

**Assessing Visitor Use Impacts to Natural Resources and
Creating Restoration Recommendations for North Manitou
Island, Sleeping Bear Dunes National Lakeshore**

by
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Abstract

A wilderness camping assessment was conducted on North Manitou Island, part of Sleeping Bear Dunes National Lakeshore in Northern Michigan, to assess the impacts of dispersed campsites on natural resources throughout the island. Backcountry camping permits were used to gather visitor data, and an informal camper location survey was conducted to verify that permit data reflected actual camping patterns. Natural resource impacts on each campsite were measured using indicators of dune bluff erosion, damage to native vegetation, soil compaction, proliferation of human waste, litter, invasive plant species and others. Indicators were quantified and assigned an impact rating of 1-3 (with 3 being the most heavily impacted) and all indicators per campsite were averaged to determine total impact. A similar assessment of trail condition was also conducted.

Camping permits showed that visitor use is concentrated on the central western shore of the island and eastern shore of Lake Manitou inland. Of the 116 campsites measured, 12 had an impact ranking above 2 (on a 3.0 scale) and require rehabilitation work or fortification to withstand future visitor use. Fourteen campsites were larger than 1,000ft² in total camp area. Of those fourteen, five sites were greater in area than all sites in the Village Campground, the only designated campground on the island. Recommendations were made to Lakeshore management regarding the rehabilitation or fortification of these sites, including the Village campground, as well as needs for future visitor education and data collection.



Acknowledgements

Though this project was designed as an independent research project, it was anything but independent and I would like to thank those that helped along the way. First and foremost I need to thank my supervisors at Sleeping Bear Dunes, particularly Amanda Brushaber, for continuously supporting this project and the importance of scientifically informed management decisions. The entire 2011 natural resources crew at Sleeping Bear Dunes was an amazing group of people that helped me pull this project together. Whether serving as a sounding board, providing me with new ideas and guidance, helping with data entry or collection, or even just moral support, each crewmember was a part of this project. Special thanks go out to Benjamin Copper for his dedicated data entry, Ian Smith for a behemoth data collection backpacking trip, Jennifer Chaffin for her assistance with data quality control and Rebecca Hill for her guidance and support.

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Introduction

North Manitou Island is a 15,000 acre¹ wilderness island in northern Lake Michigan and part of Sleeping Bear Dunes National Lakeshore, a unit of the National Park Service. The National Lakeshore (hereafter Lakeshore) is headquartered in Empire, Michigan, approximately 25 miles west of Traverse City in northwest Lower Michigan. The entire Lakeshore is 71,291 acres and has 65 miles of coastline, including two islands, beaches, 450' tall dune bluffs, and northern hardwood forests (Sleeping Bear Dunes NL 2009). Each year the Lakeshore hosts over 1 million visitors (Sleeping Bear Dunes NL 2006). In 2010, approximately 3,113 of those visitors were campers on North Manitou Island.

In 1981, a Wilderness Recommendation was proposed to Congress to list nearly 31,000 acres within the Lakeshore as designated wilderness. This included the majority of North Manitou Island (Sleeping Bear Dunes NL 2009). In 1982, Congress passed legislation requiring the Lakeshore to manage the proposed areas as wilderness until formal Congressional recommendations establish the amount of land to be officially designated as wilderness (Public Law 97-361 1982). In 2010, the wilderness proposal moved into respective House and Senate committees within Congress and though progress has been made, a final vote is still pending. Nevertheless, this interim designation requires the Lakeshore to enforce wilderness regulations in proposed wilderness areas, even though it is not legally wilderness. If policies are finally passed in 2012, results from this study will be vital for management of wilderness camping in the Lakeshore.

North Manitou comprises about half of the total proposed wilderness areas in the entire Lakeshore. Ninety-nine percent of the island is currently *managed* as wilderness. The 1%, or 27 acres, that are excluded from proposed wilderness are an historic village including Cottage Row and the dock area, where visitors arrive (Figure 1). These areas will remain excluded from wilderness classification because stipulations of the 1964 Wilderness Act require that no humans reside within wilderness. Law Enforcement officers and maintenance workers reside in this village to facilitate island operations during the open season from April to November.

¹ The data in this report were produced for Sleeping Bear Dunes National Lakeshore which commonly uses the English unit of measure; SI units are not reported.

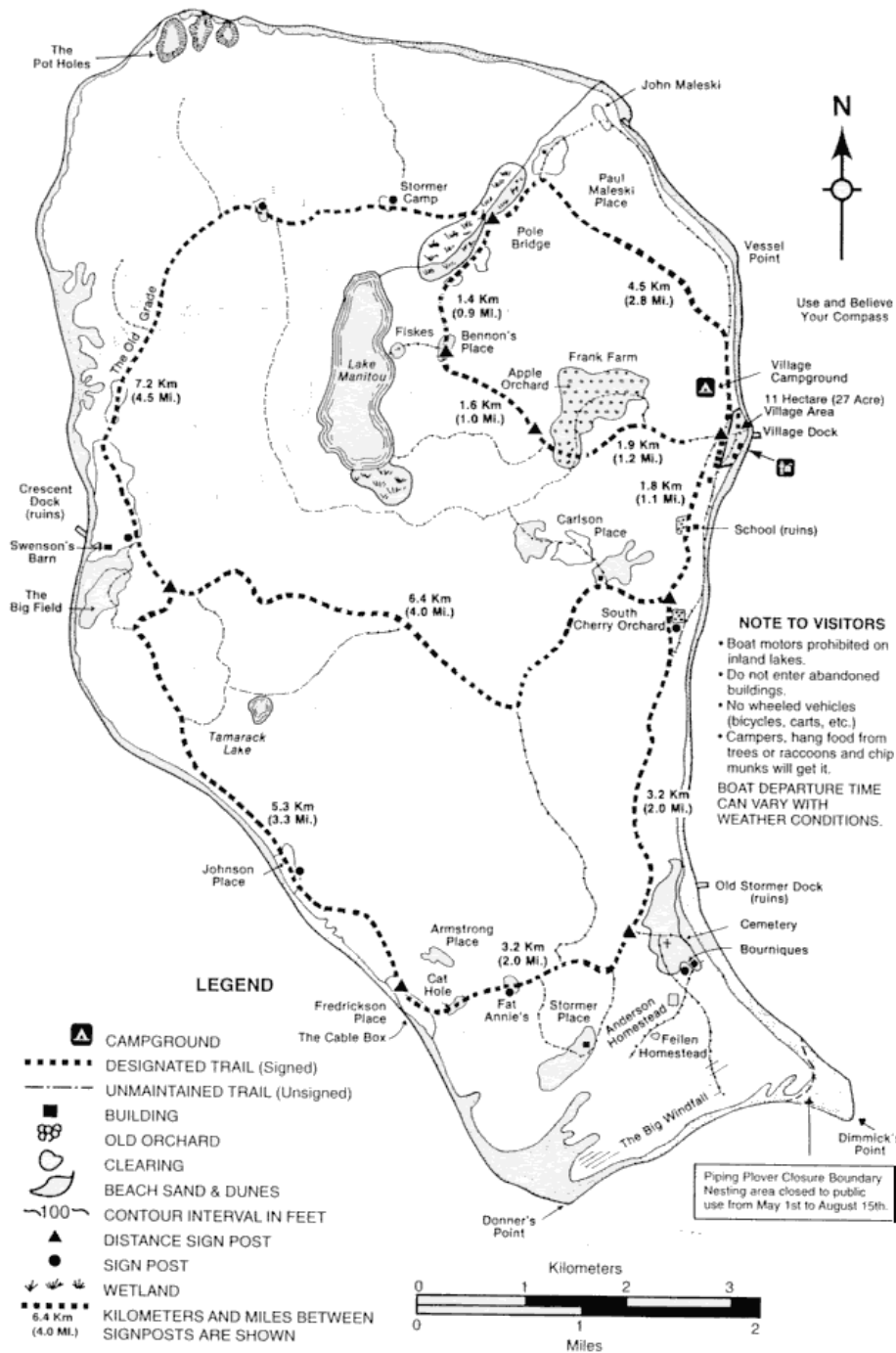


Figure 1. Map of North Manitou Island provided to visitors. Note the dock area and Village located in the northeast portion of the island. All other areas are managed as wilderness.

Current Lakeshore policy only requires the use of established campsites on North Manitou Island if staying near the Village Campground and allows “dispersed camping” in wilderness areas. The Village Campground has 6 individual sites and one group site, with 2 communal fire rings shared across the Campground. If campers want to stay elsewhere on the island, dispersed camping allows campers to find or create their own campsites, within some regulations. A camper-created site, hereafter campsite, must be 300’ from any water body, historical structure or other camp and 100’ from any main trail. Open campfires are not permitted anywhere except in the communal fire rings in the Village Campground. These regulations were established to protect the natural and cultural resources of the island while upholding the guidelines of the Wilderness Act of 1964. The act outlines the following four criteria necessary for wilderness areas:

1. “Appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable
2. Has outstanding opportunities for solitude or a primitive and unconfined type of recreation
3. Has at least five thousand acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition
4. May also contain ecological, geological, or other features of scientific, educational, scenic, or historical value (PL 88-577).”

In addition, the Lakeshore’s Superintendent’s Compendium provides regulations stipulating that a maximum of two tents and four people are allowed per campsite (Shultz 2010). Following these federal and Lakeshore criteria, the dispersed camping on North Manitou allows visitors to pursue their own type of camping experience in a fairly large wilderness area. By allowing visitors to choose their own campsites, they have the opportunity for a primitive camping experience in solitude, or with a small group of people. The lack of established campgrounds or campsites allows the area to appear more natural and “untrammelled by man”, as required by the Wilderness Act. North Manitou had dispersed camping even prior to Lakeshore establishment in 1972, and is the only National Park in the Great Lakes region that still does so.

Purpose and Need

To maintain this popular visitor opportunity while ensuring preservation of the natural and cultural resources of the island, the Lakeshore requested a camping impact assessment to be completed to inform future management

decisions. The purpose of this study is to address the following questions posed by management:

- Is dispersed camping causing degradation to the natural resources of the island?
- How many dispersed campsites are there and are there geographic areas where campsites are most dense?
- Are social trails excessive, causing degradation to perched dune bluffs or becoming unsafe for visitor use?
- If degradation to the natural resources is occurring, at what threshold do we decide to act and how do we best respond?

In order to answer these questions, an assessment instrument was created and implemented to measure impacts to natural resources in areas of camping and on trails of North Manitou Island. This assessment was designed to inform management of the current impacts, their level of severity, as well as provide management recommendations for focal areas of restoration/rehabilitation or fortification. Restoration is the process of removing human impacts on the landscape and returning the area to a more natural appearance and function, indistinguishable from unimpacted lands. Rehabilitation signifies a slightly less pure form of restoration. Recognizing that visitor use will continue and restoration to a most pure, natural state is unlikely, rehabilitation aims to work *towards* the ideas of restoration by removing signs of human impact and replacing natural vegetation and woody debris. For the purposes of this study, the two approaches will be considered equivalent and the terms interchangeable. Fortification with regard to campsites refers to the process of focusing visitor use on a site, thereby protecting the adjacent natural resources. This can be done by creating log boundaries for tent areas or benches, and adding log “steps” to uphill trails to mitigate erosion.

This project has two phases; phase one was completed during the summer of 2011 (Drekich 2011) and its details are covered in the methods and results sections of this report. Findings from phase one were also compiled into a report for an interdisciplinary team (IDT) of Lakeshore Management officials and contributed to the creation of restoration recommendations (Drekich 2011). A dispersed campsite monitoring plan was also created for Lakeshore use in the future (Drekich 2011). Phase two of the project, to be completed in 2012, utilizes research results from 2011 to implement restoration plans and possibly new regulations, based on management’s pending decisions.

Part of phase one of the project also involved compiling existing user data from within the Lakeshore to assess camping trends on North Manitou. Based on several years of data (2001, 2005, 2009, 2010) obtained from backcountry camping permits collected by the Lakeshore, North Manitou Island has an average of 3,248 backcountry campers per year and comprises roughly 44% of the park's total backcountry camping (Sleeping Bear Dunes 2011). Using the same data set, total user nights (number of people multiplied by the number of nights they stay) on North Manitou average 8,489 per year, or 51% of the backcountry user nights in the entire Lakeshore. July has the highest number of average user nights per month, with just over 2,000, followed by August with just over 1,900 average user nights (Figure 2a).

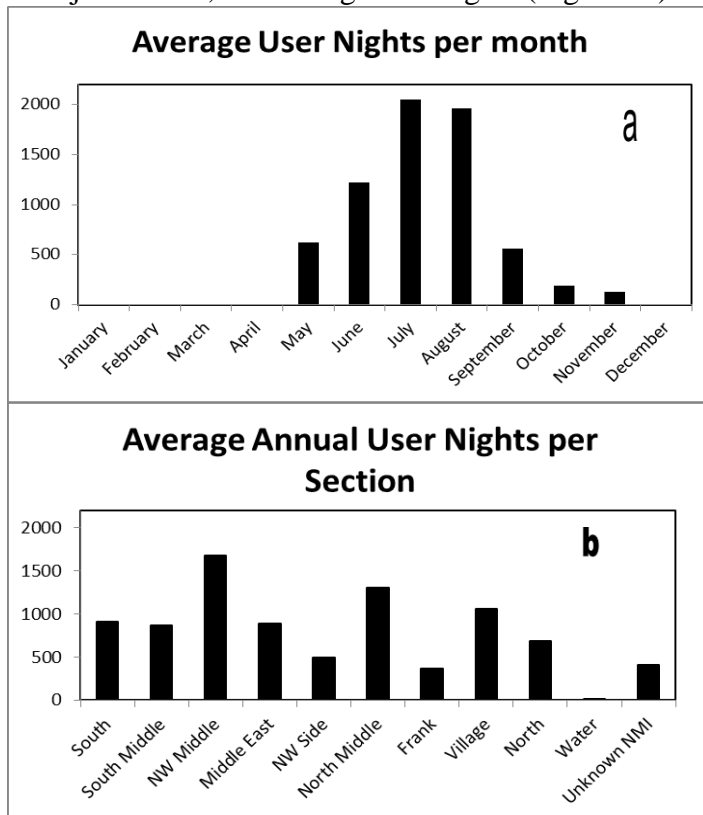


Figure 2. Distribution of camping on North Manitou Island by average user nights per month (fig. a above) and per section (fig b above). Average taken from 4 years of data (2001,2005,2009,2010). Sections on Figure b coordinate with map divisions in Figure 3. "Unknown NMI" are the permits that did not specify a camping location on the island or writing was illegible and "water" indicates those that stayed offshore on their boats (water n=11).

The island is divided into several sections for law enforcement purposes and visitors must indicate on their permits the sections in which they will be camping (Figure 3). Data on camping permits could differ from actual camper locations. Campers fill out their permits *before* embarking on their trip, and may not actually camp in the areas specified on their permit. In practice, the observations collected during this camping assessment, as well as a North Manitou camping report completed by law enforcement (Martin and Henry 1993) suggest that most visitors follow their permit itinerary.

Furthermore, popular locations have maintained their popularity over the last 20 years when comparing more recent data to Martin and Henry's (1993) study. Thus, over the years, campers have been attracted to many of the same places on the island. This has the potential to result in heavier impacts to the natural resources in such areas of concentration. Campers are known to prefer certain topography and soil types and a GIS study completed by Schultz (2007) predicts the Northwest Middle and North Middle sections as the most appropriate areas to camp based on these criteria. Personal observations and discussions with Lakeshore employees show that within these sections, the most heavily used and desirable camping locations on the island are along the west shore of the island in the Northwest Middle section and also along the east shores of Lake Manitou in the North Middle section (Figures 2a and 3).

Some of the most preferred campsites are also among the more sensitive habitats on the west shores of the island and around Lake Manitou inland. The west side of the island is composed of many high dune bluffs, protected as Critical Dunes in the state of Michigan. Around Lake Manitou in the center of the island, fragile vegetation of the hemlock forest has been trampled in places and soils compacted due to frequent camping and hiking. Campers in both of these popular areas have made many paths down the steep bluffs from their campsites to reach Lake Michigan or Lake Manitou. This can lead to severe erosion, loss of vegetation and potential safety hazards in the near future. Many of these trails converge at some point before reaching their destination, creating intersections where impacts are compounded.

The Village Campground (Figure 1), located approximately 0.25 miles north of the Village and ferry dock, has been used for decades and is the third most-popular camping place for many groups and visitors (Figure 2b). It has largely been an overnight staging point for those preparing to depart the island the next morning. It has also been well used by large groups that do not want to travel far from the Village (where there are outhouses, fresh drinking water

and fire rings). There are established campsites in this area and visitors are required to use the sites and facilities to minimize impacts. This campground is in an unattractive area that has become less desirable over the years with heavy use. Soils have become heavily compacted, sites have lost their vegetative cover, and the vault toilet has experienced heavy use. Naturally, visitors are setting up their camps increasingly further from the required locations to avoid these undesirable conditions, and are spreading their impacts outside of the campground boundaries.

Visitor density is an important factor to consider for wilderness management. The Village section of the island is also the area that has the highest visitor density (Figure 4). Though it is a fairly small section, the campground receives a high level of overnight visitor use. The Northwest Middle section has the 2nd highest visitor density, and much more acreage than the Village section. Based on overall visitation numbers, seasonal variation in visitation and visitor densities, managers can decide in the future if visitation should be limited by month or season, or if an overall visitor carrying capacity needs to be established. Assessment of impacts on natural resources is necessary to guide management decisions.

Prior to conducting the camping assessment, it was expected that major impacts from camping would include loss of vegetation, soil compaction related to proliferation of oversized campsites, and increased occurrences of litter and human waste (excrement and toilet paper). In addition to impacts around campsites, there was also concern that hiking and accessing campsites has negative impacts on natural resources. Throughout the island there are two types of trails, maintained trails and social trails. Maintained trails are the major trails crossing the island (generally old logging roads) that are actively maintained by the Lakeshore (Figure 1). Maintenance includes occasional clearing of large downed trees, erosion control, trimming of low-hanging branches, etc. Social trails are much smaller footpaths that are created by visitors repeatedly travelling in certain areas. These trails are not cleared by Lakeshore staff, and are meant to ebb and flow naturally as use changes over time. Many social trails connect maintained trails and popular camping areas. The concern with trails of this type is that social trails around campsites are becoming prolific and unnecessary and some may be causing dune bluff erosion on steep bluffs. Both trail types are discussed in this study.

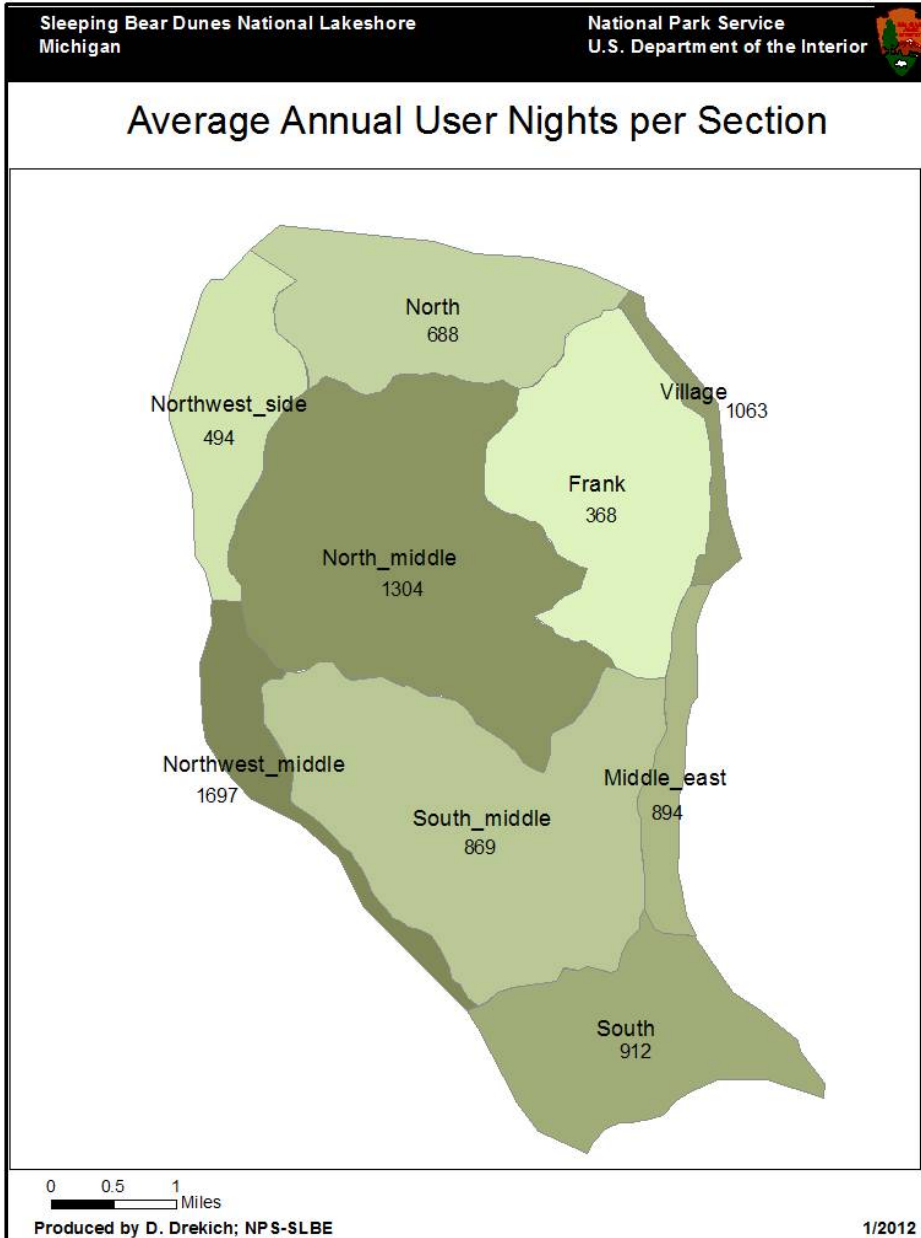


Figure 3. Section breakdown used for camping permits and the number of user nights per section gathered from backcountry camping permit data from years 2001,2005,2009,2010. Darker color indicates higher user nights. Data correspond to Figure 2b above.

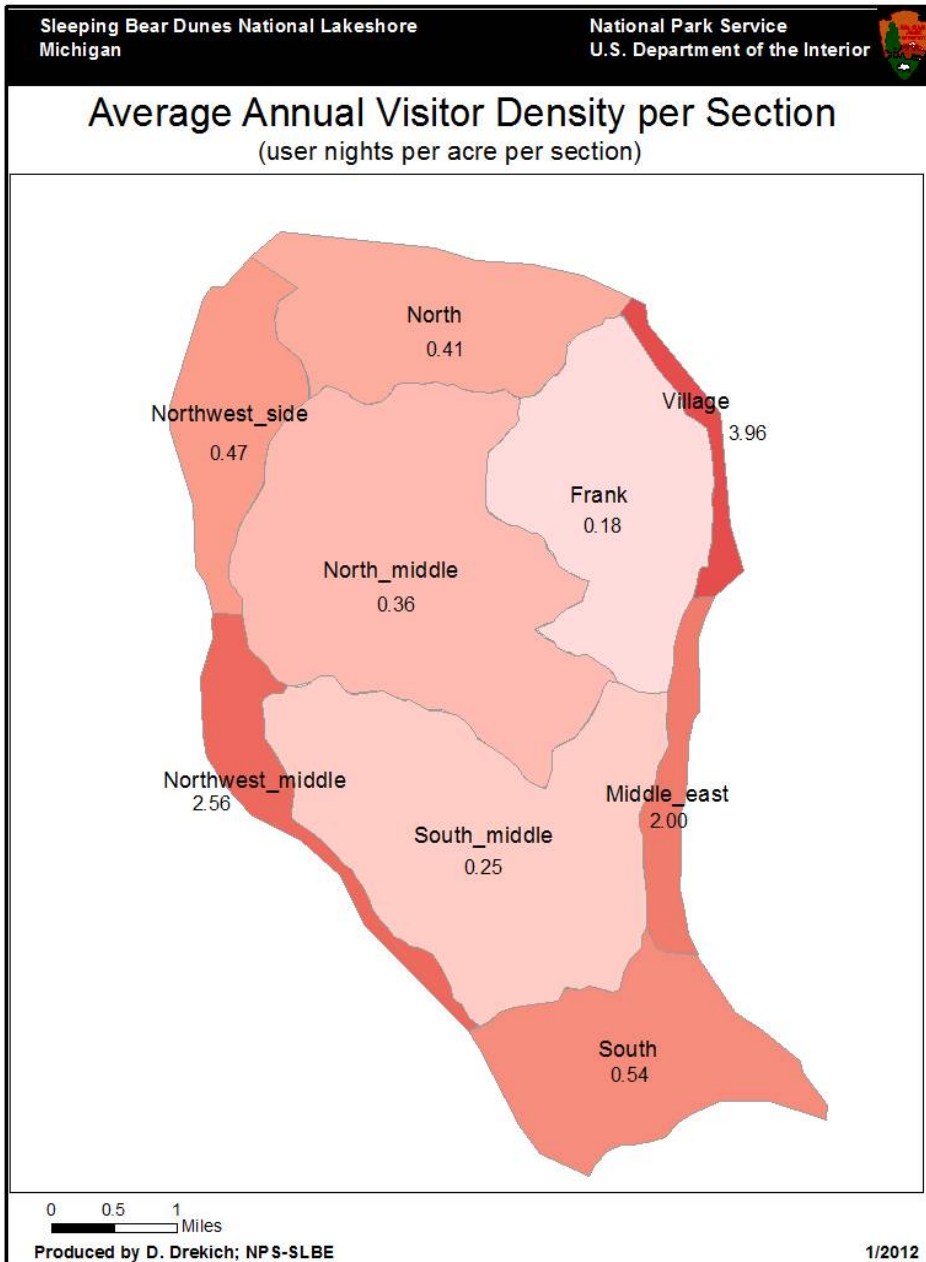


Figure 4. Average Annual Visitor density per section. Based on user nights per acre within sections. Data based on backcountry permit data for years 2001, 2004, 2009, 2010. Darker colors indicate higher density.

Methods

Preparation of methods

Prior to beginning the assessment, impact indicators and respective scales were established. The Lakeshore's General Management plan (GMP) was used in conjunction with a literature review and reports from other national parks to select assessment criteria (Table1).

Table 1. Informational resources used to develop campsite and trail assessment. Full citations listed in Literature cited section.

Type of information	Sources	Type of Source	Organization
Site monitoring protocol and methods	Julie Van Stappen, Julie Stumpf and others (2011)	Personal communications and General Management Plan, Apostle Islands National Lakeshore	Apostle Islands National Lakeshore
Site monitoring protocol and methods	Mark Romanski (2011)	Personal communication	Isle Royale National Park
Site monitoring protocol and methods	Mary Graves (2011) Jeff Benedict (1988)	Personal communication and "Lakecountry and Backcountry Site Management Plan"	Voyagers National Park
Vegetative recovery post heavy camping	Cole, D and C. Monz (2003)	Impacts of Camping on Vegetation: Response and Recovery Following Acute and Chronic Disturbance	Independent research
Effects of campsites on vegetation and soil; restoration methods	Marion, J and D. Cole (1996)	Spatial and Temporal Variation in Soil and Vegetation Impacts on Campsites	Independent research
Establishment of project methods	Landres et al (2008)	Keeping it wild: an interagency strategy to monitor trends in wilderness character across the National Wilderness Preservation	Rocky Mountain Research Station and U.S. Forest Service
Datasheet templates and tools for development of indicators	Wilderness.net A compilation of works (2011)	Toolboxes for wilderness campsite monitoring	University of Montana
Management recommendations for future campsite management	Stohlgren, T and D. Parsons (1986)	Vegetation and Soil Recovery in Wilderness Campsites Closed to Visitor Use	Independent research

Many existing parks or wilderness management plans have established *Limits of Acceptable Change* or *Minimally Accepted Conditions* (Cole and Hall 2009). *Limits of Acceptable Change*, LAC, are generally used to assess the social aspects of wilderness use by presenting visitors with various attributes to determine how important they are to the overall wilderness experience. This prioritized list of attributes (indicators) created from such data allows the managers to determine what amount of change in management is acceptable before visitor experience is negatively impacted (Cole and Hall 2009). For example, if visitors highly value solitude during their hike, then management could establish a LAC for “number of groups encountered while hiking exceeds ten groups”. If it becomes more common to meet or exceed the threshold of ten groups while hiking, managers would need to address visitor capacity in order to meet visitor desires and stay within the established LAC. Similarly, *Minimally Accepted Conditions*, MACs, are used as a threshold for conditions of natural resource indicators (Hendee and Dawson 2002). For example, a park regulation may stipulate that campsites be no larger than 200ft², thus setting a threshold of MAC for this indicator. If a campsite is found to be larger than 200ft², action is required to close or downsize the site.

Unfortunately, the Lakeshore has no LAC or MACs in place. This study serves to start their creation and test the feasibility of measuring such variables for specific LACs and MACs. Using resources listed in Table 1, indicators were chosen that seemed most suitable for this study (Table 2).

A baseline survey was created to assess these indicators with the expectation that they may be used for campsite monitoring in the future, or in the development of a wilderness management plan. All indicators are pertinent for natural resources protection as well as Lakeshore law enforcement officers, who hold the responsibility of resource *and* visitor protection. For example, trail erosion is both a natural resource and visitor safety concern. Both aspects are important to Lakeshore management in moving toward a future wilderness management plan.

Within this survey, percent cover classes (Table 3) were created to estimate ground vegetation, bare soil and leaf litter cover. As Marion and Cole (1996) observed in their studies, initial changes in impacts of camping are much more pronounced, compared to changes on sites that have long been used and impacted. For this reason, and for ease of visual estimation, the cover class categories span smaller value changes at the low-impact end of the scale.

Table 2. Indicators, measures and methods used to assess impacts of dispersed camping on North Manitou

	Indicator	Measure	Method
Campsites	Campsite size	Square footage	radial transect method for core and extent of campsite
	Soil compaction	kg/cm ²	penetrometer; average of at least 3 samples
	Vegetative cover	Percent cover	estimated using cover class categories for herbaceous, shrub and tree cover
	Bare soil	Percent cover	estimated using cover classes
	Leaf Litter	Percent cover	estimated using cover classes
	Tree Damage	Count (% of total)	tally trees felled, carved or damaged of total
	Root Damage	Count (% of total)	tally trees with exposed roots of total
	Human waste	Count	tally piles of toilet paper or feces
	Trash	Count	tally macro and micro trash
	Developments	Presence/absence	record benches, lean-tos, etc
	Fire Scars	Presence/absence	tally fire scars
	Proliferation of trails	Count	tally of each social trail corresponding with the site
Trails	Width	Feet	mean of at least 5 measurements along length of trail
	Depth/elevation (if rutted or raised above adjacent ground level)	Inches	mean of at least 5 measurements along length of trail
	Erosion	Categorical rating	categories based on type and level of erosion

Table 3. Cover classes and respective percent cover ranges used to assess vegetation, bare soil and leaf litter.

Cover class	% cover
1	0
2	1-5
3	6-25
4	26-50
5	51-75
6	76-100

Field data collection

In the field, data were collected on visitor-created campsites as well as adjacent, un-impacted areas, hereafter referred to as “control sites”. Due to the variability in habitat across the island, a control site was a necessary comparison for each campsite location to more accurately estimate the natural species abundance, vegetative cover etc. of each area. These control areas, generally 30’-60’ from the campsite, had to be comparable to the campsite in size, soil type, vegetation type and canopy cover to serve as a useful comparison to the campsite (Appendix A). The cover classes recorded for vegetative cover, leaf litter and bare soil occurring on the control site were considered to be the natural levels that should be present. The same measures were recorded for the campsite and compared with results from the control. Any difference in cover class from the control to the campsite was recorded as a “change in cover” or “loss of cover class” and was considered to be a result of human impact. Note that this is not a change over time, but merely a method of estimating the amount of change occurring on an impacted campsite compared to an un-impacted control area.

Campsites were located by starting from known popular camping areas and by following social trails from either the beach or an inland maintained trail. When a campsite was located, a GPS point was taken with the Trimble unit, a reference photograph was taken of the site and baseline vegetation data were collected on species presence and abundance. Social trails, signposts and fire scars were also mapped using a Trimble unit. Corresponding data were then collected for the control site. Indicators measured in the field were later used to calculate an overall impact rating, discussed below.

All plants within and on the edges of each campsite were identified to species level where possible (grasses and sedges identified to family level) and percent cover was estimated for each. Where applicable, species were also recorded as “undesirable” to identify those that were non-native, invasive or noxious to humans (e.g. poison ivy).

Campsite size was measured using a radial transect method (Appendix A). A measuring tape was affixed to the center-most point of the campsite, and radii were measured for at least four locations around the campsite. These measurements were then averaged. The average radius was used to calculate a square footage for the site (Appendix D). Core area was measured as the most disturbed, central, barren area of the campsite. Total camp area was the core area plus the outer edge including any places where vegetation had been trampled or disturbed.

Soil compaction data were collected as relative measurements using a penetrometer measuring the force in kg/cm^2 that was necessary to break the surface of the soil. A minimum of three randomly placed measurements were averaged for each campsite core or edge area and corresponding control site.

Indicators of tree damage, root damage, human waste, and trash were tallied as follows: tree and root damage were recorded as a percent of total trees, and trash was specified as micro or macro (Appendix D). Developments and fire scars were recorded as presence/absence. Developments consisted of benches, retaining walls, lean-tos, cooking pits or other camper-created additions to the natural campsite. Social trails were recorded as a count of these trails to and from each campsite. The condition of trails is evaluated separately using the Trail assessment methods. All these data also serve as detailed baseline information for future years of monitoring.

Rapid Assessment

To make future monitoring practical, a quick and understandable process was needed so that anyone could complete it without prior experience in campsite monitoring. Such a rapid assessment was designed to help management to more easily identify detrimental changes occurring. The rapid assessment monitoring protocol was created by converting the baseline protocol and form to a faster process using categorical ratings. (Appendix B). The basis of the assessment is still a comparison study of each campsite and a control site but instead of tallying or measuring each individual indicator, three categories, valued 1-3, are used to quickly identify level of impact for each indicator. These values, with 1 being minimally impacted and 3 being most heavily impacted, are then averaged for all the indicators at the site and the final product of this rapid assessment process is an overall Campsite Impact Rating for each campsite. For example, the vegetative cover class is determined on the campsite and on the control site, perhaps cover classes of 5 and 6

respectively. The difference in cover classes between the campsite and control site is calculated, in this case a loss of 1 cover class. Using the difference, an impact rating category is selected from the rapid assessment form for that level of difference; for this example, a change in one cover class is an impact rating of 2 for the indicator of vegetative cover class. Data from 2011 were reorganized to follow this format so as to be comparable with future monitoring results.

Different measures were required to evaluate trail condition. Tread width, cleared width, depth of trail and soil compaction were measured at a minimum of 5 random points along a trail and each indicator was averaged individually (Appendix C). Occasionally, depth of trail was negative when washouts had resulted in trail level being higher than surrounding ground level. Soil compaction was not collected if the trail was pure sand, due to limitations of sampling equipment. A six-point scale (0-5), rather than the 3 point scale used for other measures, was created to assess trail-related damage to bluffs because such damage is a major management concern. This scale accounts for steepness and levels of erosion, trampling or loss of vegetation and threats to visitor safety (Table 4). Maintained and social trails were both assessed using this method.

Table 4. Categorical assessment of sloped maintained and social trails based on impacts to natural resources and visitor safety.

Rating Category	0	1	2	3	4	5
Description Vegetation	No disturbance of vegetation	Very little to no evidence of human trampling	Decreased leaf litter/vegetation on trail	No leaf litter; Decreased vegetation around trail	Little to no vegetation on or around trail	possibility of windthrow trees from root exposure
Erosion	No evidence of erosion	Slope susceptible to erosion, but is firmly held by vegetation	slight signs of erosion, could be natural washouts	moderate evidence of erosion; gravel loosening, washouts evident at base of trail	Clear evidence of erosion. clay or roots becoming exposed, trail noticeably higher/lower than ground level	Blow out or large change in slope near or on trail.
Visitor Safety	No apparent risk	No apparent risk	No apparent risk	No apparent risk	Slight risk of slipping down slope; loose gravel	Possible threat to visitor safety.

Data Management

With these data, a master GIS map was created populated with attribute data to describe each campsite or trail. Using a template from Apostle Islands National Lakeshore, a Microsoft Access database was created to manage all data pertaining to campsites and trail monitoring. Reference photos were saved digitally at the Lakeshore and organized according to monitoring protocol (Appendix D). In the future, these photos will contribute to a photo-monitoring project for restoration sites.

Social Data

Visitors were documented by multiple natural resource crewmembers throughout the summer while conducting normal work duties on North Manitou Island. This documentation was an informal survey and included observations of visitor location, time and day of week that visitors were encountered, the number of people in the party and the activity of the visitors (e.g. hiking or fetching water). This information supplemented the campsite assessment, and attempted to determine if visitors were seen most often in areas of heavily impacted sites. The information can also be used in the future to determine when and why most visitors come in contact with each other, so that the Lakeshore can better understand instances that limit opportunities for solitude, as promoted by the Wilderness Act, and plan accordingly in a wilderness management plan.

In preparing the assessment methods, it became clear that some wilderness camping regulations were not clearly explained or established in the Lakeshore, particularly with respect to group camping. Currently, there are no camping regulations set out by the Superintendent's Compendium or otherwise that specify number of people or tents allowed per group, locations for group camping, or itinerary limits per group or permit. The only related regulations state that no more than 10 people are allowed per permit, and no more than 4 people or 2 tents are allowed per site in the campground. Large groups circumvent these regulations by purchasing more permits and all camping together. The existing limit on number of tents per site in the campground has been informally extrapolated so that one permit allows up to 10 people or 5 tents per site for group camping, though no actual regulation exists. Observational data were required to determine if groups were adhering to these informal stipulations.

Results

Campsites

A total of 116 campsites were located and mapped throughout the island (Figure 6). Of that total, indicator data were collected on 98 sites (some sites have a more complete data set than others). Some campsites were found to have smaller, lightly used adjacent sites referred to as satellite sites. Though GIS coordinates for those sites were mapped, indicator data were generally not collected, as there were minimal differences from their parent site or satellite sites were minimally impacted. Few data were collected on minimally impacted sites because it was difficult to determine if those areas were actually used as campsites. Time constraints prevented return visits to sites for additional data collection. Thus, only GIS mapping was conducted in some areas and no indicator data were collected.

Considering all 116 sites, 62% of them were found in the Northwest Middle section of the island and 22% of those were located around the Crescent dock area. The North Middle section had 18% of the campsites with a majority of them located on the east shore of Lake Manitou. The South section, in the field near Bourniques and the cemetery, contained 17% of the campsites. The remaining campsites were dispersed throughout the island. Approximately 22% of the sites were illegal because they were within 300' of water. The most densely used area was on the east shore in the South section, near the cemetery and Bourniques where there were $5.19e^{-5}$ sites per square foot. The second most densely used area was a field in the Northwest Middle section beginning at Crescent Dock south to Swenson's Barn ($2.85e^{-5}$ campsites per square foot). The east shore of Lake Manitou in the North Middle section was similar, with $1.19e^{-5}$ sites per square foot. (Appendix E). The locations of these dense camping areas are consistent with data gathered from backcountry permits that show the Northwest Middle and South sections are most heavily used sections per area, following the Village section.

The average total campsite area was nearly $1,000ft^2$ (radius of 18ft) and average size for campsite core was $497ft^2$ (radius of 13ft) (Figure 5). In the rapid assessment, these measures have an impact rating of 2, meaning that the total area of campsites and core areas have mid-level impact for both indicators. The largest site (AZ1) was located in the Middle East section under an oak grove on the east shore of the island near the south cherry orchard (Appendix E). It appears that vegetation is naturally sparse under these trees and soils are easily compacted. Large groups or hunting camps may be using this site. The area could easily accommodate far more than 5 tents, the informal maximum allowed per group.

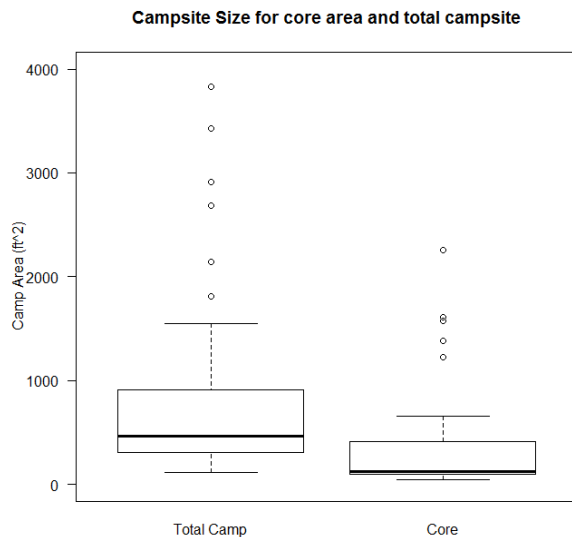


Figure 5. Raw data for Total Campsite and core campsite area (ft²). Lines within boxes designate the median value, and the whiskers show maximum and minimum values within a normal distribution. Additional points for each category were outliers and not graphed in the normal distribution. Additionally, the 4 highest outliers, 3 from total camp area and 1 from core area have been removed to more clearly display the rest of the data. Those values removed are 12,648ft², 10,346ft², and 7660ft² for the camp area and 5,805ft² for the core area.

The second largest campsite (site T) was 10,346ft² in total area (roughly 57ft radius) and is a semi-permanent base camp for a Sleeping Bear Dunes Piping Plover monitoring crew that stays on the island. The third largest site (site BM) measured 7,660 ft² (roughly 49ft radius), which was twice as large as site areas in the entire established campground in the Village (Appendix E). This site is located on the east shore of the island in the field near the cemetery and appears to be consistently used for a group campsite. Locations of these larger sites were important in recommendations for siting future campgrounds or group camping areas, to be discussed in the Recommendations section of this report. All other sites had a total size of 3,800ft² (35 ft radius) or less and the average total campsite area discounting the top three largest sites was 724ft² (radius 15ft).

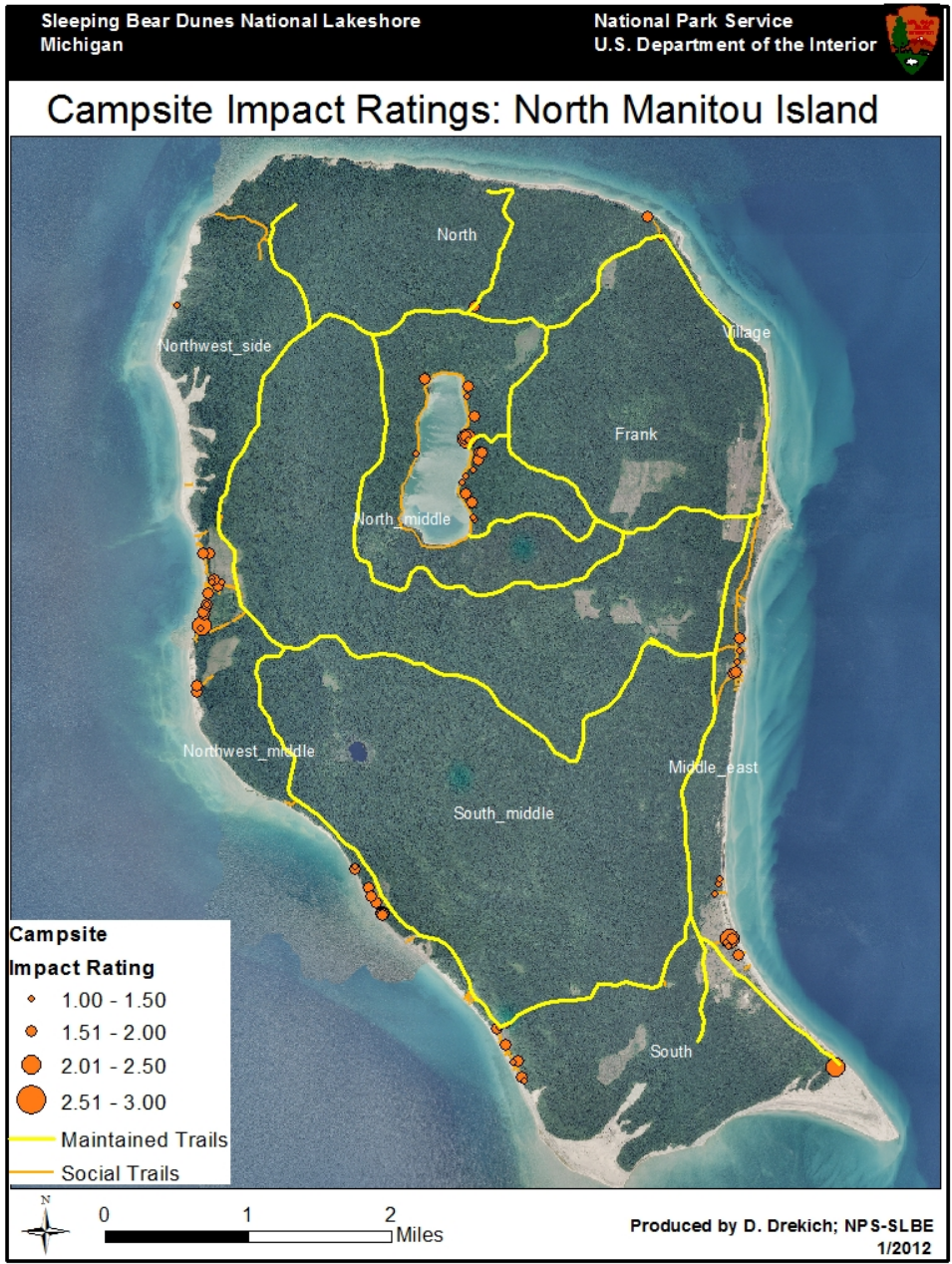


Figure 6. Locations of all campsites mapped and displayed by Impact Rating. Labels displayed denote section names and locations

A comparative analysis of soil compaction on campsites and control sites shows compaction an average of 2.6 times higher on campsites than on control sites. Soil compaction just at the edge of the campsite was on average 1.4 times less than in the center of the campsite. Increased levels of soil compaction could lead to decreases in vegetative cover as there is less pore space in the soil for existing roots to expand or new seeds to take root.

Percent cover showed variable results across indicators. Vegetative cover is the only indicator that shows little or no change between the campsite and control area. Thirty eight percent of sites maintained the same amount of vegetative cover as their control sites (Table 6). Another 51% of sites lost only one cover class, meaning the campsite had, at most, a 25% decrease in vegetative cover than the control site.

Bare soil shows more change across cover classes than vegetation or leaf litter, with 25% of sites having one cover class change, meaning up to 25% more bare soil than their control comparison. Four percent of sites had a difference of 5 cover classes, meaning that those campsites had up to 100% more bare soil than their control sites. Leaf litter showed similar results, with 17% of sites having up to 25% less leaf cover. Three percent of sites had up to 100% less leaf cover than the control site. Across all 3 of these indicators, an average of 29% of the sites sampled showed no change between campsite and control site cover categories, and 19% showed an overall change of three or more categories (up to a 50% decrease in coverage). Note that these three indicators are not mutually exclusive; there can be up to 100% leaf litter found under vegetation.

Table 6. Percentage of campsites that showed change in cover class for vegetative cover, bare soil or leaf litter when compared to their respective control sites. The category of Gains shows the % of campsites that gained coverage classes from 1-4 cover classes; no site gained 5 cover classes. Note that cover classes are not equal intervals, thus a change in one cover class could represent 1-5% coverage or 76-100% coverage (see Table 3). The n varies among indicators due to a lack of comparable sites from which to gather control data; those that did not have control data are not represented here. Vegetative cover data n=67, bare soil data n=78, leaf litter data n=74.

% of Sites with Changes in Cover Class Categories from control to campsite							
	Gains	No Change	Loss of 1 class	Loss of 2 classes	Loss of 3 classes	Loss of 4 classes	Loss of 5 classes
Vegetative Cover	5	38	51	7	0	0	0
Bare soil	7	17	25	22	17	8	4
Leaf Litter	7	33	17	14	14	10	3
Average ground cover changes across indicator classes	6	29	31	14	10	6	2

The column of Gains listed in Table 6 represents sites where the campsite scored higher than the control, meaning the campsite had higher coverage of vegetation and leaf litter, or less bare soil than the control site. These changes generally spanned one or two cover classes for vegetation and bare soil. Leaf litter had an increase of 3 and 4 categories at 1% of sites each.

Data collected on species and species occurrence show that there were fewer species on campsites than control sites (Table 7). The number of total possible species was calculated by combining the number of species found on the control site with any additional species found on the campsite. These data show that only about three-quarters of the number of herbs in the area are found on the campsite. Only 70% of possible shrub species were recorded on campsites. Camping had a slightly lesser impact on trees, with 79% of the total species in the area also occurring on campsites. This demonstrates that camping impacts species diversity and 20-30% of the species are being lost.

Table 7. Average number of species per site by plant type on campsite and control site. Percent of total possible species on site is the number of species on the campsite relative to the total number of individual species on the control + campsite.

Average # of Vegetative Species per site by cover type			
Vegetation Cover Type	Camp Site	Control Site	% of Total Possible Species On Site (control + camp)
Herbaceous	6.7	8.6	75.0
Shrub	2.2	3.0	69.6
Tree	2.9	3.4	79.4

Results related to decreases in vegetation, leaf litter and increased bare soil could have alternate social explanations. Campers could be choosing areas to set up camp intentionally because there are fewer species present that will be harmed. While the ecologically-minded camper may be aware of their impacts to species diversity, it seems more likely that campers are choosing sites for reasons related to comfort (e.g. ample room to set up camp, minimal slope and soil moisture, no stumps on ground, no shrubs or tree branches to cut out of the way, access to water, etc.). It may be that campers find areas of naturally minimal vegetation more desirable for campsites. Such choices may be represented in the data as “loss of vegetative cover” on campsites compared to control sites. However, as minimally vegetated areas will show more signs of impact, it is reasonable to interpret the results related to leaf litter, bare soil, and herbaceous cover as losses of cover due to human impact.

A majority of plants on both camp and control sites were found to be desirable species (Table 8). Undesirable species, those that are non-native, invasive or cause harm to humans (such as poison ivy), were more prevalent as herbaceous plants and a few more undesirable species were found on control sites than campsites. This could simply be because visitors avoided these areas with undesirable species, allowing these plants to persist in undisturbed forest. Trees and shrubs were generally desirable species on both types of site.

Table 8. Average percentages of desirable species by vegetation type for campsites and control sites

Vegetation Cover Type	Average % of Desirable Species	
	On Site	Control Site
Herbaceous	84.4	82.9
Shrub	96.9	96.5
Tree	99.4	99.4

Minimal impact was recorded for most other indicators. Mean percentages of tree and root damage were 16 and 19%, respectively. Human waste occurred on 8.5% of the sites. The most heavily impacted site in this category had 3 occurrences of human waste. Other indicators such as litter, developments and fire scars all had low occurrences. “Absence of Impact” was recorded for litter, developments and fires scars on 54, 55 and 86% of sites, respectively. In the litter category, most litter recorded was of the micro variety, generally only a few small bits of food wrappers. Developments were occasionally wooden benches from fallen tree limbs, but were most commonly recorded as rock cairns. These are stacks of beach stones brought into campsites by campers to indicate that they had camped there.

Impact ratings for each indicator category in the Rapid Assessment protocol were averaged for each campsite (Table 9). The mean campsite rating is 1.65 on a 3.0 scale, midway between “Good” and “Fair” condition. The campsite with the highest impact rating was campsite E, located in the Northwest Middle section just south of Swenson’s Barn on the ridge top (Appendix E), with an overall impact rating of 2.36. Among the individual indicators, camp area size, soil compaction, increase in bare soil, decrease in vegetation, presence of developments, litter and excess social trails at this campsite ranked at a 3. The second highest-ranking site is the Village Campground, which has heavy impacts in similar categories. Representative photos of highest impact ratings can be found in Appendix F.

Table 9. Impact Ratings for all campsites. n=77

Campsite Impact Rating	
Mean	1.62
highest ranked site	2.36
2 nd highest ranked site	2.27
Min	1.00

Trails and signage

Roughly 28% of campsites with trail data had 3 or more social trails and 22% of sites had at least 2 social trails. Results from trail condition assessments showed an average erosion impact rating of 3.3 out of 5. The most heavily impacted trails were social trails heading down steep sand bluffs on the west shore of the island (Appendix F). For example, a set of social trails in the Northwest Middle section near Johnson's Place scored a 5 due to a steep slope, washed out soil, collapsing ridge top and possibility of windthrow trees. This particular trail set was 1.5' higher than the natural bluff face in some areas, due to the amount of soil eroding from the top. Though this was an extreme case, other instances of bluff erosion and washout were recorded. Maintained trails across the center of the island generally exceed the regulations for maximum tread and cleared width.

Signposts located were either 4x4 wooden posts that had "No Camping" routed into the sides, or they were small green metal posts with a sign stating "This site is only X distance from water. Please move back to 300'." As they were mapped, data were also recorded on each post with regard to whether the post was no longer necessary. A total of 29 posts were located, and at least 7 were determined unnecessary. "No Camping" signs were deemed unnecessary if the area appeared unused and had naturally recovered well. Other signs were deemed unnecessary or in need of moving because they actually promoted social trailing as visitors from different directions were hiking over to read the sign.

Visitor Encounter Survey

Observation data were limited to areas where crewmembers were working, but the number of visitors observed and their locations on the island reflect the trend seen in the camping permit location data (Table 10 and Figure 3). Overall, 76% of visitors seen were hiking or gathering water. This indicates that many people were not seen while at camp, but rather out on the trails or on the beaches. Fifty six percent of the people were seen after 5:00PM, thus

people may have already set up camp and were exploring their camp area or replenishing water stores. It was also often observed that, while large groups may have been on separate permits, they all tended to camp very close to each other, exceeding the limits of 5 tents and 10 people per site. These groups often did not observe the “300’ from any other camper” rule with respect to those campers not part of their group. Law enforcement rangers have also shared that many of their contacts with visitors result from large groups not following proper regulations.

Table 10. Numbers and locations of visitors informally observed by natural resources crew. Locations correspond to Figure 3. Total observation events = 25, of parties from 1 to 20 people.

Location	# visitors observed
Northwest Middle	55
North Middle	27
Village	1
Northwest Side	2
Total	85

Discussion

Applicability of methods

Overall, indicators chosen proved applicable to actual conditions found on sites. Results of this study are comparable with results of other wilderness camping studies. Results from Stohlgren and Parson’s study (1986) in Sequoia Kings National Park showed that vegetative species diversity and coverage were lower in the central areas of campsites and showed higher levels of soil compaction than in peripheral, moderately-used areas. Similarly, results from a study by Marion and Cole (1996) showed that there were statistically significant differences in the vegetative cover, species distribution (particularly graminoids and forbs) and soil compaction on campsites compared to control sites. Although methods or data collection for the North Manitou study have potential uncertainties, as discussed below, they are commonly used measures in the field of wilderness camping assessment and yielded similar results. The success of the indicators used in this study to show impacts further demonstrate that they should be upheld for future campsite monitoring, via the rapid assessment.

A possible limitation to the methodology, is the locating of campsites. Campsites are dispersed throughout the island and thus the method of locating them is not foolproof. As a result, overall camping impacts may be

overestimated because campsites where visitors have practiced “Leave No Trace” principles would not be detected. Time constraints likely further overestimated impacts, preventing a full survey of every trail and stretch of shoreline.

Occasionally, some sites were not used in the comparison study due to a lack of comparable control site data; 9% of sites were missing vegetative cover data, 1% of sites were missing bare soil data, and 10% were missing soil compaction data. In these cases, there were no immediately adjacent areas of appropriate soil type, canopy cover, vegetation type, etc. to serve as a control site. This reflected the natural patchiness of habitat on the island, especially in edge areas where forest transitions to open dunes. This reduced the amount of overall campsite data that was available to use for quantitative comparisons of vegetation, bare soil and soil compaction data sets. Percent incomplete is not consistent across categories because, in other cases, time was short and data collection could not be completed or aspects of data collection were missed in the field. Campsites that were missing control site data spanned the entire observed range of conditions from low impact to highly impacted. Therefore, there is no indication that incomplete data for some sites affected the conclusions.

Patchy habitat is also an important factor when considering the results from the vegetative, leaf litter and bare soil coverages. As explained above, there were some instances in which the campsite had higher scores than the control with respect to these indicators. The natural patchiness of habitats could explain this variation that was observed in 4%, 6% and 6% for vegetative, bare soil and leaf litter data, respectively. In only one instance, the increase in vegetative cover was due to an increased presence of invasive species on the campsite versus the control site. On the other 3% of sites, increases in vegetation were due to an increase in native species, perhaps those which also thrive on disturbance.

In assessing trails, only those with a slope were given an impact rating. Though other impact measures were recorded on flat trails, they were not included in an overall impact rating for each trail. The Lakeshore may wish to adapt this portion of the assessment in the future to be more similar to the camping assessment, where several indicators are rated and averaged for an overall impact rating.

Maintained trails that were assessed as being too wide and clearance too high are not actually due to hiker impacts or extensive clearing, but rather are

recovering from their historic use as logging roads. Discussions with a Lakeshore Biologist and law enforcement personnel explained that they have been trying to reduce the trail clearing and allowing the saplings and other vegetation to fill them in naturally. However, due to the amount of soil compaction observed on trails, decompaction will likely be necessary for vegetation to reestablish itself along these old logging roads.

Rapid Assessment Protocol

Overall, the baseline assessment has provided for accurate and appropriate measures of camping impacts to natural resources on North Manitou and translates well into a rapid assessment without limiting the results. This will allow for cost- and time-effective future campsite monitoring. Although the rapid assessment will still under-represent the minimally impacted sites, those sites, by definition, will not likely be of major concern to management. It is hoped that this rapid assessment protocol will be used to monitor sites on a 5-year rotational cycle by law enforcement and natural resources staff within the Lakeshore when available (specifics yet to be determined by Lakeshore staff). If observations by law enforcement or other divisions show that new areas are becoming popular, they should be documented and added to the assessment for the next year of rapid assessment monitoring. Similarly, sites that show low use and decreasing impact could be removed from monitoring.

The Lakeshore may wish to adapt protocols in the future to account for individual indicators with “no impact”. The rapid assessment scale developed does not currently allow for separation of indicators that are minimally impacted as opposed to those that show zero impact. However, a category of “no impact” may be beneficial to more accurately assess each indicator, resulting in a more representative average for the overall campsite impact rating.

In future years, when a wilderness management plan is created, the indicators used in this study and monitoring protocols will likely need to be updated to reflect management priorities. The metrics used to assess each indicator may also need to be updated, if management chooses to use alternative measures. The Lakeshore should create Limits of Acceptable Change or Minimally Accepted Conditions in the wilderness management plan and these will solidify the metrics to be used for each indicator.

A Visitor Experience Survey has been created to help assess the aspects of a North Manitou camping experience that visitors value most (Dvorak 2012).

Pending approval of the Office of Budget and Management, this survey will be implemented in 2012 and the data it provides will be essential to helping the Lakeshore develop LACs or MACs. Pending management decisions, work will move forward with restoration, visitor education and continued data collection on North Manitou in 2012.

Recommendations; Process and next Steps

Based on the results of this study, initial recommendations were presented to a group of individuals representing all divisions in the Lakeshore, including the following:

- Tom Ulrich - Deputy Superintendent
- Dianne Flaugh – Environmental Compliance Officer
- Chris Johnson - Leelanau District Ranger
- Paul Chalup – Manitou Islands sub-district Ranger
- Amanda Brushaber - Biologist
- Steve Yancho – Chief of Natural Resources
- Dennis Steele – Manitou Islands maintenance supervisor
- Lisa Myers – Chief of Interpretation & Fees.

Individuals asked to participate were either partners in the project or were a logical representative of North Manitou for their division. After recommendations were presented, this group discussed each recommendation, feasibility of implementation and further related ideas to recommend to management.

Recommendations were divided into four components covering campsites and trail maintenance, visitor education, Village Campground management and future data needs. During the initial presentation and meeting with the Lakeshore staff above, existing wilderness camping regulations and policies were discussed as an option for change. Regardless of which recommended component is chosen, the related regulations (or regulation changes) must be clear and enforceable. Two aspects were of particular interest; the “300’ from water” regulation and establishing more stringent group camping regulations.

The main question regarding “the 300’ rule” was to determine the basis of the rule and thus make it more easily enforceable. The rule has been in place for decades and it was a bit unclear why the distance was originally set at 300’. Some thought that it was a conservative distance to protect all water resources from contamination via camper latrines and cooking waste. The other school of thought related to more social aspects, and that 300’ from water generally

put campers inside the treeline and out of plain view from the beach and other campers. Regardless of the reason, discussions focused on relaxing the “300’ from water” rule in specific places or all around the island to “200 from water” to allow people to continue to utilize popular (currently illegal) areas. Although this change would alleviate enforcement issues and coincide with Leave No Trace camping ethics, it would not be consistent with goals to preserve the environmental or social aspects of wilderness.

Similarly, regulations need to be clearly established to mitigate problems related to group camping. Currently, large group camps tend to violate the Lakeshore’s wilderness camping regulations and the goals of wilderness as established by the Wilderness Act. There are no camping regulations established by the Superintendent’s Compendium or otherwise that specify number of people or tents allowed per group, locations for camping, itinerary limits per group or permit. In addition to clarifying these rules directly for group camping, specific areas of the island, preferably those that are not easily impacted could be designated for large group camping (Appendix H). These areas may be left in their natural state as a “sacrificial areas” similar to the Village Campground, or they could be fortified and include hardened tent pads to withstand use. Additionally, separate group itineraries could be required for each permit within the group, so that the entire group does not have such a large impact on one place.

These changes should also be more easily enforceable by the limited staff on the island.

The undesirable state of the Village Campground was another point of discussion and a good example of how heavy camping can impact the resources. Alternative locations for a new or future campground (as a replacement to the existing one) were also discussed to allow management alternative solutions to a currently undesirable visitor experience. These are discussed below.

The final recommendations from this group are compiled below and have been provided to an Interdisciplinary Team for review. This team includes the Deputy Superintendent, Chief environmental compliance officer, Chief of maintenance, and representatives from law enforcement and natural resources divisions at the Lakeshore. Decisions are still pending with respect to Lakeshore action on recommendations. (see Appendix G for flow charts outlining the recommended options):

Component 1 - Campsite and Social Trail Rehabilitation

Several options have been discussed over the past year and are outlined below. The three options are all viable; however, exact work to be completed cannot be identified until an option is decided upon. **We ask that the IDT reviews the three options and recommends an option to Management.** The project working group recommends option 2.

Option 1: Heavily used sites and social trails within 300' of water be fully restored, popular legal sites be downsized and fortified to withstand increased visitor use and accommodate no more than five tents (group camping), in keeping with our current regulations. Approximately 6,180 feet of trail will be reinforced where necessary and 4,450 feet will be rehabilitated. Approximately 60-70 sites (as a high-end estimate) will be rehabilitated. Tent pads will be installed in the Village Campground. Unneeded "No Camping" posts and signs will be removed or relocated as necessary. Monitoring of the most popular sites would occur on a five-year rotation. See Option 1 flowchart in Appendix G.

Restoration of campsites and trails would proceed as described in Appendix G.

Option 2: All heavily used campsites that are within 300' of water be fully restored except for approximately nine illegal sites near Crescent which will be left open for further data collection. Visitors using these sites will be asked to move or a citation issued if they are found camping in these sites, per current regulations. These sites will be visited frequently throughout the summer by an intern and data will be compiled on the usage of these sites. All other proposed work would remain the same as in Option 1. See Option 2 flowchart in Appendix G.

After island closing, these data will be analyzed and presented to management with a recommendation to either rehab the sites or harden and designate them as marked legal sites within 300' of water. At this time, consideration could again be given to reducing the illegal camping zone to 200'. Other considerations may include designating a campground, group campsite, or designate the illegal sites as "day use" sites.

Restoration of campsites and trails would proceed as described in Appendix G. Of the nine illegal sites, the less desirable satellite sites and excess trails would be blocked and restored.

Option 3: Change the Compendium to exclude camping within 200' of water. Allow campsites between 200-300' from water to persist and restore any that are less desirable or within 200' of the water. This option is aligned with Leave No Trace ethics and materials. However, with the current 300' regulation, campers have typically remained at least 200' from water so a reduction to 200' may encourage campers to camp closer to water than they do now. Law Enforcement has also worked diligently over the years to educate about and enforce the 300' regulation and the public have begun to anticipate and comply with the 300' distance upon arrival to the island. All other proposed work would remain the same as proposed in Option 1.

Roughly 30 campsites are located on the shorelines at a distance of 200'-300' from water, approximately 9 of which appear to be frequently used. Some of these campsites are only moderately impacted and are not visible from shore. Others are heavily impacted and are obviously visible from shore. Those sites that are most obvious from shore or less desirable could be restored, leaving the others available for use. During the 2012 season, data can be collected regarding frequency of use on sites that are not restored, to determine if they *should* be restored in the future. See Option 3 flowchart in Appendix G.

Restoration of campsites and trails would proceed as described in Appendix G.

Component 2 - Improving Visitor Education:

More information will be made available to visitors regarding "Leave No Trace" camping ethics via the Lakeshore's website, check-in station in Leland and orientation building on the island. On the island, trowels and Biffy Bags will be available to visitors upon request to help address waste management issues for those that arrive unprepared. Two Interpretive staff members have been funded to perform the proposed work.

Further updates to the website and educational materials would be coordinated with the Media Specialist and will include the following:

- additional or re-organization of links to increase ease in finding important information
- more detail on wilderness areas, its purpose, and how/why wilderness should be used and preserved on North Manitou Island
- listing of all regulations for North Manitou Island, not just a few
- a suggested packing list to promote well-prepared visitors
- updates to village campground information
- specific rules and recommendations for group camping
- Investigate the creation of a reservation system that requires each visitor to check a box stating that they have read and accept the camping regulations laid out for North Manitou Island. (This will not require a specific campsite reservation, only that a permit holder designates that he/she has a set number of people coming on a set number of days and they understand the rules of the island). This will also aid law enforcement in anticipating how many people will be on the island each day.
- Additional photos of the island and a topographical map
- Announcements regarding current work on the island.

We will work with Manitou Island Transit (MIT) to display Leave No Trace materials in the office shared with the NPS Visitor Use Assistant in Leland and propose MIT consider selling some of these products in their shop. MIT will also be approached about altering specific faulty links on their website to reconnect directly to the North or South Manitou Island pages on the SLBE website. This will help to make visitors aware of the rules and regulations allowing them to properly prepare prior to their arrival. Similar suggestions could also be made to the owners of the website NorthManitou.com

The uniformed Interpreters will frequently make themselves available to the public in Leland and on the ferries (pending MIT approval) to answer questions about the Manitou Islands and educate the public on the above topics. Law Enforcement provides an orientation that includes important and necessary information on safety and regulations. After providing the public with this information there is little time left to provide information specific to this project and park resources. The public typically loses their attention span after about a half hour. The Interpreters would

help to better inform visitors prior to arrival on the islands alleviating the LE Rangers from needing to expand the required orientation.

Component 3 – Village Campground Establishment and Tent Pad Construction:

Upon Management request, several Village Campground relocation options have been analyzed. Factors considered in selecting alternative locations included terrain, access to Lake Michigan, current dispersed camping impacts, proximity to the Village/potable water/bathroom facilities, Compendium and CFR regulations, and forest canopy. **We ask that the IDT review the Village Campground Alternatives and provide a decision to either build the tent pads in an area that will be targeted for relocating the Village Campground or to leave the Village Campground in the current location. If the Village Campground is left at its current location, updates need to be made to the tent pads and outhouse facilities to encourage desired use (outlined below).** Attachment 2 provides both a map of the alternatives along with the pros and cons identified for each alternative. If a new location is selected then the project lead will draft a campsite layout in the early summer for Management to review. Tent pad construction will begin in early August.

Component 4 - Data Collection: A visitor use survey for North Manitou will be created and implemented in conjunction with researcher Bob Dvorak of Central Michigan University. He will be compiling surveys for use elsewhere in the Park and will assist SLBE with facilitation of the survey approval process through the Office of Budget and Management. This survey will assess visitor use, preference and experience, and will aid in planning efforts for a future wilderness management plan and visitor use capacity issues. It will be available for visitors in the North Manitou Village while they are awaiting ferry arrival for their departure.

Further data will be collected on sites that are not restored to determine how frequently they are used, how many people use them and for how long, which times of the season are most popular and other information is deemed useful in determining how to manage these sites and the island as a whole.

4) Tree Damage:	felled	lower branches broken	cuttings/carving	exposed roots
# of trees with each:	_____	_____	_____	_____
% of trees with each:	_____	_____	_____	_____
5) Soils				
Barren core area (ft ²)	_____		_____	
Area disturbed (ft ²)	_____	Bare soil Cover class? _____	Bare soil Cover class? _____	
Penetration resistance (kg/cm ²)	bare area _____	outer edge _____	bare area _____	outer edge _____
Core collected?	yes/no _____	wet weight _____	yes/no _____	wet weight _____
Label?	_____	dry weight _____	_____	dry weight _____
Number of connecting trails	_____	Directions? _____	Corresponding trail data sheet? _____	
6) Waste				
Human waste present? # of sites?	_____		_____	
Macro-Litter present? Type? <small>(lg wrappers/trash)</small>	_____		_____	
Micro-Litter present? <small>(crushed small bits)</small>	_____		_____	
7) Other				
Fire scar/benches present?	_____			
Invasive Plants present?	_____			
Cultural Resources present?	_____			
Distance from water?	1-river/stream, 2-lake, 3-spring, 4-other _____			
Distance to nearest camp?	_____	Visible? _____	# of other sites visible _____	
Distance from trail?	_____ Distance from trailhead? _____			
Photo Image #	_____			
8) Useful materials nearby for restoration?				
EX: logs for benches or trail blocks, seed sources, tree/shrub samplings, sunny vs. shady spot, leaf litter depth				

Notes:				
potential for conversion to designated site? _____				

9) Total Impact Level:				

Appendix B: Rapid Assessment Form

GENERAL SITE DESCRIPTION

- 1) Campsite Name : _____ Original Date logged: _____ Date: _____ Collected by: _____
- 2) UTM coordinates: _____ E _____ N
- 3) Rehabed site? (describe state of rehab in Comments section) Yes / no
- 4) Forest Type: 1-closed forest, 2-open forest, 3-nonforested and densely vegetated, 4-non-forested and sparsely vegetated
- 5) Barren core area (ft²) _____
- 6) Area disturbed (ft²) _____
- 7) Invasive Plants present? _____
- 8) Dominant tree types Present? _____
- _____ Bare Ground _____ Leaf litter _____ Grasses/sedges _____ Forbs/flowers _____ Shrubs
- 9) Cultural Resources present? _____
- 10) Distance from water? _____
- 11) Distance to nearest camp? _____ Visible? _____ other sites visible _____
- 12) At least 100' from maintained trail? _____
- 13) Photo Image # (taken from most obvious entrance facing into campsite) _____

IMPACT EVALUATION

Data Collection on Campsite			Data Collection in nearby Unimpacted Area			Category Impact Rating (do in office)
14) Vegetation Cover: 1 - 0% 2 - 1-5% 3 - 6-25% 4 - 26-50% 5 - 51-75% 6 - 76-100%			must be similar in species composition to campsite area 1 - 0% 2 - 1-5% 3 - 6-25% 4 - 26-50% 5 - 51-75% 6 - 76-100%			
15) Bare Soil Exposure: 1 - 0% 2 - 1-5% 3 - 6-25% 4 - 26-50% 5 - 51-75% 6 - 76-100%			1 - 0% 2 - 1-5% 3 - 6-25% 4 - 26-50% 5 - 51-75% 6 - 76-100%			
Indicators	Rating (circle one category)					
	1	2	3			
16) Vegetation change:	(No difference in coverage)	(Difference of one coverage class)	(Difference of 2 or more coverage classes)			
17) Bare Soil Change:	(No difference in coverage)	(Difference one coverage class)	(Difference 2 or more coverage classes)			

18) Tree Damage:				
# of trees scarred or broken: _____	(None)	(<50% with scars or presence of broken lower branches)	(>50% scarred or presence of felled trees)	
% of trees scarred or broken: _____ (est.)				
19) Root Exposure:				
# of trees w/exposed roots: _____	(None)	(<50% of trees with roots exposed)	(>50% trees with roots exposed)	
% of trees w/exposed roots: _____ (est.)				
20) Cleanliness:				
Litter	(None)	(Micro litter present)	(Macro litter present)	
Human waste, TP present	(None)	(1 occurrence of TP or poorly covered hole)	(>1 occurrence of TP or waste)	
Campsite luxury developments:	(None)	(Primitive log seat or rock piles)	(Multiple seats, lean-tos)	
# of Fire scars _____	(None)	(Remnants of charcoal)	(Ashes/fire ring/cook area clearly present)	
21) Trails:				
# of trails Toward beach? _____	(No more than one discernable trail)	(2-3 discernable, max 1 well-worn)	(>3 discernable or >1 well-worn)	
# of trails heading inland? _____				
22) Soil compaction				
on site: _____ avg	difference between on and off site averages is < 0.5	diff between on and off site averages between 0.5 and 1.0	difference between on and off site averages is >1.0	
offsite: _____				
23) Barren Core Camp Area:	(<50ft ²)	(50-500ft ²)	(>500ft ²)	25) Impact Rating:
24) Camp Area:	(<500ft ²)	(500-2000ft ²)	(>2000ft ²)	
Notes: Details about location of site, impacts, potential impacts, management suggestions; reference numbered items above				

Appendix C: Trail Assessment Form

Maintained or Social Trail?				Set of trails? _____			
Coinciding with campsite?		_____				Average	
Tread width (cm)		_____		_____		_____	
Cleared width (cm)		_____		_____		_____	
Slope		_____		_____		_____	
Soil composition		% sand	_____	gravel	_____	cobble	_____
Soil composition						boulder	_____
Soil composition						mineral soil	_____
Erosion present							
Rating Category	0	1	2	3	4	5	
Description Vegetation	No disturbance of vegetation	Very little to no evidence of human trampling	Decreased leaf litter/vegetation on trail	No leaf litter; Decreased vegetation around trail	Little to no vegetation on or around trail	possibility of windthrow trees from root exposure	
Erosion	No evidence of erosion	Slope susceptible to erosion, but is firmly held by vegetation	slight signs of erosion, could be natural washouts	moderate evidence of erosion; gravel loosening, washouts evident at base of trail	Clear evidence of erosion. clay or roots becoming exposed, trail noticeably higher/lower than ground level	Blow out or large change in slope near or on trail.	
Visitor Safety	No apparent risk	No apparent risk	No apparent risk	No apparent risk	Slight risk of slipping down slope; loose gravel	Possible threat to visitor safety.	
Tree roots exposed (cm)		_____		_____		_____	
Soils		Data Collection on Trail		Data Collection off trail			
Leaf litter present?		yes/no	depth(cm) _____	Leaf litter present?		yes/no	depth(cm) _____
Penetration resistance (kg/cm ²)		_____		_____		_____	
Number of connecting trails (tally while walking whole trail)		_____		_____		_____	
Useful materials nearby for restoration?							
EX: logs for benches or trail blocks, seed sources, tree/shrub samplings, sunny vs. shady spot							

Appendix D: Monitoring Protocols for Wilderness Campsites

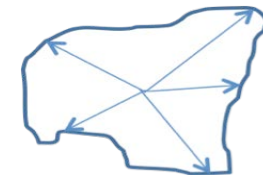
North Manitou Island Wilderness Campsite Monitoring

Monitoring of all campsites on North Manitou must take place on every 5th year, beginning in 2012. During a monitoring year, an inventory of new and previously documented campsites can be initiated and completed at any time throughout the summer season. Data should be entered into the corresponding database and analyzed the following winter. Results should be compiled into a summary report to help inform management actions in wilderness areas. When the Lakeshore develops Limits of Acceptable Change (LAC) for wilderness areas, the values for indicators used in this monitoring procedure may need to be changed to correspond with new requirements.

Monitoring forms are saved on the Natural Resources internal drive.

Fill in the appropriate blank line or circle appropriate option for each item. Items 1-4 can be obtained from previous inventories before going out into the field.

1. Previously designated Campsite Letter/code or continuation of coding system
2. List coordinates in UTM if Trimble unit not used to track sites
3. Were sites closed off and actively restored to natural conditions?
4. Circle the Forest Type that best describes the area; this will help with re-location purposes and
 - *Closed forest*=solid canopy cover; *Open Forest*= open sky mixed with some canopy cover, or could apply to forest edge; *Non-forested, densely vegetated*=solid ground cover vegetation or old orchard with many small trees; *Non-forested, sparsely vegetated* = minimal shrubs or ground vegetation, mostly leaf litter
5. Measure the area of bare mineral soil using a radial transect method
 - Place or staple on end of tape in center of site
 - Measure to outer edge of bare soil in at least 4 directions randomly, recording lengths
 - Average those measurements and calculate site area using this average as your radius ($A=\pi r^2$)
6. Judge edge of total campsite area by changes in disturbed vegetation and leaf litter or forest cover
 - Repeat methods from Step 5, measuring to outer edge of disturbed area on site



7. List any invasive plant species present (see attached list for assistance)
8. List dominant tree species. Is ground cover dominated by forbs, grasses, other?
9. Any sign of cultural resources being unearthed?
10. Estimated distance in ft from water? Circle water source
11. Distance to nearest camp in ft (can obtain from GIS data in office if difficult to measure)
12. Distance in ft to last maintained trail and trailhead
13. # of maintained or social trails possibly used by this campsite
14. No permanent marker will be placed at campsites for photo monitoring. Choose the eastern most point of the disturbed area, face due west and take the photo. Previous year's photos could be used for appropriate line-up. Track the image number from the camera in this space. Photos should be downloaded and named by "campsite_year" and saved. Notes on each photo can be added under "Properties" when right-clicking the photo.
15. Circle a cover class for total vegetation in the campsite area and a nearby unimpacted area-should be similar in slope, soil type, species composition and canopy cover
16. Circle a cover class for total bare soil in the campsite area and a nearby unimpacted area-should be similar in slope, soil type, species composition and canopy cover
17. Circle appropriate categories to compare veg cover in and outside of campsite
18. Circle appropriate categories to compare bare soil in and outside of campsite
- 19.-25 Circle appropriate categories
26. Write ratings for each category in right hand column and total to find campsite impact index

Supplies needed:

- Loggers tape, 200'
- Compass
- Clipboard
- Pens/pencils
- Campsite monitoring data sheets (some printed on Write-in-the-Rain) and protocol
- NMI map and maps printed with high use camp areas mapped out
- Plant ID book
- Previous years photos and site notes for comparison and relocation
- Trail monitoring datasheets
- Camera
- Flagging and 2 landscape staples
- Trimble with the following existing layers added:
 - NMI_overuse_camps
 - NMI_social_trails
 - NMI_fire_scars
 - NMI_LE_posts
- Penetrometer

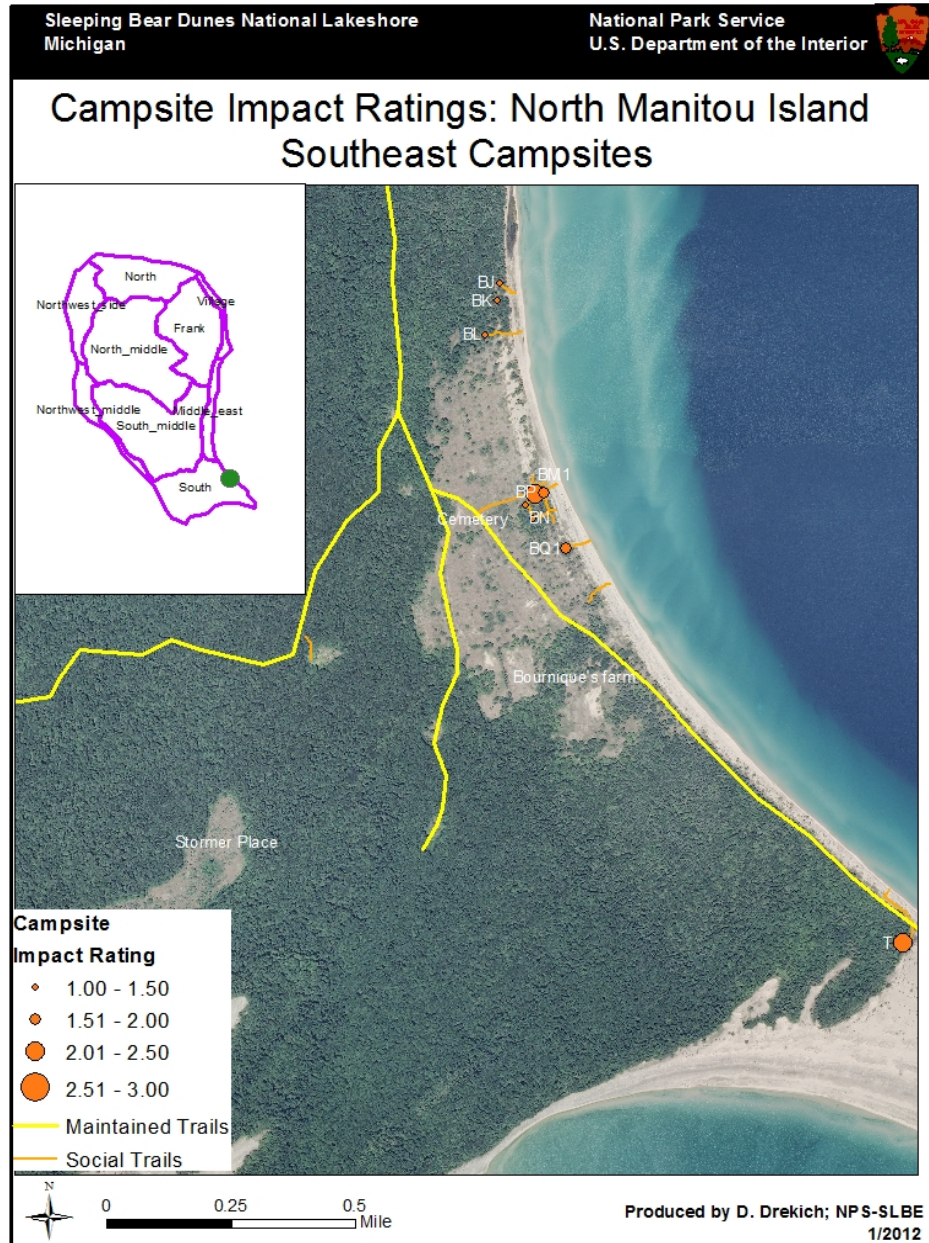
Optional gear dependent on sampling:

- Hanging scale
- Soil core
- Soil sample bags
- Clinometer
- Sharpee

Camp Gear:

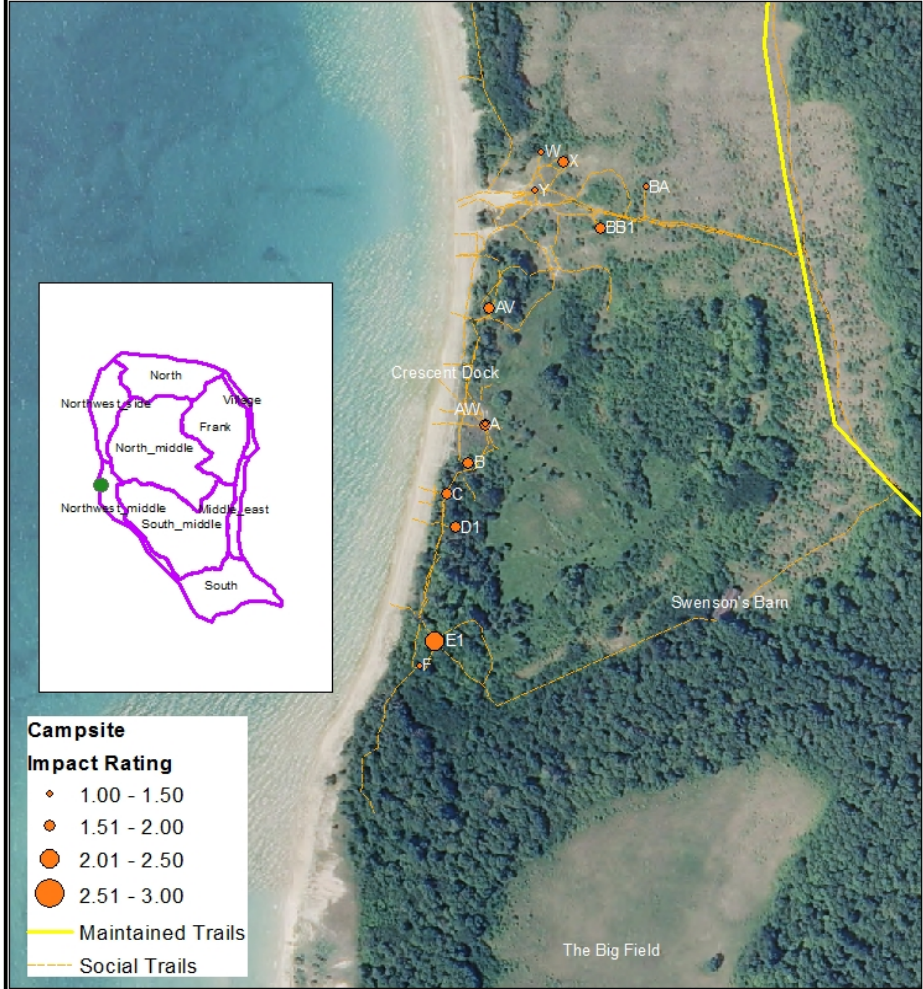
- Tent
- Sleeping Bag
- Sleeping Pad
- Water Filter and water bottles
- Cook stove and fuel
- Pot, spork, cup, sponge, soap
- Food
- Trowel and TP
- headlamp

Appendix E: Large scale maps of high-use areas. Alphanumeric codes near campsites display naming convention of campsites to be used by the Lakeshore to help interpret results and locations referenced.





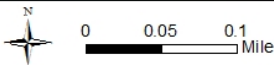
Campsite Impact Ratings: North Manitou Island West Side Campsites



Campsite Impact Rating

- ◆ 1.00 - 1.50
- 1.51 - 2.00
- 2.01 - 2.50
- 2.51 - 3.00

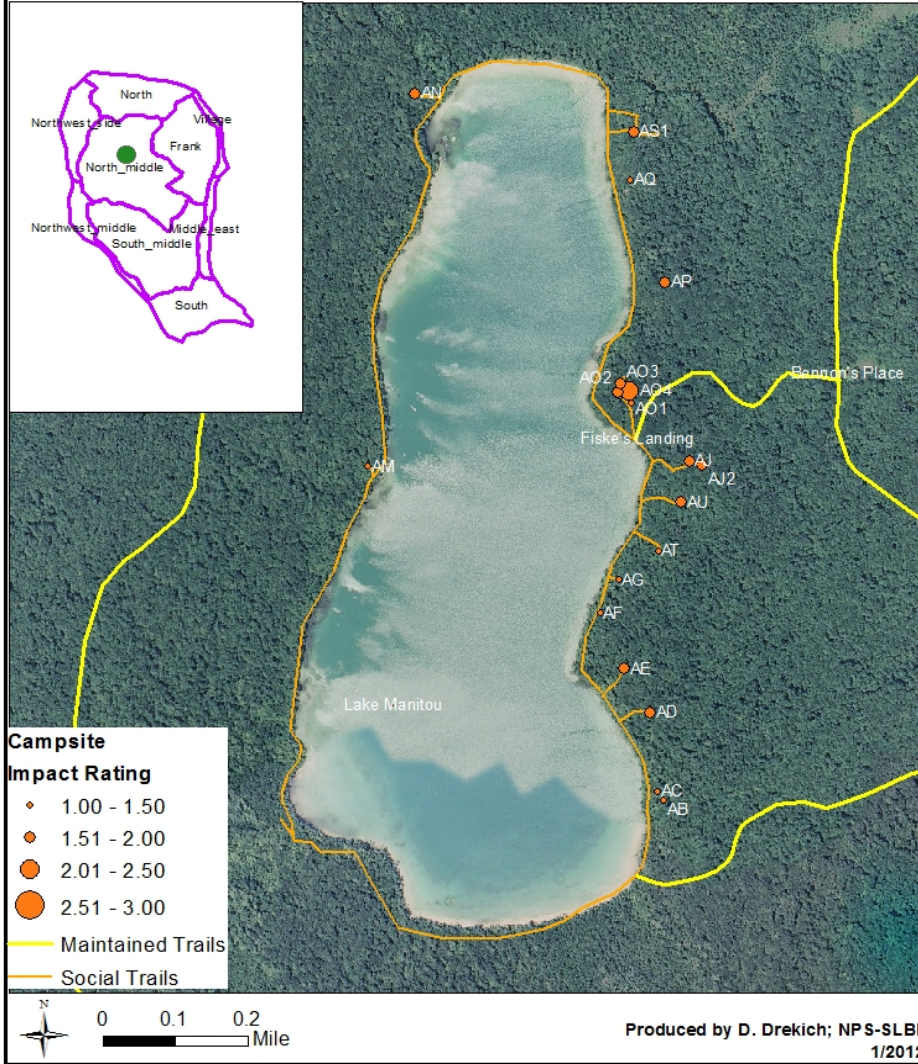
— Maintained Trails
— Social Trails



Produced by D. Drelich; NPS-SLBE
1/2012



Campsite Impact Ratings: North Manitou Island Lake Manitou Campsites



Appendix F: Example photos of heavily impacted campsites and trails



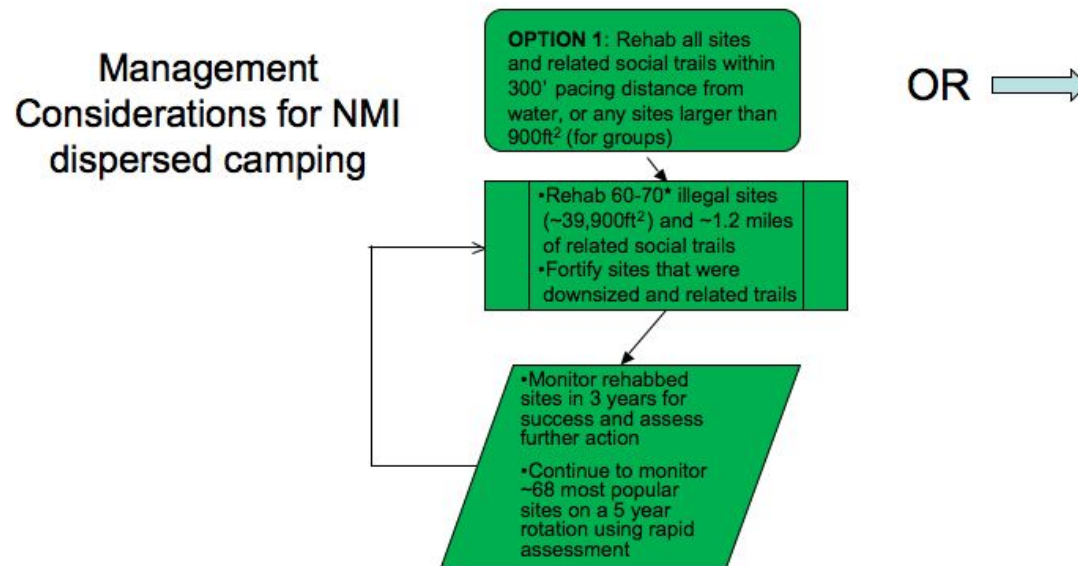
Above: Camp E located on the west shore of the island south of Crescent. Most heavily impacted campsite with a rating of 2.36.

Below: A site in the Village Campground; overall rating of 2.27



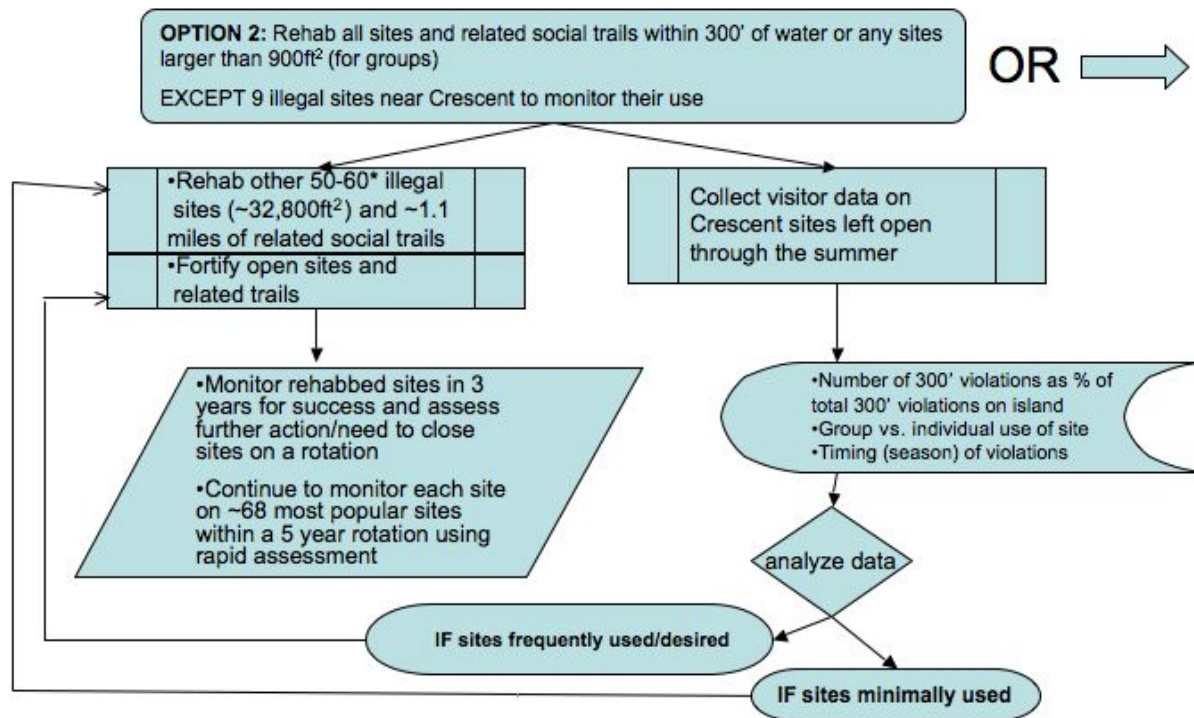
Steep bluff trails at Johnson's Place on the west shore of the island. Rating of 5 (highest) on Impact Rating Scale. Top photo is the top of the trail pictured in the bottom photo.

Appendix G: Flow Charts of Alternate Options for campsite management as outlined in recommendations to Lakeshore Management

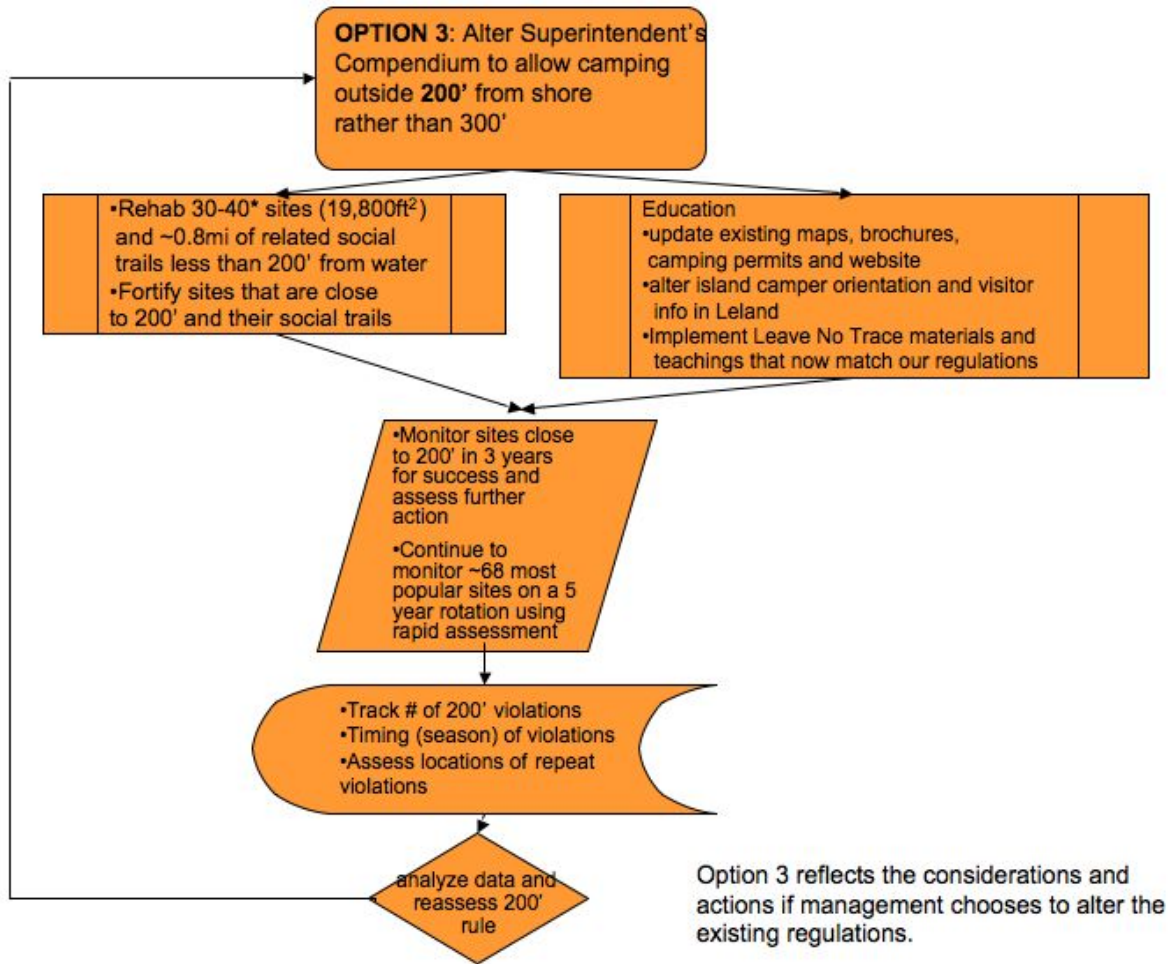


This flowchart outlines the considered options provided to management to aid in campsite management on North Manitou Island. Actions pertaining to restoration or rehab are outlined on page 4. Option 1 (shown here) reflects the course of actions considered under current camping regulations.

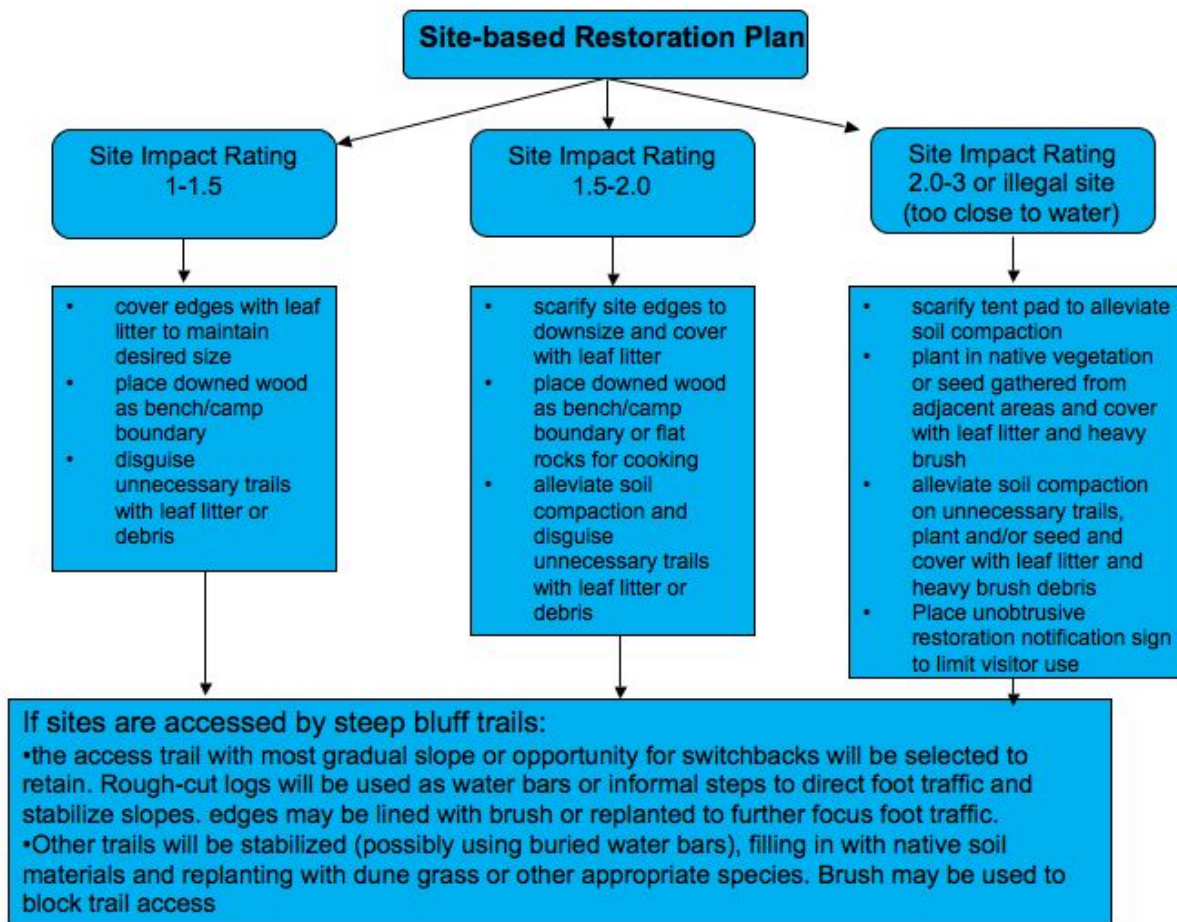
*Distance from water was calculated using GIS, so numbers of illegal sites to rehab are likely overestimates. Decisions will need to be made on a case-by-case basis in the field to account for proper paced distance from water and determine the extent of rehab necessary.



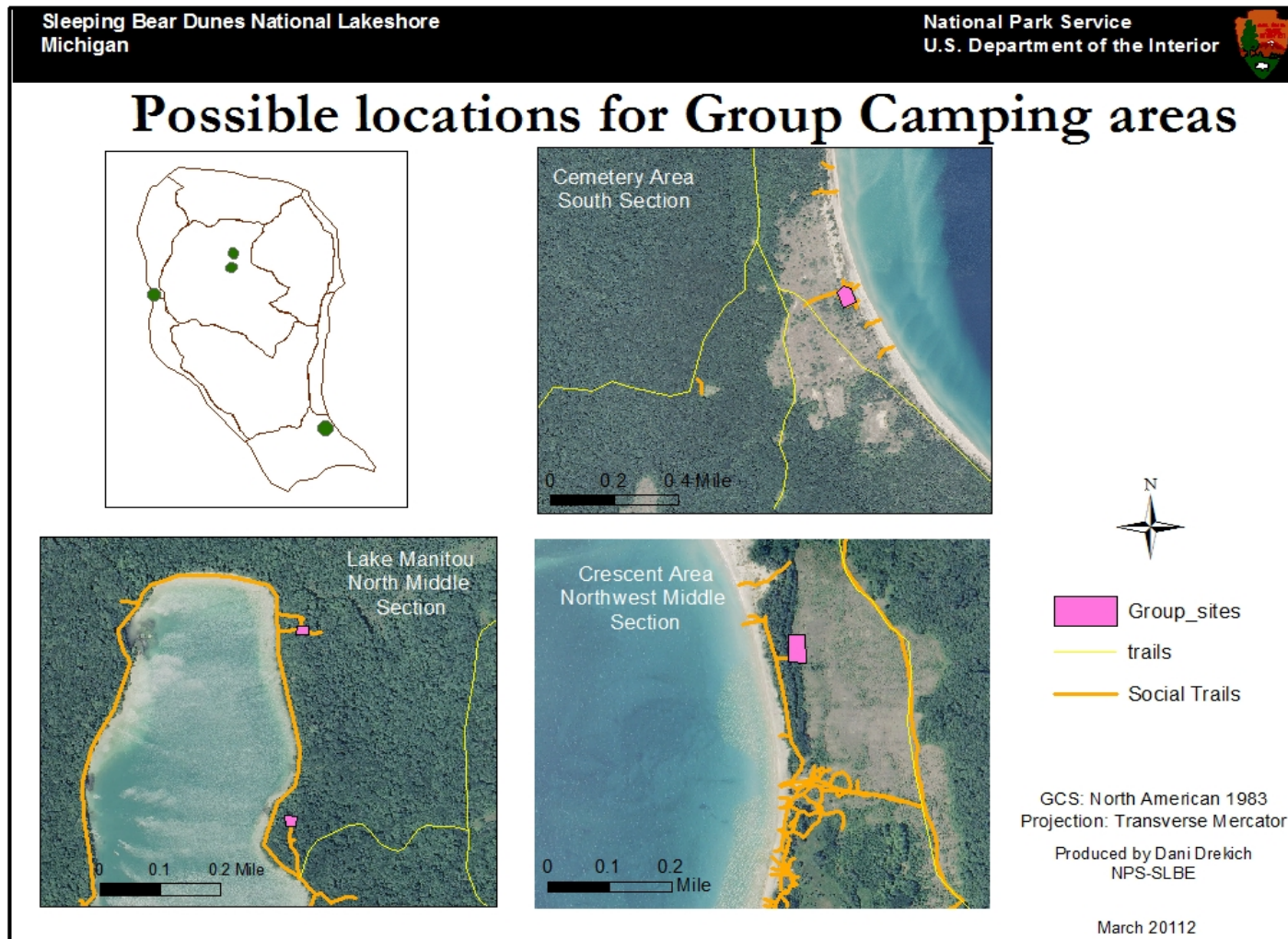
Option 2 reflects the considerations and actions in the most popular area of Crescent City. These 9 illegal sites will not be rehabbed this summer (2012) and an intern will monitor the use or desired use of these sites. Visitors using these sites will be asked to move or be given a citation if found using these illegal sites (per current regulations). At the end of the season, this data will be presented to management. If sites are minimally used and desired, they will be rehabbed. Otherwise, all or some of these sites could be hardened and designated as the only sites of legal use in this area. This designation could be done on a rotational basis so that only a certain number of sites are used each year.



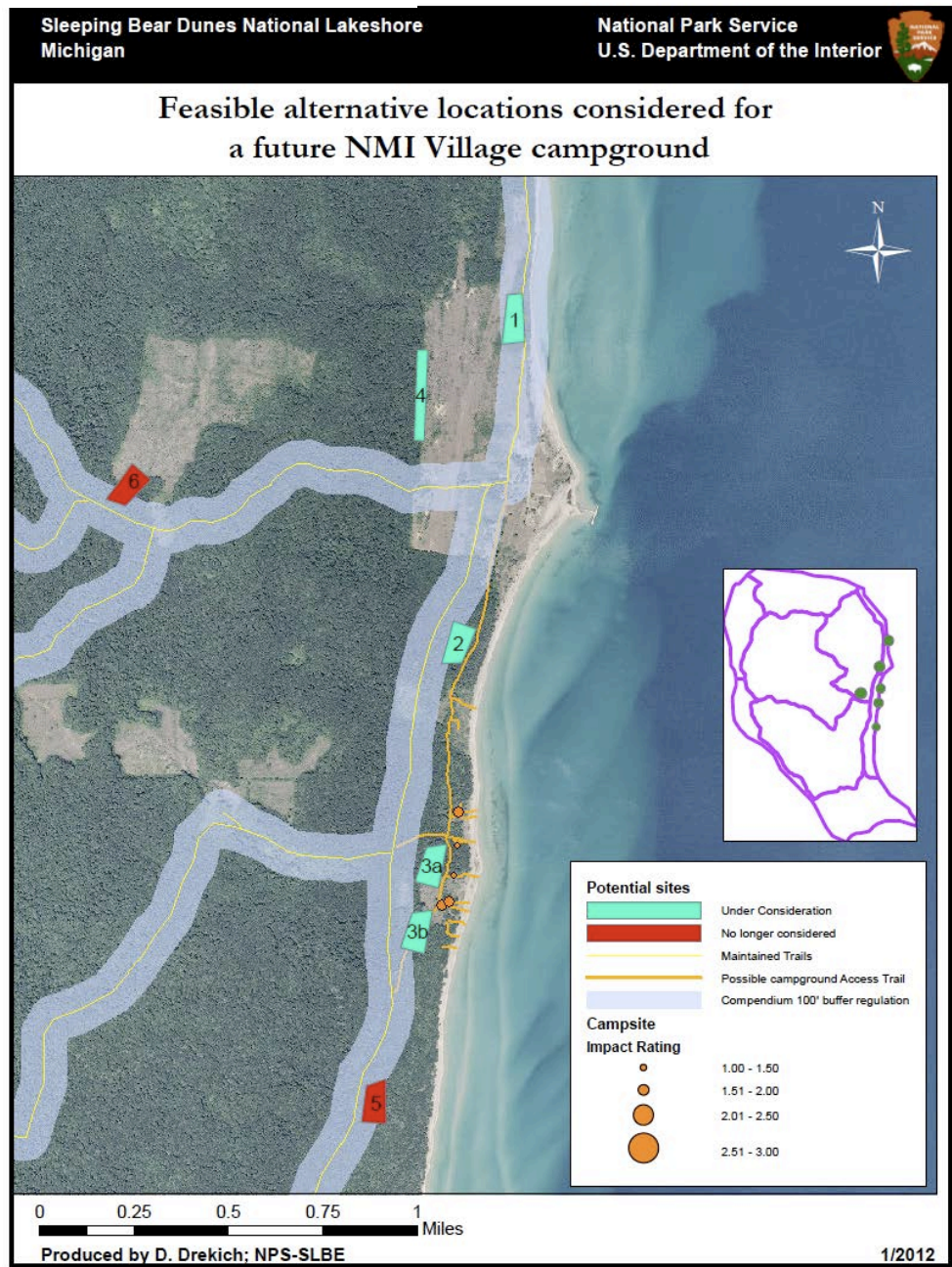
Option 3 reflects the considerations and actions if management chooses to alter the existing regulations.



Appendix H: Suggested Group Camping Areas



Appendix I: Alternative feasible locations for a future Village Campground, including pros and cons of each



Appendix #2-NMI Village Campground Location Options

Review of Potential Relocation Alternatives for the NMI Village Campground

The following locations considered for the North Manitou Island Village Campground are viewed as the best options for a campground location because based on a combination of meeting visitor needs while adequately protecting the natural and cultural resources of the Island. All options presented here correspond to the above map displaying each location. Options 5 and 6 are no longer under consideration (in red text) due to their abundance of undesirable traits.

Option 1: No Action Alternative: Keep the existing campground in use with small improvements

Pros

- No efforts needed to develop another campground
- Maintains close access to Village, restrooms, potable water and beach
- Maps, websites and educational materials remain unchanged

Cons

- Visitor impacts to vegetation and soils are spreading outside of campground due to undesirable sites and tent pads
- Existing pit toilet is undesirable for use
- Unattractive location
- Steep bluff is only access to Lake Michigan

Option 2: Establish a new campground location south of the Village, north of the school ruins

Pros

- Equivalent distance from village as existing campground (about ¼ mile); easy to catch ferry, use restrooms or get potable water
- Proximity to village allows for easier law enforcement patrols and maintenance
- Easy beach access, no bluff
- This site could utilize social trail and/or maintained trail (when if maintenance access is needed for a future pit toilet)
- Easy location to transport materials to (sand, black locust poles) for creating tent pads
- Slope gradually and slightly increases between maintained and social trails

Cons

- No existing informal campsites or social trails to build from
- Understory vegetation fairly open; native shrubs or saplings may need to be planted in to block visibility between campsites
- Entire area is forested; minimum variation in campsites available (e.g. sun vs. shade)

Option 3: Establish a new campground near South Cherry Orchard (See map, 3a and 3b)

Pros

- Fairly close to village (.9 mile); approximately 20 minute walk to ferry and potable water
- Existing informal camps and extensive social trail system could be used to help establish new campground
- Easy access to beach

Ap

- This site could utilize social trail and/or maintained trail (if maintenance access is needed for a future pit toilet)
- Campground could be focused north of old orchard field (option 3a on map) or spread out across one of the trails for better campsite privacy (option 3b on map)
- Moderately easy location to transport materials to (sand, black locust poles) for creating tent pads
- Area located at edge of forest and field (more options for diverse campsites (e.g. sun vs. shade)

Cons

- Only moderately acceptable distance for law enforcement patrols, emergency access and maintenance
- More gradient in slope here; gradual incline east to west

Option 4: Establish a new campground west of the village, just inside the treelinePros

- This site could utilize existing maintained trail for access (and if maintenance access is needed for a future pit toilet)
- Close to village (.5 mile); approximately 10 minute walk to ferry and potable water
- Proximity to village allows for easier law enforcement patrols and maintenance
- Easy location to transport materials to (sand, black locust poles) for creating tent pads
- Area is located at edge of forest and field (more options for diverse campsites (e.g. sun vs. shade)

Cons

- No existing informal campsites or social trails to build from
- Not along shoreline, no beach access (15 minute walk to beach)
- Steep gradient westward; to be equivalent in size to the existing campground, this site must stretch north south to avoid steep slope
- Could place further in forest, but would still require building into slope

Option 5: Establish a new campground on south east shore (see map)Pros

- This site could utilize maintained trail (if maintenance access is needed for a future pit toilet)
- Easy access to beach
- Land is flat, no slope to build into or cause drainage/erosion problems

Cons

- May be too far from village (1.6 miles) to catch morning ferry, use restrooms or get potable water
- No existing informal campsites or social trails to build from
- Entire area is forested; minimum variation in campsites available (e.g. sun vs. shade)
- Distance to village difficult for law enforcement patrols and emergency access
- Difficult location to transport materials to (sand, black locust poles) for creating tent pads
- Understory vegetation fairly open; native shrubs or saplings may need to be planted in to block visibility between campsites

Option 6: Establish a new campground west of the Village near Frank Farm (see map)Pros

A

- Fairly close to village (1.1 miles); approximately 20 minute walk to ferry and potable water
- Proximity to village allows for easier law enforcement patrols
- This site could utilize maintained trail (if maintenance access is needed for a future pit toilet)
- Moderately easy location to transport materials to (sand, black locust poles) for creating tent pads
- Slope fairly flat and consistent in this area
- Area located at edge of forest and field (more options for diverse campsites (e.g. sun vs. shade)

Cons

- No beach access (1.3 miles to village beach or 1.2 miles to Lake Manitou)
- Too far from Village to use restrooms
- Only moderately acceptable distance for law enforcement patrols and emergency access
- No existing informal campsites or social trails to build from; underbrush would need clearing

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