United States
Department of
Agriculture

Forest Service

General Technical

Report WO-80

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Peter Landres, Steve Boutcher, Liese Dean, Troy Hall, Tamara Blett, Terry Carlson, Ann Mebane, Carol Hardy, Susan Rinehart, Linda Merigliano, David N. Cole, Andy Leach, Pam Wright, and Deb Bumpus

Acknowledgments

We are indebted to the people who served on the Forest Service Wilderness Monitoring Committee—Beth Boyst, Mary Beth Hennessy, Brad Hunter, Patrice Janiga, Al McPherson, Douglas S. Powell, Mike Rowan, Susan Sater, Chris Barns (Bureau of Land Management [BLM]), Steve Henry (U.S. Fish & Wildlife Service [USFWS]), Mark Laker (USFWS), and Denis Davis (National Park Service)—for beginning the effort to actually preserve wilderness character and for providing such broad and capable shoulders to stand on. We thank Forest Service leaders for providing significant financial and administrative support to agency authors while they were developing this technical guide. We also thank the BLM, USFWS, and National Park Service for supporting several other people while they worked on this effort. We also deeply thank the many others who devoted significant time and effort to help on subteams: Untrammeled quality—Al McPherson, Rebecca Oreskes, David Rak, Mike Rowan, and Diane Taliaferro; Air quality—Scott Copeland, Bill Jackson, and Andrea Stacy; Aquatic systems—Steve Glasser, Chris Knopp, Russ Lafayette, Mark Laker, and David Spildie; Vegetation—Paul Alaback, Bruce D. Anderson, Steve Croy, Karen Dillman, and Mark Jensen; Wildlife—Lance Lerum, Kathleen Mathews, Jennifer Moleworth, and Amy Unthank; Undeveloped quality—Chris Barns, Liese Dean, James Demby, Vicky Duvall, Bill Hamele, David Rak, Carol Russel, Susan Sater, Jaime Schmidt, and Bev Thackeray; Outstanding opportunities for solitude or a primitive and unconfined recreation—Chris Barns, Denis Davis, Brad Hunter, Al McPherson, and Mike Rowan. We also appreciate the support of the national wilderness program leads from the four wilderness managing agencies—Don Fisher (Forest Service), Peter Mali (BLM), Rick Potts (National Park Service), and Nancy Roeper (USFWS). Last, we thank the copy editors for all of their diligence and effort to make this long and complicated document as clear as possible. The passion, dedication, and effort of all these people help ensure that present and future generations may experience the benefits of an enduring resource of wilderness.

Authors' Note

This publication was developed by a technical working group and solely represents the views of its authors. It does not represent and should not be construed to represent any agency determination or policy.

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Chapter 1. Overview

1.0. Purpose and Scope

The purpose of monitoring wilderness character is to improve wilderness stewardship by providing managers a tool to assess how selected actions and conditions related to wilderness character are changing over time. Wilderness character monitoring provides information to help answer two key questions about wilderness character and wilderness stewardship:

1. How is wilderness character changing over time?

2. How do stewardship actions affect this change in wilderness character?

Line officers need the answers to these questions to assess the outcomes of past decisions on wilderness character and to make informed decisions about future actions. Regional and forest wilderness program managers need these answers to track trends in wilderness character over time and to review the effectiveness of implementing agency wilderness policy. On-the-ground managers and rangers in an individual wilderness also need these answers to help them assess the outcomes of their efforts to preserve wilderness character.

Wilderness character is a complex idea encompassing tangible and intangible local and national aspects. To understand the scope of this technical guide, it is necessary to define what wilderness character monitoring does and does not do. Wilderness character monitoring does the following:

- Assesses national trends in wilderness character derived from compilations of nationally consistent information from individual wildernesses.
- Focuses on four specific qualities of wilderness derived from the Section 2(c) Definition of Wilderness from the Wilderness Act of 1964 that are linked to wilderness character—(1) untrammeled, (2) natural, (3) undeveloped, and (4) outstanding opportunities for solitude or a primitive and unconfined type of recreation.
- Monitors a select set of wilderness attributes and stewardship actions that indicate how these four qualities of wilderness are changing over time within a wilderness. It does not monitor the aspects of wilderness character that are unique to a specific wilderness, the intangible aspects related to the symbolic qualities of wilderness, the quality of visitor experiences, or project-specific and site-specific resources of concern.

- Evaluates whether these four qualities and wilderness character are stable, improving, or degrading over time at the scale of an entire wilderness relative to the legislative direction for each wilderness. This evaluation is based on an assessment of change in selected indicators. This monitoring does not compare wilderness character from one wilderness to another or develop a numerical index of wilderness character that could be used for such purposes.
- Uses indicators and measures that are relevant, reliable, and cost efficient. Cost-efficiency requires the use of data already existing within Forest Service or other national databases at the time this monitoring is implemented. Because of practical restrictions on funding and staffing, this technical guide does not require any new field data to be collected, although field managers will need to gather and report some information that cannot be obtained through existing databases.

This national monitoring protocol was built in two phases. The first phase consisted of developing the conceptual foundation for this monitoring in the publication *Monitoring Selected Conditions Related to Wilderness Character: A National Framework* (referred to as the "Framework"; Landres and others 2005). Developing this foundation was necessary because, unlike other resources such as air, water, and wildlife, the concept of wilderness character is poorly understood, cuts across many resource areas, and has never been formally described or monitored. The second phase consisted of developing this *Technical Guide for Monitoring Selected Conditions Related to Wilderness Character,* which provides the specific protocols for data collection, storage, analysis, reporting, and use. It is essential that the reader and user of this technical guide understand the basis and limitations for this monitoring as developed and described in the Framework.

1.1. Background

Although 18 percent of all the land managed by the Forest Service (about 35 million acres) is designated as wilderness, the agency lacks a nationally consistent way to evaluate how well it is fulfilling the central mandate of the Wilderness Act of 1964 (Public Law 88-577) to preserve the area's wilderness character. Wilderness monitoring is needed for various purposes, and, although several programs already monitor some of the specific resources within wilderness, the most critical need is to monitor what makes wilderness unique—its wilderness character—among all other National Forest System (NFS) lands.

What Is Wilderness Character?

The Wilderness Act of 1964 does not define "wilderness character," and, despite a rich legislative history on many aspects of the Wilderness Act, the congressional committees that developed and debated the Wilderness Act of 1964 did not discuss the meaning of

this phrase (Scott 2002). To develop a deeper understanding of the meanings of wilderness character, Kaye (2000, 2002) and Scott (2002) explored the historical writings of the framers of the Wilderness Act, especially those of Howard Zahniser, its principal author. This exploration reveals three mutually reinforcing societal ideals that are integral to the historical purpose of wilderness and to an understanding of wilderness character:

1. Natural environments relatively free from modern human manipulation and impacts.
2. Personal experiences in natural environments that are relatively free from the encumbrances and signs of modern society.
3. Symbolic meanings of humility, restraint, and interdependence in how individuals and society view their relationship to nature.

Wilderness character may be described as the combination of biophysical, experiential, and symbolic ideals that distinguishes wilderness from other lands. These ideals combine to form a complex and sometimes subtle set of relationships among the land, its management, and the meanings people associate with wilderness. Zahniser (1956) describes the relationships and meanings as "…the *distinctive* ministration of wilderness to modern man, the characteristic effect of an area which we most deeply need to provide for in our preservation programs." Cordell and others (2005) provide an extensive discussion about these relationships and meanings, and Havlick (2006) discusses how wilderness fosters these traits. Schroeder (2007) explores the profound psychological implications of the symbolic meanings derived from wilderness. In this technical guide, these relationships and meanings are described as "wilderness character."

Agency decisions and actions may either support or degrade wilderness character, and the humility, restraint, and respect shown by managers is central to preserving wilderness character. For example, the choice to not use a chain saw, to not build a footbridge across a stream, or to not suppress a naturally ignited fire may preserve certain qualities of wilderness character. In contrast, other management actions, such as requiring permits, designating campsites, or authorizing administrative use of motorized equipment and mechanical transportation, diminish certain qualities of wilderness character. Because management decisions and actions in wilderness may have a lasting effect on the land and on the meanings associated with wilderness, the accumulation of seemingly small decisions may result in significant loss of wilderness character over time.

Actions taken to protect one aspect of wilderness character may diminish another aspect. For example, a bridge built to protect a streambank from erosion caused by people or horses crossing the stream may also diminish the opportunity for people to experience the challenge of crossing a stream. Similarly, the required use of designated campsites to prevent the proliferation of sites and associated impacts on soil and vegetation may also

diminish the opportunity for unconfined recreation and the sense of freedom from the constraints of society.

In addition to national perceptions and meanings associated with wilderness character, unique, place-dependent or locally based aspects also exist within each wilderness. Every wilderness is a unique biophysical environment, with specific establishing purposes, management direction, and relationships that people have with the area. The combination of biophysical environment, purposes, management, and relationships means that some aspects of wilderness character are unique to each wilderness. Such aspects of wilderness character can best be evaluated with locally meaningful monitoring indicators and are not part of this national monitoring effort.

Why Is Wilderness Character Monitoring Needed?

Currently, it is not possible to consistently describe the loss of wilderness character or the positive stewardship outcomes to be derived from protecting wilderness character. This lack of agency wilderness-specific monitoring occurs despite the following:

- Zahniser's (1961) early statement that, "in all concern with wilderness, the first safety must be for the wilderness character itself."
- The Wilderness Act of 1964 and agency policy mandate to preserve wilderness character.
- The steady erosion of wilderness character perceived by many wilderness field and program managers.
- Increasing wilderness visitor use (Cole 2002) and other widespread threats to wilderness character (Cole and Landres 1996, Hendee and Dawson 2001, Landres and others 1998, Peine and others 1989).
- Repeated calls for monitoring to improve wilderness stewardship (General Accounting Office 1989, Pinchot Institute for Conservation 2001, USDA Forest Service 2000).

Following on these concerns, wilderness character monitoring is needed to fulfill legal and policy mandates; improve stewardship and accountability; and improve communication among managers, decisionmakers, policymakers, and the public.

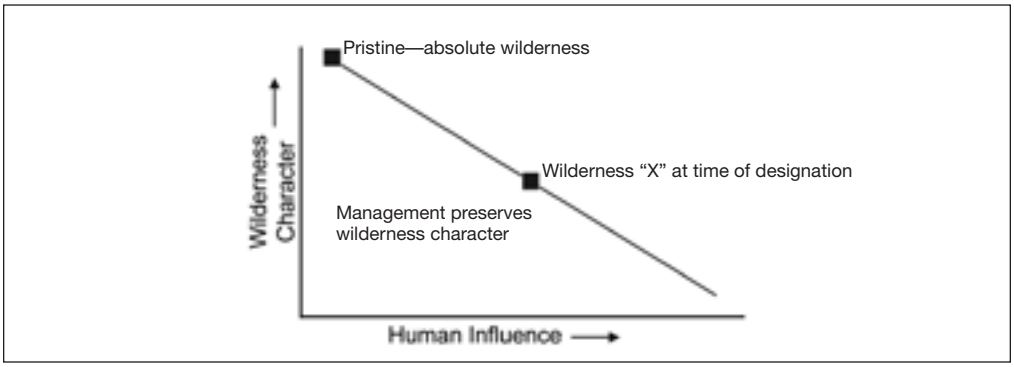
The Wilderness Act Statement of Policy, Section 2(a), states that wilderness areas "shall be administered for the use and enjoyment of the American people in such manner as will leave them unimpaired for future use and enjoyment as wilderness, *and so as to provide for the protection of these areas, the preservation of their wilderness character.*" (emphasis added). In addition to this Statement of Policy, legal scholars Rohlf and Honnold (1988)

and McCloskey (1999) assert that Section 4(b), Use of Wilderness Areas, gives the primary management direction for wilderness, that "… each agency administering any area designated as wilderness shall be responsible for preserving the wilderness character of the area." The *Congressional Record* (United States Congress 1983) reinforces this assertion, stating, "The overriding principle guiding management of all wilderness areas, regardless of which agency administers them, is the Wilderness Act (section 4(b)) mandate to preserve their wilderness character." Section 4(b) further states that even when the agency administers the area for other purposes, the agency must also "preserve its wilderness character."

Pursuant to the Wilderness Act, Forest Service Manual (FSM) 2320.2 (4), directs the agency to "protect and perpetuate wilderness character" from the time of wilderness designation. Figure 1 illustrates Forest Service Wilderness Management policy. The vertical axis shows wilderness character improving upwards, and the horizontal axis shows the amount of modern human influence on wilderness character, with increasing influence to the right. The diagonal line shows the general relationship of increasing human influence, causing a decline in wilderness character. In addition, the Government Performance and Results Act of 1993 requires Federal agencies to demonstrate accountability "by providing … information about program results and service quality." Wilderness character monitoring in accordance with this technical guide will yield information on the outcomes of agency decisions and actions to "preserve wilderness character."

Furthermore, wilderness character monitoring improves wilderness stewardship by linking a national set of on-the-ground indicators to the mandates of the Wilderness Act and agency wilderness policy. Although improving wilderness stewardship must occur at the local level, the ability to compile information at regional and national levels provides a powerful communication tool that is essential to make the case for wilderness stewardship needs and for evaluation of program effectiveness at all administrative levels (e.g., see Urquhart and others 1998). With this full set of national indicators, wilderness character monitoring is a tool to help improve wilderness stewardship in several ways, including the following:

Figure 1.—*The Wilderness Management Model modified from FSM 2320.6.*

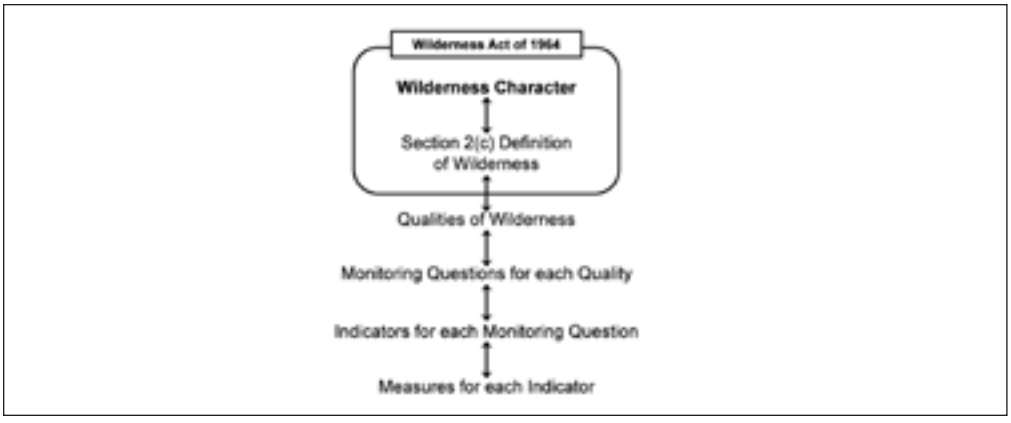


- Evaluate program effectiveness and help prioritize where future actions should be focused to improve wilderness character.
- Express how different funding levels affect the statutory requirement to preserve wilderness character.
- Link performance measures directly to the Wilderness Act mandate to preserve wilderness character.
- Make resource information about a particular wilderness more accessible to a wilderness manager (including air quality, wildlife, watershed, and vegetation).
- Establish a permanent database that enables information to be passed on and used by future managers.

How Will Wilderness Character Be Monitored?

The logical structure or conceptual model for this monitoring protocol hierarchically links the indicators and measures to wilderness character (fig. 2). The two elements of this figure inside the box are taken directly from the Wilderness Act of 1964, while the four elements outside the box were developed for this technical guide. The Section 2(c) Definition of Wilderness is used to identify specific qualities of wilderness that are related to the concept of wilderness character. Then, each of these qualities of wilderness is sequentially divided into a set of monitoring questions, indicators, and measures. Monitoring questions set specific monitoring goals, indicators are the types of information used to answer each monitoring question, and measures are the numeric values that are measured or derived to quantify change over time in the indicator. In this model (fig. 2), the downward-pointing arrowheads show that the concept of wilderness character drives the selection of all the subsequent elements and ultimately the data collected. The upward-pointing arrowheads show how data collected on the measures are used to evaluate successively higher elements.

Figure 2.—*The logical basis for wilderness character monitoring, showing the inferences (arrows) used to develop indicators and measures.*



The Section 2(c) Definition of Wilderness (see boxed text) is used to focus wilderness character monitoring because this definition directs the management of congressionally designated wilderness. In addition, legal and wilderness scholars refer to this legislative definition to understand congressional intent for the meaning of wilderness character (McCloskey 1999, Rohlf and Honnold 1988, Scott 2002). Based on this definition of wilderness, the following four qualities generally represent the concepts and ideals, and sometimes subtle distinctions that distinguish wilderness from all other lands:

1. Untrammeled.
2. Undeveloped.
3. Natural.
4. Outstanding opportunities for solitude or a primitive and unconfined type of recreation.

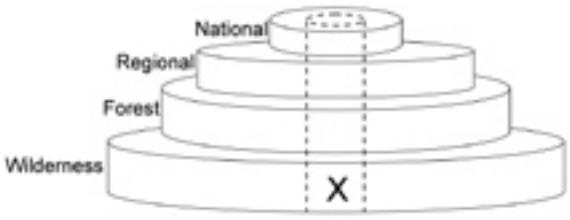
These four qualities reinforce one another and together constitute an approximation of wilderness character for this national monitoring protocol. All these qualities are equally important and none is held in higher regard than the others. The monitoring of these four qualities provides management staff, decisionmakers, and policymakers with a solid basis of information to tie some of the changes occurring within wilderness to the legislative and policy direction for wilderness.

Nationally consistent indicators compiled from individual wildernesses are necessary to paint a compelling picture of wilderness stewardship needs and to identify broad geographic changes in wilderness character that require regional or national attention (fig. 3). In this figure, adapted from Powell (2000), each horizontal layer represents the breadth of information needs of the different administrative levels within the agency. The space enclosed by the dashed vertical lines represents national core indicators that cut across all administrative levels. The portion of each administrative level outside the pair of vertical lines shows the information needs of that level in addition to the core monitoring indicators. The "X" represents the data collected from the individual wilderness under the national monitoring Framework (Landres and others 2005). Indicators are derived from management experience; they are intended to be useful both at the local level and at higher administrative levels when information is synthesized. These indicators, however, form only part of the information needed to manage a local wilderness. For example, managers of an individual wilderness may need details about specific sites (e.g., popular campsites), local issues (e.g., compliance with maintenance objectives for a particular sensitive plant species), or place-dependent aspects of wilderness character (e.g., conditions associated with airstrips discussed in enabling legislation). Such specific details are beyond the scope of this national technical guide.

The Wilderness Act of 1964 Section 2(c) Definition of Wilderness

"A wilderness, in contrast with those areas where man and his own works dominate the landscape, is hereby recognized as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain. An area of wilderness is further defined to mean in this Act an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions and which (1) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable; (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation; (3) has at least five thousand acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition; and (4) may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value."

Figure 3.—*The "wedding cake" model of administrative and information relationships within the Forest Service.*



Wilderness character monitoring can be applied to all NFS wildernesses regardless of size, location, or other place-specific attributes because it is based on the Section 2(c) legislative Definition of Wilderness and every wilderness law includes specific language that ties it to the provisions of the 1964 Act and this legislative definition (Hendee and Dawson 2002, Landres 2003). Although individual wilderness laws often include specific exceptions or special provisions that apply to the uses and values of particular areas, no act changes the Section 2(c) Definition of Wilderness provided in the Wilderness Act, and no subsequent legislation changes the management responsibility of Section 4(b) for "preserving the wilderness character of the area."

What Concerns Are Associated With Interpreting the Wilderness Act To Monitor Wilderness Character?

Developing a practical program of wilderness monitoring requires many decisions and compromises. Two general or overarching concerns accompany the use of agency interpretation of Section 2(c) to derive specific qualities of wilderness that are linked to wilderness character (specific concerns for each quality are discussed in each of the following individual chapters, as appropriate).

First, splitting the legislative definition of wilderness into four relatively distinct qualities imposes reductionistic thinking on the fundamentally holistic concept of wilderness character. One problem with this reductionism is that a particular action may be associated with either a positive or negative outcome depending on the particular quality from which the action is viewed. For example, to protect the natural quality, a bridge may be built to reduce resource damage (such as increased sediment in the stream associated with people and horses crossing a stream). Unfortunately, this bridge then reduces the outstanding opportunities quality because it diminishes the personal discovery and challenge of crossing the stream.

The second concern is focusing on just these four qualities of wilderness may enable managers and others to ignore important experiential, symbolic, and intangible aspects of wilderness character (Putney and Harmon 2003, Schroeder 1992).

Although both these concerns have merit, this national monitoring protocol provides a more solid foundation to tie wilderness stewardship to the legislative direction of the Wilderness Act than has existed before. In many cases, these concerns can be alleviated by explicitly identifying the concern and carefully interpreting the results. The monitoring protocols for each indicator explicitly describe these concerns and provide instructions for interpreting monitoring results.

1.2. Key Concepts

The concepts that form the basis for this technical guide are discussed in detail in the national Framework (Landres and others 2005) and are summarized here. All technical terms used in this technical guide are defined in Appendix A, Glossary.

The Primary Purpose of This Monitoring Is To Improve Wilderness Stewardship

This monitoring will help wilderness managers—from field staff to the Washington Office—improve wilderness stewardship by providing information on key indicators that link directly to the statutory requirements of the Wilderness Act and agency policy to "preserve wilderness character." This information will help answer key questions about the outcomes of wilderness stewardship:

- How is wilderness character changing over time?
- How do stewardship actions affect this change in wilderness character?

Wilderness character monitoring provides local, regional, and national managers a way to assess if wilderness stewardship programs are protecting and perpetuating conditions related to wilderness character. The resulting information could be used to help managers make informed decisions about stewardship priorities and analyze proposed actions for their potential consequences to wilderness character.

This Monitoring Is Nationally Consistent and Locally Relevant

To help improve wilderness stewardship from the local to the national level, this monitoring was designed from its inception to be nationally consistent and locally relevant. Monitoring must provide information that is relevant to local staff for them to devote the required time and effort to gather data and report trends. Although improvements in wilderness stewardship must occur at the local level, the ability to compile information at regional and national levels is also essential to make the case for budget and resources to address wilderness stewardship needs and for evaluating program effectiveness at all administrative levels.

Considerable effort was spent choosing a set of national core monitoring indicators that would be relevant to most NFS wildernesses and developing a standardized process to synthesize the resulting data to assess trends in wilderness character. Every wilderness will be required to report on trends in wilderness character, and using nationally consistent data and processes enables compilation of these trends at the regional and national levels.

A standardized monitoring program will enable managers to assess how wilderness character is changing over relatively long periods of time and will become a legacy spanning the careers of individual wilderness managers. This national wilderness character monitoring program complements but does not replace information needs on locally important and place-dependent aspects of wilderness character.

This Monitoring Is Based on Qualities of Wilderness Derived From the Section 2(c) Definition of Wilderness

Four qualities are derived from Section 2(c) of the Wilderness Act (see box earlier in this section) and are considered necessary and sufficient for this national monitoring effort to improve agency wilderness stewardship. The four qualities were chosen based on agency experience with managing wilderness and on the scientific literature. Government agencies are required to implement laws in their entirety, and each of the four qualities is interpreted to reflect the elements included in the Wilderness Act of 1964 (McCloskey 1966). A detailed discussion of the historical and scientific support and specific concerns for each of the four qualities is provided in the national Framework (Landres and others 2005).

- **Untrammeled.** The Wilderness Act states that wilderness "[is] an area where the earth and its community of life are untrammeled by man," and "generally appears to have been affected primarily by the forces of nature." This quality monitors human activities that directly control or manipulate the components or processes of ecological systems inside wilderness. In summary, wilderness is essentially unhindered and free from modern human control or manipulation.
- **Natural.** The Wilderness Act states that wilderness is "protected and managed so as to preserve its natural conditions." This quality monitors both intended and unintended effects of modern people on ecological systems inside a wilderness since the area was designated. In summary, wilderness ecological systems are substantially free from the effects of modern civilization.
- **Undeveloped.** The Wilderness Act states that wilderness is "an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation," "where man himself is a visitor who does not remain" and "with the imprint of man's work substantially unnoticeable." This quality monitors the presence of structures, construction, habitations, and other

evidence of modern human presence or occupation. In summary, wilderness is essentially without permanent improvements or modern human occupation.

- **Outstanding Opportunities for Solitude or a Primitive and Unconfined Type of Recreation.** The Wilderness Act states that wilderness has "outstanding opportunities for solitude or a primitive and unconfined type of recreation." This quality monitors conditions that affect the *opportunity* for people to experience solitude or primitive, unconfined recreation in a wilderness setting; it does not monitor visitor experiences per se. In summary, wilderness provides outstanding opportunities for people to experience solitude or primitive and unconfined recreation, including the values of inspiration and physical and mental challenge.

Indicators and Measures Were Selected To Be Relevant, Reliable, and Cost Effective

All the indicators and measures were selected under three primary criteria: (1) relevance, (2) reliability, and (3) cost-effectiveness. Relevance means that the indicator must have value and meaning for assessing change in the quality of wilderness and have value and meaning to the managers of an individual wilderness. The Forest Service has management responsibility for all the indicators used in this monitoring protocol, although the degree of influence varies among the indicators. Reliability means that the indicator could be measured accurately with a high degree of confidence, that measurement would yield the same result when measured by different people at different times and across different wildernesses when conditions are the same, and that a reasonable likelihood of future data availability exists. Cost-effectiveness is crucial for successful implementation, and every effort was made to select indicators and measures that were already available from other monitoring programs and would require a minimum amount of time and effort from wilderness staff. No new field data collection will be required; however, managers will need to gather and report information that cannot be obtained through existing databases. Data had to be available from at least 50 percent of NFS wildernesses for the indicator to have been selected.

The criterion of cost-effectiveness was imposed by the Wilderness Monitoring Committee to acknowledge the current budgetary climate in the Forest Service. The wilderness stewardship cause would not be served through the development of an unrealistic protocol that had a marginal chance of being funded and implemented. Fortunately, corporate databases in the Forest Service have matured to the point that they can be relied on for providing the data needed for many of the measures.

The indicators and measures in this monitoring protocol (table 1) are surrogates that are relevant to wilderness character based on best professional judgment and the available

Table 1.—*An overview of the qualities, monitoring questions, indicators, and measures that make up this monitoring protocol.*

Wilderness character			
Quality	**Question**	**Indicator**	**Measure**
Untrammeled	Manipulation	Actions	Number of management actions Number of fires suppressed Number of lakes stocked
Natural	Threats	Air pollutants	N100 ozone concentration W126 ozone concentration mg/L sulfur deposition mg/L nitrogen deposition
		Dams	Number of dams
		Nonindigenous species	Percentage of acres of nonindigenous plants Number of other nonindigenous species Number of acres of grazing allotments
	Biophysical conditions	Visual air quality	µm fine nitrate and sulfate Deciview
		Extirpations	Number of extirpated species
Undeveloped	Occupation	Physical evidence	Index of physical development
	Motorized and mechanical transport	Motorized and mechanized uses	Index of emergency uses Index of administrative and nonemergency uses
	Inholdings	Inholdings	Number of acres of inholdings
Outstanding opportunities	Solitude	Remoteness	Number of acres away from access/travel routes
		Visitors	(Option 1a) number of visiting parties (Option 1b) number of users residing in service area Number of NVUM visits per wilderness
	Primitive	Facilities	Index of recreation facilities
		Trails	Number of developed trail miles
	Unconfined	Restrictions	Index of visitor restrictions

NVUM = National Visitor Use Monitoring Program.

scientific literature. Each indicator reveals a relatively small and partial understanding about the quality of wilderness, so the evaluation of trends should be based on how the set of all indicators is changing instead of on change in any one indicator (Failing and Gregory 2003). Change in an indicator is foremost a red flag for further investigation about the conditions the indicator is tracking and the appropriateness of the indicator and quality of the data.

Reducing the holistic and complex nature of wilderness character into four relatively discrete qualities of wilderness means that some indicators will be relevant to more than one quality. For example, a dam and its effects could be monitored under all four qualities:

1. Untrammeled, because the dam was built to manipulate waterflow inside wilderness.
2. Natural, because the dam causes ecological impacts on natural streams.
3. Undeveloped, because the dam is a clear "imprint of man's work."

4. Outstanding opportunities, because the dam may interfere with the outstanding opportunity visitors have to experience a primitive recreation environment.

The Baseline for Evaluating Change Is the Time of Wilderness Designation or the First Time This Monitoring Protocol Is Applied

Change over time in the indicators and four qualities of wilderness character is measured and evaluated against a baseline reference point. Ideally, this baseline is described at the time a wilderness is designated. For wildernesses that have already been designated, appropriate historical data, if available, may be used to describe the baseline condition retrospectively. Because few existing wildernesses actually have this information, baseline condition would most likely be described from the first time this monitoring protocol is applied, even though such a description will not give an accurate picture of how the wilderness has changed since the time of designation.

Baseline conditions are simply the beginning point for tracking trends and do not imply that these conditions are "good," "bad," or "desired." For example, at the time of designation, a wilderness may have existing roads, and these roads would be part of the baseline condition of this wilderness. Monitoring would simply show how the undeveloped quality of wilderness stays the same if the roads are not removed or improves if these roads are removed. Baseline conditions are the starting point for tracking change over time; local interpretation is crucial for placing this change in its proper historical and legislative context and for evaluating its relevance.

Wildernesses Will Not Be Compared With One Another and No National Standards for Wilderness Character Will Be Developed

The status of wilderness character in a particular wilderness cannot and will not be compared with that of another wilderness. Each wilderness is unique in its legislative and administrative direction and in its social and biophysical setting, so comparing the status of wilderness character among wilderness is inappropriate. For example, a wilderness with legislative provisions that allow a State fish and game department to use motorized equipment to manage wildlife would be expected to have more actions tracked under the untrammeled quality compared with a wilderness that has no such provisions. What is important to understand is whether this motorized use is stable, increasing, or decreasing over time in a particular wilderness, given its context, so that improvements in stewardship can be made in that wilderness.

For the same reason, no national standards for wilderness character will be developed as part of this monitoring protocol. The only national direction regarding wilderness character is Forest Service policy to protect and perpetuate wilderness character relative to the time the area was designated as wilderness.

Although the status of wilderness character will not be compared among wildernesses, trends in wilderness character (stable, improving, or degrading) could be compared and compiled across different wildernesses because they are derived in a nationally consistent manner. For example, a regional wilderness specialist may want to know the percentage of wildernesses in the region with degrading trends to understand if any problems or concerns exist about how wilderness policy is being implemented.

Decision Rules Are Used To Synthesize Across Indicators, Questions, and Qualities To Evaluate Trends in Wilderness Character

Qualitative decision rules are used to synthesize information across indicators to answer a monitoring question, across monitoring questions to evaluate trends in each of the four qualities of wilderness, and across the four qualities to evaluate trends in wilderness character. The goal of these decision rules is to assess change in terms of whether the monitoring question, quality, and wilderness character are improving, stable, or degrading within a wilderness. The trend in wilderness character from individual wildernesses will be compiled at the regional and national levels to determine the overall percentage of wildernesses with wilderness character that is preserved or degrading. For details on the decision rules and how they would be applied, see Chapter 3, Assessing Trend in Wilderness Character, later in this technical guide.

1.3. Reporting and Using Information From Wilderness Character Monitoring

This technical guide is designed to produce information about trends in wilderness character in NFS wildernesses. Specifically, this monitoring enables managers to assess whether the trend in wilderness character for an individual wilderness is improving, stable, or degrading compared with baseline conditions for that area. Nationally consistent monitoring indicators are used so that information from individual wildernesses can be compiled and presented at regional and national levels. Compiling these trends across individual wildernesses enables the Forest Service to assess the percentage of wildernesses within a region or the Nation that have preserved wilderness character (i.e., show an improving or stable trend) and that show a degrading trend in wilderness character.

To demonstrate agency accountability, it is essential to link stewardship efforts directly to the outcomes mandated by the Wilderness Act. This monitoring is essentially a tool to provide information to show where wilderness stewardship is yielding positive results and where improvement is needed.

Reporting the Information From This Monitoring

Two different reports will be produced to present monitoring results:

1. **National Wilderness Report.** The purpose of the National Wilderness Report is to promote communication and enable discussion of monitoring results with line officers and program managers to inform policy review and improve wilderness stewardship. The National Wilderness Report will consist of two parts: (1) a two-page national summary of monitoring results suitable for briefings to the National Leadership Team and similar audiences, and (2) a regional summary presenting trends in wilderness character, qualities, indicators, and measures for each region.

   The two-page national summary will present the percentage of NFS wildernesses in which wilderness character is being preserved, the percentage of NFS wildernesses in which wilderness character is degrading, and the national trend in the four wilderness qualities that constitute wilderness character. The national summary will also include a map displaying trends in wilderness character for each of the nine Forest Service regions. The expanded National Wilderness Report is intended to provide the level of detail national and regional wilderness program managers need to help with accountability for wilderness stewardship and policy review. See the Supplement—National Wilderness Report Example for the suggested format for this report.

2. **Local Wilderness Report.** A standard report format will be built into the Infra-WILD application enabling local wilderness managers to query the database and produce a report for an individual wilderness. Local managers will be able to produce two different kinds of reports: (1) a summarized Local Wilderness Report suitable for communicating monitoring results with line officers and potentially with interested citizens, and (2) a detailed Local Wilderness Report or "data dump" of all the information entered into the system for use by the local manager to compare current conditions against locally established standards. Such information will help managers with work planning and developing informed management actions. See the supplement for the suggested format of the summarized Local Wilderness Report.

The National Wilderness Report will be produced on a 5-year cycle. Every year, data will be summarized for 20 percent of NFS wildernesses (approximately 80 wildernesses per year). Updates will be produced annually and a comprehensive report produced every 5 years. Producing a report annually for a portion of NFS wildernesses enables compilation and synthesis work to be spread evenly rather than having to staff up once every 5 years. In addition, annual reports provide a more even information flow to leaders in the wilderness program so that some information about trends in wilderness character is available to inform program decisions. At the forest level, highlights from Infra-WILD reports produced for

local wildernesses could be included in the monitoring and evaluation reports, as required by planning regulations.

Because trend information on wilderness character will not be available until the second 5-year reporting cycle, biannual updates will be produced for the first 5 years. These updates will discuss what is happening with wilderness monitoring, significant findings from data entered to date, share lessons learned from monitoring done to date, and discuss what will be occurring in the next 6 months.

Using the Information From This Monitoring

Every wilderness needs to be able to conclude whether wilderness character is preserved or degrading compared with baseline conditions within that wilderness. Because this national set of selected indicators is linked to the concept of wilderness character in the Wilderness Act, information from wilderness character monitoring can be used to make judgments about trends in wilderness character in a consistent manner. This practice enables managers to link wilderness stewardship directly with the purpose of management stated in the Wilderness Act and agency wilderness policy.

As noted in the overview of this technical guide, information from wilderness character monitoring cannot be used to compare different wildernesses. Comparisons using absolute values generated for indicators for an individual wilderness are not appropriate because conditions in any one wilderness are partly due to its historical context, and special provisions contained within enabling legislation often modify appropriate actions and uses in an individual wilderness. What is important is that stewardship programs in every wilderness at least maintain wilderness character compared with the character of the wilderness that existed at the time of designation. Information from wilderness character monitoring will be used at the regional and national levels to report the percentage of wildernesses with wilderness character preserved compared with the percentage of wildernesses showing a degrading trend in wilderness character. Regional or national displays of information about many wildernesses can present a much more compelling picture than information about a single wilderness. Only at the local level will absolute data values be used because these data provide meaningful information to the local manager about how conditions compare with locally established standards and what the magnitude of change is from one monitoring period to another.

More specific ways wilderness character monitoring can be used to improve wilderness stewardship include the following:

- **Prioritize Actions.** Evaluate program effectiveness and help prioritize where future actions should be focused to improve wilderness character.

- **Forest Planning.** Help with forest plan revisions by identifying monitoring requirements for wilderness.
- **Communicate Stewardship Needs.** Express how different funding levels affect the statutory requirement to preserve wilderness character.
- **Accountability.** Link performance measures directly to the Wilderness Act mandate to preserve wilderness character.
- **Establish Legacy Information.** Establish a permanent database that creates one place for wilderness information (related to recreation sites, air quality, weeds, wildlife, regulations, etc.) to be passed on and used by future managers.

Local Use of This Monitoring Information

For most wildernesses, the first time this monitoring protocol is applied, the resulting data will describe the "baseline" state of conditions related to wilderness character. With first-year monitoring information, managers will only be able to examine the status of individual indicators and use this information to inform decisions if locally developed standards that define acceptable conditions have been established. With only baseline information, it will not be possible to evaluate whether conditions related to wilderness character have been preserved or are degrading. Wilderness character monitoring will have greater value in subsequent years when it becomes possible to evaluate how conditions related to wilderness character are changing over time.

Trend information collected over 5 or more years, and information that transcends individual wilderness managers, will be especially powerful in efforts to preserve wilderness character. For example, knowing the number and type of actions taken to manipulate vegetation occurring now compared with what occurs 10 years from now is a valuable indicator about whether management programs are trending toward more or less manipulation of natural processes and conditions. Similarly, knowing the number and development level of buildings, trails, dams, and other physical evidence that exist today compared with the number and development level that will exist 10 or more years from now is a valuable indicator about whether the evidence of human occupation and modification is increasing or decreasing. Such trend information can be used to evaluate the effectiveness of existing stewardship programs and help prioritize what actions will most improve wilderness character.

Regional and National Use of This Monitoring Information

At regional and national levels, information from wilderness character monitoring has two primary uses: (1) to improve agency accountability (performance measurement), and (2) to improve agency policy review and oversight to support wilderness stewardship needs at the local level.

- **Accountability.** Information from wilderness character monitoring can be incorporated into agency performance measurement and reporting systems. Accountability systems require the development of performance measures to define what "wilderness managed to standard" means. Rather than focusing on work tasks, wilderness character monitoring provides results-based measures that show the effectiveness or outcomes of stewardship in fulfilling the Wilderness Act mandate. Regional and national summaries can show the number or percentage of wildernesses in which wilderness character is preserved compared with the number in which wilderness character is degrading. Summaries can also show which of the four qualities are most significant in creating the overall trend for wilderness character. Simple displays that capture the essence of complex concepts offer a powerful way to communicate where progress is occurring and where problems still exist.
- **Policy Review and Oversight.** Information from wilderness character monitoring can be used to help evaluate whether current wilderness management policy is fulfilling the mandate of the Wilderness Act of 1964 to "preserve wilderness character." If wilderness character across much of the NFS is degrading, a review of policy implementation may provide information on whether this decline is due to existing policies that are not being consistently implemented or to existing policies that are consistently implemented but are insufficient to preserve wilderness character. For example, a widespread trend showing an increase in the number of administrative uses of motorized equipment could trigger a review about why this increase is occurring. Such a review could examine whether current policies are sufficient, examine the consistency of policy implementation, and assess the need for higher level direction to help stabilize or reverse the trend.

Cautions About Reporting and Using This Monitoring Information

Before this effort, wilderness character had not been formally described or monitored. Therefore, this technical guide must be viewed with a full understanding of its goals and limitations:

- Wilderness character is a holistic concept. This concept can present a problem in that users might think that the whole of wilderness character is being captured when, in fact, only a portion is represented by the indicators selected for wilderness character monitoring. By definition, indicators are coarse estimators; as such, they should be viewed as "red flags" rather than as providing complete knowledge about the qualities of wilderness character.
- Significant assessment problems exist when data for some indicators are only partially available or are missing. A relatively few indicators are being used to

make a statement about the trend in wilderness character. Thus, if data are not available for some indicators, information may not be sufficient to address the larger question about trend in wilderness character. In cases in which this lack of data is anticipated to be a problem, information available at the regional or national level will be used to determine trends in wilderness character at the broader scales.

- It is important to monitor information about locally important or place-dependent aspects of wilderness character; and the monitoring described in this technical guide is intended to complement, not replace, these local information needs.

1.4. Roles and Responsibilities

Forest Service responsibilities for resource inventory and monitoring are outlined in FSM 1940.04. Specific roles and responsibilities for the monitoring and evaluation of wilderness character follow.

1.4.1. National Responsibilities

National roles and responsibilities for monitoring and evaluating trends in wilderness character include the following:

- Provide direction sufficient for the implementation of the national wilderness character monitoring protocol.
- Lead and facilitate the servicewide, interdisciplinary development of indicators and measures of wilderness character.
- Ensure that corporate database systems support the monitoring of wilderness character and that user support facilities are in place, including training, online materials, and help-desk services.
- Establish and support the centralized staffing necessary for the implementation of the protocol to monitor wilderness character.
- Secure funding resources necessary for the implementation of the protocol to monitor wilderness character.
- Provide overall responsibility for the implementation and maintenance of the protocol to monitor wilderness character, including the change management process, according to prescribed timelines.
- Conduct data analyses and synthesis at the level of the measure, indicator, monitoring question, quality, and wilderness character.

- Produce interim updates and final reports communicating progress on protocol implementation as well as the evaluation of trends in wilderness character.

1.4.2. Regional Responsibilities

Regional roles and responsibilities for monitoring and evaluating trends in wilderness character include the following:

- Identify the person who will serve as the regional wilderness character monitoring coordinator.
- Support the implementation of the wilderness monitoring protocol in the regions.
- Coordinate with adjoining regions that share common management of individual wildernesses.
- If appropriate, facilitate the development of supplemental indicators that are not a core part of the national protocol but are of particular relevance within that region.

1.4.3. Forest Responsibilities

Forest roles and responsibilities for monitoring and evaluating trends in wilderness character include the following:

- Identify the person who will serve as the forest wilderness character monitoring coordinator.
- Identify the person who will serve as the field wilderness character monitoring lead for every wilderness for which the forest has lead management responsibilities.
- Meet all data entry requirements according to the prescribed timeline, including entry of new data and validation of existing data, using the Infra-WILD Wilderness Character module.
- Ensure the maintenance of data quality by adhering to identified data quality assurance/quality control procedures.
- Help national staff interpret local data.
- Coordinate with adjoining forests that share common management of individual wildernesses.
- If appropriate, facilitate the development of supplemental indicators that are not a part of the national protocol but are of particular relevance within the local area.

1.5. Relationship to Other Federal Monitoring Programs

This effort to monitor selected conditions related to wilderness character is integrated in several ways within a broader movement to refine and focus inventory and monitoring activities across the Forest Service. First, the Washington Office Wilderness and Wild and Scenic Rivers staff, along with the Ecosystem Management Coordination staff, chartered the committee responsible for developing the conceptual Framework (Landres and others 2005) and this technical guide. Second, key representatives from Forest Service national inventory and monitoring staffs directly participated in developing the conceptual framework for this monitoring protocol and have reviewed this technical guide. Third, wilderness character monitoring will be incorporated into agencywide inventory and monitoring program plans. Fourth, this technical guide follows a standard template used by other monitoring protocol development teams and will become part of the Forest Service directives system. Fifth, and perhaps most importantly, this technical guide is built into the Forest Service Infrastructure (Infra) database application, which enables data within Infra to be used in monitoring wilderness character and data collected by this monitoring to be used by other programs.

Other wilderness managing agencies (the U.S. Department of the Interior's Bureau of Land Management, National Park Service, and U.S. Fish & Wildlife Service) have been part of this Forest Service wilderness monitoring effort. All wildernesses, regardless of which agency administers them, are part of a single National Wilderness Preservation System. Although each of the wilderness managing agencies has a unique culture and set of traditions, as well as unique needs for monitoring wilderness, all share the same legal responsibilities under the Wilderness Act of 1964 and subsequent wilderness legislation. Representatives from each of the other agencies have been active members of the Forest Service Wilderness Monitoring Committee and have made significant contributions to the conceptual framework for this monitoring. Their participation ensures ongoing interagency communication and potential coordination about wilderness monitoring programs.

This technical guide gathers as much data as possible from well-established and scientifically credible national monitoring programs within and outside the Forest Service. Inside the Forest Service, this technical guide will draw as much data as is appropriate and possible from Forest Inventory and Analysis; the Natural Resource Information System; and terrestrial, aquatic, wildlife, and social monitoring programs currently being developed and tested. In addition, at least 19 other Federal monitoring programs provide a variety of environmental and other data (Committee on the Environment and Natural Resources 1997). For example, this technical guide draws data on air pollutants from the Clean Air Status and Trends Network and the National Atmospheric Deposition Program.

1.6. Change Management

The change management process is a comprehensive process that begins with the identification of a need for change and ends with the resolution of that request. A change management process is necessary in all monitoring programs and especially for this protocol because the monitoring of wilderness character has never been attempted before. A viable change management process is needed to ensure that this protocol reflects the contemporary thinking about wilderness character, that lessons learned during implementation can be used to improve the protocol, and that the protocol uses all available data sets.

The two levels in this change management process follow.

Level 1—Minor Change

The minor-change management process is conducted every year and includes the following:

- Modification of existing indicators and measures, to be necessitated by the following factors:
  - Experience gained during the practical implementation of the monitoring protocol.
  - Availability of new data sources for existing indicators and measures.
  - New research or other perspectives about what constitutes wilderness character.
  - Need for some level of consistency of indicators and measures among the other National Wilderness Preservation System agencies.
- Changes to the wilderness character monitoring process and timeline.
- Changes to the Infra-WILD Wilderness Character module.

Change Management Process. Change management requests can be submitted at any time during the year but they are stockpiled for once annual evaluation and resolution. Requests are submitted by a change requester, who can be anyone in the Forest Service, including members of the Technical Guide Development Team, wilderness researchers, or the general user community. The change manager consolidates the change requests and conducts an initial assessment of the benefits and impacts of implementing the proposed changes as well as the impacts of not implementing the changes. The Change Management Team meets to discuss the proposed changes in total and develops its preliminary recommendations as to a potential resolution. These preliminary recommendations are posted on the Forest Service Web site for a 45-day comment period by anyone with a stake in wilderness character monitoring. Using the feedback received during the comment period, the Change Management Team develops its final recommendations.

Change Management Responsibilities. Three different responsibilities are associated with this change management process:

- The *change requester* is anyone with a vested interest in the wilderness character monitoring protocol.
- The *change manager* role will be filled by the wilderness character monitoring project leader.
- The *Change Management Team* role will be filled by members of the Wilderness Monitoring Committee (for changes related to the monitoring process, including modifications to the list of indicators and measures) and by members of the Wilderness Information Management Steering Group (for changes related to the Infra-WILD Wilderness Character module as well any additional analytical or presentation tools). Either of these teams may enlist the support of other subject matter experts, including members of the Technical Guide Development Team, as needed.

Level 2—Major Change

The major-change management process is conducted every 5 years and is more comprehensive than the level 1 process. Level 2 change includes the following:

- Determining the appropriateness of the currently used legislated wilderness qualities, monitoring, questions, indicators, and measures—including the potential for deleting existing measures or adding new ones.
- Determining the appropriateness of the data analysis and synthesis techniques.

Change Management Process. Details of the level 2 process have not yet been developed; however, a more thorough, comprehensive review is warranted every 5 years. The basic foundation of the monitoring protocol needs to be reevaluated by those directly associated with the protocol, the user community, academia, and others, based on lessons learned after several years of practical implementation as well as on any new thinking about wilderness character. This process would likely entail conducting a workshop and developing a workplan for the resolution of issues and concerns identified by participants.

Chapter 2. Data Management

2.0. Getting the Data

The data used in this protocol to assess trends in wilderness character come from several types of sources, which can generally be categorized as the following:

- Existing data currently residing in a Forest Service corporate database, with opportunities for validation and modification.
- Existing data from external data sources.
- New data entered using office records and professional knowledge.

The Infra-WILD Wilderness Character module will provide the tool to consolidate the data from these disparate sources. Screens have been built to facilitate the review, validation, and modification of existing data as well as the entry of new data.

This technical guide provides documentation for the specific attributes to be entered for each measure. The guide makes a distinction between those attributes used in the direct calculation of the measure (marked with an asterisk in the table of attributes for each measure) and those attributes that serve in a supporting role and are considered necessary to help with the documentation or subsequent interpretation of the results.

Centralized Data

Data from external sources, such as the air-quality data sets, and national internal sources, such as grazing allotment boundary maps, will be acquired, processed, and analyzed by a single, centralized data analyst. These tasks have been centralized for three reasons: (1) to markedly increase efficiency by having a single person access national data sets for all 407 National Forest System wildernesses; (2) to ensure the proper staff is processing the data because the required acquiring and processing skills, such as complex spatial analysis, are not commonly found at the field level; and (3) to remove as much of the workload burden as possible from field staff.

Professional Judgment

In certain situations, the use of professional judgment is acceptable in this monitoring protocol when no other data are available for an indicator that is deemed crucial for assessing trends in wilderness character. Professional judgment will only be used to assess the status or condition of selected measures (e.g., the coverage of nonindigenous plants within a wilderness) and will not be used to evaluate the effects of a measure on other

resources or trends of an indicator. The use of professional judgment must always be done with care and caution. In this monitoring protocol, the use of professional judgment is highly limited to only those situations in which it represents the best available data. Whenever professional judgment is used in this monitoring protocol to assess the status of a measure, other information is also required to define or bracket the quality of this judgment. For example, in the scenario about the coverage of nonindigenous plants, additional information is required about the basis of this judgment, including the extent of the wilderness actually observed, who did the observations, and how current the information is. When professional judgment is used as a source for data, these data will be used in the same way as any other data used in assessing trends in the indicator.

2.1. Data Adequacy

Data adequacy is evaluated and reported for all the measures in this technical guide. Data adequacy is defined as the reliability of the data to assess trends in the measure. The intention behind evaluating data adequacy is to understand where improvements in data collection need to be made and not to evaluate how well an individual measure represents a particular aspect of wilderness character. For example, if the data indicate a downward trend in a particular indicator and the data adequacy is deemed "low," these factors would suggest that the trend be interpreted conservatively, not discounted entirely, and that greater efforts be expended in future years to acquire more or better data.

Several dimensions of data adequacy exist, including the quantity and distribution of the data throughout the wilderness, the source of the data, whether validation techniques were used to confirm the accuracy of the data, and whether known data gaps were filled. Addressing all these aspects of data adequacy is beyond the practical and fiscal means of this monitoring protocol. Instead, two related but distinct aspects of data adequacy are subjectively evaluated: data quantity and data quality.

Data quantity refers to the level of confidence that all appropriate data records have been gathered. Data quantity is subjectively evaluated for each measure and assigned one of three categories:

1. **Complete.** This category indicates a high degree of confidence that all data records have been gathered. For example, to assess the occurrence of nonindigenous invasive plants, a complete inventory of the wilderness was conducted or all likely sites were visited. Similarly, to assess visitor use, all trailheads were inventoried. This category is represented graphically by a solid left half-circle.
2. **Partial.** This category indicates a moderate degree of confidence that all data records have been gathered. For example, to assess the occurrence of

nonindigenous invasive plants, a partial inventory was conducted or a sampling of sites was conducted in which these plants are likely to occur were visited. Similarly, visitor use was assessed at selected trailheads. This category is represented graphically by a left half-circle with a thick horizontal line in the middle.

3. **Insufficient.** This category indicates a low degree of confidence that all records have been gathered. For example, no inventory for nonindigenous invasive plants has been conducted, and visitor use was not assessed anywhere. This category is represented graphically by an empty left half-circle.

Data quality refers to the level of confidence about the source(s) of data and whether the data are of sufficient quality to reliably identify trends in the measure. Data quality is subjectively evaluated for each measure and assigned one of three categories:

1. **High.** This category indicates a high degree of confidence that the quality of the data can reliably assess trends in the measure. For example, data on the occurrence of nonindigenous invasive plants is from ground-based inventories conducted by qualified personnel; for visitor use, data would come from visitor permit data. This category is represented graphically by a solid right half-circle.

2. **Moderate.** This category indicates a moderate degree of confidence about the quality of the data. For example, data on invasive plants could come from national or regional databases; for visitor use, data could come from trailhead registers. This category is represented graphically by a right half-circle with a thick horizontal line in the middle.

3. **Low.** This category indicates a low degree of confidence about the quality of the data. For example, data on invasive plants and visitor use could come from professional judgment. This category is represented graphically by an empty right half-circle.

Each of these data quantity and data quality categories is represented graphically in the Local Report on trends in wilderness character (see the example reports in the supplement). The categories are also illustrated in table 2.

Table 2.—*A graphical representation of the different categories of data quantity and data quality.*

Data adequacy					
Data quantity			Data quality		
Complete	Partial	Insufficient	High	Moderate	Low
					

When the individual categories for data quantity and data quality are combined for each measure, they form a circle that graphically shows data adequacy for each measure, as shown in table 3.

Table 3.—*A graphical representation of some of the possible data adequacy (combined data quantity and data quality) evaluations for a measure.*

Description of data adequacy	Graphical representation
Data quantity complete/data quality high	
Data quantity complete/data quality moderate	
Data quantity partial/data quality high	
Data quantity partial/data quality moderate	
Data quantity partial/data quality low	
Data quantity insufficient/data quality moderate	
Data quantity insufficient/data quality low	

The specific criteria for evaluating data adequacy will be described in the detailed discussion for each measure. Data adequacy will be evaluated at the lowest level of measurement, generally the measure. Two measures are composed of components (management actions under the untrammeled quality and physical development index under the undeveloped quality); however, for these two measures, data adequacy will be evaluated at the component level rather than the measure level. Data adequacy applies only to the individual measure; therefore, it will not be compiled across measures, indicators, monitoring questions, or qualities to derive a single estimate of data adequacy at the regional or national levels.

For particular measures, the concept of data quantity or data quality may not be relevant or appropriate, and, in these cases, only the relevant aspect of data adequacy will be evaluated and shown in the Local Wilderness Report. For example, for the "number of management actions" measure under the untrammeled quality, data quality will not be evaluated because the only source of information is the records or recollections of resource staff; no other sources exist that could provide lower or higher quality data.

2.2. Data Quality Control and Assurance

To maintain a level of confidence in the results of the analysis and synthesis, data quality control and assurance must be maintained at all the steps in the process. Although the need for data quality control and assurance is true for all monitoring protocols, the task is made even more challenging with this protocol because of the reliance on data from so many disparate sources.

Data Cleaning

Field data must be reviewed for completeness and obvious errors before use in the Infra-WILD Wilderness Character module. Two techniques will be used to accomplish this important task.

1. **Field Level.** Staff in the field will be required to review the data for the measures they are responsible for. This requirement will involve either validating previously entered data or reviewing newly entered data using the screens provided in Infra-WILD. Additional reports or other tools will be provided to facilitate this review. Local staff will be asked to certify that the data are complete and accurate before the data are used in this protocol.
2. **Centralized/Automated.** After the data are incorporated in Infra-WILD, they will be subjected to further review. Automated data routines will be created to identify data gaps and numeric data that are outside of expected ranges. An opportunity to manually intervene or ignore potential errors will be provided.

Data Audits

A system of audits will be implemented to ensure that data integrity is maintained. These audits will apply to those data management activities conducted by both field staff and centralized staff. A number of field units will be visited each season to observe the implementation of the protocol. This practice will provide an opportunity to validate that data quality procedures are being followed and will identify other areas of the protocol needing improvement or modification for insertion in the change management process.

Metadata

"Metadata" refers to data about the content, quality, condition, and other characteristics of data or simply data about data. Because data will be coming from so many different sources, tracking metadata is particularly crucial for this protocol. All data will have the following metadata columns, where applicable:

- Data source type (internal, external, etc.).
- Data source name.
- Data pull date.
- Created date.
- Created by user.
- Created by managing organization.
- Modified date.
- Modified by user.
- Modified by managing organization.

Cuff Notes

As further documentation, users will be requested to enter "cuff notes" for each of the measures. Specific suggestions for appropriate notes for each measure will be included in the desk guide. The cuff notes are intended to create a legacy of the reasons why particular data were either entered or not entered during a particular monitoring year. These notes will be of great value in future monitoring cycles to ensure the consistency of reporting, particularly as staff changes.

2.3. Data Roles

Oracle databases ensure data integrity by assigning privileges to certain users for viewing, creating, modifying, or deleting records through the use of "roles." A new Oracle role, "wilderness character evaluator," or "ii_wild_char_eval," will be created in the Infra database to support data maintenance activities for this protocol. Other specific Infra roles will be needed to make modifications to data from other business areas, such as trails, buildings, or dams.

The wilderness character evaluator will be responsible for entering new data specifically for this protocol, reviewing existing data, and certifying the data are complete and accurate; the wilderness character evaluator also is responsible for initiating the pull process.

Each wilderness currently has an identified "lead wilderness data steward." This steward will have the responsibility to determine who should be granted the wilderness character evaluator role for a particular wilderness through the User Management Account utility in Infra.

2.4. Data Storage

Infra is a national database application consisting of more than 20 modules that serve various needs within the agency, including deferred maintenance reporting of fixed assets, range billings, and special-use permits. A wilderness module, called Infra-WILD, has been in place since 2002 to support field- and national-level business functions, and a Wilderness Character module has been developed to support this protocol (refer to figure 4).

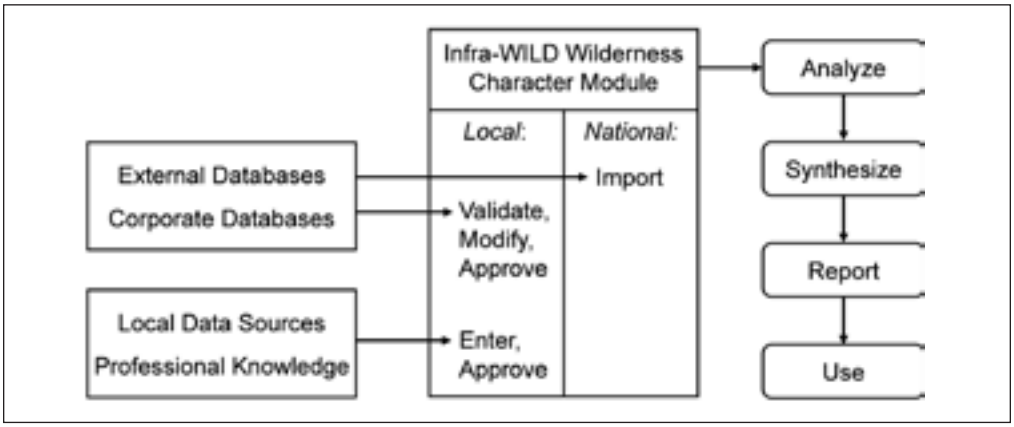
The Infra-WILD Wilderness Character module has several components:

- Data importation screens for use by national staff.
- Data validation, modification, and approval screens for use by local staff.
- Data entry screens for use by local staff.

- Data export utilities to Microsoft® Excel.
- Canned reports and ad hoc user views.

After data have been processed, they will be made available for subsequent use through the Corporate database, which is accessible from the I-Web main menu.

Figure 4.—*A conceptual view of the Infra-WILD Wilderness Character module. The two primary data sources that feed into the Infra-WILD Wilderness Character module are shown on the left. The four boxes on the right show the primary outputs from this module.*



Chapter 3. Assessing Trend in Wilderness Character

The four qualities of wilderness described in the overview to this document—untrammeled, natural, undeveloped, and outstanding opportunities for solitude or a primitive and unconfined type of recreation—will be synthesized into a single integrated assessment of trend in wilderness character. Evaluating detailed information on individual measures and indicators is critical for local managers, but it is just as critical for local managers, program managers, and policymakers to understand the larger picture—the status and trends of legislated wilderness qualities and of wilderness character. The Wilderness Act of 1964 mandates the Forest Service to preserve wilderness character as a whole, not just maintain four separate qualities of wilderness. Synthesizing this information also yields a more holistic picture that is a more powerful and effective tool for communicating trends of wilderness character to a broad audience, including the public, agency decisionmakers and policymakers, and legislators (Failing and Gregory 2003).

3.0. How Will Trends in Wilderness Character Be Assessed?

As discussed in the national Framework (Landres and others 2005), wilderness character is a complex and abstract concept, and the identification of selected conditions of wilderness character to monitor is not an absolute science. The conceptual and practical reality of identifying indicators and measures requires the selection of specific, measurable, and understandable parts of the larger concept. Similarly, although a conceptual model linking the qualities of wilderness to wilderness character has been developed in the Framework, these qualities do not cover all aspects of wilderness character. For these and other reasons described in the Framework, a numerical index or report card grade of wilderness character is not appropriate conceptually or practically and will not be used to assess trends in wilderness character.

Instead, a set of decision rules will be used to synthesize the trends from the different levels of this monitoring (measures, indicators, monitoring questions, and qualities) to derive a nationally consistent assessment of trends in wilderness character within a wilderness. This assessment will be conducted every 5 years for every National Forest System (NFS) wilderness. These decision rules assign trends into one of four categories:

1. **Improving.** (⇧) On balance, the conditions related to wilderness character are trending in a positive or improving direction.

2. **Stable.** (⇔) All the individual components are stable with no change.

3. **Offsetting Stable.** (⇳) On balance, no change in the conditions related to wilderness character is evident because degrading conditions are offset by an equal number of improving conditions.

4. **Degrading.** (⇩) On balance, the conditions related to wilderness character are trending in a negative or degrading direction.

Assigning trends into one of these four categories enables wilderness managers to show success where appropriate and take actions as needed to improve specific elements of wilderness character. Short-term trends will be assessed by comparing the current monitoring results with the immediately preceding results, while long-term trends will be assessed by comparing the current monitoring results with the baseline.

For upward reporting purposes that will yield a regional or national assessment of trends in wilderness character, the trend from each wilderness will be reported in one of two categories:

1. **Preserved.** The category is assigned from the improving, stable, or offsetting stable trends.

2. **Degrading.** The category is assigned from the degrading trend.

3.1. Decision Rules

Decision rules are used to identify significant trends in the data for each measure and then used to synthesize this information to identify trends in the indicators, monitoring questions, qualities, and, ultimately, wilderness character. Although these decision rules enable assessing the trend or direction of change, they do not enable assessing the magnitude of this change. For example, the results of this monitoring might show that wilderness character for a given wilderness has improved over the 5-year monitoring period, but this monitoring will not reveal how much wilderness character has improved.

This set of decision rules is based on the following considerations:

- Standardized decision rules are required to develop a nationally consistent assessment of trends in wilderness character.
- All indicators, monitoring questions, and qualities are given equal weight in this assessment because no conceptual or other reasons exist for giving more weight to one than any of the others.
- Quantitative data are used to assess whether a measure is improving, stable, or degrading, but quantitative data are not used to synthesize across measures, indicators, monitoring questions, and qualities because of the following conditions:

- Synthesizing would require combining elements that are completely different from one another (e.g., the number of structures and the number of motorized use authorizations).
- Sufficient uncertainty exists in the quantitative data that synthesizing at higher levels compounds this uncertainty in unknown ways.

Decision Rule 1. Identifying the Trend in a Measure

The trend in each measure is categorized as improving (⇧), stable (⇔), or degrading (⇩) based on the results of statistical analysis or specific criteria used for identifying significant change for individual measures described under each quality of wilderness character. The offsetting stable trend does not apply to the level of the measure because nothing is present to offset the trend in a single measure.

For some of the measures, the data that are reported may significantly change from one year to the next; for other measures, the data are not expected to change much, if at all, between subsequent years. Although the monitoring cycle for assessing trends in wilderness character is 5 years, data will be recorded yearly for the following measures that are expected to change year to year.

- Untrammeled quality:
  - Agency actions to manage vegetation; fish, wildlife, insects, and disease; soil and water; and fire.
  - Percentage of lightning-caused fires suppressed.
  - Lakes and other water bodies stocked with fish.
- Natural quality:
  - Pollutant and air-quality measures.
  - Number of acres of grazing allotment with authorized use.
- Undeveloped quality:
  - Mechanical and motorized equipment use measures.
- Outstanding opportunities quality:
  - Visitation—visitation and census measures.
  - Management restrictions on visitor behavior measure.

The different data collecting cycles (yearly and once every 5 years) for different types of measures require different means for assessing change from one monitoring period to the next, as follows.

1. First or baseline monitoring cycle:
   - No assessment of change in any of the measures will occur.
2. Second monitoring cycle, occurring 5 years after baseline monitoring:
   - **Measures That Have Yearly Data.** Five data points, one for the baseline and one for each of the 4 subsequent years will have been collected. Regression analysis can be used on these data to assess if a significant change has occurred over the 5-year period. See Appendix B, Statistical Analysis of Trends in the Measures, for a detailed discussion of how this analysis is used to identify significant change in the data.
   - **Measures That Do Not Have Yearly Data.** Just two data points, one for the first and one for the second monitoring cycles, will have been collected; specific criteria for assessing significant change are described for each measure under each of the qualities of wilderness character. Regression analysis cannot be used in this case because of insufficient data.
3. Third and fourth monitoring cycles, occurring 10 and 15 years, respectively, after baseline monitoring:
   - **Measures That Have Yearly Data.** Regression analysis will be used to assess if significant changes have occurred. See appendix B for details of this analysis.
   - **Measures That Do Not Have Yearly Data.** Specific criteria are described for each measure under each of the qualities of wilderness character for assessing significant short-term change that compares the two most recent monitoring cycles and long-term change that compares the first monitoring cycle data with the most recent data.
4. Fifth monitoring cycle, occurring 20 years after baseline monitoring, and all subsequent monitoring cycles:
   - For all measures, regression analysis will be used across the preceding monitoring cycles to assess if significant changes have occurred. See appendix B for details of this analysis. For the measures that have yearly data, 20 data points (one for each year, including the baseline) will have been collected. For the measures that data were collected once every 5 years, five data points will have been collected.

Decision Rule 2. Identifying the Trend in an Indicator

The trend in an indicator is derived by synthesizing across the trends in the measures that make up that indicator, using the following three steps.

1. A numerical score is assigned to the trend for each measure as follows:
   - Improving equals +1.
   - Stable equals 0.
   - Degrading equals –1.
2. The numbers for each measure are added together to yield a single numerical score for the indicator.
3. The trend for the indicator is assigned as follows:
   - Improving, when the summed numerical score is greater than 0.
   - Degrading, when the summed numerical score is less than 0.
   - Stable, when the summed numerical score is 0 because all the measures were stable.
   - Offsetting stable, when the summed numerical result is 0 because improving measures offset degrading measures.

Table 4 shows how this decision rule applies in 10 hypothetical cases to yield the trend in an indicator. In each case, if the trend in the measure is improving, it is assigned a +1; if the measure is stable, it is assigned a 0; and, if the measure is degrading, it is assigned a –1. Adding these scores across all the measures for a given case results in a total numerical score (and trend) for the indicator that is greater than 0 (improving), 0 (stable or offsetting stable), or less than 0 (degrading).

Table 4 shows that the resulting trend in the indicator is improving in the first three columns of possible outcomes, offsetting stable in the fourth and fifth columns, stable in the sixth column, and degrading in the last four columns.

Specific decision rules for assessing change in an indicator, if applicable, are discussed under each of the qualities of wilderness character.

Table 4.—*The trend in an indicator (in this case, the indicator of air pollutants) is identified by adding across the numerical score of the trends in its component measures.*

Measure	Possible trends in the measure									
Ozone N100	⇧	⇧	⇧	⇧	⇧	⇔	⇔	⇔	⇔	⇩
Ozone W126	⇧	⇧	⇔	⇧	⇔	⇔	⇔	⇔	⇩	⇩
Sulfur wet deposition	⇔	⇔	⇔	⇩	⇔	⇔	⇔	⇩	⇩	⇧
Nitrogen wet deposition	⇔	⇩	⇔	⇩	⇩	⇔	⇩	⇩	⇧	⇩
Resulting trend in the indicator	⇧	⇧	⇧	⇳	⇳	⇔	⇩	⇩	⇩	⇩

Decision Rule 3. Identifying the Trend in a Monitoring Question

The trend in a monitoring question is derived by synthesizing across the trends in the indicators that make up that question, following the steps in decision rule 2, with two additional rules.

1. An offsetting trend in an indicator is assigned a numerical value of 0.

2. If an offsetting stable trend in an indicator is added to another indicator with either a stable or offsetting stable trend, the resulting trend in the monitoring question is offsetting stable. The reason for this rule is that the offsetting stable trend is a result of some things going up and some things going down, so the resulting trend should not be stable because this would mean that the trends in all the indicators were stable. An example of this situation is shown in the fifth column of possible monitoring question trends in table 4.

Table 5 shows how this decision rule applies in 10 hypothetical cases to yield the trend in a monitoring question. In each case, if the trend in the indicator is improving, it is assigned a +1; if the indicator is stable or offsetting stable, it is assigned a 0; and, if the indicator is degrading, it is assigned a –1. Adding the scores across all the indicators gives a total numerical score (and trend) for the monitoring question that is greater than 0 (improving), 0 (stable or offsetting stable), or less than 0 (degrading).

Table 5 shows that the resulting trend in the monitoring question is improving in the first three columns of possible outcomes, offsetting stable in the fourth and fifth columns, stable in the sixth column, and degrading in the last four columns.

Specific decision rules for assessing change in a monitoring question, if applicable, are discussed under each of the qualities of wilderness character.

Table 5.—*The trend in the monitoring question is identified by adding across the trends in its component indicators.*

Indicator	Possible trends in the indicator									
Pollutants that degrade air quality	⇧	⇧	⇧	⇧	⇳	⇔	⇳	⇔	⇧	⇔
Developments that degrade rivers	⇧	⇔	⇧	⇔	⇳	⇔	⇳	⇩	⇩	⇔
Nonnative species	⇔	⇔	⇩	⇩	⇔	⇔	⇩	⇩	⇩	⇩
Resulting trend in the monitoring question	⇧	⇧	⇧	⇳	⇳	⇔	⇩	⇩	⇩	⇩

Decision Rule 4. Identifying the Trend in a Quality

The trend in a quality of wilderness character is derived by synthesizing across the trends in the monitoring questions that make up that quality, following the steps in decision rules 2 and 3.

Table 6 shows how this decision rule applies in 10 hypothetical cases to yield the trend in a quality. In each case, if the trend in the monitoring question is improving, it is assigned a +1; if the monitoring question is stable or offsetting stable, it is assigned a 0; and, if the monitoring question is degrading, it is assigned a –1. Adding the scores across all the monitoring questions gives a total numerical score (and trend) for the quality that is greater than 0 (improving), 0 (stable or offsetting stable), or less than 0 (degrading).

Table 6 shows that the resulting trend in the natural quality is improving in the first three columns of possible outcomes; offsetting stable in the third, fourth, fifth, and sixth columns; stable in the seventh column; and degrading in the last three columns.

Specific decision rules for assessing change in a quality, if applicable, are discussed under each of the qualities of wilderness character.

Table 6.—*The trend in a quality of wilderness character is assessed by adding across the trends in its component monitoring questions.*

Monitoring question	Possible trends in the question									
Threats to natural conditions	⇧	⇧	⇧	⇧	⇳	⇳	⇔	⇳	⇔	⇩
Biophysical conditions and processes	⇧	⇔	⇳	⇩	⇔	⇳	⇔	⇩	⇩	⇩
Resulting trend in the quality	⇧	⇧	⇧	⇳	⇳	⇳	⇔	⇩	⇩	⇩

Decision Rule 5. Identifying the Trend in Wilderness Character

The trend in wilderness character is identified by synthesizing across the trends in the four qualities, following the steps in decision rules 2 and 3, with one additional rule.

- For local reporting, the trend in wilderness character is identified using the same four categories (improving, stable, offsetting stable, and degrading) as described previously; for national reporting, the trend is identified as either preserved or degrading. The preserved category is assigned when the resulting trend in wilderness character is improving, stable, or offsetting stable.

The reason for this additional rule is that different users need different levels of information detail. The line officer and manager of a local wilderness unit need more detail to evaluate the outcomes of local decisions and actions. In contrast, a more general level of synthesis is appropriate for oversight and review of national wilderness policy (which directs the agency to "protect and perpetuate wilderness character").

Table 7 shows how this decision rule applies in 10 hypothetical cases to yield the trend in a quality. In each case, if the trend in the monitoring question is improving, it is assigned a +1; if the monitoring question is stable or offsetting stable, it is assigned a 0; and, if the monitoring question is degrading, it is assigned a –1. Adding the scores across all the monitoring questions gives a total numerical score (and trend) for the quality that is greater than 0 (improving), 0 (stable or offsetting stable), or less than 0 (degrading).

For local reporting purposes, table 7 shows that, for the first three columns of possible outcomes, the resulting trend in wilderness character would be reported as improving; for the fourth and fifth columns, the trend would be reported as offsetting stable; for the sixth column, the trend would be reported as stable; and, for the last four columns, the trend would be reported as degrading. In contrast, for national reporting purposes, table 7 shows that, for the first six columns, wilderness character would be reported as preserved and, for the last four columns, it would be reported as degrading.

Table 7.—*The trend in wilderness character is identified by adding across the trends in its component qualities.*

Quality	Possible trends in the quality									
Untrammeled	⇧	⇧	⇧	⇧	⇧	⇔	⇔	⇔	⇔	⇩
Natural	⇧	⇧	⇔	⇧	⇔	⇔	⇔	⇳	⇩	⇩
Undeveloped	⇔	⇔	⇔	⇩	⇔	⇔	⇳	⇩	⇧	⇧
Outstanding opportunities	⇳	⇩	⇳	⇩	⇩	⇔	⇩	⇩	⇩	⇩
Resulting trend in wilderness character	⇧	⇧	⇧	⇳	⇳	⇔	⇩	⇩	⇩	⇩

Table 8 shows a hypothetical example of how all these decision rules work together to identify the trend in wilderness character. In this example, the trend in wilderness character for this hypothetical wilderness would be degrading because the summed numerical score of –1 is derived from adding the scores of the untrammeled quality (0), the natural quality (–1), the undeveloped quality (+1), and the outstanding opportunities quality (–1).

Table 8.—*A hypothetical example showing how the decision rules work together to yield an assessment of trend in wilderness character for this wilderness.*

Measure	Trend in measure	Trend in indicator	Trend in question	Trend in quality	Trend in wilderness character
Untrammeled quality					
Management actions	⇩				
Fires suppressed	⇧	⇳	⇳	⇳	
Fish stocking	⇔				
Natural quality					
Ozone N100	⇔				
Ozone W126	⇔	⇩			
Sulfur deposition	⇩				
Nitrogen deposition	⇩		⇩		
Dams	⇔	⇔			
Nonindigenous plants	⇧			⇩	
Other nonindigenous species	⇔	⇳			
Grazing allotments	⇩				
Fine nitrate and sulfate	⇩	⇩			
Deciview	⇔		⇩		⇩
Extirpated species	⇔	⇔			
Undeveloped quality					
Physical development index	⇧	⇧	⇧		
Emergency motorized and mechanized use index	⇩	⇩	⇩	⇧	
Administrative and nonemergency motorized and mechanized use index	⇩				
Inholdings	⇧	⇧	⇧		
Outstanding opportunities quality					
Area away from access/travel	⇔	⇔			
Visiting parties	⇩*		⇩		
Users residing in service area		⇩			
NVUM visits per region	⇩			⇩	
Recreation facilities index	⇧	⇧	⇧		
Developed trail miles	⇔	⇔			
Visitor restrictions index	⇩	⇩	⇩		

** Only one trend is identified for these two measures because only one of these measures is used (for explanation, see Chapter 7, Outstanding Opportunities Quality).*

NVUM = National Visitor Use Monitoring Program.

3.2. Narrative

In addition to the decision rule-based assessment of trends in wilderness character, a narrative will be required that provides information about local conditions, circumstances, and context that affect the interpretation and use of the results of this monitoring. This narrative gives local managers the opportunity to add qualitative information and insights from their professional judgment to complement and help interpret the data obtained from the measures. This narrative, for example, will enable managers to validate and explain why downward or upward trends are occurring. This narrative will be a valuable part of the legacy information passed to future wilderness managers, help ensure consistency in reporting over time, and provide insight about this monitoring program that will feed into the change management process to improve this monitoring.

A place will be provided within the Infrastructure data reporting screens for local users to enter appropriate narrative information about the trend in each of the four qualities and about wilderness character over the 5-year monitoring period. The following questions are intended to serve as a guide to help structure this narrative.

- Is this trend in the quality or wilderness character an accurate reflection of recent conditions in your wilderness? Why or why not? Here are some examples of factors that could affect wilderness conditions:
  - Natural events in or outside wilderness (e.g., fires, weather events, snowloads, or windstorms).
  - Change in staffing or effort since the last monitoring cycle (e.g., type and amount).
  - New or expanded data collection efforts (e.g., in wilderness program and other program areas).
  - Change outside the wilderness that is affecting wilderness character (e.g., wildland-urban interface concerns or development, advertising or promotion of recreation use, or industrial development).
  - Change in legislation or interpretation of legislation that affects policy or actions (e.g., upgrades to structures based on current Americans with Disabilities Act policy guidance).
- How should this trend in wilderness character be interpreted if one of the four qualities is improving while another is degrading? Here are some examples of factors that could affect wilderness character:
  - Differences in the magnitude of change in the four qualities are not taken into account in assessing the trend in wilderness character, and key differences may exist among the qualities that you feel should be taken into account in this assessment.
  - Legislative provisions may account for the trends in one or more qualities that affect this assessment of wilderness character (e.g., the number of structures may be stable over time because they are all legislatively permitted).
- Do you have confidence in the data generated by this monitoring protocol? What is the basis for your opinion? Here are some examples of factors that could affect the quality of data:

- Professional judgment or sense of change.
- Other information about things that have affected the trend in this quality that is not included in any of the indicators or measures.
- Better data for one of the indicators or measures that suggests a trend different than that reported in this monitoring program.

- Are there aspects of this monitoring protocol that could be improved? How could they be improved?

3.3. Cautions About Assessing Trends in Wilderness Character

Many cautions should be heeded in developing this assessment of trends in wilderness character and in interpreting the resulting information.

The choice of monitoring indicators and measures represents a selection of conditions and stewardship actions related to wilderness character. This set of indicators and measures is not intended to represent the full or holistic nature of wilderness character. For example, broad societal values of wilderness character are not monitored. Furthermore, as shown in figure 3, the indicators used to derive an assessment of trends do not represent local aspects of wilderness character. Even if the entire universe of wilderness character were known, it would be impractical to design a monitoring program to include all these components. Therefore, it is critical to understand that this synthesis is not a determination of wilderness character but *an assessment of selected indicators of wilderness character*.

The assessment is based on indicators and measures that were chosen because data can be consistently gathered for them from at least 50 percent of NFS wildernesses nationwide. In assessing trends in wilderness character, the number and percentage of wildernesses contributing to the assessment will be reported.

Developing a single assessment of trends in wilderness character for an entire wilderness requires that very different elements be combined. Combining elements in this way overly simplifies the complexity of wilderness character. For example, some qualities, such as the untrammeled and natural qualities when actions are taken to restore certain natural conditions, may be inversely related. In addition, different elements change at different rates or they may represent differing wilderness aspects; combining these elements may obscure changes or trends that are important for the local manager to understand.

Chapter 4. Untrammeled Quality

4.0. Summary

Table 9 provides a summary of the monitoring question, indicator, and measures for the untrammeled quality.

The objective of monitoring the untrammeled quality is to track over time whether management programs are trending toward more or less human manipulation of plant communities, populations of fish, wildlife, insects and disease, soil and water resources, and fire processes. This monitoring focuses on agency actions that intentionally manipulate the "community of life" inside wilderness. For conceptual and practical reasons, this monitoring does not capture all human manipulations of wilderness (e.g., global manipulation of climate or small-scale, localized manipulations such as removing a single hazard tree). The focus on actions that are both important (in effect or large in amount or quantity relative to the wilderness resource) and trackable (those actions for which reasonably reliable data are available over time) provides more reliable data and is sufficient to understand whether management programs are generally trending toward less or more manipulation of wilderness. Ultimate determination of scale and importance will be left up to the individual manager. Consistency of interpretation is important at a wilderness level but may vary across National Forest System wildernesses.

The prominence of the word "untrammeled" in the Wilderness Act and the tendency of most people to blur the untrammeled quality with the natural quality justify separating these two important concepts to give each equal stature. The untrammeled quality monitors intentional agency actions whereas the natural quality monitors the effects of both intentional agency actions and external threats. Furthermore, in this monitoring protocol, untrammeled refers to management actions that constrain the land and natural processes, not those that constrain the visitor experience.

Table 9.—*A summary of the indicators and measures monitored in the untrammeled quality.*

Quality of wilderness	Monitoring question	Indicator	Measure
Untrammeled—wilderness is essentially unhindered and free from modern human control or manipulation	What are the trends in actions that control or manipulate the community of life in wilderness?	Agency actions that control or manipulate plant communities, animal populations, soils, water bodies, or natural disturbance processes	Number of actions to manage vegetation; fish, wildlife, insects, and disease; soil and water; and fire
			Percentage of natural fire starts that received a suppression response
			Number of lakes and other water bodies stocked with fish

Untrammeled quality monitoring focuses on actions rather than authorizations. This focus enables managers to track trends in the number of manipulations and controls that actually occurred. Through monitoring this untrammeled quality, information will be collected on the number of actions taken annually, reasons for those actions, trends over time, and, to some degree, the extent of each action. Some of the information collected might not be directly useful at the national level but may help the local manager interpret the data and trends over time.

4.1. Introduction

In defining wilderness, Section 2(c) of the Wilderness Act states that wilderness is "hereby recognized as an area where the earth and its community of life are untrammeled by man." The word "untrammeled" is rarely used in ordinary conversation, but Howard Zahniser, the primary author of the Wilderness Act, carefully selected untrammeled to be a key word in the definition of wilderness.

Since passage of the Wilderness Act, the word "untrammeled" and its meaning for wilderness management have been discussed at length (e.g., Aplet 1999, Scott 2002). Untrammeled means "allowed to run free" (Editors of the American Heritage Dictionaries 1992); synonyms for untrammeled include unrestrained, unrestricted, unhindered, unimpeded, unencumbered, self-willed, and wildness. National Forest Service policy defines untrammeled as an area "where human influence does not impede the free play of natural forces or interfere with natural processes in the ecosystem" (Forest Service Manual [FSM] 2320.5).

Zahniser noted that the inspiration for wilderness preservation "is to use 'skill, judgment, and ecologic sensitivity' for the protection of some areas within which natural forces may operate without man's management and manipulation." (Zahniser 1963: 2) Wilderness is very different than other lands in that legislation dictates not only the goals of stewardship but also how management is to be approached—with humility and with an eye toward not interfering with nature and not manipulating the land and its community of life. Furthering this notion, Lucas commented, "If ecological processes operate essentially uncontrolled within the Wilderness frame of reference, the results, whatever they might be, are desirable by definition. The object is not to stop change, nor to recreate conditions as of some arbitrary historical date, nor to strive for favorable change in big game populations or in scenic vistas. The object is to let nature 'roll the dice' and accept the results with interest and scientific curiosity." (Lucas 1973: 151) More recently, Nash noted that "Restraint is at the core of the new valuation of wilderness as a moral resource. When we protect wilderness we deliberately withhold our power to change the landscape" (Nash 2004: 8).

Agency actions that manipulate or control ecological systems inside wilderness degrade the untrammeled quality of wilderness character. For example, wilderness is manipulated and the untrammeled quality of wilderness character is diminished when naturally ignited fires are suppressed inside wilderness, when dams that impede natural flood cycles are built, when native animals or plants are removed, or when actions are taken to lessen the impact a pathogen might have on lands outside of but adjacent to the wilderness. This concept of trammeling applies to all manipulation since the time of wilderness designation but does not apply to manipulations that occurred before wilderness designation, such as the use of fire by native people to promote game habitat.

As already noted, wilderness is unlike any other land in the Nation because legislation directs the managing agency to scrutinize its actions and minimize control or interference with plants, animals, soils, water bodies, and natural processes. Although many people consider minimizing interference with natural processes to be part of maintaining natural conditions, the prominence of the word "untrammeled" in the Wilderness Act justifies distinguishing the untrammeled quality from the natural quality. In essence, the untrammeled quality monitors intentional agency actions whereas the natural quality monitors the effects of both intentional agency actions and effects caused by external threats to wilderness. Separating actions from effects offers clearer understanding of trends in actions compared with trends in effects, permitting more effective analysis and use of the information to improve wilderness stewardship.

Specific legislative, regulatory, and policy direction relative to the untrammeled quality is contained in the Wilderness Act, Code of Federal Regulations, and National Forest Service Policy Directives.

The Wilderness Act

In Section 2(c) of the Wilderness Act, wilderness is defined as "an area where the earth and its community of life are untrammeled by man." Although the act further defines wilderness first as an area that "generally appears to have been affected primarily by the forces of nature," Section 4(d)(1) of the Wilderness Act in does provide some latitude for agency action, stating that "measures may be taken as may be necessary in the control of fire, insects and disease, subject to such conditions as the Secretary deems desirable."

Code of Federal Regulations

Title 36 of the Code of Federal Regulations, Part 293, provides regulatory direction to the Forest Service for implementation of the Wilderness Act. This direction states that "natural ecological succession will be allowed to operate freely to the extent feasible" (293.2), but the Forest Service Chief "may prescribe measures necessary to control fire, insects

and disease" (293.3). This direction also prohibits "cutting of trees for non-wilderness purposes" (293.6).

National Forest Service Policy, Forest Service Manual 2320, Policy and Objectives Directives

The following FSM direction, while subject to change, implements the Code of Federal Regulations pursuant to the Wilderness Act.

- "Maintain wilderness in such a manner that ecosystems are unaffected by human manipulation and influences so that plants and animals develop and respond to natural forces." (FSM 2320.2)
- "Provide an environment where the forces of natural selection and survival rather than human actions determine which and what numbers of wildlife species will exist." (FSM 2323.31)
- "Discourage measures for direct control (other than normal harvest) of wildlife and fish populations." (FSM 2323.32)
- "The policy for soil and water management is generally the same as for all National Forest watersheds. However, in wilderness natural processes shall dominate; measures that modify plant cover and treat soil mantles or other activities designed to supplement natural water yield are inappropriate." (FSM 2323.42)
- "Do not permit long-term weather modification programs that produce, during any part of successive years, a repeated or prolonged change in the weather directly affecting wilderness areas." (FSM 2323.45)
- "Manage forest cover to retain the primeval character of the environment and to allow natural ecological processes to operate freely." (FSM 2323.51)
- "Do not control insect or plant disease outbreaks unless it is necessary to prevent unacceptable damage to resources on adjacent lands or an unnatural loss to the wilderness resource due to exotic pests." (FSM 2324.12).
- "Permit lightning caused fires to play, as nearly as possible, their natural ecological role within wilderness." (FSM 2324.21)
- "Forest Service managers may ignite a prescribed fire in wilderness to reduce unnatural buildups of fuels only if necessary to meet at least one of the wilderness fire management objectives set forth in FSM 2324.21 and if all of the following conditions are met:

- "The use of prescribed fire or other fuel treatment measures outside of wilderness is not sufficient to achieve fire management objectives within wilderness.
- "An interdisciplinary team of resource specialists has evaluated and recommended the proposed use of prescribed fire.
- "The interested public has been involved appropriately in the decision.
- "Lightning-caused fires cannot be allowed to burn because they will pose serious threats to life and/or property within wilderness or to life, property, or natural resources outside of wilderness." (FSM 2324.22)

- "Do not use prescribed fire in wilderness to benefit wildlife, maintain vegetative types, improve forage production, or enhance other resource values. Although these additional effects may result from a decision to use prescribed fire, use fire in wilderness only to meet wilderness fire management objectives. Do not use management ignited fire to achieve wilderness fire management objectives where lightning-caused fires can achieve them." (FSM 2324.22)

Trends in the untrammeled quality will be assessed by synthesizing information from the measures to the indicator and the monitoring question using the decision rules described in Chapter 3, Assessing Trend in Wilderness Character.

4.2. Monitoring Question 1—Actions That Manipulate Wilderness

What are the trends in actions that control or manipulate the community of life in wilderness?

Why Is This Monitoring Question Important?

The Wilderness Act states that wilderness is a place where the earth and its community of life are untrammeled by man. In today's terms, the phrase "community of life" means the biological composition, structure, and function of wilderness ecosystems, including natural disturbance processes such as fire, wind events, insect and disease outbreaks, and floods. The untrammeled quality of wilderness is fundamentally about our actions as managers, as well as actions by other agencies that conduct activities in wilderness, that affect the community of life rather than the effects on visitors.

It is acknowledged within the Wilderness Act and subsequent policy that cases exist in which plant communities, animal populations, soils, water bodies, or natural disturbance processes may be managed as necessary for wilderness purposes, for emergency conditions or public safety, or in cases in which actions were part of the management of the area at

the time the wilderness was established and in which continued practice is considered necessary. Tracking the number of agency actions, including actions allowed by law and policy, will provide a good indication of whether management programs are trending toward more or less trammeling over time.

How Will the Indicators Be Used To Answer This Question?

Only one indicator for this monitoring question exists—agency actions that control or manipulate plant communities, animal populations, soils, water bodies, or natural disturbance processes—so no synthesis of different indicators is required to answer the monitoring question. If the measures show that the indicator is decreasing, stable, or increasing, this same answer is given for the monitoring question.

What Are the Cautions About This Question?

Although it is recognized that managers make (often difficult) decisions that represent considerable restraint, untrammeled quality monitoring does not attempt to track those decisions. The intent of monitoring the untrammeled quality is not to produce a "score-card" but rather to track whether management programs are trending toward more or less human manipulation in a given wilderness.

This monitoring question does not address actions taken outside the jurisdiction of the wilderness managing agency: illegal actions that managers are not aware of or those actions that occur or are initiated outside wilderness boundaries. This question also does not consider the cumulative impact of small-scale actions. Although such small-scale actions may manipulate or control elements of the wilderness environment, they tend to be done at a lesser scale that manipulates individual animals or plants rather than populations or communities.

4.2.1. Indicator 1 for Question 1—Agency Actions

Agency actions that control or manipulate plant communities, animal populations, soils, water bodies, or natural disturbance processes.

Why Is This Indicator Important?

This indicator represents the range of actions that management agencies take to manipulate or control the biological composition, structure, and function of wilderness ecosystems. This indicator does not provide an understanding of effects but rather provides managers a way to track over time the level of these intentional actions. Monitoring this indicator will provide a way to understand whether managers, as stewards of wilderness, are controlling and manipulating wilderness or practicing restraint to enable a wilderness area to persist in its untrammeled condition.

How Was This Indicator Chosen?

This indicator was selected because actions taken by managing agencies represent most actions that control or manipulate the community of life in wilderness. The focus on actions rather than authorizations enables managers to track trends in the number of manipulations that actually occurred. Although data are not currently recorded for these actions, information can be gathered from managers and can be assumed to be credible and accurate. This indicator is responsive to change at a wilderness scale, reflected as an increase or decrease in the number of actions reported.

How Will the Measures Provide Information About This Indicator?

Each of the three measures tracks a different aspect of actions that manipulate wilderness. The first measure tracks the number of management actions, the second measure tracks the percentage of natural fire starts that received a suppression response, and the third measure tracks the number of water bodies stocked with fish. The first measure has four distinct components, and all are considered on a par despite their size, effect, or duration. All four components will be reported separately but will be combined with equal weight to represent this first measure. Different components of fire management are represented within both the first and second measures, ultimately weighting fire more than the other elements of the community of life. This weighting is considered acceptable because of the significant role fire plays as a natural disturbance process in most Forest Service wildernesses.

Two of the measures selected to assess agency actions are directly related to Forest Service policy for wilderness. This policy provides clear management direction related to this indicator and projects that are considered under each measure. A link is provided under each measure in the text of this technical guide to the applicable part of the FSM 2320. These links will be updated as necessary to reflect manual revisions.

The measures for this indicator capture the range of activities or actions that take place across the wilderness system. All these activities are of equal importance in assessing national trends in this untrammeled quality. For example, the introduction of lime to change the chemical composition of a stream may only take place in a handful of wildernesses nationally, but this action represents a significant trammeling where it does occur. This activity is comparable to the introduction of a large mammal species in a different wilderness. Viewed together, all such actions provide a representation of trammeling that is taking place nationally. In addition, reporting these actions as separate components of the measure enables further and more detailed analysis at the local, forest, or regional levels.

As described in Chapter 3, Assessing Trend in Wilderness Character, trends of the individual measures will be synthesized to develop an overall trend estimate to provide

information about the indicator. Table 10 shows possible combinations of trends in the measures and the resulting trend in the indicator of agency actions. The resulting arrows show the trend as improving (upward-pointing arrow), offsetting stable (double-headed vertical arrow), stable (double-headed horizontal arrow), or degrading (downward-pointing arrow).

Table 10.—*The trend in the indicator of agency actions is derived from adding across the trends in its component measures.*

Measure	Possible trends in the measure								
Number of actions to manage vegetation; fish, wildlife, insects, and disease; soil and water; and fire	⇧	⇧	⇔	⇧	⇩	⇔	⇔	⇩	⇩
Percentage of natural fire starts that received a suppression response	⇧	⇔	⇧	⇩	⇧	⇔	⇩	⇔	⇩
Number of water bodies stocked with fish	⇧	⇔	⇧	⇔	⇔	⇔	⇩	⇔	⇩
Resulting trend in the indicator	⇧	⇧	⇧	⇳	⇳	⇔	⇩	⇩	⇩

What Are the Cautions About This Indicator?

Although it is recognized that one action may have a greater effect on the landscape than another (e.g., the suppression of fire compared with radio-collaring of wildlife), the extent of that effect will not be analyzed here. The purpose here is to track human intent to control or manipulate, not to make a judgment on the effect or scale of the action; therefore, the size and duration of actions will not be considered directly. Species and/or acres affected will be reported for some attributes, enabling further analysis and interpretation at the local level; however, these attributes will not be considered part of the core measure for national reporting.

Management actions are often taken with the intent to improve another quality of wilderness character, especially naturalness. This relationship between qualities will be tracked by recording the reason for an action. This association will provide opportunities for further cause-and-effect analysis; however, it is not intended to provide a way to validate actions that may diminish the untrammeled quality of wilderness. The need for all actions should be analyzed through the Minimum Requirements Decision Guide before implementation (USDA Forest Service 2005). In addition, certain actions are allowed under legislative provisions of the Wilderness Act, Alaska National Interest Lands Conservation Act of 1980, or subsequent wilderness legislation.

4.2.1.1. Measure 1 for Indicator 1, Question 1—Management Actions

Number of actions to manage vegetation; fish, wildlife, insects, and disease; soil and water; and fire.

Why Is This Measure Important?

Vegetation, fish and wildlife, insects and disease, soil and water, and fire are critical components of wilderness ecosystems or the community of life as referenced in the Section 2(c) Definition of Wilderness in the Wilderness Act. Although Forest Service policy states that the intent of managing wilderness is to enable natural processes to operate freely, these elements are often controlled or manipulated by managers. This measure tracks actions that trammel these components.

What Are the Components of This Measure?

This measure includes four components and all are considered equally important:

1. Actions that manage vegetation.
2. Actions that manage fish, wildlife, insects, and disease.
3. Actions that manage soil and water.
4. Actions that manage fire.

Each of these actions in some way controls or manipulates the community of life in wilderness. The assignment of management actions into these components, however, is not straightforward and different people may reasonably assign an action to different components. For example, the introduction of an insect to biologically control invasive plants could be considered either an action to manage vegetation based on the purpose of the introduction or an action to manage wildlife based on the introduction of a new species into the wilderness.

Local managers should make these assignments based on what makes most sense to them for understanding the long-term trends in actions that trammel the wilderness. The consistency of assigning an action to a component within a wilderness is more important than which component the action is assigned to because trends are only assessed relative to an individual wilderness. The data entry screen will enable users to provide cuff notes describing why an action was assigned to a certain component.

The following examples illustrate possible assignment of many different actions into the four components.

1. Actions that manage vegetation include the following:
   - Spraying herbicide to control populations of invasive plants.
   - Removal of invasive plants by mechanical means.
   - Spreading seed to rehabilitate an area that burned.
   - Spreading fertilizer.
   - Planting vegetation.

2. Actions that manage fish, wildlife, insects, and disease include the following:

- Introducing biological control agents.
- Manipulating wildlife habitat (e.g., installing guzzlers, creating fish barriers).
- Removing animals (e.g., predators, population sampling).
- Introducing or supplementing animals (e.g., mountain goats).
- Using management-ignited fire to improve forage.

3. Actions that manage soil and water include the following:

- Burned Area Emergency Response projects, including actions that fell trees to reduce soil erosion.
- Diverting water for irrigation.
- Spreading lime to buffer acid deposition.
- Restoration of a mine site.

4. Actions that manage fire include the following:

- Suppressing human-caused fire.
- Mechanical fuel reduction to reduce accumulated fuels.
- Using management-ignited prescribed fire to reduce accumulated fuels.

Under this measure, actions are the "unit of analysis" or the information that is recorded for assessing trends in the untrammeled quality of wilderness character. Every action needs to be entered as a separate record, but what constitutes an action? An "action" is defined for this monitoring as an act or a series of acts that are purposefully taken to manipulate the biophysical environment. Only those actions taken (or authorized) by a State or Federal agency will be tracked. It is important to remember that the purpose of monitoring the untrammeled quality is to track the intentionality of a decision to take an action (i.e., to trammel) rather than track the consequence of that decision.

Different people may define an action differently, so it is critical that explicit notes accompany data entry to clarify how an action was defined. The importance of these notes cannot be overemphasized if future managers are to have consistent data over time for a given wilderness. Table 11 offers general rules to help the local manager determine how to count the number of actions; exceptions are discussed under specific action categories.

Each of these four components is described under separate headings in the following text along with pertinent FSM references to help determine which actions should be considered under each component. The attributes to be measured are also described for each of these four components.

Table 11.—*General rules for counting and reporting the number of actions for the untrammeled quality.*

Type of action	Example	Counting rule	Reporting
Single action at a single location	Spotted knapweed treated in a single location	Count as one action	Report one action
Single action at multiple locations	Spotted knapweed treated with Tordon® K in several locations	Count as one action	Report one action for the single species regardless of the number of locations
Multiple actions at a single location	Tordon K is used to treat spotted knapweed and Canada thistle in the same location	Count as multiple actions	Report one action for each species; e.g., one treatment on two species = two actions
Multiple actions at multiple locations	Mechanical treatment is used in addition to herbicides	Count as multiple actions	Report one action for each treatment on each species; e.g., two treatments on two species = four actions
Action occurs within in a single fiscal year	Spotted knapweed is treated with herbicide between June and July 2007	Count as one action	Report one action
Action spans multiple fiscal years without interruption	Herbicide treatment initiated in August 2007 ends in November 2007	Count as one action	Report as one action in fiscal year 2007
Action spans multiple fiscal years with interruption	Herbicide treatment initiated in August 2007 ends in November 2007 and is reinitiated in August 2008	Count as multiple actions	Report as one action in fiscal year 2007 and one action in fiscal year 2008

Actions that manage vegetation. Policy direction found in FSM 2323.5, Management of Forest Cover, and in FSM 2323.2, Management of Range, clarifies what constitutes an important action. Objectives for the management of vegetation in wilderness are as follows:

- "2323.51—Objective. Retain the primeval character of the environment, to allow natural processes to operate freely.
- "2323.21—Objective. Manage wilderness range in a manner that utilizes the forage resource in accordance with established wilderness objectives." (36 C.F.R. 293.7)

The intent of this component is to record important and trackable actions, such as the control of invasive plants, compared with actions of lesser importance, such as the removal of a single hazard tree or annual logging out of trails. Or, a broad-scale aerial seeding project would be monitored but the sprinkling of seed for campsite rehabilitation would not.

The introduction of insects or other organisms for invasive plant control will not be considered under this component; rather, they will be tracked under actions to manage fish, wildlife, insects, and disease.

The unintended introduction of vegetation (e.g., the spread of nonnative species by human vectors) will not be considered here but will be monitored under the natural quality as appropriate. Table 12 describes the attributes for measuring management actions that affect vegetation.

Table 12.—*Attributes for measuring vegetation management actions.*

Attribute
Name of action*
Type of action—select primary: • Vegetation seeding (with indigenous or nonindigenous seed) • Biological control of plants • Chemical control of plants • Mechanical control of plants • Fertilizing • Vegetation removal (including large-scale seed collecting) • Restoring occurrence/distribution of natural vegetation (including reforestation) • Other (specify)
Reason for action—select primary: • Improving natural quality • Improving undeveloped quality • Improving outstanding quality • Improving user safety and convenience • Legislated provision that allows State or other Federal agencies to take actions
Requesting agency—select one: • Forest Service • Other Federal agency • State agency • University/private-sector research organization
Confidence level that all the actions for this component have been captured—select one: • High • Moderate • Low

** The asterisk denotes the attribute used to compute this measure, and the remaining attributes serve a supporting role necessary to help document or interpret the results.*

Actions that manage fish, wildlife, insects, and disease. Policy direction found in FSM 2323.3, Management of Wildlife and Fish, and FSM 2324.1, Management of Insects and Disease, clarifies what constitutes an important action. Additional direction can be found in 2323.3, Management of Wildlife and Fish, as it relates to the management of habitat.

Objectives for the management of fish and wildlife in wilderness are as follows:

- "2323.31—Objectives.

  1. "Provide an environment where the forces of natural selection and survival rather than human actions determine which and what numbers of wildlife species will exist.

  2. "Consistent with objective 1, protect wildlife and fish indigenous to the area from human-caused conditions that could lead to Federal listing as threatened or endangered.

  3. "Provide protection for known populations and aid recovery in areas of previous habitation, of federally listed threatened or endangered species and their habitats."

Objectives for the management of insects and disease in wilderness are as follows:

- "2324.11—Objectives.
  1. "To allow indigenous insect and plant diseases to play, as nearly as possible, their natural ecological role within wilderness.
  2. "To protect the scientific value of observing the effect of insects and diseases on ecosystems and identifying genetically resistant plant species.
  3. "To control insect and plant disease epidemics that threaten adjacent lands or resources."

The intent of this component is to record important and trackable actions, such as the removal of an animal species, compared with actions of lesser importance, such as the removal of an individual animal.

Public hunting, fishing, or trapping will not be considered under this indicator because these are not intentional actions taken by wilderness managers. Untrammeled quality monitoring tracks management actions, not the individual number of animals taken or plants harvested; therefore, only actions taken by agency managers will be tracked under this component. Examples of such agency actions might include special hunts or predator control activities intended to reduce population numbers.

The term "fish and wildlife" should be considered broadly for this component. it includes all animals living in the wilderness, including, for example, amphibians.

The unintended introduction of fish, wildlife, insects, or disease (e.g., the spread by wind of nonindigenous plant species from outside the wilderness) will not be considered here but will be monitored under the natural quality as appropriate. Table 13 describes the attributes for measuring management actions that affect fish, wildlife, insects, and disease.

Actions that manage soil and water. Policy direction found in FSM 2323.4, Management of Soil and Water Resources, and in FSM 2323.72, Management of Minerals and Mineral Materials, clarifies what constitutes an important action. Additional direction can be found in 2323.3, Management of Wildlife and Fish, as it relates to the management of habitat. Objectives for the management of soil and water in wilderness are as follows:

- "2323.41—Objective. Maintain satisfactory natural watershed condition within wilderness."
- "2323.72—Objectives.
  1. "To preserve the wilderness environment while allowing activities for the purpose of gathering information about mineral resources.

Table 13.—*Attributes for measuring fish, wildlife, insects, and disease management actions.*

Attribute
Name of action*
Type of action—select primary: • Reintroduction, introduction, or supplementation of wildlife—check box if indigenous or nonindigenous • Removal of fish or wildlife • Manipulation of fish or wildlife habitat—check box if guzzler, baiting/salting, planting for wildlife, burning for wildlife, seeding for wildlife, or removal or addition of instream structures or barriers for wildlife • Fish or wildlife research, monitoring, or other interference—check box if capturing, netting, or collaring animals; electroshocking fish; installing transmitters in animals or fish; performing sterilization; collecting blood or performing other tissue removal; or performing disease control actions • Biological control of insect or disease • Chemical control of insect or disease • Mechanical control of insect or disease • Other (specify)
Reason for action—select primary: • Improving natural quality • Improving undeveloped quality • Improving outstanding quality • Improving user safety and convenience • Legislated provision that allows State or other Federal agencies to take actions
Requesting agency—select one: • Forest Service • Other Federal agency • State agency • University/private-sector research organization
Confidence level that all the actions for this component have been captured—select one: • High • Moderate • Low

** The asterisk denotes the attribute used to compute this measure, and the remaining attributes serve a supporting role necessary to help document or interpret the results.*

2. "To ensure that mineral exploration and development operations conducted in accordance with valid existing rights for federally owned, locatable, and leasable minerals (FSM 2810 and FSM 2820) and for nonfederally owned minerals (FSM 2830) preserving the wilderness resource to the extent possible.

3. "To ensure the restoration of lands disturbed during exploration and development activities as nearly as practicable promptly upon abandonment of operations."

Policy also states that natural processes shall dominate in wilderness areas. Measures that modify plant cover and treat soil mantles or other activities designed to supplement natural water yield are inappropriate.

The intent of this component is to record important and trackable actions, such as vegetation treatment for a municipal watershed, compared with actions of lesser importance, such as the channeling of water for a trail project. The most common form of weather

modification is cloud seeding. These activities are not performed by the Forest Service but they are commonly licensed by State agencies.

The treatment of soil can occur in several ways. Soil may be removed for hazardous waste treatment or amendments may be added. Soil treatment of an important scale should be considered as an action and tracked under this component.

Site restoration is a relatively frequent activity in wilderness. It may involve inholdings, mine sites, campsites, or other abandoned sites. Untrammeled quality monitoring is not intended to track the restoration of individual campsites. Rather, the intent is to track larger scale projects in which activities such as recontouring of the landscape take place. A campsite restoration project involving an entire area, such as a lake, basin, or drainage section, could be judged to be important. The rationale for this judgment should be described in the notes block provided in the Infra-WILD data entry screen.

The intent of reporting new water developments is not to track the development per se (which is monitored under the undeveloped quality as appropriate) but to recognize the trammeling aspect of the development—the action taken to control or manipulate the water. Table 14 describes the attributes for measuring management actions that affect soil and water.

Table 14.—*Attributes for measuring soil and water management actions.*

Attribute
Name of action*
Type of action—select primary: • Watershed condition improvements • Burned Area Emergency Response • New water developments—check box if dam, spring development, water transmission line, or flood control facility • Removing structures that impede waterflow • Weather modification • Chemical treatment of soil • Chemical treatment of waters • Large-scale manipulation (e.g., mine or dam restoration) • Other (specify)
Reason for action—select primary: • Improving natural quality • Improving undeveloped quality • Improving outstanding quality • Improving user safety and convenience • Legislated provision that allows State or other Federal agencies to take actions
Requesting agency—select one: • Forest Service • Other Federal agency • State agency • University/private-sector research organization
Confidence level that all the actions for this component have been captured—select one: • High • Moderate • Low

** The asterisk denotes the attribute used to compute this measure, and the remaining attributes serve a supporting role necessary to help document or interpret the results.*

Actions that manage fire. Policy direction found in FSM 2324.2, Management of Fire, clarifies what constitutes an important action. Objectives for the management of fire in wilderness are as follows:

- "2324.21—Objectives.

  1. "Permit lightning-caused fires to play, as nearly as possible, their natural ecological role within wilderness.

  2. "Reduce, to an acceptable level, the risks and consequences of wildfire within wilderness or escaping from wilderness."

The impacts of fire-suppression accumulated fuels are well known and mechanical fuel reduction and management-ignited prescribed fire are used or being considered for many wildernesses to restore a more natural fire regime. These actions, however well intended, are strong manipulations of the ecosystem. Each fire project will be recorded as a separate trammeling action.

The use of management-ignited fire for the purposes of forage improvement is permitted in some cases (see FSM 2323.26b (5)) and is tracked as an action to manipulate wildlife habitat.

Although the historical role humans have played in introducing fire into the landscape is well documented, current Forest Service policy mandates the suppression of all human-caused fire. Although the effects of suppression activities may have greater impacts on the wilderness resource than the fire, the purpose of this monitoring is to record the trammeling actions and not the effects of the action. Each wildfire suppressed—not each suppression action taken—will be recorded as a separate trammeling action. Fire ignitions that are part of a suppression strategy will not be documented as part of this component. Actions taken to suppress natural, lightning-caused fires will be recorded under a separate measure, "percentage of natural fire starts that received a suppression response." Table 15 describes the attributes for measuring actions related to the management of fire.

Table 15.—*Attributes for measuring fire management actions.*

Attribute
Name of action*
Type of action—select primary: • Management-ignited fire • Mechanical fuel reductions • Wildfire suppression
Reason for action—select primary: • Improving natural quality • Improving undeveloped quality • Improving outstanding quality • Suppression of human-caused fire • Reduction of fire hazard to protect socioeconomic values outside wilderness • Improving forage • Legislated provision that allows State or other Federal agencies to take actions
Confidence level that all the actions for this component have been captured—select one: • High • Moderate • Low

** The asterisk denotes the attribute used to compute this measure, and the remaining attributes serve a supporting role necessary to help document or interpret the results.*

How Will the Data Be Collected?

- **Primary and secondary (if needed) data sources.** Field data stewards will be responsible for entering all the data on actions into the Infra-WILD Wilderness Character module. Secondary data sources may vary depending on the component and the data being collected.

  - ***Actions that manage vegetation.*** The secondary resource would be the district or forest manager with wilderness responsibilities or the forest botanist, ecologist, or range specialist. Some forests may have available data on invasive plant control in the Natural Resource Information System database. Although it is not reliable at the current time, this data source should improve in the future. All pesticide use requires approval of a Pesticide Use Proposal from the respective regional office. Regional wilderness specialists are a data source for these data.

  - ***Actions that manage fish, wildlife, insects, and disease.*** The secondary resource would be the district or forest manager with wilderness responsibilities.

  - ***Actions that manage soil and water.*** The secondary resource would be the district or forest manager with wilderness responsibilities or the forest hydrologist. The availability of data on weather modification varies by State; however, some information, including maps, is available on the Internet, and data may become more available in the future. Spatial overlays of wilderness boundaries on these maps may provide data regarding weather modification activities.

- ***Actions that manage fire.*** The secondary resource would be the district or forest manager with wilderness responsibilities or the forest fire management officer.

- **Frequency of data collection.** Data will be collected and input annually at the wilderness level and assessed every 5 years at the national level.

How Complete Are These Data?

- **Percentage of Forest Service wildernesses that have these data.** These data are currently unavailable, and local managers will need to report these new data through Infra-WILD.

- **Known spatial, temporal, and other data gaps.** This measure does not include temporal or spatial subsets. Data gaps will be minimized by identifying a local lead data steward, providing funding, and requiring timely data entry. Communication with other resource programs is critical to minimize data gaps.

- **Data adequacy.** Data quantity will be assessed by the attribute about the data stewards' level of confidence that all actions have been captured for each component: high, moderate, or low. Data quality is not relevant for this measure and will not be assessed.

How Will the Data Be Processed and Analyzed?

Data reported in Infra-WILD will be extracted for the particular wilderness along with the attributes of interest. The number of actions recorded in each of the four components of this measure will be counted and tallied as "actions." As described in Chapter 3, Assessing Trend in Wilderness Character, because these data will be collected yearly, regression analysis will be used to identify if the trend in the number of actions over the 5-year monitoring cycle is significantly increasing, stable, or decreasing (see appendix B for details on this analysis).

A narrative block will be provided for managers to make comments about individual attributes and to identify other important actions that may be occurring in their wilderness.

What Are the Cautions About This Measure?

Scale is important when tracking actions related to this measure. This monitoring focuses on agency actions that represent larger scale, more important manipulations of populations, communities, and disturbance processes rather than smaller scale, localized manipulations. The structure of this monitoring protocol enables local managers to make the determination as to what is important for their wilderness. As long as that determination is made consistently within each wilderness, some variation across wildernesses is acceptable. To improve consistency over time within a wilderness, a "notes" text block

is provided for the wilderness manager to document the rationale used to determine importance.

Actions to be tracked include those taken by area managers as well as those taken by managers of other agencies, such as State fish and game agencies. Only those actions that take place after wilderness designation and are initiated within the congressionally designated boundaries of wilderness will be tracked in this monitoring effort. Although potentially important on a local scale, unauthorized or illegal actions will not be tracked under this indicator for several reasons: data are not considered reliable or consistent nationally, and trends may reflect the amount of effort extended to track such actions rather than the actual number of illegal actions. Wilderness units may want to consider collecting information on unauthorized or illegal actions locally.

This measure will not represent a subjective judgment of the value of each action (e.g., does one action "trammel" more or less than another?) or the effects of that trammeling. Actions clearly vary in significance; however, it is neither practical nor reasonable to try to apply a value beyond an equal weight to various actions.

4.2.1.2. Measure 2 for Indicator 1, Question 1—Fires Suppressed

Percentage of lightning-caused fires that are suppressed.

Why Is This Measure Important?

Policy direction for the management of fire in wilderness found in FSM 2324.2, Management of Fire, clarifies what constitutes an important action. Objectives are as follows:

- "2324.21— Objectives.
  1. "Permit lightning-caused fires to play, as nearly as possible, their natural ecological role within wilderness.
  2. "Reduce, to an acceptable level, the risks and consequences of wildfire within wilderness or escaping from wilderness."

Fire is a critical agent of change in many wilderness ecosystems and an important component of the community of life as referenced in Section 2(c) of the Wilderness Act. In contrast to human-caused fire, Forest Service policy allows lightning-caused fire to play its natural role in wilderness. Nevertheless, the suppression of lightning-caused fire is allowed by the Wilderness Act and subsequent policy for many reasons, including threat to life and property, and lightning-caused fire is commonly controlled or manipulated by managers. By tracking the percentage of lightning-caused fires that are suppressed, this measure shows the level of restraint in management and a willingness to allow fire to play its natural role in wilderness.

What Are the Attributes of This Measure?

This measure records the percentage of lightning-caused fires that are suppressed. In this measure, the term "suppressed" means the intention to suppress a lightning-caused fire with the full range of tactical options for suppression, including the use of confinement strategies. Because policies and guidelines for managing fire are complex and changing, the protocol described here will apply to a broad range of situations but not all. For those situations in which the protocol does not fit, local flexibility is acceptable because trends are assessed only relative to the wilderness. In these situations, local consistency over time is more important than adhering to an arbitrary standard, and detailed records should be entered into the appropriate notes section in the Infra-WILD application to ensure this consistency.

In reality, the range of fire-suppression strategies and tactics is huge. For example, a lightning-caused fire in an area not under any fire management plan would by default be categorized as a wildfire and suppressed, but, if firefighting resources are unavailable, the fire may in fact not receive any management action other than monitoring. Conversely, a variety of management actions, such as dropping water or building handline, may be used in a wildland fire use (WFU) fire (USDA/DOI 2005) to reduce risks to an inholding or structure or meet other management objectives.

Rather than try to make rules to account for this variety of situations and potential management responses (an impossible task), this monitoring takes a coarser approach based on the intent behind the categorization of a lightning-caused fire. Three different suppression situations will be tracked in this monitoring.

1. If an area (fire management unit) is not under an approved fire management plan that authorizes WFU, policy requires that all lightning-caused fires will be suppressed; therefore, they will be counted as suppressed in this monitoring.
2. If an area is under a fire management plan that does authorize WFU and the Stage I Wildland Fire Implementation Plan decision was to suppress the fire, it is counted as suppressed in this monitoring.
3. If the Stage I decision was to manage the fire as WFU but later this fire was converted to a wildfire with the intent to suppress it, the fire is counted as suppressed in this monitoring.

What is less clear is the situation described previously in which management actions are taken on a WFU fire to reduce specific risks. For this monitoring, as long as the fire management objective remains WFU (i.e., to allow lightning-caused fire to play as near a natural role as possible), the fire is not counted as suppressed even though more intensive

management actions may have been used. Table 16 describes the attributes for measuring actions related to the suppression of naturally ignited fires.

Table 16.—*Attributes for measuring actions to suppress naturally ignited fires.*

Attribute
Number of lightning-caused fires*
Number of lightning-caused fires that were suppressed*
Confidence level that all the records for this measure have been captured—select one: • High • Moderate • Low

** The asterisk denotes the attribute used to compute this measure, and the remaining attributes serve a supporting role necessary to help document or interpret the results.*

How Will the Data Be Collected?

- **Primary and secondary (if needed) data sources.** Field data stewards will be responsible for entering all the data on actions into the Infra-WILD Wilderness Character module. The secondary data source would be the district or forest manager with wilderness responsibilities or the forest fire management officer. Consideration is being given to the development of a tracking system for these data within the Forest Service firetracking database. At this time, however, reporting this information is not required and data availability varies considerably among forests. Close coordination with local dispatch offices may facilitate the tracking and reporting of these data.
- **Frequency of data collection.** Data will be input annually.

How Complete Are These Data?

- **Percentage of Forest Service wildernesses that have these data.** This information is currently unavailable. This measure tracks activities on an annual basis. New data will need to be generated by local managers and reported annually through Infra-WILD.
- **Known spatial, temporal, and other data gaps.** This measure does not include temporal or spatial subsets. Data gaps will be minimized by identifying a local lead data steward, providing funding, and requiring timely data entry. Communication with other resource programs is critical for minimizing data gaps.
- **Data adequacy.** Data quantity will be assessed by the attribute about the data stewards' level of confidence that all actions have been captured for each component: high, moderate, or low. Data quality is not relevant for this measure and will not be assessed.

How Will the Data Be Processed and Analyzed?

The percentage of lightning-caused fires that were suppressed will be calculated by adding together the number of fires not covered under a fire management plan, the number of fires that received a "no go" decision, and the number of WFU fires that were later converted to wildfire. The percentage of lighting-caused fires that were suppressed will be calculated by dividing the total number of suppressed fires by the total number of lightning-caused fires during the year.

As described in Chapter 3, Assessing Trend in Wilderness Character, because these data will be collected yearly, regression analysis will be used to identify if the trend in the number of actions over the 5-year monitoring cycle is significantly increasing, stable, or decreasing.

What Are the Cautions About This Measure?

Tracking the percentage of lightning-caused fires that were suppressed provides only a portion of the information needed to understand what types of trammeling take place within a wilderness. This information does not provide the manager with an understanding of the rationale behind fire suppressions; however, the wildland fire implementation plan does require documentation of this rationale and it is recommended that units track this information locally for improved management decisions at that level.

Manual direction should be referenced for further information on the management of fire (FSM 2323.04 and 2324.04).

4.2.1.3. Measure 3 for Indicator 1, Question 1—Fish Stocking

Number of lakes and other water bodies stocked with fish.

Why Is This Measure Important?

Stocking fish is typically conducted to create or enhance recreational fishing opportunities and, more recently, to restore native fish species. Despite these positive reasons, stocking fish, both indigenous and nonindigenous species, significantly affects aquatic systems inside wilderness (Knapp and others 2001) and is a significant trammeling. For two reasons, this measure is monitored separately from the other actions that manage fish and wildlife populations. First, in wildernesses that have many lakes, the number of lakes stocked each year would completely swamp any trends in other actions taken to manage fish and wildlife populations. Second, it is important to track the effect State fish and game stocking programs have on wilderness character.

What Are the Attributes of This Measure?

The total number of lakes and other water bodies such as ponds and streams within the wilderness that are stocked with either indigenous or nonindigenous fish in a given fiscal year is recorded. For example, if 322 lakes are stocked during the fiscal year, that is the number that is recorded. The percentage of lakes stocked within the wilderness was considered for this measure, but, because the total number of lakes within the wilderness does not change, it is just as accurate to record the number of lakes stocked. For local purposes, wilderness managers may be interested in the percentage of lakes stocked within the wilderness and it would be easy to calculate this percentage. Table 17 describes the attributes for measuring the number of lakes and other water bodies stocked with fish.

Table 17.—*The attribute for measuring the number of lakes and other water bodies stocked with fish.*

Attribute
Number of lakes and other water bodies stocked with fish*
Source of data—select all that apply: • State agency records • District and forest records • Internet resources • Personal observation • Other (specify)
Confidence level that all the records for this measure have been captured—select one: • High • Moderate • Low

** The asterisk denotes the attribute used to compute this measure, and the remaining attributes serve a supporting role necessary to help document or interpret the results.*

How Will the Data Be Collected?

- **Primary and secondary (if needed) data sources.** Field data stewards will be responsible for entering the number of stocked lakes and other water bodies into the Infra-WILD Wilderness Character module. In most cases, this information will come from the staff fisheries biologist or wildlife biologist. The staff biologist may need to contact the appropriate State department for this information. The availability of stocking records varies from State to State, as does the relationship between Federal and State biologists, so a variety of information sources, such as State records, State fisheries, wildlife biologists, and/or private angling groups, may need to be consulted to acquire these data.
- **Frequency of data collection.** Data will be collected annually at the wilderness level and assessed every 5 years at the national level. Fish stocking typically occurs on a 3- to 5-year rotational sequence, and the 5-year assessment period of this wilderness character monitoring should accommodate this range.

How Complete Are These Data?

- **Percentage of Forest Service wildernesses that have these data.** All wildernesses that have fish stocking programs should have these data or at least access to these data from the State fish and game department that generally maintains complete records on all lakes and other water bodies stocked with fish.
- **Known spatial, temporal, and other data gaps.** Close communication between the Federal and State biologists will be needed to address any data gaps.
- **Data adequacy.** Data quantity will be assessed by the attribute about the data stewards' level of confidence that all records have been captured for this measure: high, moderate, or low. Data quality will be assessed by the attribute about the source of the data: high data quality would be from records acquired from State agency; moderate data quality would be from district and forest records, Internet resources, or personal observation; and low data quality would be from observation from others.

How Will the Data Be Processed and Analyzed?

The data do not need to be processed because the total number of lakes or other water bodies stocked with fish will be reported.

As described in Chapter 3, Assessing Trend in Wilderness Character, because these data will be collected yearly, regression analysis will be used to identify if the trend in the number of lakes and other water bodies stocked over the 5-year monitoring cycle is significantly increasing, stable, or decreasing.

What Are the Cautions About This Measure?

For several reasons, this measure may not fully assess the number of lakes and other water bodies that have been stocked. First, some lakes that had been stocked in the past now might have self-sustaining fish populations and are not currently being stocked. Second, private angling groups continue to stock fish and some of these actions would be difficult or impossible to monitor. Third, stocking typically occurs by dropping fish from helicopters or fixed-wing aircraft, and sometimes a lake may be stocked that was not supposed to be and a lake that was supposed to be stocked may not be. Fourth, a lack of communication between the State fish and game department and the local Forest Service staff biologist may result in not identifying some lakes or other water bodies in wilderness as being stocked.

This measure monitors only the direct stocking action and not the effects of these actions on the lake or other water body. For example, past stocking actions may have significantly

affected lake biota long after the actions have stopped, but these long-term effects are not monitored under the natural quality because of the lack of capability to monitor such effects.

This measure does not distinguish between the stocking of indigenous versus nonindigenous species because the act of stocking directly degrades the untrammeled quality. In this case, the species of fish is not directly related to the impact on the untrammeled quality.

Chapter 5. Natural Quality

5.0. Summary

Table 18 provides a summary of the monitoring questions, indicators, and measures for the natural quality.

The Wilderness Act of 1964 intended that ecological systems inside wilderness—the community of life in all its varied composition, structure, and function—be free from the effects of "an increasing population, accompanied by expanding settlement and growing mechanization." This natural quality of wilderness character strives to monitor the effects of modern people on ecological systems inside wilderness. Although the untrammeled and natural qualities of wilderness character often are combined, they address distinctly different and important aspects of wilderness character (Landres and others 2005). The untrammeled quality monitors the actions that manipulate or control wilderness ecological systems, thereby tracking a vital symbolic ideal of wilderness character, while the natural quality tracks the effects of these and other actions on the community of life in wilderness.

Table 18.—*A summary of the indicators and measures monitored in the natural quality.*

Quality of wilderness	Monitoring question	Indicator	Measure
Natural—wilderness ecological systems are substantially free from the effects of modern civilization	What are the trends in human threats to natural conditions?	Pollutants that degrade air quality and air-quality–related values such as plants, animals, soil, and water	Ozone exposure statistic N100—episodic ozone concentrations affecting sensitive plants
			Ozone exposure statistic W126—chronic ozone concentrations affecting sensitive plants
			Concentration of sulfur in wet deposition
			Concentration of nitrogen in wet deposition
		Developments that degrade the free-flowing condition of rivers and streams	Number of dams inside wilderness
		Nonindigenous species that alter the composition of natural plant and animal communities	Percentage of wilderness acres (in categories) with invasive plant species that are not indigenous to the wilderness
			Number of nonplant species (e.g., stocked fish, livestock, invertebrates, fungi, or pathogens) of concern that are not indigenous to the wilderness
			Number of acres of grazing allotments with authorized use
	What are the trends in selected biophysical conditions and processes sensitive to human threats?	Visual air quality	Average sum of anthropogenic fine nitrate and sulfate
			Average deciview
		Indigenous ecosystems, plant communities, and plant and animal species that have been extirpated	Number of indigenous plant and animal species that have been extirpated

The natural quality is divided into two monitoring questions. The first monitoring question asks about the trends of selected human-caused threats to ecological systems inside wilderness. Threats are important to monitor because they are known to be direct and significant threats to the composition, structure, and functioning of ecological systems in wilderness. In addition, in many cases, threats are easier and more reliably monitored than their myriad and sometimes subtle effects.

The second monitoring question asks about the trends of selected biophysical conditions and processes that are sensitive to human-caused threats. Ultimately, trends in these conditions and processes are what matter most to preserving the natural quality of wilderness character. Despite this focus, our present state of monitoring and understanding is generally very poor with regard to ecological systems in large, remote areas; the indicators were chosen because they represent important aspects of ecological systems and data are available for them.

Many other indicators were identified for both monitoring questions, but the data are not yet available or the indicators were dropped for a variety of other practical and conceptual concerns (see appendixes C and D for desired and dropped indicators, respectively). Although the limitations of the indicators to be monitored are clearly recognized and discussed in the following text, as a set, these indicators are considered barely adequate at this time for monitoring the natural quality of wilderness character.

5.1. Introduction

Designated wilderness, the most protected of all land management designations in the United States, has always been associated with protecting and preserving ecological systems from the impacts of modern people (Sutter 2004). Section 2(c) of the Wilderness Act of 1964 states that wilderness is "protected and managed so as to preserve its natural conditions." In other words, wilderness ecological systems are to be substantially free from the adverse ecological effects of modern civilization. Although the untrammeled quality monitors the actions managers take, this natural quality monitors the intended and unintended effects of modern people on ecological systems inside wilderness. Ideally, these effects would be monitored from the time the area was designated as wilderness. The national Framework (Landres and others 2005) provides a detailed discussion of the goals and concerns for monitoring this natural quality.

No new field data will be collected for monitoring this natural quality of wilderness character. Instead, existing data are used that fit the conceptual model of the natural quality of wilderness character described in the national Framework. Data from a variety of sources will be used, including the Forest Service Infrastructure (Infra) database and

the Natural Resource Information System (NRIS), national air-quality data stored by the Environmental Protection Agency (EPA) and interagency data stored on university Web sites, data stored by the U.S. Department of the Interior's U.S. Geological Survey and U.S. Fish & Wildlife Service and the U.S. Army Corps of Engineers, and State-level data from State natural heritage programs and conservation data centers.

Trend in the natural quality will be assessed by synthesizing information from the indicators and the monitoring questions using the decision rules described in Chapter 3, Assessing Trend in Wilderness Character.

5.2. Monitoring Question 1—Human Threats

What are the trends of human threats to natural conditions?

Why Is This Monitoring Question Important?

This monitoring question focuses management attention on selected human-caused threats that affect or alter ecological systems inside wilderness. Whereas ecological systems are very complex and highly variable, and therefore difficult to monitor, threats generally are easier and more reliably monitored. In this case, threats are monitored as a surrogate for the variety of complex effects they likely have on the ecological systems inside wilderness. In addition, monitoring selected human-caused threats gives managers important information they may use to directly modify policies and practices to improve the natural quality of wilderness character. The greater the number of threats, the greater the adverse impact on the natural quality of wilderness character.

A wide range of human-caused threats affects wilderness ecosystems. These threats include management actions (e.g., the effects of suppressing natural fire ignitions); regional-scale threats that cross into a wilderness without regard to the wilderness boundary (e.g., air pollutants and nonnative invasive species); and global threats such as global climate change. This monitoring question addresses only selected threats that are known to or are likely to adversely affect the natural quality of wilderness character in at least 50 percent of Forest Service wildernesses and have credible data to assess trends over time within a wilderness.

How Will the Indicators Be Used To Answer This Question?

The indicators were chosen because they are known to be direct and significant threats to the composition, structure, and functioning of ecological systems in wilderness. Many threat indicators were considered but deemed unacceptable for a variety of reasons (see appendixes B, C, and D). Of all the different threats to wilderness, three were chosen as indicators because of their broad impacts on ecological systems and because data generally are available for them.

1. Pollutants that degrade air quality and air-quality–related values (AQRVs).
2. Developments that degrade the free-flowing conditions of rivers and streams.
3. Nonindigenous species that alter the composition of natural plant and animal communities.

As described in Chapter 3, Assessing Trend in Wilderness Character, trends of the individual indicators will be synthesized to develop an overall trend estimate to answer this monitoring question. Table 19 shows possible combinations of trends in the indicators and the resulting trend to answer the monitoring question about human threats to natural conditions in the natural quality of wilderness character. The resulting arrows show the trend as improving (upward-pointing arrow), offsetting stable (double-headed vertical arrow), stable (double-headed horizontal arrow), or degrading (downward-pointing arrow).

Table 19.—*The trend in the monitoring question about human threats is derived from adding across the trends in its component indicators.*

Indicator	Possible trends in the indicator							
Pollutants that degrade air quality	⇧	⇧	⇧	⇧	⇔	⇔	⇧	⇳
Developments that degrade rivers	⇧	⇳	⇧	⇔	⇔	⇩	⇩	⇔
Nonnative species	⇔	⇔	⇩	⇩	⇔	⇩	⇩	⇩
Resulting trend in the monitoring question	⇧	⇧	⇧	⇳	⇔	⇩	⇩	⇩

What Are the Cautions About This Question?

The term "threat" is clearly value laden because what is considered a threat in one place may not be considered a threat in a different place. In this technical guide, only threats that apply to at least 50 percent of Forest Service wildernesses nationwide are considered. In addition, many natural "agents of change" exist that may threaten certain natural conditions and processes in wilderness (e.g., a natural fire that threatens to eliminate the last stand of old-growth trees). In this technical guide, however, only human-caused threats are considered.

The three indicators chosen for use in this monitoring are not the full set of human-caused threats to ecological systems inside wilderness. The practical constraints of national applicability, local relevance, and data availability resulted in using just these three threats. Users of this monitoring information should recognize that other threats may be more important to a local wilderness. In addition, the measure(s) for each of these indicators similarly reflect the same practical constraints, so trends in each indicator also need to be interpreted with caution because other (especially site-specific) measures may yield a different result than the ones used in this monitoring protocol. Specific concerns about each of the indictors are discussed under the appropriate section for each indicator.

5.2.1. Indicator 1 for Question 1—Air Pollutants

Pollutants that degrade air quality and air-quality–related values such as plants, animals, soil, and water.

Why Is This Indicator Important?

Air quality and AQRVs, such as plants, animals, soil, and water, can be degraded by air pollution. The term ”air-quality–related value” and the unique AQRV protection responsibilities Federal land managers have within Class I areas originated in the Clean Air Amendments of 1977; the Forest Service has an affirmative responsibility to manage air pollutants in these areas. In the context of this technical guide, air pollution effects on plants, animal, soils, and water are important in any of the 407 wilderness areas regardless of whether the Clean Air Act designation of the wilderness is Class I or Class II.

By monitoring this indicator, wilderness and air-quality managers can track the status and trends in certain pollutants and then draw conclusions as to the likely effects of those pollutants on the natural condition of wilderness. Then, working with air-quality scientists, regulators, industry, and the public, Forest Service managers can present an effective case for reducing pollution emissions where current pollution levels or trends are affecting the natural condition of wilderness.

How Was This Indicator Chosen?

Some forms of pollution are routinely measured across the country through a variety of large networks, sometimes in the immediate vicinity of wildernesses and sometimes in representative sites. The use of representative sites and networks enables air-quality modelers to provide broad estimates of pollution levels in cases in which onsite monitoring is not possible or feasible. Pollutant levels are a very feasible indicator given the combination of data from numerous monitoring sites and carefully modeled values generated for wildernesses without nearby monitors. Whether monitored or modeled, pollutant levels generally are tracked as part of interagency networks, with rigorous and standardized methods of data collection, quality assurance, and interpretation ensuring a high degree of credibility of the information obtained.

Monitoring air pollution is vital because air pollution can affect virtually all aspects of the natural condition of wilderness (e.g., species composition, water chemistry, fire frequency, and soil fertility). Other indicators considered and rejected are discussed in appendix E.

How Will the Measures Provide Information About This Indicator?

Two statistics produced from ozone monitoring data, N100 and W126 (explained in the first and second measures in the following text), and wet deposition concentrations of

sulfur and nitrogen have been selected as core measures for assessing air pollution impacts on the natural condition of wilderness. These measures provide direct information about the levels of three of the major pollutants affecting sensitive plants, water, soils, and animals in wilderness across the country.

As described in Chapter 3, Assessing Trend in Wilderness Character, trends in the individual measures will be synthesized to develop an overall estimate of the trend in this indicator. Table 20 shows possible combinations of trends in the measures and the resulting trend in this indicator. The resulting arrows show the trend as improving (upward-pointing arrow), offsetting stable (double-headed vertical arrow), stable (double-headed horizontal arrow), or degrading (downward-pointing arrow).

Table 20.—*The trend in the indicator of pollutants that degrade air quality is derived from adding across the trends in its component measures.*

Measure	Possible trends in the measure									
Ozone N100	⇧	⇧	⇧	⇧	⇧	⇔	⇔	⇔	⇔	⇩
Ozone W126	⇧	⇧	⇔	⇧	⇔	⇔	⇔	⇔	⇩	⇩
Sulfur wet deposition	⇔	⇔	⇔	⇩	⇔	⇔	⇔	⇩	⇩	⇧
Nitrogen wet deposition	⇔	⇩	⇔	⇩	⇩	⇔	⇩	⇩	⇧	⇩
Resulting trend in the indicator	⇧	⇧	⇧	⇳	⇳	⇔	⇩	⇩	⇩	⇩

What Are the Cautions About This Indicator?

By monitoring concentrations of pollutants rather than the impacts of those pollutants, it is difficult to make definitive statements about the actual effect of the pollutant on the natural condition of a given wilderness. For example, by monitoring the concentration of sulfur and nitrogen in wet deposition, we know that both elements contribute to the acidification of water and soils in a wilderness, but we cannot actually quantify the degree of acidification that might occur in any given wilderness without additional information such as bedrock geology, meteorology, and soil survey results.

A strong caution for the measures of the concentration of sulfur and nitrogen in wet deposition is that, although the concentration gives an excellent indication of temporal trends in pollutants, it can lead to a gross underestimation of the overall deposition of these pollutants. Atmospheric deposition occurs both during precipitation events (captured in wet deposition measurements) and at all other times, in dry or fog/cloud deposition. In many areas, especially in dry areas such as the Southwest, dry deposition may provide a much greater portion of atmospheric deposition than wet deposition, so using only wet deposition measurements can produce a gross underestimation of total deposition. Unfortunately, deposition other than wet deposition is monitored in relatively few locations and cannot be used to provide estimates across the country, and its contribution to total atmospheric deposition varies widely because of differing precipitation levels.

The other major problem with tracking the concentration of sulfur and nitrogen in deposition is that deposition is a function of both concentration and precipitation. A wilderness area may have a relatively low concentration of pollutants but a high level of precipitation, so the impact on the wilderness may be large even though the air is relatively clean. This scenario is especially true at upper elevations where precipitation levels are high. Yearly variations in precipitation make it difficult to determine trends in deposition; therefore, monitoring concentration provides a much better method of tracking temporal trends. The manager must use caution in interpreting these numbers because the total deposition is what determines the impacts on the wilderness resources.

In addition, because these measures will use extrapolated data for many wildernesses, managers should be cautious in how the measures are used; the pollutant levels are being modeled rather than measured at that particular wilderness.

The measures chosen (sulfur and nitrogen deposition and the ozone statistics) are by no means inclusive; many other pollutants can harm the natural condition of wilderness resources. For example, the issue of mercury deposition and its impacts on aquatic fish and wildlife is becoming more and more prominent. Unfortunately, mercury monitoring data are currently insufficient to include in this technical guide. Mercury, particulate matter, and carbon monoxide all are significant pollutants of concern but were rejected for this effort for a variety of reasons. Other indicators considered and rejected are discussed in appendix E.

5.2.1.1. Measure 1 for Indicator 1, Question 1—Ozone N100

Ozone exposure statistic N100—episodic ozone concentrations affecting sensitive plants.

Why Is This Measure Important?

Ozone is the principal component of urban smog; however, ozone and its precursor emissions—nitrogen oxides (NO_x) and volatile organic compounds (VOCs)—can travel long distances, resulting in elevated ozone levels in wildernesses. Unlike most pollutants, ozone is not emitted directly from smokestacks or motor vehicles. Emissions of NO_x and VOCs from these pollution sources react in the presence of sunlight to form ozone, which is one of the most phytotoxic air pollutants and causes considerable damage to vegetation throughout the world. Many native plants in natural ecosystems are reported to be sensitive to ozone. The effects of ozone range from visible injury to the leaves and needles of deciduous trees and conifers to premature leaf loss, reduced photosynthesis, and reduced growth in sensitive plant species.

Tracking trends in ozone concentration and exposure provides an indication of how air pollution may be affecting plants in wildernesses. The amount of ozone measured with an

ozone monitor is the concentration in the atmosphere; however, the amount of ozone that enters the leaf, called "dose," depends on whether the plant's stomata are open, which, in turn, depends on atmospheric conditions. The effective dose is the amount of ozone that enters the leaf during the growing season and has an impact on physiological processes or causes cell death.

The potential effects of ozone concentration on wilderness character will be described in this assessment using two vegetation exposure statistics termed N100 and W126. The N100 statistic is the number of hours accumulated when the measured ozone concentration is greater than or equal to 100 parts per billion (ppb). Experimental trials have shown greater vegetation growth loss under conditions with ozone peaks of more than 100 ppb than under conditions without those peaks. The second statistic is the seasonal ozone exposure metric called "W126," which summarizes the chronic ozone exposure of vegetation over the entire growing season. The Federal Land Managers' Air Quality Related Values Workgroup (FLAG) has produced standardized guidelines for air-quality measures. FLAG recommends using both N100 and W126 together in interpreting ozone data because each statistic addresses different environmental conditions that potentially affect different sensitive plant species. Therefore, both metrics will be used in this assessment. An increase in N100 or W126 indicates an increase in the threat or impact of ozone on wilderness ecosystems.

Spatial extrapolations of the available ozone monitoring data for W126 and N100 have been developed for the lower 48 States. The spatial analysis used interpolates data from a known set of sample points to a continuous surface.

What Are the Attributes of This Measure?

Ambient ozone monitoring data will be obtained to calculate W126 and N100. The results from a specific monitoring site will be used if the monitor is located within 25 mi of a wilderness; otherwise, ozone monitoring data within a region will be used to spatially extrapolate W126 and N100 across the landscape to provide estimates for a particular wilderness. N100 and W126 are annually derived statistics; one value will be generated for each wilderness for each year. Table 21 describes the attributes for measuring ozone N100.

How Will the Data Be Collected?

- **Primary and secondary (if needed) data sources.** The first-choice data for calculating the W126 and N100 metrics are from ambient monitoring of ground-level ozone. This monitoring occurs within and outside forest boundaries and a variety of locations nationwide. Hourly average ozone data are obtained by the air regulatory agencies and are stored in EPA's database, Aerometric Information

Table 21.—*Attributes for measuring ozone N100.*

Attribute
Ozone N100 ambient concentration*
Source of data—select one: • EPA AIRS • CASTNET • Spatial interpolation
Year of data
Station number (optional)
Distance to station (optional)

** The asterisk denotes the attribute used to compute this measure, and the remaining attributes serve a supporting role necessary to help document or interpret the results.*

AIRS = Aerometric Information Retrieval System. CASTNET = Clean Air Status and Trends Network. EPA = Environmental Protection Agency.

Retrieval System. Typically, a contractor is hired to retrieve the data, perform a final quality assurance check, and format the data.

Any data obtained by the Forest Service are accessed at http://216.48.37.155/calculator/ozone_state_years.htm. All Forest Service data should be stored at this site. These data should be used to represent each wilderness where monitoring stations are located within 25 mi of the wilderness boundary.

A wilderness located more than 25 mi from an ambient monitoring site should use the estimates of the ozone statistics performed by spatial analysis available at http://216.48.37.155/ozone/spatial/. Typically, the spatial analysis is provided for a 0.5-degree-latitude-x-0.5-degree-longitude grid for the lower 48 States. Only monitoring sites with greater than 75-percent data capture for each month from April through September are included in the analysis. Interpolation techniques are used to estimate the statistics as if the analysis included 100-percent data capture for each monitoring site. The results provide W126 and N100 estimates for each grid cell and the associated 95-percent confidence interval. Multiple grid cells within a wilderness should be averaged to develop a single W126 and N100 metric for each wilderness.

Each year, the selection of a representative monitoring site or, alternatively, the use of spatially interpolated data, should be confirmed with the zone or regional air-quality specialist or manager. Monitoring networks close and add sites periodically and the air-quality specialist/manager will be aware of any changes. In addition, local pollution sources and meteorology may influence the choice of sites located more than a short distance from the wilderness boundary.

- **Frequency of data collection.** Monitoring occurs hourly and is accumulated annually. Data for a specific year (such as 2004) are not available until May of the

following year (2005, in this example). Typically, a 6-month delay occurs in the availability of data from a specific monitoring site, and a 12- to 18-month delay occurs in the availability of data that need to be spatially extrapolated.

How Complete Are These Data?

- **Percentage of Forest Service wildernesses that have these data.** All wildernesses in the lower 48 States are covered either by local monitoring or by spatial extrapolation.
- **Known spatial, temporal, and other data gaps.** Spatial extrapolations of the available ozone monitoring data have been developed for the lower 48 States; the extrapolations address most spatial gaps. Wildernesses in Alaska can use ozone data from the Pacific Northwest, which are expected to be reasonably representative of background ozone values in Alaska. Where significant temporal gaps exist in local monitoring data, the extrapolated data covering that area could be used.
- **Data adequacy.** These data are derived from a national data collection program that has been rigorously tested and refined over a long period time, and no other data exist that could be collected; therefore, data quantity is complete. Data quality is assessed by the attribute about the source of the data: EPA and Clean Air Status and Trends Network (CASTNET) data are of high quality, and spatial interpolation is of moderate quality.

How Will the Data Be Processed and Analyzed?

Hourly ozone monitoring data obtained by the Forest Service need to be formatted (in ASCII) to be compatible with the Ozone Calculator. The location of available monitoring data can be found at http://fhpr8.srs.fs.fed.us/ozone/ozone.html and the hourly average data are found at http://216.48.37.155/calculator/ozone_state_years.htm.

The results from the spatial analysis for wildernesses where no monitoring site within 25 mi exists are stored as raster files compatible with ArcMap® at http://216.48.37.155/ozone/spatial/.

Data analysis methods are described for using the two approaches: (1) site-specific ozone data, and (2) spatially extrapolated ozone data.

No processing will be required if the hourly average data are downloaded from the Forest Service's national Web site (http://216.48.37.155/calculator/intro.htm) or if the spatial analysis has been completed (http://216.48.7.155/ozone/spatial).

Site specific. Site-specific analysis is performed using the Ozone Calculator, which will calculate the ozone statistics (Summary Statistics button). (The software and instructions can be downloaded at http:/216.48.37.155/calculator/calculator.htm.) A site is considered to have sufficient data capture when the value is 75 percent or greater for the months of April through September. Ten years of data should be used to assess trends in ozone exposures. Calculations of the number of times the 8-hour National Ambient Air Quality Standards (0.085 parts per million [ppm]) are exceeded may also be desirable to give an indication of the health risks for wilderness visitors.

The Ozone Calculator can generate a report containing ancillary data that will be helpful for interpreting trends in the ozone statistics. The report should note whether any particular year was abnormally hot and dry or cool and rainy. The report should also present the following information:

- Whether the average ozone concentration for each hour of the day is showing a diurnal pattern (indicating urban influence).
- A comparison of the ozone frequency distribution for the wilderness of interest with the San Bernardino Mountains in California (a forested site with the highest ozone exposures in the United States) and Yellowstone National Park in Wyoming (a forested site that has one of the lowest ozone exposures in the United States). Both the 1988 San Bernardino Mountains and Yellowstone National Park data are included with the Ozone Calculator and will be installed on the user's computer.
- The report may also include the number of days the 8-hour average ozone concentration was greater than or equal to 0.085 ppm (the national health standard for ozone) and at what hour(s) of day the greatest 8-hour averages occurred.

Spatial extrapolation. For each wilderness, an analysis can be performed using the Zonal Statistics option in Spatial Analyst®. The spatial data layers needed for the analysis include the following:

- Wilderness boundary (polygon).
- N100 (raster).
- N100 95-percent confidence interval (raster).

To conduct such a comparative analysis, the wilderness is selected using ArcMap. Then, for each year for which spatial analysis results exist, the Zonal Statistics option in Spatial Analyst will compute the average N100 values and the average 95-percent confidence interval for the exposure statistic. These results can be presented in tabular or graphical results. The ultimate goal is to have 10 years of data to describe the trends in ozone exposures the wilderness is receiving. Most eastern wildernesses will be located in only

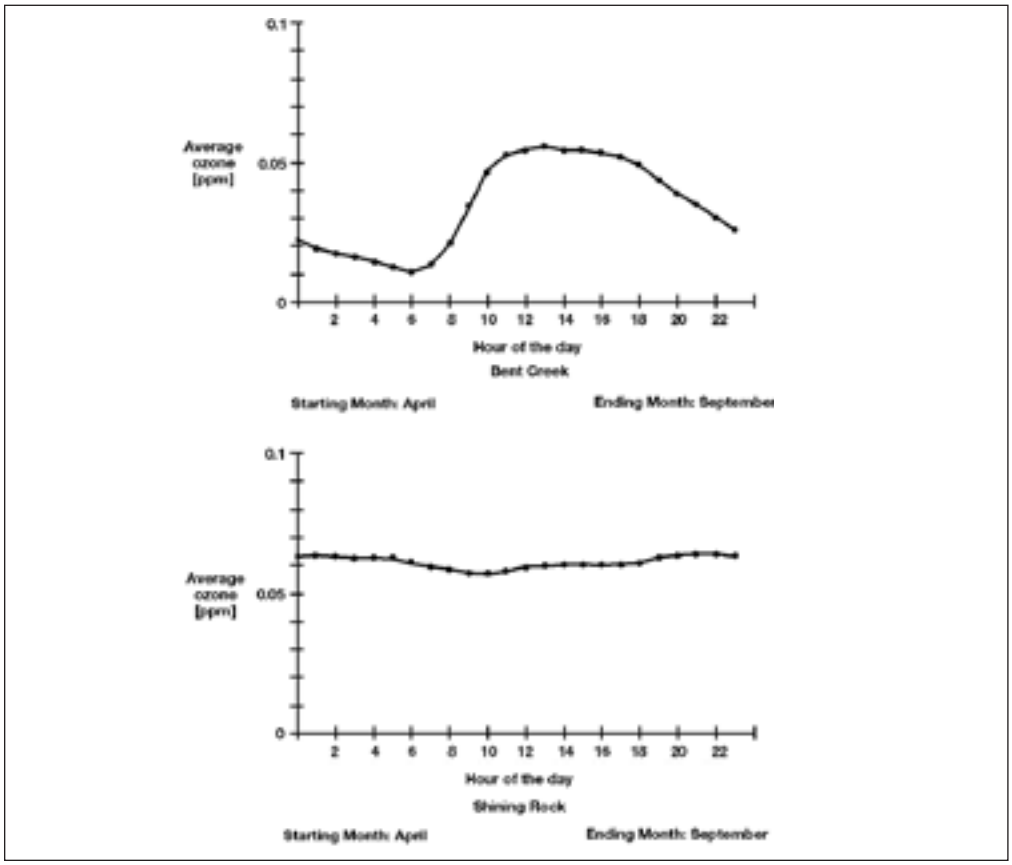
one grid (raster) cell. In cases in which a wilderness area covers more than one cell, the results should be averaged to give one value for the wilderness.

As described in Chapter 3, Assessing Trend in Wilderness Character, significant change in this measure will be assessed using regression analysis at the end of the first 5-year monitoring cycle.

What Are the Cautions About This Measure?

Hourly ozone concentrations vary across the landscape and usually are greater near large metropolitan areas compared with rural areas (fig. 5). Most of the ozone monitoring in the United States is conducted where a large number of people exists, but the number of rural monitoring sites has increased in the past 10 years. Many of the rural ozone monitoring sites were established because the area was suspected to have ozone levels that were unhealthy for people or was near a Class I area. Numerous wildernesses, especially in the western United States, are more than 25 mi away from the nearest ozone monitoring site, so extrapolated data will have to be used for those areas.

Figure 5.—*Hourly differences in average ozone in two areas. Bent Creek shows a diurnal pattern typical of either low-elevation or urban sites. Shining Rock shows a linear pattern typical of either rural or high-elevation sites.*



ppm = parts per million.

Ozone exposures also vary by elevation. Lower elevation sites (lower than 3,500 ft, such as Bent Creek in figure 5) and those near urban areas have a diurnal pattern in the average ozone exposure for each hour of the day. Rural high-elevation or exposed ridgetops (such as Shining Rock in figure 5) have a flat pattern for the average ozone concentration for each hour of the day. Therefore, the cumulative ozone exposure is greater for high-elevation sites compared with many low-elevation sites. A wilderness with a wide range in elevation and topography (complex terrain) will have varying ozone exposures; however, if differing ozone statistics for the wilderness exist, they will be averaged.

Ozone exposures also differ among years because meteorological conditions can vary from one year to the next. Ozone is formed when NO_x and VOCs combine on warm, sunny days. Yearly changes in meteorological conditions will have an influence on the amount of the two primary pollutants released into the atmosphere and on whether atmospheric conditions are favorable for the formation of ground-level ozone. Trends data can be assessed when 5 years of data are available; however, accumulation of at least 10 years of data is preferable. For many sites, this assessment can be done immediately, because many years of past data are available.

Data capture rates also vary among sites and years. Although many sites achieve a 90-percent or greater data capture of the hourly averages, data can be missing occasionally if the equipment fails because of mechanical malfunction or loss of electrical power or if the building temperature falls outside what is recommended in the protocols.

The statistics chosen show the frequency and timing of levels of ozone in the atmosphere likely to affect the growth and health of sensitive plants. It is assumed that sites with higher ozone exposures are more likely to have an impact on the wilderness resource values than sites (or years) with lower ozone exposures. Caution should be used when discussing the trend in ozone exposures if fewer than 10 years of data are available. Growth losses due to ozone are likely to be minimal during periods of drought, even though exposures may be higher, because the stomates are likely to be closed.

The use of the results from a single monitor is always problematic depending on the distance of the monitor from the wilderness and on the elevation of the monitoring site. Wilderness locations above or below the monitoring site will probably have higher or lower ozone levels, respectively, than those at the monitoring site. Spatial extrapolation techniques, such as such as that used for this process, do not take elevation or landform features into consideration. The statistical techniques average the results of a number of monitors that are closest to the area (raster cell) of prediction. This practice has a tendency to "smooth" the data. For example, these results will typically overestimate ozone exposures when compared with monitoring results with a low value. Conversely, estimated

ozone exposures are lower when compared with sites in which the monitor measured a high ozone exposure.

To estimate direct impacts on vegetation, the Ozone Calculator provides estimates of biomass reductions for some species (mainly eastern) based on the ozone exposure statistics. Further research needs to be conducted on more vegetation species found in wildernesses throughout the United States. Research needs to focus on estimating the amount of biomass reduction compared with the effective dose of ozone. Effective dose estimates also must be presented in such a way as to relate back to hourly ozone concentrations. Relating back to ambient concentration will be essential when working with air-quality regulators to develop control strategies to protect sensitive vegetation from harmful effects of ozone.

5.2.1.2. Measure 2 for Indicator 1, Question 1—Ozone W126

Ozone exposure statistic W126—chronic ozone concentrations affecting sensitive plants.

Why Is This Measure Important?

As mentioned in the previous section, both the N100 and W126 ozone exposure statistics need to be tracked to monitor ozone effects on an environment. N100 tracks peaks in exposure; W126 summarizes exposure over the growing season. The W126 metric was developed as a biologically meaningful way to summarize hourly average ozone data. The W126 metric places a greater weight on the measured values as the concentrations increase. Thus, it is possible for a high W126 value to occur with few to no hours above 0.100 ppm. Therefore, it is necessary to look at both statistics when estimating ozone impacts on vegetation. Because some plant species will be more affected by peaks in ozone concentration and others will be more affected by chronic exposure over the growing season, both statistics are useful in assessing the range of ozone impacts to natural conditions of wilderness.

What Are the Attributes of This Measure?

Table 22 describes attributes for measuring ozone W126.

How Will the Data Be Collected?

- **Primary and secondary (if needed) data sources.** See the previous measure, ozone exposure statistic N100, for data collection sources.
- **Frequency of data collection.** See the previous measure, ozone exposure statistic N100, for data collection sources.

Table 22.—*Attributes for measuring ozone W126.*

Attribute
Ozone W126 ambient concentration*
Source of data—select one: • EPA AIRS • CASTNET • Spatial interpolation
Year of data
Station number (optional)
Distance to station (optional)

** The asterisk denotes the attribute used to compute this measure, and the remaining attributes serve a supporting role necessary to help document or interpret the results.*

AIRS = Aerometric Information Retrieval System. CASTNET = Clean Air Status and Trends Network. EPA = Environmental Protection Agency.

How Complete Are These Data?

- **Percentage of Forest Service wildernesses that have these data.** All wildernesses in the lower 48 States are covered either by local monitoring or by spatial extrapolation.
- **Known spatial, temporal, and other data gaps.** Spatial extrapolations of the available ozone monitoring data have been developed for the lower 48 States; the extrapolations address most spatial gaps. Wildernesses in Alaska can use ozone data from the Pacific Northwest, which are expected to be reasonably representative of background ozone values in Alaska. Where significant temporal gaps exist in local monitoring data, the extrapolated data covering that area could be used.
- **Data adequacy.** These data are derived from a national data collection program that has been rigorously tested and refined over a long period time, and no other data exist that could be collected; therefore, data quantity is complete. Data quality is assessed by the attribute about the source of the data: EPA and CASTNET data are of high quality and spatial interpolation is of moderate quality.

How Will the Data Be Processed and Analyzed?

See the previous measure, ozone exposure statistic N100, for information on this topic. In the step detailing spatial extrapolation, simply download the W126 and W126 95-percent confidence interval raster files instead of the N100 files. Wherever the Ozone Calculator produces N100 numbers, it will produce W126 numbers similarly. Both N100 and W126 values calculated for each wilderness can be compared with high and low values at benchmark sites (e.g., San Bernardino Mountains for high values and Yellowstone National Park for low values). See the previous measure for additional details about how to do this

comparison. Trends over time for each wilderness will be the key benchmark for assessing changes in wilderness character.

As described in Chapter 3, Assessing Trend in Wilderness Character, significant change in this measure will be assessed using regression analysis at the end of the first 5-year monitoring cycle.

What Are the Cautions About This Measure?

See the previous measure, ozone exposure statistic N100, for cautions about this measure.

5.2.1.3. Measure 3 for Indicator 1, Question 1—Sulfur Wet Deposition

Concentration of sulfur in wet deposition.

Why Is This Measure Important?

Atmospheric deposition is the process by which airborne particles and gases are deposited to the earth's surface. When these pollutants are deposited in rain, snow, clouds, or fog, they are known as wet deposition. Wet deposition is monitored routinely and extensively across the United States and is a factor of the amount of precipitation multiplied by the concentration of pollutants. Dry deposition occurs during periods without precipitation but it is not well monitored across the United States.

The measure selected for wet deposition is sulfur concentration. Although deposition gives a more direct link to ecosystem impacts than does concentration, concentration is a more consistent measure for tracking temporal trends in pollution and for the purpose of extrapolation or interpolation of data (from sites in which wet deposition is measured to locations where it is estimated). The annual amount of precipitation may vary widely among wildernesses and within a wilderness because slope, aspect, elevation, and other factors affect precipitation. The use of concentration rather than deposition thus provides a more consistent number to represent an entire wilderness and reduces uncertainties associated with temporal and spatial variability of precipitation within a wilderness.

An increase in concentration indicates an increase in the threat or impact of atmospheric pollutants to wilderness ecosystems. Wet deposition can contain acidic components (nitrogen and sulfur) that cause chemical changes to freshwater lakes, streams, ponds, and soils. These changes can then affect algae, aquatic invertebrates, amphibians, fish, soil microorganisms, plants, and trees.

Spatially interpolated data maps use measured pollutant concentrations to estimate concentrations in areas without monitoring. Because not all wildernesses have a nearby National Atmospheric Deposition Program/National Trends Network (NADP/NTN)

monitoring site, the spatially interpolated data maps will be used for this wilderness character monitoring effort. This guide will focus on accessing and interpreting data provided in these spatially interpolated maps.

What Are the Attributes of This Measure?

Although NADP/NTN measures a range of ions in precipitation samples, sulfate (calculated as S) and nitrate and ammonium (calculated and added together as N) will be used to approximate the impacts of acidic deposition and N fertilization on wilderness ecosystems. These values will be reported as total wet sulfur concentration and total wet nitrogen concentration for this analysis effort. NADP/NTN provides the data in two units of measure—as deposition estimates (kilograms per hectare per year) or as ionic concentrations (milligrams per liter). The ionic concentration measurements will be used for this analysis effort because yearly variations in precipitation make it difficult to determine trends in deposition. Therefore, monitoring concentration provides a much better way to track temporal trends, and the concentrations of S and N will be used to track temporal trends in this assessment. The manager must use caution in interpreting these numbers, however, because the total deposition is what determines the impacts on wilderness resources. Table 23 describes the attributes for measuring sulfur in wet deposition.

Table 23.—*Attributes for measuring sulfur in wet deposition.*

Attribute
Wet sulfate concentration*
Source of data—select one: • Single site • Averaged site • Raster data
Year of data
Station number (optional)
Distance to station (optional)

** The asterisk denotes the attribute used to compute this measure, and the remaining attributes serve a supporting role necessary to help document or interpret the results.*

How Will the Data Be Collected?

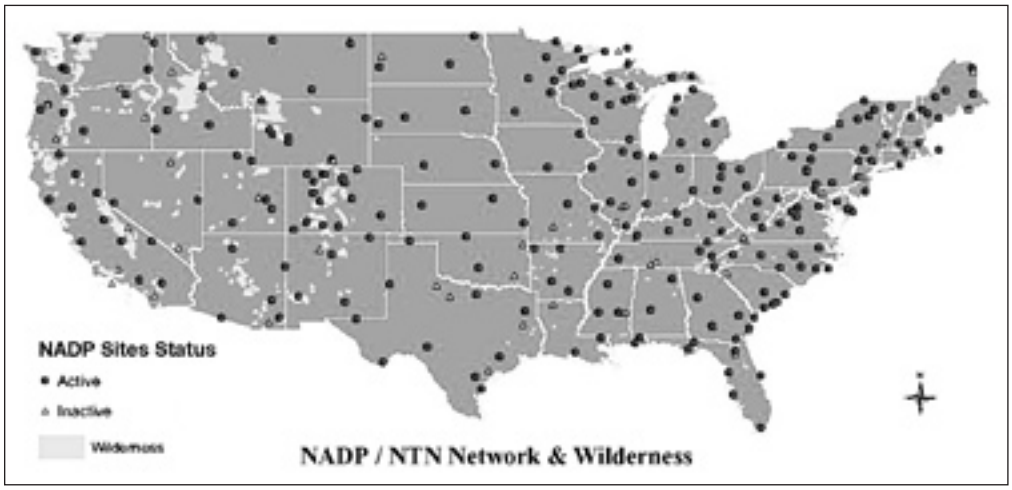
- **Primary and secondary (if needed) data sources.** The NADP/NTN is a collaborative effort among many Federal agencies (including the Forest Service), universities, State government agencies, and private-sector entities. The primary data source is precipitation chemistry data collected by the network across the United States to establish long-term temporal and geographical trends. Precipitation samples are collected on a weekly basis and sent to the Central Analytical Laboratory in Champaign, IL, where they are analyzed for pH, sulfate, nitrate, ammonium, chloride, and base cations (such as calcium, magnesium,

potassium, and sodium). To ensure accurate and precise data records, precipitation samples are collected and analyzed according to strict clean-handling procedures and a rigorous quality assurance program. (To view the NADP/NTN quality assurance/quality control information, go to http://nadp.sws.uiuc.edu/QA/.) Centralized analysis also increases consistency in the data.

The first NADP/NTN sites began monitoring precipitation in 1978. Since then, the network has grown significantly from 22 sites to more than 200 sites in the continental United States, Alaska, Puerto Rico, and the Virgin Islands. The current network for the lower 48 States is depicted in figure 6.

Chemical concentration data from each monitoring site are available in multiple forms, including tabular annual and seasonal precipitation weighted means, trend plots, and spatially interpolated data maps. The actual site data are used when the site is adjacent (within 25 mi) to a wilderness; otherwise, maps extrapolate measured ion concentration values to wildernesses lacking a nearby monitoring site. Because not all wildernesses have a nearby NADP/NTN monitoring site, the spatially interpolated data maps will be used frequently for this wilderness character monitoring effort. Although this technical guide focuses on accessing and interpreting data provided in the spatially interpolated maps, interpolation methods average data values among monitoring sites and the result has a "smoothing" effect on the data. Consequently, data collectors are encouraged to investigate the NADP network on line to determine where NADP/NTN monitoring sites are located relative to wildernesses of interest. For those wildernesses with a nearby NADP/NTN site, the site-specific data should be used to assess changes in S and N concentrations rather than the interpolated values. For example, the James

Figure 6.—*National Atmospheric Deposition Program/National Trends Network and wilderness boundaries.*



NADP = National Atmospheric Deposition Program. NTN = National Trends Network.

River Face Wilderness in VA has an NADP site (VA99) located within 2 mi of the wilderness boundary. In this case, data collectors should use the VA99 site data rather than the interpolated data. Some wilderness areas may have two or more NADP sites nearby (within 25 mi); the site that best represents conditions inside the wilderness should be used. If both sites are equal in that regard, the site closest to the wilderness boundary should be used to represent the wilderness in this assessment.

The site-specific data available on line have been analyzed and trend plots have been developed. Using readily available data where applicable could save time in the analysis effort. For wildernesses for which site-specific data are not available, the spatially interpolated maps are a surrogate for assessing trends. The spatially interpolated maps are available as raster data sets for use in Geographic Information System (GIS) applications. Estimated values for 2.5-km grids are averaged over an entire wilderness to provide average concentration values for each wilderness.

No additional data are necessary for this indicator; however, if locally available, additional information, such as streamwater chemistry data, aquatic biota data, soil water chemistry data, and/or soil chemistry data, can provide a better picture of overall deposition trends and site-specific ecosystem effects. These data can also be used to interpret the significance of any trends. Although the wilderness character monitoring effort will not interpret or report on these ancillary data nationally, regional air specialists should be able to help interpret it on a regional, forestwide, or wilderness-specific basis.

Each year, the selection of a representative monitoring site or, alternatively, the use of spatially interpolated data, should be confirmed with the zone or regional air-quality specialist or manager. Monitoring networks close and add sites periodically and the air-quality specialist/manager will be aware of any changes. In addition, local pollution sources and meteorology may influence the choice of sites located more than a short distance from the wilderness boundary.

- **Frequency of data collection.** To develop accurate trend plots, the NADP/NTN data will be analyzed for each year they are available. The analysis, however, does not need to be done on an annual basis; e.g., the data for 5 sampling years could be downloaded and analyzed simultaneously every 5 years.

How Complete Are These Data?

- **Percentage of Forest Service wildernesses that have these data.** Spatially interpolated data maps extrapolate measured pollutant concentrations to areas without monitoring in the lower 48 States. Because not all wildernesses have a

nearby NADP/NTN monitoring site, the spatially interpolated data maps will be used most frequently in this wilderness character monitoring effort. New sites are added infrequently, usually only where significant spatial gaps exist and when the hosting agency (in this case, the Forest Service) is willing to make a long-term commitment to fund installation and data analysis for a new site. Although this technical guide will focus on accessing and interpreting data provided in the spatially interpolated maps, interpolation methods average data values among monitoring sites and the result is a smoothing effect on the data.

- **Known spatial, temporal, and other data gaps.** Although the GIS raster files have no spatial or temporal gaps in the continental United States, they do not include interpolated data for Alaska or Puerto Rico. Four active NADP/NTN monitoring sites are in Alaska and one active site is in Puerto Rico. The NADP program began in 1978, and, consequently, some NADP/NTN monitoring sites have a lengthy historical data record. This record is beneficial to wildernesses with a nearby monitoring site. Temporal gaps may exist in the data record if the data collection did not meet minimum criteria established by NADP. In those years, interpolated data should be used. Wildernesses that must rely on interpolated data can assemble a historical record back to 1994.
- **Data adequacy.** These data are derived from a national data collection program that has been rigorously tested and refined over a long period time, and no other data exist that could be collected; therefore, data quantity is complete. Data quality is assessed by the attribute about the source of the data: single and average data are of high quality, and raster data is of moderate quality.

How Will the Data Be Processed and Analyzed?

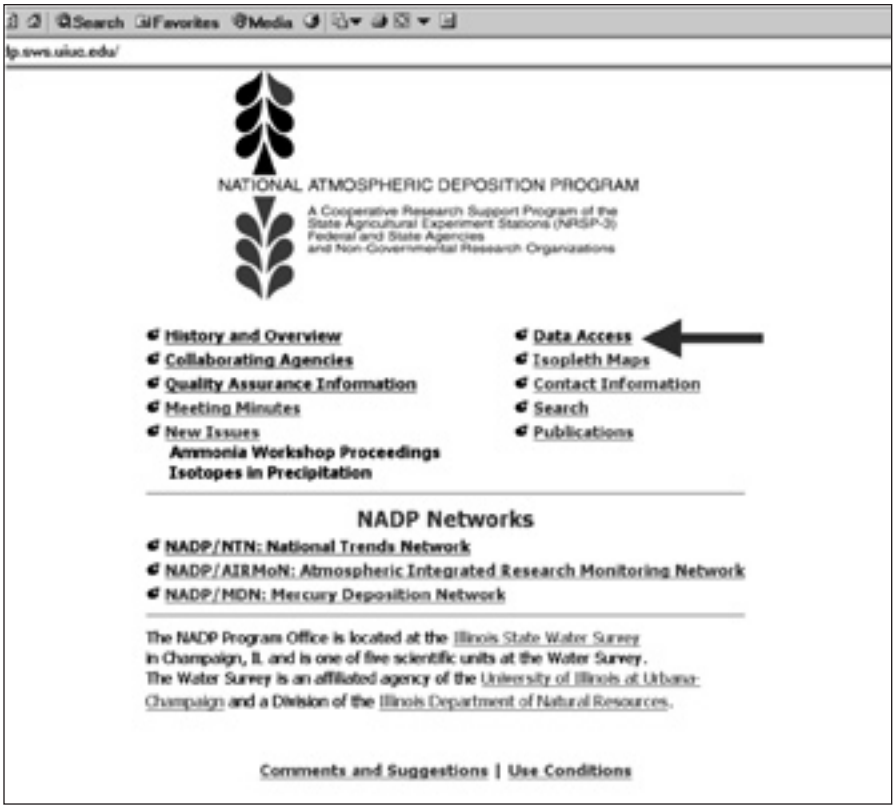
NADP/NTN data is stored on the NADP Web site. NADP/NTN data analyzed for this effort should be stored in a tabular format, such as a Microsoft Excel spreadsheet, in a project folder created for this specific indicator. All information relating to this indicator (including GIS projects and data sets) should be stored in the project folder.

Most data collected by the NADP/NTN can be downloaded from the Internet at http://nadp.sws.uiuc.edu/. The following steps will take you through collecting site-specific data and downloading the interpolated GIS raster files.

To view the NADP monitoring network and monitoring site location data and access site-specific information, complete the following five steps:

1. Click on the NADP home page link (http://nadp.sws.uiuc.edu/).

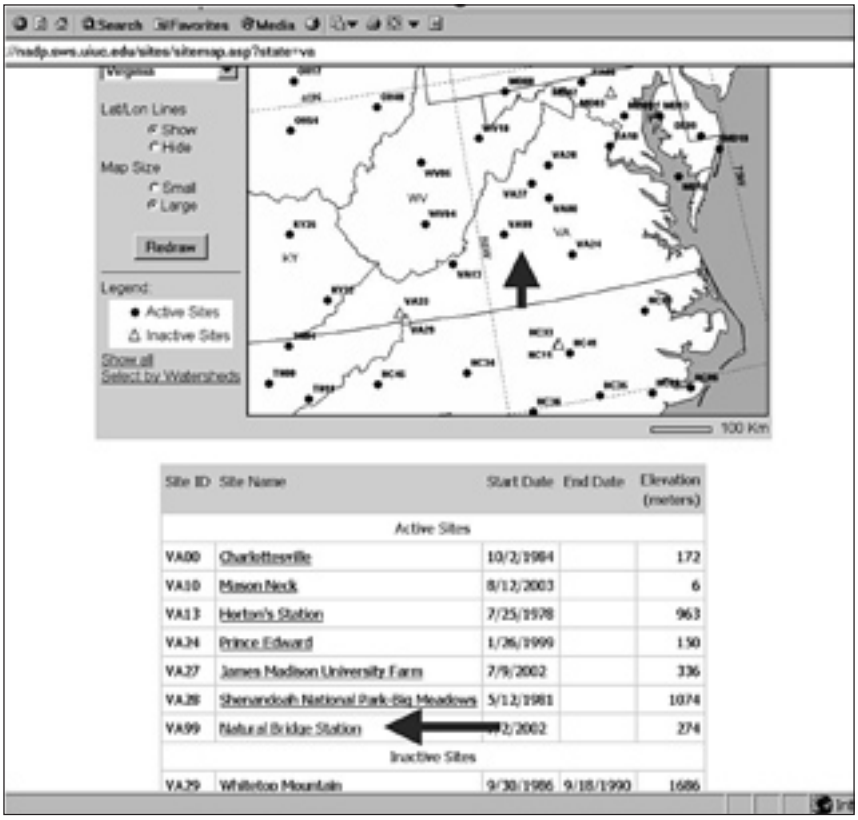
2. Click on the "Data Access" link (http://nadp.sws.uiuc.edu/sites/ntnmap.asp?).



3. Click on the appropriate State(s).

4. Choose the monitoring site(s) of interest from the list or from the map. If more than one site is within 25 mi of the wilderness boundary, the site that is most representative of conditions (e.g., elevation, ecosystem types) within the wilderness should be selected; otherwise, the site closest to the wilderness boundary should be selected.

5. The following text will provide monitoring site information and links to trend plots, annual data summaries, and tabular annual and seasonal data. (See the figures in the following text.) Note: a description of intended use must be entered to access tabular data. The trend plots and annual data summaries will be the most useful information for wilderness managers.

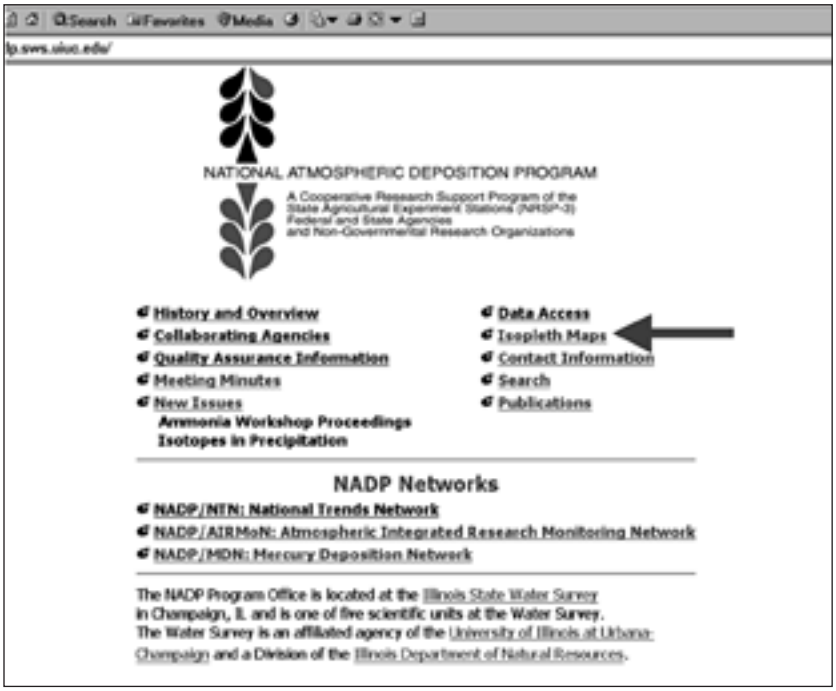

Search Favorites Media
Lat/Lon Lines
Show
Hide
Map Size
Small
Large
Redraw
Legend:
Active Sites
Inactive Sites
Show all
Select by Watersheds
100 Km
Site ID Site Name Start Date End Date Elevation (meters)
Active Sites
VA00 Charlottesville 10/2/1984 172
VA10 Mason Neck 8/12/2003 6
VA13 Horton's Station 7/25/1978 963
VA24 Prince Edward 1/26/1999 150
VA27 James Madison University Farm 7/9/2002 336
VA28 Shenandoah National Park-Big Meadows 5/12/1981 1074
VA99 Natural Bridge Station 7/2/2002 274
Inactive Sites
VA29 Whiteoak Mountain 9/30/1986 9/18/1990 1686


NADP Site Information - Microsoft Internet Explorer provided by USDA Forest Service
File Edit View Favorites Tools Help
Back Search Favorites Media
Address http://nadp.sws.uiuc.edu/sites/siteinfo.asp?id=VA99&net=NTN
Home AIRMoN MDN Search
Data Maps QA Sponsors Overview Contacts
National Atmospheric Deposition Program
NADP/NTN Monitoring Location VA99
Station Natural Bridge Station (VA99)
Location Rockbridge County, Virginia
Dates of Operation 7/2/2002 - Present
Latitude 37.6283
Longitude -79.5117
Elevation 274 meters
USGS 1:24000 Map Name Natural Bridge, 1978
Operating Agency U.S. Forest Service
Sponsoring Agency Virginia Department of Environmental Quality
More Site Photographs
2002 Site Survey (13) Large Small
Site Survey Information
NADP/NTN Wet Deposition Data Available
Trend Plots
Annual Data Summaries
Annual Data
data by calendar and water years
wet deposition totals
precipitation-weighted mean concentrations
Seasonal Data
wet deposition totals
precipitation-weighted mean concentrations
Monthly Data
precipitation-weighted mean concentrations
Weekly data
concentrations
Daily Data
Done

To access the NADP/NTN interpolated raster files, complete the following seven steps:

1. Click on the NADP home page link (http://nadp.sws.uiuc.edu/).

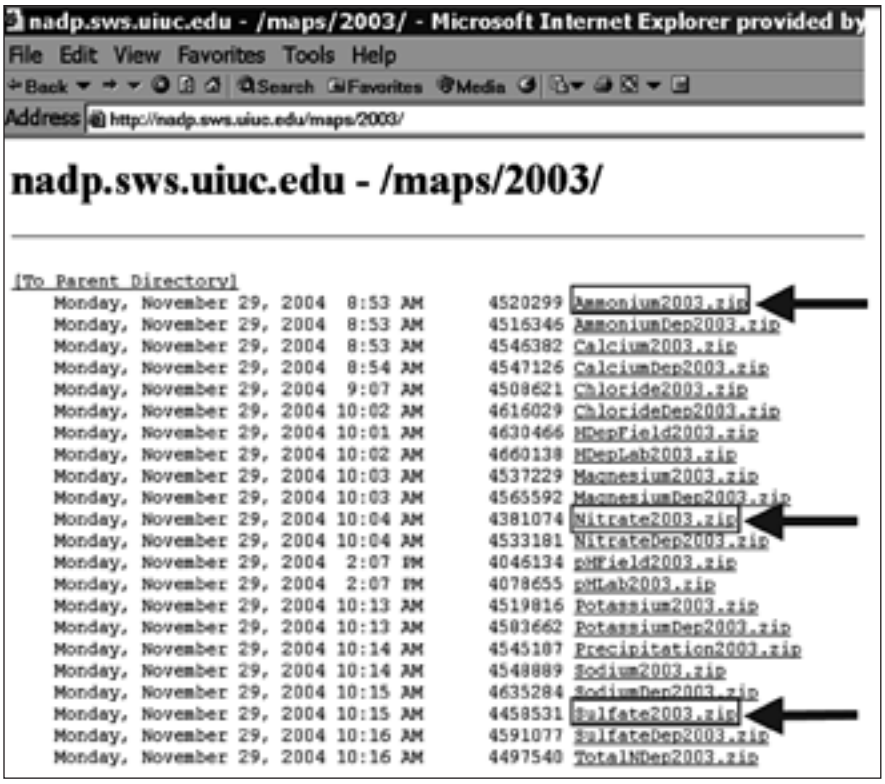
2. Click on the "Isopleth Maps" link (http://nadp.sws.uiuc.edu/isopleths/).



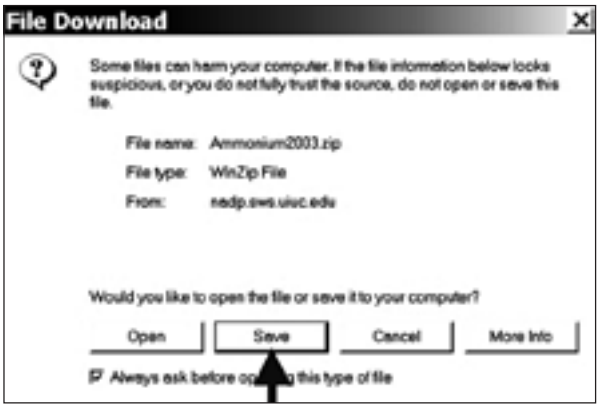
3. Click on the "Arcview grid files" link (http://nadp.sws.uiuc.edu/isopleths/grids.asp). (Note: The isopleth map animations are useful graphical tools for PowerPoint presentations.)

4. Raster files are currently available for 1994 through 2003. To establish a baseline trend, you should download and analyze data for all available years (selection of data for years before wilderness designation is acceptable in the rare cases that these data are available). To begin downloading files, click on the desired year.

5. From the maps download page, choose to download the "SulfateXXXX.zip" files ("XXXX" is the year you selected in the previous step).



6. After clicking on the maps download link, a file download box appears. Save the file to your computer and navigate to where the file is to be saved. (Create a project directory for this wet deposition indicator; i.e., create a folder titled "Wilderness_ Air_wetdep" where you store all information relating to this indicator.)



7. Once the download is complete, navigate to the downloaded Zip file and unzip the file into the project folder. When the files are unzipped into the project folder, a separate folder will automatically be created for each raster file you extract.

For wildernesses with an adjacent NADP/NTN monitoring site, trend plots can be downloaded directly from the Internet and no further analysis is necessary. For wildernesses with multiple collocated monitoring sites, annual average concentration values from each site should be averaged to come up with one representative value.

For areas lacking an adjacent monitoring site, raster files will be used to obtain a concentration estimate. Most of these analyses for all wildernesses will be completed by a wilderness data analyst at the national level, and the results will be housed in a central location.

To begin this analysis, load the following data layers into an ArcMap project:

- NADP/NTN raster files for sulfate (SO_4), nitrate (NO_3), and ammonium for the year(s) of interest. (Because of the size of the raster files, we recommend that you not load all years to be analyzed into one ArcMap project.)
- The current official wilderness boundaries layer.
- Any additional data layers, such as roads, trails, and streams, you would like to use in your analysis.

The NADP/NTN raster files have a pixel resolution of 2.5 x 2.5 km. The pixel values are the *estimated* means of the annual precipitation weighted ion concentrations at that given point. Because the grid resolution is relatively small, a given wilderness may have a range of ion concentration within its boundaries. To streamline the analysis process, the concentration values will be averaged over the entire wilderness. These averaged concentration values will be considered representative of the wilderness for a given year. Calculating the average value over each wilderness can be done using Spatial Analyst in ArcMap. In cases in which the wilderness coverage is broken into multiple polygons, the polygons should be merged if there is no geographic reason for the separation (such as an island in a river or lake) before calculating the average concentration value. In situations in which a geographical explanation for multiple polygons within the coverage exists, and the results supply multiple averaged concentration values for the wilderness, average these values together. Again, this step in the analysis should be completed by the wilderness program nationally to provide consistency in methodology.

The wilderness averaged concentration values for SO_4 should be recorded for each sampling year in a spreadsheet. The spreadsheet should also contain the wilderness name, the year, and a column for calculating the total S concentration.

The total S concentration is the value that will be reported in the data trends for this analysis. This value can be calculated from the SO_4 concentration as follows:

Calculating total wet component S:

- To convert SO_4 to S, multiply the SO_4 concentration by 0.3337.

Example:

- 1.93 mg/L SO_4 x 0.33337 = 0.644 mg/L S.
  (Note: These multipliers are the ratios of the atomic weights; the atomic weight of S is 32.06 and the atomic weight of SO_4 is 96.06. The ratio of total S in SO_4 is $^{32.06}/_{96.06}$, or .3337.)

Summarizing the data. The final analysis step is to develop trend plots for the S component of wet deposition for each wilderness. This step enables wilderness managers to track wet deposition concentrations of S in each wilderness over time. The trend plots should include the sampling year on the x axis and the S concentrations on the y axis. (See figure 7 as an example of an ion trend plot. In the wilderness character assessment, a linear trend line, rather than the type illustrated in the figure, will be developed.)

As described in Chapter 3, Assessing Trend in Wilderness Character, significant change in this measure will be assessed using regression analysis at the end of the first 5-year monitoring cycle.

Figure 7.—*An example of a total nitrogen ion trend plot.*

Note: The figure displays an example only for National Atmospheric Deposition Program/National Trends Network Site WV18; these data are not the correct total nitrogen values.

What Are the Cautions About This Measure?

Several important aspects must be considered when interpreting the data provided in this analysis. Although in many regions of the country wet deposition is a serious problem leading to decline in aquatic and terrestrial ecosystems, the wet deposition component

does not reflect the total deposition load, which also includes dry and cloud or fog water deposition; these other components of deposition may contribute greatly to changes in the natural quality of wilderness character. In addition, it is difficult to quantify what percentage of the total deposition load is attributable to the wet component because wet deposition varies significantly on a regional basis. Wet deposition alone is not a sufficient metric to assess total deposition trends; however, it is used in this assessment because the spatial coverage of the wet deposition sites across the United States is very good, while dry deposition or cloud water measurement data are seldom available.

Furthermore, the NADP/NTN interpolated data are estimated for all regions of the country using the inverse distance weighting method. This method simply averages the data values between clusters of monitoring sites. This practice not only tends to smooth the data but it also fails to account for a variety of factors that influence wet deposition patterns. The amount of atmospheric input an area receives via wet deposition is highly dependent on the amount of precipitation as well as on the acidic ion concentrations in that precipitation. Factors such as geographic and topographic location, regional precipitation patterns, and regional pollution sources influence the levels of wet deposition. Higher elevations in a wilderness often receive much more deposition than lower sites because of higher levels of precipitation at higher elevations, even if the concentrations of pollutants are similar or even lower than those at lower elevations. Consequently, a significant amount of uncertainty is associated with the interpolated values. These values should be used not as the absolute value of the total deposition inputs a wilderness area receives but rather as indicators of the general trend in deposition.

Finally, knowing deposition levels for a specific wilderness does not necessarily translate into knowing what the effects of those levels are going to be. The effects of deposition inputs are highly dependent on the physical elements of an ecosystem. For example, bedrock geology and soil type significantly influence the amount of acidic inputs that aquatic and terrestrial ecosystems can effectively "buffer" before harmful changes begin to occur. Streams flowing through bedrock geology with a very low buffering capacity, such as granite, will begin to acidify much faster than streams flowing through bedrock geology with a high buffering capacity, such as limestone, even with similar deposition levels. Information about the physical components of a wilderness and the deposition inputs can give managers a best guess as to whether a wilderness is at risk for harmful impacts. Although risk assessments are time and labor intensive, risk assessments that take these factors into account can be conducted for a wilderness to more accurately evaluate the potential for harmful impacts. Some of these risk assessments have been conducted by the Forest Service Air Program.

5.2.1.4. Measure 4 for Indicator 1, Question 1—Nitrogen Wet Deposition

Concentration of nitrogen in wet deposition.

Why Is This Measure Important?

Both sulfur and nitrogen are the major components of acidic deposition, which causes chemical changes in freshwater lakes, streams, ponds, and soils that can affect aquatic and terrestrial plants and animals. In addition, deposition of nutrient fertilizers (nitrogen and phosphorus) contributes to unnatural nutrient enrichment in coastal, estuarine, alpine, and grassland ecosystems, which can result in loss of plant and animal diversity and shifts in ecosystem processes. Most, but not all, ecosystems are nitrogen limited, making nitrogen the most important nutrient to monitor for unnatural fertilization effects.

See the text about sulfur concentration (measure 3) for more complete information.

What Are the Attributes of This Measure?

Table 24 describes attributes for measuring nitrogen in wet deposition.

Table 24.—*Attributes for measuring nitrogen in wet deposition.*

Attribute
Wet nitrate concentration*
Wet ammonium concentration*
Source of data—select one: • Single site • Averaged site • Raster data
Year of data
Station number (optional)
Distance to station (optional)

** The asterisks denote the attributes used to compute this measure, and the remaining attributes serve a supporting role necessary to help document or interpret the results.*

How Will the Data Be Collected?

- **Primary and secondary (if needed) data sources.** See the text about sulfur concentration for data collection sources.
- **Frequency of data collection.** See the text about sulfur concentration for the frequency of collecting data.

How Complete Are These Data?

- **Percentage of Forest Service wildernesses that have these data.** See the text about sulfur concentration.

- **Known spatial, temporal, and other data gaps.** See the text about sulfur concentration.
- **Data adequacy.** These data are derived from a national data collection program that has been rigorously tested and refined over a long period of time, and no other data exist that could be collected; therefore, data quantity is complete. Data quality is assessed by the attribute about the source of the data: single and average data are of high quality and raster data is of moderate quality.

How Will the Data Be Processed and Analyzed?

Follow the methods outlined in the text about sulfur concentration with the following exceptions, using nitrate (NO_3) and ammonium (NH_4) rather than sulfate.

- From the maps-download page, choose to download the "NitrateXXXX.zip" and "AmmoniumXXXX.zip" files, where XXXX is the year you selected in the previous step.
- To begin this analysis, load the following data layers into an ArcMap project: NADP/NTN raster files for NO_3 and NH_4 for the year(s) of interest. (Because of the size of the raster files, we recommend that you not load all years to be analyzed into one ArcMap project.)

The wilderness area's averaged concentration values for NO_3 and NH_4 should be recorded for each sampling year in a spreadsheet. The spreadsheet should also contain the wilderness name, the year, and columns for calculating total N concentrations.

The N concentration is the value to be reported in the data trends for this analysis. This value can be calculated from the NO_3 and NH_4 concentrations, as follows.

Calculating total wet component N:

- To convert NO_3 to N, multiply the NO_3 concentration by 0.2258.
- To convert NH_4 to N, multiply the NH_4 concentration by 0.7778.
- Add the N component of NO_3 to the N component of NH_4 to get the total wet component N concentration.

Examples:

- mg/L NO_3 x 0.2258 = 0.244 mg/L N.
- 0.20 mg/L NH_4 x 0.7778 = 0.156 mg/L N.
- 0.244 mg/L N + 0.156 mg/L N = 0.40 mg/L total N.

The final analysis step is to develop trend plots of the N component of wet deposition for each wilderness. This step enables wilderness managers to track wet deposition concentrations of N in each wilderness over time. The trend plots should include the sampling year on the x axis and the N concentrations on the y axis. (See figure 7 for an example.)

As described in Chapter 3, Assessing Trend in Wilderness Character, significant change in this measure will be assessed using regression analysis at the end of the first 5-year monitoring cycle.

What Are the Cautions About This Measure?

See the text in the previous measure about sulfur concentration.

5.2.2. Indicator 2 for Question 1—River and Stream Developments

Developments that degrade the free-flowing condition of rivers and streams in wilderness.

Why Is This Indicator Important?

The desired condition for aquatic resources in all National Forest System wilderness rivers, streams, and lakes is to be essentially free of human-caused changes in streamflows and water quality and to meet the Clean Water Act and the needs of the designated beneficial uses. In other words, wilderness aquatic systems are to be substantially free from the effects of modern civilization (Landres and others 2005).

This indicator partially answers the question of how human actions have changed streamflows within wilderness areas by evaluating human threats in the form of dam construction. Where dams occur, they may significantly alter the aquatic environment. Dam construction or enlargement would result in a reduction in free-flowing condition. Dam removal or breaching would restore the free-flowing condition on a river or stream by returning the flow regime to one responding to natural processes.

How Was This Indicator Chosen?

This indicator was chosen because dams directly impede and alter the free-flowing condition of wilderness streams and lakes, which degrades the natural quality of wilderness character. This indicator will not change much over time.

A free-flowing condition indicator that was desirable but not included at this time was developments that alter wilderness lakes (see Appendix D, Desired Indicators and Measures, for the reason why this indicator was not included). Other free-flowing condition indicators considered but dropped are found in Appendix E, Dropped Indicators and Measures.

How Will the Measures Provide Information About This Indicator?

The measure for this indicator is the number of dams that occur within the wilderness. Because just one measure exists, any significant changes in this measure will directly affect this indicator. For example, a decrease in the number of dams would indicate that modern civilization has reduced the free-flowing condition of wilderness streams and rivers.

What Are the Cautions About This Indicator?

The question of free-flowing condition in wilderness streams and rivers is only partially addressed. At this time, the Forest Service data set that tracks structures (Infrastructure [Infra]) is limited to larger dams, primarily those higher than 6 ft. Nationally, other wilderness water developments have not been consistently entered into Infra. As the Infra data set enlarges, it will be possible to add other wilderness water developments (e.g., fish barriers and weirs) to this indicator.

Only dams found within wilderness are considered. Dams upstream or downstream of wilderness areas are not counted. Dams outside wilderness, both upstream and downstream, may affect free-flowing conditions within a wilderness. With this monitoring effort, however, it is not possible to identify which dams may be having an effect and which are not; thus, the decision was made to include only those dams found within the boundaries of the wilderness.

Only dams on perennial rivers or streams are counted. Dams on ephemeral or intermittent streams are not assessed because data are not be available in digital form for 50 percent of the wilderness areas.

5.2.2.1. Measure 1 for Indicator 2, Question 1—Dams

Number of dams inside wilderness.

Why Is This Measure Important?

A change in the number of dams indicates a change to the free-flowing condition of rivers and the natural condition of stream and lake habitat. This measure will help wilderness and watershed managers assess impacts to the desired condition for wilderness aquatic resources by evaluating one aspect of human change to streamflows. This measure estimates impacts to the free-flowing condition of wilderness streams by monitoring human threats in the form of dam development.

What Are the Attributes of This Measure?

For the attributes of this measure, see the attributes for measuring Forest Service-owned dams under the undeveloped quality.

How Will the Data Be Collected?

- **Primary and secondary (if needed) data sources.** The primary source will be data extracted from the Infra-Dams module, which is the primary repository for data relating to dams. In cases in which Infra data are not complete, local wilderness and watershed managers would have to provide the requested information as a secondary data source.
- **Frequency of data collection.** Data will be collected for all dams every 5 years. Current business requirements mandate the updating of the data in the National Inventory of Dams (NID) on a biennial basis as required by the Dam Safety and Security Act of 2002. Data about dams that do not meet the NID criteria are maintained on a less frequent basis.

How Complete Are These Data?

- **Percentage of Forest Service wildernesses that have these data.** It is expected that all the dams meeting the NID criteria are entered into the Infra-Dams module and it is anticipated that most of the required data fields will be complete. Dams that do not meet the criteria are entered in Infra on a less frequent basis and many of the required data fields may be missing.
- **Known spatial, temporal, and other data gaps.** Data gaps will need to be addressed through updating the Infra database and through review from local forest staff.
- **Data adequacy.** The data for this measure are derived from a national data set; therefore, data quantity should be complete and data quality should be high.

How Will the Data Be Processed and Analyzed?

Data currently in the Infra-DAMS database will be extracted for the particular wilderness. Any change in the number of dams over the 5-year monitoring cycle is deemed significant. For example, if the number of dams goes from four to five during the monitoring cycle, a significant degradation in this measure has occurred; if the number goes from four to three, a significant improvement has occurred.

What Are the Cautions About This Measure?

Cautions are similar to those mentioned previously for the indicator and include the following:

- The current Infra database for dams may not be complete.
- The current Infra database for dams may not be consistent (e.g., data may not be of similar accuracy or may not have been collected using similar protocols and definitions).

- This measure does not include the other structures described in the index of physical evidence of development under the undeveloped quality that may degrade the free-flowing condition of wilderness streams and rivers. These other structures, such as fish ladders, fish passes, fish barriers, weirs, and diversion ditches, are not included here because evaluating the significance of their impact would require detailed analysis of hydrologic flow regimes and is beyond the means of this monitoring protocol.

5.2.3. Indicator 3 for Question 1—Nonindigenous Species

Nonindigenous species that alter natural plant and animal communities.

Why Is This Indicator Important?

Natural plant and animal communities are an integral part of the natural quality of wilderness and are composed of indigenous species. These species are defined by the Forest Service Manual (FSM) 2605, as "a species which originally inhabited a particular National Forest or National Grassland." For the purposes of this technical guide, the term "indigenous" means a species that originally inhabited the wilderness and the term "nonindigenous" means a species that occurs inside the wilderness by human influence (Lodge and others 2006).

A species that is not indigenous (sometimes referred to as "alien species") is not from the wilderness. These species may significantly alter the composition, structure, and function of natural communities, thereby degrading or eliminating habitat for native species and degrading the natural quality of wilderness character. Nonindigenous species, especially invasive species that quickly increase in population size and distribution once introduced, may directly compete with indigenous or native species for limited resources such as water, nutrients, food, and shelter (Corn and others 1999, Office of Technology Assessment 1993).

Invasive species are commonly defined as "an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health" (Clinton 1999). Examples of nonindigenous aquatic and terrestrial animal species include zebra mussels, balsam and hemlock woolly adelgid, and European starlings. Other species that are not indigenous, but not typically considered in this context, include domestic livestock such as cows, horses, and sheep that are present in wilderness by permit, or species that have become naturalized, such as mustangs and burros. For plants, this measure includes, but is not limited, to State-listed noxious weed species. In each case, such species were introduced, intentionally or unintentionally, by humans and are directly competing with or harming native species and altering ecological systems in wilderness.

How Was This Indicator Chosen?

Nonindigenous species, including aquatic and terrestrial plant and animal species, are considered one of the greatest threats to the integrity and function of natural communities and ecosystems within wilderness (Tempel and others 2004). Although many nonindigenous species are present throughout the United States, invasive nonindigenous species are a particular threat to wilderness character and are the focus of this monitoring protocol.

How Will the Measures Provide Information About This Indicator?

Three measures will be used to provide information about this indicator.

1. Percentage of area (in categories) of wilderness occupied by invasive plant species that are not indigenous to the wilderness.

2. Number of nonplant species that are not indigenous to the wilderness.

3. Number of acres of grazing allotment with authorized use.

Nonindigenous plant species are a separate measure from species that are not plants (including wildlife, invertebrates, fungi, and pathogens) because generally more and better information is available for plant species. For example, State agencies have a long tradition of managing noxious weeds and they maintain databases that may be useful for tracking species over time both within and adjacent to wilderness. Also, the geographic extent or number of acres of nonindigenous plants is a widely used tracking standard used by many agencies, although this information may not available for most wildernesses at this time.

These three measures will be used in combination to establish a baseline from which further monitoring will develop trends in the nonindigenous species indicator. As described in Chapter 3, Assessing Trend in Wilderness Character, trends in the individual measures will be synthesized to develop an overall estimate of the trend in this indicator. Table 25 shows possible combinations of trends in the measures and the resulting trend in this indicator. The resulting arrows show the trend as improving (upward-pointing arrow), offsetting stable (double-headed vertical arrow), stable (double-headed horizontal arrow), or degrading (downward-pointing arrow).

Table 25.—*The trend in the indicator of nonindigenous species is derived from adding across the trends in its component measures.*

Measure	Possible trends in the measure							
Percentage of area (in categories) occupied by invasive nonindigenous plants	⇧	⇧	⇧	⇧	⇔	⇔	⇧	⇔
Number of nonplant nonindigenous species	⇧	⇔	⇧	⇔	⇔	⇩	⇩	⇔
Number of acres of grazing allotment with authorized use	⇔	⇔	⇩	⇩	⇔	⇩	⇩	⇩
Resulting trend in the indicator	⇧	⇧	⇧	⇳	⇔	⇩	⇩	⇩

What Are the Cautions About This Indicator?

The introduction of nonindigenous aquatic and terrestrial plant and animal species by human activity is an ongoing concern that requires periodic surveying to determine new introductions of species, range expansions or contractions of known species, and the severity of impact on native species and ecosystems.

Nonindigenous species, particularly invasive species, can spread into a wilderness from human-caused actions outside the wilderness. Therefore, an increase in the number of nonindigenous species over time could be caused by actions not under the control of a wilderness manager. This situation may be an especially severe problem in smaller wildernesses.

Some nonindigenous species that could be tracked over time are intentionally introduced within wilderness either by law or agreement with other Federal or State agencies. Examples of these introductions include livestock placed on active grazing allotments and stocked fish species placed in lakes and streams. Interpretations of trends over time for these species need to consider the legal framework that allows the continued presence of these species.

5.2.3.1. Measure 1 for Indicator 3, Question 1—Nonindigenous Invasive Plants

Category of percentage of wilderness acres with invasive plant species that are not indigenous to the wilderness.

Why Is This Measure Important?

Probably the most simple and intuitively appealing measure is how much of the wilderness is covered by invasive plant species that are not indigenous. This measure involves estimating the total amount of area within the wilderness that is occupied by invasive nonindigenous plant species and using that estimate to compute the percentage of wilderness acreage occupied by these plants.

Nonindigenous invasive plants may spread into a wilderness by natural vectors (e.g., wind, water, animals) and by anthropogenic vectors (e.g., intentional planting, broadcasting seed following disturbance such as fire, unintentionally spreading seed lodged in clothes or the gut of stock animals). The intent of this measure is to track nonindigenous invasive plants that have spread into the wilderness by anthropogenic vectors. If it is known with certainty that natural vectors enabled a nonindigenous plant to become established in the wilderness, then that species would not be counted in this monitoring. On the other hand, if any uncertainty exists about whether the vector is natural or anthropogenic, then the species should be counted.

Although some nonindigenous species spread slowly or occupy restricted habitats, others can spread very rapidly and occupy large areas once introduced and established. The greatest threat to the natural quality of wilderness character is from nonindigenous plants that are also invasive. Invasive nonindigenous plants tend to occur at lower elevations, along travel corridors, and in other areas of higher human or natural disturbance, such as campsites or fire, respectively. Nonindigenous invasive species may displace native vegetation by occurring in pure stands or by slowly crowding and outcompeting indigenous plant species. Nonindigenous invasive plants may also cause significant changes to the animal community within an area (Ortega and others 2004).

What Are the Attributes of This Measure?

This measure tracks the category of percentage of wilderness acres on which nonindigenous plant species occur. Using broad categories is a crude measure. Although most wilderness do not have accurate information on the occurrence of nonindigenous plants, it should be possible to use field experience combined with professional judgment to assign these broad categories. Furthermore, this monitoring records the occurrence of only the nonindigenous plant species that are invasive. A plant species may be invasive in one locale but not in another; therefore, the local ecologist or botanist will need to decide which nonindigenous plant species are invasive to include in this monitoring.

Two general ways can be used to derive an estimate of the occurrence of invasive nonindigenous plants. The first is to sum the acres on which each of the individual plant species occur, and the second method is to count an acre only once regardless of how many nonnative plant species occur on it. This technical guide uses the second method for two reasons. First, because several different nonindigenous species may occur on a single acre of land, the first method may yield an acreage estimate greater than the total acres of wilderness. Second, many wildernesses may not have individual nonindigenous plant acreage data, so lumping species to derive a single estimate of acres, at least at this initial stage of monitoring, would enable some wildernesses to begin monitoring this measure. Table 26 describes the attributes for measures the percentage of area occupied by invasive plants that are not indigenous to the wilderness.

Inventory, as used in the previous attribute, means a field survey to document the occurrence of all nonindigenous plants within the wilderness. In this context, a complete inventory means that all likely locations, including areas such as trails, campsites, outfitter camps, areas where livestock grazing is authorized, helispots, and fire camps, were surveyed based on the judgment of the local resource specialist. A partial inventory means that some but not all areas were surveyed. A casual estimate means that a field survey has not been conducted and the estimate of area occupied is based solely on the professional judgment of the resource specialist.

Table 26.—*Attributes for measuring the percentage of area occupied by invasive plants that are not indigenous to the wilderness.*

Attribute
Category of percentage of area of wilderness on which invasive, nonindigenous plant species occur*—select one: • Trace = < 1% • Low = 1–5% • Moderate = 6–25% • High = > 25% (specify estimated percentage of area occupied)
Source of data—select all that apply: • NRIS • District and forest records • Internet resources • Personal observation • Observation from others • Other (specify)
Estimate of area occupied is based on—select one: • Complete field inventory within the past 10 years • Partial field inventory within the past 10 years • Casual estimate

** The asterisk denotes the attribute used to compute this measure and the remaining attributes serve a supporting role necessary to help document or interpret the results.*

NRIS = Natural Resource Information System.

Although nearly everyone is concerned about nonindigenous invasive plants in wilderness, data on the plants' distribution is meager and this measure draws on a variety of sources for information. This variety of sources raises additional concerns about the reliability of the data, especially in assessing long-term trends. Reliability is a complex interaction of three factors: (1) whether the plant was actually observed in the area or a deduction was made that the plant is likely to be in the area, (2) the person's knowledge about the plants in the area, and (3) the time since an area was last visited.

To provide a more reliable basis for interpreting change in this measure, local staff are encouraged to record a variety of information in the cuff notes for this measure. The information includes the following:

- Name (genus and species) of invasive nonindigenous plants used in this measure.
- Location of these species.
- Date of field inventories.
- Personnel who conducted these inventories.
- Estimate of acres occupied by each species.
- Estimate of density for each species.
- Likely effects of these species on other species or ecosystem processes (such as disturbance regimes, predation, competition, or soil nutrient availability).

How Will the Data Be Collected?

- **Primary and secondary (if needed) data sources.** The primary data source for this information is the NRIS, the Forest Service corporate application for storing, managing, and retrieving data on soils, geology, geomorphology, vegetation, and climate. NRIS also contains the Invasive Plant Inventory.

  The secondary source of information is the Forest Service resource specialist, such as the forest botanist, ecologist, and/or invasive species coordinator, on the district or forest in which a wilderness is located. The resource specialist would likely have to develop his or her best professional estimate about the number of acres occupied by invasive nonindigenous plants and then, from this estimate, calculate the percentage category of wilderness acres. The resource specialist could use a variety of different sources for the data, including the following:

  - District and forest records.
  - Forest Service Web site on invasive species (http://www.fs.fed.us/invasivespecies/).
  - U.S. Department of Agriculture (USDA) PLANTS Database (http://plants.usda.gov). Administered by the USDA Natural Resources Conservation Service, this resource is USDA's single source of standardized information about plants. Although this database is not limited to invasive species, it does contain Federal and State lists of noxious weeds and a composite list of invasive plants in the United States Focusing on vascular plants, mosses, liverworts, hornworts, and lichens of the United States and its territories, the PLANTS Database includes scientific and common names, checklists, automated tools, identification information, species abstracts, distributional data, crop information, plant symbols, plant growth data, plant materials information, plant links, references, and other plant information.
  - The Nature Conservancy (TNC) Global Invasives Species Team Web site (http://tncweeds.ucdavis.edu). This Web site provides access to TNC's weed management library with many resources for individual invasive species (including Elemental Stewardship Abstracts for specific plant species). In addition, TNC's extensive *Weed Control Methods Handbook: Tools and Techniques for Use in Natural Areas* can be downloaded (in increments or in its entirety).
  - TNC's NatureServe Web site (http://www.natureserve.org/). This Web site provides central access to all the State natural heritage programs with extensive information on plant species, including distribution maps, life histories, conservation status, and conservation needs.

- U.S. Geological Survey (USGS) Web sites. Several Web sites run by the USGS can be used for information on invasive species. The two primary Web sites are (1) the Invasive Species Information Node (http://invasivespecies.nbii.gov/), which serves as a central repository for information on the identification, description, management, and control of invasive species; and (2) the National Institute of Invasive Species Science (http://www.niiss.org/cwis438/websites/niiss/home.php?WebSiteID=1). The institute provides a hub for invasive species science collaboration, coordination, and integration across agencies and disciplines. The institute works with other partners to coordinate data and research from many sources to predict and reduce the effects of harmful nonnative plants, animals, and diseases in natural areas throughout the United States.
- The Aldo Leopold Wilderness Research Institute's online invasive species resource center (http://leopold.wilderness.net/research/invasives/invas_resources.htm). This site provides numerous national and regional links for available invasive species databases that pay particular attention to species that occur in wilderness. The Wilderness Invaders database (http://leopold.wilderness.net/research/invasives/invaders.htm) provides access to a survey of wilderness managers and resource specialists conducted in 1997 and 1998 about nonnative and invasive species occurring in Forest Service wildernesses.
- National Invasive Species Information Center Web site (http://www.invasivespecies.gov/). This comprehensive site is the gateway to Federal efforts concerning invasive species. It includes information regarding the impacts of invasive species, the government's response, profiles of selected species, news updates, and links to other agencies and organizations. The National Invasive Species Council, also accessed through this Web site, coordinates responses to the problems associated with invasive species. The site contains links to agency Web sites, Presidential Executive Order 13112 on invasive species, and the national invasive species management plan entitled Meeting the Invasive Species Challenge.
- DigiTop, USDA's Digital Desktop Library (http://www.nal.usda.gov/digitop/). This is online library for USDA employees provides access to scientific literature databases, online publications from hundreds of peer-reviewed scientific journals, and recent timely research on invasive species. Users can search to see if any publications describing a particular species within a wilderness are available.
- Regionwide or landscape planning documents.
- Personal observation.
- Observation from other knowledgeable sources.

- **Frequency of data collection.** After data are initially collected, periodic review and updates every 5 years would be sufficient to track changes over time.

How Complete Are These Data?

- **Percentage of Forest Service wildernesses that have these data.** It is estimated that sufficient data are available for at least 50 percent of the wildernesses.
- **Known spatial, temporal, and other data gaps.** Initially, data gaps for this information will likely be filled from the estimates of local resource specialists. Inventorying nonindigenous invasive plants is a high priority for the Forest Service, so data gaps will be filled over time.
- **Data adequacy.** Data quantity will be assessed by the attribute about the estimate of the area occupied by nonindigenous invasive plants: a complete inventory yields complete data quantity, a partial inventory yields partial data quantity, and a casual estimate yields insufficient data quantity. Data quality will be assessed by the attribute about the source of the data: NRIS data would be high data quality; district and forest records, Internet resources, and personal observation would be moderate data quality; and observation from others would be low data quality unless those people were known to be competent at plant identification.

How Will the Data Be Processed and Analyzed?

The percentage of area of a wilderness on which invasive nonindigenous plant species occur will be categorized into one of four different groups.

1. Trace equals < 1 percent.
2. Low equals 1 to 5 percent.
3. Moderate equals 6 to 25 percent.
4. High equals > 26 percent.

A significant change over time in the percentage of area of the wilderness on which invasive nonindigenous plant species occur is defined as a change from one percentage category to another category. For example, a change from the trace to the low category is a significant degrading of this measure, while a change from the high to the moderate category is a significant improvement in this measure.

Depending on the data source, data may be downloaded from Web sites or other sources as tabular or spatial data. State or localized data may involve Geographic Information System shapefiles that can be compared spatially with GIS wilderness boundaries to determine which nonindigenous species occur within the wilderness boundary. A tabular display from State agencies may be organized by county, and county boundaries would

then need to be spatially matched with wilderness boundaries to determine which species occur within the wilderness. The initial data set will form the baseline from which trend information can be developed based on future downloads of similar data. Through time, field monitoring or surveys will contribute to our knowledge of species occurrence within the wilderness.

A wilderness managed by more than one administrative unit will require the resource specialists from each unit to discuss and agree on the assigned category for this measure.

What Are the Cautions About This Measure?

There are several cautions about this measure, including the following:

- The large size and remoteness of some wildernesses may make it difficult or impossible to conduct a complete inventory of all locations within the wilderness.
- New infestations of nonindigenous invasive plants may occur at any time, so the number reported in this monitoring effort at a given point in time may not be accurate.
- Nonindigenous invasive plants do not occur uniformly within a wilderness but tend to occur within certain locations that may or may not have been inventoried or observed.
- Relying on a variety of external data sources may introduce substantial but unknown variation in the quality of the data.

5.2.3.2. Measure 2 for Indicator 3, Question 1—Other Nonindigenous Species

Number of nonplant species (i.e., wildlife, livestock, fish, insects, pathogens, or fungi) of concern that are not indigenous to the wilderness.

Why Is This Measure Important?

The introduction or spread of nonindigenous aquatic and terrestrial animals, pathogens, and fungi (hereafter referred to as other nonindigenous species) can cause degradation or loss of habitat for native species and directly compete with native species for finite resources such as shelter and food (Tempel and others 2004), thus degrading the natural quality of wilderness character. Examples include stocked nonindigenous fish, zebra mussels, hemlock woolly adelgid, gypsy moth, sudden oak death pathogen, and European starlings. In each case, nonindigenous species were introduced, intentionally or unintentionally, by modern people and are now directly competing with or harming native species and associated ecological systems. So many nonindigenous species (e.g., insects,

microscopic organisms) likely exist that it would be impossible or impractical to monitor them all; instead, the intent of this measure is to monitor only those species that are of concern to the local resource specialists.

A decrease in the number of other nonindigenous species over time in a wilderness indicates an increase in the natural quality of wilderness character. Conversely, an increase in other nonindigenous species over time indicates a reduction in the natural quality of wilderness character.

What Are the Attributes of This Measure?

Table 27 describes attributes for measuring nonplant species that are not indigenous to the wilderness.

Table 27.—*Attributes for measuring nonplant species that are not indigenous to the wilderness and are of concern.*

Attribute
Scientific name (genus and species) of the other (nonplant) nonindigenous species*
Source of data—select all that apply: • NRIS • District and forest records • Internet resources • Personal observation • Observation from others • Other (specify)
Confidence level that all nonplant species that are not indigenous and are of concern have been accounted for—select one: • High • Moderate • Low

** The asterisk denotes the attribute used to compute this measure, and the remaining attributes serve a supporting role necessary to help document or interpret the results.*

NRIS = Natural Resource Information System.

Other information that would affect the reliability of this measure and the interpretation of its change over time should be entered into the cuff notes associated with this measure. The information includes the following:

- Location of these species.
- Date and location of any field inventories.
- Personnel who conducted these inventories.
- Estimate of acres occupied or percentage of wilderness occupied by each species.
- Likely effects of these species on other species or ecosystem processes (such as disturbance regimes, predation, competition, or soil nutrient availability).

How Will the Data Be Collected?

- **Primary and secondary (if needed) data sources.** The primary data source for this information is NRIS, the Forest Service corporate application for storing, managing, and retrieving data on terrestrial vertebrate and invertebrate species, including nonindigenous animals.

  The secondary data source is the Forest Service resource specialist, such as the forest wildlife biologist, ecologist, botanist, or invasive species coordinator, for nonindigenous animal, pathogen, and fungus species on the district or forest in which a wilderness is located. The resource specialist could use a variety of different sources for these data, including all the sources described under the measure for nonindigenous invasive plant species. It is not expected that the resource specialist would spend an exhaustive amount of time on this measure; it is more likely that this person would either know of other nonindigenous species that occur in the wilderness or would simply place a few phone calls to validate his or her judgment.

- **Frequency of data collection.** Once data are collected initially, periodic data collection or review every 5 years would be sufficient to track changes over time.

How Complete Are These Data?

- **Percentage of Forest Service wildernesses that have these data.** An estimated 90 percent of wilderness areas would have access to such data.

- **Known spatial, temporal, and other data gaps.** Initially, data gaps for this information will likely be filled from the professional judgment of local resource specialists. Inventorying other nonindigenous species is a high priority for the Forest Service, so data gaps will be filled over time.

- **Data adequacy.** Data quantity will be assessed by the attribute about the confidence level that all nonplant species that are not indigenous to the wilderness and of concern have been accounted for: high confidence yields complete data quantity, moderate confidence yields partial data quantity, and low confidence yields insufficient data quantity. Data quality will be assessed by the attribute about the source of the data: NRIS would be high data quality; district and forest records, Internet resources, and personal observations would be moderate data quality; and observations from others would be low data quality unless those people were known to be competent at identification.

How Will the Data Be Processed and Analyzed?

The data do not need to be processed because a single number is reported. Similarly, no analysis is needed because any change in the number of nonplant species that are not indigenous to the wilderness is considered a significant change. For example, if the number of these species increases by one, this increase is considered a significant decline in this measure. Trends in the number of other nonindigenous species over time will enable assessment of how the natural quality of wilderness character is changing within a wilderness. New data will be used as they become available.

What Are the Cautions About This Measure?

The presence of other nonindigenous species is an ongoing problem that requires periodic surveying to determine new introductions of species, range expansions (or contractions), and the severity of impact on native species and ecosystems.

5.2.3.3. Measure 3 for Indicator 3, Question 1—Grazing Allotments

Number of acres of grazing allotments with authorized use.

Why Is This Measure Important?

Grazing allotments introduce large nonindigenous herbivores such as domestic cattle, horses, and sheep in a wilderness. By their grazing and trampling activities, these nonindigenous herbivores may significantly diminish the natural quality of wilderness character by directly altering habitat for wildlife, reducing populations of rare or at-risk plants, introducing disease and other pathogens, increasing soil erosion, and altering hydrologic flow regimes (Belsky and Blumenthal 1997, Belsky and others 1999, Fleischner 1994). A decrease over time in the number of acres of grazing allotments with authorized use in a wilderness would indicate an increase in the natural quality. Conversely, an increase over time of the number of acres of grazing allotments with authorized use would indicate a decrease in the natural quality.

What Are the Attributes of This Measure?

Only allotments that are currently authorized for grazing use at any time of the year are recorded in this measure. Table 28 describes the attributes for measuring authorized grazing allotments.

Table 28.—*Attributes for measuring the number of acres of grazing allotments with authorized use in wilderness.*

Attribute
Number of acres in wilderness with authorized grazing use*
Range Management Unit identification
Range Management Unit name

** The asterisk denotes the attribute used to compute this measure, and the remaining attributes serve a supporting role necessary to help document or interpret the results.*

How Will the Data Be Collected?

- **Primary and secondary (if needed) data sources.** The primary data source for this information is Infra RANGE, the Forest Service database with a section for range management reporting and billing activities; this database has a section specifically for wilderness range use. To be counted under this measure, allotments must be authorized for use within the wilderness. The secondary data source is the Forest Service range specialist, such as the district or forest range manager, on the district or forest in which a wilderness is located. The wilderness manager may also know what allotments have authorized grazing use within the wilderness at any time during the year.
- **Frequency of data collection.** Data would be collected yearly because billing occurs yearly and range allotments can vary yearly in activity (active or inactive) and in level of use (number of individuals grazing a particular allotment) from one year to the next.
- **Percentage of Forest Service wildernesses that have these data.** If a forest has a range program, all allotments with authorized use (including those in wilderness) are required by regulation to be permitted and tracked by district and forest records and Infra RANGE (FSM 2230).
- **Known spatial, temporal, and other data gaps.** Through the Forest Service Range Program, all allotments with authorized use should be entered into the data reporting system. No data gaps should occur.
- **Data adequacy.** These data are derived from the Forest Service corporate database and it is assumed that data quantity is complete and data quality is high. This assumption was generally validated in the pilot test of this technical guide that was conducted during the summer of 2006.

How Will the Data Be Processed and Analyzed?

As described in Chapter 3, Assessing Trend in Wilderness Character, regression analysis will be used at the end of the 5-year monitoring cycle to determine if a significant improving or declining trend in this measure has occurred.

Notes on the number of allotments with authorized use, type(s) of animal grazed, whether the authorized use actually occurred, total number of individuals per allotment, and the number of livestock actually occurring inside the wilderness would help local staff keep track of how allotment uses are changing over time.

What Are the Cautions About This Measure?

Stock may be moved from one pasture to another, so it is important to verify that stock are actually authorized when the allotments are counted for this monitoring. Impacts from domestic livestock grazing on ecosystems can vary depending on several factors, such as the species of domestic livestock, the number of individuals permitted per grazing allotment, whether the allotment is fenced, and whether riparian areas are protected from livestock use. These impacts can vary widely across wildernesses that have active grazing and within an individual wilderness.

5.3. Monitoring Question 2—Conditions Sensitive to Threats

What are the trends in selected biophysical conditions and processes sensitive to human threats?

Why Is This Monitoring Question Important?

This monitoring question is important to focus management attention on selected conditions and processes that are known to be caused by or sensitive to modern human-caused threats. Ultimately, the natural state of ecological conditions and processes in wilderness (the community of life as described in the Wilderness Act of 1964) enables evolution to occur unfettered by human desires. This natural state of ecological conditions and processes is the fundamental basis for the natural quality of wilderness character. This monitoring question is designed to show the effects of human-caused threats on selected conditions and processes that are surrogates for a broader set of effects on the ecological systems inside wilderness.

How Will the Indicators Be Used To Answer This Question?

From the myriad different indicators that could have been used to answer this monitoring question, two were chosen because they represented significant aspects of ecological systems, nationally consistent data were available for them, and they would be relevant locally. These indicators are visual air quality (usually referred to as visibility) and ecosystems, plant communities, and plant and animal species that have been extirpated. Many more indicators were considered but deemed unacceptable for a variety of reasons (see appendixes C and D).

As described in Chapter 3, Assessing Trend in Wilderness Character, trends in the individual indicators will be synthesized to develop an overall trend estimate to answer this monitoring question. Table 29 shows possible combinations of trends in the indicators and

the resulting trend to answer the monitoring question about human threats to natural conditions in the natural quality of wilderness character. The resulting arrows show the trend as improving (upward-pointing arrow), offsetting stable (double-headed vertical arrow), stable (double-headed horizontal arrow), or degrading (downward-pointing arrow).

Table 29.—*The trend in the monitoring question about selected biophysical conditions is derived from adding across the trends in its component indicators.*

Indicator	Possible trends in the indicator								
Visual air quality	⇧	⇧	⇳	⇧	⇩	⇔	⇔	⇩	⇩
Indigenous ecosystems, plant communities, and plant and animal species that have been extirpated	⇧	⇔	⇧	⇩	⇧	⇔	⇳	⇳	⇩
Resulting trend in the monitoring question	⇧	⇧	⇧	⇳	⇳	⇔	⇩	⇩	⇩

What Are the Cautions About This Question?

Many cautions exist about the interpretation of change based on this monitoring question. Ideally, the status of all natural conditions and processes in wilderness would be monitored. In reality, a general dearth of understanding about the composition, structure, and functioning of large, relatively natural ecosystems exists, and even less knowledge about how to cost-effectively monitor critical aspects of these systems is available. Compounding this lack of information, ecological systems are vastly complex, vary over time and from one place to another, and may be strongly affected by past circumstances.

Monitoring modern anthropogenic impacts on natural conditions and processes requires that there be sufficient understanding about how these conditions and processes naturally vary to distinguish human-caused change from natural change. In practice, this understanding is lacking in general and specifically for nearly all wildernesses. This monitoring question therefore is *not* intended for understanding change over time in the following:

- The full range of ecological complexity and variation.
- Cause-and-effect relationships between specific threats and their effects on natural conditions and processes.
- Natural conditions and processes that are not affected by modern anthropogenic threats.

Management actions may cause a variety of ecological impacts that will not be tracked under this natural quality because of insufficient understanding about the impacts. The suppression of naturally ignited fires, e.g., may directly change the species composition and spatial distribution of vegetation and cause many other indirect ecological impacts on wildlife and aquatic systems. Detailed, local understanding of prior vegetation conditions and how ecological succession in a specific area is affected by fire suppression would be

required to evaluate these ecological impacts. In general, understanding such impacts would require research that is beyond the scope of this monitoring protocol.

Because of all these constraints and cautions, trends in the indicators used to answer this monitoring question are only red flags that suggest the need for more intensive monitoring and possibly research to verify the change and understand its cause.

Although the baseline for determining human-caused change in biophysical conditions and processes ideally is the time of wilderness designation, it is more likely that baseline will be determined the first time this monitoring is conducted. This assessment does not assume or imply that current conditions are natural or in a desired condition; however, current conditions are the only practical baseline from which change can be evaluated.

The information from this monitoring question is not intended to maintain static or unchanging ecological conditions in wilderness as defined by some arbitrary point in time (such as pre-European settlement). All ecological systems change over time and from one location to another, and this variation is a critical and essential part of the natural quality of wilderness character.

5.3.1. Indicator 1 for Question 2—Visual Air Quality

Visual air quality.

Why Is This Indicator Important?

Visual air quality (visibility) measurements provide a direct link between the concentration of pollutants in the atmosphere and degradation of the natural, physical condition of clean air in wilderness. Although air-quality managers often refer to visibility (or the lack thereof) in terms of its impacts on human perception, visibility is a general indicator of air quality that should be monitored for its inherent value, just as one would monitor the biophysical condition of water quality. In the context of sulfate and nitrate measurements, reduced visibility causes increased reflective power, which can affect local climate and photosynthetic activity. In addition, visibility directly affects many wildlife species, such as raptors, far more than it does humans because many species depend on clear, clean air for successful foraging.

How Was This Indicator Chosen?

The natural condition of visibility can be described as air quality in the absence of any human-made pollutants. This natural condition has been estimated for all areas of the country as part of the Environmental Protection Agency's regional haze tracking program. Natural conditions of visibility can be used as a reference point from which to assess change in wilderness character related to clean air.

Visibility measurements are readily available through a national, interagency network and are already compiled and interpreted on a yearly basis by the Forest Service Air Program. The methodologies for data collection, quality assurance, and interpretation are standardized and well documented. Gathering and using these measures for wilderness monitoring is both feasible and highly credible.

Visibility is arguably the biophysical condition related to air quality most sensitive and responsive to changes in anthropogenic sources. Long before changes are detected in other resources or processes such as nutrient cycling, visibility measurements will show change, both improvements and degradation. Visibility is the "canary in the coal mine" of air-quality conditions, giving the earliest warning of problems.

How Will the Measures Provide Information About This Indicator?

Pollutants in air affect the transmission of light by both scattering and absorption; this effect is called light extinction. The "deciview," a unit of measure, is used to mathematically transform this extinction measurement to a convenient scale. Visibility in a wilderness depends on a complex interaction of natural and anthropogenic factors. For example, haze in a wilderness could be caused by a wildfire or natural soil dust, while a similar effect could be caused by power plant emissions or automobiles. The additional measure of the sum of anthropogenic fine nitrate and sulfate enables the wilderness manager to determine what portion of the pollutants affecting visibility is from anthropogenic sources rather than natural causes. Table 30 shows how different combinations of hypothetical trends in two measures would be combined to yield a single trend in the indicator.

Table 30.—*The trend in the indicator about visual air quality is derived from adding across the trends in its component measures.*

Measure	Possible trends in the measure								
Average sum of anthropogenic fine nitrate and sulfate	⇧	⇧	⇔	⇧	⇩	⇔	⇔	⇩	⇩
Average deciview	⇧	⇔	⇧	⇩	⇧	⇔	⇩	⇔	⇩
Resulting trend in the indicator	⇧	⇧	⇧	⇳	⇳	⇔	⇩	⇩	⇩

What Are the Cautions About This Indicator?

The visibility measurements of deciview and the sum of anthropogenic fine nitrate and sulfate are used in assessing regional haze. Regional haze encompasses a wide geographic extent, generally much greater than one wilderness area, so these measures, although applicable to a given wilderness, are not specific to that wilderness. Regional haze also implies long-range transport of pollutants, often interstate and sometimes international in nature, so the manager must consider the long-range aspect in deciding how to use the results for management and policy-related decisions.

5.3.1.1. Measure 1 for Indicator 1, Question 2—Fine Nitrate and Sulfate

Average sum of anthropogenic fine nitrate and sulfate.

Why Is This Measure Important?

Pollution-induced haze that obscures good visibility is caused by small particles suspended in the atmosphere that absorb and scatter light. Particles less than 2.5 microns in diameter are called fine particles. Fine particles are routinely described by five distinct species categories: (1) sulfates, (2) nitrates, (3) organics, (4) elemental carbon, and (5) soil. Of these categories, sulfates and nitrates are predominantly from anthropogenic sources. In many cases, sulfates and nitrates are also the predominant contributors to regional haze. Some of the nitrates and sulfates are natural in origin, so this measure subtracts estimated natural levels from current measured levels of sulfates and nitrates. The remaining concentrations provide a good surrogate for estimating anthropogenic contributions to regional haze and hence a measure of whether the natural condition of visibility is changing.

Increases in this measure directly indicate degradation of visibility conditions. Trend data showing changes in these measures can be used by Forest Service managers for public information purposes and for implementation of Clean Air Act mechanisms (such as the Prevention of Significant Deterioration program and the air-quality regional planning organizations) at district, forest, regional, and national levels. A clear indication of increase in the threat to visual air quality provides the scientific basis to approach air-quality regulators regarding pollution control strategies.

What Are the Attributes of This Measure?

Information about changes in pollution emissions in counties surrounding each wilderness is available from EPA via the National Emissions Inventory. These data can be considered optional for local wilderness managers to use in interpreting changes in this indicator. In addition, information about emissions from wildfire and prescribed fire may aid in interpreting the visibility trends data. Table 31 describes the attributes for measuring fine nitrate and sulfate.

Table 31.—*Attributes for measuring fine nitrate and sulfate.*

Attribute
Average sum of anthropogenic fine nitrate and sulfate*
Representative IMPROVE site
Year of data

** The asterisk denotes the attribute used to compute this measure, and the remaining attributes serve a supporting role necessary to help document or interpret the results.*
IMPROVE = Interagency Monitoring of Protected Visual Environments.

How Will the Data Be Collected?

- **Primary and secondary (if needed) data sources.** Visibility data for the Forest Service come from a national interagency network, Interagency Monitoring of Protected Visual Environments (IMPROVE). IMPROVE data are available in a processed form from the Visibility Information Exchange Web System (VIEWS) Web site (http://vista.cira.colostate.edu/views/web/improve/summary_data.htm). No secondary sources of this type of data exist that have appropriate spatial extent. The representative sites have been determined in a legal process and must be used as they are listed. Each year, the representative monitoring site should be confirmed with the zone or regional air-quality specialist or manager. Monitoring networks close and add sites periodically and the air-quality specialist/manager will be aware of any changes to the site determined to be representative of the wilderness.
- **Frequency of data collection.** Samples are collected every 3 days, and data are processed and ready for access on an annual basis.

How Complete Are These Data?

- **Percentage of Forest Service wildernesses that have these data.** All wildernesses have representative data.
- **Known spatial, temporal, and other data gaps.** Data provided on the VIEWS Web site already have been quality checked, filtered, and processed. Sites that have years without annual mean values will have to be omitted from analysis for that year. After completing the table that cross-references wildernesses with IMPROVE sites (All wildernesses_viz.xls), it is apparent that the greatest spatial gaps are the central coast of Oregon and the Wasatch Range in Utah. Available data for Alaska wildernesses also are limited. Sites will be added and removed from the IMPROVE network in the future; when that happens, this list will have to be reevaluated. The standard rules for spatial representativeness may be violated in some cases.
- **Data adequacy.** These data are derived from a national data collection program that has been rigorously tested and refined over a long period time; therefore, data quantity is complete and data quality is high.

How Will the Data Be Processed and Analyzed?

Sulfate and nitrate measurements are added for each 3-day sample, and the annual mean of this sum is the metric used in this assessment. The data file for the monitoring site representative of the wilderness of interest should be downloaded to provide this information. Data files are currently offered as comma-separated variable files for import into any spreadsheet program. The necessary sulfate and nitrate averages can be easily extracted from this file.

Group 50 values (those representing the mean of the median 20 percent of observations) can be taken directly from the VIEWS data file. Group 50 values are used because they represent median days closest to the annual mean value desired. Group 50 values are listed for each IMPROVE site for each sample year that meets data completeness requirements. A lookup table could be developed that shows which IMPROVE site has been selected for every wilderness, and includes the Group 50 values assigned to that wilderness. Table 32 provides a lookup table for the State of Washington as an example.

Table 32.—*Group 50 nitrate and sulfate example lookup values for wildernesses in the State of Washington.*

Wilderness	Representative IMPROVE site	Natural ammonium nitrate + ammonium sulfate (μg/m^3)
Alpine Lakes Wilderness	SNPA1	0.2
Boulder River Wilderness	NOCA1	0.2
Buckhorn Wilderness	OLYM1	0.2
Clearwater Wilderness	MORA1	0.2
Colonel Bob Wilderness	OLYM1	0.2
Glacier Peak Wilderness	NOCA1	0.2
Glacier View Wilderness	MORA1	0.2
Goat Rocks Wilderness	WHPA1	0.2
Henry M. Jackson Wilderness	NOCA1	0.2
Indian Heaven Wilderness	WHPA1	0.2
Lake Chelan-Sawtooth Wilderness	PASA1	0.2
Mount Adams Wilderness	WHPA1	0.2
Mount Baker Wilderness	NOCA1	0.2
Mount Skokomish Wilderness	OLYM1	0.2
Noisy-Diobsud Wilderness	NOCA1	0.2
Norse Peak Wilderness	WHPA1	0.2
Pasayten Wilderness	PASA1	0.2
Salmo-Priest Wilderness	CABI1	0.2
Tatoosh Wilderness	WHPA1	0.2
The Brothers Wilderness	OLYM1	0.2
Trapper Creek Wilderness	WHPA1	0.2
Wenaha-Tucannon Wilderness	STAR1	0.2
William O. Douglas Wilderness	WHPA1	0.2
Wonder Mountain Wilderness	OLYM1	0.2

IMPROVE = Interagency Monitoring of Protected Visual Environments.

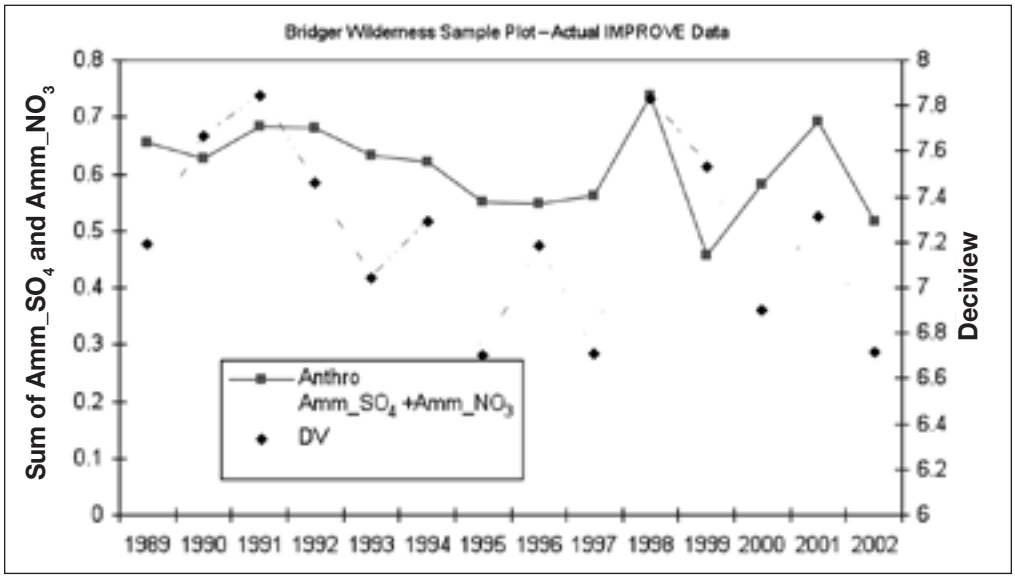
Unlike the natural estimates, the group 50 values do not precisely correspond to the annual mean value. For purposes of this analysis, the values are similar enough and the work involved in calculating true annual means is not justified. Trends will be virtually unaffected by the choice of group 50 values.

For each wilderness, add the ammonium sulfate (Amm_SO_4) value to the ammonium nitrate (Amm_NO_3) value and subtract the provided natural estimate of Amm_SO_4 + Amm_NO_3 for each year. (Note that the natural estimate of Amm_SO_4+Amm_NO_3 is constant for each wilderness.) Taken together, these values create a table of wildernesses showing deciview and anthropogenic (manmade) sulfate and nitrate by year.

Time-series plots for each site can be generated, as shown in figure 8.

As described in Chapter 3, Assessing Trend in Wilderness Character, significant change in this measure will be assessed using regression analysis at the end of the first 5-year monitoring cycle.

Figure 8.—*An example of a possible time-series plot for Interagency Monitoring of Protected Visual Environments data.*



IMPROVE = Interagency Monitoring of Protected Visual Environments.

What Are the Centralized Data Analysis Tasks?

To download the data used for computing deciview, follow these steps:

1. Download the most current data from http://vista.cira.colostate.edu/views/web/improve/summary_data.htm (in 2006, the most current data were from 2003).
2. From the data set, select group 50 (mean of means of the middle 20-percent visibility days) data.
3. From the group 50 data, compute the average sum of anthropogenic fine sulfate and nitrate ([Amm_SO_4]+[Amm_NO_3]-[Env]) for each site and join this information with the site-wilderness crosswalk.
4. Note that this task can be done for all wildernesses at once each year. Deciview data should also be collected in the same way at the same time.

What Are the Cautions About This Measure?

Although human perception of visibility conditions is not of primary interest to managers in this wilderness character assessment, visibility measurements are used in this assess-

ment because they provide a direct way to measure the clean air conditions in wilderness. Note that the actual physics of visibility are considerably more complex than can be captured by measurements of pollutant concentrations and deciview. Despite these limitations, these measures are appropriate and sufficient, especially in terms of capturing trend information.

These measures will not generally capture impacts from plume blight, which is a form of visibility impairment caused by coherent plumes of pollutants. In addition, these measures capture only one component of nighttime visibility. In many cases, nighttime visibility obscuration will be magnified by light sources, especially urban areas, outside the wilderness.

5.3.1.2. Measure 2 for Indicator 1, Question 2—Deciview

Average deciview.

Why Is This Measure Important?

Deciview is a haziness index used to express light extinction. Although the sulfate plus fine nitrate measure provides a good estimate of anthropogenic regional haze, it does not provide a cumulative measure of impact to visibility. For example, in some cases, a 50-percent reduction in sulfate and nitrate concentrations would yield a dramatic, easily perceptible improvement in visibility conditions. At other sites, with different fine particle concentrations and species composition, such a reduction would produce only a very slight improvement. The use of the deciview measurement addresses this issue.

What Are the Attributes of This Measure?

Information about changes in pollution emissions in counties surrounding each wilderness is available from EPA via the National Emissions Inventory. These data can be considered optional for local wilderness managers to use in interpreting changes in this indicator. In addition, information about emissions from wildfire and prescribed fire may aid in interpreting the visibility trends data. Table 33 describes the attributes for measuring average deciview.

Table 33.—*Attributes for measuring average deciview.*

Attribute
Average deciview*
Representative IMPROVE site
Year of data

** The asterisk denotes the attribute used to compute this measure, and the remaining attributes serve a supporting role necessary to help document or interpret the results.*
IMPROVE = Interagency Monitoring of Protected Visual Environments.

How Will the Data Be Collected?

- **Primary and secondary (if needed) data sources.** See the information under measure 1, average sum of anthropogenic fine nitrate and sulfur.
- **Frequency of data collection.** See the information under measure 1, average sum of anthropogenic fine nitrate and sulfur.

How Complete Are These Data?

- **Percentage of Forest Service wildernesses that have these data.** See the information under measure 1, average sum of anthropogenic fine nitrate and sulfur.
- **Known spatial, temporal, and other data gaps.** See the information under measure 1, average sum of anthropogenic fine nitrate and sulfur.
- **Data adequacy.** These data are derived from a national data collection program that has been rigorously tested and refined over a long period time; therefore, data quantity is complete and data quality is high.

How Will the Data Be Processed and Analyzed?

See the information under measure 1, average sum of anthropogenic fine nitrate and sulfur. At the point at which the directions indicate adding the sums of Amm_SO_4 to Amm_NO_3, etc., simply obtain the value for deciview directly from the group 50 "DV" column instead.

As described in Chapter 3, Assessing Trend in Wilderness Character, significant change in this measure will be assessed using regression analysis at the end of the first 5-year monitoring cycle.

What Are the Centralized Data Analysis Tasks?

To download the data, follow these steps:

1. Download the most current data from http://vista.cira.colostate.edu/views/web/improve/summary_data.htm (in 2006, the most current data were from 2003).
2. From this data set, select group 50 (mean of means of the middle 20-percent visibility days) data.
3. Join the deciview data with the site-wilderness crosswalk.
4. Note that this task can be done for all wildernesses at once each year. The average sum of anthropogenic fine nitrate and sulfate data should also be collected in the same way at the same time.

What Are the Cautions About This Measure?

See the information under measure 1, average sum of anthropogenic fine nitrate and sulfur.

5.3.2. Indicator 2 for Question 2—Extirpated Species

Indigenous ecosystems, plant communities, and plant and animal species that have been extirpated.

Why Is This Indicator Important?

To the American public, wilderness is a place in which indigenous plant and animal species can thrive and serve as symbols of the wildness and natural character of wilderness. Wilderness visitors expect the opportunity to observe and experience the plants and wildlife that originally inhabited an area, and protecting wildlife habitat and endangered species are two of the most important values the American public identifies with wilderness (Cordell and others 1998). Furthermore, as wildernesses become increasingly surrounded by development, they may increasingly become important areas for the survival of rare or at-risk indigenous species. If these species are extirpated from the wilderness (i.e., no longer occur there) the natural quality of wilderness character is diminished.

The loss or extirpation of indigenous species from a wilderness can profoundly affect public understanding and experience of that area. The wolf and grizzly bear, for example, have long been symbols for wilderness, and those areas that now lack these species are, in the view of most people, less wild and less of a wilderness. In the Eastern and Midwestern United States, examples of extirpated indigenous wildlife include timber wolves, ivory-billed woodpeckers, Bachman's warblers, and Appalachian Berwick's wrens. Many western wilderness now lack wolves, lynx, and grizzly bears.

The loss of individual species may profoundly affect wilderness ecosystems. Beaver, for example, function as ecological engineers by damming free-flowing streams to create sluggish ponds that provide habitat for many terrestrial, aquatic, and amphibian species. Beaver were extirpated from many areas and their loss has caused the decline of many habitats and species. The serious decline and loss of whitebark pine from some western wildernesses has removed nutritious seeds that were a major food source for grizzly bears during late summer and fall.

How Was This Indicator Chosen?

This indicator was chosen to get at the role that wilderness plays in protecting and maintaining biological communities and species populations; indigenous species that were extirpated are a sign that this protective function of wilderness is diminished. The intent of this measure is to track only those species that are formally recognized as extirpated

or are reasonably known by resource specialists to have occurred in the wilderness in the past but no longer occur there.

Many other indicators were considered to get at this species and community protection role of wilderness but were dropped for a variety of different reasons (see Appendix E, Dropped Indicators and Measures).

How Will the Measures Provide Information About This Indicator?

The single measure—number of indigenous plant and animal species that have been extirpated from the wilderness—is a direct measure of this indicator.

What Are the Cautions About This Indicator?

Concern about using this indicator exists because extirpation within a wilderness may be strongly affected by what has happened outside the wilderness. Landres and others (1998) describe in detail these external forces affecting species inside wilderness. Although the intent of this indicator is to track only those species that were extirpated due to wilderness management activities such as the introduction of nonindigenous plants or animal species, fire suppression, or physical damage to populations from human activity, in reality, isolating or even discerning these causes is, in most cases, difficult or impossible.

Although our understanding of major plant and animal extirpations is fairly good, virtually no data are available for invertebrates, fungi, and all the other little organisms that we can not see without a microscope. Furthermore, even though a species no longer occurs within a wilderness, the species' habitat may still occur within the wilderness, and individuals may continue to occur in geographic areas outside the wilderness.

5.3.2.1. Measure 1 for Indicator 2, Question 2—Extirpated Plants and Animals

Number of indigenous plant and animal species that have been extirpated.

Why Is This Measure Important?

The number of species that were indigenous to a wilderness but are now extirpated from that area is a clear signal that the species composition of the wilderness is diminished from what it was in North America before European contact.

What Are the Attributes of This Measure?

Table 34 describes the attributes for measuring extirpated plant and animal species known to be indigenous to the wilderness.

Table 34.—*Attributes for measuring the number of extirpated species.*

Attribute
Scientific name (genus and species) of the species*
Source of data—select all that apply: • NRIS • State Heritage Program • Scientific literature • Surveys or monitoring • Museum collections • Personal knowledge • Knowledge of others • Other (specify)
Confidence level that all extirpated species have been accounted for—select one: • High • Moderate • Low
Reason for extirpation (optional)—select all that apply: • Habitat loss • Direct human action (e.g., predator removal) • Invasive species • Pollutants • Other (specify)

** The asterisk denotes the attribute used to compute this measure, and the remaining attributes serve a supporting role necessary to help document or interpret the results.*
NRIS = Natural Resource Information System.

Unlike the other measures in this monitoring protocol that assess the impacts of modern people from the time the wilderness was designated, this measure assesses impacts based on the known history of an area from the time of European contact in North America to the present day. For example, if wolves are known to have occurred in an area before it was designated wilderness and they are now extirpated, this extirpation would be counted under this measure. Going back to the time of European contact is necessary for this measure for two reasons: (1) public perception of the natural quality of wilderness character is strongly associated with such species that were likely extirpated before wilderness designation, such as wolves and grizzly bears; and (2) if species that were extirpated before wilderness designation (e.g., wolves) were restored to a wilderness, most people would associate this restoration with an improvement in the natural quality of wilderness character.

How Will the Data Be Collected?

- **Primary and secondary (if needed) data sources.** The primary data source will be the NRIS. The data within NRIS on extirpated species largely come from monitoring programs established by The Nature Conservancy through a network of natural heritage programs and conservation data centers based in all 50 States that track the conservation status of species at global and State levels. Extirpated species are listed in the Natural Heritage Database as GX (globally extirpated) or SX (State extirpated).

A secondary data source for this information will be botanists and ecologists with responsibilities for individual wildernesses or other resource specialists familiar with the general area. These professionals could use a variety of different sources for these data, including the following:

- Individual State natural heritage programs or conservation data centers, located in all 50 States. The Nature Conservancy's NatureServe Web site (http://www.natureserve.org/) provides central access to all the State natural heritage programs with extensive information on species, including distribution maps, life histories, conservation status, and conservation needs.
- University herbaria.
- Forest and district files.
- Regionwide or landscape planning documents.
- Personal observation.
- Observation from other knowledgeable sources.

It is not expected that that the resource specialist would spend an exhaustive amount of time on this measure; it is more likely that this person would either know of the extirpated species that had occurred in the wilderness or would make a few phone calls to validate his or her judgment.

- **Frequency of data collection.** After data are collected initially, periodic review and updates every 5 years would be sufficient to track changes over time. The comparison between data collected at year 1 and year 5 will form the basis for documenting trends in this indicator.

How Complete Are These Data?

- **Percentage of Forest Service wildernesses that have these data.** All wildernesses should have data available for extirpated species because these data are tracked in all 50 States through State natural heritage programs and conservation data centers. Additional information on extirpated species will be largely dependent on local data sources.
- **Known spatial, temporal, and other data gaps.** New data coverage should be entered into NRIS as it becomes available because NRIS is the Forest Service repository for natural heritage program data. In addition, individual State natural heritage programs and conservation data centers will continue to serve as clearinghouses for information from various sources. Data gaps can also be addressed through scientific literature. DigiTop, an online scientific literature

database for USDA employees, is one source of current scientific literature. Using this resource, queries can be conducted for a variety of topics, including information on individual plant species, plant habitats, and habitat management.

- **Data adequacy.** Data quantity is assessed by the attribute about the confidence level that all extirpating species have been accounted for: a high level of confidence yields complete data quantity, a moderate level of confidence yields partial data quantity, and a low level of confidence yields insufficient data quantity. Data quality is assessed by the attribute about the source of the data: data from NRIS, State Heritage Program, scientific literature, surveys or monitoring, and museum collections are of high quality; data from personal knowledge is of moderate quality; and data from other people is of low quality unless these other people are known experts in the appropriate field.

How Will the Data Be Processed and Analyzed?

Washington Office staff will download data from the various State natural heritage programs and conservation data centers as Geographic Information System shapefiles and then compare these shapefiles with GIS wilderness boundaries to determine which extirpated species occurred within the wilderness boundary. A tabular display can then be developed showing which species had occurrences (polygon coverage) within the wilderness boundaries.

To identify significant trends in this measure, any change in the number of species is deemed to be significant. For example, if one species is added (e.g., because new data shows that an indigenous species is now extirpated), this addition a significant degradation in this measure. If one species is removed from this list (e.g., because new data shows that a species has expanded back into the wilderness) this removal is a significant improvement in this measure. Similarly, if an extirpated indigenous species is reintroduced to the wilderness, this reintroduction is a significant improvement in this measure.

What Are the Cautions About This Measure?

Most wildernesses lack information on the species that have been extirpated from the area or even on all the animal species that currently occur there. Natural variability in species abundance and distribution at the population level (metapopulation dynamics) must be taken into account during any periodic assessments of trend. For example, a known population of a species may disappear even though a new population appears elsewhere in the wilderness.

The professional review and advice of ecologists, botanists, and others who are knowledgeable about the species will be needed to determine the causes of changes to species

and their habitats. In some cases, a correlation between management threat and population decline may be as direct as a personal observation of physical damage to the species from human or livestock trampling. In such cases, direct management intervention will be possible. In many cases, however, it may be difficult or impossible to determine the exact cause of species or community decline.

All indigenous species that have been extirpated within a wilderness will never be fully known, and the intent of this indicator is to track only as many extirpations as are reasonably known (see the data sources explained in the measure for this indicator). Periodic surveying and monitoring are also needed to determine newly extirpated species and range expansions (or contractions) of known extirpated species that may disperse back into a wilderness.

Reintroduction of species through Federal or State agency efforts would be one source of change in the presence of extirpated indigenous species within a wilderness. Natural reintroduction of species by migration would be another source of change.

In addition, new research or inventory and monitoring activities may change our knowledge about the presence or lack of presence of certain species within a wilderness. Therefore, caution is necessary in interpreting trends in this measure to ensure that trends are due to an increase or decrease in species numbers and not due to availability of new information.

Species may be extirpated from or reinhabit a wilderness for reasons that have nothing to do with wilderness designation and management. Species populations may be influenced, for example, by global climate change or habitat changes occurring outside the wilderness.

Chapter 6. Undeveloped Quality

6.0. Summary

Table 35 provides a summary of the monitoring question, indicator, and measures for the undeveloped quality.

Three monitoring questions have been identified to evaluate the status of the undeveloped quality of wilderness character. Each question addresses a fundamentally different aspect of the quality as defined in the Wilderness Act.

The first question evaluates the physical evidence of modern use and occupation: the permanent infrastructure. This evidence includes those items constructed to support recreation use, such as trails and bridges, as well as other infrastructure, such as buildings and dams. More commonly, these items existed at the time the area was designated as wilderness; however, other items have been added since that time after having been determined as necessary for the administration of the area as wilderness.

Development-level indexes will be developed for various types of physical infrastructure to address the first monitoring question. Each development-level index involves the calculation of a weighted index, relying on attributes of the various types of infrastructure that connote differing levels of development. The index has the advantage of tracking aspects of the infrastructure that might be more sensitive to change based on stewardship decisions and actions, although the index also introduces additional bias into the process.

The second question evaluates the effect of motorized equipment and mechanical transport use on the undeveloped quality of wilderness. This use also includes authorizations for emergency use (such as the use of chain saws during fire-suppression efforts or helicopter access to extricate an injured hiker) and for administrative and other nonemergency

Table 35.—*A summary of indicators and measures monitored in the undeveloped quality.*

Quality of wilderness	Monitoring question	Indicator	Measure
Undeveloped—wilderness is essentially without permanent improvements or modern human occupation	What are the trends in physical evidence of modern human occupation or modification?	Physical evidence of development	Index of physical development
	What are the trends in the use of motorized equipment and mechanical transport?	Motorized equipment and mechanical transport use authorizations	Index of emergency motorized equipment and mechanical transport use Index of administrative and nonemergency motorized equipment and mechanical transport use
	What are the trends in inholdings?	Inholdings	Acres of inholdings

purposes (such as the use of motorized equipment to maintain dams, utility infrastructure, and fixed instrumentation and to access State and private lands). The use of these devices, although authorized by the Wilderness Act under certain conditions, provides an indication of a manager's actions that diminish the undeveloped quality.

The third question evaluates the effects inholdings have on the surrounding wilderness lands. Inholdings interior to designated wilderness are not encumbered by the same constraints as wilderness and can have roads constructed, homes built, and forests logged. In addition, the Forest Service must provide right-of-way access to these lands. Although inholdings are not wilderness, they clearly can have an effect on the adjoining lands.

A fourth aspect was considered for inclusion under this quality but eventually not included. The physical presence of people inside a wilderness—whether the people are recreationists, wilderness rangers on foot patrol, or scientists conducting research—was considered an important component of the undeveloped quality. Ultimately, human presence per se was not included because data would have been difficult to gather to support this monitoring question; furthermore, the other two questions relate to the physical presence of people and can serve as a surrogate. The intent of this protocol is to identify selected indicators of wilderness character, not to monitor all aspects concurrently.

6.1. Introduction

The opening sentence of Section 2(a) of the Wilderness Act states that "In order to assure than an increasing population, accompanied by expanding settlement and growing mechanization, does not occupy and modify all areas within the United States." The Wilderness Act goes further in Section 2(c) to define wilderness as "an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation" and "where man himself is a visitor who does not remain."

For many people, wilderness is defined by its lack of developments—most commonly, the absence of roads. As stated in the Wilderness Act of 1964, wilderness is intended to contrast "with those areas where man and his works dominate the landscape" Of course, no wildernesses have escaped the physical evidence of modern human occupation and modification. Many developments were grandfathered by the authorizing legislation, meaning they predated the establishment of the wilderness. Although not typically allowed in designated wilderness, the presence of such developments did not preclude the formal designation of the area. These developments include buildings, roads, dams, power line and water pipe corridors, and mines. The overall trend in these developments is downward. As a particular piece of infrastructure outlives its intended purpose, it is often removed if the law allows for its removal: roads are put to bed, buildings torn down,

and dams decommissioned. In other situations, however, new infrastructure is sometimes put into wilderness, most commonly in the form of fixed instrumentation sites, such as volcanic activity sensors and snow water content monitoring stations.

One of the concerns with these kinds of physical evidence is the impact on a visitor's experience of a "primitive" environment because wilderness is supposed to be a place in which the evidence of human activity is substantially unnoticeable. Some physical evidence of occupancy and use is acceptable because of special provisions in legislation or because it is considered the "minimum necessary for administration of the area for the purpose of the Act" (Section 4(c) of the Wilderness Act of 1964). For example, historical structures and cultural artifacts are recognized in the Wilderness Act as part of the value of wilderness. A minimal system of trails and campsites is considered essential to manage the effects of recreation use while enabling people to use and enjoy wilderness. Because campsites, travel routes, and structures strongly influence people's opportunity to experience wilderness, managers are to exercise restraint in fulfilling their administrative responsibilities so that a wilderness does not increasingly appear developed, occupied, and modified.

"Expanding settlement and growing mechanization" are identified within the Wilderness Act as forces that cause wild country to become occupied and modified. Legislative history underscores the close association among motorized use, mechanical transport, and people's ability to develop, occupy, and modify wilderness. By monitoring the authorizations for administrative use of motorized equipment and mechanical transport, it is possible to capture a myriad of special provisions allowed by the Wilderness Act and other wilderness legislation as well as those Section 4(c) activities deemed by the agency to be the "minimum necessary." By monitoring trends in the use of these authorizations over a relatively long period of time, managers can be aware of upward trends and respond to them with appropriate management decisions to reverse or stabilize these trends.

The use of motorized equipment and mechanical transport in wilderness features prominently in Forest Service regulation and policy directives. Part 293 of Title 36 of the Code of Federal Regulations disallows "the use of motor vehicles, motorized equipment, motorboats, or other forms of mechanical transport; no landing of aircraft; no dropping of materials; supplies or persons from aircraft" (except as provided in the Wilderness Act or subsequent legislation).

National Forest Service policy sets forth the following objectives in Forest Service Manual (FSM) 2326, Use of Motorized Equipment or Mechanical Transport in Wilderness:

> "Accomplish management activities with non-motorized equipment and non-mechanical transport of supplies and personnel."

> "Exclude the sight, sound, and other tangible evidence of motorized equipment or mechanical transport within wilderness except where they are needed and justified."

At the same time, this policy provides direction as to when and by whom use may be authorized, based on the special provisions outlined in the Wilderness Act.

6.2. Monitoring Question 1—Modern Human Occupation or Modification

What are the trends of physical evidence of modern human occupation or modification?

Why Is This Monitoring Question Important?

Wilderness should essentially be without physical evidence of modern human occupation or modification; however, in reality, this is not always the case. Some level of infrastructure, such as trails and trail bridges, are permitted to enable the "use and enjoyment of the area as wilderness." Other types of structures, such as dams, predate the designation of wilderness and their use is allowed to continue. In limited cases, other types of improvements, such as snow gauging stations, have been added in some wildernesses since designation.

In general, the fewer developments inside a wilderness, the better. Wilderness character is evaluated as improving as the number of developments decreases. In addition to the number of developments, the type of developments is also important because not all developments are the same; this technical guide attempts to assign weights accordingly. Consequently, the measure used for this indicator should be responsive to stewardship decisions that influence wilderness character; e.g., the replacement of a primitive, log stringer bridge with a manufactured steel structure.

How Will the Indicators Be Used To Answer This Question?

Only one indicator for this monitoring question exists—the physical evidence of developments—so a synthesis of different indicators to respond to the monitoring question is not required. If the evaluation of the measure suggests that the indicator is decreasing, stable, or increasing, then the corresponding answer will be provided for the monitoring question.

What Are the Cautions About This Question?

This protocol is pragmatically constrained to focus on measures for which data occur in 50 percent or more of the wildernesses. Several other components of the measure that would have been useful for informing managers about trends in the physical evidence of developments were not included as core measures because of lack of data. For example, nonsystem trails, campsites, and commercial range developments are not included due to

data unavailability, although each component would be useful for evaluating trends in this quality. Despite these absences, the attention placed on agency accountability for inventory management and deferred maintenance reporting over the past decade has resulted in relatively reliable data sets for many of the components of the measure of this indicator.

Other measure components may also be important to the wilderness character of an individual area but they do not occur consistently enough for this national protocol. One example is wilderness landing strips. Where they occur, landing strips have the potential to significantly affect one's sense of the undeveloped quality of a particular area, and they should be included in the identification of local core indicators. Nevertheless, because landing strips occur in only a handful of wildernesses, their use as a national core measure is limited and they are not included in this protocol.

6.2.1. Indicator 1 for Question 1—Physical Evidence

Physical evidence of development.

Why Is This Indicator Important?

The presence or absence of the physical evidence of development is a good indicator because of the direct link between the indicator and the monitoring question.

How Was This Indicator Chosen?

Developments are a logical and obvious indicator for this monitoring question. When most people think about the undeveloped quality of wilderness, they envision an area without lasting signs of human use and occupation, free of inhabited structures, without dams impeding natural streamflow, without power lines crossing the landscape, and, most typically, without roads providing easy access for cars and other motorized vehicles.

How Will the Measures Provide Information About This Indicator?

The measure involves the calculation of a development level index, which assesses the cumulative development level of each occurrence of a specific indicator (for a building, dam, trail, etc.). These indexes are calculated by evaluating selected attributes for each type of physical infrastructure and assigning differential weights based on perceived differences in the level of development.

Although not without weaknesses, this concept of calculating a development level index was widely supported during pilot testing.

The development level index for each of the individual measure components will be combined to determine an overall development index that can be used to inform managers

about trends in the indicator and to directly address the monitoring question. Not all measure components have the same development level associated with them; e.g., a small wooden trail bridge has a significantly different development level than a large concrete dam.

To account for these differences, an inherent weighting has been assigned to each measure component. Components with a relatively low level of development are assigned a value of 1, components with a moderate level of development are assigned a value of 2, and components with a high level of development are assigned a value of 3. Measure components were assigned a low inherent weight if they are typically small in geographic scale and/or often of a primitive nature. For example, fixed instrumentation sites are routinely quite small in size and were assigned an inherent weight of "1." Other measures were assigned higher weights if they tended to be less primitive and/or have a typically greater level of impact on wilderness resources.

The measure components used under this monitoring question have been subjectively determined by a sampling of wilderness managers to have the inherent weights shown in table 36.

Table 36.—*Inherent weighting of different types of physical evidence.*

Measure component	Inherent weight
System trails and features	1
Campsites	1
Buildings	2
Dams	3
Roads	3
Infrastructure	3
Mines	3

The overall development level will be calculated by adding each of the development indexes multiplied by the inherent weight of the development type:

Development level index equals—
(Building development index x 2) +
(System trail development index x 1) +
(Campsite development index x 1) +
(Dam development index x 3) +
(Road development index x 3) +
(Infrastructure development index x 3) +
(Mine development index x 3)

The number produced from this calculation will be the development level index for the wilderness. The number will not be meaningful in an absolute sense; e.g., a value of 2X should not be interpreted as having twice the development level of a wilderness with a

development level of 1X. The use of a development level is useful in a relative sense, showing increasing or decreasing trends over time.

What amount of change is required in the overall development level index to result in a determination that the status and trends of physical evidence of modern human occupation or modification are either improving or degrading? To determine the direction of change, the overall development level must increase by 5 percent or more between time point 1 and time point 2 to result in a determination of degrading; conversely, a decrease of 5 percent or more will result in an improving score. All other results will be categorized as stable. This relatively broad band of 10-percent allowed change acknowledges the low level of precision and accuracy associated with the data used in this protocol. Any change above this 10-percent band will be determined to be beyond noise in the data and to be reflective of actual change in wilderness conditions.

What Are the Attributes of This Indicator?

The attributes vary based on the type of infrastructure being evaluated as a measure component. For details, refer to the attribute text written for each of the measure components.

What Are the Cautions About This Indicator?

The use of the development level index has a couple of obvious limitations. First, it is uncertain whether the attribute data needed to assign the relative weights will be available in all wildernesses. Second, bias is introduced into the process by the selection of the attributes upon which the relative weights are assigned and the specific relative and inherent weights.

The issue of how features of historical significance are addressed in this protocol needs to be explicitly addressed. Features of historical significance will not be evaluated any differently in this protocol than other features. Although the Wilderness Act does acknowledge in Section 2(c) that wildernesses "may also contain ecological, geological, or other features of scientific, educational, scenic or *historical* value" (emphasis added), it does not clearly state, or even imply, that these historical values should be interpreted as part of the wilderness character of the area. In fact, as previously stated, the Wilderness Act suggests that the absence of permanent improvements constitutes an important aspect of wilderness character.

Further discussion of this issue is probably useful. The issue of historical significance most commonly relates to structures in wilderness. For example, the Moose Creek Ranger Station, which is in the Selway-Bitterroot Wilderness and is on the National Register of Historic Places, would be evaluated as detrimental to wilderness character. The station provides a base for crews to work from and enables agency employees to occupy and use wilderness, which is what this indicator is attempting to measure. That is not to say that the Moose Creek Ranger Station does not contribute to the value of the area, because the

opposite is true. The station tells a compelling story about the earliest use and settlement of the area before its designation as wilderness, but the value it contributes to is not the wilderness character of the area, at least as defined in this protocol.

Other structures that have been determined to be of historical value may not be actively maintained. If they can no longer serve the purpose for which they were built, they will not be categorized as buildings and will not be considered as part of this protocol. For example, if all that remains of a settler's cabin is a foundation and chimney, the site would be classified as a historic site and not a building. Other types of historic sites, such as orchards, plane wreckage, and cemeteries, are not included in this protocol. Although these sites are visible evidence of prior occupation and modification, they are listed a dropped indicator for a couple of reasons. First, data relative to historic sites can be difficult to acquire because it is given a high level of security due to concerns about these sites being disturbed by unauthorized people. This issue is not insurmountable but it does contribute to the challenge and workload associated with acquiring data. Second,, and more importantly, these data are not subject to change as a result of stewardship actions. Although the physical evidence associated with historic sites may diminish over time, this process can take place over many years. We do not want to even create the appearance of a conflict between wilderness character and historic sites by including these sites as a component of the physical evidence of development.

6.2.1.1. Measure 1 for Indicator 1, Question 1—Physical Development Index

Index of physical development.

Why Is This Measure Important?

This measure evaluates the relative contribution of individual occurrences of different types of physical developments inside wilderness, such as buildings, trails, and dams, and produces a cumulative index based on both the relative and inherent impacts each of these occurrences has on the level of development in a specific wilderness.

What Are the Components of This Measure?

This measure has seven equally important components.

1. Index of building development.
2. Index of system trail development.
3. Index of campsite development.
4. Index of dam development.

5. Index of road development.

6. Index of infrastructure development.

7. Index of mine development.

Unlike other chapters in this technical guide, each of the different components under this measure requires its own description of data collection and processing, data completeness, and cautions about interpretation.

Index of building development

The index of building development is calculated for each building inside a particular wilderness based on key attributes, such as building type and length of resident occupancy, and then summed for the entire wilderness.

A building is defined as "a structure to support, shelter, or enclose persons, animals, or property of any kind" (Forest Service Handbook 6509.11k, sections 56.05 and 7309.11, section 05). A structure that can no longer serve the purpose for which it was constructed, such as an abandoned settler's cabin, will not be considered a building under this protocol.

Why is this component important?

Buildings that occur in wilderness may be of a broad range of types, including crew quarters, outfitter and guide lodges, toilet structures, lookouts, and recreational shelters and cabins. Buildings are important because they enable people to occupy and inhabit wilderness, and through this occupation people are further enabled to modify the environment around them. In short, buildings are the physical manifestation of human habitation referenced in Section 2(c) of the Wilderness Act.

This measure not only tracks the number of buildings, it also weights the relative influence of an individual structure on the undeveloped quality by evaluating the amount of time that a building serves to house people. This inference is based on the logic that the more time people are housed at an individual structure, the greater the likelihood they will modify the surrounding environment, thereby increasing the associated development level.

What are the attributes of this component?

Table 37 describes attributes used in calculating the index of building development.

Table 37.—*Attributes for calculating the index of building development.*

Attribute
Category*
Subcategory*
Residence type*—select one: • Nonresidential • Part-time residential • Full-time residential
Building identification
Building name
Status
Data quantity—select one: • Complete • Partial • Insufficient
Data quality—select one: • High • Moderate • Low

** The asterisk denotes the attribute used to compute this measure, and the remaining attributes serve a supporting role necessary to help document or interpret the results.*

All attributes are currently required for buildings entered into the Infra-Buildings module, with the exception of residence type, which will need to be entered as part of this protocol implementation.

How will the data be collected?

- **Primary and secondary (if needed) data sources.** Buildings that occur in wilderness are divided into two distinct categories: (1) those owned by the Forest Service, and (2) those owned by other entities but authorized through a special-use permit. This distinction is important because of the sources and types of data available for each of these categories.

  Information about buildings that are owned by the Forest Service is stored in the Infra-Buildings module. Although for several years it has been required that all buildings owned by the Forest Service be entered into the corporate database, it has never been required that those buildings that are inside wilderness be identified as such. A link will need to be established between the constructed feature (the building) and the land unit (the wilderness), using either a spatial overlay or a manual linking process. All needed attributes, identified previously, currently are either mandatory or required, with the exception of residence types.

  Information about buildings owned by other entities but authorized through a special-use permit is stored in the Infra-Special Uses Database System (SUDS).

Although current policy directs forests to have a record in SUDS for all special-use permits, they are not required to also create a corresponding record in the Infra-Buildings module if the special-use permit authorizes use of a non-Forest Service building. The system will be able to initially identify those special uses that authorize buildings by focusing on the use code, which contains values such as "cabin" and "residence, privately owned building." Corresponding records will also need to be entered in the Infra-Buildings module, although just for the mandatory data fields and entry of the residence type, because the building attributes are used to calculate the building development level index. This building record will also need to be linked to the wilderness of interest.

- **Frequency of data collection.** The Infra-Building data will be retrieved for this protocol every 5 years. Real property maintenance requirements direct field units to update their inventory of buildings every 5 years and the records in SUDS are updated annually.

How complete are these data?

- **Percentage of Forest Service wildernesses that have these data.** All national forests should have all Forest Service-owned buildings and buildings authorized through special-use permits entered into the Building and Infra-SUDS modules, respectively. Those buildings that are authorized through special-use permits will need to have a corresponding record established in the Buildings module if it has not been done already. The links identifying which buildings are in which wilderness will need to be established in most cases. The "residence type" field for all buildings will be entered.
- **Known spatial, temporal, and other data gaps.** Local forest staff will be required to view the data that currently reside in the Infrastructure (Infra) database and to make any necessary edits, including the following:
  - Make corrections to existing data where needed.
  - Complete missing mandatory attributes where missing, including residence type.
  - Develop link records to the appropriate wilderness record, where needed.
  - Enter missing buildings that had not been entered previously.
- **Data adequacy.** Data quantity will be evaluated from the standpoint of whether all structures that meet the definition of a building are included in the current inventory. Greatest attention will be placed on those buildings that are not Forest Service owned. Data quality will be assessed from the standpoint on whether the attributes are accurate and complete.

How will the data be processed and analyzed?

Local forest staff will be required to validate the existing data in Infra and to make any needed edits. A building development index will then be calculated for each building in the wilderness, based on the amount of time a building was occupied, if at all.

Buildings have been determined to have three development level values.

1. **Nonresidential.** For buildings, such as toilets and storage sheds, that do not house people. Note: toilets are included in this assessment only if they include some form of structure and can be classified as a building.
2. **Part-time (seasonal) residential.** For buildings occupied by people for a cumulative total of 6 months or less each year. These buildings may include some lookouts as well as certain recreation shelters. Note: For this counting, buildings that only receive day use are included.
3. **Full-time (year-round) residential.** For buildings occupied by people for a cumulative total of more than 6 months each year. These buildings may include crew quarters, outfitter and guide lodges, and certain recreational cabins. Note: For this counting, buildings that receive only day use are included.

The development level value will be established for every building in the wilderness and these values will be added to produce a building development index for the entire wilderness. For example:

> Building development index = (building number1 * relative weight) + (building number2 * relative weight) + and so on.

What are the cautions about this component?

A caution about the values selected to evaluate the relative impact of an individual building on the development level of the wilderness exists. The concerns are of two types: (1) the arbitrariness of the values chosen, and (2) the implied relationship between different numeric values (e.g., that a building with inhabitants for more than 6 months per year has three times more impact than a storage shed). The only way these concerns can be addressed is to stress that the number produced is meaningless in and of itself in an absolute sense; what matters is change over time in an individual wilderness.

Index of system trail development

The index of system trail development is an index that is calculated by combining the indexes assessed to both system trail miles and major trail features. These individual

indexes are determined using key attributes, such as the trail class of system trails and the materials used to construct major trail features.

Trails are defined as "A linear feature constructed for the purpose of allowing the free movement of people, stock, or OHV's" (USDA Forest Service 2003a).

Trails can be subdivided into system trails and nonsystem trails; the latter are also referred to as user-developed trails or social trails. Other nonsystem trails may be authorized through special-use permits to access private or State inholdings. This protocol only evaluates changes in system trails that are actively maintained by the Forest Service. Although nonsystem trails are of great interest to wilderness managers, data are not routinely collected about them, which makes their use in this protocol impractical at a national level.

Major trail features may be defined as major constructed features associated with a system trail. Because this assessment is focused on the more significant, countable trail features, only trail bridges, stairways, boardwalks, docks, and puncheons are included. Other minor trail features, such as signs and drainage structures, are not.

Why is this component important?

System trails and associated major trail features are relevant to this quality because, although sanctioned as a legitimate use by the Wilderness Act of 1964, they are physical evidence of human use and occupation. These features are among the most prevalent types of developments to be encountered in wilderness. The current inventory indicates more than 23,000 system trail mi exist in wilderness. These trails are important because they serve as the primary routes through which a wilderness is accessed, thereby providing the gateway for further use and occupation above and beyond the development associated with the system trails themselves.

Some wildernesses are currently without any system trail miles; however, this measure still is meaningful because any change in this status over time would have a potentially significant effect on the undeveloped quality of a wilderness.

What are the attributes of this component?

Attributes for measuring system trails and major trail features are described in the following tables and text.

System trails. Table 38 describes attributes for measuring system trails.

Major trail features. Table 39 describes attributes for measuring major trail features.

Table 38.—*Attributes related to system trails for calculating the index of system trail development.*

Attribute
Trail class (linear event)*—beginning mile post (BMP) and ending mile post (EMP)
Trail number
Trail name
Wilderness name (linear event)—BMP and EMP
Trail status
Trail type
Data quantity—select one: • Complete • Partial • Insufficient
Data quality—select one: • High • Moderate • Low

** The asterisk denotes the attribute used to compute this measure, and the remaining attributes serve a supporting role necessary to help document or interpret the results.*

Table 39.—*Attributes related to major trail features for calculating the index of system trail development.*

Attribute
Type*
Category*
Material*
Feature identification
Feature beginning mile post
Quantity
Data quantity—select one: • Complete • Partial • Insufficient
Data quality—select one: • High • Moderate • Low

** The asterisk denotes the attribute used to compute this measure, and the remaining attributes serve a supporting role necessary to help document or interpret the results.*

How will the data be collected?

- **Primary and secondary (if needed) data sources.** The data will be pulled from the Infra-Trails module. All trails were to have been entered into the Infra-Trails module by September 30, 2004. This direction also included that each trail segment that resided in a wilderness be identified as such. The documentation of trail class for each trail segment is a requirement for annual deferred maintenance reporting purposes.

A secondary data source should not be needed. Local knowledge will supplement the information currently in the Infra-Trails module if the records in the corporate database are incomplete or inaccurate.

- **How frequently will these data be collected?** Data will be collected every 5 years for all system trails and major trail features. Current trail program business requirements mandate all system trail miles and major trail features be inventoried every 5 years.

How complete are these data?

- **Percentage of Forest Service wildernesses that have these data.** The completeness of this data, as validated during pilot testing, is quite variable across the country despite the requirement that all wilderness trail segments be identified through linear events and all major trail features be mileposted. In most cases, the linear events were appropriately entered for those system trails in wilderness. The completeness of mileposting of major trail features was more problematic.
- **Known spatial, temporal, and other data gaps.** Local forest staff will be presented with the pertinent information currently contained within the Infra-Trails module and will have the opportunity to make any edits or additions needed to complete or update the data set. Linear events for any wilderness trails or changes in trail class that are missing can be entered at the time the protocol is applied. If mileposting of major trail features has not yet been accomplished, and it is not reasonable to expect it to be completed as a part of the application of this protocol, forests will be given the opportunity to develop a consolidated listing of all features by type (bridge, boardwalk, etc.) within the wilderness of interest, with the number of each type of feature in each of the three weighted categories.
- **Data adequacy.** The issue of data adequacy will be addressed in terms of both data quantity and quality. Data quantity will be evaluated from the standpoint of whether all system trails and trail features have been included in the current inventory. This aspect of data adequacy will need to be closely scrutinized in those cases in which major trail features are consolidated in the absence of accurate mileposting. Data quality will be assessed from the standpoint on whether the attributes are accurate and complete.

How will the data be processed and analyzed?

Data currently in the Infra-Trails database will be extracted for the particular wilderness, along with the attributes of interest. Forest staff will be required to validate the existing data and make any necessary edits, including the following:

- Make corrections to existing data where needed.
- Complete missing mandatory attributes where missing.
- Create linear events or develop link records to the appropriate wilderness record, where needed.
- Enter missing major trail features that had not been entered previously.

A system trail development index will then be calculated for each wilderness based on the amount and type of system trails and major trail features that occur in that wilderness.

System trails. To assess a weighted value for different system trail segments, the trail class was selected to represent different development levels. "Trail class" is defined as "the prescribed scale of development, representing the intended design and management standards of the trail" (USDA Forest Service 2004b).

System trails have been determined to have three development level values.

1. **Primitive.** For system trails with an assigned trail class of 1.
2. **Simple.** For system trails with an assigned trail class of 2.
3. **Moderate to highly developed.** For system trails with assigned trail classes of 3 or 4. It is assumed that no trails with a trail class of 5 (fully developed) exist in wilderness, but, if they occur, they would be assigned this value.

It should be noted that the trail class for a particular trail can be quite different from the conditions found on the ground. Trail class is the level of development that is planned for a trail, whereas the actual (operational) maintenance level of the trail will determine such factors as the amount of brushing that takes place each season plus the dimensions of the actual trail tread—which changes from year to year, based on funding and local workload priorities. The operational maintenance level of systems trails, while perhaps a preferable attribute, is not routinely collected, and, therefore, not of use to this protocol.

Major trail features. Relative weights are assigned to each major trail feature based on selected attributes, such as construction style and building material. These attributes are used to assign three development level values.

1. **Primitive.** For major trail features built with raw, native materials, such as a log bridge.
2. **Constructed with native materials.** For major trail features built with native materials that have been processed to form dimensional materials, such as a log stringer bridge with decking.

3. **Constructed with nonnative materials.** For major trail features built using nonnative materials as a primary building component, such as a bridge with steel supports.

The system trail development index will be calculated by tallying the individual values for all trail segments and major constructed features. For example:

> System trail development index = (x.x mi trail segment number 1 * relative weight) + (major trail feature number 1 * relative weight) + and so on.

What are the cautions about this component?

This measure introduces bias by assigning subjective relative and inherent weights to system trails and major trail features. It also introduces other complexity by combining two related but dissimilar components (trails and features). As previously mentioned, concern also exists about relying on trail class, which may not be an accurate reflection of how the trail is currently managed. This last concern might be tracked by adding a checkbox to ask "Does the trail class accurately reflect how the trail is currently being managed?" Tracking this concern would be useful in the change management process.

Index of campsite development

The index of campsite development is calculated for an entire wilderness by totaling the individual campsite impact scores for each campsite in the wilderness. This index increases as either the number of campsites or the magnitude of impact on campsites increases.

A wilderness campsite may be defined as an area demonstrating observable impacts from repeated overnight wilderness visitation.

Why is this component important?

Campsites are the most common development that occurs in wilderness. Although campsites are generally necessary, too many campsites and too much campsite impact detracts from the undeveloped character of wilderness. As a result of their inclusion in the 10-Year Wilderness Stewardship Challenge, both the number of wildernesses with campsite data and the quality of that data are improving.

What are the attributes of this component?

Table 40 describes attributes for computing the index of campsite development.

The specific attributes collected as part of routine campsite monitoring vary across the country. In support of the 10-Year Wilderness Stewardship Challenge, a national

Table 40.—*Attributes for calculating the index of campsite development.*

Attribute
Status*
Overall impact rating*
Recreation site identification
Recreation site name
Data quantity—select one: • Complete • Partial • Insufficient
Data quality—select one: • High • Moderate • Low

** The asterisk denotes the attribute used to compute this measure, and the remaining attributes serve a supporting role necessary to help document or interpret the results.*

minimum site monitoring protocol was developed to ensure a minimum standard for this element across the Nation. Local monitoring protocols must meet or exceed this national standard in order in order to claim credit for accomplishment under the challenge. In this protocol, campsites are assigned an overall impact rating with a score from 0 to 8. This rating is a composite of separate scores for ground cover disturbance of the central portion of the site, tree damage, and the size of the overall disturbed area.

Those wilderness staff using protocols with different attributes, especially those relying on detailed site measurements, will need to either develop a crosswalk to the national minimum site monitoring protocol or will need to develop their own scoring system that results in three levels of impact scores to which impact level ratings can be assigned. Consistency between the approaches used by different forests is not essential because this protocol does not compare one wilderness with another. What is important is that, whatever approach is used for an individual wilderness, the same approach be used in subsequent years so that trends can be evaluated.

How will the data be collected?

- **Primary and secondary (if needed) data sources.** The primary data source for campsite monitoring is the Recreation Site Impact Monitoring Module in Infra-WILD. Those wilderness staff relying on other databases or spreadsheets for managing their recreation site inventory data can enter their campsite impact scores directly into the Infra-WILD Wilderness Character module screens.
- **Frequency of data collection.** These data will be collected every 5 years, while recognizing some sites may not have been visited since the last monitoring cycle. Typically, recreation site inventories are expected to be repeated on a maximum cycle of 10 years.

How complete are these data?

- **Percentage of Forest Service wildernesses that have these data.** At the present time, it is estimated that 20 to 30 percent of wildernesses have a campsite inventory that meets the standard established in the national campsite monitoring protocol. Despite this estimate, because campsite monitoring is included in the 10-Year Wilderness Stewardship Challenge and the agency's commitment to have all wildernesses meet a baseline level of wilderness stewardship within the decade, it is reasonable to assume that more than 50 percent of wildernesses will have reliable campsite inventories, including assessment of campsite condition, within the next several years.
- **Known spatial, temporal, and other data gaps.** Local forest staff will be required to view the data that currently reside in Infra and to make any necessary edits, including the following:

  1. Make corrections to existing data where needed.

  2. Enter missing campsites that had not been entered previously.

- **Data adequacy.** The issue of data adequacy will be addressed both in terms of data quantity and quality. Data quantity will be evaluated from the standpoint of whether all campsites have been included in the current inventory. The national recreation site monitoring protocol requires the entire wilderness be censused in all likely locations. Data quality will be assessed from the standpoint of whether the attributes are accurate and complete, with particular attention on the overall impact rating. The protocol was developed with the intent of selecting site parameters and values with a reasonable level of accuracy and that were repeatable by different crews over time.

How will the data be processed and analyzed?

Local forest staff will be required to validate the existing data in Infra and to make any needed edits. A campsite impact index will then be calculated for each campsite, based on the overall impact rating.

Campsites have been determined to have three impact level values.

1. **Light impact.** Assign a value of 1 to campsites that had an overall impact rating of 1 to 3.
2. **Moderate impact.** Assign a value of 2 to campsites with an overall impact rating of 4 to 6.
3. **Severe impact.** Assign a value of 3 to campsites with an overall impact rating of 7 to 8.

The impact level value will be established for every campsite in the wilderness and these values will be added to produce a campsite impact index for the entire wilderness. For example:

> Campsite development index = campsite number 1 impact level value + campsite number 2 impact level value + and so on.

What are the cautions about this component?

Campsite monitoring is perhaps the most common type of monitoring that takes place in wilderness, and it has been in place for a couple of decades in some wildernesses. No specific cautions about this component exist.

Index of dam development

The index of dam development is an index that is calculated for each individual occurrence of a dam or other instream structure that occurs inside a particular wilderness. The index is then summed for the entire wilderness. Different occurrences of dams are differentially weighted based on key attributes, such as dam size and building material.

Dams are defined as "any artificial barrier… which impounds or diverts water" (FSM 7505). Other instream structures include constructed features found within a river channel, such as diversions, fish ladders, and weirs.

Why is this component important?

Dams and other instream structures, where they occur, are strong visible evidence of modern human modification of resources inside wilderness. Some dams preexist the designation of the area as wilderness and are typically grandfathered in under the authorizing legislation. The grandfather clause may include provisions for specific maintenance requirements, such as the use of motorized equipment.

Although the construction of a new dam inside a wilderness requires presidential action and is highly unlikely, the decommissioning and removal of dams is under consideration in some areas. Changes in this measure are not likely to be common but, where they do occur they can be quite significant, justifying being included in this protocol. The addition of other instream structures, such as weirs to gauge streamflows and fish ladders to mitigate the passage of anadromous fish, is more likely to occur.

What are the attributes of this component?

The attributes used for measuring dams and other instream structures are described in the following tables and text.

Dams. Table 41 describes the attributes used to calculate the index of dam development.

Table 41.—*Attributes related to dams for calculating the index of dam development.*

Attribute
NID identification*
Design style—select primary:* • RE—earth • ER—rockfill • PG—gravity • CB—buttress • VA—arch • MV—multiarch • CN—concrete • MS—masonry • ST—stone • TC—timber crib • OT—other
Dam identification
Dam name
Administrative organization
Year constructed
Owner type—select one: • F—Federal • S—State • L—local government • U—public utility • P—private
Administrative class—select one: • A—dams > 100 ft or impound 50,000 acre-ft or more • B—dams 40 to 100 ft or impound 1,000 to 50,000 acre-ft • C—dams 25 to 40 ft or impound 50 to 1,000 acre-ft • D—dams < 25 ft or impound < 50 acre-ft)
Data quantity—select one: • Complete • Partial • Insufficient
Data quality—select one: • High • Moderate • Low

** The asterisk denotes the attribute used to compute this measure, and the remaining attributes serve a supporting role necessary to help document or interpret the results.*

NID = National Inventory of Dams.

Other instream structures. Table 42 describes attributes used to calculate the index of instream structures.

Table 42.—*Attributes related to other instream structures for calculating the index of instream structures.*

Attribute
Feature type—select:* • Other (nondam) instream structure
Feature identification
Feature name
Feature category—select one: • Dike • Ditch • Diversion • Fish ladder • Weir
Principal material
Ownership
Administrative organization
Year constructed
Data quantity—select one: • Complete • Partial • Insufficient
Data quality—select one: • High • Moderate • Low

** The asterisk denotes the attribute used to compute this measure, and the remaining attributes serve a supporting role necessary to help document or interpret the results.*

How will the data be collected?

- **Primary and secondary (if needed) data sources.** The data will be extracted from two data sources. The National Inventory of Dams (NID), which is maintained by the U.S. Army Corps of Engineers, is the national repository for all dams that meet certain size criteria based on potential risk to the general public. The NID includes all dams having a height greater than 6 ft and a maximum storage greater than 15 acre-ft, regardless of ownership.

  The second data source, the Infra-Dams module, contains records for all dams owned by the Forest Service. This module is used to populate the NID with dams owned by the Forest Service and meeting the previously mentioned size criteria. Although all dams meeting these criteria must be entered for national reporting purposes, other dams of lesser size may also be entered.

  Both data sets will be accessed for a full accounting of all dams in wilderness. The NID provides a complete listing of all larger dams regardless of ownership and the Infra-Dams module provides a listing of Forest Service-owned dams, potentially

including dams that do not meet the NID criteria but that are still of interest to this protocol.

The listing of dams from both of these sources will be used as the starting point for local staff to validate. Missing dams can be entered into the Infra-Dams module to provide a more complete listing.

Other instream structures, such as fish ladders and diversions, are generally not entered into Infra, although a record in the Infra-Special Uses Database System (SUDS) may exist when these features are not owned by the Forest Service. A record for each instream structure will need to be entered into the Infra-Features module, along with a limited set of required attributes.

- **Frequency of data collection.** Data will be collected for all dams and other instream structures every 5 years. Current business requirements mandate the updating of the data in the NID on a biennial basis as required by the Dam Safety and Security Act of 2002. Data about dams that do not meet the NID criteria are maintained on a less frequent basis.

How complete are these data?

- **Percentage of Forest Service wildernesses that have these data.** It is expected that 100 percent of the dams meeting the NID criteria are entered into the NID and it is anticipated that most of the required data fields will be complete. Dams that do not meet the criteria are entered into Infra on a less frequent basis and many of the required data fields will likely be missing.

  In most cases, records for the dams will exist in Infra, although they may not be referenced as being inside a wilderness. The current Dam Inventory form in the Infra-Dams module contains a field to identify those dams that are inside a wilderness but direction has never been issued from the Washington Office for the population of this data field. Effort will be required to accurately identify all dams inside a wilderness. Geographic Information System technology may be useful in this task because the coordinates of all dams are required for those structures meeting the NID criteria.

- **Known spatial, temporal, and other data gaps.** Local forest staff will be presented with the pertinent information currently contained within the Infra-Dams and SUDS modules and will have the opportunity to make any edits or additions needed to complete or update the data set.

  It is generally assumed that other instream features will not exist in Infra, but the wilderness manager, along with other resource specialists such as range conservationists, fishery biologists, hydrologists, and special-use coordinators, will

be able to establish new records in Infra-Features based on local knowledge and existing records in SUDS.

- **Data adequacy.** Data quantity will be evaluated from the standpoint of whether all dams and other instream structures have been included in the current inventory. Due to the reliability of NID, greatest attention will be placed on those dams that do not meet the NID criteria as well as the other instream structures. Data quality will be assessed from the standpoint on whether the attributes are accurate and complete.

How will the data be processed and analyzed?

Data currently in the Infra-DAMS database will be extracted for the particular wilderness, along with the attributes of interest. Forest staff will be expected to review the current data and make the following edits:

- Make corrections to existing data where needed.
- Complete missing mandatory attributes where missing.
- Create link records to the appropriate wilderness record, where needed.
- Enter missing dams or instream structures that had not been entered previously.

A dam development index will then be calculated for each dam in a wilderness, based on the size of the dam and related impoundment and the construction material used.

Dams and other instream structures have been determined to have three development level values.

1. **Dams not meeting NID criteria or other instream structures.** Those dams of a height less than 6 ft or a maximum storage less than 15 acre-ft, or other instream structures.
2. **Dams meeting NID criteria constructed of native materials.** Dams with a height greater than 6 ft and a maximum storage greater than 15 acre-ft that are constructed with native materials (such as earthen dams).
3. **Dams meeting NID criteria constructed of nonnative materials.** Dams with a height greater than 6 ft and a maximum storage greater than 15 acre-ft that are constructed with nonnative materials (such as concrete dams).

It should be noted that the operational maintenance associated with dams was also considered but not included because of concerns about data availability.

The dam development level index will then be calculated for the entire wilderness by summing the scores of each individual occurrence of a dam. For example:

Dam development index = (dam number 1 * relative weight) +
(dam number 2 * relative weight) + and so on.

What are the cautions about this component?

A general concern exists about the bias introduced in the protocol by assigning a subjective weighting for each dam. Although few would argue that a simple earthen dam has a lower development level than a large concrete structure, the introduction of numeric weights to assess these differences raises questions about the values used and the relative weights assigned.

Index of road development

The index of road development is an index that is calculated for each road segment inside a particular wilderness based on key attributes, such as operational maintenance level, and then summed for the entire wilderness.

A road is defined as "a motor vehicle travelway over 50 inches wide, unless designated and managed as a trail" (36 C.F.R. 212.1).

Why is this component important?

Although roads are not common inside wilderness, they are still important for assessing wilderness character because, for many people, wilderness is simply defined as an area without roads. Roads inside wilderness will be split into two categories: system roads and nonsystem roads; the latter category includes "ghost roads" and other user-developed roads.

System roads do exist in wilderness although they are few in number. These roads typically access private inholdings or active mining claims. Data on these roads are maintained in the Infra-Roads module.

Nonsystem roads also occur in wilderness. These roads are not actively managed as system roads but they are still visible to the visitor and are clearly distinguishable as having been constructed as a road. Some roads preexist wilderness designation, most commonly in the eastern regions, and have been allowed to fall into disrepair or may have been actively decommissioned. Other roads have been constructed by users to access private lands or areas of special interest, such as favorite hunting or fishing areas. These roads are typically quite crude and only support four-wheel drive use.

What are the attributes of this component?

Table 43 describes the attributes used to calculate the index of road development.

Table 43.—*Attributes for calculating the index of road development.*

Attribute
Operational maintenance level*
Road identification
Road name
Wilderness name (linear event)—beginning mile post and ending mile post
Route status
Data quantity—select one: • Complete • Partial • Insufficient
Data quality—select one: • High • Moderate • Low

** The asterisk denotes the attribute used to compute this measure, and the remaining attributes serve a supporting role necessary to help document or interpret the results.*

How will the data be collected?

- **Primary and secondary (if needed) data sources.** Data will be extracted from the Infra-Roads module. This module is the primary repository for data relating to Forest Service roads and related infrastructure. Local staff will be required to review the data currently residing in Infra and make any edits, including the entry of missing records, if necessary.

  Data on nonsystem roads are not currently managed in Infra. For this protocol, the wilderness manager, in consultation with the transportation engineers, will be required to estimate the number of miles of nonsystem roads. It will be suggested that these nonsystem roads be noted on a map to ensure repeatability the next time the protocol is applied.

- **Frequency of data collection.** Data will be collected every 5 years for all roads in wilderness. Current business practices mandate that all roads in the national inventory be updated every 5 years.

How complete are these data?

- **Percentage of Forest Service wildernesses that have these data.** The completeness of this data is variable. Most system roads will be included in the Infra-Roads module, although this inclusion needs to be validated by forest staff. In almost all cases, the link record between the travel route (road) and the land unit (wilderness) will need to be established. Data on nonsystem roads are not presently stored in a corporate data system and an estimate of nonsystem road miles will need to be generated.

- **Known spatial, temporal, and other data gaps.** Local forest staff will be presented with the pertinent information currently contained within the Infra-

Roads module and will be required to make any edits or additions necessary to complete or update the data set.

- **Data adequacy.** Data quantity will be evaluated from the standpoint of whether all roads, both system and nonsystem, have been included in the current inventory. Greatest attention will be placed on the nonsystem roads because data are not routinely collected on them. Data quality will be assessed from the standpoint on whether the attributes are accurate and complete.

How will the data be processed and analyzed?

Data currently in the Infra-ROADS database will be extracted for the particular wilderness, along with the attributes of interest. Forest staff will be expected to review the current data and make the following edits:

- Make corrections to existing data where needed.
- Complete missing mandatory attributes where missing.
- Create link records to the appropriate wilderness record, where needed.
- Enter missing roads or road segments that had not been entered previously.

A road development index will then be calculated for each wilderness, based on the status, number of miles, and operational maintenance level of each road segment.

Roads are assigned to one of three development level values.

1. **Nonsystem roads, decommissioned system roads, and existing system roads with operational maintenance level of 1.** All nonsystem roads, roads that have been actively put to rest, and those that have been closed to vehicle traffic and are receiving only custodial care.
2. **Existing system roads with operational maintenance level of 2.** System roads that are actively being maintained to support high-clearance vehicles.
3. **Existing system roads with operational maintenance levels 3 and higher.** System roads that are actively being maintained to support passenger vehicles of varying user comfort levels.

The road development index will then be calculated for the entire wilderness by summing the scores of each individual road development level value. For example:

> Road development index = (x.x mi road segment number 1 * relative weight) + (x.x miles of road segment number 2 * relative weight) + and so on.

What are the cautions about this component?

This measure attempts not only to count the number of road miles but also to assess the relative development level of each segment; however, by doing so, the measure introduces bias by assigning subjective values to the different road development level values. A succinct definition will need to be provided for nonsystem roads to ensure repeatability from year to year.

Index of infrastructure development

The infrastructure development index is an index that is calculated from two types of infrastructure found in wilderness: (1) utility corridors and sites and, (2) fixed instrumentation sites. Each occurrence of infrastructure is differentially weighted based on key attributes and then summed for the entire wilderness.

Utility infrastructure is defined in this protocol as "the constructed features used to convey or support basic services such as electricity, telecommunication, gas, or water." This measure consists of two main types: (1) point features (such as repeater sites and telecommunication facilities) and, (2) linear features (such as water pipelines and telephone lines).

Some utility infrastructure, such as repeaters installed to support fire management activities for a specific incident, is only in place on a temporary basis. This measure component only includes the utility infrastructure that is in place on a more permanent basis—in this case, 1 year or longer.

Similarly, historic utility infrastructure, such as old polyvinyl chloride water pipes and phone lines that are no longer in service, will not be included in this measure component. These data are not routinely tracked in Infra and would be time consuming and costly to inventory for this protocol.

Fixed instrumentation sites are defined in this protocol as "unattended measurement devices left in place for at least 1 year for the purpose of recording environmental data, such as meteorology and seismic activity." These sites typically contain measuring equipment, a data logger, and a power source. Some of these devices transmit data offsite for storage and analysis.

Why is this component important?

Both aspects of this measure component are important, although for different reasons. Utility infrastructure, although not common in wilderness, can be a significant indicator for development in wilderness, particularly for linear features such as water pipelines, which can occupy a substantial acreage in wilderness and be substantially noticeable.

This type of infrastructure typically predates the designation of the area as wilderness, and future additions are unlikely.

Fixed instrumentation is typically used to record, store, and often transmit data recorded about environmental conditions, such as seismic activity and snow water content. Because of prohibitions against installations in Section 4(c) of the Wilderness Act, fixed instrumentation typically is not placed in wilderness; however, other interests can override this prohibition if instrumentation is determined to be "necessary to meet minimum requirements for the administration of the area." This aspect of the measure component is important to track trends over time because of increasing pressures to place additional installations inside wilderness boundaries for environmental monitoring.

What are the attributes of this component?

Table 44 describes the attributes used to calculate the index of infrastructure development.

Table 44.—*Attributes for calculating the index of infrastructure development.*

Attribute
Feature type*
Size*
Feature identification
Feature name
Category
Administrative organization
Ownership
Historical status
Year constructed
Data quantity—select one: • Complete • Partial • Insufficient
Data quality—select one: • High • Moderate • Low

** The asterisk denotes the attribute used to compute this measure, and the remaining attributes serve a supporting role necessary to help document or interpret the results.*

How will the data be collected?

- **Primary and secondary (if needed) data sources.** Data for this measure will be stored in the Infra-Features module. Utility infrastructure and fixed instrumentation sites owned by the Forest Service are required to be entered into the Infra-Features module for annual real property maintenance reporting. The feature types applicable to this component include the following:

- Communication system.
- Ditch.
- Miscellaneous.
- Other utility.
- Power system.
- Recording site categories:
    - Air-quality monitoring site.
    - Meteorology monitoring site.
    - Seismic monitoring site.
    - Snow gauging station.
    - Water gauging station.
- Utility along route.
- Wastewater system.
- Water system.

Infrastructure owned by another entity should have a record in the Infra-SUDS module and will need to have a corresponding record entered in the Features module, along with the required attributes. The Infra-SUDS module contains detailed information for special-use authorization but not for the use that is authorized. The special-use authorizations of interest to this measure component can be determined by the use code. The use codes applicable to this component include the following:

- Irrigation water trans pipeline less than 12 in in diameter = 913.
- Irrigation water trans pipeline greater than or equal to 12 in in diameter = 912.
- Oil and gas pipeline = 631.
- Oil and gas pipeline related facility = 632.
- Oil and gas production and storage area = 633.
- Other utility improvement = 644.
- Other utility improvement, Federal Lands Recreation Enhancement Act (REA) financed = 642.
- Power line = 643.
- Power line, REA financed = 641.
- Resource monitoring site = 814.
- Sewage transmission line = 343.
- Stream gauging station = 941.
- Telephone and telegraph line = 821.

- Telephone line, REA financed = 822.
- Water trans pipeline less than 12 in in diameter = 915.
- Water trans pipeline greater than or equal to 12 in in diameter = 914.
- Weather station = 423.

The feature length and/or acreage may need to be estimated for this protocol if it is not contained in the Infra-SUDS or Infra-Constructed Feature database.

- **Frequency of data collection.** Current business practices require all active special-use permit records be updated annually; however, because utility permits do not vary much from year to year, they will be retrieved for this protocol only every 5 years.

How complete are these data?

- **Percentage of Forest Service wildernesses that have these data.** Those wildernesses that contain utility infrastructure or fixed instrumentation sites owned by the Forest Service should have records in the Infra-Features module because of real property and deferred maintenance reporting requirements. Infrastructure owned by other entities should have records in the Infra-SUDS module, but few will have corresponding records in the Features module, which is required to calculate the index.
- **Known spatial, temporal, and other data gaps.** Local forest staff will be presented with the pertinent information currently contained within the Infra-Features and Infra-SUDS modules and will be required to make any edits or additions needed to complete or update the data set.
- **Data adequacy.** The issue of data adequacy will be addressed both in terms of data quantity and quality. Data quantity will be evaluated from the standpoint of whether all utility corridors and sites and fixed instrumentation sites have been included in the current inventory. Greatest attention will be placed on those features not owned by the Forest Service where data records may not exist. Data quality will be assessed from the standpoint on whether the attributes are accurate and complete.

How will the data be processed and analyzed?

Data currently in the Infra-SUDS database will be extracted based on the specific use codes identified previously for the particular wilderness, along with the attributes of interest. Similarly, data will be extracted for Forest Service-owned utility infrastructure based on the feature types listed previously. Forest staff will be expected to review the current data and make the following edits:

- Make corrections to existing data where needed.
- Complete missing mandatory attributes where missing.
- Develop link records to the appropriate wilderness record, where needed.
- Enter missing utility infrastructure that had not been entered previously.

Utility infrastructure and fixed equipment sites have been determined to have three development level values.

1. **Small scale.** For fixed instrumentation sites and for utility infrastructure that consists of an individual site, such as a repeater site, occupying less than 1 acre in total size.
2. **Moderate scale.** For utility infrastructure that either consists of an individual site that exceeds 1 acre in size or requires corridors but is of a generally small scale, typically less than 1 mi in length.
3. **Large scale.** For utility infrastructure that requires corridors but is of a generally large scale, typically greater than 1 mi in length.

The numeric value for each occurrence of utility infrastructure will be summed to generate a utility development index for the entire wilderness. For example:

> Utility development index = (utility infrastructure number 1 * relative weight) + (fixed equipment site number 1 * relative weight) + and so on.

What are the cautions about this component?

This measure attempts not only to count the number of occurrences of utility infrastructure and fixed instrumentation sites but also to assess the relative development level of each facility; however, by doing so, the measure introduces bias by assigning subjective values to the different types of infrastructure. It is unclear how consistently utility infrastructure owned by the Forest Service is entered into a corporate database. An additional concern exists about fixed instrumentation sites that have been placed inside wilderness areas without the Forest Service's knowledge. Anecdotal evidence suggests State government agencies, academic institutions, and even other Federal agencies have placed installations inside wilderness without Forest Service knowledge and involvement.

Index of mine development

The index of mine development is an index that is calculated for each individual occurrence of a mine inside a particular wilderness based on key attributes, such as the type of mine and the area involved, and then summed for the entire wilderness.

Why is this component important?

For the purposes of this protocol, mines can be divided into three general categories.

1. Active, under development.

2. Abandoned, under reclamation.

3. Abandoned, historical.

Although limited in number, mines can be a significant intrusive commodity use of wilderness. Mines in the first category (active) are uncommon today. "Reported mineral extraction from any wilderness is limited to nonexistent." (Hendee and Dawson 2002) Abandoned mines, however, whether actively under reclamation or merely identified as a historic resource, are more common.

What are the attributes of this component?

Table 45 describes the attributes used to calculate the index of mine development.

Table 45.—*Attributes for calculating the index of mine development.*

Attribute
Status*—select one: • Abandoned, historic • Abandoned, not historic and not under reclamation • Abandoned, under reclamation • Active
Size*—select one: • Small (< or = 1 acre in size) • Large (> 1 acre in size)
Mine identification
Mine name
Mine type
Source of data—select all that apply: • BLM's LR2000 database • EPA's AML program • Forest Service's AML program • Infra-Heritage • Professional knowledge • Other
Data quantity—select one: • Complete • Partial • Insufficient
Data quality—select one: • High • Moderate • Low

** The asterisk denotes the attribute used to compute this measure, and the remaining attributes serve a supporting role necessary to help document or interpret the results.*

AML = Abandoned Mine Land. BLM = Bureau of Land Management. EPA = Environmental Protection Agency. LR2000 = Land & Mineral Legacy Rehost 2000 System.

How will the data be collected?

- **Primary and secondary (if needed) data sources.** Data about mines are not currently tracked in a corporate database, with the exception of the Mineral Materials module in Infra. As a result, new records will need to be entered into the Infra-WILD Wilderness Character module to track wilderness mines. This workload is not expected to be onerous because mines are not common in wilderness and the required attribute set is small.

  Local resource managers, including mining engineers, geologists, archaeologists, and wilderness managers, are generally aware of locations in which mining activity has taken place in a particular wilderness. Other sources can also be referenced based on the general category and status of the mine, such as the following:

  - For active mines currently under development, the national data source is the Bureau of Land Management's Land & Mineral Legacy Rehost 2000 System database (http://www.blm.gov/lr2000/).
  - For abandoned mines currently under reclamation, the national data source is the Environmental Protection Agency's Abandoned Mine Land (AML) program. (http://www.epa.gov/superfund/programs/aml/amlsite/nonnpl.htm).
  - For abandoned mines that have historical value, the national data source is the Infra-Heritage module. In addition, some historic mine sites may be known in wilderness, either to wilderness or Heritage Program staff, although a record does not yet exist in Infra because a site inventory has not been conducted.

- **Frequency of data collection.** Data will be collected every 5 years on mines of all three types within each wilderness.

How complete are these data?

- **Percentage of Forest Service wildernesses that have these data.** The percentage of wilderness having data on mines varies depending on the category of mines. The inventory of current mining claims and mines enrolled in the AML program are well known and documented. The data are also quite complete for historical mines, although clearly the more significant the mine, the more likely it has been inventoried and entered into the corporate database.

- **Known spatial, temporal, and other data gaps.** Local forest staff will be presented with the pertinent information currently contained in all three data sources and will have the opportunity to make any edits or additions needed to complete or update the data sets.

- **Data adequacy.** Data quantity will be evaluated from the standpoint of whether all mines have been included in the current inventory. Due to the reliability of NID, greatest attention will be placed on those dams that do not meet the NID criteria as well as the other instream structures. Data quality will be assessed from the standpoint on whether the attributes are accurate and complete.

How will the data be processed and analyzed?

Data currently in all three data sources will be extracted for the particular wilderness, along with the attributes of interest. Forest staff will be expected to review the current data and make the following edits:

- Make corrections to existing data where needed.
- Complete missing mandatory attributes where missing.
- Develop link records to the appropriate wilderness record, where needed.
- Enter missing mines that had not been entered previously.

Mines will be assigned one of three development level values.

1. **Inactive.** For mines that are no longer actively being worked, including abandoned historical mines as well as those that have previously been reclaimed.
2. **Active, small-scale.** For mines that are either currently under development or abandoned but under reclamation and are less than or equal to 1 acre in size.
3. **Active, moderate to large-scale.** For mines that are either currently under development or abandoned but under reclamation and greater than 1 acre in size.

It should be noted the acreage values are for the actual disturbed areas and not the total size of the mining claim.

Each mine will be assessed separately, assigned the appropriate development level value, and then summed to generate a total value for the wilderness. For example:

> Mine development index = (mine number 1 * relative weight) +
> (mine number 2 * relative weight) + and so on.

What are the cautions about this component?

This measure attempts not only to count the number of mines in a particular wilderness but also to assess the relative development level of each occurrence; however, by doing so, the measure introduces bias by assigning subjective values to the different mine development level values.

This measure attempts to assess the development level associated with each mine and not its ecological effect. Clearly, small mines may have the potential for greater ecological effects than large mines, but such an assessment is not the intent behind this measure.

6.3. Monitoring Question 2—Motorized Equipment and Mechanical Transport

What are the trends of the use of motorized equipment and mechanical transport?

Why Is This Monitoring Question Important?

This monitoring question assesses the effect of motorized equipment and mechanical transport use on the undeveloped quality of wilderness. This monitoring question covers uses for emergency and for administrative and other nonemergency purposes. Although authorized by the Wilderness Act under certain conditions, the use of these devices diminishes the undeveloped quality. Monitoring motorized equipment and mechanical transport can be used to compare and contrast equipment and transport use over time and to help make well-considered management decisions grounded within the Wilderness Act.

How Will the Indicators Be Used To Answer This Question?

The single indicator—motorized equipment and mechanical transport use—directly tracks the status and trends of such use. If the evaluation of the measures suggests that the indicator is decreasing, stable, or increasing, then the corresponding answer will be provided for the monitoring question.

What Are the Cautions About This Question?

The decision to include this question under the undeveloped quality of wilderness character was based on the close and historical association between motorized use, mechanical transport, and people's ability to develop, occupy, and modify wilderness. At the same time, the impact from the use of motorized equipment and mechanical transportation on opportunities for solitude is undeniable. Although this monitoring question is not intended to analyze the effects of the use of motorized equipment or mechanical transport on the experience of visitors or on the environment, the selected measures and their attributes do reflect this relationship.

6.3.1. Indicator 1 for Question 2—Motorized/Mechanized Use

Use of motorized equipment and mechanical transport.

Why Is This Indicator Important?

Agency regulations and policy for all national forest wildernesses restrict the use of motorized equipment and mechanical transport, requiring authorizations for such use at various levels of the agency when it is deemed necessary. This indicator tracks the actual use of motorized equipment and mechanical transport for emergency, administrative, and other nonemergency purposes (including mineral rights, special provisions, and State and private land access), reflecting the status and trends of such use.

Forest Service policy for the authorization and use of motorized equipment and mechanical transport is given in FSM 2326, Use of Motorized Equipment or Mechanical Transport in Wilderness. Key definitions are found in FSM 2320.5, as follows:

> "3. Mechanical Transport. Any contrivance for moving people or material in or over land, water, or air, having moving parts, that provides a mechanical advantage to the user, and that is powered by a living or nonliving power source. This includes, but is not limited to, sailboats, hang gliders, parachutes, bicycles, game carriers, carts, and wagons. It does not include wheelchairs when used as necessary medical appliances. It also does not include skis, snowshoes, rafts, canoes, sleds, travois, or similar primitive devices without moving parts.
>
> "4. Motorized Equipment. Machines that use a motor, engine, or other nonliving power sources. This includes, but is not limited to, such machines as chain saws, aircraft, snowmobiles, generators, motorboats, and motor vehicles. It does not include small battery or gas powered handcarried devices such as shavers, wristwatches, flashlights, cameras, stoves, or other similar small equipment."

How Was This Indicator Chosen?

This indicator was selected to assess the status and trends of the use of motorized equipment and mechanical transport because of the availability of data currently being collected through Infra-WILD. These data are considered credible and complete, responsive to change by management, and, because they are already being collected, these data place little additional burden on managers.

Mechanical transport and motorized equipment use authorizations was initially selected as an indicator. Pilot testing, however, exposed the difficulty in obtaining emergency use data on authorizations. Another concern with tracking use authorizations was that this indicator would not take into account those actions that are authorized but do not actually take place.

How Will the Measures Provide Information About This Indicator?

Two measures respond to the indicator "use of motorized equipment and mechanical transport."

1. Index of emergency motorized equipment and mechanized transport use.
2. Index of administrative and nonemergency motorized equipment and mechanized transport use.

Both measures involve the calculation of a use level index, which assesses the cumulative impact level of each use of a specific equipment type. These indexes are calculated by evaluating each type of use, assigning weights based on perceived differences in the level of impact, and then multiplying this weighted use by the amount of use or its assigned inherent weight.

The index for each of the individual measures will be combined to determine an overall index that can be used to inform managers about trends in the indicator and to directly address the monitoring question. Not all equipment types have the same impact level associated with them. For example, a wheelbarrow has a significantly different impact level than a bulldozer has.

To account for these differences, an inherent weighting has been assigned to each equipment type based on its perceived impact to social and biophysical resources, as shown in table 46. Mechanized equipment and motorized equipment with a relatively low level of impact are assigned a value of 1, motorized equipment with a moderate level of impact is assigned a value of 2, motorized equipment with a high level of impact is assigned a 3, and motorized equipment with a very high level of impact is assigned a 4. Equipment types were assigned a low inherent weight if typically they cause a small impact to the

Table 46.—*Inherent weights of different types of motorized equipment and mechanical transport used in wilderness.*

Equipment type	Inherent weight
Air compressor	2
Air tanker	3
All-terrain vehicle	3
Battery-powered tool	1
Bicycle	1
Chain saw	3
Concrete equipment	3
Fixed-wing aircraft	3
Float plane	3
Generator	2
Heavy equipment	4
Helicopter	3
Motorcycle	3
Motorized watercraft	3
Motorized winch	2
Portable pump	2
Rock drill	3
Snowmachine	3
Truck	3
Wheelbarrow	1
Wheeled litter	1

social environment and little to no impact to the biophysical environment. For example, handheld motorized equipment and mechanized transport devices that are relatively quiet and have little impact on the wilderness resource were assigned an inherent weight of 1. Other uses were assigned higher weights if they tended to be larger with more presence and noise associated with them or have a typically greater level of impact on wilderness resources. These weights were subjectively determined by a sampling of wilderness managers.

The overall use level will be calculated for each authorization by multiplying the number of pieces of equipment by its inherent weight by the amount of use (either by weight assigned to use categories for the emergency use measure or actual use days for the administrative and nonemergency use measure). At the end of each fiscal year, these values will be added together to cumulatively provide a single total use level index for each measure.

This use level index is useful in a relative sense for showing increasing or decreasing trends over time within a wilderness. This index is not meaningful, however, in an absolute sense for comparing two different wildernesses: a wilderness with a value of 2X does not have twice the use level of a wilderness with a value of 1X.

What amount of change is required in the overall development level index to result in a determination that the trends in the use of motorized equipment and mechanical transport are either improving or degrading? To determine the direction of change, the overall use level must increase by 5 percent or more between time point 1 and time point 2 to result in a determination of degrading; conversely, a decrease of 5 percent or more will result in an improving score. All other results will be categorized as stable. This relatively broad band of 10-percent allowed change acknowledges the low level of precision and accuracy associated with the data used in this protocol. Any change above this 10-percent band will be determined to be beyond noise in the data and to reflect actual change in wilderness conditions.

As described in Chapter 3, Assessing Trend in Wilderness Character, trends of the individual measures will be synthesized to develop an overall trend estimate to provide information about the indicator. Table 47 shows possible combinations of trends in the measures and the resulting trend to provide information about motorized equipment and mechanical transport use. The resulting arrows show the trend as improving (upward-

Table 47.—*The trend in the indicator of use authorization actions is derived from adding across the trends in its component measures.*

Measure	Possible trends in the measure								
Index of emergency motorized equipment and mechanized transport use	⇧	⇧	⇔	⇧	⇩	⇔	⇔	⇩	⇩
Index of administrative and nonemergency motorized equipment and mechanized transport use	⇧	⇔	⇧	⇩	⇧	⇔	⇩	⇔	⇩
Resulting trend in the indicator	⇧	⇧	⇧	⇳	⇳	⇔	⇩	⇩	⇩

pointing arrow), offsetting stable (double-headed vertical arrow), stable (double-headed horizontal arrow), or degrading (downward-pointing arrow).

What Are the Cautions About This Indicator?

It should not be assumed that the measures for this indicator capture all mechanical transport and motorized equipment use. Although it is recognized that motorized equipment or mechanical transport use occurs without being authorized, this monitoring protocol does not attempt to track such uses. Examples of such uses include illegal uses or places in which the private use of motorboats or fixed-wing aircraft is allowed by special provision, such as under the Central Idaho Wilderness Act of 1980 or the Alaska National Interest Lands Conservation Act (ANILCA) of 1980. To track such types of use is not feasible and would not present an accurate accounting of activities because data on unauthorized use may just represent the level of law enforcement. Local units may consider monitoring these uses for information at a local level (see "Undeveloped Quality" in Appendix F, Local Indicators and Measures).

6.3.1.1. Measure 1 for Indicator 1, Question 2—Emergency Motorized/Mechanized Use Index

Index of emergency motorized equipment and mechanical transport use.

Why Is This Measure Important?

The emergency use of motorized equipment and mechanical transport is explicitly authorized by the Wilderness Act under certain conditions; these uses nonetheless diminish the undeveloped quality. This measure captures such uses, including the use of motorized equipment and mechanical transport for fire and law enforcement purposes and for search and rescue. It also evaluates the types of equipment used, categorizes and weighs the extent of such use, and produces a cumulative index based on both the relative and inherent impacts each of these uses has on the overall use of motorized equipment and mechanical transport.

The index of emergency motorized equipment and mechanical transport use is calculated for each individual use of motorized equipment or mechanized transportation inside a particular wilderness based on key attributes and then summed for the entire wilderness.

What Are the Attributes of This Measure?

Table 48 describes the attributes used for measuring emergency use authorizations.

Table 48.—*Attributes for measuring emergency use authorizations.*

Attribute
Equipment type*
Amount of actual use—select one:* • One piece, 1 day • Multiple pieces, 1 day • One piece, more than 1 day • Multiple pieces, more than 1 day
Name of authorization
Authorization type—select one: • Emergency, fire • Emergency, law enforcement • Emergency, search and rescue • Emergency, other
Confidence level that all the records for this measure have been captured—select one: • High • Moderate • Low

** The asterisk denotes the attribute used to compute this measure, and the remaining attributes serve a supporting role necessary to help document or interpret the results.*

How Will the Data Be Collected?

- **Primary and secondary (if needed) data sources.** Field data stewards will be responsible for entering all uses into the Infra-WILD Wilderness Character module. The secondary source would be the district or forest manager with wilderness responsibilities.
- **Frequency of data collection.** Data will be input annually at the wilderness level and assessed every 5 years at the national level.

How Complete Are These Data?

- **Percentage of Forest Service wildernesses that have these data.** Although information is currently collected annually on motorized equipment and mechanical transport uses, it is not collected in a consistent way that supports the analysis of trends over time. The requirements for this reporting will necessitate different data entry protocols in Infra-WILD.
- **Known spatial, temporal, and other data gaps.** This measure does not include temporal or spatial subsets. Data gaps will be minimized by identifying a local lead data steward, providing funding, and requiring timely data entry.
- **Data adequacy.** Data quality and quantity are not easily split for this measure. A single attribute will be used to assess data adequacy based on the data stewards' level of confidence that all actions have been captured for each component: high, moderate, or low. This attribute will be reported under data quantity.

How Will the Data Be Processed and Analyzed?

Data reported in the Infra-WILD database will be extracted for the particular wilderness, along with the attributes of interest.

A use level value will be calculated for each authorization by multiplying the inherent weight of each type of equipment by the inherent weight of the amount of actual use, as shown in table 49. All pieces of equipment that are actually used will be calculated as described and summed for a value for that authorization. At the end of each fiscal year, these values assigned to individual authorizations will be added together to cumulatively provide an annual use index for the wilderness.

For example, fire crews working on the Hot Creek Fire are authorized to use two helicopters, several chain saws, and one pump. The actual use of each piece of equipment is as follows:

- Helicopter one used 1 day.
- Helicopter two used more than 1 day.
- Chain saws used more than 1 day.
- Pump used 1 day.

Table 50 shows how to calculate the use level value for this example Hot Creek Fire authorization.

Table 49.—*Inherent weights for the actual uses of motorized equipment and mechanical transport.*

Amount of actual use	Actual use weight
One piece, 1 day	1
Multiple pieces, 1 day	2
One piece, multiple days	2
Multiple pieces, multiple days	3

Table 50.—*A hypothetical example showing the calculation of the use level value for emergency uses of motorized equipment and mechanical transport.*

Type of equipment	Inherent weight	Amount of actual use	Actual use weight	Equipment use value
Helicopter one	3	1 day	1	3
Helicopter two	3	More than 1 day	2	6
Chain saws	3	More than 1 day	3	9
Pump	2	1 day	1	2
			Use level value	**20**

What Are the Cautions About This Measure?

Two types of concerns about the values that weight the relative impact of an individual type of equipment on the use level of the wilderness exist: (1) the arbitrariness of the values chosen, and (2) the implied relationship between different numeric values (e.g.,

that multiple chain saws used for multiple days has three times more impact than a single helicopter used for 1 day). The only way these concerns can be addressed is to stress that the number produced is meaningless in and of itself in an absolute sense; what matters is change over time in an individual wilderness.

6.3.1.2. Measure 2 for Indicator 1, Question 2—Administrative and Nonemergency Motorized/Mechanized Use Index

Index of administrative and nonemergency motorized equipment and mechanical transport use.

Why Is This Measure Important?

Administrative and other nonemergency uses of motorized equipment and mechanical transport are explicitly authorized by the Wilderness Act and some subsequent legislation (such as ANILCA) under certain conditions; the use of these devices nonetheless diminishes the undeveloped quality. This measure attempts to capture such use, including motorized equipment and mechanical transport to maintain dams, utility infrastructure, and fixed instrumentation for administering mineral rights, special provisions, and State and private land access. As described for the previous measure, this measure evaluates the types of equipment used and weighs the extent of such use, producing a cumulative index based on both the relative and inherent impacts each of these uses has on the overall use of motorized equipment and mechanical transport. The difference between measure 1 and measure 2 is that the use level value for measure 2 (administrative and nonemergency use) is based on the actual number of pieces of equipment and the number of days of actual use rather than the broader actual amount of use categories applied in measure 1 (emergency use). This refinement is possible because administrative use data is more readily available and reliable than data for emergency use.

The index of administrative and nonemergency motorized equipment and mechanical transport use is calculated for each individual occurrence of an authorization for the use of motorized equipment or mechanized transportation inside a particular wilderness based on key attributes and then summed for the entire wilderness.

What Are the Attributes of This Measure?

Table 51 describes the attributes used to calculate the index of administrative and nonemergency use days.

Table 51.—*Attributes for measuring administrative and nonemergency use days.*

Attribute
Equipment type*
Number of pieces of equipment*
Number of days actual use*
Name of authorization
Confidence level that all the records for this measure have been captured—select one: • High • Moderate • Low

** The asterisk denotes the attribute used to compute this measure, and the remaining attributes serve a supporting role necessary to help document or interpret the results.*

How Will the Data Be Collected?

- **Primary and secondary (if needed) data sources.** Field data stewards will be responsible for entering all uses into the Infra-WILD Wilderness Character module. The secondary source would be the district or forest manager with wilderness responsibilities.
- **Frequency of data collection.** Data will be input annually at the wilderness level and assessed every 5 years at the national level.

How Complete Are These Data?

- **Percentage of Forest Service wildernesses that have these data.** Although information is currently collected annually on motorized equipment and mechanical transport uses, it is not collected in a consistent way that supports the analysis of trends over time. The requirements for this reporting will necessitate different data entry protocols in Infra-WILD.
- **Known spatial, temporal, and other data gaps.** This measure does not include temporal or spatial subsets. Data gaps will be minimized by identifying a local lead data steward, providing funding, and requiring timely data entry.
- **Data adequacy.** Data quality and quantity are not easily split for this measure. A single attribute will be used to assess data adequacy based on the data stewards' level of confidence that all actions have been captured for each component: High, moderate, or low. This attribute will be reported under data quantity.

How Will the Data Be Processed and Analyzed?

Data reported in the Infra-WILD database will be extracted for the particular wilderness, along with the attributes of interest.

A use level value will be calculated for each authorization by multiplying the inherent weight of each type of equipment by the number of days of actual use. All pieces of equipment that are actually used will be calculated and summed to yield a total value for that authorization. At the end of each fiscal year, these values assigned to individual authorizations will be added together to cumulatively provide a single annual use index for the wilderness.

For example, an authorization is made for the Alpine Way Trail Reconstruction Project to use a helicopter, two chain saws, and one power auger. The actual use of each piece of equipment is as follows:

- Helicopter used 3 days.
- Chain saws used 6 days each.
- Power auger used 1 day.

Table 52 shows how to calculate the use level value for this example Alpine Way Trail Reconstruction Project authorization.

Table 52.—*A hypothetical example showing calculation of the use level value for administrative and nonemergency uses of motorized equipment and mechanical transport.*

Type of equipment	Inherent weight	Days of actual use	Equipment use value
Helicopter one	3	3	9
Chain saw one	3	6	18
Chain saw two	3	6	18
Power auger	2	1	2
		Use level value	**47**

What Are the Cautions About This Measure?

Two types of concerns about the values that weight the relative impact of an individual type of equipment on the use level of the wilderness exist: (1) the arbitrariness of the values chosen, and (2) the implied relationship between different numeric values (e.g., that multiple chain saws used for multiple days has more impact than a single helicopter). The only way these concerns can be addressed is to stress that the number produced is meaningless in and of itself in an absolute sense; what matters is change over time in an individual wilderness.

6.4. Monitoring Question 3—Inholdings

What are the trends of inholdings?

Why Is This Monitoring Question Important?

Because inholdings interior to designated wilderness are not given the same protections as the wilderness lands around them, these lands can be developed for various purposes at the discretion of the landowner. These lands can be roaded and logged or, more commonly, developed with recreational lodges, facilities, or private residences. Ironically, in many cases it is the proximity to protected lands around them that gives the inholdings value and makes them susceptible to development.

Due to the vulnerability of these lands to development, and the adverse effect this development would have on the surrounding wilderness values, inholdings are afforded a high priority for acquisition or exchange by the Forest Service. Unfortunately, the consummation of this transaction typically requires a willing seller, which is often difficult to find.

How Will the Indicators Be Used To Answer This Question?

The sole indicator for this question is inholdings.

What Are the Cautions About This Question?

Although inholdings clearly have a potential effect on the wilderness lands around them, this effect arguably is no different than private or State lands outside of although adjacent to the wilderness boundary. Inholdings are the focus of this question because their potential effect is amplified due to the fact they are surrounded by wilderness, and adequate access must be granted to the owner if requested, thereby further increasing the level of development inside of wilderness.

6.4.1. Indicator 1 for Question 3—Inholdings

Inholdings.

Why Is This Indicator Important?

This indicator is the logical choice to respond to the monitoring question.

How Was This Indicator Chosen?

This indicator is the only meaningful choice that directly answers the monitoring question.

How Will the Measures Provide Information About This Indicator?

The number of acres of inholdings was selected to represent changes to the indicator over time. Although it is unlikely that the acreage will ever increase, the number of acres may decrease over the years as inholdings are acquired through purchase or exchange. As the number of acres of inholdings decrease, it will be interpreted as improving the wilderness character of the surrounding lands.

What Are the Cautions About This Indicator?

No specific cautions have been identified at this time.

6.4.1.1. Measure 1 for Indicator 1, Question 3—Inholding Acres

Acres of inholdings.

Why Is This Measure Important?

The acres of inholdings are viewed as the most meaningful way to track changes over time for this indicator. Although unlikely to increase, this number may decrease over the years due to successes by the Forest Service lands program. The number of inholding parcels was also considered as a measure but not included due to the perception that the number of parcels was less meaningful to wilderness character than the number of acres.

What Are the Attributes of This Measure?

Table 53 describes the attributes used to calculate the index of inholdings.

Table 53.—*Attributes for measuring inholdings.*

Attribute
Parcel acres*
Parcel owner name
Parcel number
Land status disposal method (if applicable)—select one: • Purchase • Exchange • Donation
Threat assessment
Data quantity—select one: • Complete • Partial • Insufficient
Data quality—select one: • High • Moderate • Low

** The asterisk denotes the attribute used to compute this measure, and the remaining attributes serve a supporting role necessary to help document or interpret the results.*

How Will the Data Be Collected?

- **Primary and secondary (if needed) data sources.** Data for most of the attributes for this measure are currently stored and maintained in the Automated Lands Project (ALP) database. The data will be requested annually for the wildernesses within the coming year's monitoring cycle. The threat assessment is a narrative describing the likelihood that an individual parcel may be developed. This attribute is not currently collected in ALP but will be entered by the local wilderness manager into Infra-WILD upon consultation with the Forest Lands staff.
- **Frequency of data collection.** The data will be collected on 5-year intervals because changes to this measure are infrequent.

How Complete Are These Data?

- **Percentage of Forest Service wildernesses that have these data.** The presence or absence of inholdings is known for every wilderness. About half of all wildernesses have inholdings of some type, either State or privately owned land.
- **Known spatial, temporal, and other data gaps.** Data gaps are not of concern in this measure. It is assumed that the data in ALP is current and complete.
- **Data adequacy.** Data quantity will be evaluated from the standpoint of whether all inholdings have been included in the current inventory. Data quality will be assessed from the standpoint of whether the attributes are accurate and complete, with particular attention on the number of acres of inholding parcels. Due to the reliability of the data in the ALP, both the quantity and quality of data are assumed to be high.

How Will the Data Be Processed and Analyzed?

The acres of inholdings, along with the ancillary attributes, will be requested annually from the ALP for the wildernesses in the upcoming monitoring cycle. These data will be input centrally into Infra-WILD and then presented to the forest staff for validation. The wilderness manager will also be requested to enter narrative on the potential threat of these lands to wilderness as well as any supporting notes.

What Are the Cautions About This Measure?

The current measure only tracks the number of acres of inholdings and does not attempt to weight the potential effect of these lands based on different levels of perceived development risk. The measure also does not consider the different effects access has on the surrounding wilderness, although it is assumed this impact would be evaluated by the measure components contributing to the development index, particularly roads and trails.

Chapter 7. Outstanding Opportunities for Solitude or a Primitive and Unconfined Type of Recreation Quality

7.0. Summary

Table 54 provides a summary of the monitoring question, indicator, and measures for the outstanding opportunity for solitude or a primitive and unconfined type of recreation quality.

The outstanding opportunities quality of wilderness character has three monitoring questions and five indicators. Each question addresses a specific aspect of wilderness experience as described in the Wilderness Act: solitude, primitive recreation, and unconfined recreation. The three dimensions can change independently of each other, which makes it necessary to monitor all three to understand change in the quality. A conservative decision rule is used to evaluate change, so that if one of the dimensions deteriorates over time, the conclusion will be that a decline has occurred in outstanding opportunities.

This protocol develops valid indicators and adequate measures to assess changes in opportunities for primitive and unconfined recreation; i.e., to answer two of the monitoring questions. Data for these measures are readily obtainable through existing or planned corporate databases, and they should be adequately reliable and accurate.

The other monitoring question that addresses solitude has two indicators, both of which are necessary. The remote, trailless wilderness indicator can easily be measured for all wildernesses, but, for indicator 2 (wilderness visitation), data for measure number 1 are not available for most wildernesses. For these wildernesses, two surrogate measures (number of parties visiting during the primary use season and National Visitor Use Monitoring (NVUM) Program annual wilderness visits) will be reported. Serious questions about the

Table 54.—*A summary of the indicators and measures monitored in the outstanding opportunities quality.*

Quality of wilderness	Monitoring question	Indicator	Measure
Outstanding opportunities for solitude or a primitive and unconfined type of recreation—wilderness provides outstanding opportunities for people to experience solitude or primitive and unconfined recreation, including the values of inspiration and physical and mental challenge	What are the trends in outstanding opportunities for solitude?	Remote, trailless wilderness	Number of acres of wilderness away from access or travel routes
		Wilderness visitation	Number of parties visiting a wilderness during the primary use season
			Number of adult wilderness users residing in the service area
			NVUM annual wilderness visits
	What are the trends in outstanding opportunities for primitive recreation?	Recreation facilities	Index of recreation facilities
		Trail development level	Number of trail miles in developed condition classes (classes 3 to 5)
	What are the trends in outstanding opportunities for unconfined recreation?	Management restrictions on visitor behavior	Index of restrictions on visitor behavior

NVUM = National Visitor Use Monitoring Program.

validity of these two measures exist. Therefore, if the measures provide conflicting information about trends in a given wilderness, it will be concluded that the monitoring question cannot be answered for that wilderness. Despite the lack of data for the indicator, the monitoring question is critical to wilderness character; therefore, the indicator is retained.

7.1. Introduction

To a large extent, the natural, untrammeled, and undeveloped qualities address wilderness conditions or stewardship actions related to the biophysical environment. The outstanding opportunities quality, on the other hand, was developed to address Wilderness Act direction regarding the experiences available to people in wilderness. Section 2(c) of the Wilderness Act states that wilderness "has outstanding opportunities for solitude or a primitive and unconfined type of recreation." Wilderness is the only public land classification with this provision. This quality is concerned with conditions that affect the *opportunity* for people who are visiting wilderness to experience solitude, primitive recreation, and/or unconfined recreation.

The objective of monitoring the outstanding opportunities quality is to track, over time, how conditions likely to promote such opportunities are changing across all National Forest System (NFS) wildernesses as well as within individual wildernesses. These conditions include management actions as well as aspects of the physical and social environment. If managers are to fulfill the requirements of the Wilderness Act, they must understand how their actions (or inaction) and changes in the physical and social environment may affect the opportunity for specific types of visitor experiences over time. This quality of wilderness character may change because of land management as well as changes in visitation that result from factors such as population growth.

The protocol does not monitor opportunities for types of experiences other than solitude, primitive recreation, and lack of confinement, even if visitors desire other experiences. Consideration was given to the development of a monitoring question surrounding the opportunity for challenge or the opportunity to experience inspiration because these experiences are also important in wilderness. Ultimately, it was determined that such opportunities were adequately addressed by the three primary questions because factors that affect solitude or primitiveness also influence opportunities for challenge or inspiration.

Three monitoring questions were developed for the outstanding opportunities quality. Each question addresses a different dimension of the outstanding opportunities quality that is explicitly named in the Wilderness Act. Each dimension taps into a slightly different opportunity, and each dimension can change independently of the others. For example, use limits would detract from the unconfined dimension but would protect op-

portunities for solitude. Similarly, the removal of toilets would increase opportunities for primitive recreation but would probably not have an impact on solitude.

For each monitoring question, a range of indicators was carefully considered. The Key Concepts section in this technical guide sets out the criteria used for selecting indicators. In the case of the outstanding opportunities quality, preference was given to indicators and measures that could be subject to management influence; however, in one case, a measure was selected that is independent of management control: a measure of wilderness visitation derived from estimates of population growth in the region.

Solitude has two indicators: (1) remote, trailless wilderness; and (2) wilderness visitation. For the first indicator, a single measure will be computed through Geographic Information System analysis using existing data layers for each wilderness. For the second indicator, three alternative measures are described, one of which—number of parties visiting during the primary use season—is necessary to make a determination about solitude and answer monitoring question 1 at the individual wilderness level. Currently, it is not expected that data for this measure will be available for each NFS wilderness; however, this measure still is included because it is so central to the experience of solitude.

Although the preferred measure usually cannot be monitored, data can be obtained for two surrogate measures of visitation at the wilderness level: (1) the number of wilderness users residing in the service area, and (2) the number of visits based on NVUM data. These two measures will be combined to assess change in wilderness visitation where data for measure 1 are not available.

For primitive and unconfined recreation, the strategy to monitor change over time depends largely on analysis of spatial data and the synthesis of data from the Infra-WILD and Infra-Trails databases. Although Infra-WILD provides information on selected facilities that affect the primitiveness dimension, which will be used to measure an indicator of "recreation facilities," some data must be supplied by wilderness managers because these data are not currently reported in established protocols. Infra-WILD also provides information on selected rules and regulations that will be used to measure management restrictions on behavior for the unconfined dimension. Because all NFS wildernesses are required to update this information annually, the data already exist in one centralized location. For both indicators, the specific items or rules that constitute the measures are combined to generate single measures, as explained later. The final indicator is trail development level, an indicator of primitive recreation. Analysis of measures for this indicator will be made using the Infra-Trails database.

Care is needed when interpreting data from the three monitoring questions to make inferences about the outstanding opportunities quality. For example, a tension exists between

providing opportunities for solitude and ensuring opportunities for unconfined recreation. As recreation demand increases, actions such as use limits that are taken to improve opportunities for solitude necessarily place constraints on visitors and are thus confining. A similar tension may exist between protecting naturalness and opportunities for unconfined recreation: actions taken to protect naturalness (such as designated site camping requirements) impinge on visitor freedom. On the other hand, a synergy generally exists between the undeveloped quality and the opportunity for primitive recreation; i.e., developments that detract from the undeveloped quality also detract from opportunities for primitive recreation.

7.2. Monitoring Question 1—Solitude

What are the trends of outstanding opportunities for solitude?

Why Is This Monitoring Question Important?

The Wilderness Act explicitly states that wilderness must provide outstanding opportunities for solitude. Solitude is understood to refer to escape from civilization and the increasing demands and pressures of everyday life. Thus, solitude includes a connotation of remoteness from society and its trappings (Hollenhorst and Jones 2001, Marshall 1930). Solitude also refers to an individual psychological state that researchers agree is multidimensional (Hammitt and Madden 1989). Some of the important dimensions include peace and tranquility, a feeling of inspiration or awe, connection with nature that can occur when one is focused on the external environment rather than on social interaction, and a sense of timelessness and lack of competing obligations for one's attention (Borrie and Roggenbuck 1998). Importantly, solitude has been considered dependent both on undeveloped features of the natural environment and on the absence of other people, particularly those outside one's immediate group. Opportunities for solitude are most outstanding where the environment is undeveloped and appears natural, visitors can determine when and where they wish to go, and few other people are present.

How Will the Indicators Be Used To Answer This Question?

This monitoring question has two indicators: (1) remote, trailless wilderness; and (2) wilderness visitation. The two indicators work together to get at two very different aspects: (1) the opportunity to get away from people by going off trail and to get away from the noise and sights of civilization by being away from roads and other travel corridors; and (2) the density of people in the wilderness, which affects opportunities for those going to places where they may encounter other people. The first aspect captures the availability of places for solitude seekers; the second aspect captures the likelihood that the typical

visitor will encounter other visitors. The two indicators can vary independently, and most change over time is likely to occur with indicator 2. Indicator 2 also is the most relevant to the solitude opportunities of most people on most trips because most people stay on trails and use is highly concentrated.

As described in Chapter 3, Assessing Trend in Wilderness Character, trends of the individual indicators will be synthesized to develop an overall trend estimate to answer this monitoring question. Table 55 shows possible combinations of trends in the indicators and the resulting trend to answer the monitoring question about outstanding opportunities for solitude. The resulting arrows show the trend as improving (upward-pointing arrow), offsetting stable (double-headed vertical arrow), stable (double-headed horizontal arrow), or degrading (downward-pointing arrow).

Table 55.—*The trend in the monitoring question about solitude is derived from adding across the trends in its component indicators.*

Measure	Possible trends in the measure								
Remote, trailless wilderness	⇧	⇧	⇔	⇧	⇩	⇔	⇔	⇩	⇩
Wilderness visitation	⇧	⇔	⇧	⇩	⇧	⇔	⇩	⇔	⇩
Resulting trend in the monitoring question	⇧	⇧	⇧	⇳	⇳	⇔	⇩	⇩	⇩

Note: An improving trend in wilderness visitation means less, not more, visitation.

What Are the Cautions About This Question?

An important issue for this monitoring question is whether the focus should be on the *opportunities* provided to visitors or their *actual experience*. The two indicators can generate very different pictures. For example, visitors may have the opportunity to use low-density trails but choose instead to go to heavily used destinations. Thus, they might not experience solitude, even though opportunities exist. The team responsible for developing this monitoring protocol took a middle ground on this issue: the first indicator clearly addresses opportunities that are available (whether people avail themselves of them). The second indicator acknowledges that people tend to congregate in attractive places; therefore, the opportunities for solitude at those places may be impaired.

Although the two indicators selected for this monitoring question do a reasonably good job of addressing outstanding opportunities for solitude, data for the necessary measure of wilderness visits are not available for most wildernesses. In other words, the indicator of wilderness visitation is valid and important but we are unable to measure it well and, in many cases, we cannot confidently answer this monitoring question at the level of the entire wilderness.

7.2.1. Indicator 1 for Question 1—Remote, Trailless Wilderness

Remote, trailless wilderness.

Why Is This Indicator Important?

Remoteness, meaning distance from the sights and sounds of civilization, is important for achieving a sense of solitude (Dawson 2004). In addition, research shows that most wilderness visitors stay on developed trails and that a large proportion of use is concentrated within a few miles of trailheads or access points, especially where day use makes up much of the visitation. Therefore, remote locations within a wilderness that are away from trails provide opportunities for solitude-seekers to find solitude.

All other things being equal, a decrease in remote, trailless wilderness is considered deterioration in opportunities for solitude. An increase in remote, trailless wilderness is considered an improvement in the opportunity for solitude.

How Was This Indicator Chosen?

This indicator can be measured with adequate levels of reliability and accuracy because, for the most part, the locations of trails and roads are known and Geographic Information System (GIS) analysis can generate accurate, reliable information. In addition, data are widely available for the selected measures through existing corporate databases. This indicator has high credibility and significance. Most wilderness acres are away from roads and trails; people who choose to go to these places will likely find high quality opportunities for solitude. Thus, the indicator is faithful to the phrase "outstanding opportunities for solitude" in the Wilderness Act.

The major limitation to this indicator is that it is unlikely to change, especially in the direction of improvement. Nevertheless, large-scale changes might occur as a result of recreational or other development, both in and outside of a wilderness, and the addition or deletion of wilderness acres. Management decisions to build or decommission roads or trails will be reflected in this indicator as well.

How Will the Measures Provide Information About This Indicator?

Only one measure exists for this indicator: the number of wilderness acres away from access and travel routes. Ideally, one would want to restrict the scope of this indicator to those areas that provide reasonable opportunities for off-trail travel. For example, one could argue that trailless areas in subalpine areas that can be traversed with only moderate effort provide for higher quality opportunities for solitude than trailless acres in a virtually

inaccessible swamp. This point is debatable, however, and it was deemed too difficult to be able to consistently define different qualities of off-trail acres. Even if this task could be done, it would be quite difficult and subjective to compute the area "suitable" for off-trail travel. Thus, the percentage of all wilderness acres away from roads or trails was considered a reasonable compromise. Because analysis focuses on change within each wilderness individually and does not compare across wildernesses, this measure should be adequate for tracking change.

As the number of acres for this measure increases, the conclusion would be that an increase in remote, trailless wilderness has occurred.

What Are the Cautions About This Indicator?

One concern about this indicator is its ability to reflect change in the actual opportunities for solitude. If new roads are built near wilderness boundaries, this ability will be picked up immediately through analysis. Similarly, if trails are decommissioned, this ability will be readily captured. On the other hand, in places where the presence of roads and trails is quite stable, the indicator may not change from year to year, even if use density on existing access routes or trails is increasing (or decreasing) dramatically. For wildernesses with shorelines used by motor vessels, this lack of ability to detect change is also a problem. In addition, this indicator does not involve the measurement of user-created trails, which can be one of the more important changes occurring in wilderness. Unfortunately, no data are available to assess user-created trails.

Overall, this indicator is a crude and rather inaccurate proxy for the opportunities for solitude that people who travel on trails may experience. Actual opportunities are much more directly affected by the distribution of recreational use in the wilderness. Such use has been shown to be highly variable, with only a few trails receiving most visitation (Lucas 1980). Thus, probably a very weak relationship exists between remote, trailless wilderness and actual onsite use density. For the few who travel off trail, however, this indicator is a reasonable choice.

7.2.1.1. Measure 1 for Indicator 1, Question 1—Area Away From Access and Travel Routes

Number of acres of wilderness away from access and travel routes.

Why Is This Measure Important?

Open maintained roads, motorized trails, railways, and shorelines used as travel ways surrounding a wilderness as well as system trails and aircraft landing sites within a wilderness are included in this measure. Outstanding opportunities for solitude are considered

diminished within a specific distance (buffer) assigned to each of these features (Carver and others 2002, Fritz and others 2000).

System trails within the wilderness are included in this measure because most visitation occurs on trails. Aircraft landing sites (e.g., landing strips in certain wildernesses or an entire lake in Alaskan wildernesses) are included because the motorized incursion, although allowed, may severely diminish the outstanding opportunity for solitude. Open maintained roads, motorized trails, railways, and shorelines surrounding wilderness islands outside the designated wilderness are included in this measure because they have the following attributes:

- They provide access to wilderness and, therefore, have some relationship to use levels. (It is recognized, however, that many access points receive very little use, and the relationship with solitude is weak.)
- They have an impact (via sight and sound) on wilderness visitors' experiences.
- They reflect other developments that could affect the feeling of remoteness, such as city lights that reduce night sky visibility or timber harvest activities that can be seen or heard from inside a wilderness.

The following distances away from access and travel routes were subjectively chosen as likely to be meaningful in most wildernesses:

- Nonmotorized system trails within a wilderness and nonmotorized boat travel routes—1/4 mi.
- Open roads, motorized trails, shoreline travel routes used by motor vessels, and railroads—1/2 mi.
- Aircraft landing sites—1 mi.

The actual distances at which these features affect outstanding opportunities for solitude would vary from site to site given factors such as vegetation density and surrounding topography. For the purposes of monitoring change, the precise distance is less important than accurately and consistently tracking changes that occur over time in these features within each wilderness independently.

What Are the Attributes of This Measure?

Table 56 describes the attributes for calculating the total area that is away from access routes and travel corridors.

The total number of acres is reported rather than the percentage of wilderness acres. This practice will enable changes that might occur because of the addition or deletion of lands

Table 56.—*The attribute for measuring the total area that is away from access routes and travel corridors.*

Attribute
Acres of wilderness away from access and travel routes*
Year of most recent travel layer update
Road types included in the travel layer—select all that apply: • Active maintained • Closed roads • Private roads • Decommissioned roads

** The asterisk denotes the attribute used to compute this measure, and the remaining attributes serve a supporting role necessary to help document or interpret the results.*

from a wilderness. Moreover, reporting percentages might promote comparisons among wildernesses and such comparison is not the intent of this monitoring protocol.

How Will the Data Be Collected?

- **Primary and secondary (if needed) data sources.** Data on roads and trails will come from corporate Forest Service Infrastructure (Infra) databases. For aircraft landing sites, railroads, and shorelines, new GIS data layers may need to be created. For each wilderness, GIS analysis will be used to compute the number of acres that are more than ¼ mi from any system trail (management constructed) or nonmotorized sections of shoreline, ½ mi from open ("active management") system road and motorized sections of shorelines, and 1 mi from aircraft landing sites. Trails open to motorized use outside the wilderness will be considered open system roads.

  Although existing trail layers are presumed to be adequately complete, wilderness managers or forest engineers will need to provide information about the coverage of road layers. Specifically, they will report on which road types (active maintained, closed, private, or decommissioned) are included. They also will report whether and which roads are open or closed to traffic during the primary wilderness use season.

- **Frequency of data collection.** Because change is unlikely to occur rapidly, data will be collected at 5-year intervals. This practice will consist of updating the travel route layer in Infra.

How Complete Are These Data?

- **Percentage of Forest Service wildernesses that have these data.** Although existing system trails and active, maintained roads should be well represented in existing GIS databases, decommissioned and private roads may be variably represented, and ghost roads are unlikely to be digitized. Furthermore, it is

unknown at this time if wilderness-specific GIS layers exist for aircraft landing sites and shorelines used for access or travel.

- **Known spatial, temporal, and other data gaps.** Wilderness managers will be queried about the coverage of their road layers. This information will be reported along with the value for measure 1.
- **Data adequacy.** There should be no problems related to data quantity for this measure because all wildernesses have travel layers and all wildernesses will be able to supply additional information about the locations of features not present in existing corporate databases (i.e., shoreline travel routes, railroads, and aircraft landing sites). Therefore, this protocol assumes that data are complete for all wildernesses. Despite this assumption, pilot testing of the protocol showed some problems with the quality of data. In particular, cases occurred in which roads and trails were still present in GIS layers even though they had been closed or obliterated. Data quality will be assessed by asking wilderness managers to indicate when the travel layers were last updated and which types of roads are included. High-quality data would be travel layers updated within the last 5 years on which types of roads are shown.

How Will the Data Be Processed and Analyzed?

Analysis will be done in the Forest Service Washington Office (WO), using data supplied via Infra. The travel route layer will be overlaid with wilderness boundaries, and simple analysis will generate the number of acres.

Significant trends in this measure are defined as a change of 5 percent or more over the 5-year monitoring cycle in the number of acres of wilderness away from access and travel routes. For example, if the initial reporting is 10,000 acres away from access and travel routes, and at the end of the 5-year monitoring cycle 9,800 acres are reported (because a new trail was built), this 2-percent decrease in acreage is not a significant change. Or, if at the end of the 5-year monitoring cycle 10,600 acres are reported (because a trail was closed), this 6-percent increase is a significant improvement in the measure. This 6-percent decline would be a significant degradation in the measure.

Results that represent less than a 5-percent increase or decrease in the data value over the monitoring cycle will be categorized as stable. This relatively broad band of 10-percent allowed change acknowledges the low level of precision and accuracy associated with the data used in this protocol. Any change above this 10-percent band will be determined to be beyond noise in the data and to be reflective of actual change in wilderness conditions.

What Are the Centralized Data Analysis Tasks?

Data processing that could be accomplished by a centralized data analyst includes the following:

1. Acquiring GIS layers for all travel routes—one for trails, one for roads, and one for aircraft landing sites.
2. Creating a buffer of appropriate size around each travel route.
3. Subtracting the buffers from the wilderness polygon using the erase tool.
4. Calculating the area of the remaining wilderness polygon after all the travel route buffers have been erased from it.

What Are the Cautions About This Measure?

The measure provides a reasonably good assessment of the indicator. For example, where no roads exist, generally no vehicles and no population centers exist and where no trails exist, visitor density (and, therefore, encounters) generally is quite low. Despite this attribute, the measure does not capture other important aspects of remoteness, such as proximity to urban centers, which may indirectly have substantial impacts on opportunities for solitude such as city lights, distant sounds of traffic, or airplane overflights. Furthermore, military overflights were excluded from this measure, although they may significantly degrade outstanding opportunities of solitude, because of the difficulty of capturing data on these overflights.

Remoteness also is affected by user-created trails, which encourage the use of off-trail areas; user-created trails are not monitored in this measure because data are not available for most wildernesses and cannot easily be generated. The measure also does not account for the configuration of remote areas—whether they occur in large blocks or in areas dissected by trails. The measure combines acres away from roads with acres away from trails, thereby considering the nature of the influence of roads and trails to be equivalent, although they may not be. Finally, this measure is unlikely to change much because road and trail systems and shorelines are (at least at present) relatively stable.

7.2.2. Indicator 2 for Question 1—Wilderness Visitation

Wilderness visitation.

Why Is This Indicator Important?

Indicators of opportunities for solitude should relate to the amount of recreational use occurring within a wilderness. Use density affects encounters among groups, which, in turn,

has an influence on opportunities for solitude (Hammitt and Rutlin 1995). Use density also may affect feelings of peace, quiet, and mental calm, which are associated with solitude. Thus, use density (wilderness visitation) is a reasonable indicator for solitude (Dawson 2004).

Because of the central importance of the solitude dimension of the outstanding opportunity quality, this indicator was considered necessary. An increase in wilderness visitation is interpreted as a decline in the opportunity for solitude.

How Was This Indicator Chosen?

This indicator was selected primarily because of its significance and the absence of any other known, measurable indicator that adequately captures the outstanding opportunity for solitude. The indicator also is responsive to management in that managers are capable of affecting wilderness visitation. The primary drawback is a lack of feasibility in obtaining information on the necessary measure.

The number of encounters was considered as an indicator because it is a more valid assessment of opportunities for solitude than use density (Hammitt and Rutlin 1995). Total visitation may not correspond as well to solitude as would the number of encounters among groups (Hammitt and others 1984). Because of lack of standard protocols and the very high level of effort required to reliably measure encounters, that indicator was dropped. Wildernesses that do conduct encounter monitoring are strongly encouraged to use those data to make local judgments about trends in the opportunity for solitude.

How Will the Measures Provide Information About This Indicator?

This indicator has one primary and two surrogate measures. The intention is not to combine them to assess the indicator. Rather, either data for measure 1 will be used or data for measures 2 and 3 will be combined to make a determination about trends.

At the wilderness level, if data are available for the number of parties visiting during the primary use season (measure 1 in the following text), the indicator is deemed adequately addressed and no other data are required to make a determination of change at the wilderness level. As the number of parties visiting increases, the opportunity for solitude declines. Most wildernesses will not have data for this primary measure, and for these areas the monitoring question cannot be answered fully.

Lacking data on the primary measure, the two fallback measures will be the number of wilderness users residing in the service area (measure 2 in the following text) and the estimate of wilderness visits based on NVUM (measure 3 in the following text). These

two measures have several weaknesses, as explained in the following text; hence. they must both indicate a trend in the same direction for a conclusion to be drawn about trends in the indicator.

In general, if wilderness visitation is increasing, opportunities for solitude are declining.

What Are the Cautions About This Indicator?

Use density has been shown to have a variable, often weak, relationship to encounters, and encounters usually do not show a strong relationship to achievement of solitude (Stewart and Cole 2001). Nevertheless, use density is probably the most consistent measurable factor affecting opportunities for solitude (Johnson and others 2005). Solitude is a complex, subjective experience, and science has not been able to identify a well-accepted indicator for it.

Interpretation of this indicator will require special attention in analysis Conclusions will depend on which of the measures is used, as discussed previously.

7.2.2.1. Measure 1 for Indicator 2, Question 1—Visiting Parties

Number of parties visiting a wilderness during the primary use season.

Why Is This Measure Important?

This measure relates most directly to solitude far more so than does measure 2. Although data on encounters would be preferable, total group visits have been shown to have a relationship (albeit weak) to encounters. An increase in party visits will be interpreted as an increase in wilderness visitation, and, therefore, as a decline in opportunities for solitude.

This measure uses the group or party as the unit rather than the number of individual people. This decision was made because there appears to be some evidence in research that people pay attention more to the number of groups they see than the specific number of people. In addition, many wilderness monitoring systems use the group as the base measure (e.g., self-issuing wilderness permits).

The measure is restricted to the primary use season for two reasons. First, most wilderness use occurs during a small portion of the year. Second, most wildernesses do not monitor use year round. The primary use season is determined by the wilderness manager. Ideally, the primary use season should be defined to encompass at least 80 percent of the use, but the decision will be made locally. It is less important that the time span capture 80 percent of the use than that the period be clearly defined so that monitoring can be done consistently over time.

What Are the Attributes of This Measure?

Table 57 describes the attributes used to calculate the number of visiting parties.

Although data are not currently reported for most wildernesses, Infra modules have been developed to track wilderness use. For example, a module for reporting self-issue permit data exists. Because different wildernesses may use different techniques to arrive at their estimates of group visits, various attributes of the data and data collection systems will need to be reported. For the attribute of the number of parties visiting, some wildernesses may track use by individuals rather than groups (e.g., through traffic counters); if this practice is done, data will need to be converted to groups by adjusting for average party size.

At the wilderness level, it is strongly recommended that managers track data individually by trailhead or portal. Use typically is uneven across wildernesses, and long-term data show that increases at one trailhead may not correspond to changes at nearby trailheads.

Table 57.—*Attributes for measuring the number of visiting parties.*

Attribute
Number of parties visiting*
Data source—select all that apply: • Office-issued permit • Self-issued permit • Trailhead register • Trail counter • Other (specify)
Geographic area monitored—select one: • Selected trails • All trails
Method used to validate data—select all that apply: • Compliance check • Observation • None • Other (specify)
How data gaps are treated—select one: • Ignored • Statistically interpolated • Estimated

** The asterisk denotes the attribute used to compute this measure, and the remaining attributes serve a supporting role necessary to help document or interpret the results.*

How Will the Data Be Collected?

- **Primary and secondary (if needed) data sources.** Wildernesses will need to develop a reliable, valid system for measuring use. Examples include permit systems and trailhead registrations (with checks for compliance), car counts (adjusted for the number of people per vehicle), or trail counters (see Hollenhorst and others 1992, Watson and others 2000, Yuan and others 1995). For this protocol, it is recognized that most wildernesses will not have such systems in place and

data cannot be reported for this measure. Wilderness managers' estimates of wilderness visitation were deemed insufficiently reliable and accurate for use as a secondary data source.

- **Frequency of data collection.** Ideally, data will be reported annually. For some systems, such as self-issue permits in popular wildernesses, the burden of entering data annually may be quite high. Therefore, the data collection interval is set at 5 years. This interval is short enough to permit tracking of changes, which might occur rapidly in some areas, but long enough to enable wilderness managers to plan for the extra effort required to collect and report field data.

How Complete Are These Data?

- **Percentage of Forest Service wildernesses that have these data.** Although precise numbers are not available, it seems highly unlikely that more than a small percentage of wildernesses currently collect data on visitation.
- **Known spatial, temporal, and other data gaps.** Use data often contain gaps. Sometimes data are collected for only selected trails or locations. Other times, temporal gaps occur because of missing observations, vandalized trailhead registers, or other factors. These issues will be handled by collecting additional information from wilderness managers.
- **Data adequacy.** Data quantity will be evaluated based on the information supplied about the geographical area monitored. Data will be deemed complete if the entire wilderness is monitored, partial if only some trails/access routes are monitored, and insufficient if no data are collected.

  Data quality will be assessed via information supplied by wilderness managers. Data will be considered to be of high quality if based on office-issued permits or on self-issue permits in cases in which estimates have been adjusted for compliance rates (where appropriate) and in cases in which data gaps are interpolated. Data will be judged to be of moderate quality if they are based on self-issue permits without adjustment for compliance. Trail counter data are also judged to be of moderate quality. Data will be judged to be of poor quality if they are based on trailhead registers without adjustment for compliance or attention to data gaps.

How Will the Data Be Processed and Analyzed?

Wildernesses will report use through existing Infra modules where feasible. If this reporting is not feasible, estimated annual use—along with the information from managers—will be reported. The numbers generated will be total parties visiting the wilderness during the primary use season.

Wilderness visitation can be highly variable year to year, depending on various factors such as the cost of gasoline, the nature of winter snowpack, the intensity of wildfires, and publicity. Therefore, it will be necessary to have multiple years of data to draw firm conclusions about trends in visitation.

As described in Chapter 3, Assessing Trend in Wilderness Character, because these data on the number of visiting parties will be collected at 5-year intervals, regression analysis will be used to determine if the trend in the number of visiting parties over the 5-year monitoring cycle is significantly increasing, decreasing, or stable.

What Are the Cautions About This Measure?

This measure, if available, would provide adequate information about the indicator, but it would not capture the geographic variation in use. It might be important, for example, to know whether all the increases in use were occurring at one or two places or across all wilderness destinations.

The measure does not capture use during the off-peak times of year. In some years, depending on weather and snow, this use may amount to significant visitation. Nevertheless, trends in the peak season, when opportunities for solitude are by definition most limited, would give a sufficient indication of what is occurring wilderness-wide over time.

As currently proposed, this measure can be used to report visitation to an entire wilderness or to a subset of areas or trails. If a wilderness has data for only selected places, the determination of change in the indicator may be less accurate than for wildernesses with complete data.

7.2.2.2. Measure 2 for Indicator 2, Question 1—Users Residing in Service Area

Number of adult wilderness users residing in the service area.

Measure 2 represents the number of adults (age 16 and older) residing in the primary service area of a wilderness who say that they have made at least one visit to a wilderness in the past year. The measure is derived from combining population estimates in the area identified as the primary service area with estimates of the adult wilderness participation rate available for each State from the National Survey on Recreation and the Environment (NSRE). When this measure is used (because measure 1 is not available), it will always be combined with measure 3 to draw conclusions about trends in the indicator.

Why Is This Measure Important?

Although this measure is a large step removed from actual visits to an individual wilderness, it may serve as an early warning system for managers. Measuring adult wilderness users residing in the service area is insufficient to make a confident conclusion about trends in the opportunities for solitude; however, if such use is increasing, it may give an indication that managers need to examine their local conditions more closely. In addition, the measure has the advantage of being able to be used in a proactive way; i.e., future population projections are available and managers may be able to anticipate whether use will be changing in the future by using those projections for the service area of a wilderness.

This measure clearly is not subject to managerial control but it has some advantages. First, population estimate data required for the measure generally are quite accurate. They also are available in tables or spatially (maps) from the U.S. Census Bureau as well as in electronic spreadsheets. The measure should identify and capture significant differences in trends across NFS wildernesses as a whole because, in some regions, population is increasing dramatically while in other areas, population is stable or even declining. Wildernesses in different regions thus face very different levels of threat to the outstanding opportunities quality.

When interpreting change in this measure, it will be important to note whether a wilderness has regulatory limits on visitation because such limits would protect opportunities for solitude in spite of rising populations. For most wildernesses, if the measure is increasing over time, this increase should be interpreted as a clue to investigate actual wilderness visitation further. The lack of specificity of the measure means that it cannot be definitively known whether visitation to a specific wilderness is actually increasing.

What Are the Attributes of This Measure?

Table 58 describes the attributes used in calculating the number of adult users residing in the service area.

For the first attribute, different wildernesses have different service areas. For example, a wilderness whose use consists primarily of day visitors probably has most of its use coming from within about 100 mi. For such wildernesses, the local counties or cities probably encompass the major service area. Other wildernesses—especially flagship areas with high levels of overnight use, such as the Bob Marshall Wilderness or Boundary Waters Canoe Area Wilderness—have larger service areas. Therefore, this attribute specifically requires identification of the primary service area for each wilderness. Careful documentation of the geographical areas used is critical so that they do not change over time, or, if they are changed for some reason, that the change is well documented.

Table 58.—*Attributes for measuring the number of adult users residing in the service area.*

Attribute
Adult (16 years and older) population of each geographical unit in the service area, derived from U.S. Census Bureau data*
Wilderness participation rate adopted from NSRE*
Counties, cities, or standard metropolitan service areas that constitute the service area, determined by the wilderness manager
Basis for determination about geographical area—select primary: • Professional judgment • NVUM • Other data
Presence of use limits (yes or no)
Type of use limits
Geographical extent of use limits

** The asterisk denotes the attribute used to compute this measure, and the remaining attributes serve a supporting role necessary to help document or interpret the results.*
NSRE = National Survey on Recreation and the Environment. NVUM = National Visitor Use Monitoring Program.

The primary service area is defined as the geographical region(s) in which 75 percent or more of the wilderness visitors live. The 75-percent cutoff is arbitrary; however, for each wilderness, analysis will assess the amount of change within the same region(s) over time, so whether one wilderness has a narrower service area than another should not present a major confound.

How Will the Data Be Collected?

- **Primary and secondary (if needed) data sources.** Ranger district or forest staff will have to identify the service area for each wilderness. In doing so, they may identify counties, cities, or standard metropolitan service areas. (It is undesirable to use a combination of counties and cities because city populations are included within county populations.) This practice may require some effort initially; however, unless population distributions change dramatically over time, the service area is likely to remain stable. If the primary service area cannot be confidently identified or is not supplied, the default will be all counties within which the wilderness is located. In this case, Forest Service WO staff will overlay a GIS layer of wilderness boundaries with a GIS layer of county boundaries and identify all intersections. This procedure will generate the names of counties within which each wilderness falls.

  Estimates of per capita wilderness visitation are available for the different States from the NSRE, which is conducted at regular intervals by the Forest Service's Southern Research Station. Estimates of county-level population (age 16 and older) are available every 10 years from the U.S. Census Bureau, with projected changes provided for every year. Assuming per capita wilderness participation

remains relatively stable across time, the number of wilderness users will increase or decrease according to total population changes.

- **Frequency of data collection.** This measure relies on data collected at 10-year intervals (U.S. Census Bureau data and NSRE projections). Although census data also provide projected population numbers for all years between actual censusing, NSRE projections are usually not interpolated between one survey period and the next. The data will be *collected* using the collection interval of NSRE (approximately 10 years), but *reported* annually. That is, when new NSRE estimates become available, they and the census data will be accessed for each wilderness. Estimates reported annually for each subsequent year will be interpolated using the most recent NSRE participation rate and census projections.

How Complete Are These Data?

- **Percentage of Forest Service wildernesses that have these data.** Currently, although a service area is not reported for any wilderness, the task of identifying the service area requires minimal effort in many cases and can be established through professional expertise. (Managers may wish to consult NVUM data on visitor origins.) If no information is available, the default area will be used as described previously. Thus, information is available for all wildernesses. Census data and NSRE data are complete.
- **Known spatial, temporal, and other data gaps.** There should be no gaps in data. If a wilderness does not supply a primary service area, the default will be used. No spatial gaps occur in the NSRE or census data.
- **Data adequacy.** Data quantity is deemed to be complete for all wildernesses. The primary threat to data quality is in misspecification of the service area, which will be assessed via information provided by wilderness managers about the basis for defining the service area. No effort to evaluate the quality of census or NSRE data will be made. If the service area is determined from NVUM or other measured data, data quality is judged to be high. If the service area is based on professional judgment, the data quality is judged to be moderate. No cases exist in which data quality will be judged to be poor.

How Will the Data Be Processed and Analyzed?

Data from the U.S. Census Bureau will be obtained for every county or city determined to form part of the primary service area. Wilderness managers or Forest Service WO staff will access the U.S. Census Bureau's Web site and obtain population estimates for residents aged 16 years and older for each county. In addition, they will identify projected

populations aged 16 years and older for each county for each upcoming year. These population estimates will be multiplied by the most recent per capita participation rate estimated by the NSRE for the geographical area within which the county falls. Currently, Cordell (2004) provides estimates at the State level for visiting a wilderness or primitive area; this is the item to be used. The computation will generate an estimated number of adult wilderness users in the primary service area.

During analysis and interpretation of change over time, the first step will be to determine which wildernesses have use limits. In wildernesses with use limits, it will be concluded that wilderness visitation is stable, regardless of changes in the number of wilderness users in the primary service area based on measure 2. For all other wildernesses, an increase in measure 2 suggests that wilderness visitation may be increasing. The conclusion about trends in the indicator depends on measure 3 as well; only if the two measures show change in the same direction will a conclusion about the indicator be drawn. Otherwise, it will be reported that adequate data are not available.

In reports to the regions, change over time will be reported for each county or city for each wilderness. (Table 59 shows a hypothetical case.) In the National Report, only total change in the number of wilderness users in the primary service area will be reported.

Significant trends in this measure are defined as a change of 5 percent or more over the 5-year monitoring cycle in the number of adult users residing in the service area. For example, if the initial reporting is 30,000 adult users, and at the end of the 5-year monitoring cycle 32,700 adult users are reported (because of net movement of people into the service area), this 9-percent increase is a significant degradation in the measure. Conversely, a 9-percent decline would be a significant improvement in the measure. Or, if at the end of the 5-year monitoring cycle 31,200 adult users are reported, this 4-percent increase is not a significant change.

Table 59.—*Hypothetical change over time in the number of adult wilderness users residing in the service area of one wilderness.*

County	Attribute	Year 1	Year 2	Percent change
Leopold	Total population	58,000	62,000	6.9
	Estimated wilderness users[1]	29,464	31,496	6.9
Marshall	Total population	17,500	23,000	31.4
	Estimated wilderness users	8,890	11,684	31.4
Olson	Total population	19,500	18,750	– 3.8
	Estimated wilderness users	9,906	9,525	– 3.8
Totals	Total population	95,000	103,750	9.2
	Estimated wilderness users	48,260	52,705	9.2

[1] Estimated wilderness users residing in the primary service area, based on National Survey on Recreation and the Environment estimate of 50.8 percent of respondents from Idaho indicating they had visited a wilderness or primitive area in the past 12 months.

Results that represent less than a 5-percent increase or decrease in the data value over the monitoring cycle will be categorized as stable. This relatively broad band of 10-percent allowed change acknowledges the low level of precision and accuracy associated with the data used in this protocol. Any change above this 10-percent band will be determined to be beyond noise in the data and to be reflective of actual change in wilderness conditions. The conclusion drawn from this measure will be compared with the conclusion drawn based on measure 3, as described previously.

What Are the Centralized Data Analysis Tasks?

Data processing that could be accomplished by a centralized data analyst includes the following:

1. Determining the service area for each wilderness (typically the neighboring counties).
2. Looking for population data at http://quickfacts.census.gov/qfd/states/.
3. Determining the growth rate for the entire population and applying this rate to people aged 16 years and older to project the portion of the population composed of people aged 16 years and older for the current year. The U.S. Census Bureau will have population data for all people for the date of the last census and typically a more recent extrapolated value that may not be for the current year. The census will only have population data for people aged 16 years and older for the date of the last census.
4. Looking up NSRE per capita participation wilderness visitation rate for the State of each county in the service area. Multiply visitation rates by the projected county population of people aged 16 years and older to calculate the number of users residing in the service area.

What Are the Cautions About This Measure?

This measure can reliably be computed over time. Data exist and are of acceptable accuracy, and computations are straightforward. Therefore, this measure is a reliable measure of the indicator.

Despite these qualities, this measure is an insufficient for assessing opportunities for solitude and is not deemed adequate by itself to generate information needed to answer monitoring question 1. As a result, this measure must be used in conjunction with measure 3 if data for measure 1 are not available. At best, a weak relationship exists between the number of wilderness users living in the primary service area and the number of people concentrated in particular wilderness locations at any given time. The per capita participation rates from NSRE do not provide any information about which particular wildernesses people

visit or how often they visit them. In reality, use is likely to be concentrated in certain wildernesses and certain places within those wildernesses. This measure treats all wildernesses served by a given market area as identical in use.

Another concern is the validity of the NSRE participation estimates. NSRE studies ask about wilderness or primitive area visitation, but it is unclear whether citizens actually know what wildernesses are. Even if they do know and accurately report whether they have visited a wilderness, the question does not ask about which wildernesses were visited or when, and data do not indicate anything about frequency of participation. Such information is crucial for understanding actual use patterns within specific wildernesses.

Moreover, even if using the number of wilderness users in a service area were an accurate measure of wilderness visitation, the problem of correctly identifying the primary service area exists. If most visitors come from a small area, and if this area is well described, then the estimates will be more accurate. If users come from diverse geographic areas, then measures will be less likely to relate to actual use of the wilderness. In addition, this measure assumes that managers know enough about their visitors to identify the service area.

Although census data are quite accurate, using data for entire counties may add noise to the assessment. For example, with very large counties, it is probably the case that different portions of each county contribute differently to recreational use pressure.

7.2.2.3. Measure 3 for Indicator 2, Question 1—NVUM Visits

NVUM annual wilderness visits.

Measure 3 uses NVUM data to estimate the number of visits to wilderness, where a visit is defined as one entry by an individual. Unlike measure 2, this measure reflects frequency of visitation. In addition, data are collected on site at wilderness trailheads, so it is certain (unlike with measure 2) that people actually visited a wilderness.

Why Is This Measure Important?

The NVUM Program has become the standard Forest Service way to report recreational use of NFS lands. Through a stratified sample of types of areas—one of which is wilderness—the program generates estimates and 80-percent confidence intervals for wilderness visits, reported as the number of individual visits to a wilderness per year for each national forest. The program collects data from a sample of wilderness access points on each forest that have wilderness. The sampling protocol does not permit individual wilderness-level estimates because only a small number of access points are sampled for a small number of days. Wilderness use is extremely uneven, both spatially and temporally, so it is not possible to use data to interpolate estimates for areas that are not sampled; however,

NVUM does provide an estimate of the total number of wilderness visits for each national forest. The measure relies on the judgment of wilderness managers to determine what percentage of the forest's wilderness use occurs in each wilderness on the forest.

To monitor wilderness character, it is essential to be able to assess solitude to make a determination about trends in the outstanding opportunities quality. Although NVUM data have many drawbacks, they can be used in conjunction with measure 2 to draw tentative conclusions about trends in this indicator of opportunities for solitude.

What Are the Attributes of This Measure?

Table 60 describes the attributes used in calculating NVUM annual wilderness visits.

Table 60.—*Attributes for measuring the National Visitor Use Monitoring annual wilderness visits.*

Attribute
Number of wilderness visits*
Estimated percentage of a national forest's wilderness use that occurs in this wilderness*

** The asterisks denote the attributes used to compute this measure.*

How Will the Data Be Collected?

- **Primary and secondary (if needed) data sources.** Forest-level data are derived from the NVUM databases (http://www.fs.fed.us/recreation/programs/nvum/), but local wilderness managers must provide an estimate of the proportion of that use that occurs in each wilderness.
- **Frequency of data collection.** Data will be collected every 5 years. This timeframe is also the data collection interval for NVUM.

How Complete Are These Data?

- **Percentage of Forest Service wildernesses that have these data.** Although in some cases, samples of wilderness visitors for a given wilderness are quite small, all NFS wildernesses are represented in the NVUM data.
- **Known spatial, temporal, and other data gaps.** Any data gaps are dealt with by NVUM before reporting.
- **Data adequacy.** In one respect, serious concerns about data quantity exist because NVUM estimates are often based on very small samples. Nonetheless, it is outside the scope of this protocol to address this issue. Therefore, data quality will be judged to be complete for wildernesses in which NVUM has provided a forest-wide estimate of wilderness visitation.

Data quality may be poor, particularly if managers' estimates of the percentage of use that occurs in each wilderness are inaccurate. At present, it is not possible to assess this limitation directly. The issue is acknowledged by requiring that trends in both measure 2 and measure 3 converge before conclusions are drawn about trends in the indicator.

How Will the Data Be Processed and Analyzed?

Estimates of the percentage of wilderness use that occurs on each wilderness within a forest will be supplied by wilderness managers. NVUM data for the forest will be acquired by staff in the WO and apportioned to each wilderness based on the information provided by managers.

Significant trends in this measure are defined as a change of 5 percent or more over the 5-year monitoring cycle in the number of NVUM visits. For example, if the initial reporting is 20,000 NVUM visits and at the end of the 5-year monitoring cycle 21,400 NVUM visits have been reported, this 7-percent increase is a significant degradation of this measure. Conversely, a 7-percent decrease is a significant improvement in the measure. Or, if at the end of the 5-year monitoring cycle 19,200 NVUM visits have been reported, this is a 4-percent decrease and is not a significant change.

Results that represent less than a 5-percent increase or decrease in the data value over the monitoring cycle will be categorized as stable. This relatively broad band of 10-percent allowed change acknowledges the low level of precision and accuracy associated with the data used in this protocol. Any change above this 10-percent band will be determined to be beyond noise in the data and to be reflective of actual change in wilderness conditions.

The conclusions drawn from this measure will be compared with conclusions based on measure 2. Only if both measures indicate a trend in the same direction will a conclusion be drawn about change in the indicator.

What Are the Cautions About This Measure?

NVUM data are based on small samples and generate wide confidence intervals. Therefore, if local data are available from observations, permits, or other systematic measures of use, those measures should be used to make local-level determinations about the indicator of wilderness visitation. NVUM data have the potential to be skewed by selecting especially high- or low-use trailheads, by weather, or by other factors. To date, no effort has been made to validate estimates based on other tested measurement systems. Anecdotal information suggests that, in some cases, the estimates diverge considerably. In addition, different trails may be sampled in different cycles, raising questions about the comparability of the data over time. Information on the NVUM methods can be found at http://www.fs.fed.us/recreation/programs/nvum/index.shtml.

Estimates of the percentage of a forest's total wilderness use that occurs within each wilderness are based on professional judgment, and their accuracy is unknown.

7.3. Monitoring Question 2—Primitive Recreation

What are the trends of outstanding opportunities for primitive recreation?

Why Is This Monitoring Question Important?

The Wilderness Act explicitly calls for the protection of opportunities for "primitive and unconfined recreation." In this monitoring, this statement from the Wilderness Act is interpreted as two distinct dimensions and two separate monitoring questions are generated for primitive recreation and unconfined recreation. Primitive recreation is conceptualized more narrowly than solitude, referring to types of recreation that require primitive travel and living in an environment with minimal facilities (Johnson and others 2005, Roggenbuck 2004). The founders of the wilderness idea referred to primitive travel, such as canoeing, horse packing, and hiking, as exemplifying appropriate activities in wilderness. Primitiveness also entails a sense of self-reliance; one must be responsible for one's own safety and decisions (Borrie and Roggenbuck 1998, Borrie 2004) and, as such, the experience of primitive wilderness recreation may be more likely on multiday trips. Opportunities for primitive recreation are most outstanding in wildernesses in which few facilities (other than trails, perhaps) exist and in which visitors must use their skills to navigate, travel, and live in wilderness conditions.

Primitive recreation consists of activities that require self-reliance and no modern conveniences. Although developments are specifically tracked under the undeveloped quality, they also have an independent effect on the opportunities for visitors to experience primitive recreation if the developments are located in parts of the wilderness area visited by recreationists and if the developments are facilities that make the experience more comfortable. Even if visitors appreciate such comforts, they identify them as reducing the feeling of primitiveness (Johnson and others 2005). Therefore, an indicator of recreation facilities was developed. Primitive recreation also relates to the nature of travel in the wilderness (Roggenbuck 2004) and the type of trail is important to this aspect (Hall 2001). Thus, a second indicator for this monitoring question addressed trail development level.

Although it is likely that many other modern developments or structures (such as dams and scientific installations) also affect the opportunities for primitive recreation, those developments are captured under the undeveloped quality and are not tracked under this monitoring question. Thus, this indicator focuses specifically on recreation facilities.

Some people question whether the use of modern equipment, such as gas-burning stoves, high-tech gear, and Global Positioning System (GPS) units, detracts from the experience of primitive recreation in wilderness (e.g., discussed in Pohl [2006]). Because this debate is unresolved, and because it would be impractical to attempt to monitor individual choices about equipment, an indicator related to modern equipment was not developed. In addition, one can argue that it is an individual choice whether to bring modern equipment, and as long as managers provide an environment free of facilities and equipped with primitive trails, visitors have the *opportunity* to experience primitive recreation.

How Will the Indicators Be Used To Answer This Question?

The two indicators together do a reasonably accurate job of addressing the monitoring question. Primitive recreation is narrowly defined and aspects of facilities and trails encompass many of its dimensions.

The measures for each indicator—recreation facilities index and developed trail miles—are in different metrics. Thus, combining them will require a qualitative assessment of whether each has changed and in what direction. As described in Chapter 3, Assessing Trend in Wilderness Character, trends of the individual indicators will be synthesized to develop an overall trend estimate to answer this monitoring question. Table 61 shows possible combinations of trends in the indicators and the resulting trend to answer the monitoring question about outstanding opportunities for primitive recreation. The resulting arrows show the trend as improving (upward-pointing arrow), offsetting stable (double-headed vertical arrow), stable (double-headed horizontal arrow), or degrading (downward-pointing arrow).

Table 61.—*The trend in the monitoring question about primitive recreation is derived from adding across the trends in its component indicators.*

Measure	Possible trends in the measure								
Recreation facilities index	⇧	⇧	⇔	⇧	⇩	⇔	⇔	⇩	⇩
Developed trail miles	⇧	⇔	⇧	⇩	⇧	⇔	⇩	⇔	⇩
Resulting trend in the monitoring question	⇧	⇧	⇧	⇳	⇳	⇔	⇩	⇩	⇩

Note: An improving trend in developed trail miles is fewer, not more, developed trail miles.

What Are the Cautions About This Question?

In discussions with the technical team, and based on a review of the literature, there seems to be relatively little disagreement about the value of this monitoring question. The indicators selected are deemed to provide a useful indication about trends in primitive recreation. Nevertheless, some dimensions of primitive recreation are not captured here, the most important of which is the risk factor. Ideally, an additional indicator of primitive

recreation would monitor opportunities for personally challenging experiences, such as coping with the possibility of encounters with dangerous wildlife or crossing large streams where no bridges exist. It was not considered possible to develop such an indicator at this time.

Another aspect of primitive recreation that is not captured with the selected indicators is the opportunity to practice primitive skills, such as firebuilding, or subsistence activities, such as hunting or berry picking. If regulations such as fire bans or restrictions on hunting or fishing are in place, some people argue that this scenario restricts opportunities for primitive recreation.

7.3.1. Indicator 1 for Question 2—Recreation Facilities

Recreation facilities.

Why Is This Indicator Important?

Indicator 1 captures durable or permanent facilities provided by managers for the use of visitors. Regardless of whether they are provided for resource protection or visitor convenience, these facilities affect the sense of primitiveness. If an increase in recreation facilities occurs, the opportunity for primitive recreation will be said to have declined.

How Was This Indicator Chosen?

This indicator meets many of the criteria for indicator selection. It is feasible to measure using data already reported or easily obtained, it is significant, it is responsive to management actions, and it is credible.

Other related indicators were considered but ultimately dropped. For example, discussions occurred about whether outfitted use should be monitored under this indicator because outfitted trips generally provide a high level of conveniences that detract from the primitive experience. No such indicator was developed because it could be argued that all visitors have the ability to outfit themselves with conveniences and modern equipment.

How Will the Measures Provide Information About This Indicator?

Only one measure for the indicator exists: recreation facilities index. This index is a measure of the total number of facilities. If the number increases over time, it will be concluded that recreation facilities have increased and the indicator is trending in a negative direction.

What Are the Cautions About This Indicator?

Recreation facilities are a useful indicator of opportunities for primitive recreation. Ideally, an indicator that monitors challenging opportunities that are intentionally preserved in the environment, such as large streams that must be forded because no bridges exist, also would be present. Existing databases track only facilities themselves, however, not situations in which facilities might be but are not placed. Therefore, this indicator is based only on the presence of facilities.

7.3.1.1. Measure 1 for Indicator 1, Question 2—Recreation Facilities Index

Recreation facilities index.

Why Is This Measure Important?

Recreation facilities provided by management that reduce the feeling of primitive recreation are monitored. These include shelters, developed water sources, toilets, and other facilities that make the experience more comfortable or easy. Even though visitors may enjoy such facilities, and in some cases they may be authorized by law, they are inconsistent with primitive recreation. Physical location (spatial) information is not prescribed for this indicator because it is assumed that most recreational facilities are located where visitors travel.

This measure is accurate, reliable, and sensitive to change. Several facilities are tracked through Infra, and the definition of each facility is clear and precise. Managers can easily and accurately report the presence of most facilities that are not currently reported. If management actions add or remove facilities, the impact on the indicator and the outstanding opportunity quality is immediate and direct. A decrease in the number of recreation facilities indicates an improvement in the opportunities for primitive recreation. An increase in recreation facilities indicates deterioration in the opportunities for primitive recreation.

This index includes nearly all recreation facilities and developments in wilderness and, therefore, is a good measure of the indicator. Other developments unrelated to the immediate recreation experience (such as scientific installations or dams) are monitored under the undeveloped quality.

What Are the Attributes of This Measure?

Table 62 describes attributes used in calculating the index of recreation facilities.

Each structure is weighted equally. All recreation facilities at a site are counted separately; e.g., a toilet and a fire ring at one site are counted separately, as would be a bear box that is attached to a shelter. The team could not develop a plausible rationale for weighting the different structures differently.

Table 62.—*Attributes for measuring the index of recreation facilities.*

Attribute
Number of toilets*
Number of constructed tent pads or sleeping platforms (those dug out of the earth with no constructed elements are not included)*
Number of picnic tables*
Number of bear poles or other food storage structures*
Number of developed (permanent) fire rings/grates*
Number of shelters*
Number of developed water sources*
Number of corrals*
Number of large bridges*

** The asterisks denote the attributes used to compute this measure.*

How Will the Data Be Collected?

- **Primary and secondary (if needed) data sources.** Currently, data on several of these elements are not reported. Nevertheless, local wilderness managers can accurately report these features with minimal effort and without the need for field data collection. In addition, information on toilets, tables, and fire rings are part of the national campsite monitoring protocol currently under development. Corrals are not tracked in that effort and are not currently tracked elsewhere, but they are retained in this protocol because managers probably know where corrals are located and how many exist. Information on bridges will be obtained through the Infra-Trails database. Information on developed water sources is tracked in the Infra-Water Sources module, and shelters are tracked in the Infra-Constructed Features module.

  Airstrips were explicitly discussed and dropped from the measure because very few airstrips exist in NFS wildernesses. Their effect appears primarily to be on the opportunity for solitude, and they are included in measures for that monitoring question.

- **Frequency of data collection.** These features are unlikely to change over the short term. Therefore, data will be collected and reported at 5-year intervals.

How Complete Are These Data?

- **Percentage of Forest Service wildernesses that have these data.** Most Forest Service wildernesses provide information on some of these elements. The remaining information is not currently reported but is easily obtained without additional fieldwork.

- **Known spatial, temporal, and other data gaps.** Information for all elements in the index must be provided to generate a score. If information is not available for any one or more elements, reporting will note that data are not available for that wilderness.
- **Data adequacy.** Data will be judged to be complete for all wildernesses as long as data have been entered in Infra. Data quality will be ensured by the process of review and certification. That is, data generated centrally will be validated by field managers. Therefore, data quality will be judged to be high for all wildernesses.

How Will the Data Be Processed and Analyzed?

As discussed previously, some data will need to be provided by local wilderness managers. Analysis will take place at the Forest Service WO for this measure. A summative index will be computed for each wilderness. Although different facilities probably have different influences on the feeling of primitiveness, it was not deemed possible to develop a defensible weighting system. Therefore, each structure or feature is weighted equally, and the index is thus a simple total. Data will be reported for each type of feature in each wilderness, however, because knowledge about specific types of features may be locally important. Each year after baseline, the change from the previous year will be reported as the simple (absolute) change.

Significant trends in this measure are defined as a change of 5 percent or more over the 5-year monitoring cycle in the index of recreation facilities. For example, if the initial reporting for this index is 20, and at the end of the 5-year monitoring cycle the index is 23 (because two shelters and one bear pole were added), this 15-percent increase is a significant degradation of this measure. Conversely, a 15-percent decrease would be a significant improvement in this measure. Or, if at the end of the 5-year monitoring cycle the index is 19 (because one bear pole was removed), this is a 5-percent decrease and is a significant change. In a case in which a wilderness has no recreation facilities and one is added, this decrease represents a significant change and, even though it does not meet the 5-percent criterion discussed previously, this change is deemed a significant degradation.

Results that represent less than a 5-percent increase or decrease in the data value over the monitoring cycle will be categorized as stable. This relatively broad band of 10-percent allowed change acknowledges the low level of precision and accuracy associated with the data used in this protocol. Any change above this 10-percent band will be determined to be beyond noise in the data and to be reflective of actual change in wilderness conditions.

What Are the Cautions About This Measure?

The measure provides a reliable assessment of this indicator. Recent research (Johnson and others 2005) suggests that visitors associate facilities closely with the concept of primitiveness. Most of the facilities that would influence the opportunity for primitive recreation are or will be tracked in Infra, and little ambiguity about them exists.

Overall, as a measure of opportunities for primitive recreation, this measure captures many of the influences on the feeling of primitiveness. Nevertheless, several scholars think that the experience of primitiveness is as much or more influenced by the types of equipment visitors bring with them than the environment they encounter (Roggenbuck 2004). Such factors are not captured with this measure.

No differential weights are assigned to the different elements in the index. Therefore, the actual impacts on opportunities for primitive recreation could be different among wildernesses that receive the same score on the measure. For example, one that has 10 toilets would receive the same score as one that has 10 shelters. This scenario reinforces the need to avoid comparisons among wildernesses.

7.3.2. Indicator 2 for Question 2—Trail Development Level

Trail development level.

Why Is This Indicator Important?

A significant influence on visitors' experiences is the quality of the trail they travel. Traveling on a narrow, rocky path creates a more primitive feeling than traveling on a wide, groomed surface (Hall 2001). The term "trail development" can be defined reliably using existing reporting categories that are well defined in Forest Service direction. This indicator is sensitive to change and able to show both improvement and deterioration in opportunities for primitive recreation. Definitions and measures are objective and clear. In practice, if the information reported by management units is not based on field surveys, it may be less reliable or accurate than desired.

How Was This Indicator Chosen?

This indicator was selected because it addresses the travel aspects of wilderness recreation, while the recreation facilities indicator addressed primarily campsite features. This indicator is feasible to measure and appears to be significant. In principle, it is responsive to management, although changes in trail condition class are not likely to occur often, and, when they do, change may be gradual (such as when a trail gradually disappears because of a lack of maintenance).

How Will the Measure Provide Information About This Indicator?

Only one measure for this indicator exists. An increase in the number of trail miles in developed condition classes represents a decline in opportunities for primitive recreation. A decrease in the overall developed character of trails represents an improvement in opportunities for primitive recreation.

What Are the Cautions About This Indicator?

Although trail condition has been shown to be an important influence on the feeling of primitiveness, it captures only one aspect of the quality. Thus, the other indicator of primitive recreation is also required to answer the monitoring question. As mentioned previously, changes in this indicator are likely to be slow. In addition, different users may have different perceptions or feelings about how trail development level affects their opportunities for primitive recreation. For example, hikers may feel that a developed trail restricts their opportunities for primitive recreation, whereas a person riding a horse may feel that the same level of developed trail is necessary for their recreation in wilderness.

7.3.2.1. Measure 1 for Indicator 2, Question 2—Developed Trail Miles

Number of trail miles in developed condition classes (classes 3 to 5).

Why Is This Measure Important?

This measure is a direct, strong measure of the indicator. An increase in trail miles would represent an increase in trail development level and a decline in the opportunity for primitive recreation.

What Are the Attributes of This Measure?

Table 63 describes attributes used in calculating the number of trail miles in developed condition classes.

Table 63.—*Attributes for measuring the number of trail miles in developed condition classes.*

Attribute
Miles of trail in each condition class (classes 3 to 5)*
Method used to determine mileage—select all that apply: • Trail wheel • Planimeter used on map • GIS • Other (specify)
Year of most recent trail inventory

** The asterisk denotes the attribute used to compute this measure, and the remaining attributes serve a supporting role necessary to help document or interpret the results.*

GIS = Geographic Information System.

Wildernesses without trails will be assigned a value of 0. The measure does not track primitive trails (condition classes 1 and 2) because those levels are consistent with primitive recreation. If more primitive trails are constructed over time, this scenario would not be interpreted as adversely affecting opportunities for primitive recreation. It would, however, signal a decline in the undeveloped quality; therefore, all trail miles are tracked under that quality instead of under this measure.

Wilderness managers will be asked to report the method used to determine mileages. This information is important for interpreting change over time. For example, mileages determined with a measuring wheel are more accurate, and apparent change over time based on data obtained this way is more likely to reflect real changes.

How Will the Data Be Collected?

- **Primary and secondary (if needed) data sources.** Currently, the Infra-Trails database requires reporting current trail standard by condition class.
- **Frequency of data collection.** Because changes are likely to be slow, data will be collected and reported at 5-year intervals.

How Complete Are These Data?

- **Percentage of Forest Service wildernesses that have these data.** Data are complete for most wildernesses.
- **Known spatial, temporal, and other data gaps.** All wildernesses are likely to have trail information, so data quantity is not an issue. The quality of these data, however, may be a problem in some cases. It is possible that trails that no longer exist still show up on trail maps. In addition, trails may be maintained to a standard higher or lower than that indicated on maps.
- **Data adequacy.** Data quantity will be judged to be complete because all wildernesses have Geographic Information System travel layers. In some cases, however, inconsistencies occur between this GIS layer and what is actually on the ground. Data quality will be evaluated based on additional information provided by wilderness managers about the basis for mileage estimates and the year of the most recent inventory.

How Will the Data Be Processed and Analyzed?

The measure is a simple total number of miles. Change over time will be reported as a percentage of change from the baseline.

Significant trends in this measure are defined as a change of 5 percent or more over the 5-year monitoring cycle in the number of developed trail miles. For example, if the initial reporting for this number of trail miles is 200, and at the end of the 5-year monitoring cycle the number of trail miles is 220 (because a new section of developed trail was built), this 10-percent increase is a significant degradation of this measure. Conversely, a 10-percent decrease would be a significant improvement in this measure. Or, if at the end of the 5-year monitoring cycle 192 developed trail mi are reported (because one section of trail was not maintained), this percent decrease is not a significant change.

Results that represent less than a 5-percent increase or decrease in the data value over the monitoring cycle will be categorized as stable. This relatively broad band of 10-percent allowed change acknowledges the low level of precision and accuracy associated with the data used in this protocol. Any change above this 10-percent band will be determined to be beyond noise in the data and to be reflective of actual change in wilderness conditions.

What Are the Cautions About This Measure?

Obtaining accurate initial information on the number of miles of trail in each condition class may be quite time consuming if wilderness managers do not already have this information, and estimates may be rather inaccurate. Some concern exists about the accuracy of the mileage and condition estimates, which may be provided by GPS mapping, estimation via GIS, or professional judgment. Therefore, for each wilderness, the technique used to generate mileage estimates will be reported. Once initial baseline data are obtained, updating the information at 5-year intervals should not be difficult.

7.4. Monitoring Question 3—Unconfined Recreation

What are the trends of outstanding opportunities for unconfined recreation?

Why Is This Monitoring Question Important?

The Wilderness Act stipulates that wilderness should be managed to protect opportunities for primitive and unconfined recreation. Thus, this question directly addresses the statutory language of the act. Unconfined recreation refers to types of recreation in which visitors experience a high degree of freedom over their own actions and decisions (Dustin and McAvoy 2000, Hendee and Dawson 2002). In this sense, unconfined recreation is largely affected by the types of rules and regulations imposed by management, although it is also likely to be affected to some extent by the presence and behavior of other visitors, because worrying about how others affect one's peace of mind and behavior can be considered confining. Unconfined recreation also encompasses the sense of discovery,

adventure, and mental challenge presented by large wildernesses in which one can travel widely and explore unique and unknown environments on one's own. Outstanding opportunities for unconfined recreation thus are most likely to occur in wildernesses that are large, have many acres suitable for off-trail exploration, have relatively low levels of use, and are free from management restrictions over visitors' activities.

How Will the Indicators Be Used To Answer This Question?

Although the single indicator—management restriction of behavior—addresses a central aspect of the monitoring question, other aspects that might be considered confining (such as individual or social factors) are not addressed (McCool 2004). An increase in management restriction would indicate a decline in opportunities for unconfined recreation.

What Are the Cautions About This Question?

Direct regulatory actions taken to increase opportunities for solitude will be defined as confining (McCool 2004); i.e., in certain respects, improvements in one opportunity necessarily entail declines in the other. This tradeoff should be explicitly noted where relevant, and additional information from managers track the reasons that actions are taken.

7.4.1. Indicator 1 for Question 3—Management Restrictions

Management restrictions on visitor behavior.

Why Is This Indicator Important?

Visitors' opportunities to experience freedom from management are significantly affected by the number and type of regulations in place (McCool 2004). Although some regulations are not considered specifically detrimental to feeling unconfined (e.g., prohibitions on littering), other regulations have considerable effect.

How Was This Indicator Chosen?

This indicator is highly accurate, reliable, sensitive to change, and meaningful to the unconfined dimension of the outstanding opportunities quality.

How Will the Measure Provide Information About This Indicator?

Only one measure exists, so interpretation is straightforward. A decrease in the level of restriction represents an improvement in the opportunity for unconfined recreation. An increase in the level of restriction represents a decline in the opportunity for unconfined recreation.

What Are the Cautions About This Indicator?

Ideally, this indicator would incorporate the spatial extent of different regulations. It makes a difference, for example, if use limits are in place at only one destination as opposed to limits across an entire wilderness. With existing data, however, it is probably too burdensome to ask wilderness managers to compute the precise spatial extent of each regulation. Instead, a compromise was reached in which it will be recorded whether regulations apply to an entire wilderness or a portion of the wilderness.

In addition, scholars continue to debate about whether regulations imposed outside wilderness differ in the way they affect the wilderness experience from regulations that govern behavior once a person enters a wilderness. The measure we use does not take into account whether regulations affect a person before the trip (e.g., use limits) or after they are inside a wilderness (e.g., campfire prohibitions).

This indicator captures an important domain of factors that influence the sense of unconfined recreation. The way the measurement is computed takes into account the fact that some regulations are more onerous than others. Many management actions have a considerable influence on visitors' sense of freedom and adventure, and most of these actions are captured well by this indicator. Lack of confinement is also likely to be influenced by other factors, especially the presence and behavior of other visitors. Such influences are not captured with this indicator.

7.4.1.1. Measure 1 for Indicator 1, Question 3—Visitor Restrictions Index

Index of restrictions on visitor behavior.

Measure 1 is a weighted index of restrictions on visitor behavior, with scores (0 to 3) for each of 11 categories of regulations weighted by geographic extent (1 equals subarea, 2 equals wildernesswide). Scores on the index can range from 0 to 46.

Why Is This Measure Important?

This index incorporates all regulations commonly used that affect recreational visitors. It is tightly linked to the indicator: an increase in the index equates to an increase in management restriction of behavior. The index weights more onerous restrictions more heavily.

What Are the Attributes of This Measure?

Table 64 describes the attributes used in calculating the index of restrictions on visitor behavior.

Table 64.—*Attributes for measuring the index of restrictions on visitor behavior.*

Attribute
Visitor use regulations*
Geographical extent of regulations*—select one: • Subarea • Entire wilderness area
Purpose of regulations—select all that apply: • Enhance experience quality • Resource protection

** The asterisk denotes the attribute used to compute this measure, and the remaining attributes serve a supporting role necessary to help document or interpret the results.*

Information about the purpose of each regulation will be important when interpreting changes in the different indicators for the outstanding opportunity quality (e.g., whether restrictions were imposed to enhance solitude).

This index is composed of the following regulations. The specific labels are derived from the database fields in Infra-WILD. Other regulations may be in place but were not included because they do not present significant confinement of the visitor (such as anti-littering regulations) or are very uncommon.

- Campfire restriction—designated site only.
- Campfire restriction—above designated elevation.
- Campfire restrictions—mandatory setbacks, other.
- Campfire restrictions—mandatory setbacks, water.
- Campfires prohibited.
- Campsite restriction—in designated sites only.
- Campsite restriction—mandatory setback, other.
- Campsite restriction—mandatory setback, sites.
- Campsite restriction—mandatory setback, trails.
- Campsite restriction—mandatory setback, water.
- Fees required.
- Human waste restrictions—must pack out.
- Maximum length of stay.
- Permits required.
- Permits required—day use.
- Permits required—multiple day use.
- Permits required—overnight use.
- Stock use restrictions—grazing prohibited.
- Stock use restrictions—feed restricted.

- Stock use restrictions—mandatory setback, sites.
- Stock use restrictions—mandatory setback, trail.
- Stock use restrictions—mandatory setback, water.
- Stock use restrictions—no camping with stock.
- Stock use restrictions—no free trailing.
- Stock use restrictions—no hitching or tethering.
- Swimming and/or bathing prohibited.
- Area closures.
- Maximum party size.
- Dogs restricted—leashed/under control.
- Dogs restricted—prohibited.

How Will the Data Be Collected?

- **Primary and secondary (if needed) data sources.** Infra-WILD includes a description of the regulations, with presence or absence information for each wilderness. Processing and analysis will be done at the Forest Service WO.
- **Frequency of data collection.** Because regulations can change quickly, data will be collected and reported every year.

How Complete Are These Data?

- **Percentage of Forest Service wildernesses that have these data.** Because these data are used for public information purposes, they tend to be up-to-date and complete. As many as one-fourth to one-third of wildernesses report having none of the various categories of regulations in place, but some wildernesses use a range of different regulations.
- **Known spatial, temporal, and other data gaps.** Data Gaps should not be a problem for this measure.
- **Data adequacy.** Data will be judged to be complete, because all wildernesses report information on regulations via Infra-WILD. Data quality will be ensured by the process of review and certification. That is, data generated centrally will be validated by field managers. Therefore, data quality will be judged high for all wildernesses.

How Will the Data Be Processed and Analyzed?

Initially, a score is given within each category of regulation according to the guidelines presented in table 65. If a wilderness has more than one type of regulation within a given

category, the score will be assigned that corresponds to the most restrictive regulation in place. A higher score indicates a greater degree of restriction on visitor behavior.

- A score of 0 indicates no regulation within the category.
- A score of 1 indicates some restriction but retention of some individual choice. For example, designated site camping policies enable visitors to choose from available sites when they arrive at their destination. A score of 1 is also assigned in cases in which regulations are restrictive but affect only one segment of the population (e.g., group size limits generally will not affect most users, and leash laws affect only those with dogs).
- A score of 2 indicates that no choice is permitted. For example, assigned site policies that require visitors to select campsites before beginning their trip would receive a score of 2.
- A score of 3 is reserved for the most restrictive regulations: use limits, waste pack-out requirements, closures to stock, and area closures to all use.

Table 65.—*A list of categories, scores, and types of restrictions for computing the visitor restriction index.*

Category	Score	Type of restriction
Campfires	0	No regulation
	1	Designated site, above designated elevation, or mandatory setback
	2	Total prohibition
Camping	0	No restriction
	1	Any mandatory setback; designated sites
	2	Assigned sites
Fees	0	No fees
	1	Fees charged of selected user type
	2	Fees charged of all visitors
Permits	0	No permit or registration
	1	Voluntary self-registration
	2	Mandatory, nonlimiting permit or registration
	3	Mandatory; use limited
Human waste	0	No regulation
	3	Pack out required
Length of stay	0	No restriction on length of stay
	1	Length of stay limited
Stock use	0	No restriction
	1	Mandatory setbacks; no hitching, tethering
	2	Grazing prohibited or feed restricted
	3	No camping with stock; area closures to all stock
Swimming/bathing	0	No restrictions
	2	Prohibited
Area closure	0	No restriction
	3	Area closed to use
Group size limits	0	No restriction
	1	Group size limits in place
Dogs/domesticated animals	0	No restrictions
	1	Required to be on leash
	2	Prohibited

After the score is assigned for each category of regulation, these scores will be weighted to reflect the geographic coverage of the regulation as follows:

- 1—the regulation applies to a subarea of wilderness.
- 2—the regulation applies to an entire wilderness.

The example in table 66 demonstrates the process for the hypothetical ABC Wilderness.

The scores for each of the 11 types of regulations will be reported for each wilderness along with the total index score.

As described in Chapter 3, Assessing Trend in Wilderness Character, because these restrictions on visitor behavior data will be collected annually, regression analysis will be used to identify if the trend in the number of visiting parties over the 5-year monitoring cycle is significantly increasing, decreasing, or stable.

Table 66.—*An example of visitor restriction scoring for the ABC Wilderness.*

Type of regulation	Score	Geographic weight	Total score
Campfire restriction	1	2	2
Camping	2	1	2
Fees	0	—	0
Permits	1	2	2
Human waste	0	—	0
Length of stay	0	—	0
Stock use	1	1	1
Swimming/bathing	0	—	0
Area closure	0	—	0
Group size limits	1	2	2
Leash requirement	1	1	1
		Index total	**10**

What Are the Cautions About This Measure?

Data for the index measure are reliably and accurately reported through Infra. The items tracked encompass the range of management actions likely to affect visitors' feelings of confinement. Despite these characteristics, the index has a significant drawback in that it can capture only three levels of extent (no regulation, subarea, and total wilderness). Ideally, it would be best to have a more precise measure of spatial extent to better track change over time and to more accurately measure the impact on visitors.

Another limitation is that, although the weighting scheme seems logical, the specific weights are subjectively determined. This limitation can be addressed through simulations using different weighting schemes, however, and, at the wilderness level, the data will be captured in a way that permits disaggregation of the specific components.

Appendixes

Appendix A. Glossary

absorption—The process by which incident light is removed from the atmosphere and retained by a particle. (National Park Service 2000)

acidification—The decrease of acid neutralizing capacity in water or base saturation in soil caused by natural or anthropogenic processes. (National Park Service 2000)

air-quality–related value (AQRV)—A resource, as identified by the Federal land manager for one or more Federal areas, that may be adversely affected by a change in air quality. The resource may include visibility or a specific scenic, cultural, physical, biological, ecological, or recreational resource identified by the Federal land manager for a particular area. (National Park Service 2000)

anthropogenic—Produced by human activities. (Malm 1999)

atmospheric deposition—The process whereby airborne particles and gases are deposited on the earth's surface. (National Atmospheric Deposition Program 2003)

attribute—A description of an item of significance; i.e., any detail that serves to classify, quantify, qualify, identify, or express the state of an entity. (Barker and Longman 1992)

building—A structure to support, shelter, or enclose persons, animals, or property of any kind. (Forest Service Handbook [FSH] 6509.11k, sec. 56.05 and FSH 7309.11, sec. 05)

Class I area—As defined in the Clean Air Act, the following areas that were in existence as of August 7, 1977: national parks larger than 6,000 acres, national wilderness areas and national memorial parks larger than 5,000 acres, and international parks. (National Park Service 2000)

dam—A barrier obstructing the flow of water that increases the water surface elevation upstream of the barrier; usually built for water storage or to increase the hydraulic head. (Armantrout 1998)

deciview—A unit of visibility proportional to the logarithm of the atmospheric extinction. Under many circumstances, a change in one deciview will be perceived to be the same on clear and hazy days. (Malm 1999)

dry deposition—The fraction of atmospheric deposition deposited in dry weather through such processes as settling, impaction, and adsorption. (National Atmospheric Deposition Program 2003)

extinction (with regard to light)—The attenuation of light due to scattering and absorption as it passes through a medium. (National Park Service 2000)

extirpated species—A species that formerly occurred within a wilderness but is no longer present there. An extirpated species is different from an extinct species in that extinction is the loss of all the individuals of a species, whereas a species may be extirpated from one area but still living in another area.

extrapolate—To predict by projecting past experience or known data. (Merriam-Webster 2002)

fixed instrumentation site—An unattended measurement device left in place for at least 1 year for the purpose of recording environmental data, such as meteorology or seismic activity. These sites typically contain measuring equipment, a data logger, and a power source. Some even have the facility for transmitting data off site for storage and analysis.

free-flowing condition—A stream or stream reach that flows unconfined and naturally without impoundment, diversion, straightening, riprapping, or other modification of the waterway. (Armantrout 1998)

haze—An atmospheric aerosol of sufficient concentration to be visible. The particles are so small that they cannot be seen individually but are still effective at attenuating light and reducing visual range. (National Park Service 2000)

indigenous species—A species that originally inhabited a particular national forest or national grassland. (Forest Service Manual 2605)

injury (with regard to pollution effects on plants)—Any physical or biological response to pollutants, such as a change in metabolism, reduced photosynthesis, leaf necrosis, premature leaf drop, or chlorosis. (National Park Service 2000)

interpolate—To estimate values of a function between two known values. (Merriam-Webster 2002)

invasive species—A species that is nonnative (or alien) to the ecosystem under consideration *and* whose introduction causes or is likely to cause economic or environmental harm or harm to human health (Clinton 1999). Invasive species can be plants, animals, or other organisms (such as microbes). Human actions are the primary means of invasive species introductions. (National Invasive Species Council 2001)

irrigation structure—A device designed to provide water to vegetation, such as a ditch, canal, pipe, sprinkler, or other device. (Armantrout 1998)

keystone species—(1) A species on which a large number of other species within a given community depend for survival (Meffee and Carroll 1997); (2) A species that affects the survival and abundance of many other species in the community in which it lives. Its removal or addition results in a relatively significant shift in the composition of the community and sometimes even in the physical structure of the environment. (Wilson 1992)

major trail feature—A significant constructed feature associated with a system trail. Most commonly, this term refers to a trail bridge, but it also includes a dock, constructed stairs, and a boardwalk, excluding other minor features such as trail signs and culverts.

management-ignited fire (also referred to as prescribed fire)—Any fire ignited by management actions under certain predetermined conditions to meet specific objectives related to hazardous fuels reduction or habitat improvement. A written, approved prescribed fire plan must exist, and National Environmental Policy Act requirements must be met before ignition. Prescribed fires are ignited and managed within a "window" of very specific conditions, including winds, temperatures, humidity, and other factors specified in the burn plan. (Healthy Forests and Rangelands Interagency Web site 2009)

mechanical transport—Any contrivance for moving people or material in or over land, water, or air, having moving parts, that provides a mechanical advantage to the user, and that is powered by a living or nonliving power source. This category includes, but is not limited to, sailboats, hang gliders, parachutes, bicycles, game carriers, carts, and wagons. It does not include wheelchairs when used as necessary medical appliances. It also does not include skis, snowshoes, rafts, canoes, sleds, travois, or similar primitive devices without moving parts. (USDA Forest Service 2005)

metapopulation—A series of populations (or population subdivisions) with dynamic patterns of local extinctions and recolonizations; gene flow or migration among subunits provides characteristic evolutionary and ecological features that help prevent the extinction of the entire metapopulation. (Fiedler and Jain 1992)

motorized equipment—Machines that use a motor, engine, or other nonliving power sources. This category includes, but is not limited to, such machines as chain saws, aircraft, snowmobiles, generators, motor boats, and motor vehicles. It does not include small battery- or gas-powered handcarried devices such as shavers, wristwatches, flashlights, cameras, stoves, or other similar small equipment. (USDA Forest Service 2005)

N100—The number of hourly average concentrations equal to 100 parts per billion. (National Park Service 2000)

National Inventory of Dams (NID) dam—(1) A dam that is a high or significant hazard potential class dam; (2) A low hazard potential class dam that exceeds 25 ft in height and 15 acre-ft storage; (3) A low hazard potential class dam that exceeds 50 acre-ft storage and 6 ft in height. (U.S. Army Corps of Engineers 2005)

natural wilderness lake—A body of water not originally created by human impoundment (such as via a dam or levee).

nitrates—Gases and aerosols that have origins in the gas-to-aerosol conversion of nitrogen oxides (e.g., nitrogen dioxide); nitric acid and ammonium nitrate are of primary interest. Ammonium nitrate is very hygroscopic, so its contribution to visibility impairment is magnified in the presence of water vapor. (National Park Service 2000)

operational maintenance level—The maintenance level currently assigned to a road considering current needs, road condition, budget constraints, and environmental concerns. This term defines the level to which a road is currently being maintained. (USDA Forest Service 2004a)

perennial stream—A stream, lake, or water body with water present continuously during a normal water year. (Armantrout 1998)

phytotoxic—Poisonous to plants. (National Park Service 2000)

road—A motor vehicle travel way wider than 50 inches, unless classified and managed as a trail. (36 C.F.R. 212.1.)

scattering—The interaction of light with an object (such as a fine particle) that causes the light to be redirected in its path. (National Park Service 2000)

significant manipulation—Exercising control that is important in effect or large in amount or quantity relative to the wilderness resource.

stomata—Small pores in the epidermis of the leaf that provide for the entry of carbon dioxide and the discharge of oxygen and water vapor. (USDA Forest Service 1999)

sulfates—Aerosols that have origins in the gas-to-aerosol conversion of sulfur dioxide; sulfuric acid and ammonium sulfate are of primary interest. Sulfuric acid and ammonium sulfate are very hygroscopic, so their contribution to visibility impairment is magnified in the presence of water vapor. (National Park Service 2000)

suppression—All the work associated with extinguishing or containing a fire, beginning with its discovery. (Healthy Forests and Rangelands Interagency Web site 2009)

system trail—A linear feature constructed for the purpose of enabling the free movement of people, stock, or off-highway vehicles. (USDA Forest Service 2003b)

taxon—The name applied to a taxonomic group in a formal system of nomenclature.

trail class—The prescribed scale of development, representing the intended design and management standards of the trail. Each trail class is defined in terms of applicable tread and traffic flow, obstacles, constructed feature and trail elements, signs, typical recreation environment, and experience. Trail classes range from trail class 1 (minimal/undeveloped trail) to trail class 5 (fully developed trail). (USDA Forest Service 2004b)

untrammeled—Wilderness that is unhindered and free from modern human control or manipulation. (Landres and others 2005)

utility infrastructure—The constructed features used to convey or support basic services such as electricity, telephone, gas, or water.

W126—An ozone index that multiplies each specific concentration by a sigmoidal weighted function and then sums all values. $W_i = 1/[1 + Me^{-(A \times Ci)}]$, where M and A are constants 4403 and 126 parts per million $(ppm)^{-1}$, respectively; w_i is the weighting factor for c_i; and c_i is concentration in ppm. (National Park Service 2000)

wet deposition—The fraction of atmospheric deposition contained in precipitation, predominantly rain and snow. (National Atmospheric Deposition Program 2003)

wilderness water developments—Dams, irrigation structures, stock or wildlife ponds, channelization, mining, energy development, urban and suburban development, or alteration of riparian vegetation communities. Other than dams (primarily those more than 6 ft high), wilderness water developments are not addressed in this monitoring guide.

wildland fire—Any nonstructure fire, other than prescribed fire, that occurs in a wildland area. (Healthy Forests and Rangelands Interagency Web site 2009)

wildland fire use—The management of naturally ignited (usually by lightning) wildland fires to accomplish specific prestated resource management objectives in predefined areas outlined in fire management plans. (Healthy Forests and Rangelands Interagency Web site 2009)

Appendix B. Statistical Analysis of Trends in the Measures

This appendix describes how trends in the measures will be statistically analyzed.

This analysis applies only to those measures that have five or more data points. For the measures for which data are gathered annually, this analysis will be performed at the end of the first 5-year monitoring cycle. For the measures for which data are gathered once every 5 years, this analysis will be performed at the end of the fifth monitoring cycle, 20 years after baseline data were first collected, yielding five data points.

To statistically evaluate whether a trend in the data is significant or not, a trigger point or threshold of change needs to be identified. The selection of this trigger point, in statistical terms the "alpha level," is based solely on managerial and philosophical considerations of how much randomness is acceptable in identifying a significant change. Two polar examples illustrate the implications of choosing different alpha levels:

1. **0.05 Alpha Level.** This threshold means that when there is a trend in the data, there is a 5-percent chance that this trend is occurring at random and there is a 95-percent chance that this trend is real. This alpha level reduces what statisticians call Type I error, the risk of calling a change significant when in fact it is not significant. This alpha level implies that managers can be reasonably confident that changes identified as significant are in fact significant and not merely the result of all sorts of random factors. The downside of this alpha level is that, from a managerial perspective, some changes may in fact be important but they will not be statistically significant.

2. **0.20 Alpha Level.** This threshold means that when there is a trend in the data, there is a 20-percent chance that this trend is occuring at random and there is an 80-percent chance that this trend is real. This alpha level reduces what statisticians call Type II error, the risk calling a change not significant when in fact it is significant. Although at first this level may seem too low a threshold for identifying significant change, this alpha level implies that no change escapes notice; therefore, managers have more opportunity to intercede and take action before unacceptable changes occur. In other words, even though a manager would be less certain that changes identified as significant are really significant, on-the-ground trends may be caught earlier, enabling corrective actions to be taken sooner.

The Technical Guide Development Team selected an alpha level of 0.1 as an appropriate balance between the need to catch trends early (especially given the relative crudeness of several of the indicators and measures used in this monitoring protocol) while maintaining as much statistical rigor as possible in correctly identifying significant trends.

Trends will be assessed using simple linear regression in which the independent variable X is time (measurement year) and the dependent variable Y is the value of the measure (such as deciview or number of trammelings). Thus the regression model is $Y_i = \beta_0 + \beta_1 X_i + \varepsilon_i$ where β_0 is the intercept, β_1 is the slope, and ε is the error (Greek letters are used to represent true population parameters and roman letters are used to represent estimates of those population parameters). We can test the hypothesis $\beta_1 = 0$ via the following test:

$$H_0 : \beta_1 = 0$$
$$H_a : \beta_1 \neq 0$$
$$t^* = \frac{b_1}{s\{b_1\}}$$

The test statistic t^* is distributed as *t* distribution with degrees of freedom n-2 (where n is the number of data points). Thus, the null hypothesis can be rejected when $|t^*| > t(1-\alpha/2, n-2)$. Where b_0 and b_1 are the point estimates for β_0 and β_1 respectively and

$$t^* = \frac{b_1}{s\{b_1\}}$$
$$s\{b_1\} = \sqrt{\frac{MSE}{\sum(X_i - \bar{X})^2}}$$
$$MSE = \frac{\sum(Y_i - \hat{Y}_i)^2}{n-2} = \frac{\sum(Y_i - b_0 - b_1 X_i)^2}{n-2}$$
$$b_0 = \bar{Y} - b_1 \bar{X}$$
$$b_1 = \frac{\sum(X_i - \bar{X})(Y_i - \bar{Y})}{\sum(X_i - \bar{X})^2}$$

Some examples appear in tables B.1 and B.2 and in figure B.1. The first example is real air pollution data from Acadia National Park. The second example is hypothetical data loosely derived from the Acadia National Park data.

By examining plots of the two data sets, it appears that a downward trend occurs in visibility for both the true data (example 1) and the modified data (example 2), although more noise occurs in the modified data. Nevertheless, performing the hypothesis test with a 90-percent confidence level (alpha equals 0.1) yields the detection of a statistically significant trend for the true data (example 1) but the failure to detect a statistically significant trend for the modified data (example 2).

Table B.1.—*Air pollution data from Acadia National Park used to illustrate regression analysis.*

Year	Example 1 (true deciview data from Acadia National Park)	Example 2 (slightly modified data from Acadia National Park)
1998	13.89156	13.40000
1999	13.63324	13.63324
2000	13.34949	13.34949
2001	13.42895	13.42895
2002	13.11163	13.11163
2003	12.53548	13.20000

Figure B.1.—*True (example 1) and modified (example 2) air pollution data from Acadia National Park plotted to show graphical trend in the data.*

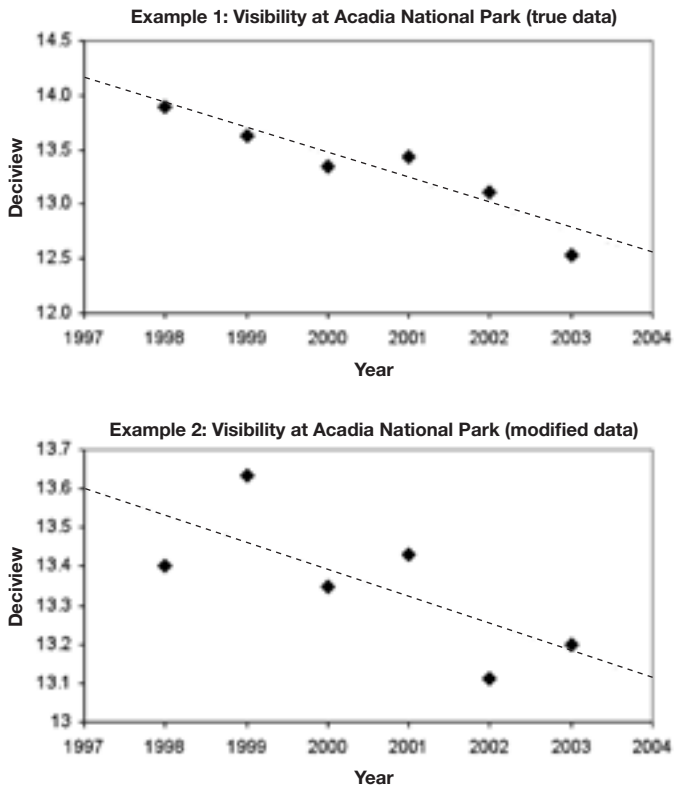


Table B.2.—*Regression test results for the air pollution data from Acadia National Park.*

Statistic	Example 1 (true deciview data from Acadia National Park)	Example 2 (slightly modified data from Acadia National Park)
b_1	– 0.23617	– 0.07101
b_0	485.774400	155.410400
MSE	0.030058	0.019986
$s\{b_1\}$	0.041444	0.033794
t^*	5.698409	2.101275
t(0.95,4)	2.132000	2.132000
Conclusion if alpha = 0.1	Reject null hypothesis and conclude a significant trend exists	Fail to reject null hypothesis and conclude no significant trend exists

Appendix C. Likely Indicators and Measures

Likely indicators and measures will *likely* have data available to be included in this national monitoring protocol within 5 years from the time this technical guide is first implemented.

Untrammeled Quality

No likely indicators and measures were identified under the untrammeled quality.

Natural Quality

The first monitoring question about threats in this quality of wilderness character has two core indicators and two likely measures:

1. **Core Indicator.** Ozone concentrations.
   Likely Measure. Ozone concentrations via remote sensing data.
   These data will be available from a National Aeronautics and Space Administration satellite within 5 years or so. These data, when available, will provide a much more accurate picture of ozone concentrations across the country and will eliminate the need to interpolate ozone data. The data will track temporal (and spatial) trends more accurately for any given location without the smoothing effect of interpolative methods. This measure was not selected because it does not meet the availability criterion. In addition, some concern exists about whether the data will meet the relevance criterion because the data may not be representative of ground-level concentrations of ozone that are relevant to plant uptake and may not be available in the hourly over the growing season format needed to calculate the existing ozone plant response metrics of N100 and W126.

2. **Core Indicator.** Nonnative species that alter the composition of natural plant and animal communities.
   Likely Measure. Invasibility index for nonnative plant species.
   NatureServe has developed a national invasibility protocol for nonnative plant species (Morse and others 2004). Under this approach, invasive species are assessed individually within a geographic area of interest to determine a quantitative rank to categorize their negative impact on native plant communities. The susceptibility of a wilderness to invasion by nonnative plant species depends on many factors, including the life history characteristics of individual nonnative species, the habitat present within individual wildernesses, the resiliency of the system, and other factors. Using this tool, managers are able to design inventories of highest priority nonnative species within their wilderness and to determine

which nonnative plant species need the most immediate management actions. This tool will also help local, regional, and national wilderness managers in planning and budgeting for nonnative plant species management. This measure is not ready to be incorporated into this monitoring protocol at this time because processing is still needed to make this tool readily available and usable within all Forest Service wildernesses.

The second monitoring question about biophysical conditions and processes sensitive to threats in this quality of wilderness character has two core indicators and two likely measures:

1. **Core Indicator.** Ecosystems, plant communities, and plant species that are rare or at risk.
   Likely Measure. National vegetation classification systems.
   Several broad-scale vegetation classification efforts are under way by both government agencies and nonprofit organizations to develop ecological classification systems to provide baseline data for terrestrial vegetation that could be applied to wildernesses nationwide. For example, the Forest Service is developing a national vegetation classification system using remote sensing imagery from Thematic Mapper data. The U.S. Geological Survey is also working on nationwide remote sensing products that would provide wilderness vegetation information within the context of surrounding ecosystems.

   NatureServe biologists are in the process of developing a national vegetation classification that would be useful for monitoring imperiled and at-risk plant communities in wildernesses. This project is an ecological system classification that uses groups of plant communities and evaluates their status and trends as imperiled or at risk within the context of broad geographic areas within the United States. This project also uses remote sensing imagery combined with fieldwork for verification of the classification taxonomy. The taxonomic evaluation has been completed for the lower 48 States, with nationwide mapping currently under way. Work for Alaska occurred in 2005.

2. **Core Indicator.** Historical fire regime.
   Likely Measure. Percentage of area of wilderness in Fire Regime Condition Class 3 (FRCC3).
   The maintenance of the historical fire regime is important in wilderness because fire is one of the primary natural disturbance processes within most ecosystems. The exclusion or interruption of the timing or intensity of the historical fire regime is a threat that will negatively affect the composition, structure, and

function of native plant communities. The use of the FRCC system provides one of the best measures currently available to assess changes in fire regimes from historical levels. For the purpose of this monitoring, FRCC3, plant communities with conditions that reflect fire regimes that have been significantly altered from their historical range is the most relevant. Modeling techniques to assess FRCCs developed by Schmidt and others (2002) are currently being refined and will be made available under the Federal LANDFIRE program (www.landfire.gov/about_frcc.html).

Undeveloped Quality

The physical development indicator in this quality of wilderness character has two likely measures. Both of these likely measures are related to campsites and are therefore described together:

1. Mean number of campsites per square mile.

2. Maximum number of campsites in any square mile.

Campsites are an important measure of the physical evidence of development because they occur in almost every wilderness and are sensitive to change as a result of altering use levels or management actions. At the present time, it is estimated that 20 to 30 percent of wildernesses have a campsite inventory that meets the standard established in the national campsite monitoring protocol (under development). Because of the inclusion of element 6, recreation site inventory, in the Chief's 10-Year Wilderness Stewardship Challenge and the commitment to have all wildernesses meet a baseline level of wilderness stewardship within the decade, it is reasonable to assume that more than 50 percent of wildernesses will have reliable campsite inventories within the next 3 to 5 years.

Outstanding Opportunities for Solitude or a Primitive and Unconfined Type of Recreation Quality

No core indicators and likely measures were identified for this quality.

Appendix D. Desired Indicators and Measures

Desired indicators and measures are those that would add significant information to the assessment of trends in wilderness character but data are not likely to be available in the foreseeable future.

Untrammeled Quality

No desired indicators and measures were identified under the untrammeled quality.

Natural Quality

The first monitoring question about threats in this quality of wilderness character has four desired indicators and associated measures:

1. **Desired Indicator.** Nitrogen oxides (NO_x) and Sulfur dioxide (SO_2) emissions.
   Desired Measures. SO_2 and NO_x emissions.
   The emissions data provide direct information of local sources of these pollutants. This information, in turn, enables managers to evaluate threats to wilderness natural conditions such as visibility, water quality, and soil chemistry. Data could be obtained from the Environmental Protection Agency's (EPA's) National Emissions Inventory. The team decided that the end results of these emissions effects (i.e., visibility measurements and deposition measurements) better met the relevance criterion because they are more direct measures of the impacts of pollutants on wilderness resources, but these emissions could be useful locally in interpreting trend changes in deposition, visibility, or ozone.

2. **Desired Indicator.** Mercury deposition.
   Desired Measure. Mercury deposition.
   Although EPA maps currently being developed will estimate mercury deposition across the country, mercury deposition data are not currently available for most of the western United States. In addition, the relevance of these data is fairly site specific because mercury deposition is a greater risk to fish and wildlife in aquatic areas in which it can be converted to the toxic compound methyl mercury.

3. **Desired Indicator.** Light pollution that degrades night sky quality and night sky quality values.
   Desired Measure. Average diminished night sky visibility.
   Increasing light pollution in the past 50 to 100 years has become an increasing threat to the biology of a variety of wildlife and plant species (Longcore and Rich 2004), affecting the natural quality of wilderness character. Recent research has developed a method for monitoring night sky visibility (Cinzano and others 2000,

2001) based on broad-scale modeling results. These results could be overlaid on a Geographic Information System map of wilderness boundaries to derive an averaged estimate of diminished night sky visibility within a wilderness.

4. **Desired Indicator.** Developments that alter natural wilderness lakes.
   Desired Measure. Number of natural wilderness lakes enlarged or impounded behind dams.
   The indicator and measure would be used to assess potential changes in the flow timing and lake habitat cycles in which a dam has impounded or enlarged a natural wilderness lake (natural lakes are defined as those not originally created by human impoundment). An increase in the number of natural lakes enlarged or impounded behind dams would be an indicator that human actions are affecting natural lake dynamics.

The second monitoring question about biophysical conditions and processes sensitive to threats in this quality of wilderness character has five desired indicators and associated measures:

1. **Desired Indicator.** Potential ecological risk metric for air-quality–related values.
   Desired Measure. The measure would be a Geographic Information System (GIS)-based metric combining ozone concentrations, Palmer Drought Severity Index, the presence of ozone-sensitive species, atmospheric deposition levels of nitrogen and sulfur, and the underlying sensitive bedrock geologies.

   The data sources are variable: ozone concentrations from EPA data, Palmer Drought Severity Index available on the Internet (see main text), and nitrogen and sulfur deposition from the National Atmospheric Deposition Program/National Trends Network. Lists of ozone-sensitive species and bedrock geology would have to be obtained from local sources and brought into GIS layers if necessary. Although this metric could be useful in giving a wilderness a position on a scale regarding risk from some air pollution sources, the collection and compilation of this information from varying data sources has not been done and could be expensive, so the cost-effectiveness criterion is not met. In addition, significant data gaps likely would exist for more than 50 percent of the wilderness areas, so the availability criterion also is not met.

2. **Desired Indicator.** Water chemistry.
   Desired Measure. Acres of wilderness lakes or miles of streams in which water chemistry is unchanged over time.
   This indicator would be used to assess wilderness lake and streamwater quality related to air pollution impacts. Attributes of this measure would be nitrogen, phosphorus, pH, acid neutralizing capacity, dissolved organic carbon, and conductivity.

Wilderness lake and stream chemistry data are not available for most wilderness areas at this time. Some units have collected water chemistry data related to air pollution impacts, and limited baseline data are available for many States from EPA's National Surface Water Survey. During the writing of this technical guide, the need to develop standardized water chemistry methods and attributes was identified. Standardization would clearly give the wilderness manager information as to the current state of surface waters with regard to acidification and unnatural fertilization.

3. **Desired Indicator.** Lichen.
   Desired Measure. Lichen air-quality index score.
   The data could be obtained from Forest Health Monitoring plots that are located in many wildernesses throughout the country. A methodology would also need to be developed to incorporate this information into the process for assessing trends in wilderness character.

4. **Desired Indicator.** Status and trend of water quality.
   Desired Measure. Miles of wilderness rivers or streams in which Clean Water Act water quality standards and beneficial uses are met.
   This indicator would be used to assess overall water quality and the ability of wilderness streams to support their designated, beneficial uses. An increase in the miles of impaired rivers or streams would indicate that human actions are affecting wilderness water quality. The attribute of this measure would be miles of wilderness rivers or streams on EPA and State 303(d) lists (identified as impaired through a total maximum daily load (TMDL) analysis).

   The identification of waters as impaired by the Clean Water Act (Section 303(d)) is an EPA function delegated to each State. Early in the listing process, protocols for listing streams were not clearly identified and some streams were listed without careful review of the data. Currently, most States are writing TMDL reports and restoration plans for all Section 303(d) listed waters. Part of this analysis includes a review of the scientific credibility of the data used for the original stream listing and determining if the designated beneficial use is impaired. Because the TMDL process is applied to currently listed waters, the list of impaired waters will be revised to reflect the true condition of the Nation's waters. As this process is completed nationwide, this measure will become a valuable tool for monitoring the wilderness aquatic resources.

5. **Desired Indicator.** Vertebrate species.

   Desired Measures. Presence and distribution of vertebrate species.

   The Forest Service's Multiple Species Inventory and Monitoring protocol aims to provide statistically reliable data nationwide on the presence and distribution of a variety of vertebrate wildlife and their habitats. If implemented nationally, this monitoring protocol would provide data that could be used for assessing trends in this important component of wilderness character.

Undeveloped Quality

The physical development indicator in this quality of wilderness character has three desired measures. All three measures are related to user-created, nonsystem, or social trails and are therefore described together:

1. Mean length of user-created trails/square mile.
2. Maximum length of user-created trails in any square mile.
3. Total length of user-created trails in each condition class.

To assess change in the physical evidence of modern human occupation or modification, it is important to assess the extent and condition of the official trail system (and associated structures), the campsite system (and associated structures), and the user-created trail system. Measures concerned with the user-created trail system are not included in this protocol, or even as likely indicators, because data do not routinely exist and because it is not realistically expected that they would exist on a consistent, national scale without a significant infusion of additional monitoring funds. Nevertheless, where data do exist locally to support use of these measures, they should be incorporated into the protocol.

Increases in any of the three measures would indicate that user-created trails are proliferating, becoming increasingly dense, and/or having higher impacts. Any of these changes represent increased physical evidence of occupation and/or modification and suggest that wilderness character is declining because wilderness is becoming more developed. All three of these measures require field data collection for each individual wilderness. This process requires a census of all user-created trails in the entire wilderness and the assignment of a condition class rating to each trail. Such data are virtually nonexistent. Protocols are not well established, as they are for campsite monitoring, but could be developed.

Outstanding Opportunities for Solitude or a Primitive and Unconfined Type of Recreation Quality

The wilderness visitation indicator under the monitoring question about solitude has two desired measures:

1. **Desired Measure.** Number of encounters with other groups per day.
   Most wilderness visitors associate encountering other groups as an impediment to attaining solitude. Degradation of solitude also (probably) relates to the level of jostling or stress caused by interactions among groups and is therefore an integrative measure. Currently, data do not exist for enough wildernesses to be able to monitor this measure.

2. **Desired Measure.** Number of groups camped within sight and sound.
   For campers, the presence of other groups nearby is a major impact on the feeling of solitude. Currently, data do not exist for enough wildernesses to be able to feasibly monitor this measure.

The monitoring question about unconfined recreation has one desired indicator:

1. **Desired Indicator.** Jostling index.
   It would be ideal to have an indicator that addresses the impact of the presence of other people and on the opportunity for unconfined recreation. In other words, how do wilderness visitors change their behavior in response to other people? Do visitors not stop at a viewpoint when others are there? Do visitors not camp in a certain area because others are there? To what extent are visitors jostled or feel they were forced to take actions they preferred not to? Currently, no accepted measures exist, and any techniques for collecting data would be beyond the realm of what is feasible because they largely rely on surveying visitors.

Appendix E. Dropped Indicators and Measures

Many indicators and measures were considered but eventually dropped for a variety of reasons. Table E.1 summarizes these dropped indicators and measures and the reasons why they were dropped from this monitoring protocol.

Table E.1.—*Indicators considered and reasons why they were dropped. (1 of 3)*

Dropped indicator	Reason why indicator was dropped				
	Insufficient quality of data that are currently available	Insufficient data coverage across all wildernesses	Insufficient conceptual development of indicator	Important in less than 50 percent of Forest Service wildernesses	Low relevance to assessing wilderness character
Natural quality: air					
Ecological effects metric for AQRVs	X	X	X		X
Particulate matter smaller than 2.5 μm					X
Carbon monoxide emissions					X
Volatile organic carbon emissions					X
Dry deposition		X			
Budget reporting	X	X	X		X
Natural quality: aquatic systems					
Removal of vegetation and trampling of soils around campsite leading to site erosion and sediment deposition	X	X		X	
Water quality	X	X			
System trail crossings	X				
Introduction of human and animal waste due to campsite location	X	X		X	
Loss of riparian or lakeside vegetation or bank stability	X	X		X	
Impervious surfaces		X	X	X	
Air pollutants that degrade water quality with a measure of acres of wilderness lakes or miles of wilderness streams unaffected by air pollution	X	X		X	
Flow alteration or water chemistry changes due to other wilderness developments		X		X	
Changes in wilderness streamflow with a measure based on existing stream gauges		X		X	
Lake clarity		X	X	X	
Stream surveys		X		X	
Miles of perennial streams that go dry due to human actions		X		X	

AQRV = air-quality–related value.

Table E.1.—*Indicators considered and reasons why they were dropped. (2 of 3)*

Dropped indicator	Reason why indicator was dropped				
	Insufficient quality of data that are currently available	Insufficient data coverage across all wildernesses	Insufficient conceptual development of indicator	Important in less than 50 percent of Forest Service wildernesses	Low relevance to assessing wilderness character
Natural quality: wildlife					
Composition, distribution, and abundance of predator community	X	X			
Composition, distribution, and abundance of herbivore community	X	X			
Composition, distribution, and abundance of disturbance specialists	X	X			
Composition, distribution, and abundance of biophysical modifiers (e.g., beaver)	X	X			
Composition and abundance of lake biota	X	X	X		
Natural quality: vegetation					
Changes in the composition, distribution, and abundance of native plant communities due to human actions	X	X			
Changes in the composition, distribution, and abundance of plant species due to human actions	X	X			
Change in the ratio of shade-tolerant to shade-intolerant species due to human actions	X	X			
Change in fragmentation and aggregation of vegetation (patch distribution and size) due to human actions	X	X			
Change in vertical patterns of vegetation within ecosystems due to human actions	X	X			
Anthropogenic alterations to historical disturbance regimes	X	X	X		
Effects of nonnative disease and insects on native plant communities	X	X			
Change in distribution of life forms and ecotones due to altered disturbance regimes	X	X			
Resilience of plant communities and ecosystems due to human actions	X	X	X		
Changes in chlorophyll density due to air pollution	X	X			
Changes in primary productivity of vegetation due to human actions such as grazing and air pollution	X	X			

Table E.1.—*Indicators considered and reasons why they were dropped. (3 of 3)*

Dropped indicator	Reason why indicator was dropped				
	Insufficient quality of data that are currently available	Insufficient data coverage across all wildernesses	Insufficient conceptual development of indicator	Important in less than 50 percent of Forest Service wildernesses	Low relevance to assessing wilderness character
Tree mortality		X			X
G-listed species from State Heritage Programs	X	X	X		
Undeveloped quality					
Commercial grazing infrastructure		X			
Outstanding opportunities quality					
Trail encounters		X			
Campers audible/visible		X			
Visitor reports of disruptions			X		
Night sky visibility		X	X		
Proportion of wilderness outside of electronic communication with the outside world			X		
Dangerous situations (acres inhabited by animals that could kill or eat people)			X		
Incidence of motorized or mechanized uses		X			
Visitor reports of displacement or behavior change due to management or other visitors		X	X		
Campsite availability		X			

Appendix F. Local Indicators and Measures

In the course of developing this national monitoring protocol and reviewing dozens of potential indicators, the different teams identified some indicators that were not applicable at the national level but may be applicable to an individual wilderness. These local indicators provide specific information that may be useful or important for preserving wilderness character in an individual wilderness. The indicators presented in the following text are offered only as suggestions and are in no way a complete list of local indicators. Although a local wilderness may find some of these indicators useful, data may or may not be available to implement monitoring of these indicators.

Untrammeled Quality

1. **Local Indicator.** Rationale for fire-suppression decisions.
   This information is tracked as part of all wildland fire implementation plans and trends may provide local managers with insight about the barriers to fire use implementation.

Natural Quality

1. **Local Indicator.** Water chemistry.
   Local Measure. Acid neutralizing capacity and nitrate.
   Ongoing chemical monitoring of wilderness waters for air pollution impacts has occurred under numerous efforts. Nothing in this technical guide is intended to change these ongoing monitoring efforts. Nevertheless, during the development of this technical guide, the need to standardize methods and attributes was identified (see Appendix C, Likely Indicators and Measures). Standardization would provide wilderness managers information as to the current state of their surface waters with regard to acidification and unnatural fertilization.

Undeveloped Quality

1. **Local Indicator.** Unauthorized use.
   Any known unauthorized use of motorized equipment and mechanical transport should be tracked locally. The Law Enforcement and Investigations Management Attainment Report System database has the potential to help with the tracking of unauthorized use documented through violation notices or incident reports.

2. **Local Indicator.** Airstrips.
   Landing strips are not common in wilderness (estimated at less than a half dozen) and were not included as a core indicator for that reason. Where they do occur, however, they can have a significant effect on the undeveloped quality and should

be included as a local indicator. It is suggested that an estimate of the number of flights yearly be included in this measure.

3. **Local Indicator.** Commercial grazing infrastructure.
   Commercial grazing infrastructure includes such items as fences, guzzlers, and water tanks; where present, commercial grazing infrastructure can have a significant negative effect on the undeveloped quality. Although the existence of this infrastructure is known and is recorded in a corporate database (Infra-Range), it was dropped as a suitable indicator because the linking of these many features to the individual wildernesses was determined to be problematic. If presence of these features inside a wilderness is known on a particular forest, this indicator could be used as a local indicator.

Outstanding Opportunities for Solitude or a Primitive and Unconfined Type of Recreation Quality

No indicators and measures were identified as local indicators for this quality.

Appendix G. Process Used To Develop Indicators and Measures

The lead for each quality determined the overall process for choosing the indicators and measures in this technical guide.

Untrammeled Quality

The process used to develop indicators and measures for the untrammeled quality consisted of working within a small but geographically diverse group of wilderness specialists to gather and evaluate a representative range of activities that take place within wildernesses that manipulate or control ecological systems. Those activities were then combined into like categories using the structure defined by current Forest Service policy (Forest Service Manual 2320). Measures were developed by defining a like quantifier (action) that could be aggregated to represent the untrammeled quality. Members of the technical team for the untrammeled quality included Liese Dean (Sawtooth National Forest), who served as subteam leader; Al McPherson (George Washington and Jefferson National Forests); Rebecca Oreskes (White Mountain National Forest); David Rak (Tongass National Forest); Mike Rowan (Okanogan National Forest); and Diane Taliaferro (Gallatin National Forest). This same team also developed the measures for the mechanized and motorized indicator under the undeveloped quality.

Natural Quality

Four separate teams were established to provide technical direction for the different resources included under the natural quality.

Air Quality. A six-member air-quality technical team was assembled for the air-quality and air-quality–related values question. The team was composed of the following individuals: Tamara Blett (National Park Service, Air Resources Division), who served as the subteam leader; Scott Copeland (Forest Service Washington Office and Colorado State University); Bill Jackson (North Carolina national forests); Ann Mebane (Forest Service, Intermountain Region); Andrea Stacy (Monongahela National Forest); and Trent Procter (Forest Service, Pacific Southwest Region). The group held two conference calls in May and June 2004 to brainstorm potential indicators and measures and then held a face-to-face meeting in July to refine the indicators for wet deposition, ozone, and visibility and to refine the measures to best reflect changes in wilderness character. A conference call was held between the air-quality technical team leader and the Forest Service regional and national Air Program managers to explain the wilderness character project and the air team role. Three air technical team members then developed draft technical guidance for the indicators. The air technical team reviewed and edited the air

technical guidance, which was then circulated to the Forest Service Air Program regional and national leaders for review and comment.

Aquatic Systems. A number of aquatic specialists were contacted, often repeatedly, regarding the development of aquatic indicators and measures. These individuals provided support, suggestions, and critical review of the research and information contained in this document. The aquatics technical team was composed of Terry Carlson (Bitterroot National Forest), who served as subteam leader; Steve Glasser (Forest Service, Washington Office); Chris Knopp (Forest Service, Washington Office); Russ Lafayette (Forest Service, Northeast Regional Office); Mark Laker (U.S. Department of the Interior [DOI], U.S. Fish & Wildlife Service [Alaska]); and David Spildie (Forest Service, Aldo Leopold Wilderness Research Institute). Individuals from the Environmental Protection Agency and U.S. Geological Survey were also contacted regarding nationwide aquatic data sets that may be available from other agencies.

Vegetation. A seven-member team of agency and university ecologists and botanists evaluated the vegetation quality. Team members came from widely divergent geographic areas and provided broad ecological knowledge of the various wilderness ecosystems within the United States and Alaska. The team developed its indicators and measures through a series of conference calls in May and June 2004. By the sixth and final conference call, the group had developed an extensive list of ecological indicators and had identified data sources for the indicators. Early on, the team broadly organized the indicators and measures by vegetative composition, structure, and processes. Under these categories, the team recognized the importance of monitoring ecosystem process and function; however, it recognized that these indicators would be difficult to assess and that surrogates would have to be used as measures. Further into the project, the vegetation indicators were refined by threats to the natural quality and by biophysical components being threatened. From there, the vegetation indicators and measures that were finally chosen were based on extent and availability of data.

The vegetation subteam included Susan Rinehart (Forest Service, Northern Region), who served at the subteam leader; Paul Alaback (The University of Montana); Bruce D. Anderson (Superior National Forest); Steve Croy (George Washington and Jefferson National Forests); Karen Dillman (Tongass National Forest); Mark Jensen (Forest Service Northern Region); and Peter Landres (Forest Service, Aldo Leopold Wilderness Research Institute).

Wildlife. A team of wildlife and fisheries specialists was assembled to work on the indicators and measures for wildlife (including both terrestrial and aquatic species) under the natural quality. This technical team consisted of Carol Hardy (George Washington and

Jefferson National Forests), who served as subteam leader; Deborah Bumpus (Sitgreaves National Forest); Peter Landres (Forest Service, Aldo Leopold Wilderness Research Institute); Lance Lerum (Tongass National Forest); Kathleen Mathews (Forest Service, Pacific Southwest Range and Experiment Station); Jennifer Molesworth (Okanogan and Wenatchee National Forests); and Amy Unthank (Forest Service, Southwestern Region). Started in May 2004, this group interacted eight times via conference calls and participated in several e-mail reviews of draft documents.

Undeveloped Quality

Both of the indicators under this quality were approached in a similar fashion. The resource subject matter experts on the Technical Guide Development Team took the initial listing of indicators and measures from the Wilderness Monitoring Committee and worked through a number of iterations of the table, relying on their respective tech teams, which consisted of subject matter experts from across the country.

The physical developments tech team consisted of Steve Boutcher (Forest Service, Washington Office), who served as subteam leader; Chris Barns (DOI, Bureau of Land Management [BLM] and Arthur Carhart National Wilderness Training Center); David Cole (Forest Service, Aldo Leopold Wilderness Research Institute); Dave Rak (Tongass National Forest); and Susan Sater (Forest Service, Pacific Northwest Region). A number of subject matter experts were also contacted to learn more about specific data sets, including James Demby (Infra-Dams), Bill Hamele (Infra-Buildings), Carol Russell (Infra-Roads), Jaime Schmidt (Infra-Trails), and Bev Thackeray (retired—Infra-Special Uses Database System).

Outstanding Opportunities for Solitude or a Primitive and Unconfined Type of Recreation Quality

Historical and philosophical literature was consulted to determine how the dimensions of solitude, primitiveness, and lack of confinement should be defined. Interviews with 200 wilderness visitors conducted in 2002 were also important in this effort (Johnson and others 2005). Social science research was used to identify how various conditions affect visitor experiences of each dimension. Following this review, a 3-day workshop was convened of scholars from around the country who specialize in understanding the wilderness experience. These scholars were charged with describing and defining the outstanding opportunity quality, identifying the full range of possible indicators, and prioritizing recommended indicators. The outcome of that workshop was published as a special issue of the *International Journal of Wilderness* (Volume 10(3), December 2004).

The workshop led to a large list of potential indicators, at that point unconstrained by considerations such as data availability. Subsequently, discussions with the Wilderness Monitoring Committee, a small informal group of specialists, and review of available data led to the refinement of the indicators to a list of six. Protocols for monitoring were developed by the subteam leader, with review from field specialists. The team included Troy Hall (University of Idaho), who served as subteam leader; Chris Barns (DOI, BLM and Arthur Carhart National Wilderness Training Center); David Cole (Forest Service, Aldo Leopold Wilderness Research Institute); Denis Davis (DOI, National Park Service); Brad Hunter (Tongass National Forest); Al McPherson (George Washington and Jefferson National Forests); and Mike Rowan (Okanogan National Forest).

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USDA

United States Department of Agriculture

Forest Service

November 2012

Monitoring Conditions Related to Wilderness Character:

National Report on Trends Across Forest Service Wildernesses

2007–12

Supplement—National Report With Hypothetical Data

This supplement shows example reports developed with hypothetical data to illustrate the elements that would or could be used in reporting trends in wilderness character at the national, regional, and local levels. The reports in this supplement are for illustrative purposes only and were developed by a technical working group solely representing the views of its authors. These reports do no represent and should not be construed to represent any Forest Service determination or policy.

Photo credit: National Park Service, Olympic National Park, Wilderness Information Center
Wilderness: Olympic Wilderness

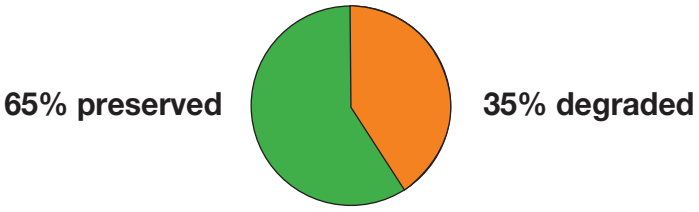
National Summary of Trends in Wilderness Character Across 407 Forest Service Wildernesses, 2007–12

National Trends in Wilderness Character

National trends are derived by compiling a trend in wilderness character and the qualities of wilderness character across all 407 Forest Service wildernesses from 2007 through 2012.

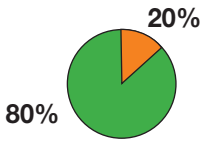
= % of 407 wildernesses with wilderness character **preserved**

= % of 407 wildernesses with wilderness character **degraded**

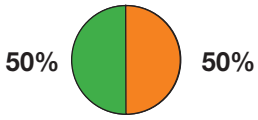


National Trends in Four Qualities of Wilderness Character

Untrammeled



Natural



Undeveloped

Outstanding Opportunities

"This protocol provides a scientifically defensible basis for demonstrating the changes to wilderness character we intuitively know are occurring."

—Deb Gale,
Wilderness Manager,
West Fork Ranger District,
Bitterroot National Forest

"I find this new protocol to be a great tool to capture a picture of present condition. With periodic monitoring, we can track changes over time and actually practice adaptive management."

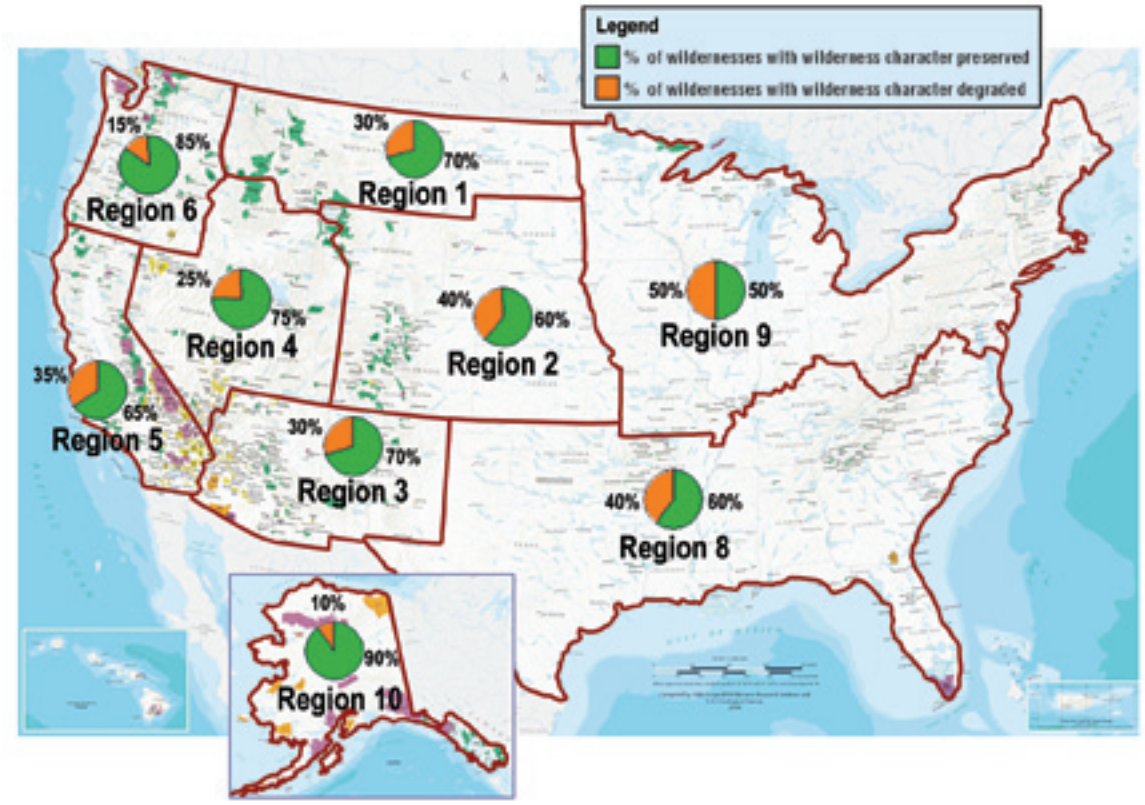
—Gabe Garcia,
District Ranger,
San Bernardino
National Forest

Narrative About These National Trends

The central mandate for wilderness stewardship is the Wilderness Act of 1964's assertion that "*each agency administering any area designated as wilderness shall be responsible for preserving the wilderness character of the area*" (Sec. 4b). This monitoring provides a national summary of trends in wilderness character and the four qualities that make up wilderness character: untrammeled, natural, undeveloped, and outstanding opportunities for solitude or a primitive and unconfined type of recreation. The trends seen in the past 5 years yield the following observations:

- Wilderness character is being preserved in a majority of Forest Service wildernesses.
- Suppression to fight extraordinarily intense fires has caused degradation of the untrammeled quality.
- Focused efforts to restore fire-adapted forests contributed to this degradation.
- New policy direction to control nonindigenous invasive species has improved the natural quality.

Regional Trends in Wilderness Character, 2007–12



Narrative About These National Trends

These regional trends reflect the following conditions that influenced the trend in wilderness character:

- An increase in fire suppression efforts because of accelerating climate changes.
- The spread of nonindigenous insects harming forest health throughout eastern wildernesses in this region, requiring aggressive control efforts to prevent severe forest dieback.
- The population in the region has increased by 12 percent during the past 5 years, and recreation use of the wilderness has increased by a similar amount. This increased use has required a new permit system and various restrictions in the use of specific locations to reduce recreation impacts. These changes have led to a decline in the outstanding opportunities for solitude or a primitive and unconfined type of recreation quality of wilderness character.

Regional Summaries of Trends in Wilderness Character, 2007–12

Contents*

(This contents page is an example only.)

*The following pages show an example of a regional report only for Region 1 to give readers an idea of what the report would "look and feel" like. The real report would include a separate report similar to the one for Region 1 provided here for each of the regions and would include the appendix as well.

Introduction

This report summarizes the results from 5 years of monitoring selected conditions related to wilderness character across all 407 wildernesses managed by the Forest Service. The information generated by this monitoring is intended to improve wilderness stewardship by assessing trends in agency efforts to preserve wilderness character and fulfilling a primary legislative and policy mandate on 18 percent of National Forest System lands.

Why Monitor Wilderness Character?

- The Wilderness Act of 1964 and all subsequent wilderness legislation require the agencies responsible for managing wilderness to preserve wilderness character. Forest Service Manual section 2320.2 (4), directs the agency to "protect and perpetuate wilderness character."
- Despite 40 years of wilderness management experience and managers calling for better monitoring of outcomes, wilderness character has never been defined in terms that enable the agency to evaluate trends in wilderness character.

How Was Wilderness Character Monitored?

- This protocol used the statutory language of the Wilderness Act of 1964 to identify and monitor four qualities of wilderness: (1) untrammeled, (2) natural, (3) undeveloped, and (4) outstanding opportunities for solitude or a primitive and unconfined type of recreation.
- Existing corporate data were used and integrated across staff areas with wilderness responsibilities, such as air quality, fish and wildlife, botany, engineering, range management, and recreation; additional existing national data sets were used as appropriate. No new field data were collected, which significantly reduced implementation costs and fulfilled the agency call for "data collected once, used many times."
- This monitoring is nationally consistent and locally relevant. A standard process was used to assess trends relative only within each wilderness, and these results were compiled to assess regional and national trends.
- The conceptual foundation for this monitoring was published as a Forest Service General Technical Report in April 2005, pilot testing in all nine Forest Service regions was completed in June 2006, and the monitoring protocols were published in the Technical Guide in September 2007.

What Are the Benefits of Monitoring Wilderness Character?

The monitoring effort yields the following benefits:

- It gives line officers unique information on the outcomes of stewardship actions on wilderness character, which is critical because nearly half of all agency line officers have wilderness responsibilities.
- It increases agency defensibility in litigation involving the preservation of wilderness character (to date, 54 district court and court of appeals cases have involved statutory citations about wilderness character).
- It provides accountability at all administrative levels for the mandate to "preserve wilderness character."
- It builds internal agency integration and makes information from other program areas more accessible to wilderness managers.
- It creates legacy information that spans the careers of individual managers and provides an institutional memory for future managers to improve wilderness stewardship by making decisions based on better knowledge of past conditions and actions.
- It continues the rich tradition of Forest Service national wilderness leadership started by early agency pioneers Aldo Leopold, Arthur Carhart, and Bob Marshall.

Region 1 Wilderness Character Monitoring Results, 2007–12

What Is Wilderness Character?

For this monitoring, wilderness character is described as four mutually reinforcing qualities derived from the Wilderness Act of 1964.

Untrammeled

The intentional management actions that directly control or manipulate the components or processes of ecological systems inside wilderness.

Natural

The effects of modern people on ecological systems inside wilderness since the time the area was designated.

Undeveloped

The presence of structures, construction, habitations, and other evidence of modern human presence or occupation.

Outstanding opportunities for solitude or a primitive and unconfined type of recreation

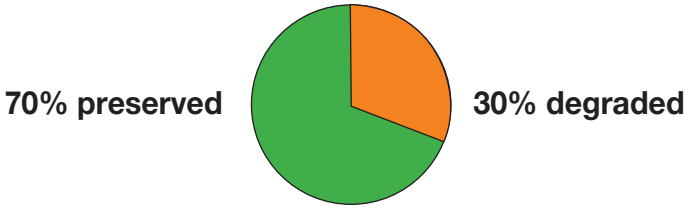
The conditions that affect the opportunity for people to experience solitude or primitive, unconfined recreation.

Region 1 Trends In Wilderness Character

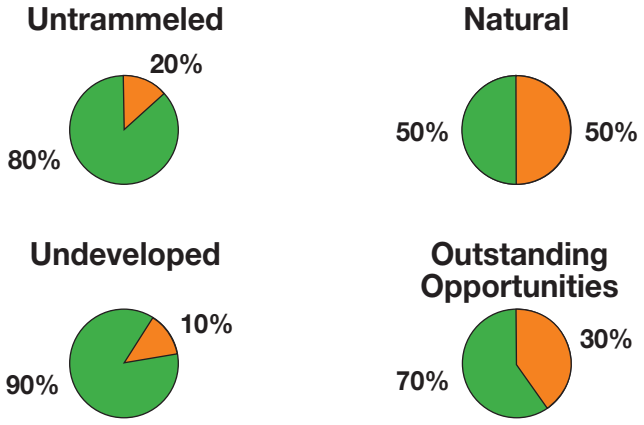
Regional trends are derived by compiling trends in wilderness character and the qualities of wilderness character across all 14 Forest Service wildernesses from 2007 through 2012.

= % of 14 wildernesses with wilderness character **preserved**

= % of 14 wildernesses with wilderness character **degraded**



Region 1 Trends in Four Qualities of Wilderness Character



Narrative About These Regional Trends

Significant findings and key interpretations:

- …….
- …….
- …….
- …….
- …….

Data adequacy in the region:

Data quantity (percentage of wildernesses reporting data and explanations).

Data quality (problems local wildernesses reported with collecting data and trends shown).

Summary of Trends in Wilderness Character Across the 14 Wildernesses in the Region

Name of Wilderness	Trend in Wilderness Character
Selway-Bitterroot Gospel-Hump Gates of the Mountains Absaroka-Beartooth	Improving
Rattlesnake Mission Mountains Lee Metcalf Anaconda Pintler Bob Marshall Great Bear Frank Church-River of No Return	Stable or Offsetting Stable
Cabinet Mountains Scapegoat Welcome Creek	Degrading

Untrammeled Quality

Wilderness is essentially unhindered and free from modern human control or manipulation.

Wilderness Act of 1964

Wilderness is "an area where the earth and its community of life are untrammeled by man," and "generally appears to have been affected primarily by the forces of nature."

Howard Zahniser, the primary author of the Wilderness Act, noted that the inspiration for wilderness preservation "is to use 'skill, judgment, and ecologic sensitivity' for the protection of some areas within which natural forces may operate without man's management and manipulation."

This quality monitors management activities that directly control or manipulate the components or processes of ecological systems inside wilderness.

Trends in the Untrammeled Quality Across the 14 Regional Wildernesses

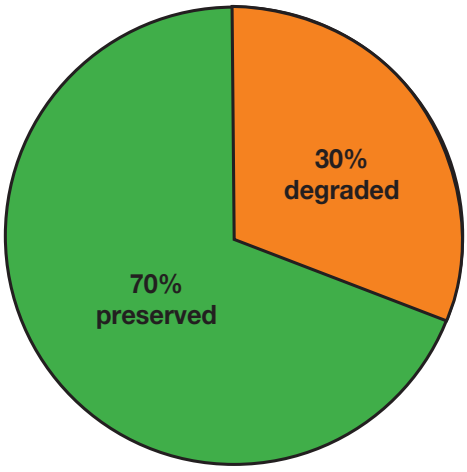


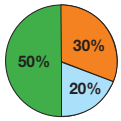
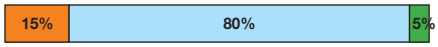
Photo credit: U.S. Fish and Wildlife Service
Wilderness: Okefenokee Wilderness

Photo credit: Dennis Schramm
Wilderness: Lava Beds Wilderness

Untrammeled Quality (continued)

Trends in the Indicator and Measures Across the 14 Regional Wildernesses

Percent of 14 wildernesses that are improving, stable or offsetting stable, or degrading

Indicator	Trend	Measure	Trend
Monitoring Question: What are the trends in actions that control the "community of life" in wilderness?			
Agency actions that control or manipulate plant communities, animal populations, soils, water bodies, or natural disturbance processes		Number of actions undertaken to manage vegetation; fish, wildlife, insects, and disease; soil and water; and fire	
		Percentage of lightning fires that are suppressed	
		Number of lakes and other water bodies stocked with fish	

Narrative About the Untrammeled Quality

- What are the significant findings and key interpretations regarding trends in this quality?
- If problems occurred with the data used to generate trend information for this quality, what did they consist of?
- What is the explanation for the observed trends?

Natural Quality

Wilderness ecological systems are substantially free from the effects of modern civilization.

Wilderness Act of 1964

Wilderness is "protected and managed so as to preserve its natural conditions."

This statement means that the indigenous species composition, structures, and functions of ecological systems in wilderness are protected and allowed to function and change on their own, without the planned intervention or the unintended effects of modern civilization. Trends are ideally monitored from the time of wilderness designation.

Only through such protection may wilderness truly serve as "a laboratory for the study of land-health" and as an ecological baseline for understanding the effects of modern civilization on natural systems.

Trends in the Natural Quality Across the 14 Regional Wildernesses

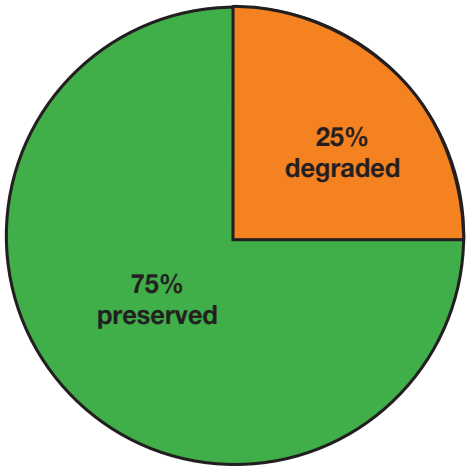


Photo credit: Montana Fish, Wildlife and Parks, Tom Flowers
Wilderness: Bob Marshall Wilderness

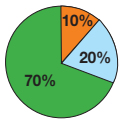
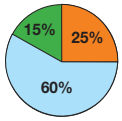
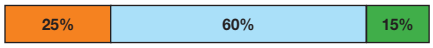
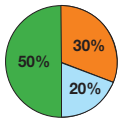
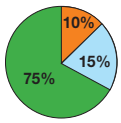
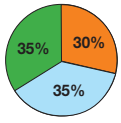
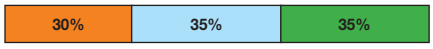
Photo credit: Peter Landres
Wilderness: Anaconda Pintler Wilderness

Narrative About the Natural Quality

- What are the significant findings and key interpretations regarding trends in this quality?
- If problems occurred with the data used to generate trend information for this quality, what did they consist of?
- What is the explanation for the observed trends?

Trends in the Indicators and Measures Across the 14 Regional Wildernesses

Percent of 14 wildernesses that are improving, stable or offsetting stable, or degrading

Indicator	Trend	Measure	Trend
Monitoring Question: What are the trends in human threats to natural conditions?			
Pollutants that degrade air quality and air quality-related values such as plants, animals, soil, and water		Ozone exposure statistic N100 episodic concentration	
		Ozone exposure statistic W126 chronic concentration	
		Concentration of sulfur in wet deposition	
		Concentration of nitrogen in wet deposition	
Developments that degrade the free-flowing condition of rivers and streams		Number of dams inside wilderness	
Nonindigenous species that alter the composition of natural plant and animal communities		Percentage of wilderness acre category with invasive plant species	
		Number of nonplant species of concern that are not indigenous to the wilderness	
		Number of acres of active grazing allotment	
Monitoring Question: What are the trends in selected biophysical conditions that are sensitive to human threats?			
Visual air quality		Average sum of anthropogenic fine nitrate and sulfate	
		Average deciview	
Indigenous ecosystems, plant communities, and plant and animal species that have been extirpated		Number of indigenous plant and animal species that have been extirpated	

Undeveloped Quality

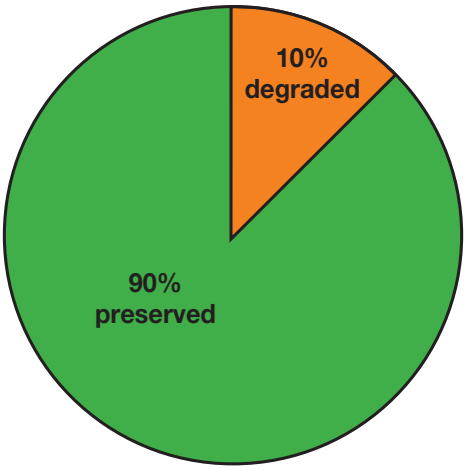
Wilderness is essentially without permanent improvements or modern human occupation.

Wilderness Act of 1964

Wilderness is "an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation…where man himself is a visitor who does not remain," and "with the imprint of man's work substantially unnoticeable."

Some evidence of occupancy and use is acceptable because of special provisions in legislation or because it is considered the "minimum necessary for administration of the area for the purpose of the Act" (Wilderness Act of 1964, Sec. 4(c)). Regardless, managers must exercise restraint so that a wilderness does not increasingly appear developed, occupied, and modified.

Trends in the Undeveloped Quality Across the 14 Regional Wildernesses



This quality monitors the number and development level of structures, construction, habitations, and other evidence of modern human presence or occupation.

Photo credit: Lisa Eidson
Wilderness: Absaroka-Beartooth Wilderness

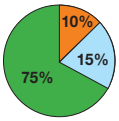
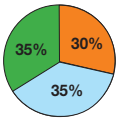
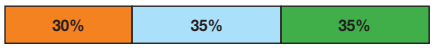
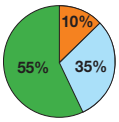
Photo credit: http://wilderness.net
Wilderness: Not identified

Narrative About the Undeveloped Quality

- What are the significant findings and key interpretations regarding trends in this quality?
- If problems occurred with the data used to generate trend information for this quality, what did they consist of?
- What is the explanation for the observed trends?

Trends in the Indicators and Measures Across the 14 Regional Wildernesses

Percent of 14 wildernesses that are improving, stable or offsetting stable, or degrading

Indicator	Trend	Measure	Trend
Monitoring Question: What are the trends in physical evidence of modern human development or modification?			
Physical evidence of development		Index of physical development	
Monitoring Question: What are the trends in the use of motorized equipment and mechanical transport?			
Motorized equipment and mechanical transport use authorizations		Number of mechanical transport use days authorized	
		Number of motorized equipment use days authorized	
Monitoring Question: What are the trends in inholdings?			
Inholdings		Acres of inholdings	

Outstanding Opportunities for Solitude or a Primitive and Unconfined Type of Recreation Quality

Wilderness provides outstanding opportunities for people to experience solitude or primitive and unconfined recreation, including the values of inspiration and physical and mental challenge.

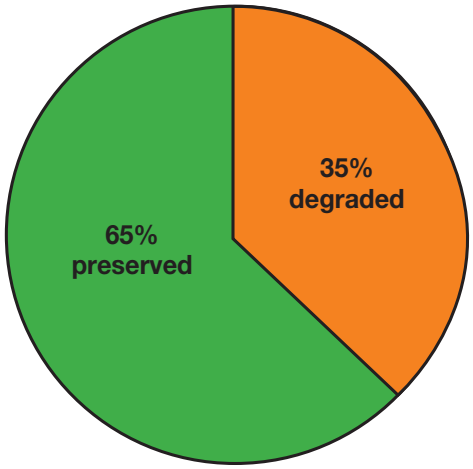
Wilderness Act of 1964

Wilderness "has outstanding opportunities for solitude or a primitive and unconfined type of recreation."

The meaning of solitude in wilderness encompasses separation from people and civilization, inspiration, and a sense of timelessness. Primitive recreation encompasses travel by nonmotorized and nonmechanized means and also includes reliance on personal skills to travel and camp in an area rather than reliance on facilities or outside help.

Unconfined recreation encompasses self-discovery, exploration, and freedom from societal or managerial controls.

Trends in the Outstanding Opportunities Quality Across the 14 Regional Wildernesses



This quality monitors conditions that affect the *opportunity* for people to experience solitude or primitive, unconfined recreation; it does not monitor visitor experiences directly.

Photo credit: Peter Landres
Wilderness: Selway/Bitterroot Wilderness

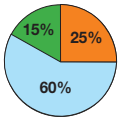
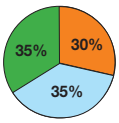
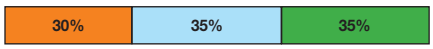
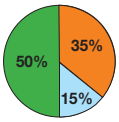
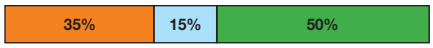
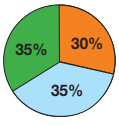
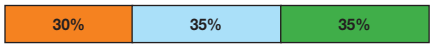
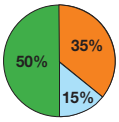
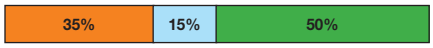
Photo credit: National Park Service
Wilderness: Not identified.

Narrative About the Outstanding Opportunities Quality

- What are the significant findings and key interpretations regarding trends in this quality?
- If problems occurred with the data used to generate trend information for this quality, what did they consist of?
- What is the explanation for the observed trends?

Trends in the Indicators and Measures Across the 14 Regional Wildernesses

Percent of 14 wildernesses that are improving, stable or offsetting stable, or degrading

Indicator	Trend	Measure	Trend
Monitoring Question: What are the trends in outstanding opportunities for solitude?			
Remote, trailless wilderness		Number of acres of wilderness away from access and travel routes	
Wilderness visitation		Number of parties visiting a wilderness during the primary use season	
		Number of National Visitor Use Monitoring visits per region	
Monitoring Question: What are the trends in outstanding opportunities for primitive recreation?			
Recreation facilities		Index of recreation amenities	
Trail development level		Number of trail miles in developed condition classes (classes 3 to 5)	
Monitoring Question: What are the trends in opportunities for unconfined recreation?			
Management restrictions on visitor behavior		Index of restrictions on visitor behavior	

Monitoring Selected Conditions Related to Wilderness Character: A Report on Trends in the XXXX Wilderness From 2007 Through 2012

What Is Wilderness Character?

For this monitoring, wilderness character is described as four mutually reinforcing qualities derived from the Wilderness Act of 1964.

Untrammeled

The intentional management actions that directly control or manipulate the components or processes of ecological systems inside wilderness.

Natural

The effects of modern people on ecological systems inside wilderness since the time the area was designated.

Undeveloped

The presence of structures, construction, habitations, and other evidence of modern human presence or occupation.

Outstanding opportunities for solitude or a primitive and unconfined type of recreation

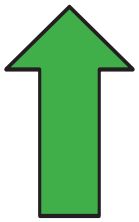
The conditions that affect the opportunity for people to experience solitude or primitive, unconfined recreation.

Why Monitor Wilderness Character?

- To fulfill legal and policy mandates to preserve wilderness character.
- To assess the outcomes of wilderness stewardship.
- To improve wilderness stewardship.
- To establish information that will endure as personnel and conditions change.

"…each agency administering any area designated as wilderness shall be responsible for preserving the wilderness character of the area."

—Wilderness Act of 1964, (Sec. 4b)



The overall trend in wilderness character is improving

Photo credit: Andrea Davidson
Wilderness: Bridger Wilderness

Trends in the Qualities of Wilderness Character

Quality of wilderness character	Trend 2007–12
Untrammeled	Offsetting stable
Natural	Degrading
Undeveloped	Improving
Outstanding opportunities	Improving
Trend in wilderness character	Improving

Summary of Trends in the XXXX Wilderness, 2007–12

Measure	Trend in measure	Trend in indicator	Trend in question	Trend in quality	Trend in wilderness character
Untrammeled quality:					
Management actions	↓	↕	↕	↕	
Fires suppressed	↑				
Fish stocking	↔				
Natural quality:					
Ozone N100	↔	↓	↓	↓	
Ozone W126	↔				
Sulfur deposition	↓				
Nitrogen deposition	↓				
Dams	↔	↔			
Nonindigenous plants	↑	↕			
Other nonindigenous species	↔				
Grazing allotments	↓				
Fine nitrate and sulfate	↓	↓	↓		
Deciview	↔				
Extirpated species	↔	↔			
Undeveloped quality:					
Physical development index	↑	↑	↑	↑	
Mechanical transport use	↓	↓	↓		
Motorized equipment use	↓				
Inholdings	↑	↑	↑		
Outstanding opportunities quality:					
Area away from access or travel	↑	↑	↑	↑	
Visiting parties	↔*	↔			
Users residing in service area					
National Visitor Use Monitoring visits per region	↔				
Recreation facilities index	↑	↑	↑		
Developed trail miles	↔	↔			
Visitor restrictions index	↓	↑	↑		

* *One trend is identified for these two measures because only one of these measures will be used.*

Untrammeled Quality

Wilderness is essentially unhindered and free from modern human control or manipulation.

Wilderness Act of 1964

Wilderness is "an area where the earth and its community of life are untrammeled by man," and "generally appears to have been affected primarily by the forces of nature."

Howard Zahniser, the primary author of the Wilderness Act, noted that the inspiration for wilderness preservation "is to use 'skill, judgment, and ecologic sensitivity' for the protection of some areas within which natural forces may operate without man's management and manipulation."

Trend in This Quality

Offsetting stable

This quality monitors management activities that directly control or manipulate the components or processes of ecological systems inside wilderness.

Photo credit: Tom Kogut
Forest: Gifford Pinchot Forest

Photo credit: Tom Kogut
Forest: Gifford Pinchot Forest

Trends in Indicators and Measures for the Untrammeled Quality

Indicator	Trend	Measure	Trend	Data adequacy*
Monitoring Question: What are the trends in actions that control the community of life in wilderness?				
Agency actions that control or manipulate plant communities, animal populations, soils, water bodies, or natural disturbance processes	↕	Number of actions to manage vegetation; fish, wildlife, insects and disease; soil and water; and fire	↓	◐
		Percentage of lightning fires that are suppressed	↑	◐
		Number of lakes and other water bodies stocked with fish	↔	◔

**Left half of circle = data availability: filled in = complete; thick line = partial; empty = insufficient. Right half of circle = data quality: filled in = high; thick line = moderate; empty = low.*

Narrative About the Untrammeled Quality

- Why is this trend in the untrammeled quality an accurate reflection of recent conditions in the wilderness?
- If problems occurred with the data used to generate trend information for this quality, what did they consist of?
- What is the explanation for the observed trend?

Natural Quality

Wilderness ecological systems are substantially free from the effects of modern civilization.

Wilderness Act of 1964

Wilderness is "protected and managed so as to preserve its natural conditions."

This statement means that the indigenous species composition, structures, and functions of ecological systems in wilderness are protected and allowed to function and change on their own, without the planned intervention or the unintended effects of modern civilization. Trends are ideally monitored from the time of wilderness designation.

Trend in This Quality

Degraded

Only through such protection may wilderness truly serve as "a laboratory for the study of land-health" and as an ecological baseline for understanding the effects of modern civilization on natural systems.

Photo credit: Andrea Davidson
Wilderness: Bridger Wilderness

Photo credit: Jann Williams
Forest: Eldorado Forest

Narrative About the Natural Quality

- Why is this trend in the natural quality an accurate reflection of recent conditions in the wilderness?
- If problems occurred with the data used to generate trend information for this quality, what did they consist of?
- What is the explanation for the observed trend?

Trends in Indicators and Measures for the Natural Quality

Indicator	Trend	Measure	Trend	Data adequacy*
Monitoring Question: What are the trends in human threats to natural conditions?				
Pollutants that degrade air quality and air quality related values such as plants, animals, soil, and water	↓	Ozone exposure statistic N100 episodic concentration	↔	
		Ozone exposure statistic W126 chronic concentration	↔	
		Concentration of sulfur in wet deposition	↓	
		Concentration of nitrogen in wet deposition	↓	
Developments that degrade the free-flowing condition of rivers and streams	↔	Number of dams inside wilderness	↔	
Nonindigenous species that alter the composition of natural plant and animal communities	↕	Percentage of wilderness acre category with invasive plant species	↑	
		Number of nonplant species of concern that are not indigenous to the wilderness	↔	
		Number of acres of active grazing allotment	↓	
Monitoring Question: What are the trends in selected biophysical conditions that are sensitive to human threats?				
Visual air quality	↓	Average sum of anthropogenic fine nitrate and sulfate	↓	
		Average deciview	↔	
Indigenous ecosystems, plant communities, and plant and animal species that have been extirpated	↔	Number of indigenous plant and animal species that have been extirpated	↔	

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Undeveloped Quality

Wilderness is essentially without permanent improvements or modern human occupation.

Wilderness Act of 1964

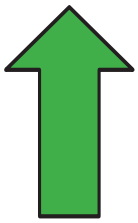
Wilderness is "an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation…where man himself is a visitor who does not remain," and "with the imprint of man's work substantially unnoticeable."

Some evidence of occupancy and use is acceptable because of special provisions in legislation or because it is considered the "minimum necessary for administration of the area for the purpose of the Act" (Wilderness Act of 1964, Sec. 4(c)). Regardless, managers must exercise restraint so that a wilderness does not increasingly appear developed, occupied, and modified.

This quality monitors the number and development level of structures, construction, habitations, and other evidence of modern human occupation.

Photo credit: Deborah Caffin
Wilderness: Raven Cliffs Wilderness

Trend in This Quality



Improving

Photo credit: Gordon Ash
Wilderness: Great Bear Wilderness

Undeveloped Quality (continued)

Trends in Indicators and Measures for the Undeveloped Quality

Indicator	Trend	Measure	Trend	Data adequacy*
Monitoring Question: What are the trends in physical evidence of modern human development or modification?				
Physical evidence of development	↑	Index of physical development	↑	◐
Monitoring Question: What are the trends in the use of motorized equipment and mechanical transport?				
Motorized equipment and mechanical transport use authorizations	↓	Number of mechanical transport use days authorized	↓	◐
		Number of motorized equipment use days authorized	↓	◐
Monitoring Question: What are the trends in inholdings?				
Inholdings	↑	Acres of inholdings	↑	◐

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Narrative About the Undeveloped Quality

- Why is this trend in the undeveloped quality an accurate reflection of recent conditions in the wilderness?
- If problems occurred with the data used to generate trend information for this quality, what did they consist of?
- What is the explanation for the observed trend?

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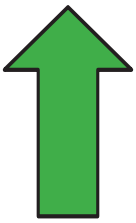
This quality monitors conditions that affect the *opportunity* for people to experience solitude or primitive, unconfined recreation; it does not monitor visitor experiences directly.

Photo credit: Kevin Hood
Wilderness: Tracy Arm-Ford's Terror Wilderness

Trend in This Quality



Improving

Photo credit: Kirk Johnson
Wilderness: Lake Clark Wilderness

Narrative About the Outstanding Opportunities Quality

- Why is this trend in the outstanding opportunities quality an accurate reflection of recent conditions in the wilderness?
- If problems occurred with the data used to generate trend information for this quality, what did they consist of?
- What is the explanation for the observed trend?

Trends in Indicators and Measures for the Outstanding Opportunities Quality

Indicator	Trend	Measure	Trend	Data adequacy*
Monitoring Question: What are the trends in outstanding opportunities for solitude?				
Remote, trailless wilderness	↑	Number of acres of wilderness away from access and travel routes	↑	
Wilderness visitation	↔	Number of parties visiting a wilderness during the primary use season	↔	
		National Visitor Use Monitoring visits per region	↔	
Monitoring Question: What are the trends in outstanding opportunities for primitive recreation?				
Recreation facilities	↑	Index of recreation amenities	↑	
Trail development level	↔	Number of trail miles in developed condition classes (class 3 to 5)	↔	
Monitoring Question: What are the trends in opportunities for unconfined recreation?				
Management restrictions on visitor behavior	↓	Index of restrictions on visitor behavior	↓	

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