An Overview of Recreation Site Monitoring Programs and Systems

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Note – This paper summarizes and compiles recreation site inventory and monitoring information from various sources for an overview of the topic useful for wilderness managers implementing a recreation site monitoring program. A comprehensive source for recreation site monitoring techniques is: Wilderness Campsite Monitoring Methods: A Sourcebook, Cole, David N., GTR-INT-259, April 1989. *found at:* http://leopold.wilderness.net/pubs/179.pdf

Background:

Campsite impact monitoring evolved similar to trail monitoring programs through the use of repeated photographs (Cole 2000a). In 1978, Sidney Frissell published an article entitled "Judging recreation impacts on wilderness campsites". His work was the first of its kind to publish methods of campsite monitoring (Cole 2000a). Frissell proposed a condition class method of monitoring campsites (1978). One year later Schreiner and Moorhead published methods outlining a radial transect technique (1979). Building on these initial methods, more elaborate and precise protocols have been developed (Cole 2000a).

Campsite impact assessments and monitoring methods range from photographic approaches to condition class approaches to a more intensive quantitative measurement of multi-parameters, as well as a combination of all three methods (Leung and Marion 2000). The monitoring programs vary in their use of qualitative versus quantitative attributes, temporary versus permanent sampling sites, and single versus multiple impact parameters (Cole 2000a).

Photographic System:

Photographic systems were among the first applied to campsite monitoring and are based on repeat photographs taken from permanently established photo points (Cole 1989b; Williams and Marion 1995). The benefit of the photographic system is that it is relatively quick and easy to accomplish and can play a crucial role in site relocation by acting as a reference for monitoring personnel to determine if he/she is at the correct site (Cole1989b). This type of monitoring system is sometimes helpful in combination with other styles of programs to enhance field data. Photographs can be used to validate field assessments and visually convey information on site conditions calculated by field measurements (Hammitt and Cole 1998). The drawbacks of this system are that few types of impact can be accurately evaluated in photographs and it is difficult to assign interval level ratings for site comparison (Cole 1989b). Other disadvantages include poor comparability due to inconsistent photographic quality, changes in areas hidden from view or not in the photograph, and a high level of observer bias (Williams and Marion 1995; Cole 1989a).

The three basic techniques in the photographic system are the use of photopoints, quadrat photography, and panorama photography. The photopoint technique involves taking photographs from a location that can be reestablished in the future (Hammitt and Cole 1998). The photopoint locations can be referenced to permanent campsite features such as large rocks, metal markers, or permanent structures located on the site. The location of the photopoints should be referenced in terms of distance and bearing to the landmark. A second option of locating photopoints is using a Global Positioning System (GPS) unit (Glidden 2001). These units use satellites to triangulate the user's position and georeference it on the earth's surface (Trimble Navigation Limited. www.trimble.com/gps/how.html. Accessed on 1/29/04). This system can be used to quickly and accurately relocate a site.

The quadrat photography technique involves taking a series of replicable photographs of established quadrats. A device called a quadrapod holds the camera at a set distance above the ground and photographs are taken of ground cover. The prints, slides, or digital image is then traced onto paper for areal measurements. The quadrat photography technique allows managers to view an individual quadrat or the entire site from an aerial view (Hammitt and Cole 1998).

The panorama photography technique involves piecing together a series of photographs to create a 360-degree view of the campsite. This is typically done by placing a camera on a tripod at a point that can be relocated and taking a series of photographs while incrementally rotating the camera for each photo.

In addition to the three photographic systems, some monitoring programs are including digital video clips of each site monitored. By videoing the site's assessment, it allows managers to evaluate if observers display any biases that may affect the data they recorded. The video clips can also allow managers to review the assessments, verify that protocols were followed, and confirm no impacts were overlooked. The downfall to video clips is the size of the file and the subsequent digital storage space that is needed.

Condition Class System:
Condition class campsite monitoring systems are based on observers comparing site conditions to pre-determined descriptive condition classes, and recording the class that most closely matches the conditions (Williams and Marion 1995). The system consists of descriptions of five condition states that are based on the extent of vegetation damage, mineral soil exposure, tree root exposure, erosion, and tree mortality (Table 1). Because some sites fall between the delineated condition classes, some researchers have added additional incremental scores, such as 1.5 or 2.5.

Table 1: *Condition class rating table. (Source: Frissell 1978)*

Condition Class Rating Table

Condition Class	Visible Indicators	Management
1	Ground vegetation flattened, but not permanently injured. Minimal physical change except for possibly a simple rock fireplace.	These sites are barely recognizable as camping areas. If not in situations known to be sensitive to use (e.g. wet or slump areas), no management action is necessary. Maintain current use or allow increase if other sites must be closed.
2	Ground vegetation worn away around fireplace or center of activity.	Site change now apparent, but still within acceptable limits. These areas are readily identifiable as campsites and will continue to attract use. Future use should be carefully monitored to detect adverse change.
3	Ground vegetation lost on most of the site, but humus and litter still present in all but a few areas.	A transitional condition. Considerable change in plant cover is evident but few signs of soil problems. This condition might be accepted as normal in high use areas. Modification of current use patterns and intensities may be needed to prevent further change.
4	Bare mineral soil widespread. Tree roots exposed on the surface.	Deterioration is accelerating. If current level and type of use continues, soil erosion, loss of tree cover, and aesthetic degradation are likely. Withdraw use from these sites to allow recovery. Consider artificial rehabilitation. Is site is improperly located, permanent closure should be considered. If site is reopened insure that use patterns are adjusted to prevent re-injury.
5	Soil erosion obvious. Trees reduced in vigor, or dead.	Natural recovery will be extremely slow. Sites should be closed permanently and alternate ones located. If the site is crucial to recreation patterns, extensive rehabilitation will be required to return it to acceptable condition.

The condition class system is quick, easy to apply, relatively inexpensive, and provides a useful summary of resource conditions and an overall count of the number of sites (Cole 1989b; Williams and Marion 1995). The major drawbacks of this monitoring program are that it is high in observer bias and lacks quantifiable data (Cole 1989b; Williams and Marion 1995). Further, condition class monitoring programs only give a gross estimate of the overall impact of the site, and do not provide information on individual impact attributes. When using this system, managers only know that the site in either improving or deteriorating, but not in which aspects (Cole 1989b).

The condition class system may work well in coniferous forests with dense ground vegetation and thick organic soil layers, but it may not apply as well in other environments, such as grasslands, deserts, or above timberline (Cole 1989b). This drawback is manifested in the fact that there is no control site for comparison of vegetation cover and mineral soil exposure. For example, if an environment naturally has an abundance of mineral soil exposure or is sparsely vegetated, the condition class rating may exaggerate the level of impact by considering naturally existing conditions as human caused conditions.

The final disadvantage of this system is it tends to foster a "wait-and-see" type of management, forcing managers to be reactive rather than proactive in their management strategies (Marion 1998). By the time conditions have been altered enough to be reflected in a change in condition class, a significant amount of change has occurred (Hammitt and Cole 1998).

Multi-parameter System:
The multi-parameter systems are based on individual measurements and appraisals of specific indicators of resource condition. This system requires greater observer training and often takes longer to perform, but can yield more accurate and precise measurements of campsite conditions (Williams and Marion 1995; Leung and Marion 2000). A number of rapid estimation multi-parameter systems have been developed over the years (Parsons and MacLeod 1980; Cole 1983; Marion 1984; Glidden 2002). Most of these systems include 6 to 12 variables, each with 2 to 5 quantitatively defined rating categories that represent the degree of impact for a particular indicator (Table 2) (Williams and Marion 1995; Hammitt and Cole 1998). See Appendix A for an expanded list of indicators.

Table 2: ***Campsite impact indicators and their associated attribute choices (Source: Glidden 2001).***

Site Impact Indicator	Attribute Choices
Vegetation Cover On-site	(0-5%) (6-25%) (26-50%) (51-75%) (76-100%)
Vegetation Cover Off-site	(0-5%) (6-25%) (26-50%) (51-75%) (76-100%)
Mineral Soil Exposure On-site	(0-5%) (6-25%) (26-50%) (51-75%) (76-100%)
Mineral Soil Exposure Off-site	(0-5%) (6-25%) (26-50%) (51-75%) (76-100%)
Tree Damage	(0-5%) (6-25%) (26-50%) (51-75%) (76-100%)
Root Exposure	(0-25%) (25-50%) (51-75%) (76-100%)
Presence of Noxious Weeds	(Yes) (No)
Evidence of Stock	(None) (Feed/ Manure) (Manure Odor/ Dishing)
Development	(None) (Primitive Structure) (Temporary Structure) (Perm. Structure)
Cleanliness	(No Trash or Manure) (Trash Present) (Manure Present) (Trash and Manure Present)
Presence of Human Waste	(Yes) (No)
Number of Social Trails	(None) (1-2) (3 or more)

Using the multi-parameter system, surveyors compare the indicator's condition on the campsite to similar but undisturbed areas immediately adjacent to the site. By using the neighboring area as a control, measured impacts are not exaggerated as with the condition class system. The variable score recorded for each indicator is multiplied by a weight based on the managers' opinion of an indicator's relative importance and ability to recover. The products of the rating and weights are then summed to give an overall impact index for the site (Hammitt and Cole 1998; Glidden 2001). This style of campsite monitoring program takes approximately 15 to 30 minutes per site to complete, depending on the complexity of the monitoring protocol (Williams and Marion1995; Hammitt and Cole 1998; Glidden 2002).

The benefit of this system is that it accounts for sites where one type of resource impact is high and another is low. It also contains specific information about each attribute, which makes it is possible to track change of individual attributes. This monitoring program also retains the flexibility to change the impact indicators or reevaluate the importance of an indicator without having to reinventory all of the sites.

Combination System:
A combination of the photographic, condition class, and the multi-parameter monitoring systems has also been developed (Marion 1991, Glidden 2001). This system adopts elements of all three systems to capture campsite conditions effectively and efficiently. These systems allow for a rapid but thorough inventory of numerous sites in a short amount of time (Williams and Marion 1995; Glidden 2002).

More comprehensive research-level approaches for measuring campsite conditions have also been developed (Cole 1983). These procedures require surveyors skilled in statistical sampling, laboratory analysis of soil properties, field identification of vegetation species, and consequently, large amounts of time (Williams and Marion 1995).

Selecting a Monitoring Program:
Monitoring programs vary in the type and sophistication of research methods used to collect data (Leung and Marion 2000). The choice of monitoring methods is based on the research questions being asked, types of data needed for management, character of the study area, the training of investigators, and logistical constraints (Cole 1989b; Leung and Marion 2000). The standardization of systematically collected data is particularly important where monitoring personnel turnover is frequent, as it is in many governmental agencies that use seasonal employees (Hammitt and Cole 1998). The standardization of recreation monitoring program protocols ensures data will be collected in the same way, even if the same person does not collect it.

During the past two decades, recreation managers have developed and refined campsite monitoring programs (Leung and Marion 2000). This has led to a wide variety of methods that have been used and the associated differing levels of accuracy, precision, cost, and applicability to management (Cole 1994a).

Differing levels of accuracy, precision, cost, and applicability to management concerns can make selecting the appropriate campsite monitoring program difficult for managers. This article presents selection criteria for managers to consider when choosing an appropriate monitoring program, and discusses the characteristics of monitoring programs that can affect the accuracy, precision, and cost of a program.

Accuracy and Precision:

Because error is inherent in all measurements, it is important to assess the level of accuracy and precision. Precision is fundamentally crucial to monitoring, therefore it is also imperative to identify the magnitude of measurement error. Knowing the level of precision of a monitoring program will enable managers to identify the difference between two dissimilar measures of the same condition and a real change in the condition (Cole 1989b; Williams and Marion 1995). Knowing the levels of accuracy and precision of the various monitoring programs will also enable managers to apply a program capable of answering their management question.

Accuracy:

The accuracy of a campsite monitoring program refers to the extent to which observations scored by an observer match those of the actual condition (Neuman et al. 1999). The level of accuracy is often referred to as systematic or bias error. Systematic errors are reproducible inaccuracies that are consistently in the same direction. Systematic errors are often due to a problem that persists throughout the entire experiment (Province of British Columbia 1998). For example, if the scale used to measure the weight of an object is consistently high by 0.005 grams then the measurement is not accurate because of a systematic error. Systematic errors are difficult to detect and cannot be analyzed statistically, because all of the data is off in the same direction. Systematic error can however be studied through intercomparisons, calibrations, and error propagation (Province of British Columbia 1998). While accuracy is important in campsite monitoring programs, precision is more important for predicting change in resource conditions over time.

***Precision*:**

The precision of a campsite monitoring program refers to the variability in estimates of campsite impact indicators among multiple people (Williams and Marion 1995). The level of precision is also referred to as the random error of the study. High precision indicates that random variation associated with the collection procedure is minimized (Province of British Columbia 1998). Unlike accuracy, precision can be studied through statistical analysis of repeated measurements. Unfortunately, because one individual or a group of individuals typically inventories campsites at one point in time, calculating the level of precision is difficult to execute. Imprecise data that will not allow managers to distinguish real change from separate imprecise estimates of the same value (Cole 1989a). Techniques that yield precise data are particularly important to government agencies where monitoring personnel turnover is high (Hammitt and Cole 1998). Because accuracy and precision both place constraints upon efficiency and cost-effectiveness, managers are forced to balance the two (Williams and Marion 1995).

Selection Criteria:

When selecting a campsite monitoring program, managers need to know what their management question is, what the scope of the question is, what data is needed, and what kind of budget is available. Further, when considering budget managers also need to consider the time and equipment involved in establishing and maintaining a monitoring program. Knowing the answers to these questions enables managers to best decide how to balance accuracy, precision, and budget.

What is the management question?

The most important step in selecting a monitoring program is to identify the management question. Why are we collecting data? What question(s) are we trying to answer using the data? The answers to these questions can be derived from the agency's objectives, general management plans, and local and regional threats.

Having a clear and specific management question is crucial to developing a monitoring program. For example, a management question that simply states "what are the campsite impacts in the wilderness area", is not specific enough to decide what indicators to use. On the other hand, a management question of "what is the site-by-site trend in the level of vegetative impact cause by overnight camping in the Spring Creek Wilderness" is more specific and would indicate that the monitoring program will need to include a vegetation survey element. The management question also indicates that the vegetation survey element will need to be monitored at every site and needs to be precise enough to indicate true trend. A clear and specific management question will also dictate the scope of the monitoring program.

What is the scope of the management question?

The scope of the monitoring program is based on the scope of the management question. The scope of monitoring programs can be based on geographic areas, political boundaries, or management areas. Within these larger areas the scope of the monitoring program can be broken down into the number of sites that need to be inventoried (a sample or the entire population) and how many attributes of site condition are collected. Having a clear and specific management question will allow managers to better identify the scope of the monitoring program. For example, a management question that simply states "what are the campsite impacts in the wilderness area" is not specific enough to decide what indicators to use. On the other hand, a management question of "what is the site-by-site trend in the level of vegetative impact cause by overnight camping in the Spring Creek Wilderness" is more specific and would indicate that the monitoring program will need to include a census of campsite vegetation impacts. The management question also indicates that the vegetation survey element will need to be accurate and precise enough to indicate true trend.

Because different agencies manage different types of environmental and social settings, the management objectives derived from the management frameworks are different. The differing management objective will create the need for different indicators and standards, and thus different data needs.

What are the data needs?

The data that a monitoring program needs to collect is a function of data needed to answer the management question minus data that has already been collected. In many cases, the data needed to answer the management question comes from other disciplines within the agency. For example, if a manager was concerned with the proximity of campsites to streams, and data on stream locations already existed in the corporate database, the manager could use GIS software to georeference the campsite location and find distance to water. Other types of questions like general slope, aspect, dominant vegetation community, distance to trail, campsite densities, and general soil type can also be answered in the same manner. By knowing what data is already available, managers will not collect duplicate information, reducing the time and cost of data collection.

In addition to knowing what data already exists, managers also need to know the application of data. For example, if most of the existing data are in a format that is applicable to a specific software program, in most cases it would be best to collect data in that format to save time converting data formats. Because data collection is a time-consuming process, it is also an expensive process.

What kind of budget is available?

All agencies work within limited financial constraints and the amount of available resources will dictate what type of a monitoring program can be implemented. In an ideal world managers would have unlimited time and money to collect the most accurate and precise measurements of campsite impact. Unfortunately, this is not the case. Managers are left to decide what is the most accurate and precise data they can afford to collect and still be able to answer the management question. In most cases, the key limiting financial factors are time and equipment.

When considering time spent and equipment used on a monitoring program managers should consider five major factors; 1) establishing a protocol; 2) training; 3) travel time; 4) data collection; and 5) data management.

Establishing a Monitoring Protocol:

Establishing a monitoring protocol is crucial to the level of accuracy and precision of a monitoring program. By establishing a campsite monitoring program protocol, managers can ensure that the correct data is being collected and it is being collected in a consistent manner over time. By making sure that the correct information is collected managers can reduce the need to go back to a site to recollect data. Although many campsite monitoring program protocols exist, managers need to consider what protocol would work best to facilitate answering their own management question. Because management objectives and questions are different for each agency and each section of that agency, monitoring protocols should represent those differences. When writing the protocol, managers need to strive to be as explicit as possible, to ensure that no questions are left unanswered. Because the complexity of monitoring program varies, the time it will take to complete the monitoring protocol will also vary. When the protocol is complete, a manager should be able to give the manual to an observer and have them able to carry out the campsite monitoring program on their own, from pre-field planning to data management and analysis. Establishing a thorough protocol will help managers train their monitoring personnel.

Training:

Training monitoring personnel is also an important and time consuming task. Even if a manager is successful in creating a comprehensive protocol, monitoring personnel still need to be trained. By training monitoring personnel to the protocol, it enables mangers to remove biases among individuals, thus improving the level of precision. Sometimes even a comprehensive protocol cannot address all situations in the field. In this case, training also allows managers to remove many subjective judgments from the data collection process. Training also allows managers to ensure that the correct techniques are being used in collecting the data. Training should occur before data collection begins as well as during the data collection process to recalibrate individual data collectors. The amount of time spent training monitoring personnel depends on the number of data fields that are collected, the complexity of the data collection technique, and the abilities of the monitoring personnel. For example, training an individual to do condition class surveys will take less time than training individuals to complete a multi-parameter system.

Travel Time:

The third consideration relating to time and equipment is the amount time it takes to get to a campsite. In most cases with wilderness campsite monitoring, it will take longer to get to the campsite than it will to inventory it. Creating a systematic sequence for inventorying campsites will help save time and money. In planning for data acquisition, managers should consider the amount and type of access to the area they wish to monitor. In many wilderness areas where access and travel is restricted, this factor can pose a challenge.

Data Collection:

Because campsite monitoring programs use different methods to access site conditions, each system takes a different amount of time. When it comes to choosing a method for collecting data, managers need to decide how to balance accuracy, precision, and budget. Managers need to decide if they can answer their management question with a program that will take many less-accurate, less-precise measurements, or if they need a few more-accurate, more-precise measurements. They then need to figure out what they can afford. As noted previously, the amount and complexity of methods used is a derivative of the management question.

The reported amount of time that each method takes for each site varies from 1 to 20 minutes for a photographic system, 1 to 5 minutes for a condition class system, 15 to 30 minutes for a rapid inventory multi-parameter system, and up to several hours for the more advanced systems (Cole 1989b; Williams and Marion 1995; Glidden 2002). Because travel time to sites can be significant, managers need to decide if it is worth their monitoring personnel spending the extra time to collect additional data where travel time is significant. For example, if monitoring personnel have to travel three hours to a site, is it worth the extra 15 to 30 minutes to collect additional data? Managers concerned with just the number of campsites and overall campsite condition may decide that the 1 to 5 minutes spent completing the condition class system survey is sufficient, but managers interested in individual impact attributes may decide it is worth the extra 15 to 30 minutes to perform the multi-parameter system.

Time spent on the data collection process can also be affected by the availability of personnel and inventory tools. For example, significant time and effort can be saved in the data collection process by having two individuals inventory different parts of the same site; although this may jeopardize the consistency of the data. If the resources are available, managers can also create a team of monitoring pairs.

Using the most current technology available also can speed up the data collection process. For example, some monitoring programs now rely on Global Positioning Systems (GPS) units (Glidden 2001). The data collection grade units now have the ability to hold data dictionaries (an electronic inventory form), photographs, sound clips, and navigational maps. These units also have the ability to record positions within one meter of their location. These features can allow for rapid and accurate data collection that is already in digital form for data management and use. The drawback to these units is their cost. Although these units carry a high cost, they save time and money, especially on large scale monitoring projects. Additional technological advancements that can aid in data collection include digital cameras and remote sensing applications.

Data Management:

Once the data has been collected managers must account for time spent managing and using the data. Paper based systems require manual entry of data into a database. This process can take a lot of time and can result in translation errors. Systems that are digitally based can alleviate some of these hassles, but can have problems with losing data. It is crucial for a manager to establish a data management protocol before beginning a data management program. Poor data management can lead to catastrophic problems, such as mixed-up and/or lost data.

Spreadsheet software, such as *Microsoft Excel*, or *Access* can be helpful in managing and using monitoring data. Most of these programs have the ability to run statistical functions and make visual representations of the data with ease. For example, if a manager decides to use a multi-parameter system with an over all impact index, they can use the spreadsheet software applications to automatically calculate the index. In addition, many of these programs share similar properties that allow for data transfer.

When managers are considering the data they want to collect they must consider how much data storage space is needed. For example, the use of digital video and photos can be helpful in managing the data, but the large size of the files may require a lot of room for storage.

Choosing Among Systems:

When selecting a monitoring program, managers must consider the program's ability to address the management question. Monitoring programs vary in their ability to answer management concerns. Table 3 presents a basic comparison of the four methods and their abilities to address management concerns. These comparisons are based on the individual programs and not a combination of programs.

Table 3: *Comparison of monitoring methods and their applicability to management questions (Extrapolated from Cole 1989*b*).*

	Number of CS[2]	Overall CS Conditions	Locations of CS	Which CS are highly impacted	Trend in CS Conditions	Which type of CS impact are most severe	How have individual impacts changed	Ability to document CS size	Ability to detect small changes
Photographic Systems[1]	Fair	Poor to Good	Poor	Poor to Good	Poor to Fair	Poor	Poor	Poor	Poor
Condition Class Systems	Good	Fair	Good	Fair	Good	Poor	Poor	Poor	Poor
Multi-parameter Systems (Rapid Inventory)	Good	Good	Good	Good	Good	Good	Good	Fair	Fair
Multi-parameter Systems (Detailed Inventory)	Good	Good	Good	Good	Good	Good	Good	Good	Good

1 Photographic system rating will vary depending on the methods used.

2 CS=Campsites

In addition to a monitoring program's ability to address management questions, managers also need to consider a program's overall costs and the subsequent effect on the budget. Managers need to take into account the amount of time spent and equipment used when considering the overall cost of a monitoring program. Table 4 presents a comparison of the four different methods and their associated overall costs.

Table 4: *Comparison of monitoring systems and their overall cost. (Extrapolated from Cole 1989b)*

Monitoring System	Protocol	Training	Travel Time	Data Collection	Data Management
Photographic[1]	**Low-Med**	**Low-Med**	**NA[2]**	**Low-High**	**Medium**
Conditions Class	**Low**	**Medium**	**NA**	**Low**	**Low**

Multi-parameter	**High**	**High**	**NA**	**Medium**	**Medium**
Detailed Multi-parameter	**High**	**High**	**NA**	**High**	**High**

[1] *Photographic system rating will vary depending on the methods used.*
[2] *Travel time to campsite does not vary between different campsite monitoring methods.*

Finally, managers are faced with the difficult task of balancing accuracy, precision, and cost. Unfortunately, as managers attempt to increase the level of accuracy, they also increase the amount of time spent monitoring, and thus the overall cost (Figure 1). For example, a monitoring personnel collecting 6 campsite attributes would take less time to complete a survey compared to a manager collecting those same 6 campsite attribute plus an additional 4 campsite attributes.

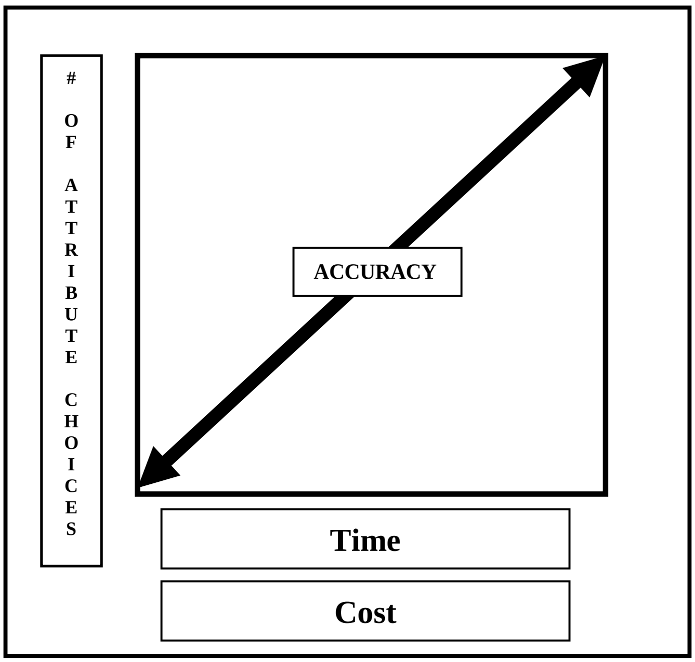

Figure 1: *Relationship between accuracy, number of attributes, time, and cost.*

As managers increase the number of categories within an attribute, in an attempt to increase accuracy, they inadvertently increase the chances of disagreement between observers, potentially lowering the level of precision (Figure 2). While this issue can be ameliorated with a clear and descriptive protocol and thorough training, the threat of jeopardizing precision theoretically exists. For example, if monitoring personnel have the choice between 5 attribute parameters they are more likely to agree than if they have the choice between 10 attribute parameters.

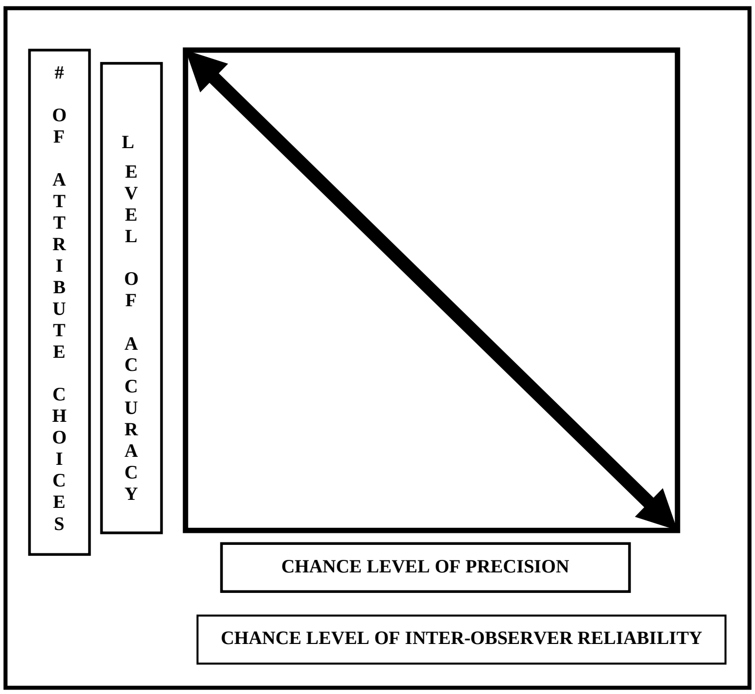

Figure 2: *Relationship between of number of attribute choices/accuracy and chance level of precision and chance level of inter-observer reliability.*

Conclusion:

Differing levels of accuracy and precision, cost, and applicability to management concerns can make selecting the appropriate campsite monitoring program difficult for managers. When selecting a campsite monitoring program, managers need to know the management question being asked, the scope of the question, the data needs, and the budget available. Managers can use this information to best decide how to balance the accuracy, precision, and budget of a monitoring program.

Managers should be cautioned not to apply monitoring programs from other agencies or forests to their own without giving thought to their management question. The diversity of management situations warrants a diversity of monitoring programs. A combination of methodologies may prove to work best in answering the management question (Williams and Marion 1995). If careful thought and consideration are applied in creating a monitoring program, managers can end up with a monitoring data that has a high level of precision and accuracy, will provide a foundation for sound management decisions, and can work within their budget constraints.

Literature Cited

Cole, David N. 1983. Campsite conditions in Bob Marshall Wilderness, Montana. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. Res. Pap. INT-284

Cole, David N. 1989a. Area of Vegetation Loss: A New Index of Campsite Impact. Research Paper. INT-389. Ogden, UT: U.S. Department of Agriculture, Forest Service, Inter-Mountain Research Station.

Cole, David N. 1989b. Wilderness Campsite Monitoring Methods: A Sourcebook. Ogden, UT: U.S. department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. Gen. Tech. Rep. INT-259.

Cole, David N. 1995a. Disturbance of natural vegetation by camping: Experimental applications of low-level stress. Environmental Management. 19(3): 405-416.

Cole, David N. 2000a. Biophysical impacts of wildland recreation use. In: Gartner, W.C.; Lime, D.W., eds. Trends in Outdoor Recreation, Leisure and Tourism. New York, NY: CABI Publishing. (Ch 23).

Frissell, Sidney S. 1978. Judging recreation impacts on wilderness campsites. Journal of Forestry. 76(8): p 481-483

Glidden, Nicholas J. 2001. Dixie National Forest Wilderness Campsite Monitoring Program Manual. United State Department of Agriculture, Forest Service, Region 4. Dixie National Forest (Unpublished).

Glidden, Nicholas J. 2002. Dixie National Forest Campsite Monitoring Program Manual. United State Department of Agriculture, Forest Service, Region 4. Dixie National Forest (Unpublished).

Hammitt, William E.; Cole, David N. 1998. Wildland Recreation: Ecology and Management (2nd edition). New York, NY: John Wiley and Sons.

Leung, Yu-Fai, Marion, Jeffrey L. 2000. Recreation Impacts and Management in Wilderness: A State-of-Knowledge Review. In: Cole, David N.; McCool, Stephen F.; Borrie, William T.; O'Loughlin, Jennifer, comps. 2000. Wilderness science in a time of change conference—Volume 5: Wilderness ecosystems, threats, and management; 1999 May 23-27; Missoula, MT. Proceedings RMRS-P-15-Vol-5. Ogden, UT: US Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Marion, Jeffery L. 1984. Campsite impact assessment systems: Application, evaluation, and development. In: Proceedings of the 1984 National River Recreation symposium. J.S. Popadic and others (eds). October 31-November 3, 1984, Baton Rouge, LA: Louisiana State University, College of Design, School of Landscape Architecture. P 561-573.

Marion, Jeffrey L. 1991. Developing a natural resource inventory and monitoring program for visitor impacts on recreation sites: A procedural manual. Denver, CO: U.S. Department of Interior, National Park Service. Natural Resource Report NPS/NRVT/NRR-91/06.

Marion, Jeffrey L. 1998. Recreation ecology research findings: Implications for wilderness and park managers. In: Proceedings of the National Outdoor Ethics Conference, April 18-21, 1996, St. Louis, MO. Gaithersburg, MD: Izaak Walton League of America. Pp. 188-196 (trampling, user-related, environmental, and managerial factors, monitoring, dual legal mandates).

Neuman, J; Chardine, J.W.; Perter, J.M. 1999. Approaches to Testing Inter-observer Reliability of Field-collected Behavioral Data. Waterbirds. 22(3): p 348-357.

Parsons, D.J., MacLeod, S.A. 1980. Measuring impacts of wilderness use. Parks. 5(3): p 8-12.

Province of British Columbia Ministry of Environment, Lands and Parks. 1998. Species Inventory Fundamentals: Standards for Components of British Columbia's Biodiversity. Ministry of Environment, Lands and Parks, Resources Inventory Branch for the Terrestrial Ecosystems Task Force, Resource Inventory Committee. No. 1, Version 2.0.

Trimble Navigation Limited. www.trimble.com/gps/how.html. Accessed on 1/29/04

Williams, Peter B., Marion, Jeffrey L. 1995. Assessing Campsite Conditions For Limits Of Acceptable Change Management In Shenandoah National Park. Technical Report NPS/MARSHEN/NRTR-95/071. Philadelphia, PA: National Park Service Chesapeake System Support Office Resource Stewardship and Partnerships. 138 p.