

Monitoring Social Conditions in Wilderness:

Visitor carrying capacity and Isle Royale National Park

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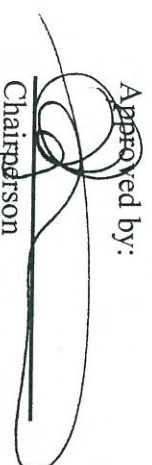
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ABSTRACT

Two primary goals of wilderness management are to provide appropriate and desired recreation opportunities and to prevent unacceptable damages to resources. Recreation has the potential to negatively impact natural resources, cultural resources, and social conditions. The cornerstone of planning frameworks for wilderness management is determining the demands to be met between pristine conditions and providing unlimited access, and then deciding how to best meet these demands. Monitoring plays a critical role in these frameworks, as a means of tracking changes to social and biophysical conditions and evaluating management effectiveness. A successful monitoring plan will identify appropriate indicators, measure what one purports to be monitoring, aid managers in directing appropriate actions, and be feasible given available resources. The problem investigated in this study is how to best utilize limited resources to monitor social conditions in wilderness. In 1996 Isle Royale National Park began the Visitor Experience and Resource Protection (VERP) process for developing a visitor carrying capacity as a part of a Wilderness Management Plan. This study aimed to assess current social conditions in Isle Royale's backcountry, determine the relationship between three methods of monitoring social conditions, and evaluate the selected monitoring methods for their strengths and weaknesses. The chosen monitoring methods were visitor trip diaries, backcountry logs completed by NPS employees, and the park's permit data. Results suggested that current conditions violate proposed standards for a large portion of the visitor season. In a comparison of results from visitor observations, NPS observations, and permit data, permit data were found to estimate the highest rates of crowding in campgrounds. When rangers traveled in the same areas as visitors, they reported similar estimates of both campground and trail crowding, which suggests that NPS observations could be an adequate measure of visitor experiences for future monitoring, given proper protocol. The results of this study also suggest that in the 2000 season one significant cause of crowding on Isle Royale was poor visitor distribution.

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CHAPTER I: BACKGROUND ON THE PROBLEM

The ideal proposed by the wilderness act was to travel through the country without leaving a trace. But it is impossible to use these interlocking waterways without leaving an imprint. Wherever humans travel—by foot over the age-old portages or unsuccessfully running a rapids by canoe—they leave their mark: artifacts found among the water-washed rocks; forest fires sweeping the country from campfires carelessly left unattended.

--Justine Kerfoot, Boundary Waters, MN

Introduction

Wilderness and Recreation Management

The basic goal of recreation management is to provide desired high quality opportunities for recreationists. For wilderness managers appropriate recreation opportunities are limited within the legal confines of the Wilderness Act of 1964, which specifies outstanding opportunities for solitude or a primitive and unconfined type of recreation as appropriate. Current interpretation of the Wilderness Act emphasizes maintaining or restoring the qualities of naturalness and solitude, while also providing for recreational access. Thus, the goals of wilderness management include minimizing degradation of both social and biophysical conditions. Alan Watson (1990) defines social conditions as “all aspects of human use of the wilderness that pose the possibility of impact to the resource and visitor experiences”. He further clarifies that this includes use levels and trends and the quality of recreation experiences provided.

Wagar (1966), in his seminal paper on quality in outdoor recreation, identified three basic premises of outdoor recreation: 1) the sole purpose of all land management is to provide benefits to people; 2) recreation, like all other human behavior is motivated by needs, which may be physiological or psychological; and 3) the quality of recreation depends on how well it satisfies the needs that motivate it. In a later analysis of quality in outdoor recreation experiences, Brown (1989) defined recreation experiences as realizations of intrinsic outcomes from engaging in recreation activities. Further, with this experience-oriented definition, quality is dependent upon

which specific experiences are salient to the participant and the extent to which they are realized. Thus, the focus is on the outcomes of engagement in activities rather than the activities themselves. The participant's experiences and interests as well as the conditions of the recreation setting, or opportunities available, influence the outcome (Driver and Tocher 1970, Brown 1983).

Within the context of wilderness recreation, quality is related to naturalness, privacy, solitude, and a lack of conflict (Cole and Lucas 1987). Wilderness visitors arrive with certain expectations derived from past experiences and knowledge, often involving some degree of freedom and self-sufficiency in a wild, uncrowded setting. Of equal consideration is wilderness managers' commitment to uphold the Wilderness Act by maintaining specific conditions and opportunities, regardless of any individual's expectations. Wilderness conditions are defined in the Act as an area where the earth and its community of life are untrammelled (unrestrained) by man, and which "generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable" (US Congress, Wilderness Act, 1964). This presents a challenge-- providing desired recreation opportunities while also maintaining minimal human impacts on social and environmental conditions. As Stankey (1972) points out, it is important to clarify that the quality of wilderness recreation should be judged by examining the extent to which the objectives of the visitor who seeks the type of opportunity appropriate in wilderness are fulfilled. Reducing the rigorosness of guidelines for wilderness management to meet less stringent public definitions of quality experiences will result in the deterioration of the unique wilderness experience for which there is no substitute.

Recreation Carrying Capacity

Concern over quality recreation on wildlands dates from the earliest days of National Parks and National Forests. Wildlands managers face the challenge of balancing recreation access with resource protection, while also providing opportunities for quality recreation experiences. In the 1960s researchers began to apply the concept of carrying capacity to recreation, asserting that

unlimited growth of recreation in wildlands would threaten the qualities essential to both the protected lands and the recreation experiences of users (Lucas 1964, Wagar 1964, 1974). The concept of recreation carrying capacity as a magic number of ideal visitor use levels has met with criticism. Although amount, timing, distribution, and behavior of recreation use can have a significant influence on the quality of recreation experiences, research has revealed no clear relationship between numbers of visitors and recreation quality (Stankey and Manning 1986). For social conditions in the Boundary Waters, Lucas (1964) found that types of encounters were more critical than amount of encounters in defining quality. Cole (1989, 1990) and Marion (1991) found that degradation of biophysical conditions in campsites and on trails may degrade rapidly with a few visitors and then slow in rate of degradation as visitation increases. Roggenbuck and associates (1993) found that in four wilderness areas in the southern and western U.S., visitors rated site impacts, noise, and numbers of wild animals seen as critically important influences on their experiences. These factors of wilderness quality relate more to visitor behavior than to amount of wilderness use.

Applied to recreation, carrying capacity involves a complex interaction of management and social goals, environmental considerations, and value judgments. In a synthesis of carrying capacity research, Manning (1999) surmised that every outdoor recreation area has a range of capacities depending upon management objectives and definitions of quality. Viewed as an ongoing process of managing for quality by minimizing negative recreation impacts, the broader concept of carrying capacity is likely to remain a part of the outdoor recreation field.

The interactions between use levels, visitor distributions, resource impacts and social conditions are complex and not well understood, but recreation research and management has improved the understanding of how visitor use patterns impact biophysical and social conditions. This information can aid managers in making better-informed judgments, shifting the focus from managing for inputs (visitor numbers) to managing for outputs (quality conditions and experiences). However, recreation management decisions remain value-based judgments about

balancing preservation and access (Cole 1994, Lewis and others 1996, Anderson and others 1998, Manning 1998 and 1999).

In the 1970s Driver and Brown (1978) identified two primary responsibilities of recreation managers related to the concept of carrying capacity: 1) to provide recreation opportunities which are demanded and appropriate for the area being managed, and 2) to prevent unacceptable damage to the resources. They purported that recreation demands include activities, settings, the realization of specific psychological outcomes, and subsequent benefits derived from those outcomes. Successfully meeting these diverse demands requires a variety of recreation opportunities and clear direction for active management, or unacceptable impacts may come to limit the opportunities available.

Planning Frameworks

Changes in social and biophysical settings for recreation can lead to disenfranchised recreationists and irreversible loss of opportunities. This recognition contributed to the development of the recreation opportunity spectrum (ROS) as a planning system (Driver and Brown 1978, Stankey and others 1979 and 1983, Brown 1989). ROS guides managers in inventorying recreation resources for inherent potential to provide demanded opportunities, which range from urban to primitive, and it provides guidelines for deciding how resources might be managed for recreation. ROS establishes measurable criteria for these opportunities, thereby facilitating an analysis of changes by providing a standard against which change can be detected. Monitoring under this framework improves understanding of the interactions between recreation, other resource uses, and site conditions. With this information managers may set objectives to provide opportunities that are appropriate for specific areas, thus facilitating quality experiences and evaluating program performance. Similarly, visitors are prepared with more realistic expectations for opportunities available in a given area. Wilderness areas offer opportunities along a narrow segment of the broad recreation opportunity spectrum.

Extensive research on the concept of carrying capacity and subsequent development of the conceptual framework of ROS laid the groundwork for the development of more detailed management planning processes. The first of these planning processes to specifically address wilderness management, and likely the most widely applied process, was the "Limits of Acceptable Change (LAC) System for Wilderness Planning" (Stankey and others 1985). In 1978 all National Parks were required by the General Authorities Act (U.S. Public Law 95-625) to develop visitor carrying capacities. In 1979 the Forest Service issued similar regulations requiring all USFS wilderness areas to develop visitor carrying capacities. Stankey and associates at the University of Montana and the USFS (1984, 1985) developed LAC in the early 1980s in response to the consequent demand from wilderness managers for assistance in producing carrying capacity plans. LAC is a framework for specifying acceptable amounts of change, determining appropriate management actions to control future change, and establishing procedures for monitoring change and evaluating management effectiveness. Change in wilderness is caused by innumerable internal and external factors, and LAC is an appropriate framework for any management issues that involve two conflicting goals. However, LAC applications thus far have focused primarily on the management of recreation impacts.

The cornerstone of LAC is determining the demands to be met between pristine conditions and providing unlimited recreation access, and then deciding how to best meet these demands. Critical steps toward specifying how wilderness recreation is to be managed include assessing current conditions, defining desired future conditions, developing management options, and assessing potential impacts of implementing management options. Monitoring and evaluation are necessary to ensure that acceptable conditions are maintained over time. Defining the acceptable conditions is inevitably a result of value judgments, and although LAC is designed to involve public participation, managers hold the ultimate responsibility for these judgments. Research and science can aid by grounding these judgments in reliable information, but science cannot specify the one right answer.

Although LAC has been widely applied throughout the USFS, BLM, and NPS, the Park Service adapted LAC into Visitor Experiences and Resource Protection (VERP) to better meet their own policy requirements (Manning and others 1996, Hof and Lime 1997). LAC, VERP, and ROS share the premise that agencies should manage visitor use continuously as an iterative process of monitoring and evaluation, in the same way they manage natural resources. VERP was designed to work within existing NPS planning processes for General Management Plans (GMP), and as a result begins with a different scope than LAC and ROS, containing conceptual elements that may be unrelated to recreation. First implemented in Arches National Park, VERP also addresses frontcountry areas, where LAC was originally used for wilderness and backcountry. Other planning processes similar to LAC include the Process for Visitor Impact Management (VIM), Quality Upgrading and Learning (QUAL), and Management Process for Visitor Activities (VAMP) (Nilsen and Tayler 1997, Manning 1999). Although the scope and order of steps for these planning processes may differ, they share fundamental similarities.

LAC and VERP are based on specifying indicators and standards with levels of acceptable conditions for each. Indicators specify what is being impacted and they must be measurable, monitorable, directly related to visitor use, and responsive to management action. Merigliano (1990) adds that effective indicators will also act as an early warning to alert managers to deteriorating conditions before unacceptable changes occur. Indicators may be defined for social conditions (i.e. campsite encounters), ecological conditions (vegetation damage), and cultural resource conditions (loss of artifacts). Standards quantitatively specify minimum acceptable conditions for these indicators. Proponents of VERP and LAC argue that the success of these frameworks, and of management itself, rests on a commitment to long-term monitoring and dedication to use available information to guide and evaluate management actions (Cole and Stankey 1997, Hof and Lime 1997, Merigliano and others 1997, USDOI NPS 1997, Manning and others 1996, Stankey and others 1984 and 1985, USDOI NPS 1995).

Monitoring as a Management Tool

Monitoring benefits decision-making by improving the ability of managers to provide for the purposes of wilderness, namely ensuring preservation while providing for recreational, scenic, scientific, educational, and conservation uses. Monitoring informs managers about existing conditions, directs attention to conditions that violate or approach standards, and tracks changes over time to evaluate the effectiveness of management actions and attainment of objectives. Implemented over the long-term, monitoring may reveal subtle trends, allowing managers to intervene to slow or halt degradation before more authoritarian action becomes necessary. Monitoring is also valuable as a tool for holding managers accountable for adequately administering public lands (Stankey and others 1983, McCool and Lucas 1990, Landres and others 1994, Landres 1995, Ashor 2000, Leng and Marion 2000, Manning and Lime 2000)

In an assessment of a decade of implementing LAC-type frameworks in wilderness areas around the country, Cole and McCool (1997) expressed a concern for a general lack of institutional support for monitoring. Nilsen and Tayler (1997) expressed a similar concern for VERP in particular, with a recognition that the will and ability to monitor sufficiently to provide information to guide management action had yet to be tested. Challenges to successful monitoring include insufficient funding and staff expertise and a lack of departmental ownership, with a subsequent lack of management accountability.

Specifically related to the VERP and LAC frameworks are four critical elements to a successful monitoring plan. First is the identification of appropriate indicators. Indicators should be significant to the identified problem. This requires clearly identifying the problem and its causes. For example, if a primary concern is a vaguely defined feeling of crowding at campsites, then causes may be total numbers of people in the area, people's behavior, or distribution and shielding of people. Each of these causes will require different indicators, with different goals for monitoring.

Second, is monitoring measuring what one purports to be measuring at an acceptable level of precision? For example, in monitoring for social conditions the complexity of perceptions come into play. If the indicator addresses visitors' experiences, monitoring should measure visitors' reports of experiences and not managers' perceptions of visitor experiences. Another source of problems comes from imprecise protocols, allowing room for subjectivity. Monitoring results can be influenced by measurement error as well as actual changes in conditions (Leng and Marion 2000, Watson and others 1998, Ritter 1997). Stankey and associates (1983) emphasized the importance of systematic collection and replicable procedures for successful monitoring.

A third element is, will the data collected aid managers in directing appropriate actions? Are we monitoring something that managers can influence? For example, managers may have control over where visitors travel and how they behave. In contrast, they do not often have control over impacts generated outside of their boundaries, such as air pollution, light pollution, or noise from neighboring development.

Finally, implementation of the monitoring plan must be feasible given managers' staffing, budgets and available partnerships. The case of social indicators demonstrates the challenges at hand. The intricacies of defining and measuring quality in social conditions are not well understood. Researcher-manager partnerships can be of great assistance in accomplishing necessary research in this area, but funding is limited for even short-term projects, let alone long-term monitoring.

Indicators for social conditions often address visitors' perceptions of their experiences.

The logical way to assess visitors' perceptions is to ask the visitors directly. Arches National Park has been successful with using visual aids and interviews to measure visitor perceptions of number of people at sites and along trails (USDOI NPS 2000a). Trip diaries have proven effective in the Boundary Waters (Lewis and Lime 1997), and for short-term more intensive surveys in Canyonlands (Warzecha et al 1999), Mt Ranier (Vande Kamp et al 1993), and many other places. However, long-term reliance on visitors for data poses potential obstacles. Visitor surveys, trip

diaries, and interviews impose on people and are activities that may be inappropriate for recreation areas, and particularly contrary to the purposes of wilderness recreation. Managers must also consider the limitations of budget and staff expertise. The costs of printing, collecting, and processing surveys may prove to be prohibitive. Additionally, many national parks and wilderness areas lack staff with expertise in the social sciences and the skills necessary to develop, implement, analyze, and interpret visitor surveys. One may argue that this suggests a need for a shift in priorities, but for the time being, these points are obstacles to long-term monitoring. Therefore, key elements to successful monitoring remain minimal investments of money, time and expertise.

Isle Royale National Park

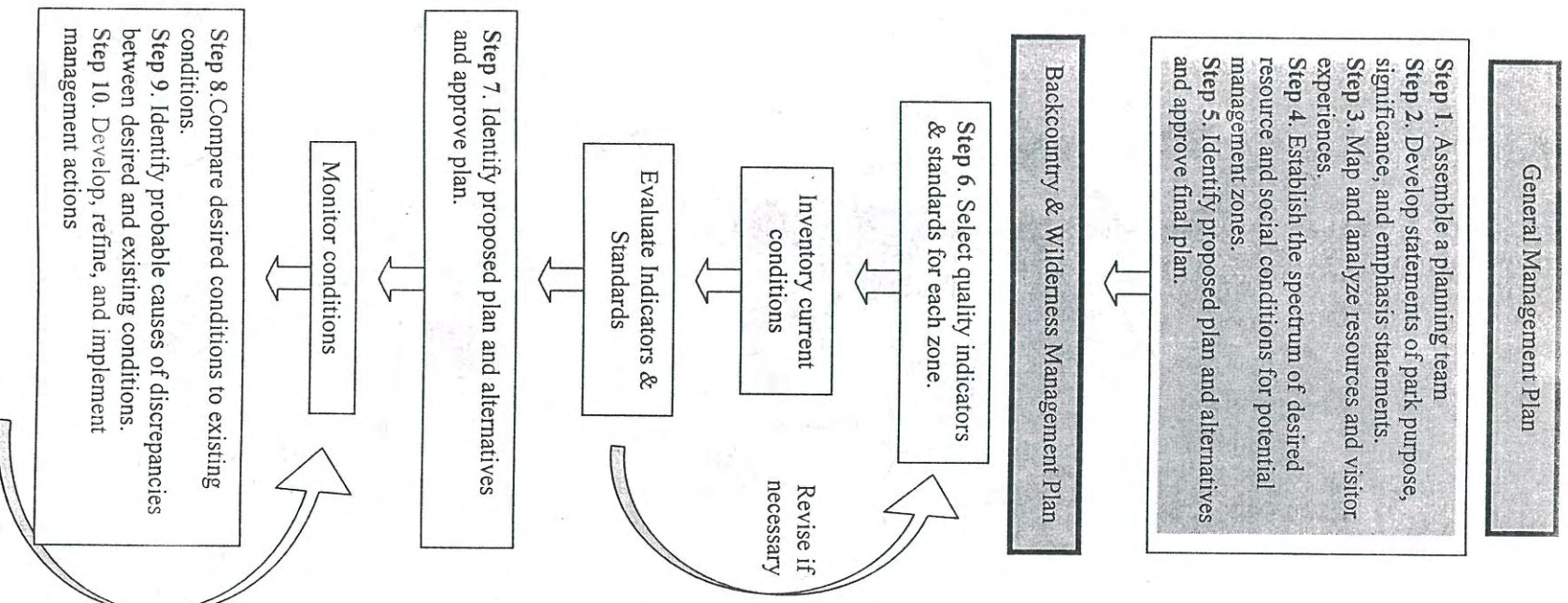
In 1997 Isle Royale became one of five National Parks to implement the VERP planning process. Steps of this process were divided between the park's GMP, which was approved in 1999, and the Backcountry and Wilderness Management Plan (WMP), which was well underway as of 2001 (Figure 1). Selecting indicators and standards, identifying appropriate management actions and developing a monitoring plan were a part of the WMP.

Isle Royale National Park is an island archipelago in Lake Superior consisting of 133,782 acres of land, 35 inland lakes, and a 4.5-mile perimeter of Lake Superior water (Figure 2). Isle Royale was designated a National Park in 1931 and received further federal protection in 1976 as a federally designated Wilderness. Today 99 percent of the park's land area is designated Wilderness. In general, backpackers and paddlers treasure Isle Royale as a wilderness retreat while boaters treasure it as a maritime park with superb fishing. The island is well known for outstanding opportunities for viewing wildlife, and is perhaps most famous for its native populations of wolves and moose. Home to a long list of threatened and endangered species, Isle Royale is also a valued ecological research area.

The park's GMP outlined several purpose statements, which help to clarify management goals (DOI 1998' p. 13):

- Preserve and protect the park's wilderness character for use and enjoyment by present and future generations.
- Preserve and protect the park's cultural and natural resources and ecological processes.
- Provide opportunities for recreational uses and experiences that are compatible with the preservation of the park's wilderness character and park resources.
- Provide park-related educational and interpretive opportunities for the public.
- Provide opportunities for scientific study of ecosystem components and processes, including human influences and use, and share the findings with the public.

Figure 1: Steps of Isle Royale's Planning Process, using the VERP framework (adapted from Manning and others 1996).



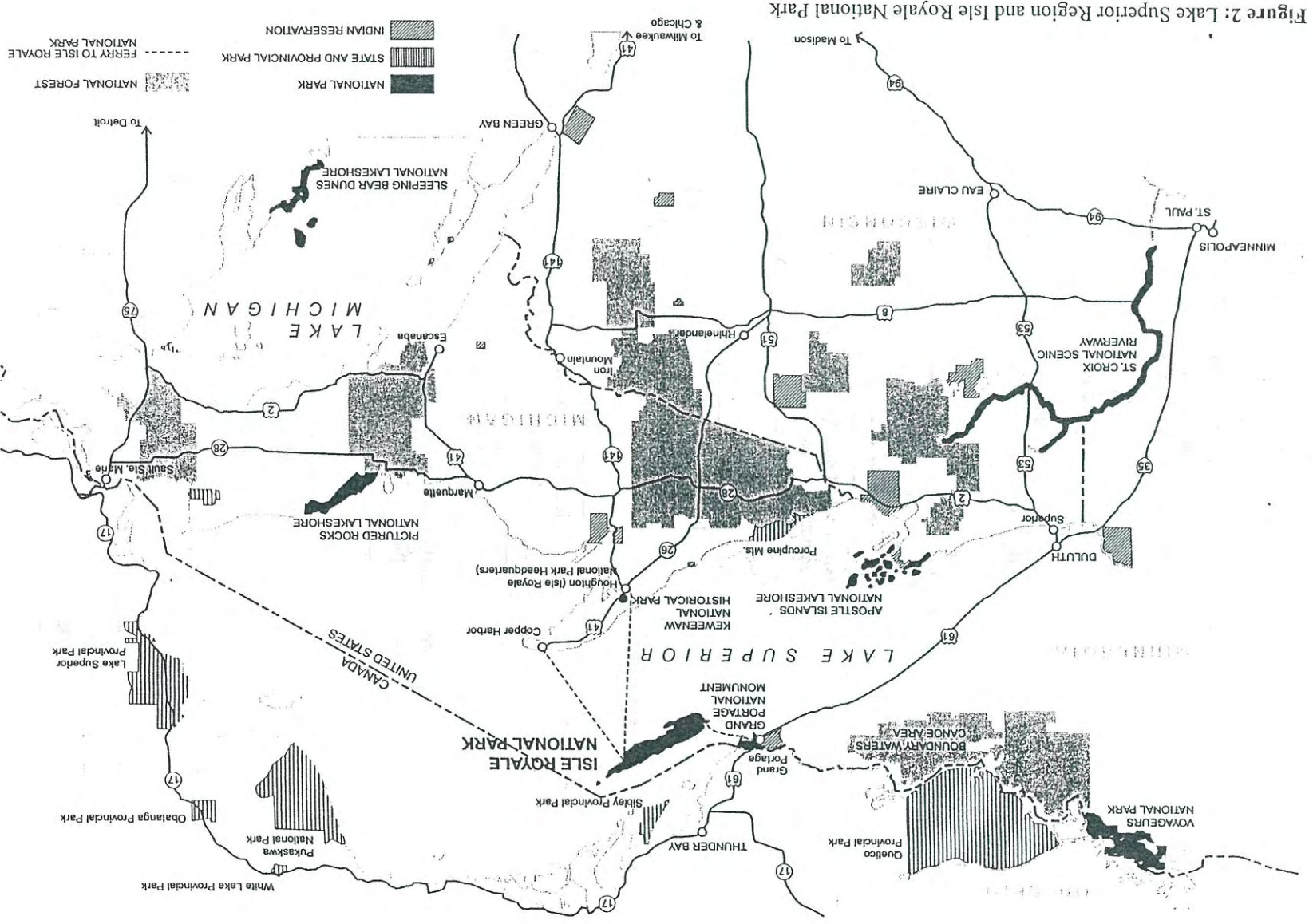


Figure 2: Lake Superior Region and Isle Royale National Park

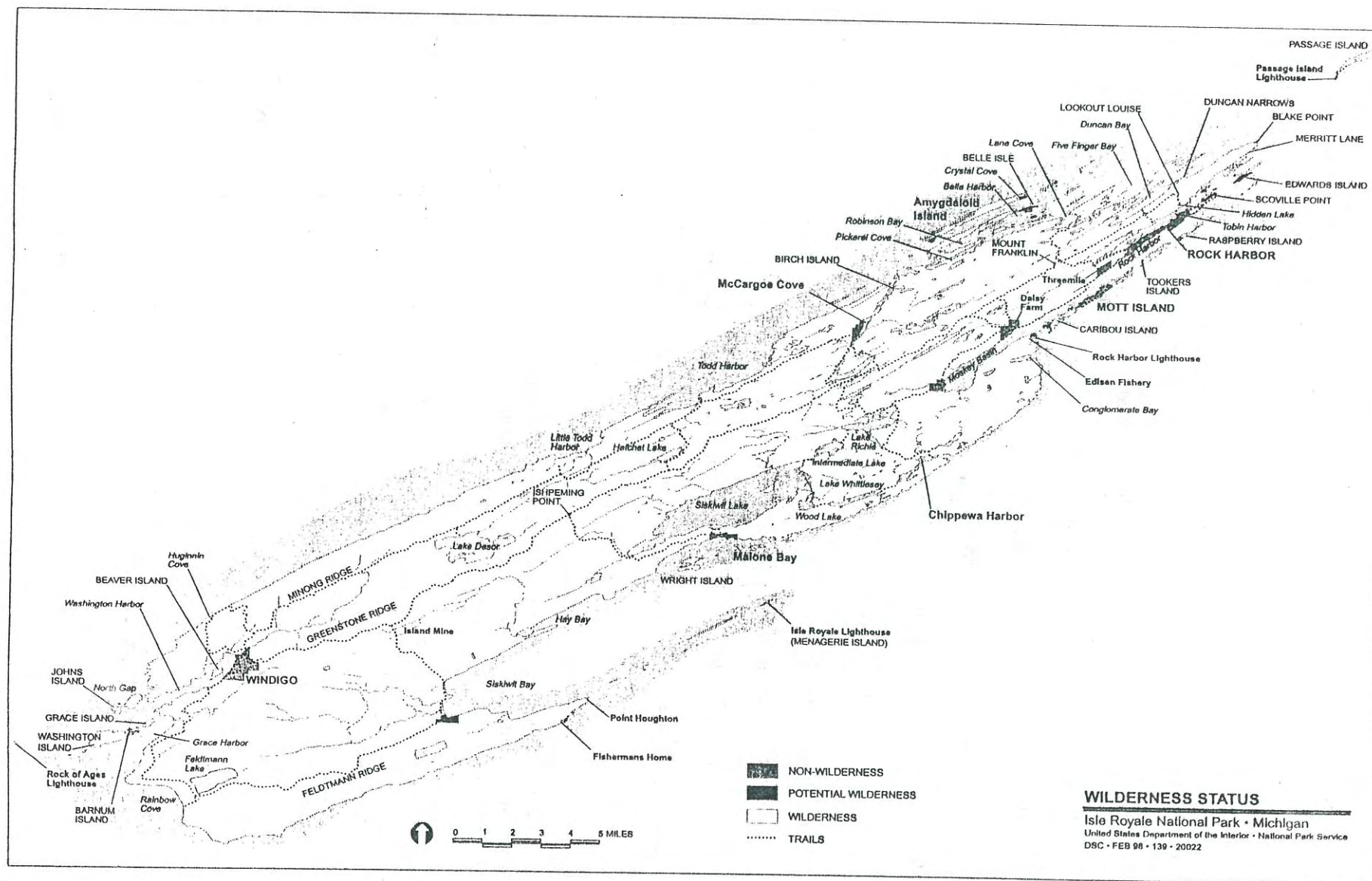
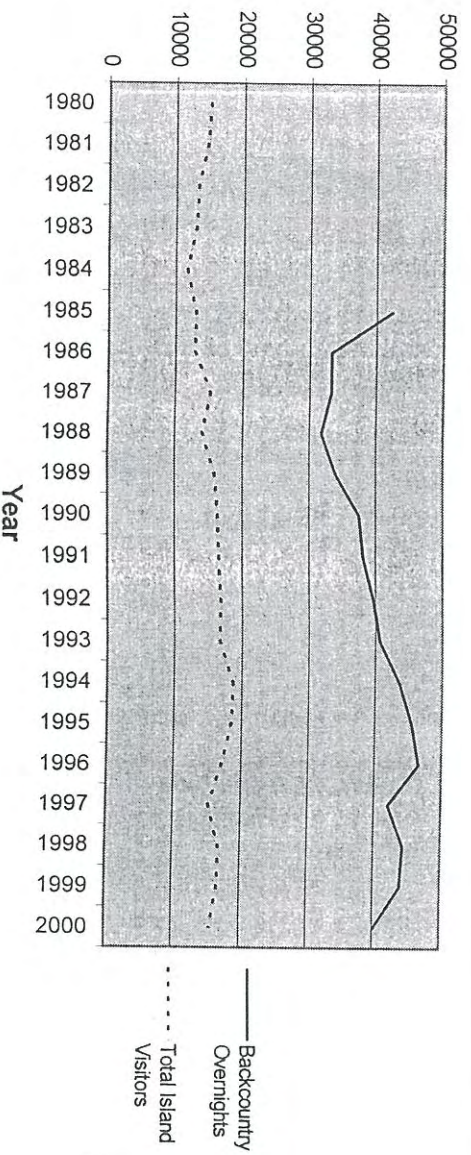


Figure 3: Isle Royale National Park map.

Isle Royale is open to the public from May through October. Two visitor hubs comprise the frontcountry of the park: Windigo on the west end and Rock Harbor on the east end (Figure 3). These hubs serve as entry points, each with a ferry dock, visitor center, and small store, and Rock Harbor has a lodge. People reach the park either by commercial ferry, private boat, or seaplane. Approximately 75 percent of visitors to Isle Royale stay in the backcountry, which is defined as the park's Wilderness and Lake Superior Waters. Isle Royale is one of the least visited National Parks in the country by total number of visitors. However, with an exceptionally high average length of stay (4.1 days) and a predominance of backcountry visitors, Isle Royale has the most densely visited backcountry of all National Parks (USDOI NPS 2000b).

The number of annual visitors to Isle Royale has fluctuated in recent decades but the 1990s saw a peak in backcountry visitation (Figure 4). Consistently more than half visit the park in July and August; 30 percent of all backcountry visitors in July and 37 percent in August (1999 permit data). The number of hikers and paddlers visiting the island is currently limited by ferry capacity, though ferries historically sell out only in July and August. The park does not limit private powerboats.

Figure 4: Isle Royale visitor use trend—backcountry overnights represent number of people visiting the backcountry multiplied by number of nights they stayed. Separate backcountry numbers are available only since 1985.



Visitors to the park's backcountry are grouped into several categories: hikers (60 percent), motorboaters (25 percent), canoers (8 percent), sailors (4 percent), and kayakers (3 percent). Hikers have access to the main island on a network of 165 miles of trails. Motorboats travel freely throughout Lake Superior waters and have access to the islands through 28 docks of varying sizes. Paddlers travel along water routes on Lake Superior and the main island's inland lakes. Recreation management is designed to concentrate camping, with 36 campgrounds ranging in size from 1 to 25 individual campsites. Camping permits with flexible itineraries are required for all overnight visitors, but there is no reservation system for individual parties, and no limit on number of parties permitted to stay in a specific campground on any night, regardless of capacity. With campgrounds spaced 2-13 miles apart, most hikers do not have the option of continuing on when a campground is full. Visitors are asked to share campsites when they arrive at a full campground. Park managers do not currently know to what extent campgrounds are overcrowded.

Park managers are now grappling with the details of visitor use management. At this time Isle Royale has limited means of monitoring visitor use patterns or perceptions of use levels in the backcountry. Although camping parties are required to register for a backcountry permit, permit data reflect planned itineraries, not where people actually travel. These permit data reveal valuable information about total numbers of people traveling in the backcountry and methods of travel. However, the accuracy of information with respect to visitor use levels in specific areas of the park is unknown, and thus of limited use to managers. Park Rangers report on conditions observed on their patrols, but patrols focus heavily on the perimeter of the island. With little time spent in the interior of the island, ranger-reported data may insufficiently describe conditions in the remote campgrounds and trails. Additionally, when rangers do travel in the backcountry, it is unknown to what extent their observations reflect visitors' experiences.

Developing indicators and standards for Isle Royale National Park

Through a combination of visitor surveys, public meetings and newsletters calling for input, Isle Royale identified significant areas of concern related to social conditions in the backcountry. Results of a visitor survey conducted by the University of Minnesota in 1996-97 (Pierskalla and others 1997, 1998) informed managers of visitors' opinions about current conditions and acceptability of future management actions. During this time, park rangers also sought input from visitors related to what was most important for a quality experience in the park. Additionally, the park distributed newsletters, requesting public feedback on proposed indicators.

With this information and lessons from other planning processes, managers identified several potential indicators for social conditions:

- Number of boats rafting-off each other at a dock.
- Frequency of parties sharing individual campsites.
- Frequency of campgrounds reported full.
- Number of trail encounters.
- Number of paddler encounters.

The next goal was to specify standards for acceptable conditions, weighing the compromise between unrestricted access and pristine conditions. For example, ideally no campers would have to share campsites due to overcrowding at campgrounds, a standard of 0 percent of parties sharing campsites. To achieve this ideal, managers might be forced to limit access to an unacceptable extent. Therefore, managers needed additional input from the public to clarify what compromises in free access would be acceptable. Similarly, they needed input on what compromises in conditions would be acceptable to maintain reasonable access. The park used newsletters and public focus groups to inform the public of the implications of managing for preferred conditions, and again requested input on indicators, standards, and appropriate means of managing visitor use when standards are violated.

Throughout the public input process boaters and hikers generally agreed that they do not like the idea of a campsite reservation system on Isle Royale, due to the loss of a flexible schedule. Rather, they generally preferred the concept of entry quotas if some cap on visitation became necessary. However, visitors disagreed over how high to set standards for social conditions and at what point managers should implement quotas. Responses to the third WMP newsletter ranged from calling for the highest standards possible, even if it means turning people away from the park (46 percent of 160 respondents), to adamantly opposing any limits on visitor access (28 percent of respondents). Personal communications between park staff and visitors in public meetings and in the park revealed that hikers often plan weeks or months ahead for their trips, needing to make ferry reservations, and did not see additional reservations to enter the park as unreasonable. Boaters, on the other hand, more often visit the park when lake conditions are suitable for crossing and opposed the idea of having to make advanced reservations.

At this point, managers are considering a preferred alternative that would set lower standards during the busiest weeks and higher standards early and late in the season, and then manage visitation with quotas for ferries and private boats to meet these standards. In effect, this proposal would turn visitors away from the park when conditions exceed standards. Because of the potential social impact of such a proposal, confidence in the data collected will be critical to assure the costs are warranted. Ongoing monitoring will also be critical to ensure that management actions are effective in maintaining quality conditions.

The Study and Problem Statement

Given the challenges to effective monitoring and recognition of the critical role that monitoring plays in VERP and LAC-type planning frameworks, the problem investigated here is how to best utilize limited management resources to monitor social conditions in wilderness. With an approved GMP, manager commitments to the VERP process, established researcher-manager partnerships, and baseline data on recreation opportunities and visitor preferences, Isle

Royale is an ideal site to test monitoring options. The purpose of this research project was to explore the role of monitoring as a part of the VERP framework in general, and to help Isle

Royale's managers determine how best to monitor indicators for social conditions as proposed in the WMP. Specific objectives for this research were the following:

- Describe current social conditions in Isle Royale's backcountry relative to the proposed indicators.
- Determine the relationships between different methods of data collection for trail and campground encounters, comparing visitor-reported data to ranger-collected data and to the park's backcountry permit data.
- Evaluate the selected monitoring methods for their strengths and weaknesses, including efficiency of implementation, reflection of the planning team's intentions, and ability to inform managers about the selection of indicators and standards.

Data collection was conducted from June through September 2000 and analysis followed.

Isle Royale National Park supported the study and provided considerable on-site assistance with data collection. The University of Minnesota Cooperative Parks Study Unit contributed ongoing consultation on the development of indicators, standards, and monitoring protocols. The

University of Montana, School of Forestry provided financial and technical assistance as well as considerable expertise in the field of recreation research and wilderness planning.

CHAPTER II: METHODS

This research project was designed as a descriptive and comparative study. To achieve the goals of describing current social conditions related to visitor distribution on Isle Royale and evaluating alternative methods for data collection, three methods of data collection were used: 1) visitor trip diaries (surveys and survey logs) (Appendix B), 2) NPS employee observations in the backcountry (NPS logs) (Appendix C), and 3) backcountry permit data (permits). The purpose of this chapter is to explain these modes of data collection and the methodology involved in analysis.

Study Design and Data Collection Methods

Visitor Trip Diaries and Survey Logs

This portion of the study adapted methods developed by Lewis and Lime for monitoring in the Boundary Waters Canoe Area Wilderness (Lewis and Lime 1997). It included two information collection instruments: (1) Isle Royale National Park trip diaries (filled out by the visitor), and (2) a survey log (filled out by NPS personnel). Prior to finalization, Isle Royale managers, the NPS Social Sciences Office, and the Office of Management and Budget approved both instruments (OMB Approval #1024-0224, NPS00-005).

Methods for survey distribution were designed for efficiency given the likelihood that the park will have limited resources for monitoring visitor use. Researchers and park staff agreed that the best means of distribution would be in conjunction with issuing the already mandatory backcountry permits. Similarly, randomly selecting sample days, rather than randomly selecting parties on all days, was determined to be the most realistic means of adhering to sampling protocol with available staff.

NPS employees distributed trip diaries from the park's four permitting locations: the Ranger III ferry, Houghton Visitor Center, Windigo Visitor Center, and Rock Harbor Visitor Center (Figure 3). On randomly selected days (Appendix D) all parties registering for camping permits were asked to participate in the survey, thus the sample population included all backcountry overnight groups, but did not include day users and lodge guests.

During their seasonal training, NPS employees were instructed about this project and its role in the development of a Wilderness and Backcountry Management Plan. NPS employees responsible for distributing surveys were trained in the necessary protocols. On sample days NPS employees briefly explained the WMP and social monitoring project to everyone registering for a permit, clarifying that such monitoring would help the park better understand where people travel and how to better manage the backcountry. They requested each party's voluntary and confidential participation in completing a trip diary, recorded participants' information on the survey log, explained how to properly complete the trip diaries, instructed that trip diaries could be returned to any ranger or mailed back to the park, emphasized the importance of returning the diaries, and gave each party one diary card, a pencil, a park map, and the letter to survey participants.

Each distribution center received a sampling schedule, sufficient supplies, and an outline of distribution protocol. Additionally, they were all contacted by radio as a reminder at the start of every sampling day. The distribution centers were contacted in person periodically throughout the sampling season to answer questions and ensure that they had ample supplies and were adhering to protocols. Because of travel limitations, the distribution centers located on the island were contacted in person more frequently than the Houghton Visitor Center, which is located on the mainland.

Sampling days were randomly selected based on 1999 visitation numbers and included weeks of peak visitation as well as slower times. When visitation in 2000 appeared to be significantly lower than in 1999, additional sample days were added in August and September to

ensure distribution of at least 500 surveys. Additionally, each distribution center skipped some sampling days in August because of a concurrent national survey of visitors. In the interest of minimizing imposition on visitors, distribution centers were instructed to skip sampling days that coincided with days of the national survey.

At least once a month survey logs and returned surveys were collected from the distribution centers. Survey participants who had not returned their surveys were contacted either by email or by mail with a reminder to return their surveys. To improve response rates, these reminders also included copies of the trip diary cards (Salant and Dillman 1994).

Visitor Trip Diaries

Visitor trip diaries (surveys) offered a direct measure of visitor experiences in campgrounds and along travel routes (Appendix B). All visitor responses remained anonymous and surveys were coded by number, referencing order and location of distribution. Survey participants were asked to record quantitative information about trail and waterway encounters and campground crowding on a daily basis. They were asked to report on the date, number and location of encounters, and assess whether or not campgrounds were full and if their party shared a campsite with another party. Surveys included separate entries for each day of the trip. Rangers working in the backcountry made additional efforts to contact survey participants, encouraging them to complete the surveys and return them at the end of their trip. Surveys were printed on cardstock and included a return address and postage for ease of mailing.

Survey Logs

NPS personnel who distributed visitor diaries recorded information for each participant on a survey log form (Appendix B). Information recorded included date of issue, age, gender, number of previous visits to the park, email address, and the party's backcountry permit number. The permit number provided additional information from the permit database, such as method

and location of travel to and from the park, mode of travel in the backcountry, and party size. This information allowed for summarizing number of surveys distributed each sampling day and analysis of significant differences between respondents and non respondents.

Nonresponse Bias

Out of 497 surveys distributed, 268 were returned (response rate of 58 percent). Three of these were copies of the trip diaries that had been sent with mail reminders. Although this is a low response rate, it was higher than a comparable monitoring project in the Boundary Waters, where the response rate for trip diaries was 38 percent (Lewis and Lime 1997). Salant and Dillman (1994) recommended that a response rate of lower than 60 percent should alert the researcher to possible nonresponse error. Such error occurs when a significant proportion of people in the survey sample do not respond and nonrespondents are different from respondents in a way that may be important to the study. A series of tests were conducted to examine the extent of nonresponse bias in the sample, using information recorded on survey logs and in the backcountry permit data. No significant differences were found in response rates by whether or not the trip leader would be the primary recorder, the mean age of the leader, mean size of the group, or month of arrival to the park.

There was, however, a significant difference in response rates by mean number of previous visits (5.26 for nonrespondents and 2.90 for respondents), gender, mode of travel, and survey distribution location (Table 1). Of particular concern to this study were the low response rates for powerboaters and sailors, suggesting that additional efforts may need to be taken in the future to adequately measure the perceptions of those user groups. This also suggests implications for interpreting results. Because of the disproportionately low number of boater and sailor responses, the results may not be representative of those user groups. Fewer conclusions may be reached in assessing social conditions for powerboaters and sailors on Isle Royale. This will be discussed further in the results chapter. The low response rate for surveys distributed from the

Houghton Visitor Center may also be of concern, since exclusively boaters are permitted there. Permits are issued less systematically from Houghton than from the other visitor centers. This combined with a new supervisor in Houghton who was unfamiliar with the park and the Wilderness Management Plan, and less personal contact with the research coordinators may explain the low response rates. Future monitoring efforts should include additional attention to the Houghton staff.

Table 1: Comparison of visitor survey respondents with nonrespondents for those characteristics with a significant difference between categories ($p \leq 0.05$).

	Percent of survey recipients	
	Did not return survey	Returned survey
Mode of Travel	Hike	38%
	Sail	71%
	Powerboat	63%
	Canoe	44%
	Kayak	53%
Gender	Female	27%
	Male	48%
	Houghton VC	83%
Survey Distribution Location	Rock Harbor VC	43%
	Ranger III Ferry	49%
	Windigo VC	35%

Returned visitor surveys resulted in 1246 visitor nights of campground information (one case for each response/night/campground), 1003 trail observations, and 149 waterway observations (one observation/day/trail or waterway).

NPS Logs

NPS Logs were a standardized form used by NPS employees to record information about visitation numbers in the backcountry (Appendix C). Information collected was more detailed than the information collected from visitors with the trip diaries. Campground logs included the total number of parties in a campground and the total number of parties sharing sites in addition to whether or not the campground was full on a specific night. Trail and waterway logs included

location and time of observations, hours traveling, and numbers of encounters. NPS logs offered a measure of employee perceptions of visitor experiences in campgrounds and along travel routes.

Employees who spent time either camping in the backcountry or patrolling campgrounds were asked to complete campground logs throughout the course of the study season, recording quantitative information for trail and campground encounters. Only wilderness rangers, who routinely patrolled trails and paddle routes, completed trail and waterway logs. Observation dates and locations were determined by work schedules, and were not considered random. All observers recorded the same information on the log forms and were instructed to limit campground observations to between 8:00 pm and 8:00 am to minimize the error of missing camping parties. All observers were trained during their seasonal training to ensure consistent protocols were followed. Additionally, all observers were contacted throughout the season to answer questions, collect completed logs, and clarify protocols. Trail crews, wilderness rangers, patrol rangers, and park researchers contributed 520 total campground observation days and wilderness rangers contributed 130 trail observations.

Permit Data

Isle Royale's backcountry permitting system offered a database of information for all registered backcountry visitors. Because park rangers enforce the requirement that all parties spending the night in the backcountry register for a permit, compliance is assumed to be nearly 100 percent. Permit data included information for every party on every night of their trip, and thus was considered a census of backcountry visitors. In addition to planned camping itineraries, the permit data included information about the parties' size of group, location of entry to and exit from the park, method of travel to and from the park, and primary mode of travel (i.e. powerboat, hike, kayak).

Twenty-nine percent of permitted parties returned their permits at the end of their trip with changes showing where they actually camped compared to their original planned itineraries.

Thus 71 percent of permits were of unknown accuracy regarding actual camping locations. Permit data provided information for 14,073 backcountry nights during the study season (1 backcountry night equals one camping party/date/campground). Permit information did not provide data for analysis of trail encounters.

Mid-way through analysis of the permit data it was discovered that 600 permits were missing from the first three weeks in august. The park was able to locate the missing permits, and researchers incorporated them into the database. However, some inconsistencies remained between the park's monthly permit reports and the dataset used for this study. In the available time it was not possible to determine the source of this inconsistency, so analysis proceeded using all available permits. Inconsistencies occurred on the first day of every month, with the park's monthly reports showing up to 100 additional parties that were not accounted for in this study's database, and could not be accounted for in the reports of parties arriving and departing on the various ferries. Thus, it was assumed that this was a program error rather than additional missing permits.

Analysis Methods

Analysis consisted primarily of three phases: 1) descriptive statistics summarizing results based on the park's proposed indicators and standards, 2) analysis of the significance of differences between the results of the three methods of data collection, and 3) an attempt to develop a prediction model for crowding conditions based on visitation levels. All data were converted to databases in SPSS 9.0 for analysis. Surveys and NPS logs provided data on both campground and travel route encounters. Permits provided data on campground conditions, as well as information related to visitation levels and distribution on a daily basis, but did not provide data on travel route encounters.

Description of Social Conditions

In the first phase of analysis, descriptive statistics were generated to summarize each dataset, looking specifically at encounter rates, frequencies of full or over-full campgrounds, and frequencies of parties sharing sites. To better aid managers, this information was broken down to target when and where proposed standards were exceeded. Additionally, where sample sizes were small, data were aggregated into weekly summaries, and summaries by management zone.

Before analysis began, all the datasets were formatted to reflect comparable data wherever possible. Surveys and NPS logs contributed scale measurements of trail and waterway encounters. Because some respondents reported encounter rates by trail section and others reported daily encounter rates, this information was converted to hourly encounter rates for analysis purposes. All datasets contributed categorical measurements of campgrounds being full on any night (yes or no) and parties sharing sites at any campground on any night (yes or no). To increase analysis potential, these data were also transformed to scale measurements of percentages of parties sharing sites, and number of parties sharing or number of campgrounds reported full by night and by week. With small sample sizes from the surveys for specific campgrounds on specific nights, some observations were grouped by week or by area of the park.

Campground conditions were inferred from the permit data based on campground capacities. The permit data were converted to reflect crowding conditions by comparing a campground's capacity with total numbers of parties permitted to camp at that campground each night. It was assumed that if 6 parties were permitted for a campground with 5 sites, then the campground would have been full and two parties would have shared a site. This information was converted to categorical measurements (was the campground full, did any parties share a site?) as well as scale measurements (total number of parties sharing and percent of parties sharing).

Although some powerboating and sailing parties sleep on their boats some of the nights of their trip, many boaters chose to use campsites when available. Because the permit data do not distinguish which nights the party slept on their boat, and which nights they occupied a campsite,

for analysis purposes, all permitted parties were assumed to be occupying a campsite. In the future, permit data may be able to be refined to more accurately reflect this distinction.

Analysis of the Relationship Between the Three Methods of Data Collection

In the second phase, statistical tests were administered to estimate the significance of differences between the findings from surveys, NPS logs, and permit data. In this case, statistical significance means the probability that differences in results were due to chance rather than the effect of different methods of monitoring. For analysis purposes, statistical significance was established as $p \leq 0.05$, meaning that when a statistical test shows a significant effect, there is less than a 5 percent chance that the given outcome could have actually occurred by chance. Where $p \leq 0.05$, a significant effect was concluded.

The Chi² test for independence between methods of data collection was used to compare the results for categorical variables, such as if a campground was reported full or if any parties reported sharing sites. Where categorical data were converted to scale measurements (i.e. percent of parties sharing a site), scatterplots were used to further examine the relationship between the results of the three data collection methods.

In all cases, scale variables, such as numbers of campgrounds reported full each week, were positively skewed to the extent that linear transformations did not normalize distributions. This necessitated the use of nonparametric tests for analysis of significant differences in results by mode of data collection. For comparison of all three modes, the Kruskal-Wallis H test of independence was used, ranking all scores and comparing the mean rank of each group. For comparison of two monitoring modes, the Mann-Whitney U test for independence of two samples was used. It is analogous to the t-test.

Daily encounter rates reported by visitors and by rangers were not normally distributed, necessitating the use of either a nonparametric test or transformation of variables to create a normal distribution for comparison of means. The Mann-Whitney U test, a nonparametric test,

was used. This analysis was conducted on a park-wide basis as well as by management zone. To strengthen this analysis, encounter data were also transformed with a calculation of $\log(\text{encounters}/\text{hour}+1)$ to normalize the distribution, allowing for use of the t-test for comparison of means. Again, determination of significant difference was based on $p \leq 0.05$.

A third phase of analysis used scatterplots and regression analysis to explore the relationship between backcountry crowding conditions and visitation levels. Variables for visitation levels included total number of parties permitted to be in the backcountry and number of parties entering or exiting the park from different locations. Analyses were conducted on a coarse level of the entire park for the entire season, as well as for specific areas of the park and specific dates, weeks, or months of the season. If visitation levels caused unacceptable social conditions in the backcountry, this analysis should reveal such a relationship. Understanding this relationship would aid managers in developing the appropriate actions to improve social conditions.

Interpretation of Analysis Results

Results of the three phases of analysis were used to evaluate the selected monitoring methods for their strengths and weaknesses, including efficiency of implementation, reflection of the planning team's intentions, and ability to inform managers about the selection of indicators and standards.

CHAPTER III: RESULTS

Data from the visitor surveys, NPS observations, and permits were used to develop an estimation of social conditions in Isle Royale's backcountry and evaluate possibilities for future monitoring. The analyses of data were interpreted following the objectives of this study; 1) estimate campground crowding and trail encounters, 2) compare results from the three modes of data collection, and 3) evaluate the three modes as future monitoring tools. Additionally, the relationship between visitor use levels and conditions exceeding standards was explored.

Description of Social Conditions on Isle Royale in 2000

Isle Royale's Wilderness Management Team distributed a newsletter in the spring of 2000 asking for public comment on two levels of proposed standards for indicators of social conditions to be applied to each management zone. The planning team is currently working under the assumption that some combination of these standards will be proposed in the draft Wilderness Management Plan. Conditions measured during the 2000 study season were evaluated against these two levels of proposed standards (Table 2). Because of small sample sizes, it was difficult to make valid assessments of conditions on a daily basis, as the indicators are written. Campsite sharing and boats rafting were aggregated by percent of visitors reported sharing or rafting each week of the season. Appendix E includes more detailed reports of crowding by date and location.

All three modes of monitoring social conditions on Isle Royale indicated that conditions in 2000 were out of standard, or unacceptable, in the Backcountry, Wilderness Portal and Frontcountry Zones at some point between June 1st and September 30th. With the tighter of the proposed standards, the remaining two management zones, the Primitive and Pristine Zones, would have been out of standard at some point as well. The duration of unacceptable conditions ranged from 1 to 12 weeks, depending on the indicator, mode of data collection, and chosen standard.

Table 2: Frequency of social indicators exceeding proposed standards, on a weekly basis for the 2000 season on Isle Royale, as reported by three different modes of monitoring.

			Number of weeks conditions would have been out of standard, by mode of data collection		
Indicator	Management Zone	Proposed Standards	Surveys	NPS Logs	Permits
Frequency of camping parties needing to share campsites on any given night	Frontcountry	5% or fewer parties sharing campsites	1	1	0
		0 parties sharing campsites	1	2	1
	Backcountry & Wilderness Portal	5% or fewer parties sharing campsites	6	2	11
		0 parties sharing campsites	9	8	12
	Primitive	5% or fewer parties sharing campsites	3	4	8
		0 parties sharing campsites	3	4	9
Frequency of boats needing to raft-off at a dock*	Backcountry & Wilderness Portal	5% or fewer boats rafting-off	2	2	N/A
		0 boats rafting off at docks	2	4	N/A
Number of hiking or paddling parties encountered on trail or water per day	Backcountry	No more than 7 parties encountered per day	11 (27 days)	1 (1 day)	N/A
		No more than 5 parties encountered per day	11 (44 days)	5 (5 days)	N/A
	Primitive	No more than 5 parties encountered per day	0	0	N/A
		No more than 3 parties encountered per day	4 (4 days)	0	N/A
Number of parties seen or heard within the Pristine Zone**	Pristine	90% of hikers will see 1 party or fewer and 50% will see no other parties	0	N/A	N/A
		90% of hikers will see no other parties	1	N/A	N/A

* Small sample size for powerboaters: 19 boating parties responded with reports for 64 nights and 5 reports of rafting off.

**Small sample size: 23 visitors responded with reports of 39 days of conditions in the Pristine Zone, and 4 reports of seeing or hearing any other parties.

All modes of assessment showed that trail and campground conditions were out of standard more frequently in the Backcountry and Wilderness Portal Zones than the other zones. They did not agree on precisely where conditions were most out of standard. Identifying the location of unacceptable conditions will help managers best target effective actions. According to permit data, sharing of campsites occurred most frequently at Grace Island (158 parties reported sharing), Caribou Island (96), East Chickenbone (82), and Hay Bay (80). NPS logs reported the highest frequency of sharing at Moskey Basin (22), West Chickenbone (13) and Lake Richie Hiking site (8). Surveys reported parties sharing sites most frequently at Three Mile (15), Caribou Island (8) and Daisy Farm (6). With the exception of Grace Island and Hay Bay, all of these campgrounds are on the eastern end of the island, and most within the Rock Harbor Channel.

The proposed standard for sharing campsites is expressed as percentage of parties sharing. Figure 5 displays the mean percent of parties sharing at each campground for the whole season. One problem with identifying unacceptable conditions as percentages is that percentages are influenced by sample size. Grace Island, for example, shows 100 percent sharing as reported by visitors, yet only three parties reported sharing sites there. In contrast, rangers reported 20 nights of observations on Grace Island, with parties present every night, and none sharing sites. Permits reported over 40 percent of parties sharing sites at Grace Island.

Beyond overfull campgrounds, park managers and visitors are concerned with overcrowding at docks, expressed with boats rafting off another boat at a dock as an indicator. Both visitors and rangers reported some rafting off, with visitors reporting rafting off during two weeks of the season and rangers reporting some boats rafting off during four weeks of the season. Although the sample size of boaters as survey respondents was small ($N=19$), boaters did report rafting off at the Beaver Island and Moskey Basin docks. Rangers reported boats rafting off most frequently at the Windigo and Malone Bay docks. Figure 6 shows the total count of boats reported rafting off. These docks are located all around the island, in Developed, Wilderness Portal and Backcountry Zones.

Figure 5: Percent of parties reported sharing sites in each campground, calculated as mean of nightly reports from the three modes of data collection. Campground codes are listed in Appendix F.

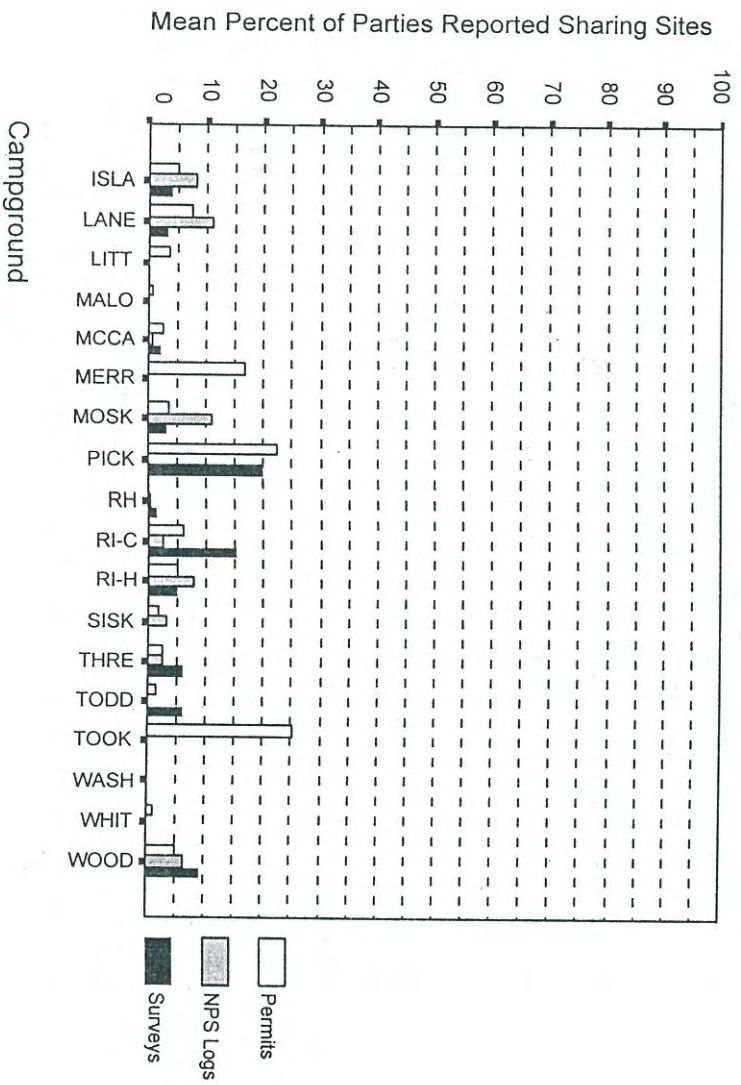
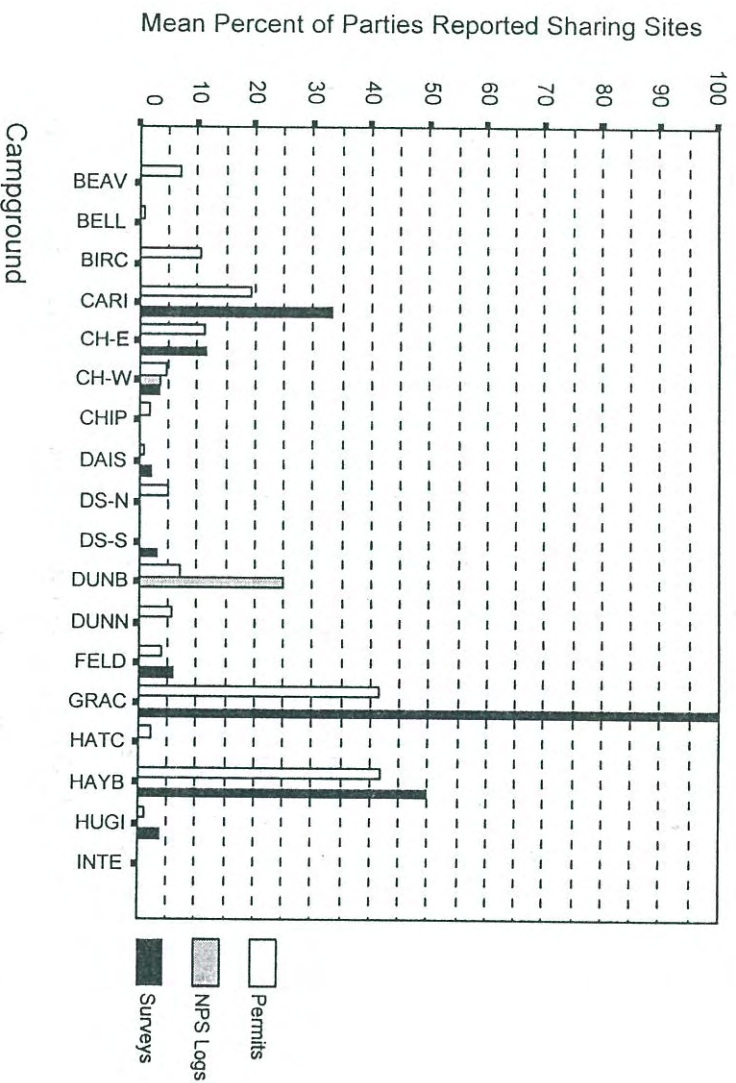
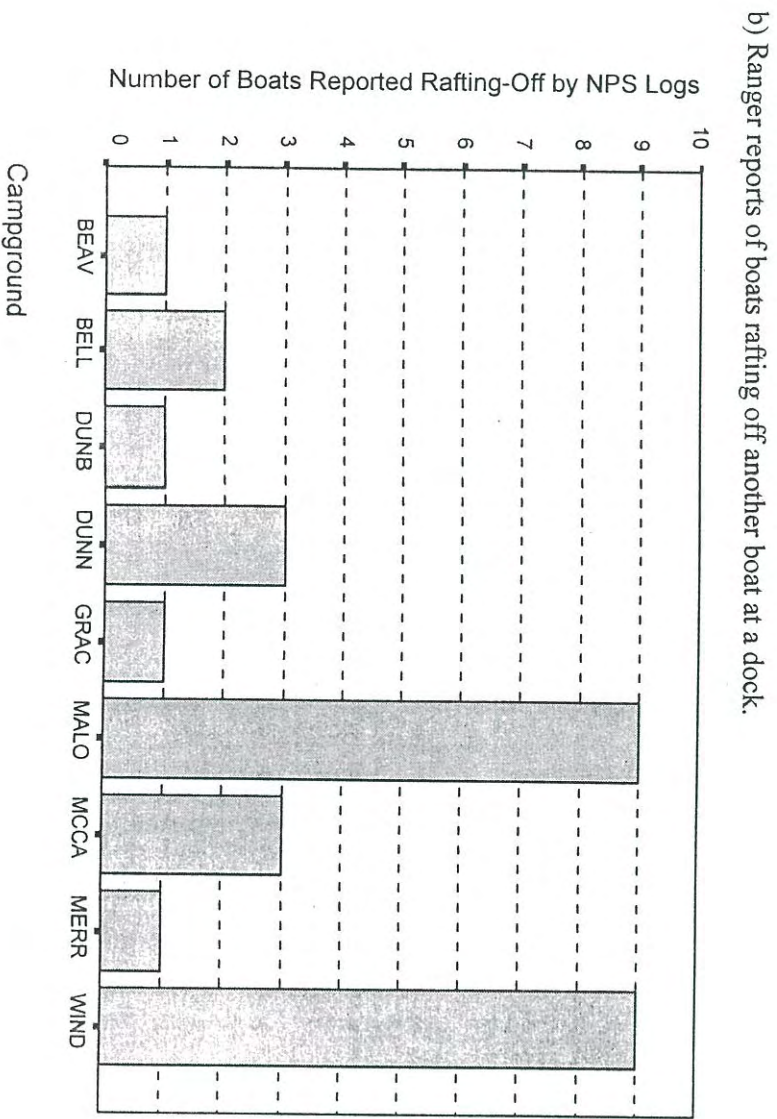
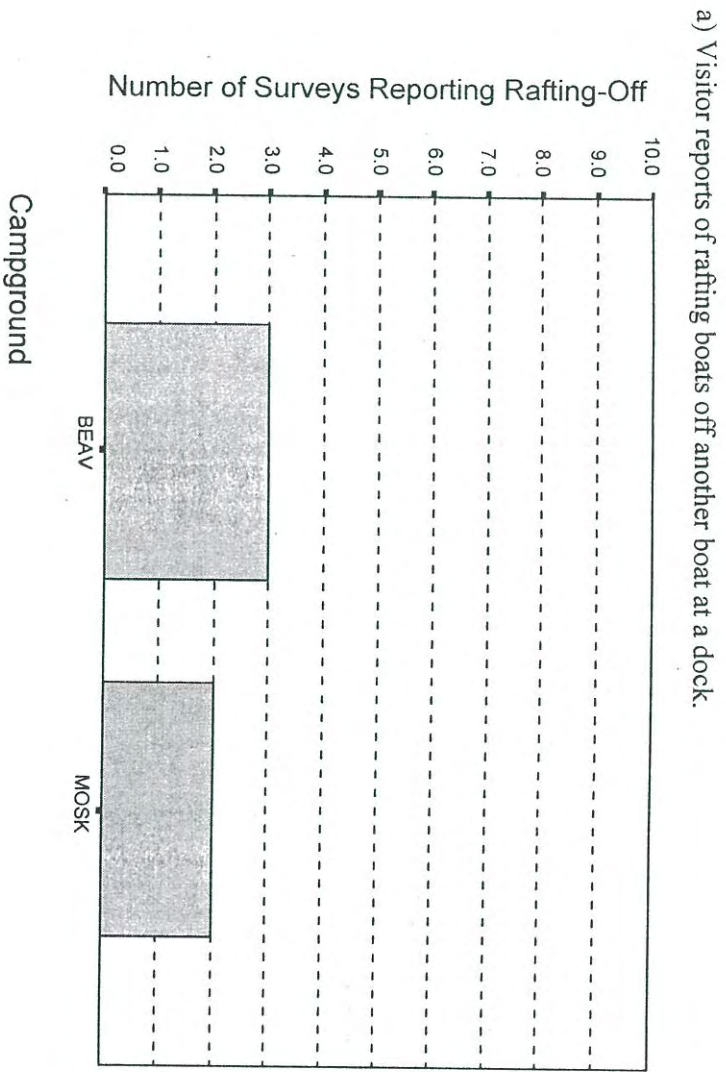
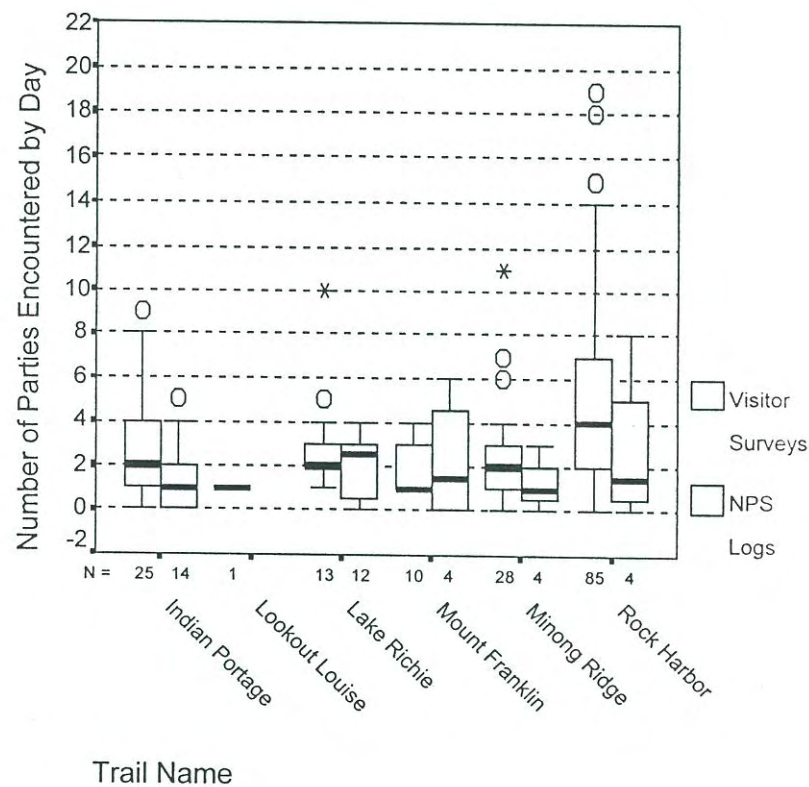
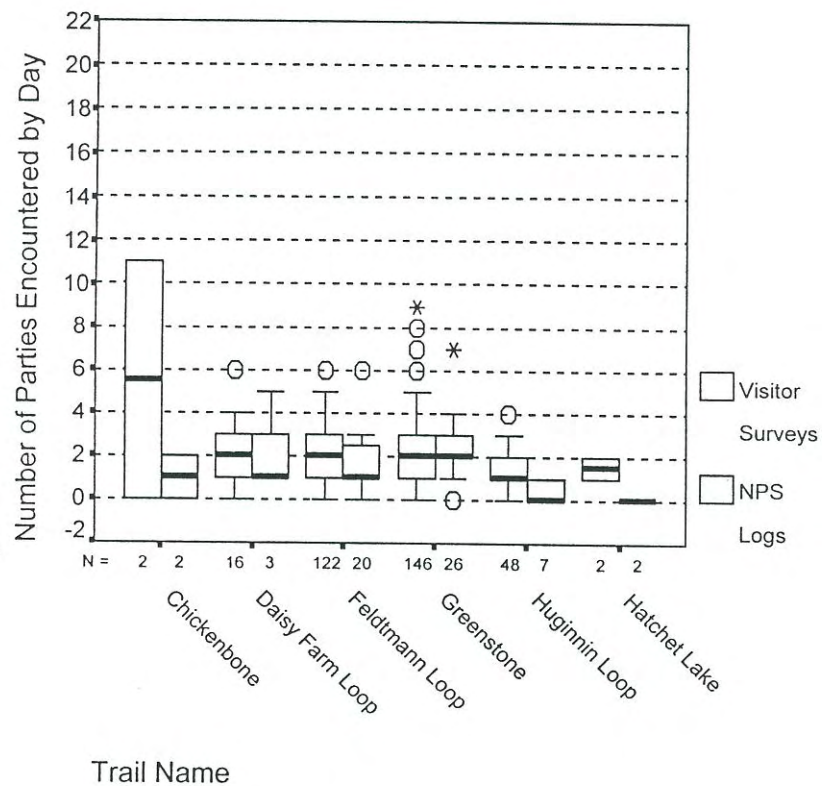


Figure 6: Frequency of boats rafting off another boat at a dock, reported by visitors (a) and rangers (b).

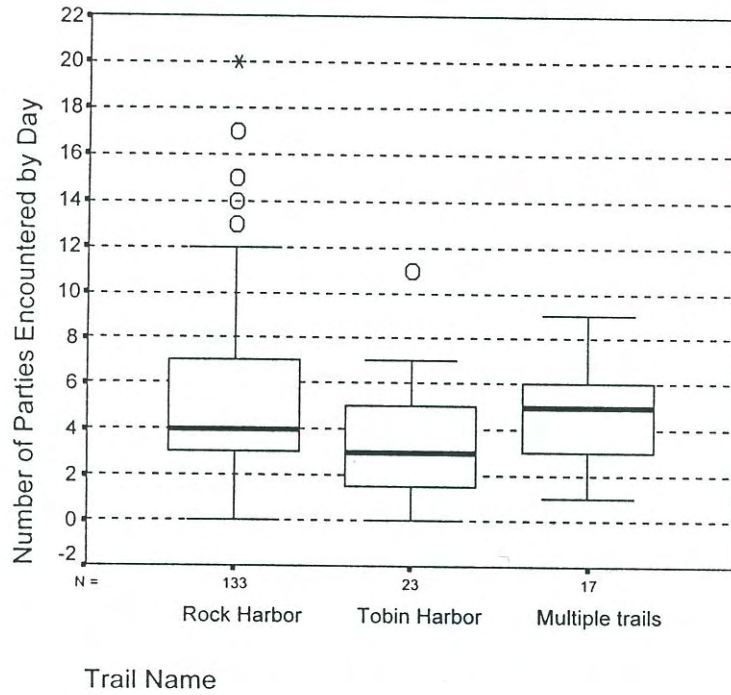


Visitor reports and ranger reports agreed that trails in the Backcountry Zone were out of standard for encounter frequencies more often than trails in the Primitive Zone, though they disagreed on the extent of conditions being out of standard (Table 2). Reports from the Rock Harbor Trail, Greenstone Trail, and hikes including the Indian Portage and Lake Richie Trails exceeded proposed standards for trail encounters more frequently than other trails in the park. These trails are located on the eastern end of the island, and those most frequently exceeding standards are along the Rock Harbor Channel. Figure 7 (a-c) displays the range of trail encounter rates reported by visitors and rangers.

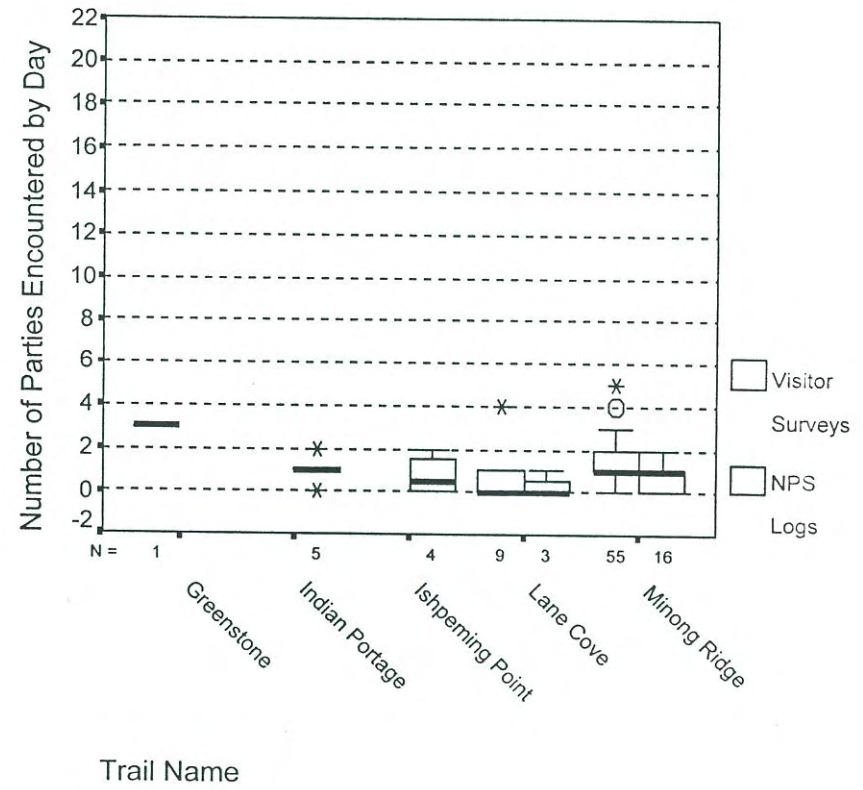


a) Party encounter rates along trails in the Backcountry Zone.

Figure 7: Boxplots of daily trail encounters reported as number of parties by visitors (visitor surveys) and rangers (NPS logs), by management zone. Bars indicate the median (middle of the ranked values), boxes the 25th – 75th percentiles, arms extend to the smallest and largest values within 1.5 box lengths, circles indicate outliers, and asterisks are extreme values. Reports that included sections of more than one trail were categorized as “multiple trails”.



b) Party encounter rates along trails in the Frontcountry Zone (no ranger reports from this zone).



c) Party encounter rates along trails in the Primitive Zone.

Comparison of Results Reported by Three Methods of Monitoring

Developing a long term monitoring program for the park will depend on better understanding the relationship between possible monitoring methods, and better understanding what is being measured. Interpreting the assessment of social conditions in the park in the 2000 season will likewise depend on understanding the discrepancy in results between the three modes of data collection. For example, permit data reported being out of standard for campsite sharing up to 12 weeks, while surveys indicated up to 9 weeks out of standard, and NPS logs reported up to 8 weeks. What accounts for the discrepancy and how should managers decide which results to follow?

There are several ways to measure the difference in results from the three modes of monitoring. Analysis was conducted on various temporal and spatial scales, including weekly and daily summaries for individual campgrounds, management zones, and the entire park. The goal of conducting analysis on these various scales was to explore the similarities and differences in possible modes of monitoring.

Analysis of Campground Conditions

For cases in which all three modes reported on the same campground on the same night ($N=137$), the Pearson's χ^2 test was used to calculate the significance of differences in reports of parties sharing and the campground being full (Table 3). For both reports of full campgrounds and parties sharing, there was not a significant difference between the three modes, based on $p \geq 0.05$ (meaning there is a greater than 5 percent chance that that the differences were due to chance, rather than actual differences in the sample populations). However, there was a stronger significance of similarity in reports of sharing than estimates of full campgrounds. Visitors estimated a higher frequency of full campgrounds than did permits or rangers. With a larger sample size the difference in estimates of campgrounds being full would probably be statistically significant. Visitors may perceive campgrounds to be full when they actually are not.

Table 3: Results of Pearson's χ^2 test for equality of reported frequencies of campgrounds being full and parties sharing sites when all modes reported on the same night for the same campground.

Mode of data collection	Campground Full?				Any Parties Sharing Sites?				
	No	Yes	N	Pearson χ^2	p value	No	Yes	N	Pearson χ^2 p value
Visitor Surveys	99 (74%)	35 (26%)	134	5.016	0.081	123 (91%)	12 (9%)	135	0.405 0.817
NPS Logs	115 (84%)	22 (16%)	137			126 (92%)	11 (8%)	137	
Permits	113 (82%)	24 (18%)	137			123 (90%)	14 (10%)	137	

These calculations summarized the 137 campground nights, but did not measure to the precision of agreement between the three modes as to what was happening in a specific campground on a specific night. Survey and NPS log reports on whether or not any parties were sharing campsites on a specific night had the highest level of agreement (92 percent). Survey and permit reports on whether or not a campground was full on a specific night had the lowest rate of agreement (78 percent), with surveys estimating a higher frequency of full campgrounds than permits.

To compare assessments of conditions in all campgrounds through the entire season, results were summarized into reports by management zone or the entire park, and by week or by date. To maintain high enough cell counts for a valid χ^2 test, weekly summaries were calculated by management zone, while daily summaries were calculated for the entire park. Table 4 shows the results. Visitor and ranger reports were statistically similar for estimates of whether or not any parties were sharing sites in the park on a weekly or daily basis. However, in both cases permits reported a significantly higher estimate of parties sharing, which concurs with the higher frequency of conditions exceeding proposed standards from Table 2.

Table 4: Results of Pearson's χ^2 test for equality of observed frequencies of parties sharing sites on a weekly and daily basis.

Cumulative weekly summary by Management Zone						
Frequency of Any Parties Sharing Campsites						
Mode of data collection	No	Yes	N	Pearson χ^2	p value	Pearson χ^2 p value
Visitor Surveys	39 (71%)	16 (29%)	55	0.062	0.803	9.579 0.015
NPS Logs	38 (73%)	14 (27%)	52			
Permits	32 (50%)	32 (50%)	64			

Summary of the entire park by date						
Frequency of Any Parties Sharing Campsites						
Mode of data collection	No	Yes	N	Pearson χ^2	p value	Pearson χ^2 p value
Visitor Surveys	69 (66%)	35 (34%)	104	1.579	0.209	60.386 0
NPS Logs	78 (74%)	27 (26%)	105			
Permits	29 (26%)	84 (74%)	113			

Proposed standards for campsite sharing are phrased as percent of parties sharing sites.

Therefore, it would be useful to understand the relationship between the three modes in reporting percent of parties sharing at different scales. Whether looking at daily or weekly summaries, and on a scale of the entire park or by management zone, visitors and NPS observers reported statistically similar results (Table 5). When analyzing results on a weekly basis for the entire park, the small sample size ($N=15$) limits the statistical significance that can be concluded. However, there is a substantive difference in the estimated percent of parties sharing sites, with permits estimating higher rates of sharing than either surveys or NPS logs. Where sample sizes were higher, differences were statistically significant, with permits again estimating higher frequencies of parties sharing sites on both daily and weekly bases. In summary, a series of small differences between permits and visitor and NPS assessments in campground crowding cumulated to statistically significant differences on larger scales.

Table 5: Results of the non parametric Mann-Whitney U and Kurskal-Wallis tests for equality of mean percent of parties reported sharing by the three modes, reported at various scales.

Percent of parties reported sharing per week, summarized for the entire park					
Mode of data collection	mean	rank	N	p value (Mann-Whitney U)	Chi ² (Kurskal-Wallis)
Visitor Surveys	0.0378	21.13	15	0.684	5.431
NPS Logs	0.0296	19.33	15		
Permits	0.0726	29.63	16		0.066

Percent of parties reported sharing per week, summarized by management zone					
Mode of data collection	mean	mean rank	N	p value (Mann-Whitney U)	Chi ² (Kurskal-Wallis)
Visitor Surveys	0.0249	79.2	55	0.869	9.082
NPS Logs	0.0405	78.69	52		
Permits	0.0577	97.78	64		0.02

Percent of parties reported sharing by date, summarized for the entire park					
Mode of data collection	mean	mean rank	N	p value (Mann-Whitney U)	Chi ² (Kurskal-Wallis)
Visitor Surveys	.04	146.71	104	0.245	37.327
NPS Logs	.03	134.35	105		
Permits	.053	200.25	113		0.000

Analysis of Trail and Waterway Conditions

When rangers traveled in the same zone as visitors, they reported similar hourly encounter rates (Table 6). When calculated as mean hourly trail encounters for the entire park, visitors reported significantly higher estimates than rangers. This may be due to the frequency of visitor reports from high use areas, and infrequency of ranger reports from these areas. Ranger reports of paddling encounters were infrequent and concentrated in areas with few visitor reports, which made comparison of paddling encounters difficult. However, when summarized for the entire park, there was no significant difference between ranger and visitor reports of hourly canoe or kayak encounters.

Table 6: Comparison of estimated trail and water encounters as reported by visitors and wilderness rangers (NPS Logs).

	NPS Logs			Visitor Surveys			p value	
	mean	standard deviation	N	mean	standard deviation	N	(Mann-Whitney U)*	(t-test)**
Backcountry Zone								
number people seen	6	6	99	8	8	696		
people/hour	2.4	3.1	99	2.09	2.11	690	0.205	0.55
number parties seen	2	2	100	3	3	643		
parties/hour	0.78	1.04	100	0.76	0.76	637	0.084	0.474
Primitive Zone								
number people seen	2	3	28	3	3	74		
people/hour	0.7	0.88	28	0.83	1.93	74	0.982	0.942
number parties seen	1	1	28	1	1	65		
parties/hour	0.27	0.31	28	0.33	0.46	65	0.607	0.497
Entire Park								
number people seen	5	6	129	9	9	991		
people/hour	2.02	2.84	129	2.57	3.06	979	0.000	0.001
number parties seen	2	2	129	3	3	920		
parties/hour	0.67	0.95	129	0.93	1.02	908	0.000	0.000
number canoes/ kayaks seen	0.84	1.34	19	1.84	2.18	147	0.045	
canoes/hour	0.29	0.58	19	0.61	0.98	139	0.077	N/A***

*p values calculated for encounters/hour due to some reports being encounters/trail and others being encounters/day. Encounters/hour were positively skewed, requiring the nonparametric test, Mann-Whitney U 2 independent samples test.

**Linear transformation calculated with encounters/hour [natural log(encounters/hour+1)] to create a less skewed distribution. P values were then calculated with the t-test for independence, 2 independent samples test.

***Linear transformations did not normalize the distribution of paddling encounters, prohibiting the use of a t-test.

Evaluation of possible monitoring tools

Management objectives will influence the selection of the best monitoring methods. Each of the methods employed in this study measured different things; visitors' perceptions of conditions, NPS perceptions, and frequency of permits issued by location. None of these are known to be measuring actual conditions in the field. Visitor trip diaries effectively measured the experiences of hikers on Isle Royale. However, the methods used in this study failed to adequately measure powerboater experiences, due to a poor participation rate for boaters. Relying on visitor trip diaries for monitoring imposes on visitors, which may be inappropriate in a Wilderness area if used on a regular basis.

NPS logs were effective for measuring employee perceptions in the areas where they traveled, which was determined by work schedules. The significant similarity between NPS reports and visitor reports suggests that NPS observations could be an adequate substitute for visitor observations, as long as NPS travel patterns represent visitor travel patterns. If the park chooses to substitute ranger observations for visitor observations, it would be prudent to periodically reassess the relationship between ranger perceptions and visitor perceptions.

When exploring conditions throughout the entire season, this study was not able to determine a significant similarity between permit reports of campground conditions and visitor perceptions or ranger perceptions. Permit data offer a plethora of information on campground conditions, but the relevance of these data is unknown. Therefore, at this point, permits do not offer a reliable measurement of visitor experiences or backcountry and wilderness social conditions.

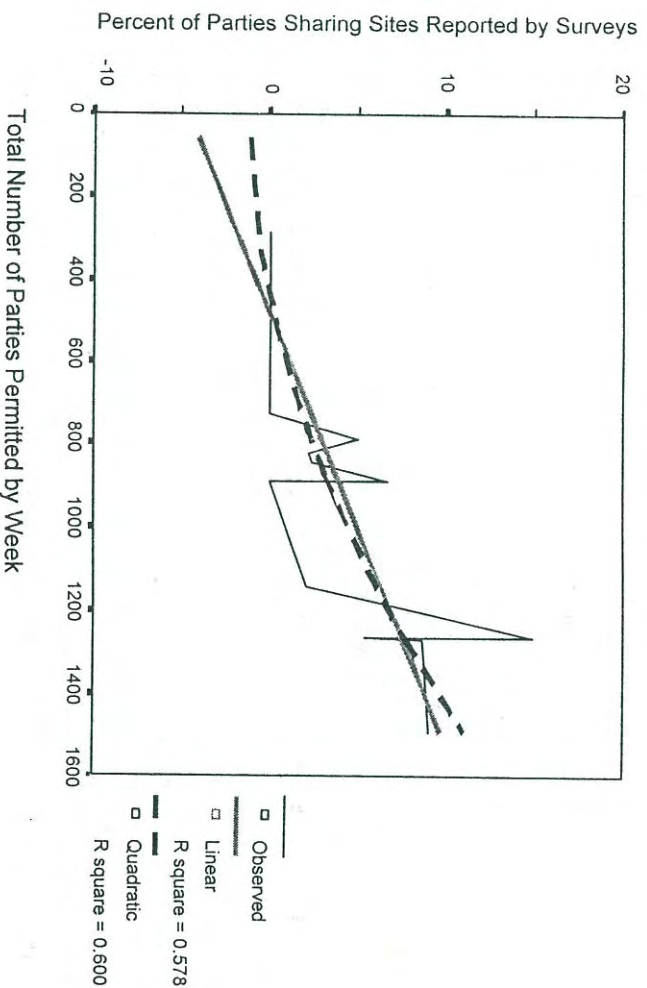
Relationships Between Visitor Use Levels and Campground and Trail Conditions

The success of using visitation levels to predict encounter rates and frequency of campground crowding was much less than expected. For the most part, scattergrams did not reveal clear relationships between visitation level variables and crowding variables. Variables reflecting visitation levels, such as the number of parties in the backcountry and the number of parties entering or exiting the park, were used as the independent variable, or predictor. Crowding variables, such as encounter rates and frequency of parties sharing campsites, were the dependent variables. Figure 8 shows some of the relationships that emerged in the analysis. Quadratic equations, using a curve, resulted in slightly stronger predictive relationships than did linear equations.

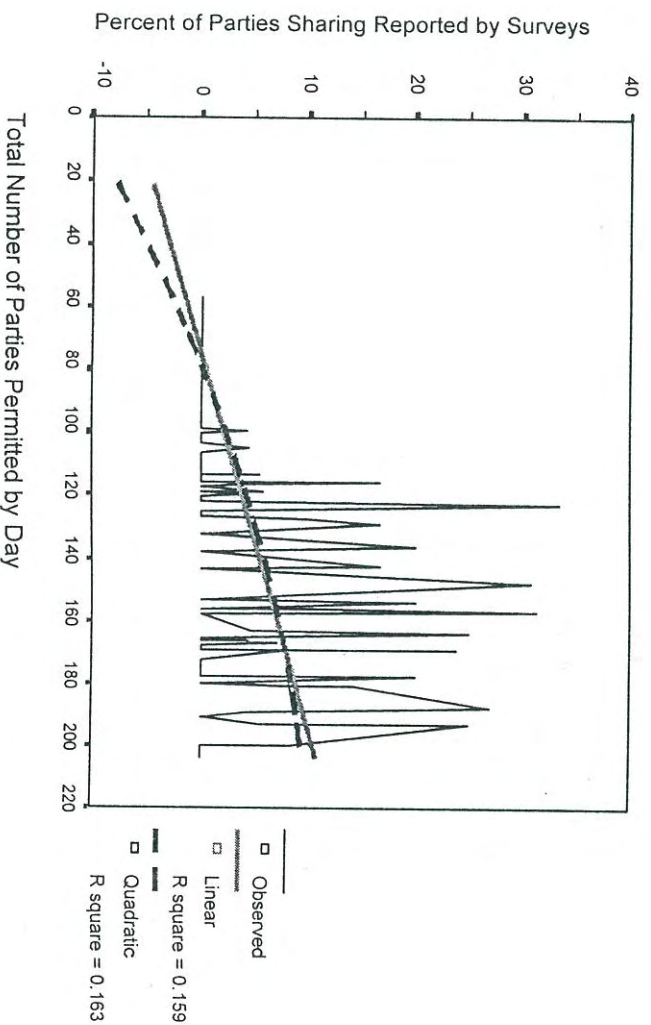
Weekly summaries of data produced stronger predictive relationships than daily summaries. With an R-square of 0.600, weekly backcountry visitation levels explained up to 60 percent of the variance in visitor-reported campsite sharing. Daily visitation levels explained 16.3 percent of the variance in visitor reported frequencies of sharing campsites. High frequencies of both campsite sharing and trail encounters were reported with moderate to high daily visitation levels. These results question the validity of assuming that lowering daily visitation levels would reduce the frequency of campsite sharing and trail encounters. The full set of scattergrams and regression equations are included in Appendix G.

Figure 8: Illustration of the relationship between visitation levels and reports of frequency of campsite sharing and trail encounters.

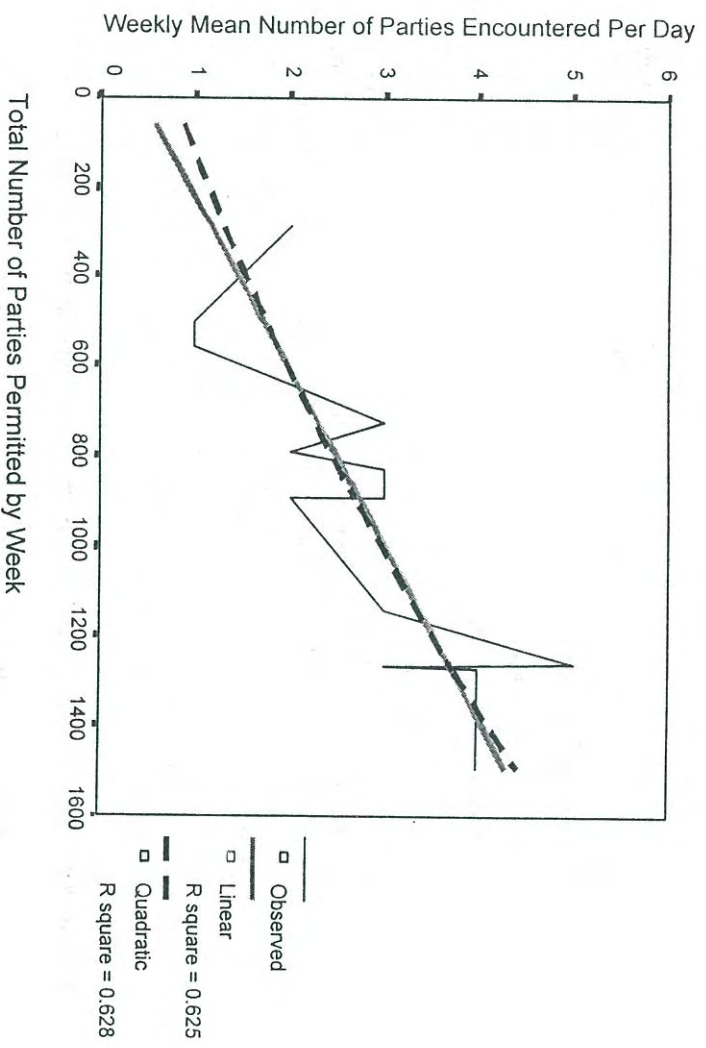
a) Weekly visitation levels as a predictor of percent of parties reporting sharing campsites, with curves for linear and quadratic regressions.



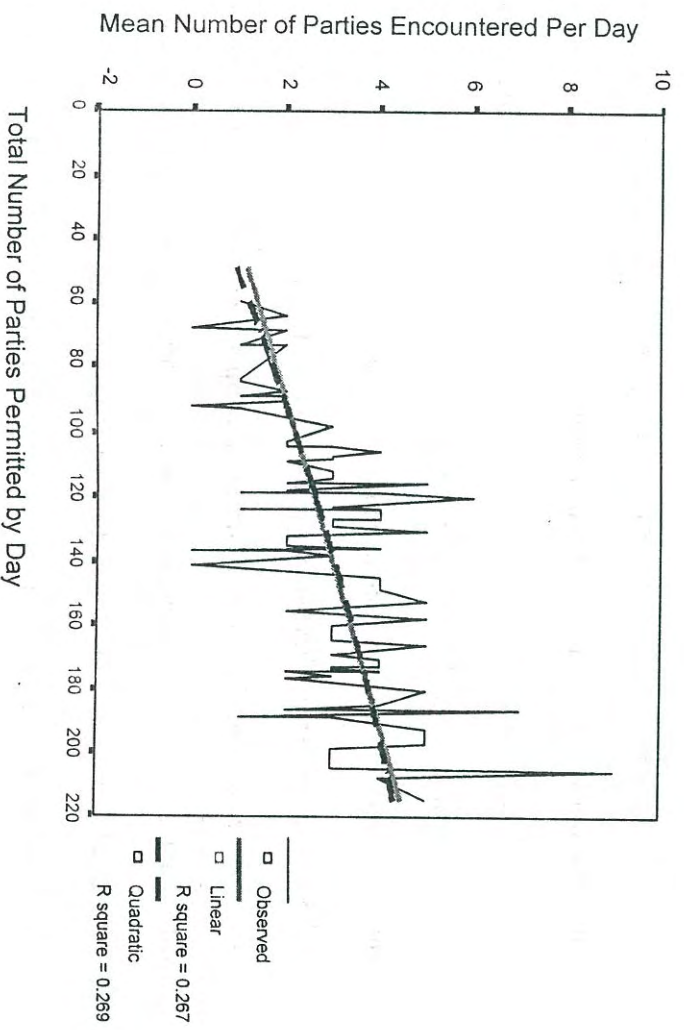
b) Daily visitation levels as a predictor of daily percent of parties reporting sharing campsites, with curves for linear and quadratic equations.



- c) Weekly visitation levels as a predictor of visitor reports of number of parties encountered on trail each day, averaged on a weekly basis.



- d) Daily visitation levels as a predictor of visitor reports of number of parties encountered on trail each day.



Discussion of Results

In summary, the main observations from the analyses were:

1. Social conditions on Isle Royale exceed proposed standards for acceptable conditions for as much as 12 weeks of the 2000 visitor season, and most frequently on the eastern end of the park.
2. Permits estimated higher frequencies of parties sharing campsites than visitors or rangers did when conditions in the park were summarized on a weekly or daily basis.
3. NPS staff and visitors reported similar estimates of frequency of parties sharing campsites and of trail encounters when they traveled in the same areas of the park. However, visitors estimated higher frequencies of full campgrounds and summaries of park conditions showed a discrepancy in the location of crowded conditions reported by rangers and visitors.
4. Daily levels of visitation in Isle Royale's backcountry do not predict social conditions that exceed standards.

The Rock Harbor Channel on the eastern end of the park emerged as the area most frequently exceeding standards for both campsite sharing and trail encounters during the 2000 visitor season. Rock Harbor is the busiest entry point, with up to 12 ferry arrivals each week. The ferry landing is located at the end of a narrow peninsula, so in addition to pulses of hikers starting their trips, congestion in the nearby trails and campgrounds is exacerbated by limited options for dispersing visitors. By contrast, Windigo, the western entry point, receives fewer visitors on up to 10 ferry arrivals each week, and has more trail and campground options for hiker dispersal. The limitations of the Rock Harbor area may require lower standards, restrictive management actions, or redesigning the flow of traffic in that part of the park.

The high frequency of overcrowding in campgrounds estimated by the permit data indicates that the park issues permits beyond campground capacities. In effect, the park may be creating or exacerbating crowding by poorly distributing camping parties. Anecdotal data from comments written on visitor trip diary cards and ranger observations suggest that when parties arrive at a campground that is full, they will continue on to the next campground, though the frequency of this is unknown. The permit data also suggest that trying to avoid full campgrounds

may be ineffective, particularly on the east end of the park. On the three busiest nights of the season clusters of campgrounds were full or overfull. There are 243 campsites in the backcountry, and in the 2000 season as many as 200 parties were permitted to camp in the backcountry on a single night. Parties leaving one full campground would likely have found the next one full as well. Another factor contributing to the permits' high estimation of campsite sharing could be an inaccurate assumption that all permitted parties would have occupied a campsite, when in fact some boaters slept on their boats some or all of the time.

The discrepancy in location of visitor and NPS reports of unacceptable conditions could be accounted for by the fact that NPS observations were determined by work schedules. Rangers reported high instances of boats rafting at Windigo and Malone Bay, both sites of ranger stations. Boating parties were poorly represented in the survey data, resulting in relatively few visitor reports on dock conditions. NPS logs also showed West Chickenbone with a high frequency of parties sharing campsites. One of the park's trailcrews spent the bulk of the season camped there, and reported nightly on crowding conditions. Appendix H includes the frequency of observations for all modes of data collection by location.

Conditions related to campsite and trail crowding were reported to be out of standard by all methods of monitoring. On a weekly level, there was a discernable relationship between total backcountry visitation and frequency of trail and campground encounters. However, the most effective management of visitation would be on a daily level. At this point it would be difficult for park managers to use visitation levels to predict when conditions will be out of standard, because there was no apparent relationship between daily visitation levels and conditions being out of standard (Appendix G).

The third objective of this study was to evaluate the selected monitoring methods for their strengths and weaknesses, including efficiency of implementation, reflection of the planning team's intentions, and ability to inform managers about the selection of indicators and standards. As mentioned previously, there are four key elements of a successful monitoring plan:

1) identifying appropriate indicators, 2) actually measuring what one purports to be monitoring, 3) monitoring something that managers can influence, and 4) determining that implementation will be feasible. Strong indicators would be measurable, monitorable, directly related to visitor use, responsive to management action, and able to act as an early warning to alert managers to deteriorating conditions before unacceptable changes occur. The results of this study suggest that frequency of sharing campsites, frequency of campgrounds being full, and rate of trail encounters are measurable with multiple modes of monitoring when calculated at a weekly or zone scale. Visitor surveys and NPS logs did not offer sufficient data to reliable report conditions on a daily basis, which is a consideration for defining indicators and standards. Frequency of boats rafting off also proved to be measurable, but sampling methods employed in this study insufficiently represented Isle Royale's boating population. These indicators are also directly related to visitor use patterns, though no direct relationship to actual visitor numbers emerged.

Without a relationship between visitor use numbers and sharing, sharing may not be responsive to management actions that attempt to control visitor use patterns (short of implementing a site reservation system) and thus may not be a strong indicator. If the park adopted the strictest standards, calling for no parties ever sharing campsites, then monitoring frequency of parties sharing sites would alert managers only when conditions had already exceeded standards. Monitoring frequency of campgrounds being full, however, would alert managers to deteriorating conditions before unacceptable frequencies of sharing occurred.

Although no direct relationship between crowding conditions and total number of parties traveling in Isle Royale's backcountry was established, this study's results suggest that crowding on Isle Royale is a distribution problem. These results suggest that management actions that would simply limit visitation may be ineffective for improving social conditions. There are, however, several other management options that would address visitor distribution and may be more effective in improving conditions: 1) improve the permitting system so better information is available about real-time use levels at campgrounds, thereby allowing visitors to avoid crowded

areas, 2) redistribute campsites, adding sites at the most heavily used campgrounds and removing sites from underutilized campgrounds, and 3) improve information available to visitors about trails and campgrounds, encouraging visitors to travel in the less busy areas of the park. A dissertation project conducted by Krumpke (1979) with Yellowstone National Park successfully redistributed 26.7 percent of visitors from high traffic areas to less used trails, using informational brochures.

Existing park staff carried out the data collection phase for this monitoring season. University researchers completed the study plan, data analysis, and report writing. Future monitoring using any of the three tested modes of data collection would require much simpler analysis limited to basic descriptive statistics. As such, it seems feasible that with the commitment of one staff member to oversee the logistics of data collection and report writing, the park could sustain long-term monitoring using any of these methods with minimal resources. Distribution, collection and analysis of visitor surveys would be the most time consuming. Utilizing NPS employee observations would require the use of standardized forms, and the commitment of one employee to train staff, and coordinate data collection, data entry, analysis, and report writing. One park staff member is already responsible for analysis of the park's permit data. Using permit data as the mode of monitoring campground conditions would require minimal additional effort.

However, it is critical to consider the discrepancies in results and weaknesses of each monitoring method before finalizing a monitoring plan. Visitor surveys inadequately represented powerboater experiences. NPS observations were not a random sample, and failed to represent visitor experiences along high-traffic areas in particular. Permit assessments of campground crowding did not correlate with either visitor or NPS employee observations.

Management Implications

If the proposed indicators and standards were adopted, conditions in Isle Royale's backcountry would have been out of standard for a bulk of the 2000 season. However, at this point there is no one clear cause of unacceptable conditions. Possible reasons for over crowding on Isle Royale include;

1. Poor distribution of visitors.
2. Insufficient information provided to visitors so they can choose to avoid crowded areas.
3. Congestion in the Rock Harbor area caused by channeling traffic along a narrow travel corridor.
4. Visitors choosing to share campsites in order to camp in their preferred campgrounds.
5. Ferry schedules limiting options for avoiding crowding because of pulses of visitors.
6. The total number of camping parties in certain areas of the park exceeding the capacity of facilities.

Each of these problems calls for different solutions, from better educating visitors to implementing entry quotas. Results of this study suggest that the most effective preliminary management actions would be site-specific, rather than system-wide. Managers need to better understand why people end up sharing sites where they do, and with this information develop appropriate management actions. In areas where expanding the campground size would be appropriate, the best action may be to add campsites and remove sites from less used campgrounds. However, increasing campground capacities may exacerbate the problem of trail crowding. System-wide actions, such as entry quotas, would likely be ineffective if crowding occurs because of the popularity of a campground or trail.

Permit data may be more useful if the park makes an effort to improve the rate of return for permits with updated itineraries. Currently, when rangers issue permits they sometimes ask

visitors to return their permits if they end up making changes to their itineraries. Aside from this, little effort is made to collect and update permits from visitors as they leave the island. Some simple steps may make significant improvements in the accuracy of the permit data: 1) advise visitors that they are required, rather than “asked”, to return their permit at the end of their trip with changes in their itinerary recorded, 2) facilitate the return of permits by installing prominent drop boxes at the visitor centers and on the ferries, 3) for visitors who are not departing the park by way of a visitor center or ferry, provide an alternative for leaving updated permits, such as attaching them to a dock cleat (which some boaters already do), and 4) include a return address and postage on the permit, allowing for return through the mail.

The level of agreement between visitor and ranger reports suggests that ranger-collected data may be appropriate for monitoring visitor experiences. However, to adequately monitor the full range of visitor experiences on Isle Royale it would be necessary for rangers to record observations systematically in all zones of the park’s backcountry. The largest shortcoming in the 2000 sampling season was the infrequency of ranger observations for high traffic trails near the developed areas of Windigo and Rock Harbor. Relying on ranger observations would also require a commitment of staff time, ensuring that rangers spend adequate time in the backcountry. Additional efforts should also be taken to improve monitoring of powerboaters’ experiences. Working collaboratively with the Isle Royale Boaters Association to identify objectives and options for monitoring may be a good start.

Once the methods of monitoring are selected, a long-term plan will also include the frequency and scope of monitoring. Manning (1999: 289) pointed out circumstances that may call for more frequent monitoring: 1) indicator conditions are close to or exceeding acceptable standards, 2) rates of environmental, social or managerial change are thought to be high, 3) the initial inventory and database are thought to be incomplete or of questionable quality, 4) the potential effectiveness of management actions is not known or predictable, and 5) unanticipated changes have occurred, such as additional access or changes in adjacent land uses. This study

indicated that social conditions on Isle Royale exceeded proposed standards in 2000. If managers implement actions to alter visitor distribution in the backcountry, effectiveness will initially be unknown and unpredictable. Both of these conditions suggest a need for frequent initial monitoring. If limited funding and staffing preclude another season of full scale monitoring, managers have the option of focusing resources on the areas and times of highest concern. Highest concern may be defined as those areas most frequently out of standard, requiring actions to improve conditions. Concern may also be appropriate for those areas and times with the highest quality conditions, to prevent future degradation.

It is important to remember that the information presented here came from one season. Managers would be wise to monitor conditions for additional seasons to clarify trends in visitor use patterns. Implementing large changes based on one season of data collection may be viewed as reactionary. However, the assessment of current conditions does indicate that immediate management actions would be appropriate at some level.

CHAPTER IV: CONCLUSIONS

In 2000, total backcountry visitation on Isle Royale dropped 14 percent from a peak in 1996. Even with this decline, social conditions in the park violated proposed standards of acceptability for much of the 2000 season. How might one reconcile a significant decrease in visitation and standards that are exceeded? It is possible that the standards are unrealistic and they should be reevaluated. It also is possible that Isle Royale has exceeded its visitor carrying capacity, in which case managers should take action to modify visitor distribution or total visitation.

This study was designed to assess current social conditions in Isle Royale's backcountry and evaluate possible monitoring methods. In evaluating the results of this study one needs to recognize that science does not provide managers with the one right answer, as management will require difficult decisions based on values. Science can, however assist by providing information to ensure that these decisions are consistent with existing goals and policies, as well as providing a means of assessing management effectiveness. Science can inform management.

In the absence of conclusive information, managers may choose to either wait for more information or act on the best available information, and be open to adaptation as better information becomes available. In today's political climate, managers may be nervous about acting to change a situation, for fear that their decisions will not hold up to public and judicial scrutiny. However, lack of action is a decision as well, an acceptance of an undirected course toward future conditions that may be unacceptable. In the case of Isle Royale, a place of unique recreation opportunities within the Great Lakes region, preserving these unique opportunities requires active management.

Isle Royale managers have suggested a problem of overcrowding in campgrounds and along trails, concerns that are supported by some sectors of the public. Given this observation, park managers have an obligation to take action. This study successfully identified specific areas

in the park that are the main problem and it appears that the major cause of crowding in these areas is the current distribution of visitors. No strong relationship between overcrowding and visitation numbers was observed on a daily level. However, visitation may eventually reach a point when total numbers, not distribution, is an issue. Ongoing monitoring will be critical; both to track the rate of improvement in problem areas and to ensure that crowding is not simply shifted to another part of the park.

This study also demonstrated a correlation between visitor and NPS employee observations of encounters in campgrounds and along travel routes, when they traveled in the same areas. These findings are consistent with work conducted by Watson et al (1998) in which wilderness ranger observations correlated with visitor observations of trail encounters in the Alpine Lakes Wilderness. This suggests that monitoring encounter rates would be feasible with existing resources for all wilderness areas staffed with wilderness rangers.

Recommendations to Improve Monitoring Methods used in this Study

If visitor trip diaries were used for future monitoring, improvements should focus on increasing boater participation and increasing the overall response rate. Options for this include:

1) collaborate with representative boaters to clarify objectives of monitoring and management and develop methods for improving participation, 2) have rangers on ferries, in visitor centers, and on patrols remind survey participants to complete and return diary cards, 3) display prominent drop boxes at trail heads for returning surveys on-site, 4) decrease the time between trip completion and follow-up contact (for this study lag time was anywhere between one and four weeks), 5) replace trip diaries with post-trip questionnaires to be administered on ferries and at visitor centers.

If NPS observations were used in place of visitor surveys, they would need to be more systematic to ensure adequate representation of visitor travel patterns. Suggestions for this include: 1) patrol trails close to developed areas as well as in the more remote backcountry, 2)

increase the area of paddle patrols, including Lake Superior routes, 3) continue to have all NPS personnel who camp in the backcountry record nightly campground information, 3) systematically patrol all management zones, and 4) generally increase the presence of rangers in campgrounds in the evenings to increase the number of nightly observations.

Although permit data from the 2000 season did not adequately represent either visitor or NPS observations, there is great potential for these data to be more valuable in the future. The usefulness of permit data depends on its accuracy, which at present is questionable. Simply increasing the return rate of permits with corrected itineraries may solve this problem.

Recommendations for Future Research

The results from this study suggest the need for future research, both to conduct further analysis with existing data as well as collecting additional information. The datasets developed for this study were not explored to their full potential. Future possibilities include developing a prediction model based on visitation levels and crowding conditions in different areas of the park. This study did not find a strong relationship between daily visitation levels and crowding conditions. One possibility for further exploring this possible relationship would be to calculate a lag time with visitor entry levels and crowding on the interior of the island. Additionally, the predictive relationship may improve by isolating areas of the park associated with entry points, rather than conducting analysis on the scale of the entire park. There is also the possibility of creating subsets of the data, such as distinguishing between boating and hiking campers. Campground use levels may also be a good predictor of trail encounters.

Several important questions remain unanswered in this study. Why do people choose to travel where they do on Isle Royale? Why do parties share campsites? Why do they hike on trails with high encounter rates? Answering these questions may require interviews with visitors, or more extensive qualitative surveys. This information would be helpful in directing the most effective management actions.

Finally, a travel simulation model may be a useful tool for Isle Royale's managers. With a random sample of visitors and where they travel, researchers may be able to develop a predictive model that would help managers better understand Isle Royale's visitor carrying capacity.

Managers and some sectors of the public suggest that use related actions are needed to protect Isle Royale National Park so that conditions do not continue to degrade. In the absence of perfect information as a guide to action, an alternative approach to recreation management is as an adaptive process where one defines a problem and likely causes, implements appropriate actions, monitors changing conditions, and alters actions as necessary to achieve management objectives. Management of wildland recreation will inevitably come down to a value-based judgment. The goal is for managers to inform their decisions with reliable information, and to maintain the uniqueness and high quality of the range of recreation opportunities for which they are charged. Maintaining up-to-date monitoring information will allow managers to make decisions based on knowledge of actual conditions in the park.

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