenting or other activities. Data from this survey can be used to help identify those sites that are unacceptably large, subject to further examination in the field.

Soil erosion control work on campsites, including slope reshaping and shallow ditching, can be employed to limit erosion by redirecting water away from exposed soils.

Site landings should be reevaluated at all campgrounds. Some landings may be unnecessary, particularly when there are multiple landings for a single site or when a single landing can easily serve two or more sites. Landings whose potential for expansion is naturally restricted are preferred, provided they also have a low potential for soil erosion. Site maintenance and restoration techniques can also be applied to limit the size or control soil erosion on landing areas. Soil erosion is of particular significance, both because it is the most permanent form of camping impact and because the erosion in boat landing areas occurs close to water, creating water quality impacts.

Tree mortality rates are frequently very high both on campsites and in adjacent off-site areas. Tree regeneration is also very low in these areas, resulting in a net loss of trees and tree cover over time. Increasing amounts of sunlight do have a positive effect by supporting an enhanced cover of grasses, which are shade-intolerant but trampling resistant. Managers in the BWCAW have witnessed increases in campsite vegetation cover as tree canopies have thinned over time. On the negative side, the gaps in tree canopies associated with campsites appear unnatural and visitors often prefer at least partially shaded sites. Over a decade ago BWCAW managers made the decision to maintain tree canopies in and around campsites and included tree planting in their site maintenance program. Trees of a similar composition to those in off-site areas are planted in protected on-site and adjacent off-site locations. Though no formal monitoring has been conducted, their efforts have been successful based on the second author's personal observations. More information regarding planting stock and techniques should be sought from the BWCAW campsite maintenance program staff. We recommend that several ISRO managers travel to the BWCAW and meet with their Forest Service colleagues to exchange information and ideas regarding campsite design, construction, and maintenance.

In spite of their intensive use, many ISRO sites have considerable vegetation cover, primarily grasses and sedges but also some trampling resistant broad-leafed herbs (often non-native). Staff may wish to consider seeding campsites that have more open overstories with grasses native to the island. Once identified a list could be circulated to some of the native seed companies in the region. Such companies can often provide seed stock that is guaranteed to be over 99% pure. Alternately, seed could be collected in the wild or plants could be propagated in a nursery. Seeding or plantings are likely to be successful only in less trafficked areas. Both seeding and plantings have been used at least historically in the BWCAW campsite maintenance program. Advice regarding vegetative stock and successful techniques should be sought.

**Leave No Trace Education**

Visitor education of appropriate low impact camping and hiking practices can also assist managers in sustaining use and preventing or minimizing resource and social impacts. The interagency *Leave No Trace* (LNT) program contains a wealth of booklets and well-defined practices applicable to ISRO. Managers may also wish to consider development of a park-specific brochure such as that designed by LNT program staff with the National Outdoor Leadership School for Great Smoky Mountains National Park (Marion and Brame 1996). BWCAW staff also have an excellent educational program and low impact camping materials. One or more park staff may also be sent

to complete the Master of *Leave No Trace* course to learn both practices and methods for communicating LNT information to other park staff and the public. The park may even wish to consider hosting such a course to gain expert opinion on practices specific to their environment and camping management structure.

## Backcountry Facilities

While recreational facilities of all kinds may be found in frontcountry zones of national parks their use is often far less appropriate in backcountry, particularly wilderness. Backcountry recreation is distinguished from frontcountry recreation by both its remote and primitive nature, including, generally, the lack of permanent facilities. However, exceptions may be made for backcountry facilities that serve resource or visitor protection purposes, such as fire rings that help prevent campfires from becoming forest fires. Facilities whose primary function is visitor convenience are generally considered as inappropriate in backcountry and wilderness settings.

### Shelters

The park has 88 three-sided screened wooden shelters, including 20 located within wilderness. Built predominantly in the 1960's these shelters have become a popular tradition among ISRO campers. The park maintains and periodically replaces these structures but does not plan to increase or decrease their number over time. Many predate the park's wilderness designation and their presence is specifically authorized by the ISRO wilderness legislation.

While many would maintain that such camping structures are primarily a visitor amenity or convenience, the survey data clearly demonstrate that they also provide a resource protection function. The median area of disturbance for shelters, including both their "footprint" and associated external disturbance, is 377 $ft^2$, in comparison to 572 $ft^2$ for individual campsites and 1496 $ft^2$ for group campsites. Shelter visitors likely spend a greater proportion of their time within the structure or immediately in front of it. The shelter is essentially one large tent, which eliminates the need and greater areas of disturbance associated with multiple tent sites.

### Picnic Tables

While typically considered a visitor amenity, survey data indicate that picnic tables also provide a resource protection function. Analyses reveal small but statistically significant reductions in areal measures of disturbance for campsites with picnic tables in comparison to campsites that lack them (Table 20). For example, the mean size of individual campsites with picnic tables is 549 $ft^2$ while the mean size for this campsite type without tables is 717 $ft^2$. The difference in size, area of vegetation loss, and exposed soil was consistently between 100-250 $ft^2$ for both individual and group campsites (Table 20). These findings were not consistent for shelter sites (those with picnic tables were larger) but only three shelter sites lack picnic tables so the sample size is insufficient for valid testing.

In spite of these findings the presence of picnic tables in backcountry zones is extremely uncommon within other NPS units. Their presence on wilderness campsites is extremely rare or nonexistent; we know of no other wilderness areas which currently contain this facility type. Forest Service managers of the nearby Boundary Water Canoe Area Wilderness removed all picnic tables in the early 1980's following a determination that they were inappropriate in wilderness. We concur with this view and recommend their removal from all wilderness sites at ISRO as well. This recommendation is based on our interpretation of wilderness management philosophy and the "minimum tool" principle (Hendee and others 1991); it is not derived from survey data. Currently there are picnic tables on 33 wilderness sites (at 19 shelters, 11 individual sites, and 3 group sites).

### Campfire Rings

Metal campfire rings provide a resource protection and visitor amenity function. Campfire rings contain fires to a single location within a campsite, preventing fire site proliferation or migration problems that occur when a facility is not provided. Fire rings also help to prevent the escape of fires that are not carefully tended or fully extinguished. Campfire rings also serve as an attraction feature that encourages activity concentration (Marion 1995). When grates are also incorporated into campfire ring design this facility also facilitates food cooking and provides a visitor amenity function. While relatively few visitors depend upon fires for cooking, fires remain a highly valued component of a backcountry camping experience for many visitors. Campfires can serve an important social function, such as when members of a group gather at the end of a day to talk or engage in quite contemplation.

Survey data indicate that the presence of campfire rings may concentrate visitor activities, leading to smaller areas of vegetation loss and exposed soil, though site size is unaffected (Table 21). There are also negative aspects associated with permitting campfires. At ISRO, sites where campfires are permitted have marginally greater tree damage in adjacent off-site areas (about one tree/site) and more trails, attributed to fire wood gathering. However, survey findings present no compelling evidence for restricting the current policy of allowing campfires at backcountry sites. Expansion of the fire policy to additional sites in areas of adequate wood supply are also possible.

## Campsite Monitoring

This report provides managers with an objective and comprehensive picture of the current status of campsite and shelter conditions. It describes the number and distribution of sites, the extent of various types of resource impact, and some environmental attributes that influence site degradation. While this information has current usefulness, the data also provide a baseline for comparison with results from future surveys. Repeated applications of these procedures as part of a long-term monitoring program will provide managers with reliable information on changing resource conditions. Monitoring provides essential information for evaluating the acceptability of recreational impacts and of the effectiveness of management responses to such problems, particularly when integrated with a decision making framework such as LAC or VERP.

The campsite monitoring procedures included in Appendix 1 are also recommended for future monitoring surveys. To increase the precision of comparisons between surveys, site remeasurement procedures are included for several indicators (see Appendix 1). However, these procedures lengthen assessment times for individual sites from an average of 15 minutes to approximately 30 minutes. We also note that due to phenological and site use changes that occur over the use season, it is critical that sites be remeasured as close to the initial assessment month and day as possible, preferably within one to two weeks.

Many options exist for conducting the campsite monitoring program. The most comprehensive option is to apply the monitoring procedures to all campsites (a census) at some specified interval of time. Due to the increased campsite assessment times, this approach would likely require twice the personnel or time as the current survey. An advantage of this approach is that all campsites are assessed, permitting park-wide evaluations of site-specific changes, aggregate change, and indicator standards of any type. A disadvantage of this approach is its higher cost. A less costly option is to sample some percentage of backcountry campsites. For example, one-half or one-third of the campsites could be assessed each monitoring cycle. The principal disadvantage of this approach is the inability to evaluate aggregate change for all sites at a specific point in time.

**Recommendations:** A monitoring cycle of about five years is recommended unless visitor use levels are rapidly changing. Monitoring surveys could be conducted every two or three years if use levels are substantially increasing or at a longer interval if use levels are decreasing. The development and refinement of monitoring procedures is a continuing process, so park staff are advised to examine and consider the substitution of improved procedures prior to each monitoring cycle. Advantages in accuracy, precision, or efficiency must be evaluated against any loss in comparability to earlier data. If funding permits, we further recommend a census approach as this option provides the most complete data for analysis of trends and management decision making.

# CONCLUSIONS

National Park Service backcountry and wilderness areas are administered under dual legal mandates that require managers to achieve an acceptable balance between resource protection and recreation provision objectives. Some degree of environmental degradation is inevitable where recreational visitation is permitted. Managers are challenged to develop recreation resource management policies that can sustain both high quality recreational experiences and environmental conditions and processes that are minimally affected by human disturbance. Recreation ecology seeks to assist managers in this difficult task by providing objective information describing the types and severity of resource impacts caused by recreation visitation. Furthermore, knowledge of relationships between the extent of resource impact and use-related, environmental, and managerial factors can suggest effective management strategies and actions for minimizing such changes. Such information, combined with managerial experience and judgement, provides a sound basis for management decision making.

The campsite and shelter inventory and condition assessment study described in this report was initiated in recognition of the managerial need for reliable information regarding the number, distribution, and condition of backcountry campsites within Isle Royale National Park. This survey sought to locate and assess the condition of all backcountry campsites using state-of-the-knowledge procedures that could be replicated as part of a permanent monitoring program. An additional objective was to evaluate and make recommendations for enhancing the park's camping management policies.

Visitor impact monitoring programs offer protected area managers an objective tool for documenting trends in resource conditions as affected by recreational activities. Monitoring data describe the nature and extent of resource changes and can be analyzed to reveal the influence of use-related, environmental, and managerial factors. As demonstrated in this report, monitoring data permit the quantitative documentation of site-specific conditions, providing a permanent and impartial record of changing resource conditions. Our analysis and interpretation revealed a number of campsite management problems, to which we applied recreation ecology and wildland recreation management knowledge to offer some potential management options. These findings provide ISRO managers with an improved understanding of backcountry campsite conditions and how additional actions might substantially improve both resource and social conditions. We recommend further evaluation of these and other alternatives by senior park managers, experienced backcountry staff, and representatives of the visiting public and organized interests.

Monitoring data alone are insufficient to deal effectively with visitor impact management problems, particularly those that require controversial management solutions. Though this report describes both insignificant and substantial changes in the condition of various impact indicators, we are unable to address the acceptability of such changes. Management planning and decision making frameworks such as LAC and VERP offer managers a defensible approach for addressing the issue of acceptability using management objectives, indicators, standards, and monitoring. We strongly

recommend management consideration of such frameworks, particularly during the development of future backcountry and wilderness management plans.

Visitation will undoubtedly increase in the future, requiring an intensification of natural resource and visitor management efforts. Effective management policies based on objective scientific information are essential if the qualities of naturalness and limited human-related impacts are to be maintained. The value society places on national park environments lies in their continued naturalness. Recreational impacts, if not monitored and controlled, can compromise the inherent value of park resources and may ultimately reduce the quality of recreational experiences.

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# APPENDIX 1

## Campsite Monitoring Manual
## Isle Royale National Park

## Description of Procedures[1,2]

(*version 6/96*)

For the purposes of this manual, campsites are defined as areas of disturbed vegetation, surface litter, or soils caused by overnight camping activities, including both designated (legal) and non-designated (illegal) campsites. In areas with multiple sites there may not always be undisturbed areas separating sites and an arbitrary decision may be necessary to define separate sites. Illegal campsites are to be identified through discussions with experienced park staff combined with thorough searches of backcountry areas of known or suspected camping activities.

This manual describes procedures for conducting a comprehensive inventory and assessment of resource conditions of backcountry campsites. Three general approaches are used for assessing the condition of campsites: 1) photographs from permanently referenced photo points, 2) a condition class assessment determined by visual comparison with six described levels of campsite impact, and 3) predominantly measurement-based assessments of 12 impact indicators.

### Materials

Topographic maps (1/24,000) with 150% copier enlargements of all campground areas (cut out and copy scale bars with enlargements
Compass, peephole type (not corrected for declination) and/or KVH Data Scope, digital compass
Tape measure (100 ft. in tenths) and/or Sonin Combo Pro distance measuring device
Measuring wheel
Flagged wire pins (25 minimum w/additional set of different color for remeasurement)
Large steel reference point stake
Camera, 35mm SLR, 35mm lens and ASA 200 color print film (store in freezer)
Aluminum numbered tags, 4 in. galvanized steel nails
Clipboard, monitoring manual, field forms (some on waterproof paper), pencils
Magnetic pin locator (remeasurement only)
Backpacking trowel

1 - Developed by Dr. Jeff Marion, USGS Patuxent Wildlife Research Center, Cooperative Park Studies Unit, Virginia Tech/Department of Forestry, Blacksburg, VA 24061-0324 (540/231-6603) email: cpsu@vt.edu.

2 - Photographs illustrating campsite boundaries, boundary flag placement, vegetative ground cover classes, soil exposure, tree damage, and root exposure are part of this manual but have been omitted from this Appendix. High quality reproductions of these photographs, some of which are in color, may be found in Marion (1991), on pages 46-51.

## General Campsite Information

1-2) **Campsite Numbers**: Both designated and non-designated campsites will have two numbering schemes. The first (see form #1, Campsite Tag No.) will be a three digit number corresponding with numbered aluminum tags that are to be buried at the campsite reference point (instructions on burial are provided later). If it is impossible to bury an aluminum tag (e.g. due to bedrock), the same numbering system as above should be applied as if aluminum tags were used. If it is a shelter site, bury the tag adjacent to the left front shelter corner post, just under the shelter. Regardless, remarks should be made on the field form indicating whether and/or where a tag was buried. If a tag is not buried it should be separated and disposed of to avoid confusion at subsequent campsites.

The second campsite numbering code (see form #2, Park No.) will begin with the campground's four digit letter code, followed by the campsite's unique two-digit campground number. Refer to the campground maps for campsite number codes. For non-designated campsites enter the code "NOND" followed by consecutive unique numbers (keep track of the numbers you have used). Write in the campsite name in the space provided (use "Illegal Site" for non-designated campsites).

Site remeasurement - Examine mapped campsite locations and field forms to determine if each campsite was present during the previous survey. Relocate centerpoints with centerpoint reference information and the pin locator and verify campsite numbers by digging up the number tags. Replace any lost tags and reference point nails only if you are absolutely certain of the campsite number and reference point location. Number new campsites with any unique number larger than any used in the previous survey.

3) **Wilderness**: Record whether the campsite is within wilderness or not.
W=Wilderness N=Non-Wilderness

4) **Access Type**: Record the code(s) that represent the most common type(s) of campsite access. (Data entry: record all applicable letters in alphabetical order without spaces between letters)
B=Powerboat C=Canoe K=Kayak T=Trail

5) **Campsite Group Type**: Record whether the campsite is an individual or group site.
C=Campsite (individual) G=Group campsite S=Shelter L=Legal non-designated I=Illegal, non-designated

6) **Stay Limit**: Record the campsite stay limit for the summer use season.
Nights: 1, 2, 3, 4, 5 (Note: Legal non-designated sites are limited to 1 night stays).

7) **Fires**: Record whether campfires (of any type) are permitted at this specific campsite. Y / N

8) **Picnic Table**: Record whether a picnic table is present or not. Y / N

9) **Date**: Month, day, and year the campsite was evaluated (e.g. August 1, 1996 = 08/01/96).

Site remeasurement - Due to phenological and campsite use changes which occur over the use season, it is critical that campsites be remeasured as close to the initial assessment month and day as possible, preferably within 1 to 2 weeks.

10) **Inventoried by**: Identify the field personnel responsible for campsite assessment by listing the first initials of first and last names.

**Locate/Label Campsite on Topo Map** - Mark the topographic map with a dot precisely indicating the campsite's location and label with its campsite tag number. Be as accurate as possible. At 1/24,000 scale 1/4 inch on map = 500 ft. on ground. Use the measuring wheel to determine distances where necessary. Campsite locations will be digitized for the park Geographic Information System off these maps. Accurate campsite location descriptions are also critical to campsite relocation. For campground sites use 150% copier enlargements so that campsites can be more accurately mapped.

**Campground Maps** - For each campground measure and record distances and compass bearings for all trails, campsites, and structures so that scaled maps can be drawn. Use a measuring wheel for trail distances. Wherever possible, measure line of sight distances with the Sonin device and record compass bearings from easily identifiable points like trail junctions, landings, or campsite to all other visible and mapped features. Label true north on each map.

**Non-Designated Campsite Maps** - Develop an area map to describe the exact location of each non-designated campsite. Describe the location using local geographic features (points, bays, inlets, islands, harbors, trail intersections, and recognizable landmarks or features) and measure distances. Use sufficient descriptive detail so that someone else five years later could relocate the campsite.

## Inventory Indicators

11) **Distance to Lakeshore**: Record the appropriate category for campsite distance to a lake or creek shoreline. 1=<25 ft. 2=26-100 ft. 3=101-300 ft. 4=301-500 ft. 5=>500 ft.

12) **Distance to Nearest Other Campsite**: Measure (nearest foot) and record the distance to the nearest other campsite or shelter. Measure from campsite boundary to campsite boundary at their closest points, if possible, or along trail if it is reasonably straight between the two sites.

13) **Distance to Campground Trail**: Measure (nearest foot) and record the distance along the campsite access trail from the campsite boundary to the campground access trail or formal park trail (whichever is closest).

14) **Other Campsites Visible**: Record the number of other shelters or campsites, which if occupied, would be visible from the campsite. This is a social variable to assess intervisibility.

15) **Site Visibility from Campground Trail**: Record whether the campsite is visible from any of the formal campground trails (not informal visitor-created trails). Y or N

16) **Site Visibility from Formal Park Trail**: Record whether the campsite is visible from any formal park trails (not campground or informal trails). Y or N

17) **Tree Canopy Cover Over Site**: Imagine that the sun is directly overhead and estimate the percentage of the campsite that is shaded by the tree canopy cover. 1=0-5 2=6-25% 3=26-50% 4=51-75% 5=76-95 6=96-100%

18) **Vegetation Type**: Record the dominant and codominant tree species on and around the campsite.

19-20) **Tent Pads**: Count and record the number of "obvious" tent pads. Differentiate between those that are "constructed" and those that are "natural". List the approximate dimensions of all tent pads. (*Office*: use a calculator to compute and sum the areas for each tent pad category. Enter as additional indicators.)

## Impact Indicators

The first step is to establish the campsites' boundaries and measure its size. The following procedures describe the use of the **Variable Radial Transect Method** for determining the sizes of campsites. This is accomplished by measuring the lengths of linear transects radiating from a permanently defined centerpoint to the campsite boundary.

**Step 1. Identify Campsite Boundaries and Flag Transect Endpoints.** Walk the campsite boundary and place flagged wire pins at locations which, when connected with straight lines, will define a polygon whose area approximates the campsite area. Use as few pins as necessary, typical campsites can be adequately flagged with 10-15 pins. Look both directions along campsite boundaries as you place the flags and try to balance areas of the campsite which fall outside the lines with off-site (undisturbed) areas which fall inside the lines. Pins do not have to be placed on campsite boundaries, as demonstrated in the diagram in Figure 1. Project campsite boundaries straight across areas where trails enter the campsite. Identify campsite boundaries by pronounced changes in vegetation cover, vegetation height/disturbance, vegetation composition, surface organic litter, and topography (refer to photographs following these procedures). Many campsites with dense forest overstories will have very little vegetation and it will be necessary to identify boundaries by examining changes in organic litter, i.e. leaves which are untrampled and intact vs. leaves which are pulverized or absent. In defining the campsite boundaries be careful to include only those areas which appear to have been disturbed from human trampling. Natural factors such as dense shade can create areas lacking vegetative cover. Do not include these areas if they appear "natural" to you. When in doubt, it may also be helpful to speculate on which areas typical visitors might use based on factors such as slope or rockiness.

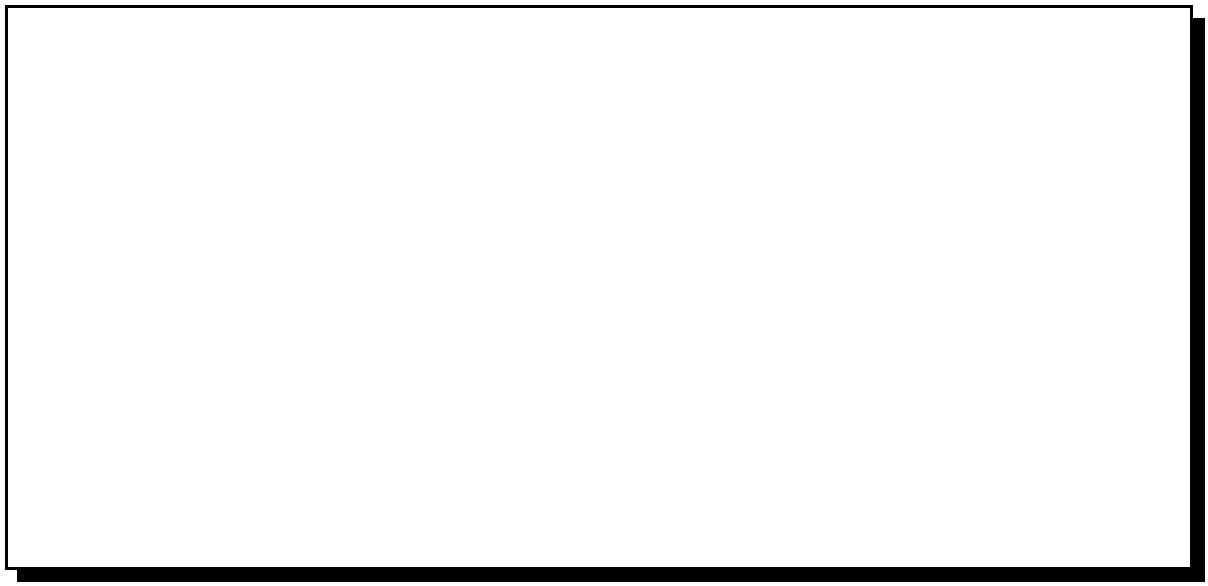


**Figure 1.** Variable radial transect method applied to a campsite.

**Step 2. Establish Campsite Reference Point.**
Select a campsite reference point which is preferably: a) visible from all the campsite boundary pins, b) close to and easily referenced by distinctive permanent features such as boulders or trees, c) at least 6 ft away from fire grates or other steel that would affect compass readings, and d) in a spot permitting the burial of the reference point nail and campsite tag. Reference this point to at least three relatively permanent and distinctive features. If trees are used select ones that are healthy and unique to the campsite area, such as an uncommon species or with unique physical characteristics (forked trunk or

large size). Try to select reference features in three opposing directions as this will enable future workers to triangulate the reference point location. Also take the reference point photograph(s) and reference the photopoint(s) as described at the end of this manual.

For each reference feature, take a compass bearing (nearest degree) and measure the distance (nearest 1/10th foot) from the feature (center of trees or the highest point of boulders) to the campsite reference point. Also measure the approximate diameter of reference trees at 4.5 ft above ground (dbh). Be extremely careful in taking these bearings and measurements as they are critical to relocating the reference point in the future. Record this information on the back of the form.

*Examples:*
1) White Birch, 2.9 ft. dbh, 8.9 ft. at 195$^{o}$ (largest tree on campsite)
2) Boulder, 7.9 ft. at 312$^{o}$, (distance and bearing to highest point)
3) Jack Pine, 1.8 ft. dbh, 8.4 ft. at 78$^{o}$, (only Jack Pine in the area)
4) SW corner of shelter, 12.5 ft. at 2$^{o}$

**Options:** Some campsites may lack the necessary permanent reference features enabling the point to be accurately relocated. If only one or two permanent reference features are available, use these and take additional photographs from several angles. If permanent features are unavailable (e.g. large sandy beach) simply proceed with the remaining steps and reference the point with photographs (a nail with campsite number tab should still be buried). This option will introduce more error in comparisons with future measurements, particularly if the campsite boundaries are not pronounced. If you are unable to bury a nail and tag (e.g. bedrock) then select a permanent feature (e.g. some obvious bedrock feature) and use it as a reference point. Complete procedures to reference its location, including photographs. Note your actions regarding use of these options in the Comments section.

**Step 3. Record Transect Azimuths and Lengths.** Standing directly over the reference point, identify and record the compass bearing (azimuth) and distance to each campsite boundary pin working in a clockwise fashion (in the exact order you would encounter them if you were walking the campsite boundary). Be careful not to miss any pins hidden behind vegetation or trees. Be extremely careful in identifying the correct compass bearings to these pins as error in these bearings will bias current and future measurements of campsite size. If a tape measure is used, anchor the end to the large steel reference point stake and route it via the shortest distance around trees or other obstructions. Record the length of each transect (nearest 1/10th foot), starting with the same boundary pin and in the same clockwise order as before. Be absolutely certain that the appropriate pin distances are recorded adjacent to their respective compass bearings. Leave boundary pins in place until you finish all other campsite measurements.

**Step 4.** Measure Island and Satellite Areas. Identify any undisturbed "islands" of vegetation inside campsite boundaries (often due to clumps of trees or shrubs) and disturbed "satellite" use areas outside campsite boundaries (often due to tent sites or cooking sites). Use campsite boundary definitions for determining the boundaries of these areas. Use the **Geographic Figure Method** to determine the areas of these islands and satellites (refer to the diagrams following these procedures). This method involves superimposing one or more imaginary geometric figures (rectangles, circles, or right triangles) on island or satellite boundaries and measuring appropriate dimensions to calculate their areas. Record the types of figures used and their dimensions on the back of the form; the sizes of these areas should be computed in the office with a calculator. Also, record the compass bearing and distance from the center of each island or satellite site to the campsite reference point.

Remove the reference point stake. Place a 4 inch long galvanized steel nail through the hole in the campsite number tag and bury at the reference point so that the tag is 3 inches underground.

**Site Remeasurement** - Relocate the reference point using point references, photos, and a magnetic pin locator. Typically the photo will get you in the right area and the pin locator will allow you to pinpoint the buried nail and tag. If you cannot find it then search for the three reference features, go to each and shoot the back azimuth (small number scale in the peep hole compass viewfinder). Use the tape measure to determine the correct distance and draw an arc on the ground. If the pin locator still does not register then repeat procedure from the other reference features and reestablish the reference point with a new tag and nail (note new campsite number on form and in database). Insert the large steel stake at the reference point location and reestablish all former campsite boundary pins using the previous transect data compass bearings and distances. Reassess boundary pin locations based on the following procedures (illustrated in Figure 2):

**Figure 2.** Illustration of transect procedures during campsite remeasurement.

**1)** Keep the same transect length if that length still seems appropriate, ie. there is no compelling reason to alter the initial boundary determination.

**2)** Record a new transect length if the prior length is inappropriate, ie. there is compelling evidence that the present boundary does not coincide with the pin and the pin should be relocated either closer to or further from the reference point along the prescribed compass bearing.

**3)** Repeat Steps 1 and 3 from above to establish additional transects where necessary to accommodate any changes in the shape of campsite boundaries. Also repeat Step 4.

These procedures are designed to eliminate much of the measurement error associated with different individuals making subjective judgements on those campsites or portions of campsites where boundaries are not pronounced. These procedures may only be used for campsites whose reference points can be relocated.

**Special Note**: Shelters are 10 x 15 ft in size. This area should legitimately be considered part of the campsite and included as 150 $ft^2$ of vegetation loss and exposed soil. However, this will be taken into account during data analysis. In the field, all assessments will ignore the space immediately occupied by the shelters.

## CONDITION CLASS DEFINITIONS

**Class 0**: Campsite barely distinguishable; no or minimal disturbance of vegetation and /or organic litter. Often an old campsite that has not seen recent use.

**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.

**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.

21) **Condition Class**: Record a campsite Condition Class using the descriptions above. If a campsite is underlain entirely by bedrock, record "-1" for this item and others (items 22 - 24 or 31) as they are not applicable for this type of campsite. Include an explanation in the field form "Comments."

22) **Vegetative Ground Cover On-Site**: An estimate of the percentage of live non-woody vegetative ground cover (including herbs, grasses, and mosses and excluding tree seedlings, saplings, and shrubs) within the flagged campsite boundaries using the coded categories listed below (refer to photographs following these procedures). Include any disturbed "satellite" use areas and exclude undisturbed "islands" of vegetation. For this and the following two indicators, it is often helpful to narrow your decision to two categories and concentrate on the boundary that separates them. For example, if the vegetation cover is either category 2 (6-25%) or category 3 (26-50%), you can simplify your decision by focussing on whether vegetative cover is greater than 25%.

| | **1 = 0-5%** | **2 = 6-25%** | **3 = 26-50%** | **4 = 51-75%** | **5 = 76-95%** | **6 = 96-100%** |
|---|---|---|---|---|---|---|
| Midpoints: | 2.5 | 15.5 | 38 | 63 | 85.5 | 98 |

23) **Vegetative Ground Cover Off-Site**: An estimate of the percentage of live non-woody vegetative ground cover (including herbs, grasses, and mosses and excluding tree seedlings, saplings, and shrubs) in an adjacent but largely undisturbed "control" area. Use the codes and categories listed above. The control site should be similar to the campsite in slope, tree canopy cover (extent of sunlight penetration), and other environmental conditions. The intent is to locate an area which would closely resemble the campsite area had the site never been used. In instances where you cannot decide between two categories, select the category with less vegetative cover. The rationale for this is simply that the first visitors would have selected a campsite with the least amount of vegetation.

24) **Exposed Soil**: An estimate of the percentage of exposed soil, defined as ground with very little or no organic litter (partially decomposed leaf, needle, or twig litter) or vegetation cover, within the campsite boundaries and satellite use areas (refer to the photographs following these procedures). Dark organic soil, the decomposed product of organic litter, should be assessed as bare soil when its consistency resembles peat moss. Assessments of exposed soil may be difficult when organic litter forms a patchwork with areas of bare soil. If patches of organic material are relatively thin and few in number, the entire area should be assessed as bare soil. Otherwise, the patches of organic litter should be mentally combined and excluded from assessments. Code as for vegetative cover above.

25-27) **Tree Damage On-Site**: Tally each live tree (>1 in. diameter at 4.5 ft.) within or on campsite boundaries to one of the tree damage rating classes described below (refer to the photographs following these procedures). **Include** trees within undisturbed "islands" and **exclude** trees in disturbed "satellite" areas. Assessments are restricted to all trees within the flagged campsite boundaries in order to ensure consistency with future measurements. Multiple tree stems from the same species which are joined at or above ground level should be counted as one tree when assessing damage to any of its stems. Assess a cut stem on a multiple-stemmed tree as tree damage, not as a stump. Do not count tree stumps as tree damage. Include only damage that is clearly human-caused i.e. obvious axe or saw cuts, disregard old scars whose cause cannot be determined and scars from moose antler rubbing or lightning strikes.

**None/Slight** . . No or slight damage: broken or cut smaller branches or a few superficial trunk scars that total less than 1 x 2 inches (2 $in^2$).
**Moderate** . . . Scars that total more than 1 x 2 inches (2 $in^2$) but less than 6 x 6 inches (36 $in^2$).
**Severe** . . . . . Scars that total more than 6 x 6 inches (36 $in^2$) or any complete girdling of tree (cutting through tree bark all the way around tree).

Site remeasurement - begin by assessing tree damage on all trees within the campsite boundaries identified in the last measurement period. Place boxes around each tally for trees in areas where boundaries have moved closer to the reference point, i.e., former campsite areas which are not currently judged to be part of the campsite. Next, assess tree damage in areas where boundaries have extended further from the reference point, i.e., expanded campsite areas which are newly impacted since the last measurement period. Circle these tallies. These additional procedures are necessary in order to accurately analyze changes in tree damage over time.

28-29) **Tree Damage Off-Site**: Tally each live tree (>1 in. diameter at 4.5 ft.) within 50 ft of campsite boundaries that is either moderately or severely damaged using the definitions above. If adjacent campsites are less than 100 ft from a boundary then assess tree damage only to the midpoint between the two campsite boundaries. Do not tally trees in the none/slight category.

30-32) **Root Exposure**: Tally each live tree (>1 in. diameter at 4.5 ft.) within or on campsite boundaries to one of the root exposure rating classes described below. **Include** trees within undisturbed "islands" and **exclude** trees in disturbed "satellite" areas. Assessments are restricted to all trees within the flagged campsite boundaries in order to ensure consistency with future measurements. Where obvious, assess trees with roots exposed by natural causes (e.g., coastline erosion) as None/Slight.

**None/Slight** . . No or slight root exposure such as is typical in adjacent off-site areas.
**Moderate** . . . Top half of many major roots exposed >1 ft. from base of tree.
**Severe** . . . . . Three-quarters or more of major roots exposed > 1 ft. from base of tree; soil erosion obvious.

Site remeasurement - Begin by assessing root exposure on all trees within the campsite boundaries identified in the last measurement period. Place boxes around each tally for trees in areas where boundaries have moved closer to the reference point, i.e., former campsite areas which are not currently judged to be part of the campsite. Next, assess root exposure in areas where boundaries have moved further from the reference point, i.e., expanded campsite areas which are newly impacted since the last measurement period. Circle these tallies. These additional procedures are necessary in order to accurately analyze changes in root exposure over time.

33) **Tree Stumps On-Site**: A count of the number of obviously human cut tree stumps (> 1 in. diameter at ground and less than 4.5 ft tall) within or on campsite boundaries. **Include** trees within undisturbed "islands" and **exclude** trees in disturbed "satellite" areas. Do not include windthrown trees with their trunks still attached or cut stems from a multiple-stemmed tree.

Site remeasurement - begin by assessing stumps within the campsite boundaries identified in the last measurement period. Place boxes around each tally for stumps in areas where boundaries have moved closer to the reference point, i.e., former campsite areas which are not currently judged to be part of the campsite. Next, assess stumps in areas where boundaries have moved further from the reference point, i.e., expanded campsite areas which are newly impacted since the last measurement period. Circle these tallies. These additional procedures are necessary in order to accurately analyze changes in stumps over time.

34) **Tree Stumps Off-Site**: A count of the number of obviously human cut tree stumps (> 1 in. diameter at ground and less than 4.5 ft tall) within 50 ft of campsite boundaries. Do not include windthrown trees with their trunks still attached or cut stems from a multiple-stemmed tree. If adjacent campsites are less than 100 ft from a boundary then assess tree stumps only to the midpoint between the two campsite boundaries.

35) **Fire Sites**: A count of each fire site, of any type, within campsite boundaries, including satellite and affiliated shoreline areas. Include old inactive fire sites as exhibited by blackened rocks, charcoal, or ashes. Do not include locations where charcoal or ashes have been dumped. However, if it is not clear whether a fire was built on the campsite, always count questionable sites that are within campsite boundaries and exclude those that are outside campsite boundaries.

36) **Access Trails**: A count of all trails leading away from the outer campsite boundaries. For trails that branch apart or merge together just beyond campsite boundaries, count the number of separate trails at a distance of 10 ft. from campsite boundaries. Do not count extremely faint trails that have untrampled tall herbs in their tread.

37) **Litter/Trash**: Estimate the percentage of a single garbage bag (40 gallon size) or number of bags that could be filled with recreation-related litter from the campsite, including landing, trail, and adjacent off-site areas. Disregard litter that has been deposited from Lake Superior. Use decimals to indicate fractions of a bag (e.g. 0.5 equals half a bag). Record a 0 if the campsite is clean or has only a handful of smaller items.

38) **Human Waste**: Follow all trails connected to the campsite to conduct a quick search of likely "toilet" areas, typically areas just out of sight of the campsite. Count and record the number of individual human waste sites, defined as separate locations with human feces present. The intent is to identify the extent to which improperly disposed human feces is a problem.

39) **Total Campsite Area**: Using the dBASE computer program, compute the campsite size using the transect data. Using a calculator, compute and sum the area of each island and satellite site (see the *Geometric Figure Method* sheet for procedures and formulas). Record these values in the spaces provided on the back of the form and calculate the Total Campsite Area. Record this value on the front of the form to facilitate computer data entry.

**Comments**: An informal list of comments concerning the campsite: note any assessments that you felt were particularly difficult or subjective, problems with monitoring procedures or their application to this particular campsite, suggestions for clarifying monitoring procedures, descriptions of particularly significant impacts beyond campsite boundaries (quantify if possible), excessive litter, human waste, or any other comments you feel may be useful.

**Campsite/Reference Point Photograph**: Select a vantage point which provides the best view of the campsite and reference point location. Try to select a location which clearly shows the reference point location in relation to nearby trees or boulders. It may be necessary to take a separate reference point

photograph in some instances. Place the tape measure or some other object against the reference point stake so that it is clearly visible in the camera viewfinder. Leave the camera lens set at a 35-38mm focal length. Take a picture, pointing the camera down to include as much of the campsite groundcover as possible. If a camera with a date/time recorder is used (preferred), record the date and time on the field form and disregard the following photolog description procedures. ***Photo description procedures***: Use the photo description space to write something unique about the photo which will allow you to recognize and label the photo for this campsite. Record the film roll and photo number(s) in the space provided. Label film rolls with your initials followed by a unique roll number.

Record the compass bearing and distance from the reference point to the photopoint. The intent is to obtain a photograph which includes as much of the campsite as possible to provide a photographic record of campsite conditions. The photo will also allow future workers to make a positive identification of the campsite and assist in reference point location. At the earliest possible time, label the backs of 3x5 prints with the campsite number, date, film roll number, photograph number, bearing, and distance. Also, label and store the negatives. Store the photographs separately from the survey forms. An opaque plastic box should be used for long-term photo and negative storage.

*** Bury reference point nail and tag about 3 inches deep, compact soil with foot. Collect all campsite boundary pins, the reference point stake, and all other equipment.**

## Campground Form Procedures

This form is to be completed for each backcountry campground following all individual campsite assessments.

1) **Park Campground Code**: Record the four-letter campground code.

2) **Park Campground Name**: Record the campground name.

3) **Date**: Month, day, and year the campground was evaluated (e.g. August 1, 1996 = 08/01/96).

4) **Inventoried by**: Identify the field personnel responsible for campsite assessment by listing the first initials of first and last names.

5) **Individual Campsites**: Record the total number of legal individual campsites.

6) **Individual Campsite Tent Pads**: Record the total number of individual campsite tent pads.

7) **Group Campsites**: Record the total number of legal group campsites.

8) **Group Campsite Tent Pads**: Record the total number of group campsite tent pads.

9) **Shelters**: Record the total number of shelters.

10) **Privies**: Record the total number of privies.

11) **Picnic Tables**: Record the number of picnic tables at the shoreline access area. These are communal picnic tables that serve the entire campground.

12) **Fire Sites**: Record the number of fire sites at the shoreline access area. These are communal fire sites that serve the entire campground.

13-16) **Predominant Use Type**: Consult experienced park field staff and review park permit data to estimate the relative proportions of four types of campsite use based on mode of travel. Estimate percent use in 10% classes and record the class midpoint (plus 0 and 100):

Boaters ___ Hikers ___ Canoeists ___ Kayakers ___

0, 5, 15, 25, 35, 45, 55, 65, 75, 85, 95, 100.
Percentages should add to 100%.

**Campground Description** Describe the following campground characteristics:

**General Location** - relative to lakes, trails, or other features

**Topography** - describe slope and any prominant topographic features

**Vegetation** - describe vegetation including type and density

**Soil** - describe the soil substrate (texture and stoniness)

**Social Problems** - from discussion with park staff, describe the presence/absence or level of severity of social problems such as crowding and conflicts between visitor groups

**Impact** - describe any notable or significant resource impacts

**Recommendations** - describe your recommendations, what might be done to minimize resource impacts or resolve visitor crowding and conflicts

## Shoreline Access Area Form Procedures

This form is to be completed after all campsite assessments for each shoreline access area or boat landing/docking location. These areas may serve the entire campground or a single campsite. Complete one form for each area.

1) **Park Campground Code**: Record the four-letter campground code.

2) **Park Campground Name**: Record the campground name.

3) **Campsite Tag No.**: If this shoreline access area serves only one campsite, record the three digit campsite tag number. Otherwise enter “999" to indicate it serves multiple campsites. If it serves a single campsite, record a compass bearing and distance from that campsite's reference point to the center of the shoreline access area.

4) **Date**: Month, day, and year the campsite was evaluated (e.g. August 1, 1996 = 08/01/96).

5) **Inventoried by**: Identify the field personnel responsible for campsite assessment by listing the first initials of first and last names.

6) **Dock**: Measure and record the dimensions of the dock, if present. Calculate the square footage of dock area in the office and record in the space indicated. Record a 0 if no dock is present.

7) **Substrate of Landing Area**: The landing area is defined as any human-disturbed area(s) along the shoreline. These areas are created by recreational activities such as landing, unloading, and loading boats, fishing, or other recreational activities. Record the predominant substrate for this area using

the coded categories below. If a dock is present record the substrate of the area where you step off the dock.
B=bedrock - shelf bedrock
C=cobble - includes gravel size stone and up
S=sand - includes sandy beach soils which do not form a surface crust in trampled areas
D=dirt/soil - includes clays to loamy sands

8) **Landing Area Size**: Apply the Geometric Figure Method to determine the total area of disturbance associated with the landing area (excluding dock surfaces). Record all necessary dimensions for as many geometric figures as necessary to accurately measure the landing area that extends beyond (higher than) the natural (undisturbed) leading edge of shoreline vegetation. Ascertain landing area boundaries by employing good and consistent judgement in identifying pronounced changes in vegetation composition or cover, and by paying close attention to local topography.

9) **Landing Area Erosion**: Assess the extent of sheet, rill, or gully erosion within the landing area:
N=None I=Infrequent, <2 inches deep C=Common, 2-4 inches deep over 10-25% of area
S=Severe, >4 inches deep over 25% of area

10) **Trail Erosion**: Assess the extent of sheet, rill, or gully erosion on the access trail(s):
N=None I=Infrequent, <2 inches deep C=Common, 2-4 inches deep over 10-25% of area
S=Severe, >4 inches deep over 25% of area

## Equipment Use Procedures

**Use of Peep Hole Compasses:** Hold the compass level with the viewfinder close to your eye and away from any metal objects. The top of the white floating scale should be centered in the viewfinder. With your chin over the reference point, align the object with the vertical black line in the viewfinder. Hold the compass very steady, allowing the compass scale to come to a rest. Read and record the bearing to the nearest degree. Be careful in reading the bearing from the scale, use large numbers (small numbers are the back azimuth) and note that scale values decrease from left to right. Large scale interval is 5 degrees, smallest interval is 1 degree. Practice and periodically compare compass readings with your partner to verify their accuracy. (Cost: $42)

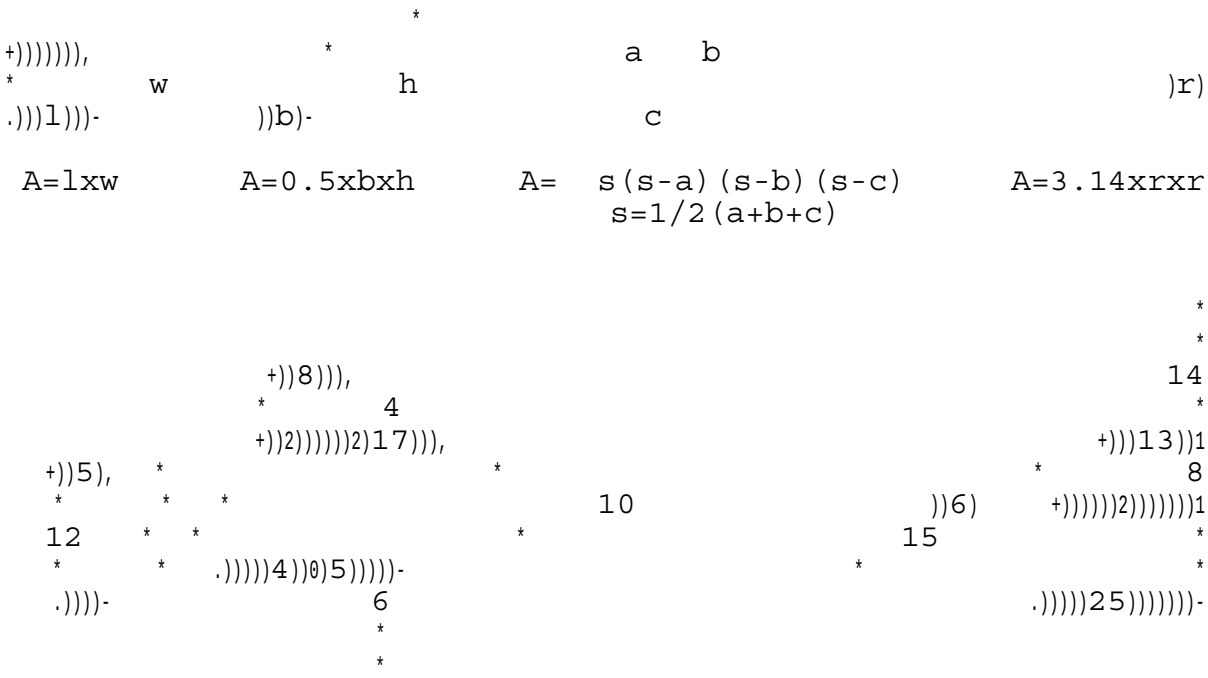
**Use of KVH Datascope:** Read Datascope manual. We will only use the compass bearing function (the distance function is intended only for estimates of long distances). Remove and safely store both lens caps. Hold the datascope approximately level (though it is gimballed for tilt angles up to $\pm 20^{o)}$ and away from metal objects. Focus on target by turning rubber eyecup. Turn unit on by pressing any button (it shuts off automatically after 2 minutes of inactivity). If necessary, press the white "mode" button until you see the "Bearing" mode inside viewfinder. Push both green and black buttons so that the word "Bearing" begins flashing, it is now in continuous scanning and averaging mode. Sighting through the unit, superimpose the vertical line on your target, hold the unit very steady. Read and record the compass bearing to the nearest ½ of a degree. Replace lens caps and store in protective case following use. Accuracy is $\pm 0.5^{o}$, *if used correctly*. The Datascope is waterproof and shockproof but lets not do any product testing - be careful! **Batteries**: Carry spare batteries (3 3-volt #2025 lithium). Unit must be recalibrated each time batteries are replaced or used in a location where the magnetic field is widely different from where it was last calibrated - see manual for procedures. (Cost: $470)

**Use of Sonin Combo Pro:** Read the Sonin manual. We will only use it in the target or dual unit mode. Turn main "receiver" unit on by pressing switch up to the double icons, turn "target" unit on and slide the protector shield up. The units power down automatically after 4 minutes of inactivity. Position units at opposite ends of segment to be measured, pointing the receiver sensors in a perpendicular orientation towards the target sensors. **Note:** The measurement is calculated from the base of the receiver and the back of the target, position units accordingly so that you measure precisely the distance your intended. Press and hold down the button with the line over the triangle symbol. The receiver will continue to take and display measurements as long as you depress the button. Wait until you achieve a consistent measurement, then release the button to freeze the measurement. Measures initially appear in feet/inches. To obtain conversions, press and hold the "C" button until the measure is converted to the units you want (tenths of a foot). Turn both devices off and store in protective case following use. Unit range is supposed to be 250 ft.; be careful and take multiple measures for distances over 100 ft. Under optimal conditions accuracy is within 4 in. at 60 ft. Device can be affected by temperature, altitude and barometric pressure, and noise (even strong wind). The units are not waterproof. **Batteries**: Carry spare batteries (2 9-volt alkaline). (Cost: $185)

# Geometric Figure Method

This method for determining the area of campsites, disturbed "satellite" sites, and interior undisturbed "island" sites is relatively rapid and can be quite accurate if applied with good judgement. Begin by carefully studying the campsite's shape, as if you were looking down from above. Mentally superimpose and arrange one or more simple geometric figures to closely match the campsite boundaries. Any combination and orientation of these figures is permissible, see the examples below. Measure (nearest 1/10th foot) the dimensions necessary for computing the area of each geometric figure. It is best to complete area computations in the office with a calculator to reduce field time and minimize errors.

Good judgement is required in making the necessary measurements of each geometric figure. As boundaries will never perfectly match the shapes of geometric figures, you will have to mentally balance disturbed and undisturbed areas included and excluded from the geometric figures used. For example, in measuring an oval campsite with a rectangular figure, you would have to <u>exclude</u> some of the disturbed area along each side in order to balance out some of the undisturbed area <u>included</u> at each of the four corners. It may help, at least initially, to place plastic tape or wire flags at the corners of each geometric figure used. In addition, be sure that the opposite sides of rectangles or squares are the same length.



# Isle Royale National Park Campsite Monitoring Form

## General Campsite Information

1) Campsite Tag No. ___ ___ ___ 2) Park No. _____ Name: _____

3) Wilderness: W / N 4) Access Type: B C K T 5) Campsite Group Type: C / G / S / L / I

6) Stay Limit: 1, 2, 3, 4, 5 7) Fires: Y / N 8) Picnic Table: Y / N

9) Date __ __ / __ __ / __ __ 10) Inventoried by: _____ Locate/Label Site on Maps ____

## Inventory Indicators

11) Distance to Lakeshore (**1**=<25 ft **2**=26-100 ft **3**=101-300 ft **4**=301-500 ft **5**=>500 ft) ____

12) Distance to Nearest Other Campsite ____

13) Distance to Campground Trail ____

14) Other Campsites Visible ____

15) Site Visibility from Campground Trail Y / N ____

16) Site Visibility from Formal Park Trail Y / N ____

17) Tree Canopy Cover (**1**=0-5% **2**=6-25% **3**=26-50% **4**=51-75% **5**=76-95% **6**=96-100%) ____

18) Vegetation Type Dominant _____ Codominant _____

19) Tent Pads "Constructed" Dimensions: _____ ____ # _____ $ft^2$

20) Tent Pads "Natural" Dimensions: _____ ____ # _____ $ft^2$

## Impact Indicators

*-- Apply Variable Radial Transect Method --*

21) Condition Class (0 to 5) ____

22) Vegetative Ground Cover On-Site (Use categories below) ____

(**1**=0-5% **2**=6-25% **3**=26-50% **4**=51-75% **5**=76-95% **6**=96-100%)

Midpoints: 2.5 15.5 38 63 85.5 98

23) Vegetative Ground Cover Off-Site (Use categories above) ____

24) Exposed Soil (Use categories above) ____

Tree Damage On-Site (Tally each tree)

25) None/Slight _____ 26) Moderate _____ 27) Severe _____

Tree Damage Off-Site (Tally damaged trees) 28) Moderate _____ 29) Severe _____

Root Exposure On-Site (Tally each tree)

30) None/Slight _____ 31) Moderate _____ 32) Severe _____

33) Tree Stumps On-Site ____

34) Tree Stumps Off-Site ____

35) Fire Sites ____

36) Access Trails ____

37) Litter/Trash ____

38) Human Waste ____

39) Total Campsite Area (Office) ____ $ft^2$

# Isle Royale National Park Campsite Monitoring Form

Comments/Recommendations:

Campsite/Reference Point Photo: Roll # ____ Photo # ____ Bearing ____ Distance ____ ft

Photo Description Date & Time: _____

Campsite Reference Point Information

1)
2)
3)
Bury Nail/Tag ___

Satellite Site Dimensions Bearing Distance

Island Site Dimensions Bearing Distance

Site Area from dBASE Program _____
+ Satellite Area _____
! Island Area _____
= Total Campsite Area _____ $ft^2$

**Transect Data**

| | Bearing | Distance (ft) |
|---|---|---|
| 1) | | |
| 2) | | |
| 3) | | |
| 4) | | |
| 5) | | |
| 6) | | |
| 7) | | |
| 8) | | |
| 9) | | |
| 10) | | |
| 11) | | |
| 12) | | |
| 13) | | |
| 14) | | |
| 15) | | |
| 16) | | |
| 17) | | |
| 18) | | |
| 19) | | |
| 20) | | |
| 21) | | |
| 22) | | |
| 23) | | |
| 24) | | |

# Isle Royale National Park Campground Form

1) Campground Code __ __ __ __ 2) Campground Name: _____

3) Date __ __ / __ __ / __ __ 4) Inventoried by: _____

5) Individual Campsites: _____ 6) Individual Campsite Tent Pads: _____

7) Group Campsites: _____ 8) Group Campsite Tent Pads: _____

9) Shelters: _____ 10) Privies: _____

11) Picnic Tables _____ 12) Fire Sites _____

Predominant Use Type (Estimate proportion of use by use type: 0, 5, 15, 25, 35, 45, 55, 65, 75, 85, 95, 100%)

13) Boaters _____ % 14) Hikers _____ % 15) Canoeists _____ % 16) Kayakers _____ %

(%'s should sum to 100%)

## Campground Description / Recommendations

# Isle Royale National Park Shoreline Access Area Form

1) Campground Code ___ ___ ___ ___ 2) Campground Name _____

3) Campsite Tag No. ___ ___ ___ Bearing _____ Distance _____ from campsite tag

4) Date __ __ / __ __ / __ __ 5) Inventoried by: _____ 6) Dock: _____ $ft^2$

7) Substrate of Landing (**B**=bedrock **C**=cobble **S**=sand **D**=dirt/soil) _____

8) Landing Area Size Dimensions: _____ _____ $ft^2$

9) Landing Area Erosion (**N**=none **I**=Infrequent, < 2 in. deep **C**=Common, 2-4 in. deep over 10-25% or area **S**=severe, >4 in. deep over 25% of area) _____

10) Trail Area Erosion (**N**=none **I**=Infrequent, < 2 in. deep **C**=Common, 2-4 in. deep over 10-25% or area **S**=severe, >4 in. deep over 25% of area) _____

# APPENDIX 2

## Campground Summaries
## Isle Royale National Park