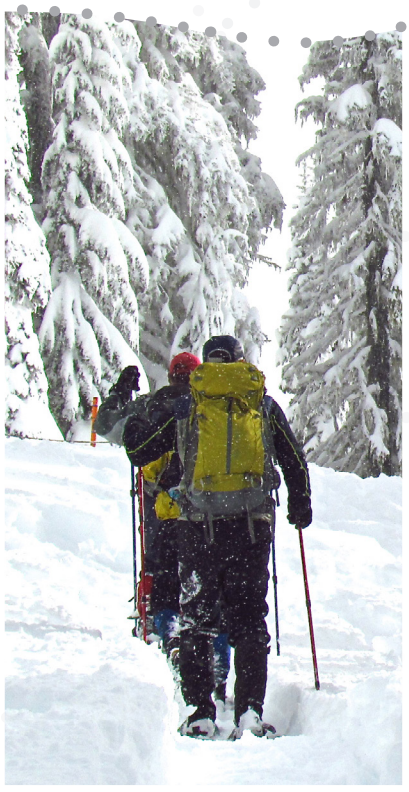
INTERAGENCY
VISITOR USE MANAGEMENT
COUNCIL

Monitoring Guidebook

Evaluating Effectiveness of Visitor Use Management

Edition One | June 2019





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The Interagency Visitor Use Management Council consists of the following agencies:

DEPARTMENT	AGENCY
Department of Agriculture	U.S. Forest Service
Department of Commerce	National Oceanic and Atmospheric Administration
Department of Defense	U.S. Army Corps of Engineers
Department of the Interior	Bureau of Land Management
Department of the Interior	National Park Service
Department of the Interior	U.S. Fish and Wildlife Service

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Contents

FIGURES

TABLES

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Abstract

Visitor use management is fundamental for maximizing benefits for visitors while protecting resources and high-quality visitor experiences on federally managed lands and waters. Monitoring is an essential part of managing visitor use, as it provides feedback for managers to evaluate the effectiveness of management actions in achieving and maintaining desired conditions. Monitoring is the process of routinely and systematically gathering information or making observations to assess the status of specific resource conditions and visitor experiences.

This monitoring guidebook, in combination with the "Visitor Use Management Framework," is intended to (1) help managers select a focused set of indicators and establish triggers, thresholds, and objectives that are relevant, cost effective, and tied to achieving and maintaining desired conditions; (2) develop a monitoring strategy to routinely and systematically collect data to assess any changes in conditions over time; and (3) use the data collected to assess whether changes in management actions are needed. Indicators, triggers, thresholds, and objectives should provide useful information to inform decisions about visitor use management, and a monitoring strategy should be designed so that a consistent effort to gather information can be sustained over time. As in the framework, the sliding scale of analysis is discussed throughout this monitoring guidebook to ensure the investment of time, money, and other resources for a project is commensurate with the complexity of the project and the consequences of the decision. This guidebook expands on the framework and is intended to be adaptable to different agencies' regulations and policies, as well as different project scales or analysis areas.

Visitors of all ages hike up a dirt trail in a forested area.

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Chapter 1: Introduction

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Chapter 1: Introduction

Every year, people seek out public lands and waters to pursue a growing variety of visitor experiences. Opportunities for access, the condition of the environment, and the quality of the visitor experience are all important to the management of federal lands and waters. Faced with visitor use that is growing and changing, federal land managers are challenged to respond to an increasingly complex array of needs and opportunities. The Interagency Visitor Use Management Council (the council) "Visitor Use Management Framework" (the framework) provides cohesive guidance on analyzing and managing visitor use on federally managed lands and waters. Monitoring is a core component of the framework and is increasingly emphasized in all agencies that manage federal lands and waters.

Monitoring is the process of routinely and systematically gathering information or making observations to assess the status of specific resource conditions and visitor experiences. Monitoring is accomplished by selecting indicators that are used to track trends in resource and experiential conditions. Established thresholds clearly define when conditions are becoming unacceptable for the selected indicators, thus alerting managers that a change in management action(s) is required. This guidebook is designed to help managers complete these tasks.

This guidebook is intended to complement the framework. In particular, the guidance offered herein builds on the expectation of already having clearly defined desired conditions that tier to the foundational direction of the project area (see the framework and figure 1, step 2 and step 5).

Desired conditions are defined as statements of aspiration that describe resource conditions, visitor experiences and opportunities, and facilities and services that an agency strives to achieve and maintain in a particular area. Such statements are often built on the foundational language that legally established the area. Desired conditions describe what conditions, outcomes, and opportunities are to be achieved and maintained in the future, not necessarily what exists today. Descriptions of desired conditions paint a picture of what the particular area will look like, feel like, sound like, and function like in the future.

This guidebook can be used by those who have not yet selected indicators and thresholds or developed a monitoring strategy, or it can be used by those who are seeking to make updates or improvements to their monitoring strategy.

This guidebook answers the following questions.

- Chapter 2: Why Monitor?
  This chapter describes why monitoring is integral to visitor use management.
- Chapter 3: What is Monitoring?
  This chapter explains the concepts of monitoring, indicators, thresholds, triggers, and objectives.

STEP 7

- Chapter 4: How is a Monitoring Strategy Developed?
  This chapter describes how to develop a monitoring strategy by selecting appropriate indicators and establishing thresholds, triggers, and objectives.

STEP 11

- Chapter 5: How is Monitoring Implemented?
  This chapter provides guidance on developing a monitoring strategy. A monitoring strategy involves details such as the frequency of monitoring and protocols for data collection, quality assurance, analysis, and storage.

STEP 13

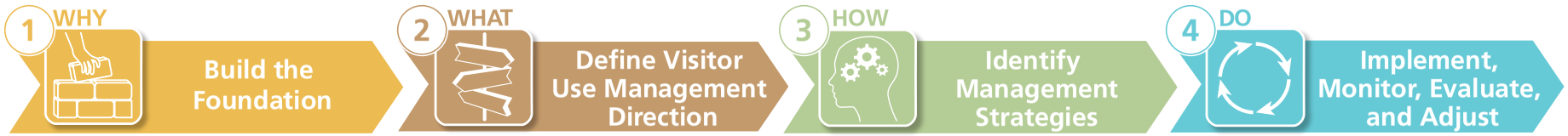
- Chapter 6: How are Monitoring Data Used?
  This chapter discusses how monitoring data are used to inform visitor use management decisions.

Appendices provide examples of indicators, thresholds, triggers, and objectives for a variety of resources and settings to show how monitoring information is used to inform management actions. Sample monitoring forms and worksheets are also provided. Numerous publications are available that have additional visitor use monitoring information (see the References section of this guidebook). The list of references and also this guidebook are not intended to be a comprehensive representation of the literature on this topic.

The icons above and to the left, indicate a reference to specific elements and steps in the framework.

Figure 1. Elements and steps of the "Visitor Use Management Framework."

Steps highlighted in yellow involve monitoring and are discussed in detail in this guidebook.



Steps:

1. Clarify project purpose and need.
2. Review the area's purpose and applicable legislation, agency policies, and other management direction.
3. Assess and summarize existing information and current conditions.
4. Develop a project action plan.

Outcome: Understand why the project is needed, and develop the project approach.

Steps:

5. Define desired conditions for the project area.
6. Define appropriate visitor activities, facilities, and services.
7. Select indicators and establish thresholds.

Outcome: Describe the conditions to be achieved or maintained and how conditions will be tracked over time.

Steps:

8. Compare and document the differences between existing and desired conditions, and, for visitor use-related impacts, clarify the specific links to visitor use characteristics.
9. Identify visitor use management strategies and actions to achieve desired conditions.
10. Where necessary, identify visitor capacities and additional strategies to manage use levels within capacities.
11. Develop a monitoring strategy.

Outcome: Identify strategies to manage visitor use to achieve or maintain desired conditions.

Steps:

12. Implement management actions.
13. Conduct and document ongoing monitoring, and evaluate the effectiveness of management actions in achieving desired conditions.
14. Adjust management actions if needed to achieve desired conditions, and document rationale.

Outcome: Implement management strategies and actions, and adjust based on monitoring and evaluation.

Monitoring related to visitor use is a broad topic. To understand the content in this guidebook, it is important to distinguish between two different types of visitor use monitoring:

1. Monitoring that is conducted to inform the development of desired conditions. This type of monitoring focuses on the question, "What is the status and trend of visitor use?"

2. Monitoring that is conducted to evaluate the effectiveness of management actions. This type of monitoring focuses on the question, "Are current actions achieving and maintaining desired conditions?"

This guidebook focuses on the second type—monitoring that is conducted to evaluate the effectiveness of management actions in achieving and maintaining desired conditions. Such monitoring responds to two key questions: (1) For selected indicators, what is the status and trend of conditions?; and (2) How do conditions compare with established thresholds?

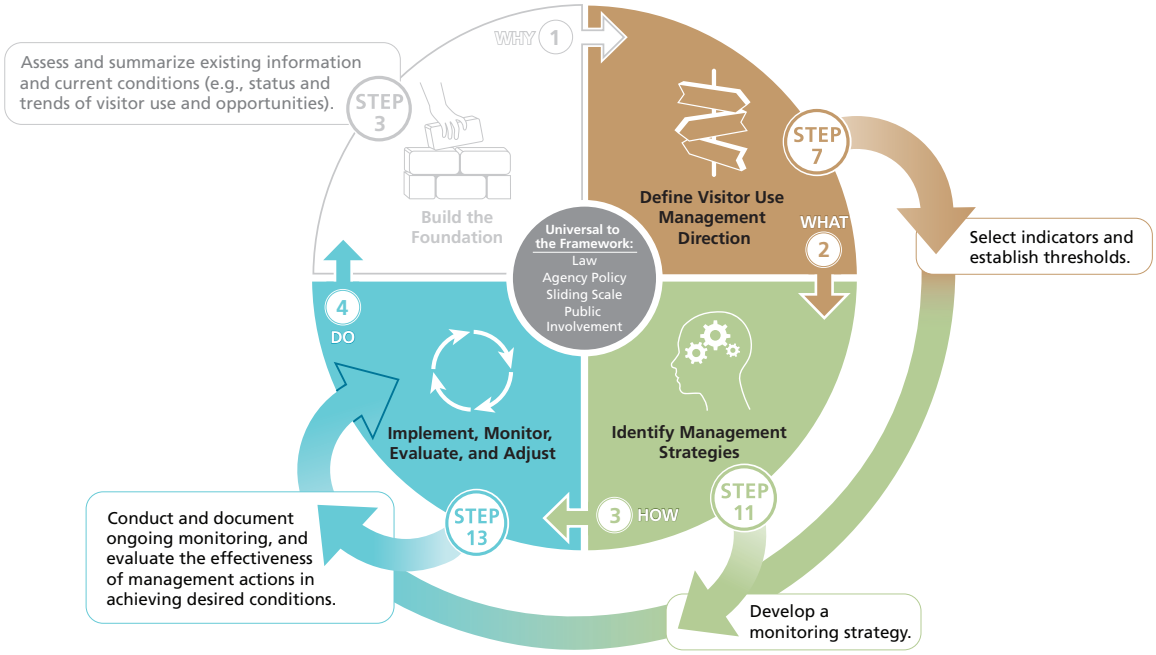
The focus of this guidebook does not diminish the importance of gathering data or conducting research related to the overall status and trend of visitor use. This broader scale of data collection may be conducted at the unit level, particularly for large units with complex visitor programs, but it is more often conducted at larger geographic scales that potentially span administrative boundaries. In addition, status and trend research can complement monitoring efforts and provide an even greater understanding of human-resource interactions. Broad-scale research or data collection helps inform step 3 of the framework (existing conditions) to build a solid foundation for the project. Examples of this type of information include:

- What is the status and trend of characteristics of visitor use (e.g., how much use is occurring, where are people going, what time of year are they visiting, in what activities are people engaged, how frequently do people return)?
- What is the status and trend of visitor demographics (e.g., age, gender, ethnicity, residence)?
- What are peoples' expectations and preferences? What are the attributes of the area that draw people to visit or reside in the area? What information sources are people using to find out about visitor opportunities?
- How much are people spending on their trips? How is visitor use contributing to the economy? How much are recreation opportunities and experiences on federally managed lands and waters contributing to quality of life considerations for individuals and businesses?
- How are external factors influencing recreation opportunities and visitor experiences (e.g., marketing campaigns, oil and gas development, gasoline prices, weather patterns)?

STEP 3

The white quadrant of figure 2 illustrates monitoring within the framework that is conducted to inform the development of desired conditions (element 1, step 3). The other quadrants of figure 2 illustrate monitoring within the framework that is conducted after desired conditions have been defined (i.e., monitoring conducted to evaluate the effectiveness of management actions in achieving and maintaining desired conditions). Again, this guidebook focuses on monitoring that occurs after desired conditions have been defined, not the monitoring that occurs to inform the development of desired conditions.

Figure 2. Representation of where monitoring is integrated into the framework.

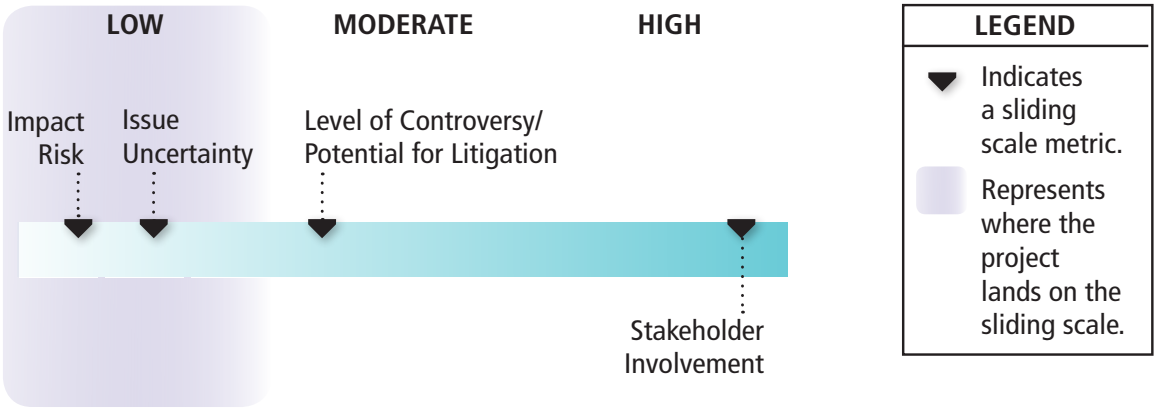


The sliding scale of analysis. Throughout this guidebook, the framework's sliding scale of analysis is emphasized to ensure that the investment of time, money, and other resources for a project is commensurate with the complexity of the project and the consequences of the decision. A variety of factors influences the appropriate level of investment in monitoring for the analysis area. The sliding scale focuses on four criteria, including the level of uncertainty about the issue, level of risk of impacts to resources and visitor experiences, degree of stakeholder involvement, and level of controversy/potential for litigation.

A sliding scale approach helps match the appropriate investment in monitoring for the analysis area with the consequences of the potential decisions to be made about managing visitor use. For example, if a decision would substantially affect one particular type of use or change how visitors access an area, a higher level of precision in the indicators, thresholds, and monitoring effort may be needed than if a decision involves a monitoring strategy that results in little change or only slightly modifies visitor use of an area. However, even in low complexity situations, desired conditions, indicators, and thresholds should be documented to track trends in conditions. Over time, it may be necessary to select more specific indicators and thresholds.

Figure 3 displays a hypothetical example of the sliding scale. In this example, the project team identifies the impact risk and issue uncertainty to be low; the level of controversy is low to medium; and stakeholder involvement is high. This example suggests that the project is generally low in complexity and does not require substantial investment of resources for the monitoring effort. However, the project team should communicate with involved stakeholders as the project progresses.

Figure 3. Representation of the four criteria involved in the sliding scale of analysis.



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Chapter 2: Why Monitor?

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Chapter 2: Why Monitor?

Ensuring quality visitor experiences and protecting the natural and cultural resources that attract people to federally managed lands and waters require a commitment to professional and proactive visitor use management. Decades of addressing visitor use issues have shown that good visitor use management requires:

- A clear description of desired conditions for resources and visitor experiences, as well as supporting facilities and services.
- An understanding of how visitor use influences the achievement and maintenance of desired conditions.
- A commitment to adaptive management and monitoring of visitor use.

Monitoring is an integral component of visitor use management, as it allows managers to objectively and effectively evaluate whether desired conditions are being achieved and maintained. Without monitoring, managers cannot determine whether their management strategies and actions are effective. Monitoring helps inform visitor use decisions. Ensuring that visitor use decisions are based on sufficient information results in a higher degree of accountability, defensibility, and transparency. Data collected systematically through monitoring help demonstrate the effectiveness of current management strategies, as well as the potential need for changes in management strategies over time. Data also help correct potential misperceptions about what is happening with visitor use. Information based on one snapshot in time is useful; however, it is incomplete. Monitoring shows how conditions change over time, including the rate and magnitude of change. In this way, monitoring provides a much richer and more complete picture to determine whether new management actions are needed to achieve and maintain desired conditions. If a visitor capacity is identified, monitoring is essential to ensure that desired conditions are achieved and maintained.

For these reasons, monitoring is as essential for managing visitor use as it is for managing natural resource conditions, such as the quality of wildlife habitat, air, water, rangeland, and other resources. Successfully addressing visitor use requires equal attention and commitment to planning, management action, and monitoring. The importance of monitoring is reflected in federal land and water management agencies' planning guidance. The following are some specific examples.

- **Bureau of Land Management:** "Planning for Recreation and Visitor Services" Manual 8320 and Handbook H-8320-1.
- **National Park Service:** National Parks Omnibus Management Act of 1998, Section 204; NPS Management Policies 2006; "Adaptive Management: The U.S. Department of the Interior Technical Guide"; NPS-75, "Natural Resources Inventory and Monitoring Guideline"; and "Integrating the Nation's Environmental Monitoring and Research Networks and Programs: A Proposed Framework."

- **U.S. Fish and Wildlife Service:** USFWS Planning Policy 602 FW 3 and 605 FW 1.
- **U.S. Forest Service:** 2012 Planning Rule (36 CFR 219.12); Forest Service Manual 1900, Chapter 1920 Land Management Planning; and Handbook 1909.12.
- **National Oceanic and Atmospheric Administration:** National Marine Sanctuaries Act of 1972 and Magnuson-Stevens Fishery Conservation and Management Act of 1976.
- **U.S. Army Corps of Engineers:** Engineer Regulation 1165-2-400, "Recreational Planning, Development, and Management Policies."

Despite the importance of monitoring, monitoring often suffers from perceptions, such as that it detracts from higher priority work, that it is overly expensive, and that it is time consuming. These perceptions stem from two common errors: (1) adopting a monitoring strategy with more indicators than can be realistically tracked over time and (2) selecting poor indicators that result in monitoring data that are not meaningful and thus are not used to inform management decisions and actions.

This guidebook helps managers avoid these pitfalls. Managers must understand how monitoring data will be interpreted and used over time and must involve staff who will be conducting the monitoring to develop a realistic monitoring strategy.

Trail counter mounted on a tree.

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Chapter 3: What is Monitoring?

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Chapter 3: What is Monitoring?

Citizen scientist works with staff to document plant density.

Monitoring is the process of routinely and systematically gathering information or making observations to assess the status of specific resource conditions and visitor experiences. Conducting an inventory of conditions or gathering information about a particular issue is not monitoring. To qualify as monitoring, three components are necessary: (1) selection of indicators, along with establishment of thresholds or objectives, and any needed triggers; (2) routine, systematic observations or data collection of the indicators over time; and (3) documentation and analysis of the observations or data in relation to the thresholds, triggers, or objectives. The sliding scale of analysis can help determine the appropriate level of monitoring for the analysis area. The key is to (1) select appropriate indicators and establish thresholds to achieve and maintain desired conditions and (2) sustain a consistent effort to gather observations or collect data about the indicators. Brief descriptions of desired conditions, indicators, thresholds, triggers, and objectives follow. Chapter 4 provides detailed guidance on selecting indicators and establishing thresholds, triggers, and objectives.

DESIRED CONDITIONS

Desired conditions are defined as statements of aspiration that describe resource conditions, visitor experiences and opportunities, and facilities and services that an agency strives to achieve and maintain in a particular area. Desired conditions do not necessarily describe the conditions that exist today; rather, they paint a picture of what a particular area will look like, feel like, sound like, and function like in the future. Monitoring an indicator at specified intervals helps managers determine whether the trend is moving toward a desired condition or away from a desired condition, potentially nearing a threshold.

INDICATORS

Indicators are specific resource or experiential attributes that can be measured to track changes in conditions so that progress toward achieving and maintaining desired conditions can be assessed. Indicators translate the broad description of desired conditions into measurable attributes that can be tracked over time to evaluate changes in conditions. Therefore, indicators must correlate directly with desired conditions. In addition, indicators must be capable of being assessed objectively over time, so that managers can determine whether conditions have changed and, if so, how.

THRESHOLDS AND TRIGGERS

A threshold is the minimally acceptable condition associated with an indicator. Visitor activities inevitably cause changes in natural or cultural resource conditions or visitor experiences. Proactive management involves determining the acceptable level of change for selected indicators. Thresholds serve this role by establishing the point at which the effects of visitor use on desired conditions are anticipated to become enough of a concern that a management action is needed to achieve and maintain desired conditions. In this role, thresholds serve as a stop sign or a "line in the sand." The concept of thresholds is well established within the field of natural resource monitoring (Guntenspergen 2014). The term "threshold" in the visitor use or recreation disciplines is synonymous with "standards" or "quality standards."

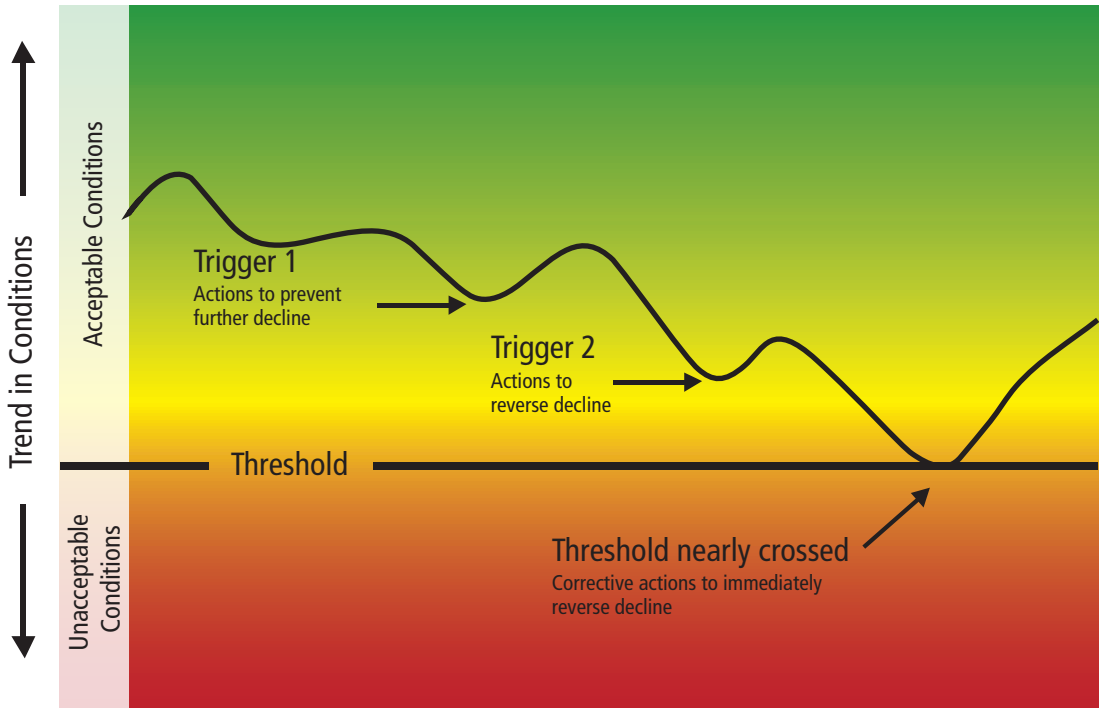
Three critically important concepts for thresholds are that: (1) although they must represent minimally acceptable conditions, thresholds still represent acceptable conditions, not degraded or impaired conditions; (2) establishing a threshold does not imply that nothing will be done prior to reaching it; and (3) a threshold should not be construed as a desired condition. Management strategies should achieve and maintain desired conditions before reaching thresholds.

Field monitoring of erosion along a popular trail.

A trigger is defined as a condition of concern for an indicator that is enough to prompt a management response to ensure that desired conditions continue to be maintained before the threshold is crossed. In more complex planning efforts in which there are particularly sensitive resources and/or considerable public interest, triggers may be established in addition to thresholds. A sensitive resource that requires close evaluation may have multiple triggers to ensure appropriate management actions are taken to avoid crossing the threshold.

Establishing a threshold and, if needed, a trigger for each indicator allows managers to determine when a change in management actions is needed to ensure that desired conditions are achieved and maintained. A change in management actions is needed when a threshold for an indicator is at risk of being reached or, if a trigger is established, when a trigger is reached. For example, if an indicator is "the number of salmon swimming past a sonar counter from May 1 to August 1," with a threshold of "600,000 salmon per season," a trigger may be "a count of less than 50,000 fish per week." Triggers and thresholds are related, but separate, values. Figure 4 displays how monitoring information is used in relation to triggers and thresholds.

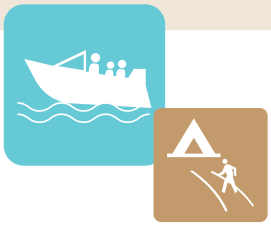
Figure 4. Trends in conditions in relation to triggers and thresholds.



Putting Indicators, Thresholds, and Triggers Together

It may be helpful to think of monitoring as similar to an annual doctor's visit. Indicators are used typically to assess general health, such as blood pressure, weight, heart rate, and body temperature. Through several years of data collection and monitoring of selected indicators, thresholds were established with associated treatment options. For example, a blood pressure threshold for people more than 60 years old might be 150/90 before a doctor recommends medication. If a person's blood pressure is below the threshold but going up over time (triggers), the doctor will recommend making some simple changes to stabilize or reverse the trend, such as a change in diet and exercise. At the next doctor's visit, if the person's blood pressure is continuing to trend near the threshold, the situation is more serious, with potential life-threatening consequences. If the actions (dieting and exercising) did not stabilize or improve the patient's blood pressure, the doctor will recommend more aggressive and immediate interventions, likely involving drug treatment combined with other lifestyle changes (e.g., enrolling in a weight loss program). However, if a patient has not been to a doctor in many years and the first assessment reveals blood pressure already above the threshold, the doctor may immediately implement all the interventions.

A patient who skips regular checkups at the doctor potentially creates a scenario in which all the interventions are necessary because the underlying cause of high blood pressure is unknown. Assessing changes in desired conditions related to the quality of opportunities available to visitors, including the quality of the environment in which those opportunities depend, should be approached with the same professionalism and commitment as a doctor assesses changes in a patient's health indicators.



OBJECTIVES (OPTIONAL)

In addition to thresholds, managers may establish specific, positive targets or objectives for resource conditions or visitor experiences. Unlike a threshold, an objective is defined as a specific result that an agency aims to achieve within a specified timeframe. If thresholds are markers to prevent negative consequences and unacceptable conditions, objectives are markers to help ensure positive progress toward achieving and maintaining desired conditions. Another distinction between objectives and thresholds is that objectives typically reflect conditions that are affected directly by agency action, whereas thresholds reflect conditions that result from the effects of visitor use under a particular management strategy. In practice, objectives are typically stated as managerial performance goals, whereas thresholds are typically based on physical, biological, or social conditions. Examples of objectives include participation rates in interpretive programs, maintenance of restrooms, and rehabilitation of trails over a specified period of time. The example in table 1 illustrates the difference between a threshold and an objective. In the framework, establishing objectives occurs at the same time as selecting indicators and establishing threshold.

Table 1. Example showing the difference between a threshold and an objective.

DESIRED CONDITION	MONITORING QUESTION	INDICATOR	THRESHOLD	TRIGGER	OBJECTIVE
Dispersed backcountry campsites are located in durable areas and are able to handle repeated use without significant degradation of surrounding natural and cultural features.	Are the current number of campsites sufficient to accommodate the existing and reasonably foreseeable amounts of visitor use without increasing in size or number?	Number of new informal* campsites identified.	No more than 3 new informal campsites are identified per year.	Two new informal campsites identified in 1 year.	Within 2 years, remove any newly established informal campsites located within the first 5 miles of trail.

* The term "informal" is used in this guidebook to describe trails and campsites created by visitors. "Formal" is used to describe designated trails and campsites. Other terms for trails and campsites created by visitors include unofficial, undesignated, social, visitor-created, and user-created.

As stated previously, attributes that relate to managerial performance (e.g., number of education programs delivered, miles of trail maintained, number of informal routes revegetated) are useful for establishing objectives.

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Chapter 4: How is a Monitoring Strategy Developed?

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Chapter 4: How is a Monitoring Strategy Developed?

This chapter provides guidance on selecting indicators and establishing thresholds and, if needed, triggers and, if desired, objectives. There is no single set of indicators and thresholds that will apply to all situations. Indicators and thresholds will vary depending on the purpose of the analysis area, desired conditions, sensitivity of valued resources, and amounts and types of visitor use. The degree of effort required to develop meaningful indicators and thresholds depends on the complexity of the project and the level of precision needed to inform future decisions. The sliding scale of analysis can help determine the degree of effort required. The sliding scale of analysis is explained in detail in chapter 2 of the framework and is also discussed as it relates directly to monitoring in chapter 5 of this guidebook. Appendix A includes a table of example indicators and thresholds. This can be used as a starting point for brainstorming indicators and thresholds. Appendix B provides monitoring scenarios illustrating the use of indicators, triggers, thresholds, objectives, and management actions. Finally, appendix C includes an example indicator and threshold worksheet that has been used in workshop settings to document a process similar to what is outlined in this chapter for selecting indicators and establishing thresholds. Also, table 2 (near the end of this chapter) includes examples of desired conditions and corresponding indicators and thresholds, as well as associated indicator and threshold rationales and monitoring methods.

PROCESS FOR SELECTING INDICATORS

The process for selecting indicators is part of element 2 in the framework: define visitor use management direction. This element answers the questions: What are we trying to achieve, and how will conditions be tracked over time?

Volunteer captures raptor migration monitoring data at Glacier National Park.

Indicators should be selected through an interdisciplinary team. Depending on the complexity of the analysis area, the team may consist of only a few people, or it may be a large team dedicated full time to the project. In either case, the team should include members with requisite subject matter expertise, including those who would be responsible for implementing the monitoring strategy.

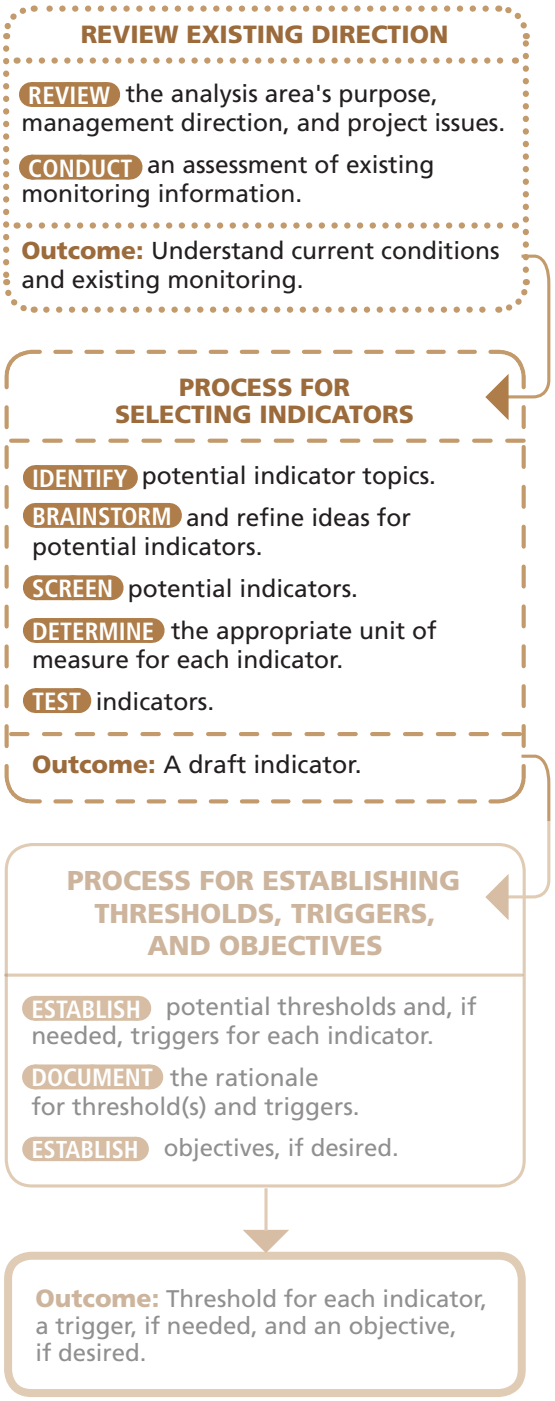
When developing potential indicators, the public and other stakeholders can play an important role. First, the public may provide insight and perspectives managers may not have considered. Second, managers may learn from the public what is

important to the visitor experience in the analysis area. Third, the public's concerns may help inform selection of indicators that reflect those concerns. Almost all federal agency planning processes require some type and degree of public involvement. Public involvement is also one of the primary purposes of the National Environmental Policy Act of 1969. The type and degree of public involvement will vary based on specific agency procedures and the level of analysis.

Note that monitoring forms that involve obtaining information from the public require approval from the Office of Management and Budget under the Paperwork Reduction Act of 1980.

When selecting indicators, build on work already done and information already collected. The following steps (figure 5) are recommended.

Figure 5. Process for selecting indicators and establishing thresholds, triggers, and objectives.



1. Review the analysis area's purpose, management direction, and project issues.

STEP 2

STEP 5

Review the area's purpose and applicable legislation, agency policies, and other management direction. Since indicators are used to assess whether desired conditions are being achieved or maintained, it is critical that the selected indicators correlate directly to the desired conditions. Desired conditions should have been developed previously. Desired conditions may not seem specific to the particular issue being addressed; however, as long as they describe the broad emphasis for the area, they will be useful to guide selection of indicators. For instance, an example of a desired condition statement for a watershed might read, *"Streams are free flowing with well-developed riparian vegetation and largely intact streambanks. Plant communities retain natural integrity with the presence of weeds confined to small localized spots that can be readily treated."*

Review issues associated with the analysis area, and consider developing a specific issue statement or monitoring question for the analysis area (see p. 24 of the framework for guidance on analysis of issues). For example, an issue statement for a watershed might read as follows:

> The Moose Creek watershed is receiving increased recreation pressure, likely because of trail closures in the nearby Joseph Canyon and Blue Forest areas. Continued use of trails that cross Moose Creek may degrade fish habitat through human-caused erosion of sediment, introduction of noxious weeds, and diseases carried by humans, animals, or equipment. There is a need to decrease human-caused sediment flow into Moose Creek to improve habitat for the threatened spotted trout.

A related monitoring question could read: "What is the trend in sediment flow into Moose Creek downstream of trail crossings?" Issue statements and accompanying monitoring questions can help focus monitoring on changes in natural resources and visitor experiences that are most likely to affect desired conditions. Clear issue statements can shape indicators and ensure that indicators directly correlate to desired conditions and that the data collected in monitoring can be used to inform future decisions.

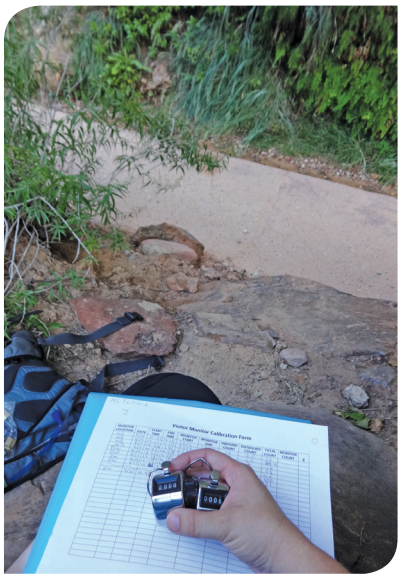
2. Conduct an assessment of existing monitoring information.

Identify information that is already being collected about the effects of visitor use on resource conditions and visitor experiences. Existing monitoring efforts could be internal as well as external. For instance, volunteer groups, nonprofit organizations, county search and rescue units, or state resource agencies could be tracking data that can contribute to the current understanding of visitor use. This assessment does not need to be an exhaustive list or report of every study, survey, and condition assessment for the analysis area. Rather, this effort should yield knowledge of available relevant sources of information specific to visitor use. It may be helpful to summarize the information that is already being collected before the team meets.

To further guide the assessment, consider the following questions:

- What is known about current visitor use, such as the patterns, timing, and types of use? And how is visitor use changing (in terms of trends in use levels, locations of use, types of activities, desired expectations)? Depending on the complexity of the analysis area, this information may come from staff observations, data collection, or research studies.
- Has any historical research or monitoring been conducted that can contribute to the understanding of long-term trends related to resource conditions that are affected by visitor use?
- Has public input identified locations or issues that merit special consideration?
- What type of monitoring, observations, or research is already being conducted that contributes to the understanding of existing conditions and may help inform achieving and maintaining desired conditions? What kind of information has influenced decisions in the past? Focus on existing resource conditions and visitor experiences that are affected by visitor use.

3. Identify potential indicator topics.



Hand tally counters being used to provide a quick assessment of use levels.

Based on the first two steps, identify potential topics related to visitor use that are most important to achieving and maintaining the analysis area's desired conditions. The indicator topics will help in the selection of measurable indicators. Appendix A provides a table of indicator topics and associated example indicators and thresholds.

To brainstorm relevant topics, discuss changes to resource conditions and visitor experiences that result from visitor use. Be specific in describing visitor use issues and impacts, as specificity is helpful in selecting useful indicator topics. Challenge the team to think about the topics that are most relevant to desired conditions rather than the topics that seem easiest to monitor. It is important that indicators measure impacts that are directly related to visitor use. Sometimes natural resource and other impacts can be difficult to tie directly to visitor use. For example, an invasive plant species could be introduced to a roadside by both visitor use and natural processes, whereas the introduction of quagga mussels to a lake may be more clearly tied to visitor use.

STEP 10

Consider whether the indicators and thresholds will inform identification of a visitor capacity (see the framework and the "Visitor Capacity Guidebook: Managing the Amounts and Types of Visitor Use to Achieve Desired Conditions"). If so, determine how the indicator guides the identification and management of appropriate use levels to achieve desired conditions.

Sort indicator topics into categories and subcategories.

Examples of common natural and cultural resource indicator topics include:

- Trail condition
- Loss or change in vegetation
- Presence of invasive aquatic species
- Wildlife disturbance or habituation
- Damage to and theft of cultural resources
- Recreation site and campsite conditions
- Water impacts
- Human waste presence
- Changes to the acoustic environment

Examples of common experiential indicator topics include:

- Changes to the acoustic environment
- Crowding at destination points
- Conflict between user groups
- Parking or roadway congestion

These broad topic categories and subcategories will help inform the selection of specific, quantifiable indicators. After the topics are categorized, group together topics that have a common issue or that could be addressed with similar data or observations. For example, a repeatedly crowded trailhead and parking lot could mean that the trail also has areas of congestion. In some cases, collecting information on trailhead parking could help address other issues in more remote areas (e.g., at attraction sites, along trails). Making decisions about how to manage trailhead parking (e.g., distribute use, create more spaces, reduce the supply of parking) could be enough to change the resource conditions and visitor experiences along the trail.

4. Brainstorm and refine ideas for potential indicators.

After categorizing and grouping indicator topics, brainstorm potential indicators for those topics. Determine simple, quantifiable indicators that correlate directly to desired conditions and that build on what is already being monitored to the extent possible. Use the questions that follow to determine what specifically is most important about the indicator topics.

For each topic, ask:

- What changes in conditions are most likely to threaten achievement and maintenance of desired conditions?
- What changes in conditions are most related to use levels and could inform a visitor capacity, if needed?
- What changes in conditions would prompt a different management response?
- What changes in conditions would cause the most concern?

Refine the topics into measurable indicators. For each topic, describe where and when impacts occur, the severity of impacts, and who or what is impacted, to help build the rationale for selected indicators, as well as to inform development of the monitoring strategy. For the purpose of assessing effectiveness of management actions in achieving desired conditions, focus on selecting indicators that directly correlate to the effects of visitor use on resource conditions and visitor experiences. For example, in certain environments, a trail that is considered an informal trail may actually be created by wildlife. Indicators that relate to managerial performance (e.g., the number of educational programs delivered, the miles of trail maintained) are more useful for establishing objectives than thresholds. If a visitor capacity has or will be identified, it is important for the project team to select an indicator(s) related to the limiting attribute(s). Note, not all indicators need to be directly connected to visitor capacity. See the "Visitor Capacity Guidebook: Managing the Amounts and Types of Visitor Use to Achieve Desired Conditions" for additional guidance on identifying visitor capacities through the evaluation of limiting attribute(s).

Some examples of natural resource topics and indicators include:

- **Topic:** Trail proliferation. **Indicator:** Miles of informal trails.
- **Topic:** Wildlife habituation. **Indicator:** Frequency of observations of animals actively seeking food from visitors.

Some examples of cultural resource topics and indicators include:

- **Topic:** Historic structure damage. **Indicator:** Integrity index.
- **Topic:** Archaeological resource damage. **Indicator:** Incidents of vandalism or other damage to cultural resources.

Some examples of experiential topics and indicators include:

- **Topic:** Soundscape. **Indicator:** Percent of time human-generated noise is audible.
- **Topic:** Crowding. **Indicator:** Number of people per viewscape.

Influence of Technology on Indicators

Evolving technology can influence the selection of potential indicators. New technology, such as handheld Global Positioning System units and smartphone applications, allows trained volunteers, citizen scientists, and staff to collect data quickly. Other technology, such as camera software that records the number of people in an area at a given time, can greatly reduce field time for staff or volunteers.

Today, soundscape technicians can analyze days of sound data in a few hours by using specific software. Remote sensing and aerial imaging capture broad-scale information that provides a more complete picture of cumulative impacts over time than data on changes collected from specific sites. An example of the use of remote sensing applications includes capturing trail or campsite proliferation across large, relatively open landscapes. Participatory interactive web mapping tools allow staff, stakeholder groups, and the public to upload photographs and comments regarding their experiences and resource conditions on detailed web-based maps.

Monitoring transportation-related variables also has evolved. Traditionally, traffic volumes (via counts) were used to understand the number of visitors using roadway systems in federal lands; emerging technology allows planners to analyze additional variables. Advances in traffic counter technology allow better understanding of not just the number but also the type, timing, and routes of vehicles by linking multiple traffic counters in real time. The ability to make correlations with the data from transportation counters and trail-use counters allows us to better understand how visitor use along roadways influences resource conditions and visitor experiences along trails and at destinations.

These technologies may make it possible to select indicators that were not considered feasible to monitor in the past. While monitoring efforts may remain the same, scale considerations for time, space, and efficiency of data collection may allow for a wider variety of indicators to be considered.

5. Screen potential indicators.

A sign indicating a designated quiet zone at Muir Woods National Monument.

There is no specific number of indicators that should be monitored. The minimum number of selected indicators should be the number needed to detect change in resource conditions or visitor experiences and to provide useful information to decisionmakers. Professional experience, interdisciplinary input, and best available science should play a role in screening potential indicators.

Additionally, indicators often measure one aspect of a topic. For example, for the topic "visitor experiences of noise in terms of intensity and duration," consider which indicators measure the intensity of noise and which measure the amount of time noise is audible, and consider which is more important to desired soundscape conditions. If both are important, consider using two indicators to monitor the soundscape.

Criteria for screening indicators can be found in the following literature: Fancy et al. 2009; Franc et al. 2001; Hennings 2017; Lime et al. 2004; and Monz and Leung 2006. The following are some of the most common and useful criteria to determine which indicators are most effective for monitoring the effects of visitor use.

Important. Does the indicator directly correlate to desired conditions? Will monitoring the indicator provide useful information to inform management actions to achieve and maintain desired conditions?

Sensitive to change. Is the indicator sensitive enough to provide useful information to managers before substantial impacts from visitor use have occurred? If an indicator changes only after impacts are substantial, it will not serve as an early warning mechanism.

Connected to visitor use. Does the indicator measure an impact that is connected to visitor use (in terms of the levels, timing, location, and types of use)? Observed changes should be because of visitor use rather than environmental factors (e.g., changes in vegetation cover may relate more to the amount of rainfall than to visitor use unless an undisturbed control area can be established as a reference point). If the connection is indirect, but relevant, be sure to provide a transparent rationale.

If the potential indicator does not directly correlate to desired conditions, is not sensitive to change, or is not connected to visitor use, remove the indicator from further consideration, as it will not be useful for visitor use monitoring.

If the indicator meets the first three criteria, then consider the following additional criteria, which are also important to select viable indicators.

Reasonable. Is the indicator related to an existing monitoring effort, or can it be reasonably and feasibly monitored with existing staff or partners?

Reliable. Can the indicator be monitored accurately and yield the same results if measured by different people (i.e., does the observed change in conditions reflect a true change rather than a measurement error)?

EXAMPLE

Indicators should not reflect conditions that will vary based on an administrative factor (e.g., staffing levels). For instance, an indicator such as "the number of speeding citations along Bear Lake Road" is more likely tied to the number of law enforcement officers assigned or available to patrol that road than to the actual number of people speeding on the road. If year one monitoring has two officers and yields 100 citations, but year two monitoring has one officer and yields 25 citations, it will be difficult to determine if the citations have decreased because of visitor behavior (i.e., slower driving speeds) or fewer officers. A better measure would be "the median speed of drivers along Bear Lake Road at a particular location." In this example, a speed tracker or tube counter could measure the speed of drivers, and management actions (such as an increased law enforcement presence) could be assessed for their effectiveness on driving speed.

As mentioned throughout this guidebook, the amount of effort required to select and monitor indicators can vary depending on the complexity of the analysis area (i.e., where it falls on the sliding scale of analysis). For example, indicators for an analysis area that falls on the high end of the sliding scale may need a high level of expertise, time (e.g., robustness of sampling), and effort to implement, whereas indicators for an analysis area that falls on the low end of the sliding scale tend to need a low level of expertise, time, and effort to apply. Numerous publications are available that have lists of indicators for visitor use monitoring (see the References section of this guidebook). Appendix A includes a list of indicator topics and associated example indicators and thresholds and can be used as a starting point for brainstorming.

6. Determine the appropriate unit of measure for each indicator.

When selecting an indicator, it is important to determine an appropriate unit of measure for that indicator. For example, there are many types of trail impacts and many different ways to measure a specific trail impact. A more specific trail indicator might be "miles of informal trails per analysis area" or "average trail width within the first 2 miles of trailheads" (with an accompanying description of what is meant by "trail width," such as "the most pronounced outer boundary of visually obvious human disturbance created by trail use—the area that appears to receive greater than 95 percent of traffic"). Different units of measure will provide different resulting data, affecting the usefulness of the indicator to managers in analyzing changes in conditions. Specificity in indicators helps to ensure reliability in data collected by different observers or data recorders.

With an indicator such as encounter rates, it is important for those collecting the data to have a clear definition of an encounter. For example, does an encounter mean physically passing someone on the trail? Does it mean seeing someone from the trail? Does it mean hearing someone from the trail? These are important questions to clarify as early as possible to ensure the indicator can be measured accurately over the long term.

EXAMPLE

Azure River Recreation Area initiated a pilot process to collect data on the number of wilderness trail encounters. During this refinement period, staff assigned patrol rangers to collect these data. The use of patrol rangers for monitoring was an efficient use of time since they were already in the field and patrolling trail segments of interest. Over time, monitoring staff noted patrol rangers were using a combination of foot and stock travel and moving in uniform directions (e.g., from patrol cabins in mornings and returning in the evenings) at times that limited the randomness of sampling. This snapshot of encounter data via patrol rangers was found to be inconsistent with desired sampling methods. Interns, volunteers, and monitoring staff now collect this information in the Azure River Wilderness. This refinement in the monitoring protocol has increased sampling to an acceptable degree of rigor to more fully understand wilderness trail encounters over time.

Determining the appropriate scale for the unit of measure is also important. For example, if trail impacts are a concern, it would be important to consider whether assessing the number of informal trails every ½ mile or every mile would provide data that are more useful. If evaluating trail depth, consider whether the indicator will supply information soon enough to respond to changes in condition if measuring depth in inches or feet.

Recognize that some indicators lend themselves better to a temporal or a spatial unit of measure. In particular, many indicators for monitoring experiential conditions are based on a temporal scale, such as a percentage of the use season. For example, "number of groups encountered along a trail" and "ability to find parking" could both show changes related to peak times seasonally and between weekends and weekdays.

Spatial units of measure can be both site-specific and aggregate. Site-specific unit measurements can yield accurate data and show the localized affects of management actions. Consider opportunities to aggregate the site-specific data to demonstrate change on broader landscape level. For example, park managers at Delaware Water Gap National Recreation Area installed anchored fire rings in the most resistant campsites to attract and concentrate use. This was highly effective and resulted in a 50% reduction in the total area of camping disturbance in five years. Despite higher levels of use, the median campsite size declined slightly, attributed to the selection of expansion-resistant sites and increased spatial concentration of activity around the fire rings (Marion and Cole 1996, Marion 2016).

Since monitoring within the framework is inherently iterative, it is appropriate to validate the indicators and refine the monitoring protocols and methods, if improved data collection methods become available (chapter 6 provides more detail on this topic). In situations in which monitoring does not yet exist, start with indicators that are simple and easy to monitor. To grasp a general understanding of change in conditions, it is suggested to begin monitoring with less specific indicators, such as photographs taken of the same area over time (Hall 2002). The sooner the monitoring process begins, the sooner useful observations can help determine whether desired conditions are achieved or maintained.

7. Test indicators.

Allot time for a pilot period, if possible. Do a trial run to make indicators as specific and as directly related to desired conditions as possible. Review and refine sampling methods to ensure staff are collecting information and interpreting protocols the same way. It may be helpful to test indicators in a variety of settings. Repeatable sampling, observation, and data collection are essential for indicators to provide useful and accurate information about long-term trends and changes in condition. Indicators can be easily altered during the pilot period. Afterward, indicators should remain stable and be consistently applied long enough to determine trends in conditions so that the effectiveness of management actions can be adequately assessed.

PROCESS FOR ESTABLISHING THRESHOLDS, TRIGGERS, IF NEEDED, AND OBJECTIVES, IF DESIRED

Once indicators have been selected, one or more thresholds should be established for each indicator. An indicator may need multiple thresholds if the indicator is being applied to various areas that have different desired conditions and therefore different levels of acceptable impacts. For example, the number of informal trails that is acceptable in a backcountry area may be different than in a highly developed frontcountry area. Use interdisciplinary team discussion, past monitoring information, public input, field observations, professional judgment, best available science, and literature reviews to establish thresholds for each selected indicator based on desired conditions.

Use the sliding scale of analysis to determine the degree of public involvement that is appropriate to establish thresholds. Consider the level of controversy in the analysis area and the sensitivity of the resources involved. Opportunities for public involvement may include visitor surveys, public meetings, or notices for public comment published on a federal land and water management agency's website. When establishing triggers, thresholds, or objectives, the following steps (figure 6) are recommended.

Two people hiking on wind-worn sandstone.

1. Establish potential threshold(s) and, if needed, triggers for each indicator.

Thresholds reflect the minimally acceptable conditions associated with an indicator. If conditions are reaching the threshold, management action must be taken to prevent and reverse unacceptable conditions. Thresholds serve a critical role to alert managers when action must be taken to keep conditions acceptable so that progress toward desired conditions can be achieved over time.

Establishing the threshold should be commensurate with the rigor associated with selecting the indicator. For instance, in situations in which there is little or no available information about existing conditions, it will be more challenging to establish thresholds. In these situations, thresholds that offer broad-scale, measurable information, such as "a visual change in the amount of bare soil based on repeat photography" may be sufficient. Over time, if more precise information is needed, establish more specific thresholds.

In some cases, natural and cultural resources or visitor experiences in an analysis area are unique and highly sensitive to change, or there is significant public interest in an analysis area, placing it on the high end of the sliding scale. Quantitative and qualitative indicators and thresholds can apply to projects on the low and high end of the sliding scale. If projects are on the high end of the sliding scale, a high degree of precision, detail, and documentation will likely be needed.

Information about existing conditions and desired conditions should inform potential thresholds. In some situations, knowledge and observations by staff and information from past studies or surveys may provide sufficient information to establish useful thresholds. For example, if staff know parking at a particular trailhead is an issue on weekends and have observed roughly how many vehicles park in undesignated areas, this information could be used to create a threshold, such as "no more than 5 vehicles are parked outside designated parking spaces at the trailhead more than once a month." In other situations, additional information may be needed to establish appropriate thresholds.

Consider collaborating with other agencies, stakeholders, or the public to obtain necessary data. Data sharing can reduce time, costs, and duplication of effort and can promote interagency coordination on visitor use management. Involving nongovernmental organizations, universities, interns, and/or citizen scientists in data collection can also reduce costs, save time, build relationships, and increase communication with the public. In addition, involving the public in monitoring can engender shared responsibility for identifying concerns and can facilitate a better understanding of any management actions to achieve and maintain desired conditions. Public input from local and nonlocal recreation and nonrecreation

users should be incorporated through ongoing civic engagement. Also, consider involving researchers or relevant research when establishing thresholds. For example, if crowding is a concern in an analysis area, consider working with individuals with a background in social science in selecting indicators and establishing thresholds. Balance input from the public and/or researchers with other management information to determine what is appropriate for a particular analysis area (Farrell and Marion 2002).

While establishing thresholds, it is important to determine the applicability of existing data (e.g., from scientific literature or other analysis areas). For example, if an administrative unit has site-specific resource and experiential conditions documented for a semiprimitive canyon trail, it may be possible to apply these data to a similar semiprimitive canyon trail within the administrative unit. However, it may not be appropriate to apply these data to a popular, more developed trail within the unit. Similarly, broad-scale data for a unit as a whole may or may not have a sufficient level of detail to inform establishment of thresholds for a site-specific situation within the unit.

Figure 6. Process for selecting indicators and establishing thresholds, triggers, and objectives.

Research and monitoring from comparable analysis areas might be relevant and applicable. For example, visitor encounters in wilderness have been researched for decades, and there are well-developed protocols for monitoring visitor encounters in wilderness. In another example, an interdisciplinary team may want to monitor equestrian water crossings in a trail system that runs through a patchwork of county, state, and federal lands. The interdisciplinary team may consult other land managers to understand how they monitor visitor use near water crossings.

Cautions associated with establishing thresholds. When establishing thresholds, some managers may want to establish thresholds of zero (e.g., no vehicles are parked outside designated parking spaces at the trailhead). However, establishing a threshold requires acknowledging that some amount of impact will be tolerated in areas that allow visitor use. Therefore, the minimally acceptable impact is not zero impact. For indicators in which there is little to no tolerance for impact (such as impacts to significant cultural resources), it may be appropriate to establish triggers that prompt management action before the threshold is crossed. A potential indicator to consider for a resource for which there is little to no tolerance for impact is an integrity index. An integrity index combines multiple measurable attributes that, together, contribute to the site's integrity. Changes in these attributes are translated into an estimated change in integrity to determine whether desired conditions are being achieved and maintained.

EXAMPLE

An interdisciplinary team determines that a cultural resource site in the analysis area should experience no more than a 15 percent reduction in its integrity index over 5 years due to visitor use. The monitoring protocol includes parameters for potsherds and stones specific to all cultural resource sites in the analysis area. At one site, a loss of five potsherds might constitute a 10 percent loss of integrity. At another site, movement of two stones might constitute a 10 percent loss of integrity. These data would be translated into an integrity calculation for each site. If the threshold is approached, a series of management actions could be triggered. Initially, managers could relocate the trail to avoid the site. If conditions continue to decline, managers could prohibit camping if there is overnight use in the area and then restrict access to tours guided by rangers. As a last resort, managers could close the area and direct visitor use to an alternate area.

Another caution is reacting to a change in condition that may be highly infrequent or an anomaly in the overall condition trend. In many cases, it is helpful to include an allowance (usually temporal or spatial) as part of a threshold. For example, a threshold may be set at "no more than five group encounters on the scenic section of the river during 80 percent of the sampled time." This provides an allowance that 20 percent of the time encounters could exceed five groups. Incorporating an allowance permits conditions to occasionally exceed the threshold, thus providing some flexibility so that new management strategies are not triggered because of an occasional or infrequent event. This allowance also acknowledges the inherent variability in visitor use patterns. It may also be wise to incorporate an allowance in thresholds to account for peak days and seasons, holidays, and weekends. For example, a threshold could be "at least 75 percent of hikers will have wait times of less than 30 minutes for pickup by a bus, averaged over the year," allowing for the unpredictability in peak visitation while still setting a threshold that ensures corrective action will be taken when there is a clear trend in overall congestion (NPS 1997). Table 2 provides an example of this approach.

Percent-based thresholds, in which a percent is used as a threshold (not just as an allowance as previously described), require special consideration. This type of threshold can be problematic for reasons including reduced sensitivity to change, compounding baseline conditions, and the potential to be unintentionally affected by related management actions. For example, two caves in the same area have varying levels of damaged stalactites. Cave A has a baseline of 20 damaged stalactites, and Cave B has a baseline of 500 damaged stalactites. If the threshold is "no more than a 10 percent increase in damaged stalactites from baseline conditions," then Cave A will reach the threshold if 2 stalactites are damaged, whereas Cave B will reach the threshold if 50 stalactites are damaged. It is important to note in this extreme example that the threshold for Cave B is likely unacceptable. A more appropriate threshold for Cave B that is more sensitive to changes over time might be based on actual counts of damaged stalactites instead of a percentage of damaged stalactites.

Another caution with percent-based thresholds is that such a threshold implies that a compounding impact or shifting baseline is acceptable. For instance, if a percent-based threshold is written as "no more than a 5 percent increase in impact annually," then 5 percent in year 1, 5 percent in year 2, and 5 percent in year 3 would result in a compounding of impacts because the baseline shifts each year, but conditions remain acceptable.

It is also possible that percent-based thresholds could be unintentionally affected by related management changes. For instance, a threshold states "no more than 50 percent of trail condition sample points can score more than 3 on a scale of 1 to 4 (which defines 1 as good condition and 4 as bad condition)"; if current conditions are at or near the threshold, then management should be prepared to take action to improve existing trails. However, if management decides to build new trails, doubling the mileage of trails, then the percent of trail condition sample points that scored 3 or more could be reduced from 50 percent to 25 percent without making improvements to existing trails.

Campsite in Mammoth Hot Springs Campground.

If monitoring data already exist from percent-based thresholds, the data still have value. If using percent-based thresholds, provide clear and thorough monitoring protocols to prevent manipulation or unintended issues so that the data can be reliably interpreted across monitoring intervals. Ultimately, the rationale for specific thresholds, including those that are percent-based, needs to be thoroughly documented.

Another consideration when establishing a threshold is that seasonality may require establishing different thresholds for different seasons (e.g., summer versus winter). Similarly, thresholds may be different for different management zones or other spatial segments of an area.

Finally, there is also often a desire to establish thresholds that are related to health and safety or operational conditions. These can be easy to adopt, as the data often exist, are accessible, and can be compelling. However, caution should be taken to ensure that the indicator and threshold are relevant and tied to achieving and maintaining desired conditions. For example, if the desired condition for a river is to "provide opportunities for class III boating" or for a trail is to "provide a technical and challenging hiking experience," the desire for high-skill/high-adventure experiences may presume some potential risk to health and safety. Thus, indicators that focus on risk reduction may be counter to the desired conditions. An additional challenge with health and safety indicators is setting a threshold. It can be difficult for managers to answer the question "how many safety incidents are too many," because the answer is usually zero. For these reasons, it can be challenging to use an indicator and threshold to inform ongoing management of visitor safety. In such cases, establishing an objective may be more appropriate. Managers can set objectives for increasing information about potential hazards, training requirements, or management strategies. For example, if emergency services are called out to the same site five times in a month, managers might establish an objective to "reduce the number of safety incidents at the site over the next 2 years" and could implement management actions such as safety education programs or a new regulation that requires boaters to wear helmets on class IV and V waters to help achieve the objective.

2. Document the rationale for threshold(s) and triggers.

The rationale for selected indicators and for the minimally acceptable condition of the associated threshold should be documented. Both rationales should discuss how the indicator or threshold monitors visitor use to achieve and maintain desired conditions. The rationale for a threshold needs to explain how the threshold was derived.

In projects that are more complex or for particularly sensitive resources, triggers may be needed in addition to thresholds. A trigger is a condition for an indicator that is enough of a concern to prompt management action to ensure that the corresponding threshold is not crossed. A sensitive resource that requires close scrutiny may have multiple triggers to ensure preventative management responses are taken to avoid crossing a threshold (figure 4).

For example, in table 2, a threshold is "the percent of time noise from airplane and helicopter tours is audible will not exceed 30 percent of the listening session averaged across 8 listening sessions." If currently there is 20 percent audibility, a trigger could be set for 23 percent audibility. Alternatively, assume that noise monitoring is conducted only every 5 years. The trigger for additional noise monitoring could be tied to an increase in the number of airplane and helicopter tours, which are reported annually. If 1,000 air tours are generally equivalent to 10 percent audibility, and 2,000 air tours are generally equivalent to 20 percent audibility, an increase in the number of air tours to 2,300 could trigger additional monitoring.

Table 2. Examples of desired conditions and corresponding indicators and thresholds, as well as associated rationales and monitoring methods.

DESIRED CONDITION	MONITORING QUESTION	INDICATOR	INDICATOR RATIONALE	THRESHOLD	THRESHOLD RATIONALE	MONITORING METHOD
In this area, natural systems predominate, cultural resources are protected, and motor vehicle use occurs only on a system of designated routes.	Is motorized use occurring outside designated routes?	Number of informal motorized trails visually determined through remote sensing data.	Informal trails may occur on poor soils and sensitive vegetation that are easily damaged. Additionally, informal trails may inadvertently damage cultural resources. They can also indicate that the trail system is not designed to satisfy the desired visitor experience.	No more than 1 new informal trail per year.	The presence of cultural resources in the area necessitates establishing a low threshold for change. Additionally, past experience suggests that managers can realistically restore only one trail per year in this area due to its remote nature. Establishing the low threshold for change ensures proliferation of informal trails does not accelerate in this area.	Remote sensing data. Download remote sensing data once per year, and visually count the number of informal trails. (Note: The term "informal trail" must be clearly defined.)
Backcountry campsites are sufficient in number and are in desirable, sustainable locations to handle current and future estimated use while still offering a semiprimitive environment.	Are the number and size of current campsites desirable and sufficient to accommodate the current and reasonably foreseeable visitor use?	Change in condition class of campsites.	Informal campsites cause vegetative loss and may not be located in durable areas. Heavily impacted campsites that are visually noticeable degrade the feeling of being in a semiprimitive, undeveloped environment.	No more than 5 campsites will change more than 2 condition classes per year.	The initial inventory found a total of 25 campsites. To provide the desired semiprimitive experience and accommodate some future growth, up to 5 campsites could show greater impact before significant changes in managing camping would be required. The threshold also recognizes the capabilities of the backcountry restoration crew to help keep site impacts acceptable.	Every odd number year, complete a full campsite condition assessment (per the national protocol for recreation site monitoring).

DESIRED CONDITION	MONITORING QUESTION	INDICATOR	INDICATOR RATIONALE	THRESHOLD	THRESHOLD RATIONALE	MONITORING METHOD
Provide a soundscape in which natural sounds predominate rather than human-caused noise.	Is noise from airplane and helicopter tours of sufficient intensity and duration to interfere with natural sounds?	Percentage of time that noise from airplane and helicopter tours is heard as determined by onsite listening sessions.	Air tours are a known source of noise in the area and can significantly reduce the effective listening area of both humans and wildlife.	The percent of time noise from airplane and helicopter tours is audible will not exceed 30% of the listening session averaged across 8 listening sessions.	To achieve the desired condition in which natural sounds predominate, the threshold reflects a condition in which visitors and wildlife hear natural sounds at least 70% of the time, on average. Setting the threshold lower than 30% is not realistic due to the presence of the airport relative to the area.	Every June, July, and August, conduct 8 sessions of 2-hour attended listening sessions.
Cultural resources are protected along backcountry trails.	Are cultural resources being degraded along backcountry trails from visitor activity?	Number of cultural and archaeological resources and artifacts showing signs of defacement or theft.	Significant cultural resources are important nonrenewable resources and are the primary reason visitors are drawn to the area.	No more than one case of defacement or theft of cultural resources each year.	The importance of cultural resources in this area necessitates establishing a low threshold for change because such resources are nonrenewable.	Once every year, conduct a visual assessment of all cultural resources for signs of defacement.

3. Establish objectives, if desired.

Field inventory of a riparian area.

Finally, establish objectives, if desired. The process for establishing objectives is similar to the process for establishing thresholds. Similar to thresholds, objectives should correlate directly with desired conditions, include an indicator, and involve monitoring to detect changes over time. Objectives reflect SMART principles: they are Specific, Measurable, Attainable, Realistic, and Time-bound (Poister 2003; Drucker 1954). As with thresholds, when establishing objectives, it is important to obtain input from an interdisciplinary team, stakeholders, and the best available science. It is also important to document the rationale for objectives (i.e., why they were selected). Objectives may be just as important and useful as thresholds in achieving and maintaining desired conditions.

5

Chapter 5: How is Monitoring Implemented?

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Chapter 5: How is Monitoring Implemented?

Snowy day in Mammoth Hot Springs in Yellowstone National Park.

This chapter provides guidance on developing and implementing a monitoring strategy to evaluate the effectiveness of management actions to achieve and maintain desired conditions. Monitoring should improve knowledge about existing conditions and help evaluate the effectiveness of management actions in achieving and maintaining desired conditions (Cole 2006). Monitoring should be operationally feasible and financially viable over an extended period. Visitor use, including the types of activities, number of visitors, and visitor behaviors, is highly susceptible to change. Therefore, monitoring the effects of visitor use is needed to ensure desired conditions are achieved and maintained for the long term. Good visitor use management involves development and implementation of monitoring long before critical decisions and management actions are needed. Recognizing the need for monitoring early can allow for a less stressful and more proactive approach to visitor use management.

A well-planned monitoring strategy provides for transparency, communication, and potential cost savings through efficiencies and possibly cost sharing. The greater the management team's awareness of visitor use monitoring, the greater the management team's receptivity to taking new management actions as a result of monitoring.

Answering the following questions will help develop a robust and comprehensive monitoring strategy and will help ensure visitor use monitoring remains consistent, efficient, and effective to meet its stated goals and objectives—ultimately informing management decisions (checklist modified from Broom and Hall 2008).

- ☑ What is going to be monitored and why?
- ☑ Where will monitoring occur?
- ☑ Which techniques will be used for each indicator?
- ☑ How often will an indicator be monitored?
- ☑ Where are comparable analysis areas for purposes of comparison? (if relevant)
- ☑ How will data be collected? Is there a manual with quality assurance protocols?
- ☑ Are there rules or regulations that apply to how the data are collected, managed, and/or reported?

- ☑ Who will collect the data?
- ☑ What equipment is needed?
- ☑ What short- and long-term resources (financial and staff) are available for monitoring?
- ☑ How will data be managed?
- ☑ How will data be analyzed?
- ☑ How will data be used? How do these findings increase effectiveness of visitor use management and/or resource protection?
- ☑ How will the findings be reported?
- ☑ Who are the audiences for receiving the monitoring information (e.g., managers, stakeholders)?
- ☑ Are there other data sources that provide the appropriate and informative data?

Answers to these questions can be informed by understanding existing conditions or (in some cases) the methods used to gather data on existing conditions. For example, the frequency of monitoring may depend on whether the desired conditions are being achieved and maintained. If desired conditions are being achieved, and there is no reason to believe immediate changes are near, monitoring could take place at longer intervals, such as every 5 years. Conversely, if existing conditions are close to or exceeding thresholds, management actions and resulting monitoring should take place as soon as possible and occur at more frequent intervals, such as every year. Additionally, if there is uncertainty about existing conditions or changes in existing conditions are possible, more immediate and frequent intervals of monitoring may be appropriate.

The sliding scale of analysis applies to developing a monitoring strategy. The level of monitoring effort should be commensurate with the complexity of the issue. At the low end of the sliding scale, one or two people could develop the monitoring strategy. At the high end of the sliding scale, an interdisciplinary team may be needed to develop the monitoring strategy, including staff who are committed to the effort over the long term. For highly complex projects, develop a monitoring strategy based on peer-reviewed, well-established, and scientifically robust protocols.

Boaters at river's edge.

Interdisciplinary team. Step 4 of the framework suggests establishing an interdisciplinary team to work through the framework for a specific project. It is helpful for this same team to develop a monitoring strategy or form the core of the monitoring team. Forming an interdisciplinary team for the monitoring strategy is incredibly valuable to development and evaluation of monitoring commitments for managing visitor use across a management unit. Team members may include participants not commonly associated with visitor and resource management, such as communication/interpretive specialists, senior leadership, administrative officers, patrol rangers, commercial/business services specialists, and others who may be involved in the monitoring strategy in the future.

Student volunteers on Long Pine Key Nature Trail at Everglades National Park.

During development and implementation, the importance of a monitoring strategy should be communicated to the public and the collective management unit to demonstrate the value of the strategy and to manage expectations externally and internally. The more the collective management unit is aware of why visitor use-related monitoring is needed, the greater the chance the strategy and resulting management actions will be viewed positively. During monitoring strategy development, an internal and external marketing effort can also be helpful to demonstrate the value of the monitoring strategy and manage expectations. Even strategies that have delivered valuable information on highly controversial management issues can be called into question over time. Initial broad-based commitment is beneficial for securing funding or staffing support. Support from the public and management for monitoring of any kind fluctuates, so having the strategy's goals and purpose documented and frequently communicated cannot be overstated.

For situations on the low end of the sliding scale, an interdisciplinary team that annually conducts a rapid assessment of conditions in the field for selected indicators may be sufficient. However, to promote manageability on larger projects, the interdisciplinary team may need to be split into small working groups related to specific monitoring strategy development and implementation functions. Structuring staffing to complete tasks is considerably easier if monitoring is a staff's primary responsibility. Although there are examples of monitoring strategies in which monitoring is a person's primary function, it is more common that monitoring roles are a collateral duty within a broader management position, and actual monitoring may be conducted by seasonal staff (ideally dedicated full-time to monitoring), interns, or volunteers.

STEP 3

Strategy scope. The scope of the monitoring strategy should consider five primary factors:

- Size of the analysis area and sampling
- Timing of the monitoring task
- Use of monitoring data
- Cost
- Number of indicators to be monitored

A clearly defined project area helps keep the project within scope. For many projects, the size of the analysis area is larger than can be reasonably monitored. Therefore, sampling is often required. Sampling, or sample of a population, can be used to generalize or draw inferences to a larger population or area (Creswell 2014). It is important for sampling to be representative of the overall condition of the indicator being monitored. However, the number and type of sampling locations can dramatically impact the time and cost of monitoring.

The monitoring strategy should consider timing for critical monitoring tasks, including when to begin data collection, how long monitoring should continue, and the frequency of monitoring. These considerations depend on many factors, such as when results are required to inform important decisions, the season in which data should be collected, and the difference between existing and desired conditions. Given the annual cycle of visitation that grows, peaks, and declines across a year, consider the timing when monitoring is conducted. For example, it is important to measure indicators for trail, recreation site, and campsite conditions at approximately the same time of year during each monitoring cycle, generally mid- to late-use season and before deciduous leaves or snow begin to fall. There is also the possibility of changing the frequency of monitoring based on prior monitoring results. For example, if a new mountain biking section of trail is created, monitoring trail conditions may take place frequently at first (e.g., yearly) and then less frequently (e.g., every 5 years) once the condition of the trail shows a stable and sustainable trend.

A park ranger leads a group of visitors on bicycles.

The monitoring strategy should also consider how many sites to monitor. For example, if there are 20 sites that could be monitored, grouping sites into representative traits could help reduce the burden of monitoring all 20 sites. These representative traits could be related to geography (e.g., west and east), size (e.g., small, medium, large), use (e.g., low, medium, high), or other traits that make sense for the context. If there are 20 sites that could be monitored, another approach could be to monitor 4 sites each year, and after 5 years, each site will have baseline information.

Access to Artist Point in Yellowstone National Park.

Additionally, temporal aspects of a monitoring strategy can be a major driver of cost. Ideally, a monitoring strategy would sample across all relevant timeframes, such as times of day, days of the week, weeks of the month, and months of the year. To cover all relevant timeframes, a robust sampling methodology would be incorporated. For example, if 5 sites are being monitored over 20 days, data collectors could begin collecting samples at sites 1, 2, 3, and 4 on day 1. Then on day 2, data collectors begin with sites 5, 1, 2, and 3, and so on as the days progress. By beginning collecting samples at different sites each day and rotating through, each site will be monitored at a different time of day.

Common questions about sampling involve sample size, which is the participation number or number of samples for which data were collected. Statistically, considerations for sample size include confidence interval, confidence level, and population size. Confidence interval is the margin of error (+ or - percentage) that can be allowed in the result, while confidence level is the percentage of certainty that the result is correct. Population size is the total number in a representative group (e.g., the number of visitors in the context of public lands). Numerous tools on the internet can assist with sample size calculations. For example, using an online sample size calculator, a population size of 1,000,000 visitors, a confidence interval of + or - 5%, and a confidence level of 95%, would result in a sample size of 384 visitors. If these visitors were picked in a random and unbiased way and were surveyed about their age, the survey result may be that "visitors are on average 41 years of age, and there is a 95% certainty that this age estimate is accurate within + or - 5%." Be aware that requirements for sample size apply to different groups. For example, to determine the average age of wilderness versus nonwilderness visitors with the same accuracy, 384 visitors to wilderness and 384 visitors to nonwilderness would need to complete surveys. Generally, estimating sample size is necessary for surveys of visitors, but in some cases, it may be used for resource impact monitoring.

How data will be used is also a part of designing the scope of the monitoring strategy. Forecasting all of the potential future uses for monitoring results can be overwhelming. The focus should be on collecting information (tied to the indicators) relevant to making sound visitor use planning and management decisions that can evolve over time. Secondary applications of results should play only a minor role in shaping monitoring considerations.

Use the sliding scale to consider the amount of investment needed in terms of sampling frequency, number of locations, level of expertise required, and many other considerations. For highly complex projects, achieving a high degree of statistical confidence is desirable. In these situations, if the requisite expertise is not available locally, seek assistance from outside the administrative unit. If statistical confidence is necessary because of a significant visitor impact concern but is not attainable, a contingency plan may be to require more frequent data collection to help validate existing conditions and trends.

Monitoring protocols and replication. One of the most critical aspects within a monitoring strategy is ensuring that data collection or observations can be replicated throughout the requisite monitoring timeframe. Whether simple or complex, a monitoring protocol should be replicable. For example, a simple protocol for monitoring trail conditions might include a single staff member walking all trails and identifying tread locations having running water and mud holes each spring. A more complex protocol might include two staff members conducting a random start, fixed interval sampling method that measures incision (depth), width, exposure of rocks and roots, and presence of mud or standing water along trails each September. Both methods (with written and more detailed protocols) are systematic and repeatable.

Clearly written data collection protocols are vital to the ability to replicate data collection methods so that results can be compared across sampling intervals.

Develop clearly written data collection protocols, particularly in cases of staff turnover or multiple data collectors. This ensures monitoring efforts can be replicated and results can be compared across sampling intervals over time (Oakley et al. 2003). A monitoring form can ensure data are documented consistently between observers. See Appendix D for sample monitoring forms. It may be helpful to provide new staff access to those with expertise in monitoring and monitoring protocols. In situations that are more complex, an attempt should be made to keep data collection protocols free of complex terminology and reliance on special expertise for analysis. Videos of procedures, in addition to written protocols, can be helpful.

When creating written protocols for replicability, for both simple and complex monitoring, it is extremely important to include detailed assessment protocols for field staff use, including measurement definitions, procedures, and, if necessary, diagrams, photographs, and quality assurance protocols. The goal is to provide a high level of measurement consistency and precision (both over time and between different data collectors) so that measurements largely reflect real changes in resource conditions rather than measurement error. The use of new technologies for collecting accurate spatially related data and digital photos can assist by ensuring field staff return to the same exact locations from prior monitoring cycles.

Use of a tablet in the field to survey visitors in Grand Teton National Park.

Visitor survey research often informs the selection of an indicator and/or establishment of a threshold. It is important to note, while sometimes appropriate, visitor surveys for a monitoring strategy require additional considerations. One of the primary considerations is public survey policies for federal agencies. Specifically, monitoring that involves obtaining information from the public (e.g., visitor surveys for perception or satisfaction thresholds) requires approval from the Office of Management and Budget under the Paperwork Reduction Act. Consider and plan for the time and cost that may be involved in the approval process.

In developing a monitoring strategy, consider:

- Creating a single overall report that includes all monitoring protocols.
- Designating an interdisciplinary monitoring coordinator.
- Selecting the requisite data analytics, such as frequency, mean, or median, and ways to display or represent monitoring data, such as bell curves or outliers (e.g., box and whisker plots or percentile measures).
- Reviewing the sliding scale of analysis to keep the process focused.
- Refining the monitoring strategy as data are collected and, if needed, revisiting indicators, triggers, thresholds, and objectives.

Funding considerations. Highlighting monitoring results and how they are used to inform management actions can remind managers about commitments with respect to staffing and funding and help build a culture that supports monitoring. Monitoring staff should anticipate the potential for fluctuation in funding and should be prepared to adapt if necessary. Monitoring efforts should be efficient and adaptable to meet management needs while focusing on a limited set of core indicators that provide results consistently over time. Otherwise, monitoring is prone to failure.

A family enjoys a scenic coastal view.

Managers should also consider how partnerships can make monitoring more sustainable and affordable. In some cases, monitoring can be accomplished through partnerships with friends groups, nongovernmental organizations, or local universities, which can result in cost savings. For example, the National Park Service Natural Sounds and Night Skies Division has a cooperative ecosystem studies unit agreement with the Colorado State University Listening Lab to assist in time intensive sound data processing. This agreement gives students an opportunity to learn about conservation and management of protected areas while leveraging National Park Service resources.

Data management. Organized data management is important for providing easy access to data, retrieving current and historical data, providing metadata files, and keeping an administrative record. Ensure all users know how to access monitoring data. Metadata documents describe how the data are set up, define acronyms and abbreviations, and contain other pertinent information. Developing an understandable architecture for data storage and query will optimize easy access to files. Files should be actively managed to ensure data quality and consistency. This includes clearly identifying types of data, different versions of data, and protocols for collecting and reporting data. Otherwise, it will be unclear how users will access, label, and present the data. Clear data management is also important for recognizing subtle changes in resource conditions, implementing alterations in collection methods, and producing reports on the monitoring strategy as a whole. In addition, a well-developed data management system will assist in interpreting monitoring data and communicating monitoring results.

Communicating monitoring results. Monitoring data are of little value if they are not analyzed, summarized, and reported in a format needed and easily understandable by decisionmakers. There are generally two audiences for monitoring reports: agency personnel and stakeholders. Decisionmakers must understand the results of monitoring, trends in resource and experiential conditions in relation to desired conditions, and anticipated management actions. Key stakeholders will likely also have an interest in monitoring results. It is important to communicate monitoring results and anticipated management actions to stakeholders in a timely manner

and be open to feedback. It can also be important to highlight unusual and highly influential extraneous events when reporting monitoring results, such as fires, floods, or droughts that may affect results.

Changes in indicators, triggers, thresholds, objectives, and/or monitoring protocols. Changes in indicators or monitoring protocols may be needed if they are not sufficiently responsive to the impacts of visitor use. Managers may decide to change or modify indicators and to revise monitoring protocols if better methods or technologies are developed to measure change. Managers may also revise indicators if they prove to not sufficiently measure the changes caused by visitor use or if they are not cost effective to implement. However, it should be noted that changes in indicators and monitoring protocols jeopardize data comparability. Therefore, changes in indicators and monitoring protocols should be made only to the extent necessary and within the first several cycles of monitoring, subject to the requisite level of public involvement and environmental compliance.

Visitors taking a photo of lower falls from Artist Point in Yellowstone National Park.

In some cases, an indicator may be appropriate and functioning well, yet the established triggers or thresholds may need adjustment. In these cases, it may be appropriate to adjust triggers or thresholds, but documentation and transparency are critical. Under no circumstance should an indicator or threshold be changed simply because a threshold has been exceeded or because staff want to postpone difficult decisions.

Monitoring strategy review. Review is recommended for all monitoring strategies, especially a complex one. If a review is conducted, it should be applied to all phases, including development, implementation, and reporting phases of the strategy. Note that these phases are iterative and may not align with the overall planning efforts.

- **Development phase:** Indicators are selected; thresholds and triggers, if needed, are established; and monitoring locations, cycles, and protocols are defined.
- **Implementation phase:** Monitoring data are collected and analyzed, and the need for management actions is assessed based on the data analysis. It may be valuable to develop a rollout plan for the implementation phase.
- **Reporting phase:** Long-term results are summarized for management deliberation and monitoring strategy validation.

These phases highlight key milestones within the life of a monitoring strategy. It makes the most sense to conduct reviews during these phases, when managers or interdisciplinary teams make important choices for the success of a monitoring strategy. Some indicators and monitoring protocols may be implemented more quickly than others because they need less testing and validation.

A peer review process should generate documentation supporting the visitor use monitoring strategy. This documentation should include major decision points for indicator selection, refinement, protocols, and reporting, as well as data analysis considerations and other key information needed by both internal and external audiences. After feedback is provided by both scientific and nonscientific audiences, a plan for consolidating, documenting, and managing this information should be the focus. These reviews should be viewed as dynamic and ongoing, enabling constructive refinements that will strengthen the monitoring strategy's utility and recognition.

Monitoring strategy reviews may also include internal or public meetings. Reviews can verify how well the strategy is understood. It is especially important for stakeholders to understand how indicators are being monitored to achieve and maintain desired conditions in situations in which management actions may be changed. Monitoring strategy reviews should be documented, and the information learned from them should be assessed to determine if strategy revisions are warranted.

A crowd of visitors looks out over a clearing where a large bison lays in the dirt.

6

Chapter 6: How are Monitoring Data Used?

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Chapter 6: How are Monitoring Data Used?

Once a monitoring strategy is developed, managers have a system for tracking changes in indicators that relate to desired conditions. Established thresholds, triggers, and objectives let managers know when to respond to changes in conditions. The next step in a successful monitoring strategy is implementing any needed management actions to achieve and maintain desired conditions and evaluating the effectiveness of those management actions.

This final chapter relates to element 4 of the framework: Implement, monitor, evaluate, and adjust. This chapter specifically relates to step 13: Conduct and document ongoing monitoring, and evaluate the effectiveness of management actions in achieving desired conditions. This chapter includes guidance on how to use monitoring data, implementing needed management actions based on those data, evaluating the effectiveness of those management actions, and understanding how and when to adjust management actions.

REVIEW AND INTERPRET THE DATA COLLECTED.

Once monitoring data are collected, managers can begin to analyze and understand existing conditions compared to desired conditions. Step 9 of the framework involves identifying management strategies and actions that are directly tied to achieving and maintaining desired conditions.

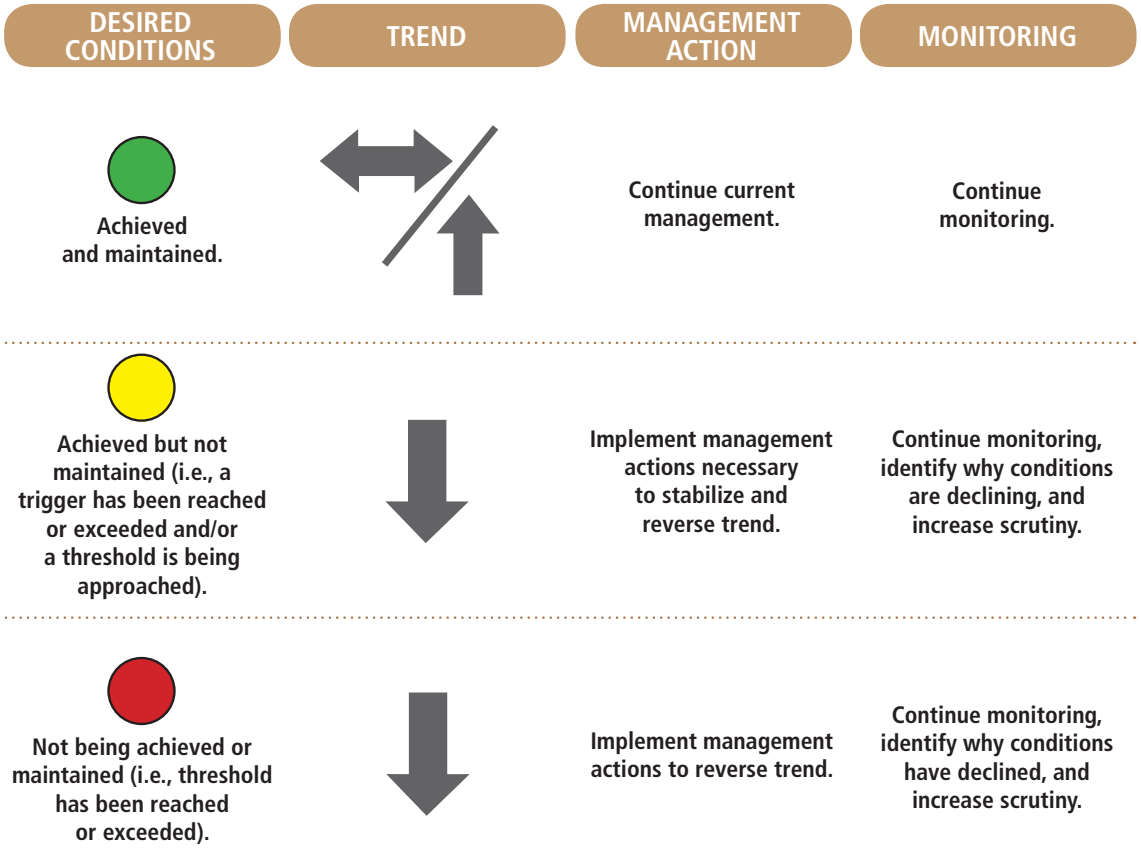
Review of monitoring data should focus on three areas: (1) compare existing conditions to desired conditions; (2) analyze trends in resource or experiential conditions; and (3) understand the causal or non-causal, but influential, factors underlying monitoring results so appropriate management actions can be taken. First, managers should compare existing conditions to desired conditions and determine whether conditions are close to or exceeding thresholds (and triggers, if used). There are three possible outcomes of this comparison: (1) conditions are acceptable; (2) conditions are near thresholds; or (3) conditions are exceeding thresholds. If objectives have been established, monitoring data should be evaluated against them as well. For objectives, the outcome of the comparison of existing and desired conditions results in either "the objective has been met within the specified time period" or "it has not."

Second, the trend in monitoring data from multiple monitoring cycles should be compiled and assessed. Multiple cycles of monitoring data enable managers to examine both short-term trends (i.e., from one cycle to the next) and long-term trends (i.e., from the first cycle of monitoring through several subsequent cycles). For example, multiple cycles of monitoring data may reveal that existing conditions are considered to be aligned with desired conditions but are trending down. This situation indicates there is a problem, and more intensive management attention is warranted. Regardless of when monitoring begins, managers should seek to continuously improve conditions. Identifying trends is complex—the more variable

the data, the greater the number of monitoring cycles needed to be confident the trend is accurately detected. During initial monitoring cycles, it is likely that refinements will be necessary to reduce variability in data. One of the arguments for long-term, routine monitoring is that it supports the ability to detect trends.

Third, some investigation should occur to understand the reasons for observed results. Resource staff, scientists, and field and seasonal staff may provide information, such as observations of visitor behaviors, sites, and resource conditions, that contributes to understanding the observed results of monitoring. A single factor (e.g., increase in one type of visitor use, change in one natural resource) can influence the condition of multiple resources. Further, management actions to improve the condition of one resource or experience may negatively impact the condition of other resources or experiences. Failure to understand the reasons for a change in conditions could lead to identifying an ineffective management action or actions resulting in negative unintended consequences. Figure 7 illustrates how monitoring data are used to inform visitor use management.

Figure 7. Use of monitoring data to inform visitor use management.



Finally, monitoring should be continually reviewed and improved in ways that preserve comparability, but also consider establishing a review point for the monitoring strategy. This review should summarize the progress, update the strategy, if needed, and also be used as a tool to ensure effective implementation.

Analysis of adverse trends. When analyzing an adverse trend in monitoring data, the interdisciplinary team should strive to determine the probable cause of the trend and the degree of its influence. If an adverse trend is due to factors other than the amounts and types of visitor use, the trend may be reversed by taking management actions unrelated to visitor use (Marion 2016). For example, analysis may reveal that campsites have expanded and proliferated in large, flat areas and that moving the campsites to small areas constrained by topography can effectively control campsite expansion and proliferation without having to alter the amounts and types of visitor use.

Student researcher enters measurements into a Global Positioning System unit.

In another example, although all campsites in an area receive similar amounts of use, some campsites may be losing substantial amounts of vegetation while others are not. Analyses may reveal that the most sustainable campsites are located in grassy areas and that the less sustainable sites are more heavily forested. Research has shown that grasses well suited for full sun are substantially more resistant and resilient to trampling than grasses growing in shady forests. Likewise, trail impact research often shows that factors such as grade, slope alignment angle, and substrate have a greater effect on the condition of trails than the amounts and types of visitor use. In other situations, in which adverse trends may be caused by visitor use and other factors, statistical analysis and testing can often help detect the most influential factors so managers can determine whether management actions that affect visitor use would be effective and appropriate.

EXAMPLE

Managers began to notice increased visitor use, congestion, and long restroom lines at a vehicle-accessible kayak launch. Managers initially identified a potential need for additional restroom facilities and initiated a simple monitoring protocol to observe visitor use of the site. Observational data revealed that visitors standing in line for the restroom were often holding clothes. Managers decided to construct an inexpensive clothes-changing station rather than additional restroom facilities, and the long lines receded. Visitor comments at the facility revealed that the changing station improved the visitor experience.

The scope and scale of adverse trends should be considered. For instance, is the trend localized or symptomatic of a larger change across an entire area? If the trend is symptomatic of a larger change, site-specific actions may be less effective or inappropriate. For example, drought could have severe impacts on an area and reduce the ability to identify underlying issues and also determine management action effectiveness. Equally important, if monitoring data reveal larger trends, rather than site-specific changes, it may be appropriate to examine whether desired conditions and indicators should be altered.

STEP 9

Implement needed and appropriate management actions. Management actions affecting visitor use generally fall into one of the three "E's"—education, engineering (including site design and restoration), and enforcement. Management actions affecting visitor use can be thought of along a continuum, from influencing to regulating behavior, from subtle to obvious, and from indirect to direct. Management actions can range from subtly influencing behavior through indirect methods, such as education, to more obvious and direct behavioral control through regulation and enforcement. See step 9 of the framework for more information about management strategies. If a visitor capacity has been or is being identified, then monitoring data, specifically indicators and thresholds related to the limiting attribute, can indicate when new management strategies and actions are needed to achieve and maintain desired conditions. See the "Visitor Capacity Guidebook: Managing the Amounts and Types of Visitor Use to Achieve Desired Conditions" for additional guidance on identifying visitor capacities through the evaluation of limiting attribute(s).

EXAMPLE

A parking area for a trail that leads to a popular waterfall becomes congested daily. The management team selected an indicator related to parking availability and a management action that initiates a gate closure if the threshold is exceeded. This indicator monitors parking availability as a proxy for monitoring crowding at the waterfall. The parking area is monitored throughout the day. When the parking area reaches the site design capacity, the gate is closed. When the parking area reaches capacity, the public is informed along the road that accesses the parking area. Information about parking availability is also shared throughout the day at entry stations and visitor information centers. Visitors are encouraged to go to other sites within the unit when the parking area is full. When parking becomes available (i.e., visitors begin to leave), the gate is reopened. The management team records the amount of time and number of incidents of parking area closure to track and compare parking area closure data between weeks and years.

STEP 14

Evaluate management actions, and adjust, if needed. Use monitoring results to adjust management strategies and actions to achieve desired conditions. When analysis of monitoring data shows that desired conditions are not being achieved or maintained, managers must act. When data analysis shows a downward trend in desired conditions, managers should intensify management actions. Managers should not wait for the end of a planned monitoring period to do so. If management actions are not improving conditions or improvement is slower than desired, managers should consider strengthening or increasing management actions.

Field staff install cameras alongside a trail.

EXAMPLE

A vegetation monitoring team began noticing an increase in the number of informal trails in a meadow that supports a rare plant species. The management team decided to provide educational signs to inform visitors about the damage informal trails can have on important sensitive resources. The team established an indicator related to the aggregate length of informal trails, a trigger, and a threshold based on the desired conditions of the analysis area. After several years of monitoring, the aggregate length of informal trails reached the trigger, resulting in implementation of two management actions: (1) construction of a trail through the meadow with barriers to deter off-trail travel and (2) restoration efforts on all informal trails. Subsequent monitoring revealed that the aggregate length of informal trails in the meadow was reduced but remained close to the trigger. An additional management action was implemented to increase agency presence and harden the trail. Subsequent monitoring revealed that the aggregate length of informal trails in the meadow has stabilized. Monitoring of the analysis area continues.

Monitoring is the best way to evaluate the effects of management actions. If multiple management actions have been implemented, more detailed data analysis may be needed to evaluate which actions are influencing which conditions. Consider other resources and monitoring efforts to ensure that management actions taken to protect one resource do not adversely affect another. For instance, rerouting a trail through an area with fewer sensitive plant species could place the trail in an area important to wildlife.

The results of continued monitoring will inform the need for subsequent management actions. If management actions are achieving and maintaining desired conditions, managers should still assess the need for adjusting management actions, such as whether management actions should be continued or whether improvements in conditions are sufficient or occurring at an acceptable rate. If resource or experiential conditions are not improving, managers should assess why and whether more direct management actions or more data and resources are needed.

At any point in the process, managers can reevaluate indicators, triggers, thresholds, objectives, monitoring protocols, and management actions. For example, it may be appropriate to ask whether there is a less costly way to monitor, or whether indicators could be adjusted to reflect desired conditions more accurately, or whether there is a way to improve monitoring protocol efficiency and effectiveness. As previously noted, an indicator, trigger, threshold, objective, or monitoring protocol should not be changed simply because a trigger has been reached or a threshold has been exceeded.

Desired conditions, indicators, triggers, thresholds, objectives, monitoring protocols, and management actions should not be changed without a documented rigorous analysis and rationale, such as changes in science, new legislation, or policy.

Needed changes should be based on monitoring data and the need to achieve and maintain desired conditions. Consider whether potential changes would result in unintended consequences, particularly the inability to compare future data to baseline conditions or data from prior monitoring cycles. If an indicator is changed, consider monitoring both the old and new indicator so that a crosswalk can be developed to preserve information from past monitoring. Additional revisions to monitoring protocols may be needed to maintain data comparability. This is the heart of adaptive management; however, adjustments often require a defined adaptable management structure (e.g., work plans, funding, staffing). Depending on the adjustment, environmental compliance may also be needed.

STEP 12

STEP 13

Document the analysis and rationale for adjustments. Document the analysis and rationale for adjustments to enhance clarity of purpose and desired outcomes for the agency and stakeholders. Documentation of rationale is especially important when conditions have reached triggers or exceeded thresholds. In documenting the analysis and rationale for adjustments, consider including:

- A summary of the indicator, trigger, threshold, objective, monitoring protocol, or management action and how it was implemented.
- Analysis of the monitoring data that suggests the need for an adjustment.
- Reasoning for the adjustments, including supporting analysis or evidence.
- Anticipated changes from the adjustments, how adjustments will occur, and the resources needed to implement adjustments.
- How the adjustments are expected to improve conditions.

Recognizing uncertainties and being transparent about assumptions in strategy development documents can support adjustments in the future. This is especially important for staff turnover, but it also helps guide institutional memories that have faded.

STEP 13

In summary, monitoring is an integral component of effective visitor use management—monitoring data provide the basis for management actions and ensure that desired resource and experiential conditions are achieved and maintained (see the framework, element 4, step 13). A monitoring strategy should be developed and implemented to provide usable data for periodically comparing existing and desired conditions, assessing the need for management actions, and evaluating the efficacy of management actions. Monitoring is, therefore, a vital component of visitor use management that should be implemented and maintained as needed or required. Consider reaching out to other practitioners, establishing communities of practice, and sharing lessons learned from monitoring.

Recording survey data at Yosemite National Park.

Appendices

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Appendix A: List of Indicator Topics and Associated Example Indicators and Thresholds

This appendix includes a list of indicator topics and associated example indicators and thresholds. Numerous publications are available that have lists of indicators for visitor use monitoring (see the References section of this guidebook).

INDICATOR TOPIC	EXAMPLE INDICATOR	EXAMPLE THRESHOLD
Campsite Condition	Aggregate area of camping disturbance for zone (this could also be used for individual campsites, areas of vegetation loss, or areas of exposed soil)	No more than a 10% increase in aggregate area of camping disturbance
Campsite Condition	Change in condition class rating for campsites	No more than 10% of campsites increase condition class ratings per monitoring period (e.g., change from class 1 to 2)
Campsite Condition	Amount of vegetation loss at a semideveloped campsite	Amount of vegetation loss at campsite will not exceed 625 ft2 (25 ft x 25 ft)
Campsite Condition	Percent occupancy of sites within campground or specified camping area	Maximum occupancy of 80% during primary use season (e.g., Memorial Day to Labor Day)
Campsite Condition	Number of tree stumps within a <4 inch diameter around campsite(s) (this could be an aggregated indicator to reflect change on a landscape level)	No more than 2 additional tree stumps over baseline conditions for campsite(s).
Crowding	Number of other camping sites/ groups visible	No more than 2 other camping sites/ groups visible more than 5 nights during primary use season
Crowding	Number of groups encountered along a trail	Encounters will not exceed 6 other groups in the management zone 80% of the time
Crowding	Number of people per viewscape	The number of people per viewscape will not exceed 85 at a specific location
Crowding	Number of people standing on the bus	There will be fewer than 5 people standing 80% of the time
Crowding	Number of times beaches need to be shared (may not be appropriate for all beaches)	A party can camp alone on a beach without sharing 80% of the time
Crowding	Number of watercraft passing by defined location per hour	No more than 10 watercraft pass by per hour

INDICATOR TOPIC	EXAMPLE INDICATOR	EXAMPLE THRESHOLD
Condition of Cultural Resources	Number of theft/ vandalism incidents	No more than 1 documented incident per year
Condition of Cultural Resources	Condition rating for integrity of cultural resource features	No less than a condition rating of good (50% integrity)
Improperly Disposed Human Waste	Aggregate number of improperly disposed human waste sites within an area or zone (as indicated by the presence of surface toilet paper or human waste)	No more than 50 human waste sites in a zone
Landscape Fragmentation	Mean patch size; GIS-measured trail and site attributes	Mean patch size should not fall below [select appropriate threshold for a given site]
Condition of Marine and Coastal Resources	Number of vessel groundings or evidence of groundings on coral reefs	No increase over baseline (2018)
Water Quality	Degree of degradation, measured by levels of fecal coliform per sampling period	State fecal coliform standard for recreational contact
Soundscapes	Periods of noise-free intervals at a specific site (defined as the period of elapsed time between human-caused sounds or the length of continuous time during which only natural sounds are audible)	The median noise-free interval at a specific site is at least 4 minutes during daytime hours (7 a.m. to 7 p.m.)
Soundscapes	Increase over natural ambient sound pressure level at a specific site	Anthropogenic noise will not increase ambient sound levels by more than 3 dBA (as measured by L50 or Leq) over natural ambient at a specific site more than 90% of daytime hours (6 a.m. to 6 p.m.)
Trail Conditions	Number of informal trails per mile of designated trail	No more than 1 informal trail leaving designated trail per 1-mile segment
Trail Conditions	Linear extent of informal trails	No more than a 10% increase in linear extent of informal trails in an area from last monitoring interval

INDICATOR TOPIC	EXAMPLE INDICATOR	EXAMPLE THRESHOLD
Trail Conditions	Trail condition as reflected by trail depth (consider splitting trail depth and width, since management actions to resolve issues may vary)	More than 70% of the time, tread incision will not exceed 8 inches, and tread width will not exceed 12 inches per 1 mile of trail
Trail Conditions	Trail condition as reflected by trail depth	More than 70% of the time, tread incision will not exceed 6 inches per 1 mile of trail (varies by trail class)
Trail Conditions	Trail condition as reflected by trail width	More than 70% of the time, tread width will not exceed 24 inches per 1 mile of trail (varies by trail class)
Parking Availability	Number of incidents of unauthorized roadside parking	No more than 3 incidents of unauthorized parking within ½ mile of a trailhead per week
Parking Availability	Ability to find parking	Parking areas are not more than 95% full more than 2 days per week during the peak use period
Use conflicts	Number of incidents specific to use conflicts reported or responded to by law enforcement	No more than 5 incidents specific to use conflicts for this fiscal year
Viewsheds	Vehicles per viewscape	No more than 15 vehicles visible in the roadway from identified key scenic locations
Wilderness (undeveloped quality)	Number of emergency authorizations to use motor vehicles, motorized equipment, or mechanical transport	No more than 2 per year associated with visitor use
Wilderness (solitude quality)	Opportunity to camp without seeing or hearing other parties (consider separating sight and sound if the management actions vary in response to sight versus sound)	Parties are able to camp out of sight and sound of others 80% of the primary use season
Wilderness (solitude quality)	Mean intersite distance (distance between sites, often calculated using GPS and GIS)	Mean intersite distance is at least 50 feet
Wilderness (solitude quality)	Number of campsites per acre	No more than 2 campsites per acre
Wildlife/fish	Density of informal trails in known, sensitive wildlife habitat	No more than 1 informal trail leaving the designated trail per 1 mile measurement

INDICATOR TOPIC	EXAMPLE INDICATOR	EXAMPLE THRESHOLD
Wildlife/fish	Number of incidents of undesirable human-wildlife encounters (e.g., habituation, atypical behavior such as aggressiveness or food stealing) (Marion et al. 2008)	Number of ground squirrels within 10 ft at one time within a 2-minute observation period
Wildlife/fish	Number of fishing violations or citations	Number of fishing violations or citations will not exceed 20 during the main season of use (Note, a standard level of enforcement or ways to ensure this information is collected consistently is important)
Wildlife/fish	Population sampling of salmonids in stream during and following project implementation (comparing up-and downstream spawning conditions is also an option)	No downward trend for more than 3 consecutive years.
Wildlife/fish	Amount of observed change in owl and eagle nesting due to visitor disturbance	No more than a 1-hour shift observed in nesting behavior

Appendix B: Monitoring Scenarios Showing the Use of Indicators, Triggers, Thresholds, Objectives, and Management Actions

This appendix presents four monitoring scenarios, each illustrating the use of indicators, triggers, thresholds, objectives, and management actions to achieve and maintain desired conditions. These scenarios are based on actual situations, and they highlight key components of monitoring and how the information collected through monitoring can inform visitor use management. For the purposes of this guidebook and for simplification, most place names have been changed or removed.

Some of the scenarios use percent-based thresholds (e.g., no more than X percent of sites have bare soil). As stated in chapter 4 of this guidebook, percent-based thresholds should be carefully evaluated, since they are sometimes not as sensitive to change and may be harder to justify and monitor. Thresholds based on actual numbers may be more appropriate.

SCENARIO #1: ENCOUNTER RATES

Both the Wild and Scenic Rivers Act and the Wilderness Act have substantive direction on stewardship requirements (e.g., protect and enhance outstandingly remarkable values, preserve wilderness character), and, as a result, desired conditions, indicators, and thresholds need to be identified with these legal requirements in mind. This scenario uses criteria that relate directly to statutory language.

Desired conditions. Visitors to the federally designated wilderness in the river corridor engage in a variety of river-related activities in an iconic landscape, where opportunities for primitive and unconfined recreation, immersion in nature, self-reliance, and solitude shape the experience. Recreationists should expect to encounter a moderate number of hikers as well as stock users, both on the trail and at popular camping areas.

Issue statement. The Blue and Green River Watershed is experiencing impacts from increased visitor use, most likely because of population growth in the nearby community.

Monitoring question. Is visitor use affecting the opportunity to feel a sense of solitude or separation from nearby population areas?

> **Indicator:** Encounter rates on trail segments having high visitor use.
>
> **Thresholds:** Any combination of two trail segments cannot be in violation of associated triggers for 4 consecutive years (table B1). Additionally, no individual trail segment can exceed its trigger for 4 consecutive years.

Objective: Increase enforcement presence on high-use segments by 20 percent to deter vehicles from being parked outside designated parking spaces, and ticket or tow vehicles parked outside designated parking spaces on all weekend days during a 4-month period.

Sliding scale of analysis: Moderate

Table B1. Encounter rate triggers for trail segments A, B, and C.

TRAIL SEGMENT	EXISTING CONDITION 2014	EXISTING CONDITION 2015	EXISTING CONDITION 2016	EXISTING CONDITION 2017	TRAIL SEGMENT TRIGGER (MEAN HOURLY ENCOUNTER RATE)
A	2	2	2	2	2
B	4	No data	4	5	4
C	No data	1	1	2	1

*Mean hourly encounter rate is quantified through observational encounter rate monitoring data collected by staff.

Rationale and background information. Wild segments of the Blue and Green Rivers flow from the heart of the nearby mountain range through towering granite peaks and impressive forests. The spectacular, rugged expanses along these segments provide exemplary landscapes for wilderness experiences characterized by solitude, personal reflection, immersion in nature, independence, and self-reliance. Activities are oriented toward primitive travel, camping, exploration, and adventure.

Of the many exemplary recreational activities, a few are particularly distinctive. Hiking or backpacking close to the rivers gives visitors the experience of spectacular cascades that change seasonally. In spring, visitors experience the sight, sound, and feeling of the powerfully crashing waters. In drier months, the beauty of delicate water plumes becomes the center of attention.

The established thresholds will allow land managers to proactively maintain the legally required mandate to preserve wilderness character, and monitoring this indicator will help assess whether thresholds are not exceeded and related desired conditions are being maintained. In situations such as this one, in which the Wild and Scenic Rivers Act and the Wilderness Act apply, there are substantive, statutory mandates to meet. The three selected trail segments offer access to multiday wilderness trips that are renowned for gorgeous riverside views, undeveloped settings, opportunities for solitude, and wilderness camping near the river. Monitoring encounter rates relates directly to the statute to provide outstanding opportunities for solitude or a primitive and unconfined type of recreation, which is dependent on managers keeping use at a low density. Monitoring will track whether overall trail conditions are being protected, although individual segments of trail may temporarily receive high levels of use (a situation that would be corrected through the triggers shown in table B1).

Kids in the field collecting data from a trail counter.

Monitoring strategy. Encounter rates on high-use trail segments A, B, and C will be monitored to assess the quality of the visitor experience. Of the 30 miles of trail that exist within the river corridor, 12 miles that have the highest use will be monitored. In addition, random trail segments will be monitored annually during the entire season of visitor use. The encounter rate monitoring protocol used for this scenario is the number of groups encountered per day, specifically on trails, regardless of direction of travel. Observers record their own encounters with groups as they travel in a manner similar to visitors. In the future, staff might consider using automated trail counters. Table B2 shows the encounter rate thresholds, management actions, and rationale.

Table B2. Thresholds and associated management actions and rationale to achieve and maintain desired conditions for wilderness recreation.

THRESHOLD	MANAGEMENT ACTION (AT LEAST ONE ACTION SPECIFIED FOR EACH THRESHOLD WILL BE TAKEN)	RATIONALE
Any combination of two segments cannot be in violation of associated triggers for 4 consecutive years (see table B1).	- Make necessary changes in the wilderness permit system, visitor capacities by zone, and/or commercial services to better manage opportunities for solitude.	- Visitor capacities are identified by zone to help manage the amount of overnight use. This action would assist in providing opportunities for solitude for each trail segment.
One individual trail segment has an encounter rate exceeding the trail segment trigger shown in table B1 for 4 consecutive years.	- Conduct monitoring the following year by direct observation on each segment exceeding its encounter rate trigger. - Increase the development and distribution of information pertaining to the unique attributes of other trails within the corridor. - Encourage visitors to begin their hikes early or late in the day to avoid periods of peak use on high-use trail segments within the corridor.	- To ensure the important resource conditions and visitor experiences are protected, the unit would immediately address early indications of unanticipated increases in encounter rates. More frequent monitoring will allow managers to identify permanent changes in use patterns and take appropriate actions. - Management actions, such as education and outreach to visitors, would help maintain the level of use by providing trip planning information to identify and avoid high-use times.

SCENARIO #2: DECIBEL LEVELS

Desired conditions. The Musketa Recreation Area provides a designated motorized trail system designed to offer a variety of high-quality experiences, including family-friendly novice trails, scenic touring trails, and a limited number of technical, physically challenging trails. The motorized trail system is designed and managed to minimize adverse effects on soil, water, fish, wildlife, vegetation, and cultural and historic resources while providing both motorized and nonmotorized visitor experiences.

Issue statement. Managers are concerned that off-highway vehicle (OHV) use does not comply with the operating hour restrictions and noise emission (decibel, dB) standards established in the management plan and is impacting resources and/or the quality of the visitor experience, particularly in the Citronella Lake area.

Monitoring question. What is the status and trend of OHV noise in the Citronella Lake area?

> **Indicator:** Maximum decibel output by individual vehicles.
>
> **Threshold:** No more than 5 percent of all machines sampled exceed 95 dB (the allowable noise standard for OHVs in the Musketa Recreation Area).
>
> **Objective:** The management plan set an objective of 95 percent compliance with the allowable noise standard (95 dB) within the next 5 years.
>
> **Sliding scale of analysis:** Low

Rationale and management strategy. The Musketa Recreation Area contains numerous opportunities for recreation, including camping in designated campsites in remote locations that are accessible only by nonmotorized or motorized trails. Much of the public land remains undeveloped, although residential development has increased on adjacent private land since the early 2000s. OHV use has increased over the last 2 decades as has the popularity of aftermarket mufflers, which have increased noise levels noticeably within the Musketa Recreation Area. A decrease in the resident population of northern saw-whet owls (Aegolius acadicus) may be linked to increased noise levels associated with visitor use in the area. Visitor and local resident noise complaints increased in the early 2000s, prompting managers to enact OHV operating hour restrictions and implement mandatory noise testing in 2007. Although there has since been a decrease in measured decibels and citations, managers have not met the stated objective. Table B3 shows trends in reported data after monitoring was implemented.

The OHV noise threshold and objective in the Musketa Recreation Area are intended to reduce the legal OHV muffler-noise output from the state legal limit of 99 dB to 95 dB. Stricter noise standards at Citronella Lake were enacted as part of a plan amendment and are intended to minimize OHV noise impacts on nearby residents, nonmotorized recreationists, and the northern saw-whet owl population.

Table B3. Violations of noise emission standards in the Citronella Lake area from 2007 to 2010.

	2007	2008	2009	2010
Violations of allowable noise standard (95 dB)	- 181 violations	- 281 violations	- 196 violations	- 185 violations
Muffler sound checks	- 64% met 95 dB level - 82% met 99 dB level	- 66% met 95 dB level - 86% met 99 dB level	- 70% met 95 dB level - 87% met 99 dB level	- 81% met 95 dB level - 94% met 99 dB level

Monitoring strategy. OHV noise is monitored by law enforcement personnel at riding area entry points and randomly selected OHV staging areas, using random sample days (stratified for day of week and season of year). Vehicle sound is measured by a decibel meter positioned 20 inches and 45 degrees from the exhaust outlet and should measure no more than 95 dB.

Decibel levels will be recorded for a total of 80 hours per year (40 two-hour sample periods), with sample periods occurring during peak OHV use (10 a.m. to 4 p.m.) on selected days. Four times annually, during peak OHV use (May to September), a curfew area will be randomly selected and monitored for 1 hour during the curfew period to determine if OHV use is occurring within the area during curfew hours. The results of sampling will be reported biennially.

Potential management actions based on monitoring. If the threshold is exceeded, managers will increase enforcement and will initiate additional restrictions on the use of OHVs in the recreation area.

SCENARIO #3: PERCENT CHANGE IN CONDITION OF PREHISTORIC AND HISTORIC SITES

Background information. The condition score is an index for assessing the condition of significant cultural resources, such as prehistoric and historic sites. The condition score focuses on disturbance caused by human activity but may include some deterioration from natural processes (e.g., natural weathering or erosion). The condition score is a reliable, accurate, and simple means of assessing the overall condition of cultural resources. An increase in the condition score of a cultural resource indicates a decline in the cultural resource's condition. Since cultural resources are irreplaceable and the condition classes are relatively broad, a small change in the score of a cultural resource is considered significant.

Desired conditions. Visitors gain an understanding of changing land use, settlement patterns, and ways of life within the forest through their experiences with cultural resources. Visitors are able to attain a sense of the past, see prehistoric and historic sites, and understand unique stories associated with the site. Interpretations are provided for some structures and archaeological sites to enhance visitors' understanding of their significance. Significant prehistoric and historic sites are protected, and damage to these resources is prevented to the greatest extent possible. Prehistoric and historic sites are located within a larger analysis area and are also subject to the desired conditions of that area.

Issue statement. Staff suspect the conditions of prehistoric and historic sites are deteriorating due to visitor-related activity.

Monitoring question. Is visitor use affecting the integrity of prehistoric and historic sites?

> **Indicator:** Percent of sites that have experienced change in site condition.
>
> **Trigger:** No more than 5 percent of sites experience an increased condition score.
>
> **Threshold:** No more than 15 percent of sites experience an increased condition score.
>
> **Objective:** Increase the number of interpretive programs that specifically address protection of prehistoric and historic sites in the analysis area from 40 to 50 (20 percent increase) during June, July, and August.
>
> **Sliding scale of analysis:** Low

Management and monitoring strategy. In the analysis area, determine which prehistoric and historic sites are significant and feasible to monitor. Prehistoric and historic sites deemed significant (listed in table B4) should be monitored more frequently than nonsignificant sites. Inputs into table B4 include site evaluations by cultural resource specialists to identify baseline conditions. Inputs include the conditions of the sites, which are noted in resource management databases,

monitoring reports, and historic resource documentation. This information is clearly identified in the monitoring protocol. Note, this indicator and threshold could be highly subjective, and documentation of the monitoring protocol is imperative to ensure consistency between observers. For monitored sites, a cultural resource specialist or facilities specialist completes site condition assessments every 5 years and assigns a qualitative condition rating to each site based on an assessment of the degree to which damage has affected the site's integrity (descriptions follow). Qualitative condition ratings are assigned by relevant cultural resource specialists using the following categories:

- **Excellent** – The site retains a high level of integrity, and there is excellent preservation of the feature in terms of materials and spatial relationship. There is little or no evidence of modern visitor-caused disturbance resulting in loss of information potential.
- **Good** – The site retains most of the aspects of its integrity. There is minor visitor-caused disturbance (e.g., moving of potshards, informal trails).
- **Fair** – The site retains some of the aspects of its integrity. There is moderate visitor-caused disturbance, but the site still possesses enough character to convey its significance. Although not apparent to the untrained eye, some material may be missing from the site.
- **Poor** – The site retains a low level of integrity and may be in danger of losing the character that conveys its significance. There is clear evidence of major visitor-caused disturbance (e.g., potshards hunting, graffiti).
- **Destroyed** – The site retains little to no integrity and no longer possesses the character that made it significant; the feature is so deteriorated from visitor-caused disturbance that it is no longer eligible for national designation or no longer provides prehistoric or historic value.

Table B4. Condition scores of significant prehistoric and historic sites.

FEATURE NAME	FEATURE IDENTIFICATION	CONDITION	COMMENTS
Traditional cultural sites	01-A through 01-F	Good	Features 01-A, 01-B, and 01-C are rated in excellent condition. However, sites 01-D through 01-F have lost some of their integrity due to informal trails through the sites and some rock displacement and thus are rated in good condition.
Teepee	02-ABC	Fair	Some poles are missing, but the structure is still largely intact.
Cliff ruins	03-ABC	Good	Digging in midden observed; monitoring schedule has been adjusted to monitor more frequently.

Rationale for indicator and threshold. Disturbance from visitor use to prehistoric and historic sites can occur intentionally (e.g., vandalism and graffiti) and unintentionally (e.g., informal trails). The condition of a site can be directly affected by its level of visitor use. Prehistoric and historic sites are nonrenewable and therefore cannot recover from natural and visitor-caused disturbance. More prehistoric and historic sites are seriously damaged or destroyed by human actions than by natural processes. The condition score is a reliable, accurate, and cost-effective way to monitor visitor-caused disturbance at prehistoric and historic sites. With consistent monitoring and condition scoring, the effects of environmental and visitor-caused degradation are regularly observed and recorded, so managers can distinguish between environmental impacts and visitor-caused degradation. Consistent monitoring of visitor-caused disturbance or destruction at prehistoric and historic sites allows managers to assess whether conditions are worsening and what type of management action is needed.

Visitor use causes some impact; therefore, it is unrealistic to assume that no impact will occur. In this situation, in which there is little to no tolerance for impact, a trigger has been established as "no more than 5 percent of sites experience an increased condition score." If the significant sites are experiencing a change in conditions during the first monitoring interval, then monitoring could increase and management could reevaluate visitor use in certain areas.

Potential management actions. If it is determined through monitoring that thresholds are being approached or exceeded, staff would use one or more of the following management actions:

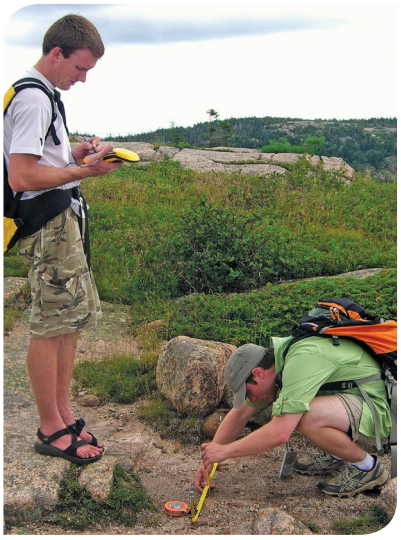
- Offer visitors improved and detailed information regarding the sensitivity of prehistoric and historic sites and the need to protect them.
- Create trails or viewing areas in places where informal trails are occurring near prehistoric and historic sites.
- Install physical barriers, such as logs or rocks, to deter inappropriate visitor behavior.
- Install signs directing visitors to stay on trails or paths.
- Increase ranger presence or law enforcement patrols.
- Conduct visitor surveys of desired visitor opportunities and visitor awareness of the importance of prehistoric and historic sites. Information learned from surveys would be used to identify additional management actions that would maintain access to the sites while implementing appropriate restrictions where needed.
- As needed, temporarily or permanently close sites to public use.
- As appropriate, install barriers or signs to discourage visitors from accessing or approaching closed sites.

SCENARIO #4: BARE SOIL

Desired conditions. Most meadows in Beauty Basin have high ecological integrity, with intact streambanks and minimal habitat fragmentation, which conserve ecosystem processes. Alpine meadows display little or no impacts from visitors or pack stock. Streambanks in the river corridor display minimal impact from visitor use.

Issue statement. Continued grazing activities in the analysis area may be affecting plant cover, primary productivity, and species composition.

Monitoring question. Is pack stock grazing reducing plant cover in selected meadows compared with reference areas?



Conducting trail depth monitoring in Acadia National Park.

Indicator: Percentage of bare soil in each river segment.

Thresholds: At least 75 percent of sites monitored in each river segment have bare soil cover values in the high ecological condition class for 3 consecutive years, and no more than 15 percent of sites monitored in each river segment have bare soil cover values in the low ecological condition class for 3 consecutive monitoring intervals. By including multiple monitoring intervals, variability due to nonhuman influences, such as drought or increased rodent burrowing, can be ruled out. Note, a minimum of seven sites in each river segment will be measured every 3 to 5 years with the goal to monitor more sites, if possible (see monitoring strategy).

Objective: Bare soil from recreation impacts occurs on no more than 100 acres. To improve impacted sites, one restoration crew will be assigned to restore impacted sites for 1 month out of every year for the next 3 years. At least 10 percent of impacted sites will be restored yearly.

Sliding scale of analysis: High

Rationale and background information. Researchers have linked grazing activities to increases in bare soil as well as decreased plant cover, decreased primary productivity, and shifts in species composition. Trampling, by either humans or pack stock, can produce similar results with the added impact of soil compaction that compromises root growth and water infiltration. The purpose of the bare soil indicator is to monitor meadow integrity in relation to grazing and trampling by people or pack stock. The amount and distribution of bare soil are considered important indicators of a meadow's stability and susceptibility to wind and water erosion.

Candidate metrics for monitoring the ecological condition of meadows subject to grazing and trampling include vegetative cover, bare soil, species composition, and plant productivity. Bare soil and basal vegetative cover are more sensitive indicators of meadow condition than species composition. Bare soil increases at lower levels of disturbance compared to shifts in species composition in a variety of montane vegetation settings in North America (including alpine meadows). Plant productivity may be more sensitive to grazing pressure than bare soil, but this measure may be impractical to monitor in wilderness meadows due to the difficulty in transporting equipment to the field and plant samples back to the laboratory. Furthermore, plant productivity is subject to high annual variability resulting from climatic factors, such as precipitation, snowpack, or snowmelt. In addition to its relevance for monitoring meadow condition, bare soil measured from line-point intercept data is efficient, objective, easily obtained, and repeatable across time and observers. Therefore, bare soil may be one of the most robust indicators of changes in the ecological condition of meadows.

A recent report generated low, moderate, and high ecological condition classes for bare soil cover values based on monitoring data from a comprehensive multiyear study in mountain meadows (table B5). In the report, ecological condition classes for bare soil cover values are based on line-point intercept data collected from a large number of meadows across a broad disturbance gradient. Line-point intercept is a rapid and accurate method for quantifying soil cover, including vegetation (Herrick et al. 2005). These values were used as a starting point to inform condition class development in the analysis area and are shown in an example in the next paragraph. Managers will revise these condition class values as needed based on monitoring data. These data will be collected from meadows with visitor and pack stock use ("meadows of concern") as well as from meadows with no or low use ("reference meadows") to identify changes in conditions unrelated to human use or management actions. Exposed bare soil occurs due to natural phenomena such as wildlife activity, drought, and flooding; therefore, some level of bare soil may be expected, regardless of visitor use.

Table B5. Bare soil cover values for ecological condition classes in high-elevation meadows.

MEADOW TYPE	HIGH ECOLOGICAL CONDITION	MODERATE ECOLOGICAL CONDITION	LOW ECOLOGICAL CONDITION
MONTANE	MONTANE	MONTANE	MONTANE
Hydric	0-4%	5-9%	> 9%
Mesic	0-6%	7-13%	> 13%
Xeric	0-8%	9-13%	> 13%

MEADOW TYPE	HIGH ECOLOGICAL CONDITION	MODERATE ECOLOGICAL CONDITION	LOW ECOLOGICAL CONDITION
SUBALPINE	SUBALPINE	SUBALPINE	SUBALPINE
Hydric	0-4%	5-8%	> 8%
Mesic	0-6%	7-13%	> 13%
Xeric*	To be determined	To be determined	To be determined

*More research is needed to determine the condition class for subalpine xeric meadows. Thresholds are scheduled to be determined after two or three monitoring cycles.

Values for bare soil cover for each ecological condition class vary according to meadow type and elevation (table B5). For instance, to be in a high ecological condition class, a moist (mesic) montane or subalpine meadow would not have bare soil exceeding 6 percent of its surface area, and a wet (hydric) montane or subalpine meadow would not have bare soil exceeding 4 percent of its surface area. The range of bare soil cover values for each ecological condition class will be revised, as needed, based on monitoring. One meadow may contain up to three meadow types (wet, moist, and dry), each of which will be sampled and assessed independently. To determine whether conditions are reaching the threshold at the segmentwide level, a percentage of sites in each low, moderate, and high ecological condition class will be monitored. The unit based these management thresholds on data and recommendations from another agency's complex monitoring project in a nearby area.

Monitoring strategy. The unit is collaborating with universities to develop a protocol to monitor bare soil cover in meadows. Together, they completed a draft monitoring protocol and collected pilot data from representative meadow types. The following summer, they refined the protocol based on pilot data and tested the protocol in meadows of concern and in a set of reference meadows.

Rotational monitoring will occur among meadows of concern and reference meadows within different river segments. A minimum number of sites will be established, approximately seven, with the goal to monitor more. As the protocol develops, specific meadows of concern will be identified for monitoring. Reference meadows will also be monitored, as needed, to provide a comparison with meadows of concern. Every 5 years, staff will reevaluate which meadows in the corridor are in need of routine monitoring. Staff will evaluate the effectiveness of the indicators on a regular basis to assure that the combination of these metrics inform management actions that fully protect the desired conditions.

The recommended monitoring interval for bare soil is 3 to 5 years unless the amount of bare soil reaches a trigger, prompting management action, including an increase in monitoring (table B6). A subset of sites will be monitored annually to obtain estimates of annual variation, and these will be the reference sites. Monitoring may occur any time between meadow flowering and first snowfall. Table B6 displays the triggers at which management actions will be taken to maintain meadow condition well above the threshold. These triggers are focused on both site-specific and segmentwide conditions. Monitoring will be conducted at the site-specific level to provide greater specificity in the data and any needed management actions. Note, if a site is identified as "low ecological condition" on first measurement, it will trigger management action.

Table B6. Triggers and management actions to achieve and maintain desired conditions for high-elevation meadows.

TRIGGER	MANAGEMENT ACTION (AT LEAST ONE ACTION SPECIFIED FOR EACH TRIGGER WILL BE TAKEN)	RATIONALE
Trigger 1: Monitoring indicates bare soil cover values in the low ecological condition class at a site.	Apply a secondary assessment method for a qualitative evaluation of meadow condition.	Rapid assessments are diagnostic tools that provide standardized, rapid, field-based results of the overall condition or functional capacity of meadows. Assessing meadow condition would aid in identifying key stressors that may be affecting meadow condition. Assessment results would assist with interpretation of monitoring results.
Trigger 1: Monitoring indicates bare soil cover values in the low ecological condition class at a site.	Increase education about best management practices in meadows for all who use them.	Education in maintaining meadow condition would help prevent further increases in bare soil associated with human use.

TRIGGER	MANAGEMENT ACTION (AT LEAST ONE ACTION SPECIFIED FOR EACH TRIGGER WILL BE TAKEN)	RATIONALE
Trigger 2*: Monitoring indicates bare soil cover values in the low ecological condition class at a site during two successive monitoring intervals AND secondary assessment indicates human use is a factor during both monitoring intervals OR less than 80% of monitored sites in a river segment have bare soil cover values in the high ecological condition class, or greater than 10% of sites in a river segment have bare soil cover values in the low ecological condition class.	Increase education about best management practices in meadows for wilderness visitors, staff, and partners.	Education in maintaining meadow condition would help prevent further increases in bare soil associated with human use.
Trigger 2*: Monitoring indicates bare soil cover values in the low ecological condition class at a site during two successive monitoring intervals AND secondary assessment indicates human use is a factor during both monitoring intervals OR less than 80% of monitored sites in a river segment have bare soil cover values in the high ecological condition class, or greater than 10% of sites in a river segment have bare soil cover values in the low ecological condition class.	Work with stakeholders to reduce grazing capacity or timing of use if needed to minimize impacts. Work with stakeholders to adjust use levels annually.	Determining effective strategies with stakeholders for managing meadow use is a necessary step in the process to protect and enhance meadow condition. Grazing capacities constitute use levels that can be sustained in a meadow based on available forage cover, productivity, and site condition, which can provide guidance in setting an appropriate level of use.
Trigger 2*: Monitoring indicates bare soil cover values in the low ecological condition class at a site during two successive monitoring intervals AND secondary assessment indicates human use is a factor during both monitoring intervals OR less than 80% of monitored sites in a river segment have bare soil cover values in the high ecological condition class, or greater than 10% of sites in a river segment have bare soil cover values in the low ecological condition class.	Increase monitoring frequency to annually for 5 years.	Frequent monitoring would help facilitate more rapid detection of, and management response to, changes in ecological condition. Its utility would be to evaluate the effectiveness of changes in the intensity and/or timing of use on meadow condition.

TRIGGER	MANAGEMENT ACTION (AT LEAST ONE ACTION SPECIFIED FOR EACH TRIGGER WILL BE TAKEN)	RATIONALE
Trigger 2*: Monitoring indicates bare soil cover values in the low ecological condition class at a site during two successive monitoring intervals AND secondary assessment indicates human use is a factor during both monitoring intervals OR less than 80% of monitored sites in a river segment have bare soil cover values in the high ecological condition class, or greater than 10% of sites in a river segment have bare soil cover values in the low ecological condition class.	Rest the meadow if necessary. Temporarily discontinue grazing until conditions improve based on secondary assessment results.	Allowing a period of meadow "rest" (removing stresses from grazing and trampling) facilitates meadow recovery. Effects of trampling and grazing that are expected to decline with reduced use or avoidance of early-season use include soil compaction, bare ground exposure, and plant disturbance.
Trigger 3*: Bare soil cover values are double the values in the low ecological condition class at a site OR previous management actions (such as reduction in use) have been ineffective OR assessments for 5 consecutive years have not shown improvement in the ecological condition class.	Discontinue grazing until conditions improve based on monitoring.	Allowing a period of meadow rest (removing stresses from grazing and trampling) facilitates meadow recovery. Effects of trampling and grazing that are expected to decline with reduced use or avoidance of early-season use include soil compaction, bare ground exposure, and plant disturbance.

*Note: Although these triggers are connected to sites with "low ecological condition," sites in high and medium ecological condition will be continually monitored. If monitoring is increased annually, it will include sites in all ecological condition classes.

Potential management actions based on monitoring. The unit will release annual monitoring reports to update stakeholders on the monitoring strategy, including any changes to the indicators and any subsequent management actions that the unit has taken.

Appendix C: Indicator and Threshold Worksheet

The indicator and threshold worksheet has been used in workshop settings to document the process of selecting indicators and establishing thresholds. Blank copies of this worksheet are typically distributed to workshop participants to brainstorm ideas and rationales. This worksheet is often the first step in developing a monitoring strategy. Consider using the blank table provided on the IVUMC website (https://visitorusemanagement.nps.gov) to record interdisciplinary team conversations or as an interactive tool for the selection of indicators and establishment of thresholds.

Table C1. Indicator and threshold worksheet.

ISSUE	INDICATOR	RATIONALE	THRESHOLD	RATIONALE	MANAGEMENT ACTION	MONITORING PROTOCOL
Informal trail development	Number of informal trails leaving the designated trail (measured every mile).	This indicator measures multiple issues of concern, including vegetation trampling, soil compaction, spread of invasive species, habitat fragmentation, safety concerns, visitor experience, degradation of cultural and archaeological resources, and contact with sensitive resources. This indicator also relates to impacts on threatened and endangered species habitat.	- Area A: No more than one informal trail leaving the designated trail per 1-mile measurement. - Area B: No more than three informal trails leaving the designated trail per 1-mile measurement.	- The thresholds are based on resource sensitivity, amount of use, and tolerance of impact. There is a range of acceptance depending on the site, area, or zone.	- Educate visitors regarding sensitive resources and staying on trails. - Improve trail identification and signs. - Rehabilitate informal trails as soon as possible. - Formalize informal trails as designated trails, if appropriate. - Use site management or design strategies, such as constructing boardwalks, rails, borders, or pavement, to improve delineation of designated trails. - Restrict off-trail travel. - Potentially, close areas. - Consolidate neighborhood access points. - Expand formal public access points.	Evaluate informal trails biannually.

ISSUE	INDICATOR	RATIONALE	THRESHOLD	RATIONALE	MANAGEMENT ACTION	MONITORING PROTOCOL
Damage to archaeological sites	- Number of incidents of vandalism or theft per year.	- Damage to archaeological sites can occur through both intentional and unintentional means. Both can cause impacts that influence the integrity of these resources.	No more than one incident of vandalism or theft per year.	Historical sites are nonrenewable; thus, the threshold for acceptable impact is very low. Triggers could be established to ensure damage to archaeological sites requires immediate management action.	- Prioritize monitoring of archaeological resources in high visitor use areas. - Educate visitors on the sensitivity of resources and the need to protect historical sites, including with the use of signs. - Target education to groups that are accessing areas with historical sites. - Increase ranger presence or patrol. - Increase enforcement and documentation. - Reroute trails. - Create physical barriers. - Close areas.	Continue to record number of incidents of vandalism or theft. Review incident reports yearly.

ISSUE	INDICATOR	RATIONALE	THRESHOLD	RATIONALE	MANAGEMENT ACTION	MONITORING PROTOCOL
Trail-based visitor conflicts	Percent of randomly sampled visitors who report "reduced enjoyment" due to encounter with another visitor.	On shared use nonmotorized trails, there is a desire to promote respectful use so that interactions among trail visitors are positive. Specific behaviors are known to cause conflict and reduced enjoyment for those visitors who encounter them (e.g., bicyclists not slowing down or not yielding to others, dog waste left on the trail, horses riding on soft, wet trails and leaving large divots).	Within the trail system, no more than 5% of randomly sampled visitors report "reduced enjoyment" due to behaviors associated with encountering other visitors.	In order to achieve a desired condition that emphasizes positive interactions among trail visitors, the established threshold is set at a low level while still recognizing that some level of reduced enjoyment is likely inevitable.	- Install more effective signs and improve educational materials about trail etiquette for specific user groups (increase patrol presence by staff and volunteer ambassadors). - Separate uses through trail design. Add dog waste stations in areas frequented by dog walkers. - Change the design of a trail to accommodate multiple user groups (e.g., frequent pull-outs). - Designate different trails for different uses.	Develop a standard visitor survey, and implement once every 3 years. Randomly select days and trailheads between May 15 and September 15, and interview one person in each group.

Appendix D: Sample Monitoring Forms

This appendix provides a sample of monitoring forms for a variety of sites of varying complexity. Accompanying each monitoring form is a brief discussion to provide context and site-specific examples of monitoring techniques.

There are several ways to monitor indicators, triggers, thresholds, objectives, and management actions to achieve and maintain desired conditions. The range of forms that can be used for monitoring varies based on the complexity, type, and resource characteristics of the analysis area. Monitoring forms may be extremely detailed and may involve simultaneous use by multiple people or may involve simple counting (e.g., the number of visitor contacts in an analysis area performed by one person). Some monitoring forms may provide explicit written instructions on how to accurately collect data (example #4). Monitoring forms can also vary by season of use. These variables should be considered in determining if a new monitoring form is needed or if one of these samples would be sufficient. Many of these forms can be digitized so data can be collected in the field using tablets or phones. This makes data entry and uploading much easier and quicker than paper forms and often reduces an element of human error. Monitoring that involves obtaining information from the public (e.g., visitor surveys) requires approval from the Office of Management and Budget under the Paperwork Reduction Act. Contact the appropriate agency's Office of Management and Budget information collections officer for guidance.

EXAMPLE #1: RECREATION SITE MONITORING FORM

Haleakalā National Park

This monitoring form is used to address resource conditions at backcountry recreation sites in Haleakalā National Park. Specifically, this form is used to monitor day use and overnight use at recreation sites, other than trails, with disturbed vegetation, surface litter, or impacted soils caused by human use. Trails are addressed separately. The instructions provide for measurements to be taken at the middle or end of the season of visitor use and for subsequent measurements to be taken as closely as possible to the time that baseline measurements were taken. The instructions specify three methods for assessing recreation site conditions: (1) photographs taken at specified points; (2) a condition assessment based on observations and descriptions of levels of trampling impacts; and (3) predominantly measurement-based assessments of impact indicators. Refer to the "Monitoring Manual for Grassland, Shrubland, and Savanna Ecosystems" (Herrick et al. 2005) for full descriptions of each indicator, assessment and quality assurance protocols, and illustrative diagrams and photos (Marion and Carr 2009).

Recreation Site Monitoring Form

General Site Information

Date	Location	Inventoried by
Site tag number	Site type	GPS

Comments:

Inventory Indicators

1. Use type (camping = C, Summit area site = S, Trail-related recreation site = T, Pool-related site = P):
2. Use Level (Low = L, Moderate = M, Heavy = H):
3. Distance to nearest other campsite (-1 = NA, 1 = < 10 yd, 2 = 11-20 yd, 3 = 21-40 yd, 4 = 41-60 yd, 5 = > 60 yd):
4. Site expansion potential (P M G):
5. Rock substrate (%, use item 7 midpoint categories, which follow):

Impact Indicators

Apply Variable Radial Transect Method

6. Condition class (0-5):

Ground cover categories

%	0-5	6-25	26-50	51-75	76-95	96-100
Midpoints	2.5	15.5	38	63	85.5	98

7. Vegetative ground cover onsite (use categories above):
8. Vegetative ground cover offsite (use categories above):
9. Exposed soil (use categories above):

10. Tree damage:

None/Slight	Moderate	Severe

11. Root Exposure:

None/Slight	Moderate	Severe

12. Tree stumps (#):

13. Access trails (#):

14. Human waste (#):

15. Total site area (office) (ft^2):

Recommendations:

Site photo:

Reference point photo:

Site Reference Point Information	Bearing	Distance	DBH
1.			
2.			
3.			

Bury Nail/Tag:

Satellite Site Dimensions	Bearing	Distance

Island Site Dimensions	Bearing	Distance

Transect Data

Bearing	Distance

Area from computer program	ft^2
+ Satellite Area	ft^2
- Island Area	ft^2
= Total Site Area	ft^2

EXAMPLE #2: WINTER USE MONITORING FORM

Bridger-Teton National Forest

This monitoring form is used to assess winter use in the Bridger-Teton National Forest. The form begins with simple counts of the number of cars, dogs, skiers, snowmobilers, snowshoers, horses, and other types of users at trailheads. Wildlife observations are assessed by conducting a visual inventory of the analysis area.

Winter Use Monitoring Form

Patroller name	
Date/Day of week	
Trailhead	
Weather conditions	
Miles patrolled	

_____# of cars at trailhead (start)

_____Time of day (start)

_____# of cars at trailhead (end)

_____Time of day (end)

_____# of dog waste piles (Cache - TH to dog pond; Game - TH to old parking)

_____# of dogs

_____# of people with more than 2 dogs

_____# of skiers

_____# of walkers/runners

_____# of snowmobilers

_____# of snowshoers

_____# of horses

_____# of other users (type)

Winter Wildlife Observations

(Please indicate whether the animal was observed inside or outside the winter closure area.)

Animal	Inside winter closure area	Outside winter closure area
Elk		
Moose		
Deer		
Other		

EXAMPLE #3: SITE MONITORING FORM

Yosemite National Park

The following monitoring form was implemented in connection with the Yosemite National Park field monitoring guide. The data collected on the form can be used to inform partners and the public as to the status of resource and visitor use conditions in the park. The field monitoring guide includes instructions for data collection and specifies the types of data to be collected, such as artifact collection piles, indicators of camping on site, and trails on or near the site boundary. Data collected on these forms is entered into a database using a specific protocol. Completed forms are retained in appropriate files. Examples of both simple and complex monitoring protocols are included in the "2009 Field Monitoring Guide: Visitor Use and Impact Monitoring Program" (https://www.nps.gov/yose/learn/nature/upload/Visitor%20Use%20Field%20Guide-2009.pdf).

Yosemite Visitor Use Impact Site Monitoring Field Form (Shortened)

Recorders	Date	YOSE Project No.

Basics

Site Type: check appropriate box(es) below

Historic:

	Graves/Cemetery		Standing Structures		Dam
	Privy/Dump/Trash		Foundations/Structure Pads		Landscaping
	Road/Trail/RR Grade		Water/Conveyance System		Machinery
	Wall/Fence		Mines/Quarries/Tailings		Wells/Cisterns
	Undetermined/Other		Architectural Feature		Habitation Debris

Prehistoric:

	Bedrock Milling Feature		Cache		Hearths/Pits
	Trails/Linear Earthworks		Quarry		Lithic Scatter
	Habitation Debris		Pictograph		Burial
	Rock Shelter/Cave		Petroglyph		Undetermined
	Other				

Function:

	Ceremonial/Religious		Storage/Holding		Communication
	Domestic/Residential		Horticulture/Gardening		Undetermined
	Processing/Manufacturing		Commerce/Trade		Other
	Transportation/Supply		Funerary/Mortuary		
	Refuse/Byproduct		Recreation/Tourism		

Formation Type:

	Earthwork		Imagery		Barrier/Enclosure
	Interment		Building		Excavation
	Wreckage		Scatter		Route-Way
	Structure		Grounds		Cumulus
	Other				

Landform:

	Basin		Dome		Talus Slope		River Floodplain
	Bench		Cirque		Meadow		Hill Slope
	Hill Top		Ridge Top		Ride Slope		Moraine
	Valley Floor		Terrace		Saddle		Other

Features:

Rock Art	YES or NO	SCORE	
Visible Features	YES or NO	SCORE	

Type of Use - Direct:

	Camping		Hiking		Climbing/Bouldering
	River Recreation		Sightseeing		Picnicking
	Park Operations		None		Other

Type of Use - 2nd:

	Camping		Hiking		Climbing/Bouldering
	River Recreation		Sightseeing		Picnicking
	Park Operations		None		Other

Natural Impacts:

	Erosion		Bioturbation		Rock Fall		None
	Tree Fall		Flooding		Other		

Visitor Use Impacts:

Artifact Collection Piles

	None		One		More than one

Describe Contents and Location:

Social Trails:

	None				One				More than one		
	Faint		Distinct		Eroding		Faint		Distinct		Eroding

Evidence of Camping:

	Fire Ring/Scar/Pit/etc.		Soil Compaction		Movement of Features		Other
	Vegetation Damage		Movement of Rocks		Trash		None

Evidence of Facilities:

	Wilderness Restoration Activities		Stock Use		None
	Utilities/Infrastructure Construction		Trails Work		Other

Evidence of Deliberate Vandalism:

	YES	NO
Old		
New		

Score:

Site Management

Site Disturbance Severity Level: Take from previous computation

	Low		Moderate		Severe		N/A (Destroyed)		Unknown

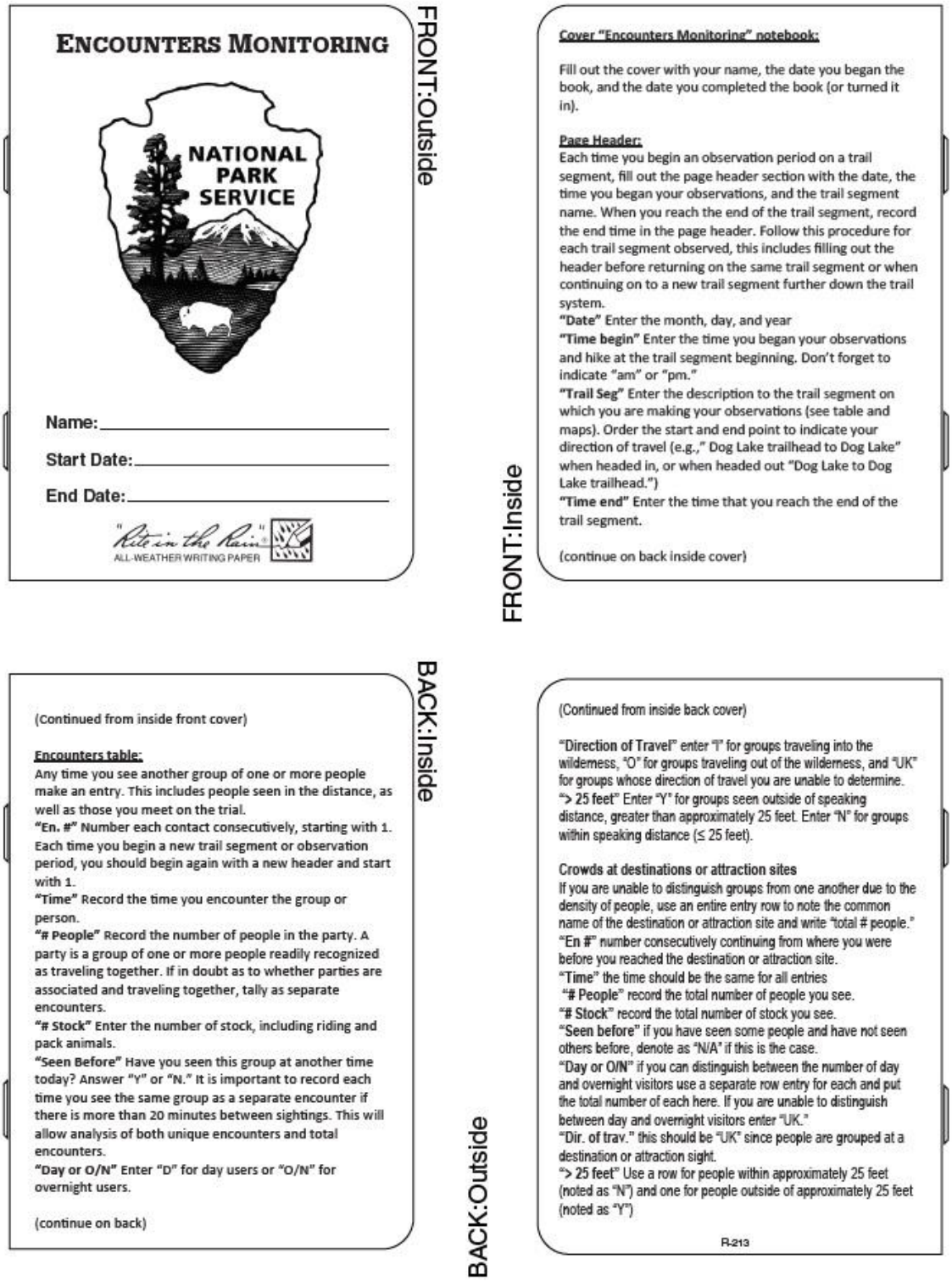
Comments/Remarks:

EXAMPLE #4: WILDERNESS ENCOUNTER RATE MONITORING FORM

Yosemite National Park

Simple monitoring forms can provide useful data. The following images of pages from a data booklet for monitoring wilderness encounters (figure D1) are appropriate for monitoring protocols with a relatively low level of complexity. These pages demonstrate ways to record and track visitor use conditions on trail segments with medium-to-low use and provide explicit written instructions on how to accurately collect data. Written instructions can serve as an informal training tool for volunteers or staff members so data can be collected in a consistent manner and yield results that can be compared if measured by different people. Written instructions can also be cost effective since they reduce the need to invest in formal training. See "A Guide to Monitoring Encounters in Wilderness" by Broom and Hall for additional guidance on encounter rate monitoring in wilderness (2008). At segments with more use, where a steady stream of visitors may make encounter rates a challenge to record, other metrics such as people per viewscape may be more appropriate. Simple monitoring forms are valuable because they can be distributed to staff from many departments and require relatively little training to use effectively.

Figure D1. Images of pages from a data booklet for monitoring wilderness encounters.



Date:_____ Time begin:_____

Trail Seg:_____ Time end:_____

En. #	Time	# People	# Stock	Seen Before	Day or O/N	Dir. Of Trav.	>25 Feet

Date:_____ Time begin:_____

Trail Seg:_____ Time end:_____

En. #	Time	# People	# Stock	Seen Before	Day or O/N	Dir. Of Trav.	>25 Feet

EXAMPLE #5: SITE MONITORING FOR CAMPGROUNDS

Pike National Forest

Simple monitoring forms (examples #5, 6, and 7) can help gather data on the amount and timing of visitor use. Temporal information helps inform managers about seasonal types of use and whether that use depends on factors such as days of the week, times of day, and weather.

Pike National Forest

Name of Site	Day, Time, and Date	# of Motor Vehicles	# of People on Ground	Main Activities	Weather	License Plate #s	Other Comments
	MON TUE WED THR FRI SAT SUN ___:___ / /19				Temp Precip Cloud cover Wind		
	MON TUE WED THR FRI SAT SUN ___:___ / /19				Temp Precip Cloud cover Wind		
	MON TUE WED THR FRI SAT SUN ___:___ / /19				Temp Precip Cloud cover Wind		
	MON TUE WED THR FRI SAT SUN ___:___ / /19				Temp Precip Cloud cover Wind		
	MON TUE WED THR FRI SAT SUN ___:___ / /19				Temp Precip Cloud cover Wind		
	MON TUE WED THR FRI SAT SUN ___:___ / /19				Temp Precip Cloud cover Wind		
	MON TUE WED THR FRI SAT SUN ___:___ / /19				Temp Precip Cloud cover Wind		

EXAMPLE #6: ENCOUNTER RATE MONITORING FORM

Visitor Encounters – All Trails

Date:_______ Data Collector(s): ___________________________________

Location/Itinerary:

Trip__

Trail Head / Jct. Name	Trail Name	Trail Head / Jct. Name
Start Time	**# of Encounters**	**Finish Time**

Trip__

Trail Head / Jct. Name	Trail Name	Trail Head / Jct. Name
Start Time	**# of Encounters**	**Finish Time**

Trip__

Trail Head / Jct. Name	Trail Name	Trail Head / Jct. Name
Start Time	**# of Encounters**	**Finish Time**

Trip__

Trail Head / Jct. Name	Trail Name	Trail Head / Jct. Name
Start Time	**# of Encounters**	**Finish Time**

Trip___

Trail Head / Jct. Name	Trail Name	Trail Head / Jct. Name
Start Time	**# of Encounters**	**Finish Time**

Trip___

Trail Head / Jct. Name	Trail Name	Trail Head / Jct. Name
Start Time	**# of Encounters**	**Finish Time**

EXAMPLE #7: PEOPLE PER VIEWSCAPE MONITORING FORM

People per Viewscape – Sunset Point

Date:_____ Data Collector(s): _____

Location:

People per Viewscape Monitoring

Record # of people in view every 10 minutes for 1 hour

	Time	Count		Time	Count
(Start) 1			7		
2			8		
3			9		
4			10		
5			11		
6			12		

Notes:

EXAMPLE #8: WILDLIFE DISTANCE OBSERVATION MONITORING FORM

Wildlife Distance Observation Form

This monitoring form can be used to gather data on visitor behavior related to wildlife viewing. Recently, multiple national park units initiated a safe wildlife viewing program. Working with researchers, this observational protocol was developed to observe visitor distances and behaviors while viewing wildlife. The data informed future communication efforts related to this topic.

Date: Time Period:

Target Species:

Location (describe; if you moved/followed wildlife, describe where. Also, photograph and/or video the location(s) with wide shots):_____

_____

Approximate number of wildlife present within viewshed (be exact whenever possible):

_____

Approximate number of people (incl. children, even those carried or in strollers) present on foot only within viewshed of up to 100 yards (be exact whenever possible): _____*

* *This includes people that did not possibly see/notice the wildlife. Does not include people in vehicles.*

Ungulates Only:

_____ # of visitors within less than 5 yards (5 yards ≈ SUV-length)

_____ # of visitors within 5-12 (12 yards ≈ RV-length)

_____ # of visitors within 13-18 yards (23 yards ≈ 1 bus + small car)

_____ # of visitors within 19-24 yards (24 yards ≈ About 3 feet less than 2 bus-lengths)

Note: In some instances, people will move closer. Wait until they stop moving, usually it's once they get their photo. The closest distance they get from the animal(s) is the category they should be counted in. This will mean if you counted them first in a further away category, you'll need to subtract them from that one and add them to the closer category they ended up in.

_____ # of visitors that *wildlife approached* and people did not back away (within 2 bus-lengths or less for ungulates)

_____ # of visitors touched wildlife

_____ # of visitors deliberately fed or attempted to feed or watered (turned on faucet) wildlife

_____ # of visitors called/clicked/kissed/whistled to attract wildlife attention

_____ # of visitors who shoo'd away (hazed) wildlife (stomped, moved toward it fast/aggressively)

Other interactions seen (count and describe):_____

_____

Describe other relevant actions (photography/videography, feeding/throwing food/leaving food, petting/touching, injury) or conversations/comments overheard of visitors:_____

_____

Given where the wildlife were throughout the observation period, was it possible for visitors to move/be further away? Describe the situation. What differences did you notice when wildlife were in a more open area vs in a more restricted area (e.g., on a paved walkway)?_____

_____

Describe other relevant actions of the wildlife (defensive, aggressive/persistent, avoiding/moving away from people):_____

_____

Describe relevant communication (mediated and interpersonal) in area where HWI was observed.

(1) Photograph and tag (by location on file name of folder that corresponds with this note) signs in area relevant to safe distance or feeding and/or note campaign signage location in area. _____

_____

(2) Describe park employee/volunteer intervention (what they did/said and how visitors responded/reacted).

_____

(3) When applicable, describe visitor-to-visitor intervention (i.e., someone tells others about safe distance or to back away).

_____

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Glossary of Key Terms

Desired conditions are statements of aspiration that describe resource conditions, visitor experiences and opportunities, and facilities and services that an agency strives to achieve and maintain in a particular area.

Indicators are specific resource or experiential attributes that can be measured to track changes in conditions so that progress toward achieving and maintaining desired conditions can be assessed.

Monitoring is the process of routinely and systematically gathering information or making observations to assess the status of specific resource conditions and visitor experiences.

A **monitoring strategy** (often referred to as a monitoring program) should be designed and implemented to provide usable data for periodically comparing existing and desired conditions, assessing the need for management actions, and evaluating the efficacy of management actions.

An **objective** is a specific result that an agency aims to achieve within a specified timeframe, and it reflects conditions that are affected directly by agency action.

The **sliding scale of analysis** is used to ensure the investment of time, money, and other resources for a project is commensurate with the complexity of the project and the consequences of the decision.

Thresholds are minimally acceptable conditions associated with each indicator.

Triggers reflect conditions of concern for an indicator that are enough to prompt a management response to ensure that desired conditions continue to be maintained before the threshold is crossed.

Visitor capacity is a component of visitor use management and is the maximum amounts and types of visitor use that an area can accommodate while achieving and maintaining the desired resource conditions and visitor experiences that are consistent with the purposes for which the area was established.

Visitor experience is the perceptions, feelings, and reactions that a visitor has before, during, and after a visit to an area.

Visitor use refers to human presence in an area for recreational purposes, including education, interpretation, inspiration, and physical and mental health.

Visitor use management is the proactive and adaptive process for managing characteristics of visitor use and the natural and managerial setting using a variety of strategies and tools to achieve and maintain desired resource conditions and visitor experiences.

The **"Visitor Use Management Framework"** provides the analytical elements necessary to address visitor use management opportunities and issues, consistent with applicable law, within existing agency management processes.

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References

Belnap, J. 1998. Choosing indicators of natural resource conditions: a case study in Aches National Park, Utah, USA. Journal of Environmental Management 53:635-642

Broom, T.J., and T.E. Hall. 2008. A guide to monitoring encounters in wilderness. University of Idaho, College of Natural Resources, Department of Conservation Social Sciences, Moscow, ID.

Cole, D.N. 2006. Visitor and recreation impact monitoring: Is it lost in the gulf between science and management? George Wright Forum 23 (2): 11-16.

Cole, D.N. 2013. Changing conditions on wilderness campsites: Seven case studies of trends over 13 to 32 years. Gen Tech Rep RMRS-GTR-300. U.S. Department of Agriculture, U.S. Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

Cole, D.N., P. Foti, and M. Brown. 2008. Twenty years of change on campsites in the backcountry of Grand Canyon National Park. Environmental Management 41: 959-970.

Creswell, J.W. 2014. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. Thousand Oaks, California: SAGE Publications.

Daigle, J.J., and C.A. Zimmerman. 2004. Alternative transportation and travel information technologies: Monitoring parking lot conditions over three summer seasons at Acadia National Park. Journal of Park and Recreation Administration 22 (4): 81-102.

Daigle, J.J., W. Opuszynski, and M. Laroche. 2017. Fifteen years of change: Campsites in the Allagash Wilderness Waterway. International Journal of Wilderness 23 (1): 18-24.

Drucker, P.F. 1954. The Practice of Management. New York: Harper & Row.

Fancy, S.G., J.E. Gross, and S.L. Carter. 2009. Monitoring the condition of natural resources in US national parks. Environmental Monitoring and Assessment 151: 161-174.

Farrell, T.A., and J.L. Marion. 2002. The Protected Area Visitor Impact Management (PAVIM) Framework: A Simplified Process for Making Management Decisions. Journal of Sustainable Tourism 10 (1): 31-51.

Franc, A., O. Laroussinie, and T. Karjalainen, eds. 2001. Criteria and Indicators for Sustainable Management at the Forest Management Unit Level. European Forest Institute Proceedings, No. 38.

Guntenspergen, G.R., ed. 2014. Application of Threshold Concepts in Natural Resource Decision Making. New York: Springer.

Hall, F.C. 2002. Photo point monitoring handbook. Gen Tech Rep PNW-GTR-526. U.S. Department of Agriculture, U.S. Forest Service, Pacific Northwest Research Station, Portland, OR.

Hamilton, R.M. 2005. Photo point monitoring. Excerpt from: A weed managers guide to remote sensing and GIS – mapping and monitoring. Remote Sensing Application Lab publication. Salt Lake City, UT.

Hammitt, W.E., D.N. Cole, and C.A. Monz. 2015. Wildland Recreation: Ecology and Management. 3rd edit. West Sussex, UK: John Wiley and Sons.

Hennings, L. 2017. Hiking, mountain biking, and equestrian use in natural areas: a recreation ecology literature review. Technical report. September 2017. Metropolitan Regional Government. Oregonmetro.gov

Herrick, J.E., J.W. Van Zee, K.M. Havstad, L.M. Burkett, and W.G. Whitford. 2005. Monitoring Manual for Grassland, Shrubland, and Savanna Ecosystems. Volume I. U.S. Department of Agriculture, Agricultural Research Service, Jornada Experimental Range, Las Cruces, NM.

IVUMC (Interagency Visitor Use Management Council). 2016. Visitor Use Management Framework: A Guide to Providing Sustainable Outdoor Recreation. Edition One. Denver, CO. http://visitorusemanagement.nps.gov.

IVUMC (Interagency Visitor Use Management Council). 2019. Visitor Capacity Guidebook: Managing the Amounts and Types of Visitor Use to Achieve Desired Conditions. Denver, CO. https://visitorusemanagement.nps.gov/VUM/Framework.

Kim, M.K., and J.J. Daigle. 2011. Detecting vegetation cover change on the summit of Cadillac Mountain using multi-temporal remote sensing datasets: 1979, 2001, and 2007. Environmental Monitoring and Assessment 180: 63-75.

Landres, P., C. Barns, S. Boutcher, T. Devine, P. Dratch, A. Lindholm, L. Merigliano, N. Roeper, E. Simpson. 2015. Keeping it wild 2: an updated interagency strategy to monitor trends in wilderness character across the National Wilderness Preservation System. Fort Collins, CO: USDA Forest Service, Rocky Mountain Research Station. 114 p. https://www.fs.fed.us/rm/pubs/rmrs_gtr340.pdf (See also agency specific technical guides)

Lime, D.W., D.H. Anderson, and J.L. Thompson. 2004. Identifying and Monitoring Indicators of Visitor Experience and Resource Quality: A Handbook for Recreation Resource Managers. University of Minnesota, Department of Forest Resources, St. Paul, MN.

MacDonald, L.H. and A. Smart. 1993. Beyond the guidelines: Practical lessons for monitoring. Environmental Assessment and Monitoring 26: 203-218.

Marion, J.L., J. Arredondo, J. Wimpey, F. Meadema. 2018. Applying Recreation Ecology Science to Sustainably Manage Camping Impacts: A Classification of Camping Management Strategies. International Journal of Wilderness 2 (24): 85-101.

Marion, J.L., H. Eagleston. 2017. Sustainable campsite management in protected areas: A study of long-term ecological changes on campsites in the boundary waters canoe area wilderness, Minnesota, USA. Journal for Nature Conservation 37: 73–82.

Marion, J.L. 2016. A review and synthesis of recreation ecology research supporting carrying capacity and visitor use management decisionmaking. Journal of Forestry 114 (3): 339-351.

Marion, J.L. and Y.-F. Leung. 2011. Indicators and Protocols for Monitoring Impacts of Formal and Informal Trails in Protected Areas. Journal of Tourism and Leisure Studies 17 (2): 215-236

Marion, J.L., and C. Carr. 2009. Backcountry Recreation Site and Trail Conditions: Haleakalā a National Park. U.S. Department of the Interior, U.S. Geological Survey, Blacksburg, VA.

Marion, J.L., R.G. Dvorak, and R.E. Manning. 2008. Wildlife Feeding in Parks: Methods for Monitoring the Effectiveness of Educational Interventions and Wildlife Food Attraction Behaviors. Human Dimensions of Wildlife 13: 429-442.

Marion, J. L., and D. N. Cole. 1996. Spatial and temporal variation in soil and vegetation impacts on campsites: Delaware Water Gap National Recreation Area. Ecological Applications 6 (2): 520–530.

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

McCool, S.F., and D.N. Cole. 1997. Proceedings—Limits of Acceptable Change and Related Planning Processes: Progress and Future Directions. Gen Tech Rep INT-GTR-371. U.S. Department of Agriculture, U.S. Forest Service, Intermountain Research Station, Ogden, UT.

Monz, C., and Y.-F. Leung. 2006. Meaningful Measures: Developing Indicators of Visitor Impact in the National Park Service Inventory and Monitoring Program. George Wright Forum 23 (2): 17-27.

NPS (National Park Service). 1997. The Visitor Experience and Resource Protection (VERP) Framework: A Handbook for Planners and Managers. U.S. Department of the Interior, National Park Service, Denver Service Center, Denver, CO.

Oakley, K.L., L.P. Thomas, and S.G. Fancy. 2003. Guidelines for Long-Term Monitoring Protocols. Wildlife Society Bulletin 31 (4): 1000-1003.

Poister, T.H. 2003. Measuring Performance in Public and Nonprofit Organizations. San Francisco, California: Jossey-Bass.

Roggenbuck, J.W., D.R. Williams, and A.E. Watson. 1993. Defining Acceptable Conditions in Wilderness. Environmental Management 17 (2): 187-197.

Stankey, G.H., D.N. Cole, R.C. Lucas, M.E. Petersen, and S.S. Frissell. 1985. The Limits of Acceptable Change (LAC) System for Wilderness Planning. Gen Tech Rep INT-176. U.S. Department of Agriculture, U.S. Forest Service, Intermountain Forest and Range Experiment Station, Ogden, UT.

USFS (U.S. Forest Service). 1992. Ideas for the Limits of Acceptable Change: Planning Process, Book Two. Washington, D.C.: U.S. Department of Agriculture, Forest Service, Recreation Staff. Pp. 65-84.

Vaske, J.J., D. Whittaker, B. Shelby, and M.J. Manfredo. 2002. Indicators and standards: Developing definitions of quality. Pp. 143-171. In: Wildlife Viewing in North America: A Management Planning Handbook. Edited by Michael J. Manfredo. Oregon State University Press, Corvallis, OR.

Vaske, J. J., and M.P. Donnelly. 2001. Social impact indicators and standards at the Columbia Icefield (HDNRU Rep. No. 47). Fort Collins, CO: Colorado State University.

Shelby, B., G.H. Stankey, and B. Shindler. 1992. Defining wilderness quality: the role of standards in wilderness management—a workshop proceedings. Gen Tech Rep PNW-GTR-305. Portland, OR: U.S. Department of Agriculture, U.S. Forest Service, Pacific Northwest Research Station.

Wimpey, J. and J.L. Marion. 2011. A spatial exploration of informal trail networks within the Great Falls Park, VA. Journal of Environmental Management 92:1012-1022.

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