

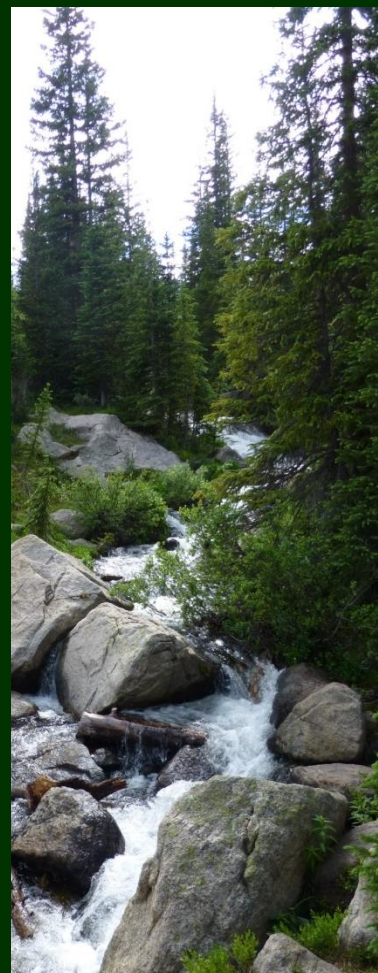
SAN ISABEL NATIONAL FOREST &
LEADVILLE NATIONAL FISH HATCHERY



Mount Massive Wilderness

A Report on Wilderness Character Monitoring

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USDA FOREST SERVICE & USDOJ FISH AND WILDLIFE SERVICE



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INTRODUCTION

The Wilderness Act of 1964 (Public Law 88-577 (16 U.S.C. § 1131)) was passed by a nearly unanimous vote in the United States Congress to protect natural lands from the seemingly endless threats of “expanding settlement and growing mechanization.” The primary mandate of the Wilderness Act is given in Section 4(b) and states that “each agency administering any area designated as wilderness shall be responsible for *preserving the wilderness character of the area*” [emphasis added]. In order to establish a common understanding of this directive, wilderness character was formally defined in 2005 by an interagency monitoring team representing the Forest Service (Department of Agriculture), as well as the U.S. Fish and Wildlife Service, National Park Service, Bureau of Land Management, and U.S. Geological Survey (Department of the Interior): wilderness character is “the combination of biophysical, experiential, and symbolic ideals that distinguishes wilderness from all other lands” (Landres et al. 2005).

Wilderness character encompasses the five qualities that are described in the definition of wilderness from Section 2(c) of the Wilderness Act. Together, these five qualities are used to monitor how stewardship actions, impacts from modernization, and other changes occurring outside of a given wilderness area, affect said wilderness over time. The five qualities apply nationally to all wilderness areas—regardless of their size, location, administering federal agency, or other unique place-specific attributes—because they are based on the legal definition of wilderness. Descriptions of these qualities as derived from Section 2(c) of the Wilderness Act are below.

Untrammeled

Wilderness is “...an area where the earth and its community of life are untrammeled by man”

Wilderness ecological systems are essentially unhindered and free from the actions of modern human control or manipulation when the untrammeled quality is preserved.

Natural

Wilderness “...is protected and managed so as to preserve its natural conditions”

Wilderness ecological systems are substantially free from the effects of modern civilization when the natural quality is preserved.

Undeveloped

Wilderness is “...an area of undeveloped Federal land ... without permanent improvements or human habitation”

Wilderness retains its primeval character and influence, and is essentially without permanent improvement or modern human occupation when the undeveloped quality is preserved.

Solitude or Primitive and Unconfined Recreation

Wilderness “...has outstanding opportunities for solitude or a primitive and unconfined type of recreation”

Wilderness provides outstanding opportunities for solitude or primitive and unconfined recreation when the quality of solitude or primitive and unconfined recreation is preserved.

Other Features of Value

Wilderness “...may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value”

Other tangible features of scientific, educational, scenic, or historical value in wilderness preserve wilderness character when they are preserved.

In addition to these five tangible qualities of wilderness character, wilderness also has important intangible aspects that are difficult or impossible to quantify or monitor. These intangible aspects are diverse and can include the scenic beauty, spiritual experiences, immensity of an area, and opportunities for self-discovery, self-reliance, and challenge that come from wilderness settings. Currently, these intangible aspects of wilderness can only be addressed in narrative form.

Wilderness character may change over time, and may be improved or diminished by the actions or inaction of managers. The challenge of wilderness stewardship is that decisions and management actions taken to protect one quality of wilderness character may degrade another quality. In addition, the accumulated result of seemingly small decisions and actions may cause a significant gain or loss of wilderness character over time. Because of this complexity, preserving wilderness character requires that agency staff document decisions made in wilderness and the impacts of those decisions.

In 2008, an Interagency Team published a national strategy for monitoring trends in wilderness character titled *Keeping It Wild: An Interagency Strategy for Monitoring Trends in Wilderness Character Across the National Wilderness Preservation System* (Landres et al. 2008). The monitoring strategy described in *Keeping It Wild* was implemented nationally from 2008 to 2014, and has proved to be an effective tool for wilderness managers with limited resources. Based on lessons learned during this initial implementation of wilderness character monitoring, the framework was revised and updated; the changes made are reflected in *Keeping It Wild 2: An Updated Interagency Strategy to Monitor Trends in Wilderness Character Across the National Wilderness Preservation System* (Landres et al. *in press*). The wilderness character monitoring strategy for the Mount Massive Wilderness contained in this document reflects the revised monitoring strategy described in the most recent draft of *Keeping It Wild 2* (released in April, 2014).

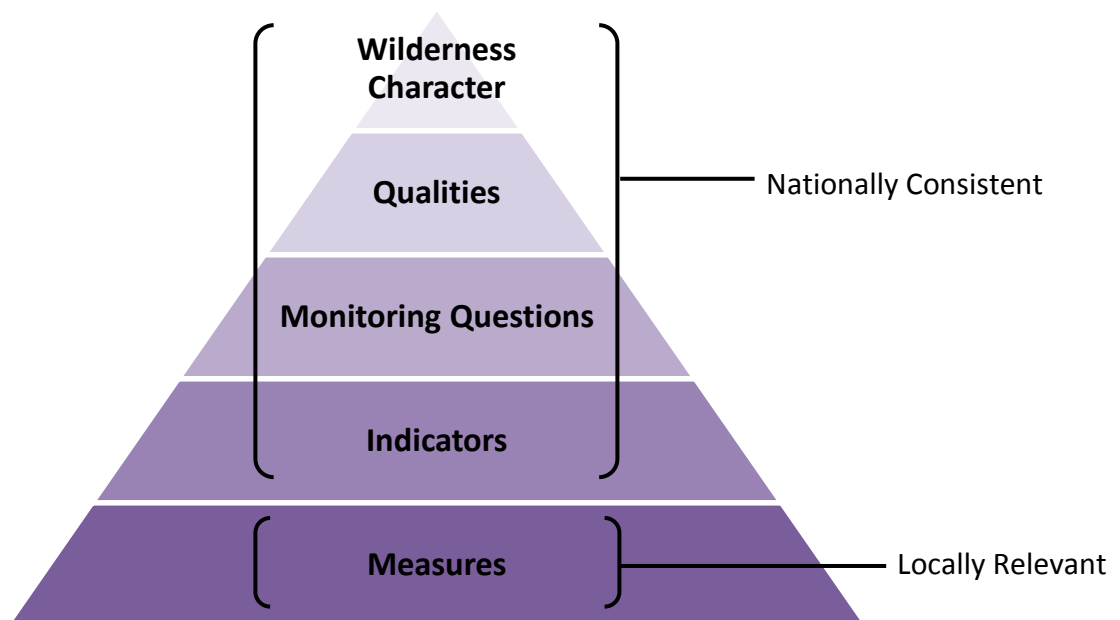


Figure 1. *Keeping It Wild* Hierarchical Framework

The updated framework of wilderness character monitoring is based on the qualities defined above. Each quality is divided into a hierarchical set of monitoring questions, indicators, and measures to assess trends in wilderness character over time. Monitoring questions frame wilderness character monitoring to answer

particular management questions; indicators are distinct and important elements within each monitoring question; and measures are a specific aspect of wilderness on which data are collected to assess trend in an indicator (Landres et al. 2008 and *in press*). Expanded definitions of wilderness character monitoring qualities, monitoring questions, indicators, and measures are available in Appendix A. While the qualities, monitoring questions, and indicators are nationally consistent, measures are specific and sometimes unique to individual wilderness areas (Figure 1).

This framework balances national and local needs for monitoring by defining locally relevant measures whose trends can be compiled at higher levels for national or regional reporting. This interagency monitoring strategy:

- Provides on-the-ground information to assess trends and make defensible decisions;
- Provides valuable information on wilderness on regional and national scales;
- Provides a set of key wilderness stewardship goals;
- Communicates a common definition of wilderness character;
- Communicates a tangible vision of wilderness within the agency and to the public;
- Clarifies how stewardship decisions and actions influence wilderness;
- Evaluates and documents the effects of actions taken inside the wilderness and effects from threats outside the wilderness;
- Synthesizes data into a single, holistic assessment of wilderness character;
- Creates a legacy of staff experience and knowledge of a wilderness;
- Improves on-the-ground wilderness stewardship.

This monitoring strategy offers a consistent means for documenting the status and trends in wilderness character and wilderness management within a wilderness. Under this monitoring strategy, trends in wilderness character are classified as upward (positive), downward (negative), or stable. These trends are both nationally consistent and independent of the unique aspects specific to any given wilderness; therefore, trends in wilderness character can be compared between wildernesses or across regions. These trends cannot be used to 'rate' or 'grade' stewardship, however, since they are meaningless when taken out of the context of wilderness character monitoring—wilderness character monitoring is a tool to holistically assess the preservation of wilderness character, not to place judgment on managers. Similarly, while *trends* can be compared between wildernesses, comparing *wilderness character itself* among different wildernesses is inappropriate. Each wilderness is unique in its legislative and administrative direction, and in its social and biophysical setting; therefore wilderness character in a particular wilderness cannot, and will not, be compared to that of another wilderness.

The purpose of this report and the measures of wilderness character is to improve wilderness stewardship by informing managers' understanding of the wilderness they manage, how wilderness character is changing over time, and why changes may have occurred. The following report establishes a baseline condition and monitoring strategy for the Mount Massive Wilderness based on the five qualities of wilderness character and measures that are specific to the Mount Massive Wilderness and are indicative of local trends in wilderness character. An online Wilderness Character Monitoring Database (at <https://wc.wilderness.net/>) accompanies this document and includes entries for all measures and baseline data specific to this wilderness where trends in wilderness character can be monitored.

HISTORICAL AND ADMINISTRATIVE SETTING OF THE MOUNT MASSIVE WILDERNESS

HISTORY OF ESTABLISHING THE WILDERNESS

The Mount Massive Wilderness was designated by the Colorado Wilderness Act of 1980 (Public Law 96-560, 99 Stat. 3265) on December 22, 1980. Originally proposed as an addition to the Hunter-Fryingpan Wilderness (designated in 1978 and located across the Continental Divide to the west), a technical oversight led to the designation of the Mount Massive Wilderness as a separate wilderness area. Over 90% (27,980 acres) of the Mount Massive Wilderness is located in the San Isabel National Forest (managed by the U.S. Forest Service (USFS)), while 2,560 acres are located in the Leadville National Fish Hatchery (managed by the U.S. Fish and Wildlife Service (USFWS)). This portion of the Mount Massive Wilderness is the only area in the National Wilderness Preservation System that is located in a National Fish Hatchery. Although the current wilderness is listed as 30,540 acres, documents from the 1980s and 1990s consistently list the wilderness as 28,047 acres, with 1,920 acres within the National Fish Hatchery. No documentation has been found to explain this abrupt change in the reported acreage, and it is now assumed to be the result of corrections made to survey data, boundary calculations, or some other mathematical or geographic error(s).

In the first years after designation, a legal opinion was requested by the Forest Service regarding the jurisdictional status of the lands within the Mount Massive

Wilderness. A letter sent to the USFS Leadville District Ranger on February 19, 1982 from the Forest Supervisor (Morgan 1982) summarized the conclusions of this opinion as follows:

1. The reservation of land for the Leadville National Fish Hatchery and the reservation of land for the San Isabel National Forest are both valid and co-existing reservations.
2. The Colorado Wilderness Act of 1980 charges the Forest Service with preserving the wilderness character of the lands. Section 104(b) of that Act states that:

"Subject to valid existing rights, each wilderness area designated by this title shall be administered by the Secretary of Agriculture in accordance with the provisions of the Wilderness Act of 1964 (78 Stat. 892)."

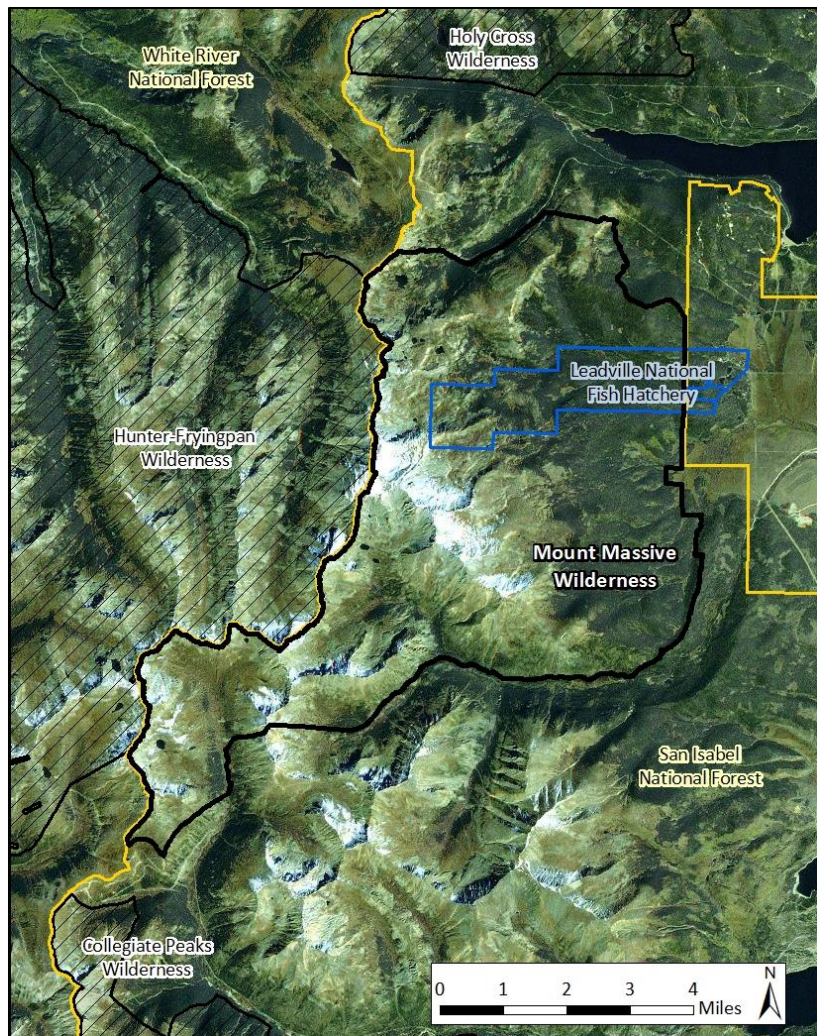


Figure 2. Mount Massive Wilderness

3. “The appropriate method to clarify responsibilities and to protect the interests of both agencies, is to develop an administrative agreement (Inter-Agency Agreement, See FSM 1587).”

A letter dated March 16, 1983 and signed by both the USFWS Leadville National Fish Hatchery Manager and the USFS Leadville District Ranger (Eide 1983) stated that:

“The Forest Service is responsible for the management of the Mount Massive Wilderness, including these lands dedicated for the use by the Leadville National Fish Hatchery. The Forest Service recognizes that the primary interest of the Fish Hatchery in these dedicated lands is the preservation of water quality in the Rock Creek Drainage and that these waters are critical for the operation of the Fish Hatchery. The Forest Service, in consultation with the Manager of the Fish Hatchery, agrees that the single most potential for damage of water quality is wildfire.”

For the past 30 years, therefore, this mutual understanding has guided management in the Mount Massive Wilderness. The Forest Service assumes the primary management responsibilities for the entire wilderness area, while striving to respect the needs and concerns of the Leadville National Fish Hatchery on the portion of the wilderness located on USFWS land. Management actions in this part of the wilderness are generally coordinated between both agencies before being undertaken by the Forest Service. While the intention has always been to formalize this arrangement through an interagency agreement, at this time such an agreement regarding the management of the wilderness does not exist.

Supplementary to this understanding, a separate interagency agreement between the Leadville National Fish Hatchery and the Pike and San Isabel National Forests, Cimarron and Comanche National Grasslands (PSICC) guides fire suppression activities in the USFWS portion of the wilderness (USDOI Fish and Wildlife Service and USDA Forest Service 2004). This agreement stipulates that the Forest Service will provide the first response and initial attack for the suppression of fires on land belonging to the Leadville National Fish Hatchery, including the portion of that land that is wilderness.



Figure 3. View from North Halfmoon Lakes

WILDERNESS PURPOSES

The Wilderness Act of 1964 states that wilderness purposes are “within and supplemental to the purposes for which national forests and units of the national park and national wildlife refuge systems are established and administered” (Section 4(a)). Furthermore, “each agency administering any area designated as wilderness shall be responsible for preserving the wilderness character of the area and shall so administer such area for such other purposes for which it may have been established as also to preserve its wilderness character. Except as otherwise provided in this Act, wilderness areas shall be devoted to the public purposes of recreational, scenic, scientific, educational, conservation, and historical use” (Section 4(b)).

The Wilderness Objectives of the Forest Service are as follows (FSM 2320.2):

- Maintain and perpetuate the enduring resource of wilderness as one of the multiple uses of National Forest System land.
- 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.
- Minimize the impact of those kinds of uses and activities generally prohibited by the Wilderness Act, but specifically excepted by the Act or subsequent legislation.
- Protect and perpetuate wilderness character and public values including, but not limited to, opportunities for scientific study, education, solitude, physical and mental challenge and stimulation, inspiration, and primitive recreation experiences.
- Gather information and carry out research in a manner compatible with preserving the wilderness environment to increase understanding of wilderness ecology, wilderness uses, management opportunities, and visitor behavior.

The U.S. Fish and Wildlife Service principles for administering wilderness are as follows (610 FW 1.14):

- Accomplish Administration Act purposes, refuge purposes, including Wilderness Act purposes, and the Refuge System mission. The Administration Act, refuge purposes, and Wilderness Act purposes tell us what to accomplish on a refuge. The Wilderness Act, however, may affect how we accomplish these purposes, and the Refuge System mission.
- Secure “an enduring resource of wilderness” by maintaining and, where appropriate, restoring, a wilderness area’s biological integrity, diversity, environmental health, and wilderness character.
- Administer wilderness areas to provide a wide variety of public benefits “for the use and enjoyment of the American people” (Wilderness Act, section 2(a)) in a manner that is appropriate and compatible with the Administration Act, refuge purposes, including Wilderness Act purposes, and the Refuge System mission; retains wilderness character; is consistent with the nondegradation principle; and leaves the areas “unimpaired for future use and enjoyment as wilderness . . .”
- Use restraint in our administration of wilderness. As a place “where the earth and its community of life are untrammelled by man,” we minimize actions for administration of wilderness areas. We may allow exceptions to the generally prohibited uses if the uses are the minimum requirement for administering the area as wilderness and are necessary to accomplish the purposes of the refuge, including Wilderness Act purposes. We may limit even nonmotorized refuge management activities to protect wildness.
- Provide opportunities for primitive recreation, giving priority to compatible wildlife-dependent activities that are enhanced by a wilderness setting. Provide physical, social, and administrative settings that are conducive to experiencing opportunities for solitude, adventure, challenge, inspiration, and other aspects of wilderness character that the American people can use and enjoy.



Figure 4. View from North Halfmoon Trail

The Pike and San Isabel National Forests Land and Resource Management Plan (USDA Forest Service 1984) identifies as its primary wilderness-related goal to: “manage wilderness to preserve the wilderness character and provide for a variety of wilderness experience opportunities.” The Mount Massive Wilderness Implementation Schedule (USDA Forest Service 1988) further describes general guidelines that serve as a philosophical base for wilderness management. These are to:

- Preserve and protect the primitive character of the Mount Massive Wilderness area consistent with the Wilderness Act of 1964 and the Colorado Wilderness Act of 1980.
- Provide opportunities to the recreation visitor for an unconfined and primitive experience with nature where the impact of humankind is substantially unnoticeable.
- Provide for the recreation visitor outstanding opportunities for solitude.
- Provide for the scientific and academic communities opportunities to study the ecological, geological or other features of scientific, educational, scenic or historic value.
- Provide for public involvement to assist in the development of this implementation schedule.

BIOPHYSICAL SETTING OF THE MOUNT MASSIVE WILDERNESS

GEOGRAPHIC SETTING

The Mount Massive Wilderness is located near Leadville, Colorado just east of the Continental Divide. In addition to the adjacent Hunter-Fryingpan Wilderness to the west, three other wilderness areas are located within ten miles of the Mount Massive Wilderness boundary: Collegiate Peaks Wilderness to the south, Buffalo Peaks Wilderness to the southeast, and Holy Cross Wilderness to the north.

The wilderness area is located in the Sawatch Range with elevations ranging from 9,700 to over 14,000 feet. The crest of the continent, the Sawatch Range forms part of the Continental Divide and contains eight of the twenty highest peaks in the Rocky Mountains. In general, mountains in this range are high, yet



Figure 5. Colorado topography

Retrieved from www.google.com/maps on August 7, 2014. The red circle indicates the approximate location of the Mount Massive Wilderness in the Sawatch Range.

relatively easy to climb due to their great bulk. Mount Massive, the mountain for which the wilderness is named, has five summits over 14,000 feet, with the highest topping out at 14,421 feet—the third tallest peak in the continental United States; (the second, fourth, and seventh highest peaks lie just south of the wilderness boundary). True to its name, Mount Massive has the greatest area of land over 14,000 feet of any mountain in the contiguous United States.

The topography of the area shows evidence of glacial sculpting—cirques, kettle ponds, and glacial debris can be found throughout the wilderness area. Much of the wilderness is located above treeline, and one permanent snowfield—known locally as Africa Bowl due to its shape—exists on Mount Massive. At lower elevations

winter temperatures average around 15 degrees Fahrenheit, while summer temperatures average around 50 degrees. Precipitation averages around 30 inches annually, with over 100 inches of average annual snowfall. July and August are the monsoon months and see the highest amount of rainfall as well as the most thunderstorms.

Located in the center of the Colorado mineral belt, mining played a large role in the growth of Leadville and other nearby communities. While no mineral resources have been identified within the wilderness, both the southwest and northeast areas are considered favorable for the presence of undiscovered mineral resources, including gold, silver, lead, zinc, and molybdenum (US Geological Survey 1989). Much of what is now the wilderness was also logged in the late 1800s for mine timbers as well as charcoal for the Leadville smelters. Evidence of historic mining and logging activities can still be found in the wilderness today.

As forest productivity decreased, outdoor recreation—including hiking, cross-country skiing, hunting, and fishing—became, and remains, popular on and around Mount Massive. In addition to these more

traditional activities, in more modern times peak climbing has become increasingly prevalent as well. In the 1990s, it is estimated that its popularity in Colorado rose 300%, and summiting Mount Massive is currently a major recreation purpose in the wilderness (USDA Forest Service 2003). The Continental Divide National Scenic Trail and the Colorado Trail also merge in this area and pass through the wilderness from north to south, drawing visitors from around the country and around the world. Overuse of the wilderness and loss of solitude have been the primary concerns in the wilderness since shortly after its designation. Wilderness reports from the late 1980s and 1990s indicate that visitor use was already exceeding actual use capacities (designated in the Forest Land and Resource Management Plan (USDA Forest Service 1984) as encountering 20 people per day on the eastern (front) side of the wilderness and 6 people per day on the western (back) side).

ECOLOGICAL SETTING

The Mount Massive Wilderness is located in the alpine, subalpine, and upper montane ecological zones. Alpine tundra at the highest elevations yields to spruce and fir forests below, which in turn yield to aspens and lodgepole pines. Riparian areas occur at all elevations with willows, grasses, and other riparian vegetation providing crucial wildlife habitat. With its large area of alpine and riparian habitat, the wilderness is presumed to be a refuge for sensitive plant species, although only limited data have been collected up to this point. Mountain lion, black bear, lynx, and bobcat roam the area as top predators, while raptors such as goshawks, bald and golden eagles, falcons, osprey, and merlins also nest and hunt in the wilderness. Lynx in particular are known to favor the wilderness areas in this region, including Mount Massive Wilderness. In recent years, there have also been reports of wolf-dog hybrids in the wilderness. Elk, mule deer, and bighorn sheep are the native ungulates in this region, while smaller mammals such as pika, snowshoe hare, and marmot occupy the talus slopes.



Figure 6. View from Windsor Trail

The Arkansas River headwaters flow through the Mount Massive Wilderness, and mountain streams and lakes are prevalent throughout. Water quality is generally thought to be good, and the wilderness is home to several subspecies of sensitive cutthroat trout. Fish have been stocked in this area since the mid-1800s, including non-native species such as brook and lake trout. Even after the designation of the wilderness, state stocking of fingerlings has continued to the present day. In 1990 and 1991, bacterial kidney disease

was found to have infected the Leadville National Fish Hatchery and the Rock Creek Drainage in the wilderness; wilderness lakes and streams in this drainage were consequently purged of their (mostly non-native) fish populations and chemically disinfected. Following this, native greenback cutthroat trout were stocked in these lakes and streams for several years to replenish fish populations in the area. Recent research has revealed that the fish that were stocked at this time were not greenback cutthroat trout as previously thought, but were instead Colorado River cutthroat trout originally from the western slope of the Continental Divide (Metcalf et al. 2012). The original trout species that was native to the Arkansas River, the yellowfin cutthroat, is now extinct (Metcalf et al. 2012). In addition, since the purge of the early 1990s, non-native brook trout have made a strong recovery in the Rock Creek Drainage and are currently the dominant fish population.

Air quality in the wilderness (a class II airshed) is generally excellent due to the high elevations, relatively low amount of local development, and a great capacity for air dispersion (Bevenger July 2014 Draft). Urban and industrial air pollution from the western U.S. is the greatest threat to air quality in this area; from Grand Junction, Colorado to Los Angeles, California, year-round urban emissions could cause a persistent impact (Bevenger July 2014 Draft). A secondary significant threat to wilderness air quality is oil and gas development in Colorado, New Mexico, Utah, and Wyoming (Bevenger July 2014 Draft).

Colorado fire regimes have changed substantially in the last 150 years due to 19th century clear-cutting and subsequent 20th century fire suppression. Wildfires today tend to be bigger and more severe than historical wildfires as a result of increased tree densities. This departure from the natural fire regime is somewhat less noticeable in the Mount Massive Wilderness due to the large area of alpine tundra, although it is still apparent in the lower elevations. The early logging history of the wilderness resulted in a decrease in ponderosa pines and an increase in lodgepole pines at these lower elevations. While ponderosa pines generally burn frequently and at lower intensities, lodgepole pines tend toward infrequent stand replacement fires. These changes have also contributed to the departure from the natural fire regime.



Figure 7. Halfmoon Lake
Photo by Emily Kuhs

DOCUMENTS CONSULTED

Documents in this section were used for context and reference purposes; therefore, only a brief citation is included here. Documents that are cited specifically in the text are also included in the References section.

San Isabel National Forest Documents

- Abandoned Mine Inventory (USDA Forest Service 1996)
- Decision Notice and Finding of No Significant Impact for the Mount Massive Route Stabilization Project (USDA Forest Service 2003)
- Draft: Wilderness Air Quality Values Plan (Bevenger July, 2014)
- Mount Massive Wilderness Implementation Schedule (USDA Forest Service 1988)
- Mount Massive Wilderness Open Files (various letters, reports, notes, and other documents on file at the Leadville Ranger District, San Isabel National Forest)
- Pike and San Isabel National Forests and Cimarron and Comanche National Grasslands Annual Monitoring Reports for Fiscal Years 2010-2012 (USDA Forest Service 2011-2013)
- Recreation capacity analysis summary (USDA Forest Service 1995)
- The Pike and San Isabel National Forests Land and Resource Management Plan (USDA Forest Service 1984)
- Threatened, Endangered, and Forest Service Sensitive Species on the Pike and San Isabel National Forests (Wrigley et al. updated June, 2012)

Leadville National Fish Hatchery Documents

- Interagency Agreement regarding fire response in the Leadville National Fish Hatchery (Pike and San Isabel National Forests and Cimarron and Comanche National Grasslands and the Leadville National Fish Hatchery 2004)
- Leadville National Fish Hatchery Annual Summaries (Fiscal Years 1990 and 1991).
- Mount Massive Wilderness Open Files (various letters, reports, notes, and other documents on file at the Leadville National Fish Hatchery)

Other Documents

- Exposure indices used to protect vegetation (A.S.L. Associates 1995; updated 2014; available from: <http://www.asl-associates.com/veg1.htm>).
- Glaciers of Colorado (Hoffman 2005; updated 2011); available from <http://glaciers.us/glaciers-colorado>
- Historical stocking data and 19th century DNA reveal human-induced changes to native diversity and distribution of cutthroat trout (Metcalf et al. 2012)
- Inside Rain: A Look at the National Atmospheric Deposition Program (Lear 1999)
- Interagency Fire Regime Condition Class (FRCC) Guidebook, Version 3.0 (National Interagency Fuels, Fire, and Vegetation Technology Transfer Team 2010)
- Mineral Resource Potential of Mount Massive Wilderness, Lake County, Colorado (U.S. Geological Survey 1989)
- The Colorado Trail (Jacobs 1992)
- USDA Watershed Condition Framework (USDA Forest Service 2011)
- White River National Forest Air Resource Management Plan (USDA Forest Service 2009)

Wilderness Character Monitoring Documents

- Draft: Keeping It Wild 2: An Updated Interagency Strategy to Monitor Trends in Wilderness Character across the National Wilderness Preservation System (Landres et al. *in press*)
In the text, this document is referred to as Keeping it Wild 2. The version of this document that was consulted for this report was released on April 30, 2014.

- Draft: Keeping it Wild in the Forest Service: A Strategy to Monitor Wilderness Character (Boutcher et al. *in press*)
In the text, this document is referred to as Keeping it Wild in the Forest Service. Several versions of this document were consulted, including drafts released in September, 2013, May 31, 2013, and June 23, 2013.
- Keeping It Wild: An Interagency Strategy to Monitor Trends in Wilderness Character across the National Wilderness Preservation System (USDA Forest Service RMRS-GTR-212) (Landres et al. 2008)
In the text, this document is referred to as Keeping it Wild.
- Measuring Attributes of Wilderness Character: BLM Implementation Guide, Version 1.5 (Bureau of Land Management 2012)
In the text, this document is referred to as the BLM Implementation Guide.
- Monitoring selected conditions related to wilderness character: A national framework (Landres et al. 2005)
- Technical Guide for Monitoring Selected Conditions Related to Wilderness Character (Landres et al. 2009)
In the text, this document is referred to as the Forest Service Technical Guide.

STAFF CONSULTED

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PROCESS USED FOR IDENTIFYING MEASURES

While the four agencies that manage wilderness—the Forest Service, National Park Service, Fish and Wildlife Service, and Bureau of Land Management—are all committed to implementing wilderness character monitoring, each has developed a slightly different approach for identifying measures. While the Forest Service created a flexible framework of recommended measures to be consistent across the National Forest System, the Fish and Wildlife Service uses local data adequacy and relevance as the primary criteria for measure selection. Since the San Isabel National Forest has assumed the primary management responsibilities for the Mount Massive Wilderness, the process for identifying the Mount Massive Wilderness character monitoring measures adhered to the Forest Service’s framework of recommended measures.

Keeping it Wild in the Forest Service: a Strategy to Monitor Wilderness Character (Boutcher et al. *in press*) adapts the national wilderness character monitoring strategy outlined in *Keeping it Wild* for the needs of the Forest Service, and describes the Forest Service approach to measure identification. The Forest Service Wilderness Character Monitoring Team began working on this document in 2013 and is currently in the process of updating it to correspond with the revisions being made in *Keeping it Wild 2*. The selected measures described here for the Mount Massive Wilderness therefore reflect the Forest Service approach described in the most recent draft of *Keeping it Wild in the Forest Service* (released in September, 2013) as revised to comply with *Keeping It Wild 2* (April 2014 Draft). This revised draft outlines 48 recommended measures which are further classified as being required (25 measures), required if relevant (13 measures), or optional (10 measures) for all Forest Service managed wildernesses. Additional measures may also be added if they are determined to be of high local relevance.

The baseline assessment for the Mount Massive Wilderness will be among the first to be completed following the drafted guidelines of the Forest Service Wilderness Character Monitoring Team. As of yet, there is no accompanying methodology document or technical guide for the recommended measures outlined in *Keeping it Wild in the Forest Service*; all data collection protocols and indices were either adapted from earlier implementation guides from the Forest Service and other agencies, or developed with the input of resource specialists to achieve maximum local relevance. When a conflict arose between the Forest Service Wilderness Character Monitoring Team’s measure descriptions, local data availability, or local priorities, this assessment erred on the side of local relevance while still making an attempt to accommodate national consistency. When a technical guide is published in the future it may or may not be necessary to update the collection protocols accordingly.

The process used to identify and select measures to monitor wilderness character is outlined below. All actions were carried out by the Wilderness Fellow unless otherwise specified.

Gather information—Background information was gathered to understand the wilderness, including its history, ecosystems, and potential future threats. This information was gathered by reading background and guiding documents for the wilderness (listed in Documents Consulted), interviews with Forest and Hatchery staff (listed in Staff Consulted), and visiting the wilderness.

Create list of possible measures—Preliminary measures were originally identified through the framework described in *Keeping it Wild in the Forest Service* (September 2013 Draft) and updated to comply with *Keeping it Wild 2* (April 2014 Draft). Additional preliminary measures for Mount Massive wilderness character monitoring that were not recommended in this document were identified through discussions with Forest and Hatchery staff.

Refine measures—Measures were prioritized and refined through discussing measures with staff and evaluating the significance, feasibility, vulnerability, and reliability of measures (Appendix B). Availability of reports and scientific information was also considered.

Approval of measures—The final list of measures was developed and submitted to wilderness supervisors Nancy Roeper (National Wilderness Coordinator, USFWS), Peter Dratch (Senior Biologist, NWRS Inventory and Monitoring), and Peter Landres (Ecologist, Aldo Leopold Wilderness Research Institute).

Locate and synthesize data—Available data for each measure was collected by contacting relevant individuals and pulling information from national databases, shared drives, and GIS or paper files. Data was processed and analyzed as necessary.

Write report—Each measure was described, including background information, collection protocol, data adequacy, measure weight, data source, and significant change. All measures were written into final report and the report was submitted to supervisors.

Enter data—Data was entered into the Wilderness Character Monitoring Database at <https://wc.wilderness.net/>.

Incorporate comments—Changes, edits, and feedback from Forest and Hatchery staff and wilderness supervisors were received by Wilderness Fellow. Edits were incorporated into the final draft.

Approval of final report—Report was finalized and approved by supervisors.

MOUNT MASSIVE WILDERNESS CHARACTER MONITORING MEASURES

This section describes in detail the measures selected to monitor the Mount Massive Wilderness. The baseline year for wilderness character monitoring in the Mount Massive Wilderness is 2014. When measures have legacy data available, the baseline *for that specific measure* will be from the first year for which data is available post-wilderness designation. For the Mount Massive Wilderness, designated in December of 1980, the earliest possible baseline year for a measure would be 1981. A measure's data value reported in 2014, therefore, may not necessarily be the measure's *baseline* data value. For examining trends in wilderness character for the wilderness as a whole, 2014 remains the overall baseline year. Trends for each data value reported in the wilderness character monitoring database are based upon the most recent previous data (a measure's baseline data value is always assigned a trend of stable).

The following aspects are described for each measure: 2014 data value, year(s) of data collection, measure description and collection protocol, background and context, data source, data adequacy, data frequency, and significant change. The content and purpose of each section is described below.

2014 Data Value—specifies the measure value entered into the Wilderness Character Monitoring Database for 2014 (the baseline year for Mount Massive wilderness character monitoring). Please note that the Wilderness Character Monitoring Database uses “year measured” to refer to the year of any given data value (e.g. the “year measured” of the “2014 data value” is 2014).

Year(s) of Data Collection—specifies the year(s) the data for a measure's data value was/were collected. For some measures, the protocol may be to report the most recent available data, regardless of when the data was specifically collected. For example, if data pulled from a national website is only available to the public two years after data collection, the data year corresponding with the 2014 data value would be 2012. Fiscal and water years are recorded as the secondary year—for example, the water year from October 2013 to September 2014 would be recorded as “2014 (water year).” More information on the year(s) of data collection can be found at the end of this section.

Measure Description and Collection Protocol—defines what is being measured and how, including the process through which data is compiled or gathered. “Collection protocol” is defined and used in this document to refer to the process by which data is gathered from existing sources and does not include in-the-field data collection instructions. If field data collection protocols are relevant to a measure and available, a location of where the protocol can be found is included. Additional instructions for performing the GIS analyses and simple linear regressions accompany this report as separate documents.

Background and Context—defines the context and relevance for the measure at an individual wilderness and addresses why the measure was selected.

Data Source—defines where baseline information for the measure can be found in the future. The intent of this section is to encourage written documentation of wilderness character so that information is accessible into the future.

Data Adequacy—defines the reliability of the data to assess trends in the measure. Data adequacy is based on both data quantity and data quality. Data quantity refers to the level of confidence that all appropriate data records have been gathered. 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. Further information on the role of data quantity and quality in wilderness character

monitoring is available in the *Forest Service Technical Guide* (Landres et al. 2009, p. 26). These two aspects of data adequacy are subjectively evaluated according to the categories described in Table 1. Data adequacy (scored as high, medium, or low) must be determined on a case by case basis from the assessments of data quality and quantity; however, a general scoring framework (Table 2) can be used as a starting point for this determination. Note that the Wilderness Character Monitoring Database refers to data adequacy as 'data confidence.'

Table 1. Data quantity and quality definitions	
Data Quantity	Data Quality
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.	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 are from ground-based inventories conducted by qualified personnel; for visitor use, data would come from visitor permit data.
Partial —This category indicates that some data is available, but the data are generally considered incomplete (such as with sampling). For example, to assess the occurrence of nonindigenous invasive plants, a partial inventory was conducted or a sampling of sites was conducted where these plants are likely to occur.	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 direct visitor contacts.
Insufficient —This category indicates even less data records have been gathered or perhaps this measure is not dependent on actual field data. For example, no inventory for nonindigenous invasive plants has been conducted, and visitor use was not assessed anywhere.	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.

Table 2. Suggested scoring for data adequacy							
Data Quantity		+	Data Quality		=	Data Adequacy	
Complete	3	+	High	3	=	High	6
Partial	2		Moderate	2		Medium	4-5
Insufficient	1		Low	1		Low	≤3

Data frequency—defines how often data for this measure should be entered into the Wilderness Character Monitoring Database. Frequency is typically determined by the time frame in which data becomes available under existing monitoring protocols for use in wilderness monitoring purposes.

Significant change—defines how much change a measure must undergo to indicate a changing trend wilderness character for a particular measure. "Significant change" is defined and used in this document differently than definitions used by other departments within USFS and USFWS and is not

intended to mean “statistically significant change” or to imply use of the Environmental Impact Statement process under the National Environmental Protection Act.

Frequency, significant change, and condition were determined by resource specialists and the Wilderness Fellow and approved by Forest and Hatchery staff. All measures within an indicator are weighted equally unless described otherwise (i.e. the measures under the plants indicator).

Data for measures can be compiled in distinct ways based on their frequency of data collection (annually or every five years) and the type of data used. Data can be either cumulative (i.e. using multiple months of data collection, such as for annual visitation numbers or annual trampling actions) or instantaneous (i.e. collected only once a year for a single snapshot, such as for the number of non-native invasive plant species currently known to be in the wilderness, or the number of developments currently present). If data are cumulative, they can be collected for the calendar year (January to December), fiscal year (October to September), or water year (October to September). Some measures reported every five years can also be a cumulative assessment of instantaneous annual data (e.g. capturing change in glacial extent via annual photographs). In addition, several measures use a regression analysis of cumulative data for all possible years of data (e.g. average winter temperature or snowfall).

How the data are compiled is described in the data frequency and measure description and protocol sections. In order to clearly indicate *when* the data for each measure are collected, however, these distinctions are reported in specific ways under the year(s) of data collection (Table 3).

Table 3. Reporting data year for various methods of compiling data		
Type of Data	Data Frequency	Year(s) of Data Collection Reporting Example*
Instantaneous data	Reported annually <i>OR</i> every five years	2014
Cumulative data for a single calendar/fiscal/water year	Reported annually	2014 (calendar year) 2014 (fiscal year) 2014 (water year)
Cumulative data for <i>five</i> calendar/fiscal/water years	Reported every five years	2010-2014 (calendar years) 2010-2014 (fiscal years) 2010-2014 (water years)
Cumulative data for five years of instantaneous annual collection	Reported every five years	2010-2014
Measures using a regression analysis of cumulative annual data for <i>all</i> years; annual data is cumulative for the calendar/fiscal/water year	Reported annually <i>OR</i> every five years	2014 (regression, calendar year) 2014 (regression, fiscal year) 2014 (regression, water year)

Together, these sections provide a comprehensive overview of each measure, provide transparency into wilderness character monitoring measures selected across the USFS and USFWS, and form the basis of the wilderness character monitoring strategy of the Mount Massive Wilderness.

OVERVIEW OF MEASURES

The table below provides a basic overview of the five qualities of wilderness character, the monitoring questions and indicators described in *Keeping it Wild in the Forest Service* (September 2013 Draft) and updated to match with *Keeping it Wild 2* (April 2014 Draft), as well as the 35 measures specifically identified for the Mount Massive Wilderness. Of the measures selected for inclusion, 25 are required, 5 are required if relevant, 2 are optional, and 3 are new (noted in the measure column on the right). Each measure is described in more detail in its respective section later in the report. For the Mount Massive Wilderness, no Other Features of Value were determined to be apposite for inclusion in wilderness character monitoring.

Table 4. Overview of Mount Massive Wilderness Character Monitoring Measures			
	MONITORING QUESTION	INDICATOR	MEASURE
UNTRAMMELED	What are the trends in actions that control or manipulate the “earth and its community of life” inside wilderness?	Actions authorized by the federal land manager that intentionally manipulate the biophysical environment	Authorized actions and persistent structures designed to manipulate plants, animals, pathogens, soil, water, or fire Required
			Percent of natural fires <i>not</i> receiving a suppression response (<i>Formerly: Percent of natural fire perimeters that were manipulated</i>) Required
		Actions not authorized by the federal land manager that intentionally manipulate the biophysical environment	Unauthorized actions by agencies, citizen groups, or individuals that manipulate plants, animals, pathogens, soil, water, or fire Required if Relevant
			Fish stocking actions (<i>Formerly: Number of lakes and other water bodies stocked with fish</i>) Required if Relevant
NATURAL	What are the trends in the natural environment from human-caused change?	Plants	Non-native invasive plant species Required
			Index of plant species of concern Required
		Animals	Non-native animal species Required
			Index of animal species of concern Required
			Index of stocked lakes Required if Relevant
		Air and water	Ozone exposure statistics N100 and W126 Required
			Concentration of nitrogen in wet deposition Required
			Concentration of sulfur in wet deposition Required
			Visibility statistics Required
		Climate change	Temperature Required
			Precipitation Required
			Glaciers and permanent snowfields Optional
			Snow (annual snow days) Required if Relevant
			Snow seasonality New
		Ecological processes	Average watershed condition class Required
			Average natural fire regime condition class Required

Table 4. Overview of Mount Massive Wilderness Character Monitoring Measures

	MONITORING QUESTION	INDICATOR	MEASURE
UNDEVELOPED	What are the trends in physical development?	Presence of non-recreational structures, installations, and developments	Index of authorized non-recreational physical development Required
		Presence of recreational structures, installations, and developments	Index of authorized recreational physical development Required
		Inholdings	Index of inholdings Required if Relevant
	What are the trends in mechanization?	Use of motor vehicles, motorized equipment, or mechanical transport	Index of administrative authorizations to use motor vehicles, motorized equipment or mechanical transport Required
			Percent of emergency incidents <i>not</i> using motor vehicles, motorized equipment, or mechanical transport Required
SOLITUDE OR PRIMITIVE AND UNCONFINED RECREATION	What are the trends in outstanding opportunities for solitude?	Remoteness from sights and sounds of people inside of wilderness	Travel route encounters Required
			Visitation New
			Area of wilderness away from access and travel routes and developments Required
			User-created campsites Required
			Miles of user-created trails Optional
			Commercial use New
	What are the trends in outstanding opportunities for primitive and unconfined recreation?	Remoteness from sights and sounds of people outside of wilderness	Area of wilderness not affected by adjacent travel routes and human developments Required
		Facilities that decrease self-reliant recreation	Index of authorized recreation facilities Required
			Miles of developed trails (condition classes 3-5) Required
		Management restrictions on visitor behavior	Index of visitor management restrictions Required

UNTRAMMELED

Wilderness is essentially unhindered and free from modern human control or manipulation

The Untrammeled Quality monitors the *actions* of humans in wilderness that intentionally manipulate the biophysical environment. Actions that intentionally manipulate or control ecological systems inside wilderness degrade the Untrammeled Quality regardless of what instigated the action or if benefits to other qualities of wilderness character are gained by the action. Withholding action is a key concept for understanding this quality; management of wilderness, in contrast to management of other types of land, should be approached with restraint and humility. When monitoring the Untrammeled Quality we can track either the decision to manipulate the biophysical environment, or the opportunity for humans to let natural processes occur without intervention. Further information on determining whether an action meets the criteria for the Untrammeled Quality can be found at <http://ecos.fws.gov/ServCatFiles/Reference/Holding/26180> (this link will be updated periodically to reflect any changes; the version of this document from April 30, 2014 is also included as Appendix C in this report).

Table 5. Untrammeled Quality					
Indicator	Measure	Frequency in Years	Data Adequacy	Significant Change	2014 Data Value
Actions authorized by the federal land manager that manipulate the biophysical environment	Authorized actions and persistent structures designed to manipulate plants, animals, pathogens, soil, water, or fire.	1	High	Any	1 action
	Percent of natural fires <i>not</i> receiving a suppression response (<i>Formerly: Percent of natural fire perimeters that were manipulated</i>)	5	High	Any	100%
Actions <i>not</i> authorized by the federal land manager that manipulate the biophysical environment	Unauthorized actions by agencies, citizen groups, or individuals that manipulate plants, animals, pathogens, soil, water, or fire	5	Medium	Any	9 actions
	Fish stocking actions (<i>Formerly: Number of lakes and other water bodies stocked with fish</i>)	5	High	Any	19 actions

Authorized actions and persistent structures designed to manipulate plants, animals, pathogens, soil, water, or fire

2014 Data Value: 1 action

Year(s) of Data Collection: 2014 (fiscal year)

Measure Description and Collection Protocol: A count of actions authorized by the Forest Service or Fish and Wildlife Service that are intended to manipulate, at a broad-scale, any component of the biophysical environment within wilderness (including vegetation, fish, wildlife, insects, pathogens, soil, water, or fire). This includes discretionary and non-discretionary actions required to uphold other laws, as well as any independent actions authorized through special permits (e.g. research actions, etc.). Suppression of natural fire is not included under this measure as it is considered to be of sufficient importance to warrant its own specific measure. Suppression of human-started fires is not considered a trammeling action as these fires are unnatural to begin with. Actions taken by other agencies that the Forest Service or Fish and Wildlife Service are unaware of (e.g. actions taken by Colorado Parks and Wildlife) are considered unauthorized actions and not included here. (State fish stocking is considered an unauthorized trammeling action and is counted under a separate measure; fish stocking actions authorized by the Forest Service or Fish and Wildlife Service, however, are included under this measure).

Scale is an important consideration in counting trammeling actions, but only to a certain point. If it is determined that the magnitude of an action's consequences will exceed a certain threshold, the action is counted as a trammeling. All trammeling actions that cross this threshold are counted equally, regardless of the extent of their effects (e.g. spraying herbicide on 100 acres is equivalent to spraying herbicide on 1,000 acres; treating one invasive plant species is equivalent to treating five invasive plant species). Below that threshold, however, actions are not considered significant enough to be counted as a trammeling action (e.g. hand pulling a couple of invasive plants, removing a hazard tree or two along the trail, etc.). The intent of this measure is to track whether management programs are trending toward more or less human manipulation in the wilderness; therefore, this approach to counting trammeling actions focuses on the *decision* to trammel, and not on the *magnitude* of trammeling's effects.

The trammeling action counting protocol is outlined in Table 8. Specific examples of authorized trammeling actions and instructions on how to report them can be found in Appendix D, and additional explanations of what may or may not be considered a trammeling action can be found in Appendix C or at <http://ecos.fws.gov/ServCatFiles/Reference/Holding/26180>. A decrease in the number of authorized actions intended to manipulate the biophysical environment in the wilderness would result in an upward trend in this measure, and would benefit the Untrammeled Quality.

Background and Context: There are currently few authorized actions that trammel the wilderness; the herbicide treatment of invasive species (begun in 2014) is the only trammeling action counted this fiscal year. Past authorized trammeling actions that may occur again in the future include trail construction, the collection of seeds, wildlife removal, and wildlife introduction. Four headgates near the private property on the eastern edge of the wilderness are no longer thought to be functioning; should the Forest Service authorize their restoration in the future, they would be included in this measure as well. From 1990-1992, the Fish and Wildlife Service, in conjunction with the state of Colorado, conducted a reclamation project in the Rock Creek Drainage (including Native Lake, Three Lakes, Rainbow Lake, and Swamp Lakes) to restore

greenback cutthroat populations; while no similar projects have taken place in the last twenty years, it is possible that they could be authorized in the future. In the past, the Fish and Wildlife Service has also used battery-powered backpack electrofishing equipment to survey Cascade Creek, and could potentially authorize electrofishing again. Although authorized trammeling usually occurs in order to achieve a positive end (e.g. to improve one of the other qualities of wilderness character, to comply with federal regulations, to improve visitor or community safety, etc.), those actions still degrade the Untrammelled Quality.

Data Source: Steve Sunday, Lead Wilderness Ranger; Michelle Mueggler, Acting Wilderness, Recreation, & Lands Staff Officer; Ed Stege, Leadville National Fish Hatchery Project leader, Nick Gerich, Hydrological Technician; Jeni Windorski, Wildlife Biologist.

Data Adequacy: High. There is high confidence that all data records have been gathered, therefore data quantity is complete. Data quality is also high.

Frequency: Annually.

Significant Change: Any change from one category to another (Table 6) is a significant change.

Table 6. Categories for significant change for authorized trammeling actions					
Category	Excellent	Caution	Poor	Trouble	Etc.
Measure Value	0-2	3-7	8-12	13-17	Etc.

Table 7. 2014 authorized trammeling actions	
Actions	Measure Value
Herbicide treatment of invasive plant populations	1

Table 8. Counting protocol for trammeling actions

IN GENERAL...

- Only count actions that are of sufficient scale (that cross the threshold);
- All actions above the threshold are counted equally, regardless of the magnitude of their effects;
- Minimum requirements analyses (MRAs) or National Environmental Policy Act (NEPA) analyses can often (*although not always*) be used as markers for actions in wilderness;
- Actions are counted once per fiscal year for every year the action occurs.

CLARIFICATIONS:

- Single projects or decisions that involve multiple types of actions count as multiple trammeling actions. (For example, a native species restoration project that requires both releasing piscicides into lakes and restocking them with native fish species would count as two trammeling actions). The magnitude of these actions, however, does not have any bearing on the number of trammeling actions reported (e.g. treating seven species of invasive plants with chemical herbicide and treating one additional species through the release of a biological control agent would count as two trammeling actions—one action for the use of chemical herbicide and one action for the release of the biological control agent; the number of species affected by each treatment type is inconsequential).
- Actions approved in perpetuity are counted as one action per event (e.g. if a blanket policy of complete fire suppression is approved in order to protect critical habitat or private property, each suppression event for naturally ignited fire would still count as one action).
- Actions that span the fiscal year are only counted as trammeling actions for the initial fiscal year (e.g. if wilderness plants are treated with herbicide from September 27 through October 4, 2014, it would count as one action for fiscal year 2014 and would count as zero actions for fiscal year 2015).
- Actions that are individually too small in scale to be counted as trammeling actions will count as trammeling actions if and when their cumulative effects cross that threshold. (For example, installing one or a few bat gates is considered too small in scale to be counted as a trammeling action, but over time it is anticipated that all the caves in a certain wilderness will be gated. A cumulative threshold for this wilderness is set at 50% of all caves—once 50% or more of the wilderness caves are gated, the wilderness is trammeled. The action that breaks this cumulative threshold, as well as every subsequent installation of additional bat gates, each count as one trammeling action regardless of the scale of the individual action. Therefore, if the wilderness has 200 caves, the installation of a single bat gate that happens to be on the 100th gated cave would be counted as a trammeling action, as would any subsequent installations of bat gates).
- Persistent structures that continue to alter wildlife distribution or movement patterns long after construction (e.g. dams, water guzzlers, enclosures, exclosures, etc.) are counted as trammeling actions only for the years in which installation or maintenance actions occur. The long-term *effects* of these structures are most appropriately captured under the Natural Quality, not the Untrammeled Quality.

***Percent of natural fires not receiving a suppression response
(Formerly: Percent of natural fire perimeters that were manipulated¹)***

2014 Data Value: 100%

Year(s) of Data Collection: 2010-2014 (calendar years)

Measure Description and Collection Protocol: The percent of natural fires that are *not* suppressed in any way. Each naturally ignited fire that receives a suppression response, regardless of the magnitude of suppression, is counted as a trammeling action. Years in which there were no natural fires are counted as 100%, as no such actions occurred. Data are compiled for the previous five calendar years (Table 10). Allowing naturally ignited fires to burn without suppression (thus increasing the percentage of fires not receiving a suppression response) would result in an upward trend in this measure, and would benefit the Untrammeled Quality.

Background and Context: Fire is a natural and essential part of the ecosystem, and suppression of natural fires is a trammeling action. Withholding our power to manipulate the landscape is a critical part of the Untrammeled Quality; as there are a finite number of naturally ignited fires in any five year period, this measure offers an opportunity to examine how often managers decide (or are able) to exercise restraint. In Mount Massive Wilderness, the lack of trees at high elevations and the frequent presence of snow allow for relatively few wildfires. There have been no large fires in the wilderness since at least the 1970s (Table 9).

Data Source: Steve Sunday, Lead Wilderness Ranger; open fire files on the USFS O drive.

Data Adequacy: High. Due to the abundance of fire documentation, data quantity is complete and data quality is high.

Frequency: Every five years.

Significant Change: Any.

¹ Although *Keeping it Wild in the Forest Service* (September 2013 Draft) calls this measure “percent of natural fire perimeters that were manipulated,” it is more accurately represented by the title of “percent of natural fire perimeters *not* receiving a suppression response.” *Keeping it Wild 2* (April 2014 Draft), in contrast to *Keeping it Wild in the Forest Service* (September 2013 Draft), focuses on the idea of counting decisions or actions that trammel—regardless of their magnitude or scale. In order to more closely align this baseline assessment with *Keeping it Wild 2* (April 2014 Draft), therefore, this measure will track opportunities for restraint, and not the percent of manipulated fire perimeters.

Table 9. Historical fires 1974-present					
Year	Name	Acres	Fire Cause		Suppressed?
			Statistical	Specific	
1974*	No name	0.1	Smoking	Smoking	Yes
1974*	No name	0.1	Campfire	Cooking fire	Yes
1976*	No name	0.1	Smoking	Smoking	Yes
1978*	No name	0.1	Campfire	Cooking fire	Yes
1979	No name	0.1	Smoking	Smoking	Yes
1982*	No name	0.1	Campfire	Cooking Fire	Yes
1983*	No name	0.1	Campfire	Burning Building	Yes
1986	No name	0.1	Campfire	Smoking	Yes
1987	No name	0.3	Campfire	Smoking	Yes
1992	No name	0.1	Miscellaneous	Lightning	Yes
1992	No name	0.1	Miscellaneous	Lightning	Yes
1997	Little	0.1	Campfire	Warming Fire	Yes
2005	Mount Massive	0.1	Campfire	Warming Fire	Yes
Only the fires in bold text (naturally ignited fires) are included in this measure.					
*These fires may or may not have been in the wilderness.					

Table 10. Percent of natural fires <i>not</i> suppressed			
Five Year Intervals	Number of Natural Fires	Number of Natural Fires Suppressed	Percent of Natural Fires <i>Not</i> Suppressed
2010-2014	0	0	100%
2005-2009	0	0	100%
2000-2004	0	0	100%
1995-1999	0	0	100%
1990-1994	2	2	0%
1985-1989	0	0	100%
1980-1984	0	0	100%

Unauthorized actions by agencies, citizen groups, or individuals that manipulate plants, animals, pathogens, soil, water, or fire

2014 Data Value: 9 actions

Year(s) of Data Collection: 2009-2013 (calendar years)

Measure Description and Collection Protocol: A count of actions not authorized by the Forest Service or Fish and Wildlife Service that are taken by individuals, citizen groups, or other agencies that are intended to manipulate, *at a broad-scale*, any component of the biophysical environment (e.g. cutting/thinning trees, purposely releasing non-native species, etc.). Actions taken by the state of Colorado *with* the knowledge and approval of the Forest Service or Fish and Wildlife Service are considered authorized actions and not included under this measure. Fish stocking by Colorado Parks and Wildlife is not included under this measure as it is considered to be of sufficient importance to warrant its own specific measure. Any unauthorized trammeling action, so long as it is considered to be of sufficient scale, is included in this count. All unauthorized trammeling actions are counted for the past five calendar years. Data from Colorado Parks and Wildlife is taken as is (that is, each action or event they count separately is also counted separately here). Other unauthorized trammeling actions are counted following the same protocols outlined in the “authorized actions...” measure if at all possible (refer to Table 8, Appendix D, and Appendix C or <http://ecos.fws.gov/ServCatFiles/Reference/Holding/26180>). A decrease in the number of unauthorized actions intended to manipulate the biophysical environment would result in an upward trend in this measure, and would benefit the Untrammeled Quality.

Background and Context: Unauthorized trammeling actions are fundamentally different from authorized actions in that they are usually taken with little or no consideration of the effects on the broader ecological systems within the wilderness. Most unauthorized actions in Mount Massive Wilderness are undertaken by Colorado Parks and Wildlife and consist mainly of fish assessments (Table 12, the double wavy lines indicate the year of wilderness designation). Gill netting and electrofishing for fish assessments are both considered trammeling actions, while visual observations and angling are not as they are so small in scale. In the past, fences and irrigation ditches have also been built in the wilderness by neighboring private land owners which would also be considered trammeling actions.

Data Source: Andrew Treble, Colorado Parks and Wildlife Aquatic Research Data Analyst; Doug Krieger, Colorado Parks and Wildlife Senior Aquatic Biologist; Ed Stege, Leadville National Fish Hatchery Project Leader; Steve Sunday, Lead Wilderness Ranger; Michelle Mueggler, Acting Wilderness, Recreation, & Lands Staff Officer.

Data Adequacy: Medium. Most data come from Colorado Parks and Wildlife fish assessment records and are highly reliable. Other data may be collected incidentally by wilderness rangers or others and are not consistent. Overall, therefore, data quantity is partial and data quality is moderate.

Frequency: Every five years.

Significant Change: Any change from one category to another (Table 11) is a significant change.

Table 11. Categories for significant change for unauthorized trammeling actions						
Category	Excellent	Caution	Poor	Very Poor	Trouble	Etc.
Measure Value	0-2	3-7	8-12	13-17	18-22	Etc.

Table 12. Unauthorized fish assessment trammeling actions			
5 Year Period	Trammeling Actions		Measure Value
2009-2013	2013	Gill netting (Middle North Halfmoon Lake)	9
	2013	Gill netting (Lower North Halfmoon Lake)	
	2013	Gill netting (Lower North Halfmoon Lake)	
	2013	Gill netting (Halfmoon Lake)	
	2012	Gill netting (Windsor Lake)	
	2012	Gill netting (Windsor Lake)	
	2012	Gill netting (Windsor Lake)	
	2011	Gill netting (Divide Lake)	
	2011	Gill netting (Blue Lake)	
2004-2008	2006	Two-pass removal (electrofishing) (Rock Creek)	3
	2006	Two-pass removal (electrofishing) (Rock Creek)	
	2006	Two-pass removal (electrofishing) (Elk Creek)	
1999-2003	None		0
1994-1998	1996	Gill netting (Halfmoon Lake)	10
	1996	Gill netting (Halfmoon Lake)	
	1995	Two-pass removal (electrofishing) (Rock Creek)	
	1995	Two-pass removal (electrofishing) (Rock Creek)	
	1995	Backpack electrofishing (Rock Creek)	
	1995	Boat electrofishing (Rock Creek)	
	1995	Boat electrofishing (Rock Creek)	
	1995	Backpack electrofishing (Elk Creek)	
	1995	Backpack electrofishing (Elk Creek)	
	1995	Backpack electrofishing (Cascade Creek)	
1989-1993	None		0
1984-1988	None		0
1979-1983	None		0
1974-1978	None		0
1969-1973	1972	Gill netting (Upper Three Lakes)	6
	1971	Gill netting (Native Lake)	
	1971	Gill netting (Divide Lake)	
	1971	Gill netting (Blue Lake)	
	1970	Gill netting (Middle North Halfmoon Lake)	
	1970	Gill netting (Lower North Halfmoon Lake)	
N/A	1968	Gill netting (Blue Lake)	N/A

Fish stocking actions²
(Formerly: Number of lakes stocked with fish³)

2014 Data Value: 19 actions

Year(s) of Data Collection: 2009-2013 (calendar years)

Measure Description and Collection Protocol: A count of the number of fish stocking events undertaken by the state of Colorado without the knowledge and/or approval by the Forest Service or Fish and Wildlife Service. Stocking events undertaken by the Forest Service or Fish and Wildlife Service (or with their approval) are counted under the “authorized actions...” measure. Data from Colorado Parks and Wildlife is taken as is (that is, each event they count separately is also counted separately here), and stocking the same lake multiple times in a given year count counts as multiple events. The measure value is the total number of events that occurred in the past five calendar years. A decreasing number of total stocking events would result in an upward trend in this measure, and would benefit the Untrammeled Quality.

Background and Context: Fish have been stocked in what is now the wilderness area since at least the late 1800s. While the Leadville National Fish Hatchery contributed to some of these pre-wilderness stocking efforts, authorized stocking by the Fish and Wildlife Service has decreased significantly since wilderness designation. After a greenback cutthroat restoration effort in the early 1990s, the hatchery has not supported any fish stocking efforts in the wilderness. Unbeknownst to both the Forest Service and the Fish and Wildlife Service, Colorado Parks and Wildlife has been regularly stocking native and non-native fish in Mount Massive Wilderness for years (Table 14, the double wavy lines indicate the year of wilderness designation). Although this stocking is considered to be unauthorized from the point of view of the Forest Service and Fish and Wildlife Service, is still within the legal purview of the state of Colorado.

Data Source: Andrew Treble, Colorado Parks and Wildlife Aquatic Research Data Analyst; Ed Stege, Leadville National Fish Hatchery Project Leader.

² *Keeping it Wild in the Forest Service* (September 2013 Draft) classifies this measure as required if relevant under the “actions authorized by the federal land manager that intentionally manipulate the biophysical environment” indicator. In this case, however, because all fish stocking in the last twenty years has been conducted by the state of Colorado without the knowledge of either the Forest Service or the Fish and Wildlife Service, it is considered to be more aptly classified under the “actions *not* authorized by the federal land manager that intentionally manipulate the biophysical environment” indicator. Any future fish stocking that is authorized by the Forest Service or Fish and Wildlife Service would be included as a trammeling action under the “authorized actions...” measure.

³ Although *Keeping it Wild in the Forest Service* (September 2013 Draft) calls this measure “number of lakes stocked with fish,” it is more accurately represented by the title of “fish stocking actions.” *Keeping it Wild 2* (April 2014 Draft), in contrast to *Keeping it Wild in the Forest Service* (September 2013 Draft), focuses on the idea of counting decisions or actions that trammel—regardless of their magnitude or scale. In order to more closely align this baseline assessment with *Keeping it Wild 2* (April 2014 Draft), therefore, this measure will track annual fish stocking actions, and not the number of lakes stocked per year.

Data Adequacy: High. Data come from Colorado Parks and Wildlife stocking records and are highly reliable. Data quantity is complete and data quality is high.

Frequency: Every five years.

Significant Change: Any change from one category to another (Table 13) is a significant change.

Table 13. Categories for significant change for unauthorized stocking actions						
Category	Excellent	Caution	Poor	Very Poor	Trouble	Etc.
Measure Value	0-2	3-7	8-12	13-17	18-22	Etc.

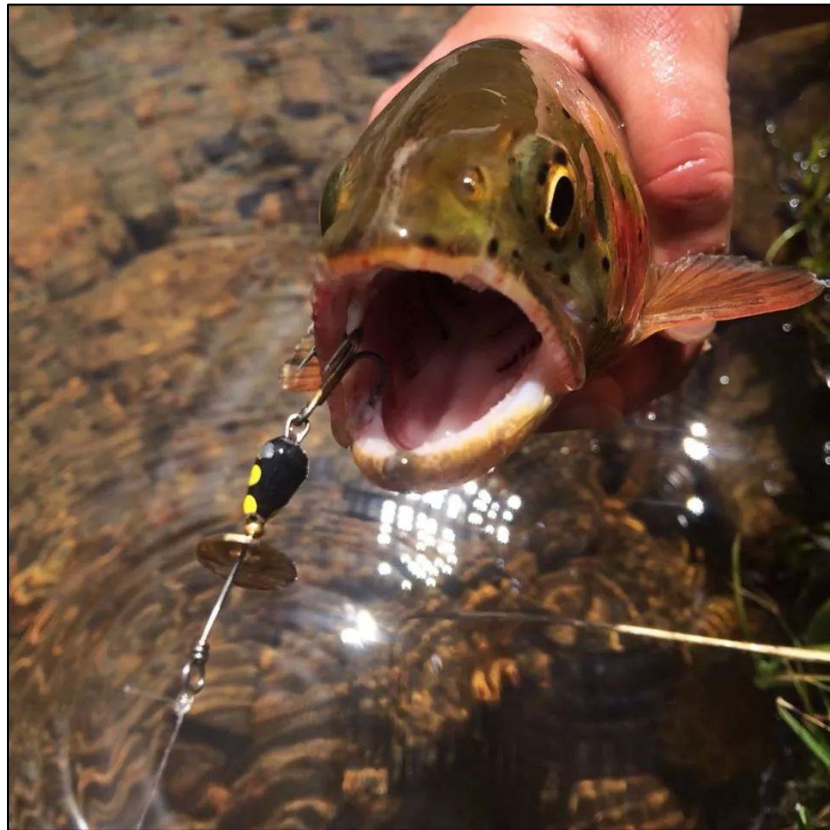


Figure 8. Cutthroat trout from Halfmoon Lake
Photo by Brittany Moore

Table 14. Stocking events		
Year	Number of Stocking Events	
2013	6	19
2012	1	
2011	6	
2010	0	
2009	6	
2008	0	11
2007	5	
2006	0	
2005	6	
2004	0	
2003	6	12
2002	0	
2001	0	
2000	6	
1999	0	
1998	6	21
1997	0	
1996	10	
1995	0	
1994	5	
1993	8	38
1992	6	
1991	12	
1990	5	
1989	7	
1988	0	27
1987	4	
1986	8	
1985	8	
1984	7	
1983	0	14
1982	0	
1981	7	
1980	0	
1979	7	
1978	0	21
1977	8	
1976	0	
1975	8	
1974	5	
1973	10	N/A

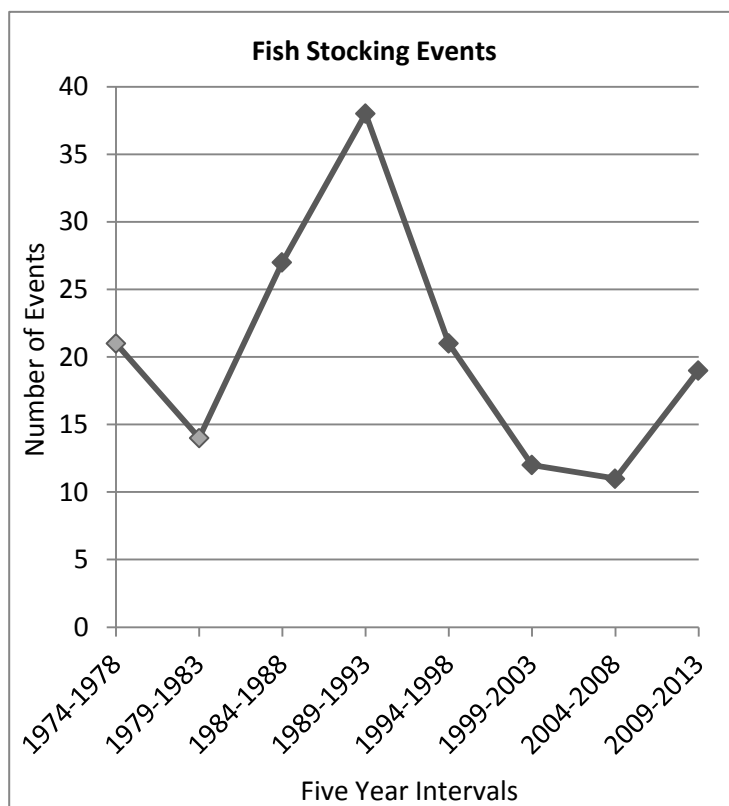


Figure 9. Fish stocking events

Light grey points indicate years prior to wilderness designation.

NATURAL

Wilderness ecological systems are substantially free from the effects of modern civilization.

The Natural Quality assesses the integrity of local ecosystems and their freedom to change and develop without human manipulation. The Natural Quality tracks the *effects* of human actions and modern civilization on natural ecosystems (in contrast to the Untrammelled Quality which tracks the actions themselves). Ecosystems include all living and non-living things in an area, as well as the interactions between them. Within wilderness, changes to the Natural Quality can be caused directly or indirectly, and intentionally or unintentionally. While some aspects of the Natural Quality may be under the control of wilderness managers, other aspects (such as air quality or the effects of climate change) may not be. Monitoring ecosystem changes inside wilderness is critical to understanding the unique character of each wilderness area and how it is impacted by human actions.

Table 15. Natural Quality

Indicator	Measure	Frequency in Years	Data Adequacy	Significant Change	2014 Data Value
Plants	Non-native invasive plant species—90%	5	High	Any	2 species
	Index of plant species of concern—10%	5	Low	Any	5 species
Animals	Non-native animal species	5	Low	Any	6 species
	Index of animal species of concern	5	Low	Any	15
	Index of stocked lakes	5	High	Any	37.2
Air and water	Ozone exposure statistics N100 and W126	1	Medium	Any	2
	Concentration of nitrogen in wet deposition	1	Medium	< 0.2 or ≥ 0.39	0.24 mg/L
	Concentration of sulfur in wet deposition	1	Medium	≥ 0.2	0.10 mg/L
	Visibility statistics	1	High	≥ 3 µg/m ³	0.45 µg/m ³
Climate change	Temperature	1	High	p-value ≤ 0.05	2
	Precipitation	1	High	p-value ≤ 0.05	0
	Glaciers and permanent snowfields	5	Medium	Any	50
	Snow (annual snow days)	1	High	p-value ≤ 0.05	0
	Snow seasonality	1	High	p-value ≤ 0.05	0
Ecological processes	Average watershed condition class	5	High	Any	1.44
	Average natural fire regime condition class	5	High	< 2.00 or ≥ 2.05	2.02

Non-native invasive plant species**2014 Data Value:** 2 species**Year(s) of Data Collection:** 2014

Measure Description and Collection Protocol: A count of the number of invasive and/or noxious weed species known to be currently present in the wilderness weighted by the acreage they occupy. Table 16 outlines the scoring protocols. A decrease in the number of non-native invasive/noxious species would result in an upward trend in this measure, and would benefit the Natural Quality.

Background and Context: Alteration of plant communities in wilderness due to the presence of invasive species has the potential to result in cascading effects to the ecosystem. In the summer of 2013, a survey of noxious weeds was conducted in the wilderness which documented 14 populations of Canada thistle (*Cirsium arvense*) totaling less than half an acre in extent and located in the Willow Creek area, and along the Rock Creek and Kearney Park trails. In this same survey, an additional population of orange hawkweed (*Hieracium aurantiacum*) was found just outside of the wilderness boundary at the Colorado Trail (Main Massive) trailhead. The known wilderness invasive plant populations were treated with herbicide in the summer of 2014, during which time an additional two populations of Canada thistle and one population of yellow toadflax (*Linaria vulgaris*) were also discovered and treated. All of these populations will continue to be monitored in the future.

Data Source: Steve Sunday, Lead Wilderness Ranger; Michelle Mueggler, Acting Wilderness, Recreation, & Lands Staff Officer; monitoring of existing populations and observational evidence by wilderness rangers, technicians, and other agency personnel in the wilderness.

Data Adequacy: High. At this time, data quantity is complete and data quality is high given that the wilderness was surveyed in 2013. While the known populations will continue to be monitored, it is doubtful whether the Leadville Ranger District will be able to conduct additional surveys in the future. Therefore, future data quantity is likely to be partial and data quality likely to be moderate.

Frequency: Every five years.

Significant Change: Any.

Weight: Due to the lack of data for sensitive plants (see next measure), this measure is weighted as 90% of the indicator.

Table 16. Counting invasive plants	
Area	Score
<1 acre	1
1-4.99 acres	2
5-9.99 acres	3
Etc.	Etc.

Table 17. 2014 Invasive plants		
Species	Area	Score
Canada thistle (<i>Cirsium arvense</i>)	< 1 acre	1
Yellow toadflax (<i>Linaria vulgaris</i>)	< 1 acre	1
Total Score		2

Index of plant species of concern⁴

2014 Data Value: 5 species

Year(s) of Data Collection: 2014

Measure Description and Collection Protocol: The number of sensitive or listed species known to be currently present in the wilderness. Any sensitive or listed plant species that has been discovered in the wilderness at any point in time counts in this measure (i.e. if a sensitive species was found in the 1990s, that would still be included in this measure unless and until the plant is determined to have been extirpated from the wilderness). An increase in rare, sensitive, or listed plant species known to exist in the wilderness would result in an upward trend in this measure, and would benefit the Natural Quality.

Background and Context: Native plant species are uniquely adapted to local environmental conditions and serve to benefit and maintain the local community of life through such roles as providing soil nutrients, preventing soil erosion, and providing food and habitat for native wildlife. Although the wilderness contains both alpine tundra and riparian shrub-dominated wetlands—habitats that generally contain high numbers of uncommon or rare plants—there is a general lack of information on the sensitive plant species present. It is assumed that the Mount Massive Wilderness is too far from a university and/or too difficult to access to be the subject of much outside research. Since the designation of the wilderness, there have been five sensitive plant species observed: *Draba grayana* (2006), *D. ventosa* (2006), *D. globosa* (1986), *Listera borealis* (1990), and *Botrychium spp.* (1998).

Data Source: Steve Olson, Botanist (Supervisor's Office).

Data Adequacy: Low. No data is currently collected on plant species in the wilderness. Data quantity is insufficient and data quality is low.

Frequency: Every five years.

Significant Change: Any.

Weight: Due to the complete lack of data, this measure is weighted as 10% of the indicator.

⁴ It is highly likely that the protocol for this measure, as described here, will change in the near future. An index of biological integrity is currently being developed for Mount Massive Wilderness Character Monitoring to assess both riparian and alpine habitats. Under the protocol being developed, changes in the prevalence of different alpine and riparian species would be used to assess the amount of human disturbance; the amount of human disturbance indicated by the index of biological integrity would then serve as a proxy for assessing habitat quality for sensitive plant species. Due to the amount of time required to establish the index protocols, this monitoring is expected to be finalized by the summer of 2015. Additional information on this prospective measure is provided in an accompanying document. Should this monitoring be implemented within the next five years as anticipated, it should replace the measure protocol described here, and the weights of the measures under the plants indicator should be equalized.

Table 18. Rare plant species			
Plant Species	Year Documented	Details	Listing Status
<i>Draba grayana</i> (Gray's Draba)	2006	Alpine species found at elevations above 11,400 feet	R2 Sensitive Species Designated as imperiled by the Colorado Natural Heritage Program
<i>Draba ventosa</i> (Wind River Draba)	2006	Alpine species found at elevations above 9,400 feet	Designated as critically imperiled by the Colorado Natural Heritage Program
<i>Botrychium spp.</i> (Moonworts)	1998	Tend to grow in disturbed areas above 9,000 feet	Several <i>Botrychium spp.</i> are listed as R2 Sensitive Species and/or are listed by the Colorado Natural Heritage Program
<i>Listera borealis</i> (Northern Twayblade)	1990	Grows in marshy areas in cold-air drainages	Designated as imperiled by the Colorado Natural Heritage Program
<i>Draba globosa</i> (Beavertip Draba)	1986	Alpine species found at elevations above 9,000 feet	Designated as critically imperiled by the Colorado Natural Heritage Program

Non-native animal species**2014 Data Value:** 6 species**Year(s) of Data Collection:** 2014

Measure Description and Collection Protocol: A count of non-native animal species that are known to be currently present in wilderness, or are highly likely to be present. This includes non-native fish species. Non-native fish species are counted based on fish assessments conducted by the state; due to the sporadic nature of these assessments, all non-native fish species found in the last 10 years are included in this measure. Non-native wildlife species included in this count are determined by the wildlife biologist. A decrease in the number of non-native species would result in an upward trend in this measure, and would benefit the Natural Quality.

Background and Context: Non-native fish species have been actively stocked in this region for over 125 years and are known to have had significant effects across the Sawatch Range. Early stocking efforts by private, state, and federal fisheries resulted in the loss of two native subspecies—the yellowfin cutthroat (*Oncorhynchus clarkii macdonaldi*) and San Juan cutthroat (unnamed)—and the geographic redistribution of regionally-native species (Metcalf et al. 2012). A recent genetic study revealed that there are four surviving subspecies of cutthroat trout native to the Sawatch Range: Rio Grande cutthroat (*O. c. virginalis*), greenback cutthroat (*O. c. stomias*), and two lineages of Colorado River cutthroats (the blue and green lineages, both formerly considered to be *O. c. pleuriticus*) (Metcalf et al. 2012). Prior to this study, greenback cutthroats were thought to be the native trout species of the Arkansas River and were frequently stocked in the wilderness. In light of the new genetic information, it is now considered unlikely that the species stocked were true greenback cutthroats, but rather other regionally-native subspecies. As it is unknown precisely which of the regionally-native cutthroat species are currently present in the wilderness, none of the four subspecies will be counted under this measure. Should it be determined which subspecies are currently present in the wilderness, or should additional information on the original distribution of these subspecies come to light, these may need to be reevaluated for inclusion.

Since wilderness designation, fish assessments have found five non-native fish species. Of these, two species—the Pikes Peak cutthroat (*Oncorhynchus clarkii ssp. 2*) and Snake River cutthroat (*Oncorhynchus clarki behnkei*)—have not been found in these assessments since 1996. Due to the length of time since their last appearance in the assessment records, these species will not be included in the 2014 data value. In addition to non-native fish, two non-native wildlife species are known or likely to be present in the wilderness, mountain goats (*Oreamnos americanus*) and moose (*Alces alces*) (see descriptions below, provided by Leadville Ranger District Wildlife Biologist Jeni Windorski). Although there are currently no precise data on these non-native wildlife species, their impacts on native flora and fauna are generally thought to be low. Each non-native wildlife or fish species known or likely to be present in the Mount Massive Wilderness is discussed in detail below.

Mountain Goat (*Oreamnos americanus*)—Mountain goats were introduced into Colorado in the late 1940s to develop a population for recreational hunting, and their populations continue to be actively maintained by the state. Within the past decade, there have been efforts to decrease the numbers of mountain goats within the Mount Massive Wilderness. In 2006 there were an estimated 60 mountain goats in the wilderness; a helicopter removal project reduced this number, but did not eradicate the

species. At that time, the state's management goal was to have fewer than 20 mountain goats north of Highway 82 (Independence Pass). According to Jamin Grigg, Colorado Parks and Wildlife Terrestrial Biologist, the goat unit that includes the Mount Massive Wilderness (G17) currently contains approximately 40 animals.

Moose (*Alces alces*)—There also are no historical records of moose residing in Colorado until an introduction to the state in the 1970s; since that time, they have naturally expanded their range south from their point of release into the Sawatch Range. It is estimated that there are currently around 15-20 moose within the Leadville Ranger District. Although there are no specific reports of moose in the Mount Massive Wilderness, it is likely they are utilizing the area. This animal is considered to be a desirable non-native species.

Brook Trout (*Salvelinus fontinalis*)—Native to eastern North America, brook trout were stocked in lakes across the state of Colorado throughout the 1800s and early 1900s. Brook trout are able to outcompete native cutthroat trout in a matter of decades—it is generally assumed that once brook trout have entered a water body in this region, they will become the dominate species within 20 years. Brook trout are no longer considered a desired species in the Mount Massive Wilderness and have not been stocked in the wilderness since at least 1973. In the early 1990s, the Fish and Wildlife Service, in conjunction with the state of Colorado, attempted a greenback cutthroat restoration project which included efforts to eradicate brook trout in the Rock Creek Drainage. Fish assessments conducted by the state show that brook trout were still present in various locations in Rock Creek in 1995, indicating that these efforts were not sufficient to completely eliminate the species. It is strongly suspected that brook trout populations have rebounded in the last 20 years and that the species is once again prevalent throughout the Rock Creek Drainage. In 2013, state fish assessments also found brook trout in Lower North Halfmoon Lake.

Lake Trout (Mackinaw) (*Salvelinus namaycush*)—Like brook trout, lake trout—native to northern North America—were also stocked in Colorado throughout the 1800s and early 1900s, and are frequently able to outcompete native species. Lake trout were last stocked in Mount Massive Wilderness in 1973 (in Windsor Lake). Recent fish assessments conducted by the state show that lake trout were still present in Windsor Lake as of 2012.

Golden Trout (*Oncorhynchus mykiss aquabonita*)—Golden trout are a subspecies of rainbow trout native to California. These fish were stocked in Windsor Lake in 2011 and 2012 by the state, and were found there in fish assessments conducted in 2012. Records show that no golden trout were stocked in the Mount Massive Wilderness from 1973-2010; it is unknown if this species was historically stocked in the wilderness.

Brown Trout (*Salmo trutta*)—Brown trout are a European trout species that were introduced in Colorado in the 1800s and early 1900s. State records show that no brown trout have been stocked in the wilderness since at least 1973. In 2006, brown trout were found in the Mount Massive Wilderness below Swamp Lakes.

Data Source: Jeni Windorski, Wildlife Biologist (with additional consultation with Jamin Grigg, Colorado Parks and Wildlife Terrestrial Biologist); Andrew Treble, Colorado Parks and Wildlife Aquatic Research Data Analyst; Ed Stege, Leadville National Fish Hatchery Project Leader.

Data Adequacy: Low. Limited data are collected on non-native species. Data quantity is insufficient and data quality is low.

Frequency: Every five years.

Significant Change: Any.

Table 19. Non-native species known to be or likely to be in the wilderness	
Total Number	Species
6	Mountain Goat (<i>Oreamnos americanus</i>)
	Moose (<i>Alces alces</i>)
	Brook Trout (<i>Salvelinus fontinalis</i>)
	Lake Trout (Mackinaw) (<i>Salvelinus namaycush</i>)
	Golden Trout (<i>Oncorhynchus mykiss aguabonita</i>)
	Brown Trout (<i>Salmo trutta</i>)

Index of animal species of concern

2014 Data Value: 15

Year(s) of Data Collection: 2014

Measure Description and Collection Protocol: An index of animal species that are sensitive species or of local concern weighted by both the listing status of the animal and its current wilderness population status (Table 20). The scores for each species included in this count are determined by the wildlife biologist (Table 21) based on the definitions provided below. An improvement in a species listing status or an increase in its abundance or habitat would result in an upward trend in this measure, and would benefit the Natural Quality.

Background and Context: Three species have been selected by the wildlife biologist to represent native animal species of concern (see descriptions below, provided by Leadville Ranger District Wildlife Biologist Jeni Windorski). Limiting factors to population density are thought to be primarily based on habitat availability; however, anthropogenic influences can also impact native animal breeding success and survival.

Boreal toad (western toad) (*Anaxyrus boreas boreas*)—The boreal toad breeds in ponds and overwinters in refugia within lodgepole pines, spruce-fir forests, and alpine meadows from 7,500 to 12,000 feet in elevation. While boreal toad breeding sites have been located on the Leadville Ranger District, none have specifically been found within the Mount Massive Wilderness (although there is suitable quality habitat present and surveys for new sites continue on an annual basis). The boreal toad has been showing declines in population size and distribution across its range in western North America. The subpopulation within the southern Rocky Mountains is particularly vulnerable because of its very small size and geographic isolation from other populations. The primary threat appears to be the chytrid fungus *Batrachochytrium dendrobatidis*, which is compounded by habitat alteration, habitat fragmentation, and human disturbance of wetlands. For these reasons, the boreal toad has been designated as a Region 2 Sensitive Species and is listed as endangered by the state of Colorado.

Canada lynx (*Lynx canadensis*)—Lynx are found in the subalpine and timberline zones in forests of dense spruce-fir, Douglas-fir, early seral lodgepole pine, and mature lodgepole pine with developing understory of spruce-fir and aspen. Caves, rock crevices, banks, and logs are used for denning, and their population is closely associated with that of the snowshoe hare. Lynx have been documented on remote sensing cameras in portions of spruce/fir forests of the Leadville Ranger District, including areas adjacent to the Mount Massive Wilderness. As part of a Forest Service research study in 2012-2013 conducted out of the Rocky Mountain Research Station, lynx were collared to learn more about movement patterns in relation to recreation users; the GPS information showed lynx using habitat within the wilderness area. Though the state did reintroduce lynx to Colorado in the early 2000s to “boost” declining population numbers, lynx are a native species to Colorado and the Leadville area. Although we know lynx are residing in the area, there is currently no population data available. A lynx research project proposed by the state of Colorado has recently been approved by the FS regional office and will be utilizing game cameras in Colorado wilderness areas to assess lynx populations starting in 2015. Canada lynx is listed as a federally threatened species.

White-tailed ptarmigan (*Lagopus leucurus*)—White-tailed ptarmigan inhabit alpine tundra with boulders as well as moist, low-growing alpine vegetation (particularly willows (*Salix ssp.*)), and that is in proximity of water. In the cold months, snowpack levels influence their winter habitat use and survival as they tunnel under the snow to stay warm. Although there are white-tailed ptarmigan utilizing the Mount Massive Wilderness, no data on population numbers or trends exist at this time; however, most Region 2 populations tend to be small. There is good evidence that the species is susceptible to local extirpation and is not thought to colonize new areas well. Most suitable habitat in Region 2 is on National Forests, and Forest Service management actions are known to directly affect the species and its habitat. For these reasons, white-tailed ptarmigan has been selected as a Region 2 sensitive species.

Definitions:*Population Status:*

- Increasing: species populations are naturally increasing (i.e. increases are not thought to be due to habitat degradation elsewhere forcing a species to crowd into the wilderness area, nor are they from reintroductions or other human manipulations).
- Stable: species population appears stable; if only presence or absence data is known, a score of 'stable' would indicate presence.
- Decreasing: species population is decreasing; this score should be based on actual State or Forest population monitoring data.
- Extirpated: a species no longer exists in the wilderness but is believed to still exist elsewhere; this score should be based on actual State or Forest population monitoring data.

Habitat Threat:

- Low/None: habitat for this species is not at risk either within the wilderness or in the immediate area surrounding the wilderness.
- Medium: habitat for this species is at moderate risk either within the wilderness or in the immediate area surrounding the wilderness.
- High: habitat for this species is at risk with improvement difficult or unlikely.

Data Source: Jeni Windorski, Wildlife Biologist (the population status is based on available data from Colorado Parks and Wildlife as well as local knowledge and anecdotal information; the habitat threat score is based on existing conditions and considers immediate threats to these habitats).

Data Adequacy: Low. At this time this score is largely subjective due to the lack of hard data being collected in the wilderness. Data quality is low and data quantity is insufficient.

Frequency: Every five years.

Significant Change: Any.

Table 20. Weighting scheme for native species of concern

National/Regional/Local Status	Score	X	Wilderness Status			
			Population Status	Score	X	Habitat Threat Status
R2 Sensitive Species, or Species of Local Concern	1	X	Increasing	1	X	Low/None
State or Federally Threatened Species	2		Stable	2		Medium
State or Federally Endangered Species	3		Decreasing	3		High
			Extirpated	4		

Table 21. Index of native species of concern

Species	National/Regional/Local Status	X	Wilderness Status			=	Total Score
			Population Status	X	Habitat Threat Status		
Boreal toad (<i>Anaxyrus boreas boreas</i>)	R2 Sensitive Species & State Endangered Species = 3	X	Declining range-wide = 3*	X	Low = 1	=	9
Canada lynx (<i>Lynx canadensis</i>)	Federally Threatened Species = 2		Stable = 2**		Low = 1		4
White-tailed ptarmigan (<i>Lagopus leucurus</i>)	R2 Sensitive Species = 1		Stable = 2		Low = 1		2
Total							15
*Unknown if populations still exist in wilderness—may be extirpated.							
**Populations likely are increasing due to reintroduction (i.e. not due to natural causes).							

*Index of stocked lakes***2014 Data Value:** 37.2**Year(s) of Data Collection:** 2009-2013 (calendar years)

Measure Description and Collection Protocol: An index of the amount of non-native fish stocked into wilderness lakes and streams. While the “number of lakes and other water bodies stocked with fish” measure in the Untrammelled Quality looks at the management *action* of stocking, this measure looks at the *effects* of stocking non-native fish into natural ecosystems. The stocking of locally native fish, therefore, is not included under this measure. An annual score (Table 23) is calculated based on the species of fish (Table 24) and the number of fish stocked in a calendar year; annual scores are then summed every five years to obtain the measure value. While the historical measure values are shown in Figure 11 and Table 25 (the double wavy lines indicate the year of wilderness designation), more detailed information, including the calculations for the annual index values and five-year measure values, can be found in Appendix E. A decrease in the measure value (indicating that fewer non-native fish are being stocked in the wilderness) would result in an upward trend in this measure, and would benefit the Natural Quality.

Background and Context: Fish have been stocked in what is now the Mount Massive Wilderness for over 125 years. Private fish hatcheries stocked non-native trout in the wilderness even before the creation of the Leadville National Fish Hatchery, and by the late 1800s it was becoming difficult to catch native fish due to the increase in non-native, stocked species. These early stocking efforts had a profound effect on the geographical distribution of cutthroat trout in the region, which has obscured our understanding of which species and subspecies were originally native which drainages. A recent genetic study (Metcalf et al. 2012) has shown that the greenback cutthroat trout (*Oncorhynchus clarkii stomias*)—previously thought to be the original trout species of the Arkansas River—is actually native to the South Platte area, north of the wilderness; the study further identified the yellowfin cutthroat (*O. c. macdonaldi*), now extinct, as the original trout species of the Arkansas River Drainage (Metcalf et al. 2012). As past stocking efforts have had such a significant and permanent effect on species distribution in the wilderness and the region as a whole, it is important to continue to monitor stocking efforts. While ideally this measure would also capture the effects of stocking fish in lakes that were originally fishless, it is unknown which wilderness lakes and streams, if any, were originally without fish.

Data Source: Andrew Treble, Colorado Parks and Wildlife Aquatic Research Data Analyst; Ed Stege, Leadville National Fish Hatchery Project Leader.

Data Adequacy: High. Data come from Colorado Parks and Wildlife stocking records and are highly reliable. Data quantity is complete and data quality is high.

Frequency: Every five years.

Significant Change: Any change from one category to another (Table 22) is a significant change.

Table 22. Categories for significant change for stocked lakes						
Category	Good	Caution	Poor	Very Poor	Trouble	Etc.
Measure Value	0-10	11-20	21-30	31-40	41-50	Etc.

Table 23. Annual counting protocol for fish stocking			
Species Score		X	Amount
Native to the region	1	X	Number of stocked fish x 0.001, rounded to the nearest tenth (e.g.: 4,250 = 4.3)
Non-native	2		

Table 24. Species scores for previously stocked trout species		
Trout Species	Score	Explanation
Greenback Cutthroat (<i>Oncorhynchus clarkii stomias</i>)	1	Native to the South Platte Drainage east of the continental divide and just north of the wilderness area (stocked from 1991 to 2013*). Given that the native yellowfin cutthroat is extinct, this species will be considered regionally native. *Considering the past misunderstandings and recent genetic revelations regarding the greenback cutthroat, it is extremely unlikely that the “greenback cutthroats” stocked in the wilderness were what we would now consider to be actual greenback cutthroats. “Greenback cutthroats stocked within the last few years were likely to have been green lineage while those stocked prior to that were likely to have been lineage CR. If this confusion as to which species is actually being stocked is clarified in future years, this species score may need to be reevaluated.
Pikes Peak Cutthroat (<i>Oncorhynchus clarkii ssp. 2</i>)	2	A hybrid species of greenback cutthroat (although possibly not the true greenback cutthroat as we now understand it), Yellowstone cutthroat, and possibly Snake River cutthroat (stocked from 1973 to 1998).
Colorado River Cutthroat (blue and green lineages, both formerly considered to be <i>O. c. pleuriticus</i>)	2	Native to the Colorado River west of the continental divide (stocked in 1994).
Snake River Cutthroat (<i>Oncorhynchus clarki behnkei</i>)	2	Native to the Snake River in southern Idaho and western Wyoming (stocked in 1984).
Golden (<i>Oncorhynchus mykiss aguabonita</i>)	2	A subspecies of rainbow trout native to California (stocked in 2012 and 2013).
Lake (<i>Salvelinus namaycush</i>)	2	Native to the northern United States and Canada, including the Great Lakes (stocked in 1973).

Table 25. Index of fish stocking		
Year	Index Value	
2013	13	37.2
2012	10	
2011	7.2	
2010	0	
2009	7	
2008	0	12.7
2007	5	
2006	0	
2005	7.7	
2004	0	
2003	7	14
2002	0	
2001	0	
2000	7	
1999	0	
1998	14	44
1997	0	
1996	18.6	
1995	0	
1994	11.4	
1993	9.8	69
1992	14	
1991	16.4	
1990	13.4	
1989	15.4	
1988	0	75.6
1987	9.2	
1986	23.8	
1985	23.6	
1984	19	
1983	0	55.2
1982	0	
1981	36	
1980	0	
1979	19.2	
1978	0	49.2
1977	12.4	
1976	0	
1975	20.4	
1974	16.4	
1973	31.2	N/A

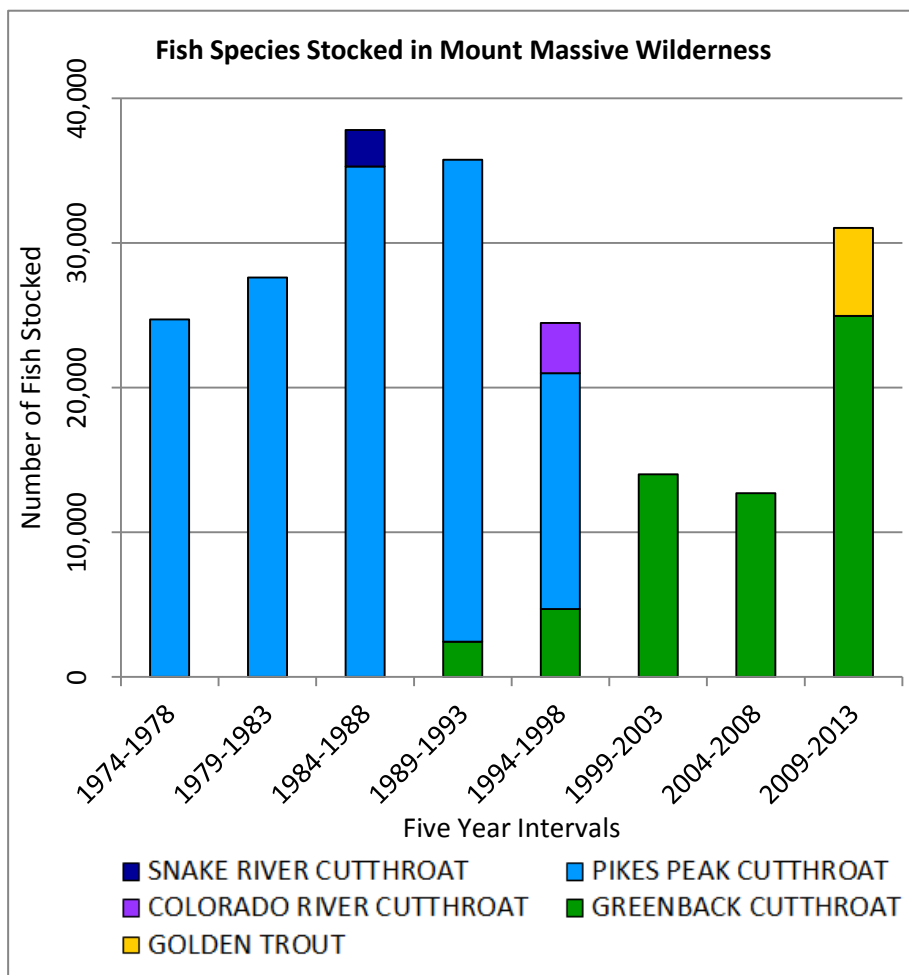


Figure 10. Species of fish stocked 1974-2013

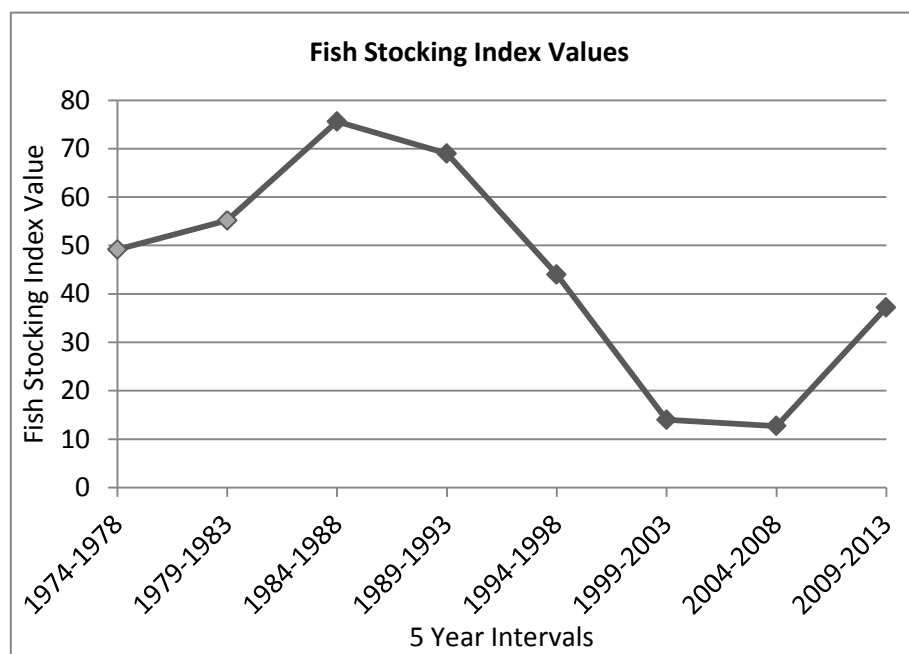


Figure 11. Fish stocking index values 1974-2013

Light grey points indicate years prior to wilderness designation.

Ozone exposure statistics N100 and W126**2014 Data Value:** 2**Year(s) of Data Collection:** 2013 (calendar year)

Measure Description and Collection Protocol: An index of the N100 and W126 ozone exposure statistics. The data collection site is located 30 miles from the wilderness boundary, near Gothic Mountain in Gunnison County, Colorado (monitoring id: 0805199911; 38.95627 north, -106.98587 west; elevation: 9,563 feet). For both statistics, 24-hour ozone data is used (as opposed to 8-hour daytime ozone data). To calculate the measure value, scores are assigned to both the annual N100 and W126 values and then summed (Table 26). A decrease in the N100 or W126 ozone exposure statistics would result in an upward trend in this measure, and would benefit the Natural Quality.

Background and Context: Ozone in the lower atmosphere is formed primarily by the reaction of nitrogen oxides (produced by automobile engines, coal-fired power plants, and other types of combustion) with volatile organic compounds on warm, sunny days. While urban areas generally have the highest emission levels, weather patterns and topographic effects can result in high ozone concentrations even in remote areas. Ozone is a phytotoxic compound and can have effects ranging from visible leaf/needle injury to premature leaf loss, reduced photosynthesis, and reduced growth in sensitive plant species. While ozone affects vegetation and plant species, as it is an airborne product of urban areas it is counted under this indicator. The current National Ambient Air Quality Standard (NAAQS) for ozone is 75 ppb (0.075 ppm); ozone concentrations under 40 are considered to be near background level. These values were determined as the primary standard for human health; however, even if an area has a low ozone concentration, high peaks in concentration can result in greater loss of vegetation growth or yield. The N100 and W126 statistics quantify the effects of these types of peaks in ozone exposure on sensitive vegetation. Although there is one other ozone monitoring site closer to the wilderness (near Aspen, monitoring id: 0809700071), this site lacks data from 2013 and there is uncertainty as to whether it is still active; therefore, the Gothic Mountain site was used for this measure.

Definitions:

N100: this statistic measures the number of hours with ozone concentrations greater than or equal to 100 ppb (0.1 ppm) during the three consecutive months of the calendar year with the highest ozone levels (these months may vary from year to year). The N100 statistic is an indicator of acute ozone exposures. A value of 4 or higher for the N100 statistic indicates an impact on vegetation.

W126: this statistic is a cumulative exposure index of hourly ozone concentration that places a greater weight on higher ozone concentrations than on mid or low level concentrations. It covers the same three consecutive months with the highest ozone levels as the N100 statistic. The W126 statistic is an indicator of chronic ozone exposure. Given that the W126 is cumulative, it is possible to have a high W126 value with a very low N100 value. The Environmental Protection Agency (EPA) recommended consideration of the W126 exposure index as a secondary ozone standard to protect vegetation, proposing to set the standard level within 7-15 ppm-hours. No final decision was reached, and the proposed revision was eventually withdrawn.

Data Source: Forest Service Air Resource Management Site (home page: <http://webcam.srs.fs.fed.us/index.shtml>; site with an interactive map of monitoring sites: <http://webcam.srs.fs.fed.us/maps/>). Specific information for monitoring site 0805199911 can be found here: http://webcam.srs.fs.fed.us/results_o3/08/051/99911/ (Click “n100.csv” and report the value that is the first number/column after the desired year; go back and click “w126.csv,” and report the value that is the first number/column after the desired year); Air Resource Specialist—Bill Jackson.

Data Adequacy: Medium. Although this monitoring site is upwind of the wilderness and at a relatively similar elevation to the lower elevations of the wilderness, because it is 30 miles away there is limited confidence that this data can represent the wilderness. Data quality is therefore moderate. Data quantity is determined by the completeness of the data (data completeness is reported on the same webpage as the W126 and N100 data (http://webcam.srs.fs.fed.us/results_o3/08/051/99911/; click “bio_pcapture.csv” and examine the value that is the first number/column after the desired year). Should the data completeness be less than or equal to 75%, data quantity will be partial; should the data completeness be less than or equal to 50%, data quantity will be incomplete. Incomplete data quantity will result in low data adequacy. At this time, data quantity is complete.

Frequency: Annually.

Significant Change: Any.

Table 26. Measure scoring protocol for ozone exposure statistics				
N100	Score	+	W126	Score
<2	0	+	<7	0
2-3	1		7-13	1
4-5	2		14-20	2
6-7	3		21-27	3
Etc.	Etc.		Etc.	Etc.

Table 27. Index of ozone exposure statistics 2011-2013						
Year	N100	Score	+	W126	Score	= Measure Value
2011	0	0	+	10.2342	1	= 1
2012	0	0		17.3193	2	
2013	0	0		16.5201	2	

Concentration of nitrogen in wet deposition

2014 Data Value: 0.24 mg/L

Year(s) of Data Collection: 2012 (water year)

Measure Description and Collection Protocol: The precipitation weighted mean concentration of nitrogen that is added to the wilderness annually. Data are collected for the water year to accurately capture annual wet deposition. The data collection site is located 30 miles from the wilderness boundary, near Gothic Mountain in Gunnison County, Colorado (site id: CO10; 38.95627 north, -106.98587 west; elevation: 9,563 feet). The concentration of ammonium (NH_4) in wet deposition is multiplied by 0.7778 and the concentration of nitrate (NO_3) in wet deposition is multiplied by 0.2258 to find the concentrations of nitrogen (N) for each; these values are then summed to attain the total concentration of nitrogen in wet deposition. A decrease in the concentration of nitrogen deposited through precipitation would result in an upward trend in this measure, and would benefit the Natural Quality.

Background and Context: Nitrogen is a major component 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, the deposition of nitrogen can result in unnatural nutrient enrichment, which can lead to changes in plant and animal diversity and shifts in ecosystem processes. In 1999, the National Atmospheric Deposition Program measured an average concentration range of 0.1-2.0 mg/L of nitrate (NO_3) and 0.02-0.6 mg/L of ammonium (NH_4) in wet deposition across the United States (Lear 1999); this can be converted to an average concentration range of 0.04-0.92 mg/L for nitrogen (N) in wet deposition.

Data Source: National Atmospheric Deposition Program/National Trends Network (NADP/NTN) website: <http://nadp.sws.uiuc.edu/data/ntn/> (site: Gothic (CO10); data tab, annual data; select same start and end year, type of data: precipitation-weighted means (mg/L), report format: HTML table, seasons to return: water year (Oct.-Sept.); find values for NH_4 and NO_3). Accessing the data may require submitting additional information on the purpose of data collection, etc. to NADP/NTN.

Data Adequacy: Medium. Although this monitoring site is upwind of the wilderness, because it is 30 miles away the confidence that this data can represent the wilderness is only moderate. Data are collected weekly and summarized annually. NADP/NTN completeness criteria are indicated in the annual reports under criteria 1-4. Data quantity is complete when criteria 1, 3, and 4 are 75% or greater, and criteria 2 is 90% or greater; data quantity is partial when one or two out of the four criteria do not meet these standards; and data quantity is insufficient when three or four of the criteria do not meet these standards. For the 2014 data value, data quantity is complete and data quality is moderate.

Frequency: Annually (annual collection will be of data from two years prior due to the delay in posting data).

Significant Change: Any change from one category to another (Table 28) is a significant change.

Table 28. Categories for significant change for the concentration of nitrogen					
Category	Excellent	Caution	Poor	Very Poor	Etc.
Measure Value	< 0.2 mg/L	0.2-0.39 mg/L	0.4-0.59 mg/L	0.6-0.79 mg/L	Etc.

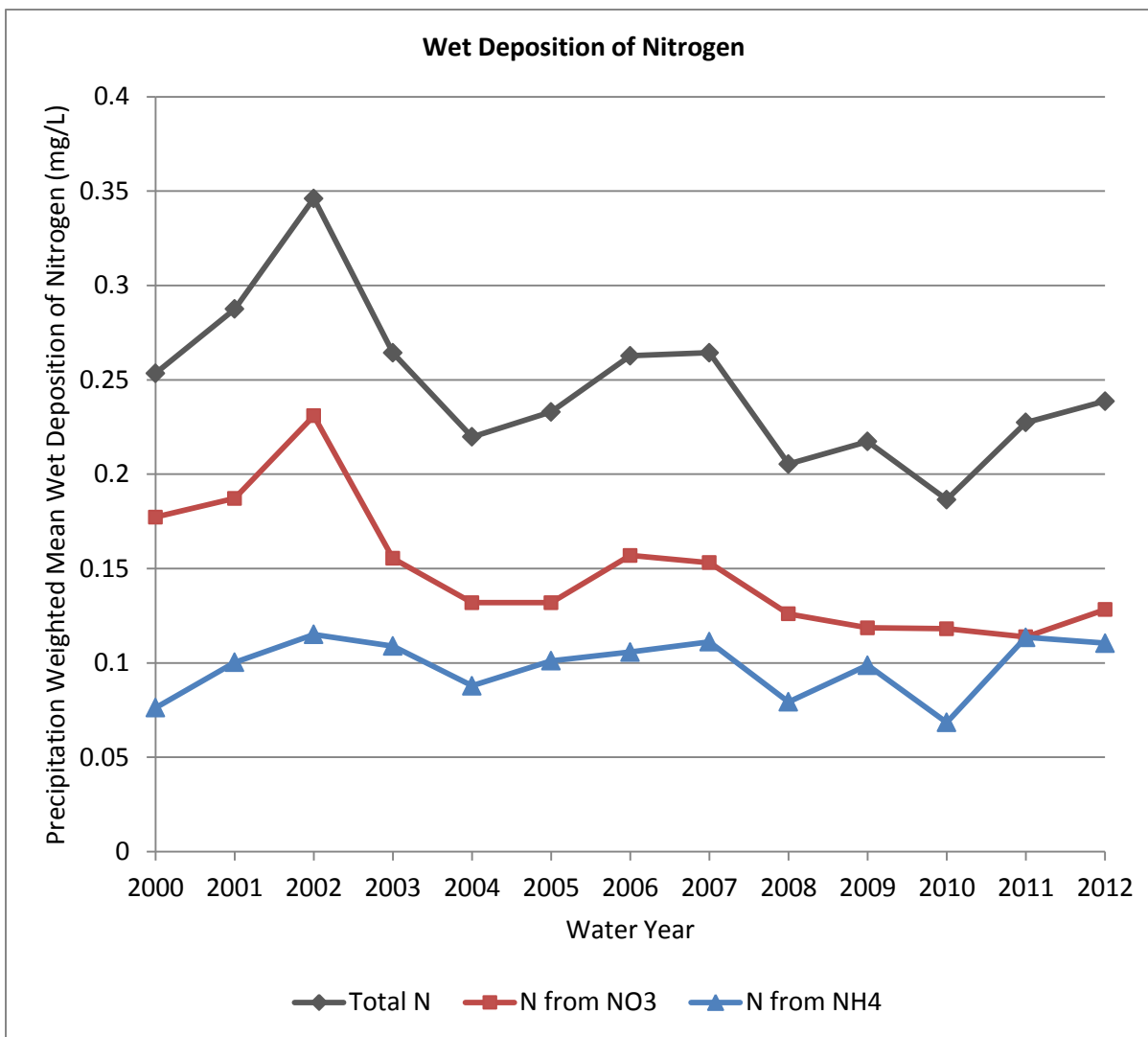


Figure 12. Precipitation weighted mean wet deposition of nitrogen (N) for the water year

Concentration of sulfur in wet deposition**2014 Data Value:** 0.10 mg/L**Year(s) of Data Collection:** 2012 (water year)

Measure Description and Collection Protocol: The precipitation weighted mean concentration of sulfur that is added to the wilderness annually. Data are collected for the water year to accurately capture annual wet deposition. The data collection site is located 30 miles from the wilderness boundary, near Gothic Mountain in Gunnison County, Colorado (site id: CO10; 38.95627 north, -106.98587 west; elevation: 9,563 feet). The concentration of sulfate (SO₄) in wet deposition is multiplied by 0.3337 to attain the concentration of sulfur (S). A decrease in the concentration of sulfur deposited through precipitation would result in an upward trend in this measure, and would benefit the Natural Quality.

Background and Context: Sulfur is a major component of acidic deposition, which causes chemical changes in freshwater lakes, streams, ponds, and soils that can affect aquatic and terrestrial plants and animals. A decrease in the concentration of sulfur in wet deposition indicates a decrease in the threat of atmospheric pollutants to the wilderness. In 1999, the National Atmospheric Deposition Program measured an average concentration range of 0.1-2.7 mg/L of sulfate (SO₄) in wet deposition across the United States (Lear 1999); this can be converted to an average concentration range of 0.03-0.9 mg/L for sulfur (S) in wet deposition.

Data Source: National Atmospheric Deposition Program/National Trends Network (NADP/NTN) website: <http://nadp.sws.uiuc.edu/data/ntn/> (site: Gothic (CO10); data tab, annual data; select same start and end year, type of data: precipitation-weighted means (mg/L), report format: HTML table, seasons to return: water year (Oct.-Sept.); find value under SO₄). Accessing the data may require submitting additional information on the purpose of data collection, etc. to NADP/NTN.

Data Adequacy: Medium. Although this monitoring site is upwind of the wilderness, because it is 30 miles away the confidence that this data can represent the wilderness is only moderate. Data are collected weekly and summarized annually. NADP/NTN completeness criteria are indicated in the annual reports under criteria 1-4. Data quantity is complete when criteria 1, 3, and 4 are 75% or greater, and criteria 2 is 90% or greater; data quantity is partial when one or two out of the four criteria do not meet these standards; and data quantity is insufficient when three or four of the criteria do not meet these standards. For the 2014 data value, data quantity is complete and data quality is moderate.

Frequency: Annually (annual collection will be of data from two years prior due to the delay in posting data).

Significant Change: Any change from one category to another (Table 29) is a significant change.

Table 29. Categories for significant change for the concentration of sulfur					
Category	Excellent	Caution	Poor	Very Poor	Etc.
Measure Value	< 0.2 mg/L	0.2-0.39 mg/L	0.4-0.59 mg/L	0.6-0.79 mg/L	Etc.

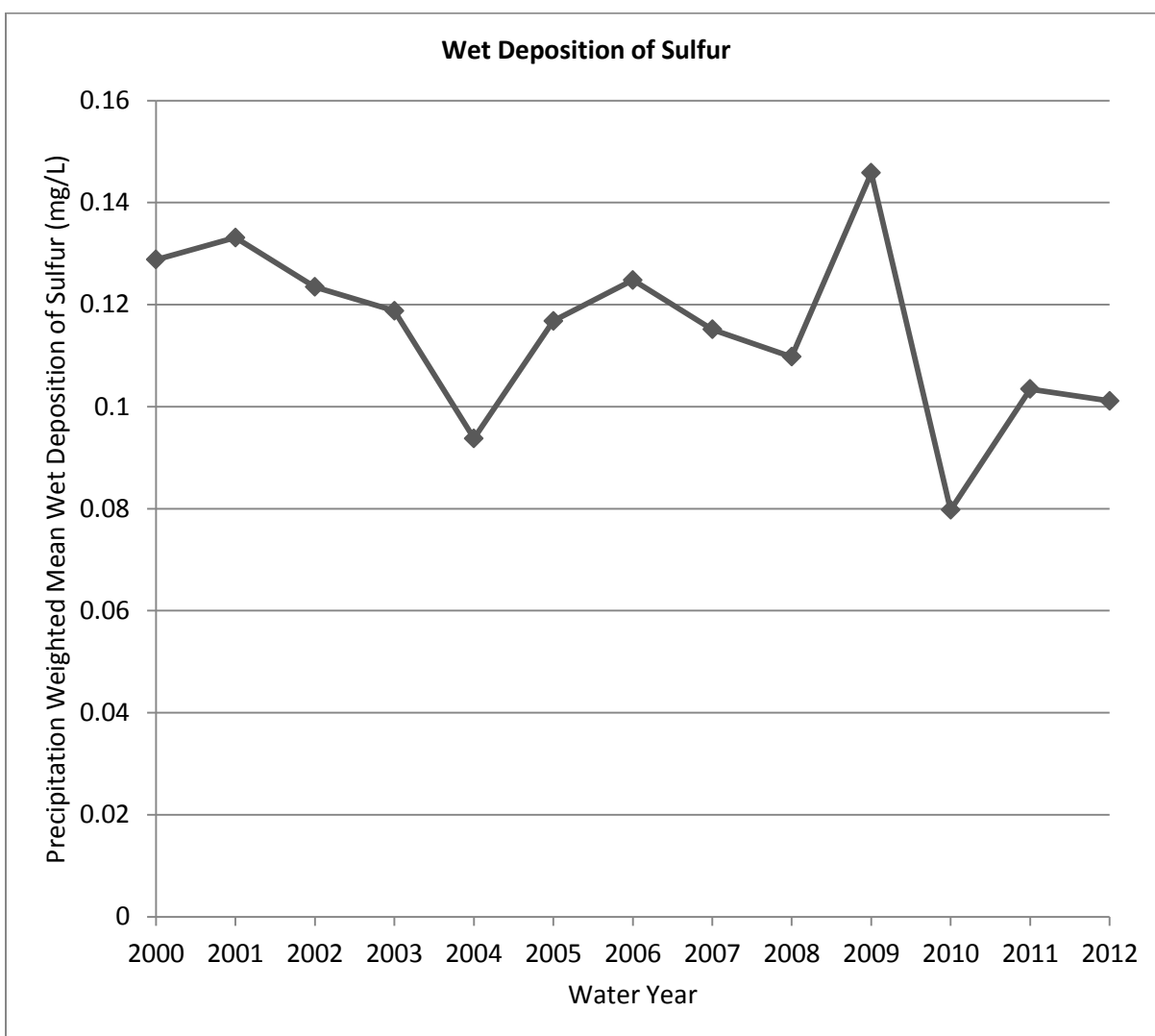


Figure 13. Precipitation weighted mean wet deposition of sulfur (S) for the water year

Visibility statistics

2014 Data Value: 0.45 $\mu\text{g}/\text{m}^3$

Year(s) of Data Collection: 2013 (calendar year)

Measure Description and Collection Protocol: The sum of the average annual anthropogenic fine nitrate and sulfate. Data are taken from the nearest monitoring site to the wilderness: a USFS communication facility located in the White River National Forest near Aspen (less than 20 miles away: 39.1536 north, -106.8209 west; elevation: 11,199 feet). The average annual fine sulfate and average annual fine nitrate are added to get a total annual sum for the calendar year. A decrease in the sum of anthropogenic fine nitrate and sulfate would result in an upward trend in this measure, and would benefit the Natural Quality.

Background and Context: Sulfate particles form from sulfur dioxide gas, which is mostly released from industrial sources; nitrate particles form from nitrogen oxide gas that is mainly released from combustion activities. Fine particulates are more efficient at scattering and absorbing light—thus impacting visibility and causing regional haze—than are coarse particulates. Reduced visibility causes increased reflective power, which can affect local climate and photosynthetic activity as well as wildlife species that depend on clear, clean air for successful foraging. The primary NAAQS for the annual mean of fine particulate pollution ($\text{PM}_{2.5}$) averaged over 3 years, is 12 micrograms per cubic meter of air ($\mu\text{g}/\text{m}^3$). Although the percentage of sulfates and nitrates in the $\text{PM}_{2.5}$ composition varies by region, they generally can represent roughly half of the total. Three nearby wilderness areas—Maroon Bells-Snowmass, Eagles Nest, and West Elk—are class 1 areas whose airsheds are protected through the Clean Air Act. As all of these wilderness areas use the White River National Forest site to monitor visibility, it is considered likely that it will remain an active monitoring site in the future. Although ideally decidview would also be included here, decidview measurements at the White River National Forest site stopped in 2005. The White River National Forest analyzed data from this site in 2009 and found that visibility at this site is the best of all five IMPROVE sites in Colorado (USDA Forest Service 2009). They also found that, in this region, sources of nitrate tend to come from the western US, while sources of sulfate come from both the western US and non-US sources (USDA Forest Service 2009).

Data Source: Visibility Information Exchange Web System (VIEWS):

<http://views.cira.colostate.edu/fed/DataWizard/Default.aspx> (Reports: site data statistics; Dataset: IMPROVE aerosol; Site: White River NF; Dates: choose one year and select all months); create report and find the averages for the parameters: “NO3f” (“nitrate (fine)”) and “SO4f” (“sulfate (fine)”).

Data Adequacy: High. Data at the White River National Forest monitoring station are collected every few days, therefore data quantity is complete. Although the monitoring station is outside the wilderness, in the Pike and San Isabel National Forest 2010 Annual Forest Plan Monitoring Report (USDA Forest Service 2011a) this site was determined to be representative of the Mount Massive Wilderness. Data quality is therefore high. The summary report in VIEWS notes the number of missed days of data collection as “Empty rec[ord]s”. Should the number of missed days exceed 20% of the total days (24 missing records), data quantity would be partial; should they exceed 50% of the total days (60 missing records) data quantity would be insufficient.

Frequency: Annually.

Significant Change: Any change from one category to another (Table 30) is a significant change.

Table 30. Categories for significant change for fine sulfate and nitrate					
Category	Excellent	Good	Caution	Poor	Etc.
Measure Value	<3 $\mu\text{g}/\text{m}^3$	3-5.99 $\mu\text{g}/\text{m}^3$	6-8.99 $\mu\text{g}/\text{m}^3$	9-11.99 $\mu\text{g}/\text{m}^3$	Etc.

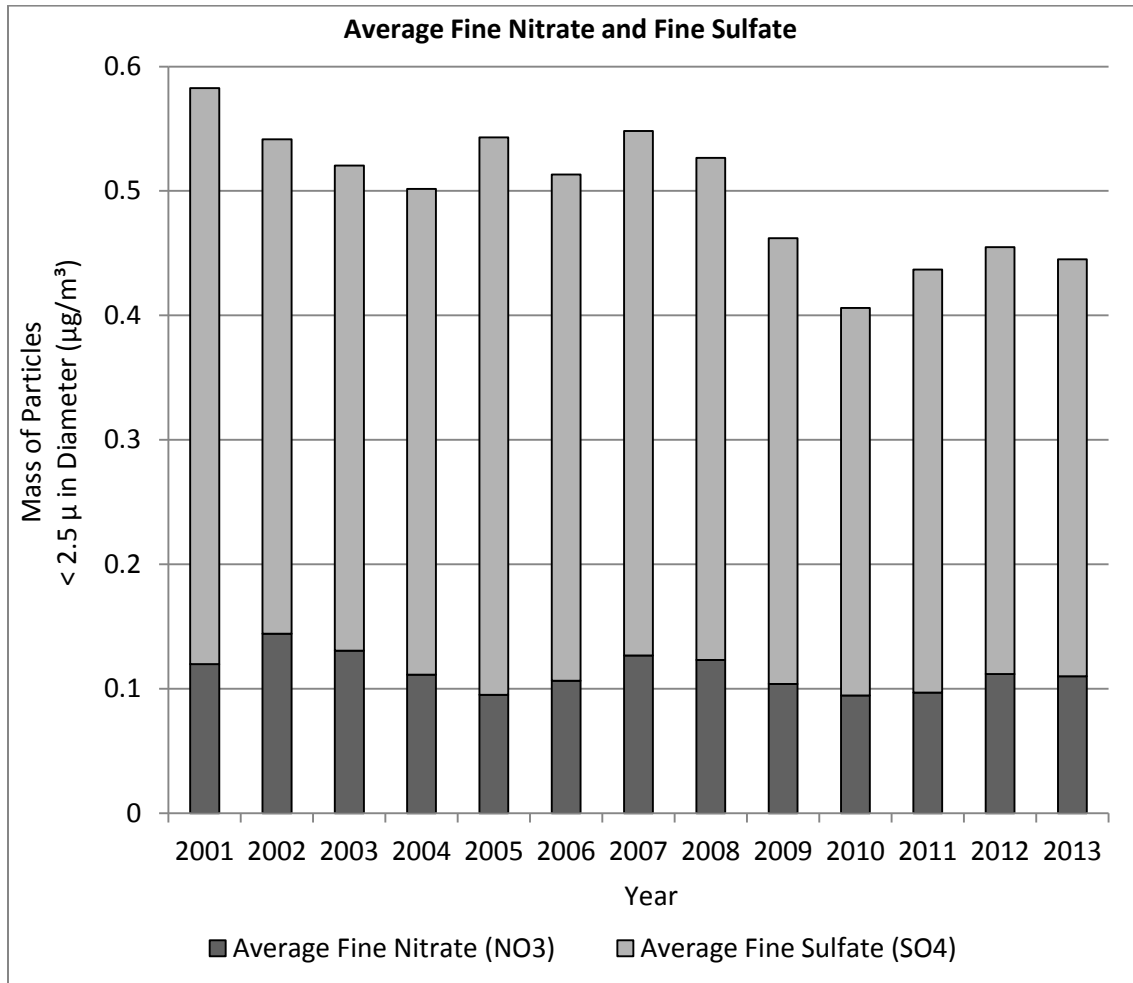


Figure 14. Average annual fine nitrate and fine sulfate

Temperature

2014 Data Value: 2

Year(s) of Data Collection: 2013 (regression, water years)

Measure Description and Collection Protocol: Average annual winter (December-February) and summer (June-August) temperatures. There are three monitoring sites within five miles of the wilderness boundary: Lodgepole Flats (RAWS site; 39 9' 12" north, 106 20' 59" west; elevation: 9,640 feet), Brumley (SNOTEL site; 39 5' north, 106 33' west; elevation: 10,600 feet), and Ivanhoe (SNOTEL site; 39 18' north, 106 33' west; elevation: 10,400 feet). For each of the three sites, the average temperature for December, January, and February, and the average temperature for June, July, and August, are calculated. Winter and summer average temperatures are counted for the water year (i.e. for 2014, data from December 2013 to February 2014 are used to calculate the average winter temperature, and data from June to August 2014 are used to calculate the average summer temperature). The measure value is based off of regression analysis; each site and season with a statistically significant trend (whether increasing or decreasing) will be scored as one point (Table 31). Sites will only be included in this measure once there are five years of data or more; summer temperatures for Lodgepole Flats, therefore, will only be considered starting next year (once the 2014 data has been collected). Sites and seasons are likewise not included in the regression analysis when the number of missed days for either summer or winter and for any site exceeds 20% of the total days (i.e. 18 missing records or more; for example, Brumley summer 2009, Ivanhoe summer 1993, and Ivanhoe winter 1993 and 1997 all have less than complete data quantity, and are not included in the data analysis). An increase in the number of sites and/or seasons with a statistically significant trend would result in a downward trend in this measure, and would diminish the Natural Quality. This measure value is not expected to decrease (i.e. an upward trend in the measure is not anticipated).

Background and Context: Climate change has the potential to drastically alter the natural systems within wilderness. Changes in annual temperature patterns affect almost all aspects of an ecosystem, from species distribution and demography, to phenology, rates of nutrient cycling, etc.

Data Source:

SNOTEL sites: Natural Resources Conservation Service (NRCS) Snow Telemetry (SNOTEL) data: <http://www.wcc.nrcs.usda.gov/snow/> (select Colorado, then select Ivanhoe (547) or Brumley (369); under Element Repots: check the box for degrees Fahrenheit; report content: "air temperature"; under "View Historic" select desired year, "water year", and "all days", then click "View Historic". Click "download" to generate an excel sheet—use the data column called "TAVG.D-1 (degF)". Remember to replace missing data with blank cells before calculating the average in excel).

RAWS site: Remote Automatic Weather Station (RAWS) data: <http://www.raws.dri.edu/> (select Colorado, then select Lodge Pole Flats; select monthly summary time series, set starting and ending month and year, select "air temperature" only, select English, html, yes to applying physical limits QC to data, leave "represent missing data as" as is, and select yes to "include number of valid observations for each element, then click "submit info"—use the data called "Ave." under average air temperature).

Data Adequacy: High. Data are collected daily and compiled monthly. Months in which any days of data collection were missed are noted. Data quality is high and data quantity is complete.

Frequency: Annually.

Significant Change: Any (Table 31); simple linear regression analysis, $\alpha = 0.05$, for all data 1987-present is used to determine if any site or season has a significant trend.

Table 31. Measure scoring protocol for significant trend of temperature					
Average Annual Summer Temperatures Score		+	Average Annual Winter Temperatures Score		
0 sites with significant trend	0		0 sites with significant trend	0	
1 site with significant trend	1		1 site with significant trend	1	
2 sites with significant trend	2		2 sites with significant trend	2	
3 sites with significant trend	3		3 sites with significant trend	3	

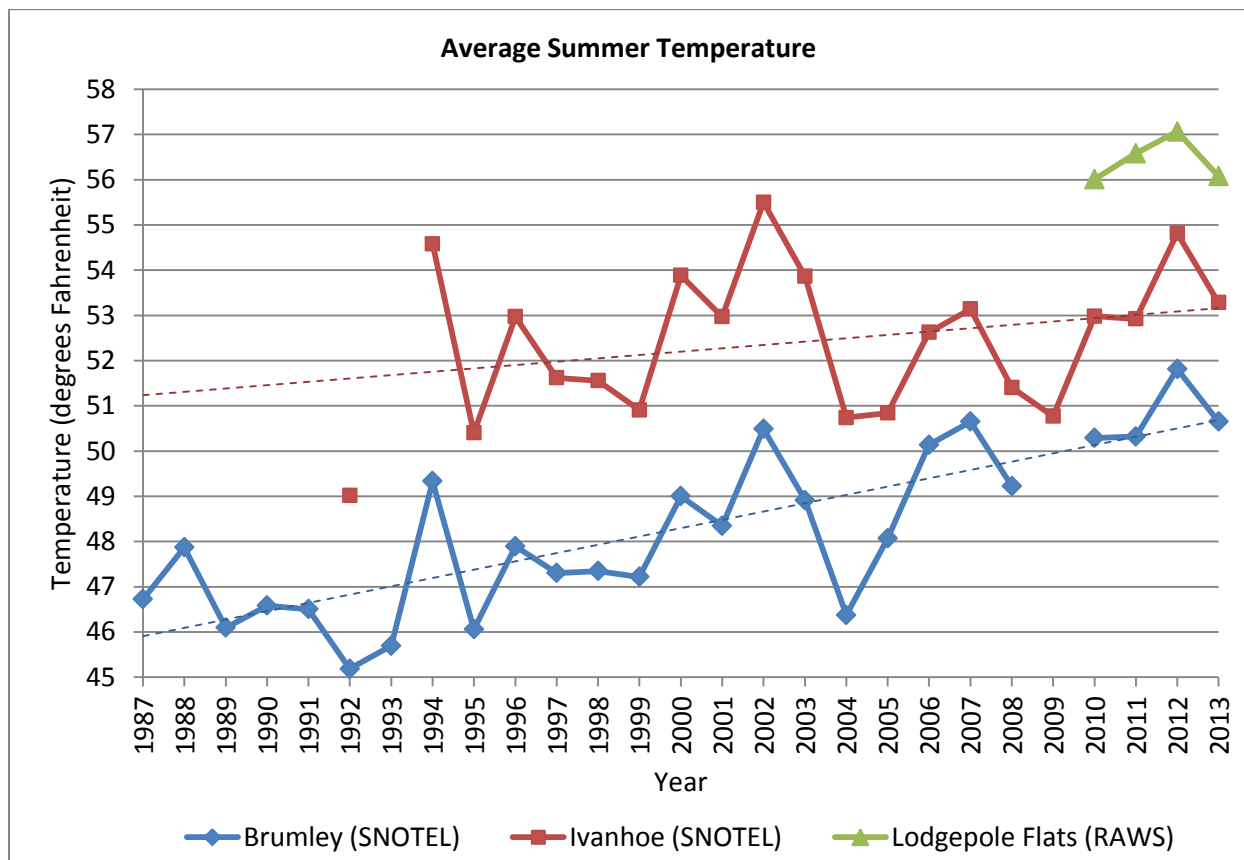


Figure 15. Average annual summer temperatures

Dashed lines indicate linear trendlines. Brumley shows a statistically significant increasing trend ($F = 39.29$; $P\text{-value} = 0.00000177$) for 1987-2013; Ivanhoe does not ($F = 1.63$; $P\text{-value} = 0.22$). Lodgepole Flats is shown here but is not yet included in the measure value as there are only four years of data.

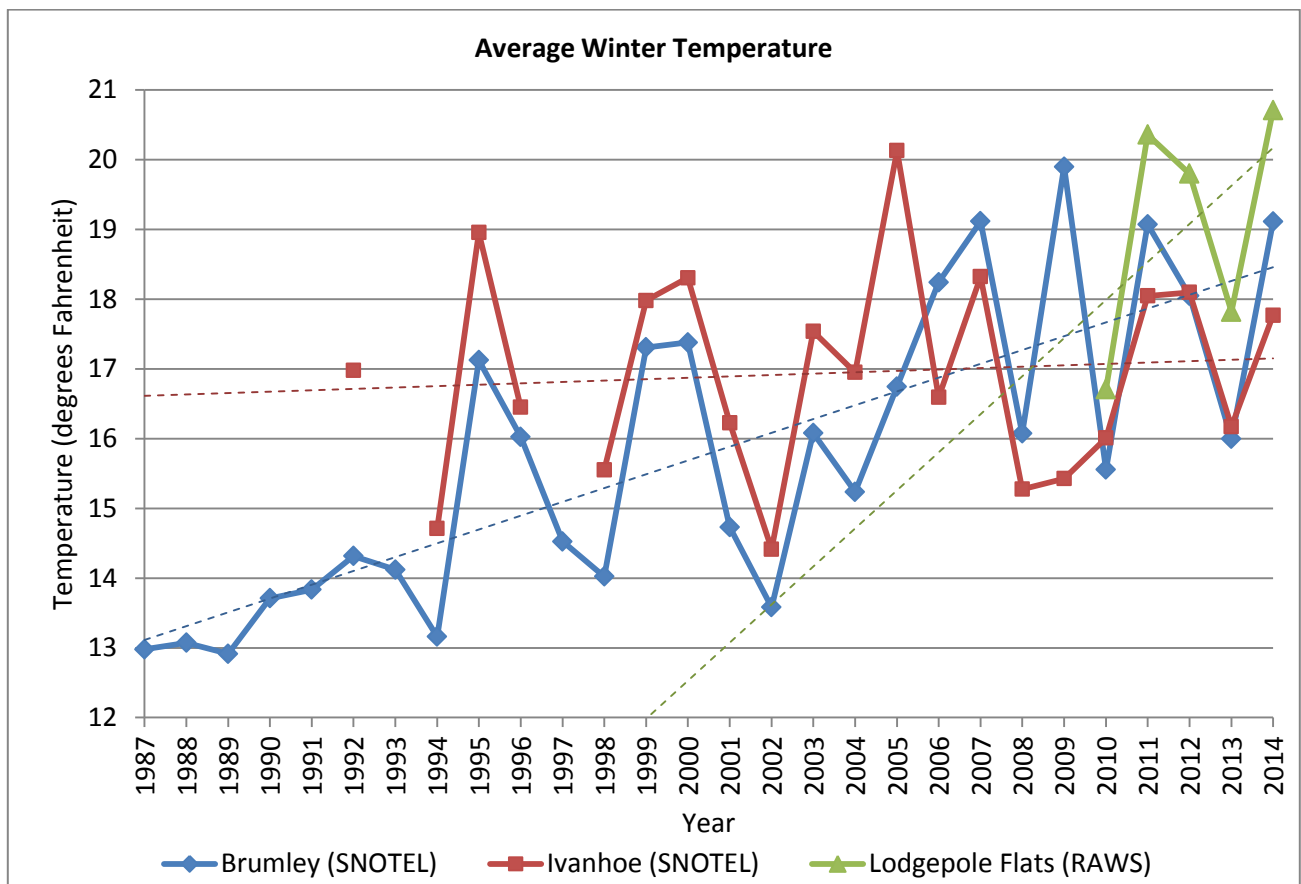


Figure 16. Average winter temperature

Dashed lines indicate linear trendlines. Brumley shows a statistically significant increasing trend ($F = 36.13$; $P\text{-value} = 0.0000024$) for 1987-2014; neither Ivanhoe ($F = 0.15$; $P\text{-value} = 0.70$) nor Lodgepole Flats ($F = 0.99$; $P\text{-value} = 0.39$) have a statistically significant trend.

Precipitation

2014 Data Value: 0

Year(s) of Data Collection: 2013 (regression, water years)

Measure Description and Collection Protocol: Total inches of annual precipitation falling in the wilderness. There are three monitoring sites within five miles of the wilderness boundary: Lodgepole Flats (RAWS site; 39 9' 12" north, 106 20' 59" west; elevation: 9,640 feet), Brumley (SNOTEL site; 39 5' north, 106 33' west; elevation: 10,600 feet), and Ivanhoe (SNOTEL site; 39 18' north, 106 33' west; elevation: 10,400 feet). Data are the annual sums of the cumulative daily (SNOTEL) or monthly (RAWS) precipitation. The measure value is based off of regression analysis; each site with a statistically significant trend (whether increasing or decreasing) will be scored as one point (Table 32). Sites will only be included in this measure once there are five years of data or more; Lodgepole Flats, therefore, will only be considered starting next year (once the 2014 data has been collected). Sites are likewise not included in the regression analysis when the number of missed days exceeds 20% of the total days (i.e. 73 missing records or more). An increase in the number of sites with a statistically significant trend would result in a downward trend in this measure, and would diminish the Natural Quality. This measure value is not expected to decrease (i.e. an upward trend in the measure is not anticipated).

Background and Context: Precipitation is a key component of the wilderness ecosystem. Both drought and excessive precipitation can have major effects on plant and animal species as well as on soil and water quality.

Data Source:

SNOTEL sites: Natural Resources Conservation Service (NRCS) Snow Telemetry (SNOTEL) data: <http://www.wcc.nrcs.usda.gov/snow/> (select Colorado, then select Ivanhoe (547) or Brumley (369); under Element Repots: report content: "precipitation accumulation"; under "View Historic" select desired year, "water year", and "all days", then click "View Historic". Use the data column called "PREC.I-1 (in)" and scroll to the bottom—the last number is the cumulative precipitation for the water year).

RAWS site: Remote Automatic Weather Station (RAWS) data: <http://www.raws.dri.edu/> (select Colorado, then select Lodge Pole Flats; select monthly summary time series, set starting and ending month and year (for water year), select "precipitation" only, select English, html, yes to applying physical limits QC to data, leave "represent missing data as" as is, and select yes to "include number of valid observations for each element, then click "submit info"—use the data called "Total" under precipitation. Sum the monthly totals to obtain the cumulative precipitation for the water year).

Data Adequacy: High. Data are collected daily and compiled monthly. Months in which any days of data collection were missed are noted. Data quality is high and data quantity is complete.

Frequency: Annually.

Significant Change: Any (Table 32); simple linear regression analysis, $\alpha = 0.05$, for all data 1981-present is used to determine if any site has a significant trend.

Table 32. Measure scoring protocol for significant trend of precipitation	
Number of Sites with Statistically Significant Trend	Measure Value
0 sites with significant trend	0
1 site with significant trend	1
2 sites with significant trend	2
3 sites with significant trend	3

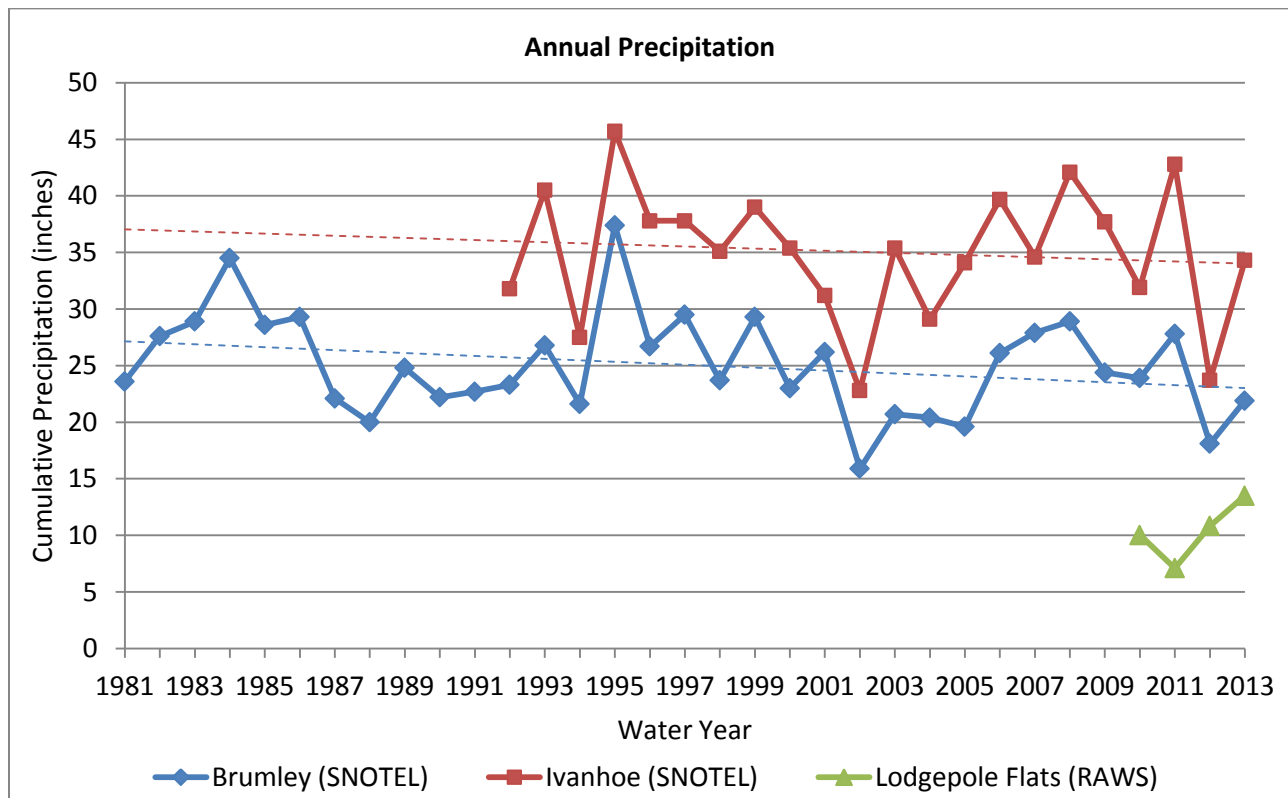


Figure 17. Cumulative annual precipitation

Dashed lines indicate linear trendlines. Neither Brumley ($F = 2.54$; $P\text{-value} = 0.12$) nor Ivanhoe ($F = 0.22$; $P\text{-value} = 0.64$) have a statistically significant trend. Lodgepole Flats is shown here but is not yet included in the measure value as there are only four years of data.

Glaciers and permanent snowfields

2014 Data Value: 50

Year(s) of Data Collection: 2014 (in the future, data will span five years)

Measure Description and Collection Protocol: The areal extent of the Africa Bowl permanent snowfield. Annual photographs are taken of the Africa Bowl at its smallest extent (during the last two weeks in August); photographs are taken from a point directly in front of the Sugar Loaf Dam commemorative marker at Turquoise Lake. Every five years, the previous five photographs are compared for change over time (e.g. in 2019, photographs from 2014-2018 will be compared; in 2024, photographs from 2019-2023 will be compared, etc.). The amount of areal change accrued in the past five years is assessed by a visual examination and then assigned a score (Table 34). The measure value is the sum of the previous measure value and the change score (a hypothetical example is shown in Table 35). Measure values and change scores should also be checked with previous years to ensure consistent scoring over time. A loss in snowfield area would result in a downward trend in this measure, and would diminish the Natural Quality.

Background and Context: Permanent snowfields and glaciers affect microclimates and provide a stable source of water throughout the year. The Africa Bowl (Figures 18 and 19) is the largest permanent snowfield in the Sawatch Range, and is unique in that it occupies a relatively flat area without significant topographic shading (Glaciers of Colorado 2005 [updated 2011]). Although repeat photographs are less quantitative than other means of recording glacial extent or depth, this method should minimize increases in workloads while effectively capturing change over time.

Data Source: Annual photographs taken from the Sugar Loaf Dam commemorative marker at Turquoise Lake during the last two weeks in August.

Data Adequacy: Medium. Annual photographs are considered a sufficient for data quantity requirements. Although aerial photographs would be preferred, photographs taken from the dam at Turquoise Lake are considered moderately sufficient for data quality. Data quantity is complete, and data quality is moderate.

Frequency: Every five years (data will be collected annually to be compared every five years).

Significant Change: Any change from one category to another (Table 33) is a significant change.⁵

Table 33. Categories for significant change in snowfield area							
Category	Etc.	Poor	Caution	Good	Caution	Poor	Etc.
Measure Value	Etc.	35-39	40-44	45-59	60-64	65-69	Etc.

⁵ As this snowfield has not been extensively studied before, these categories are mere guesses of what its normal range of areal variation may be. These categories and/or this protocol may need to be adjusted in the future as we gain a better understanding of areal changes in the Africa Bowl.

Table 34. Protocol for scoring change for the Africa Bowl permanent snowfield		
Change Category	Description	Score
Significant decreasing change	Boundaries are substantially different; the area has noticeably decreased	-2
Noticeable decreasing change	Boundaries are noticeably different; the area has slightly decreased	-1
No change or slight change	Boundaries may have changed slightly; overall the area has remained the same	0
Noticeable increasing change	Boundaries are noticeably different; the area has slightly increased	+1
Significant increasing change	Boundaries are substantially different; the area has noticeably increased	+2

Table 35. Hypothetical example of scoring snowfield area			
Year	Photo Years Compared	Change Score	Measure Value
2014 Baseline			50
2019	2014-2018	+1	51
2024	2019-2023	0	51
2029	2024-2028	-1	50
2034	2029-2033	-1	49
2039	2034-2038	-2	47

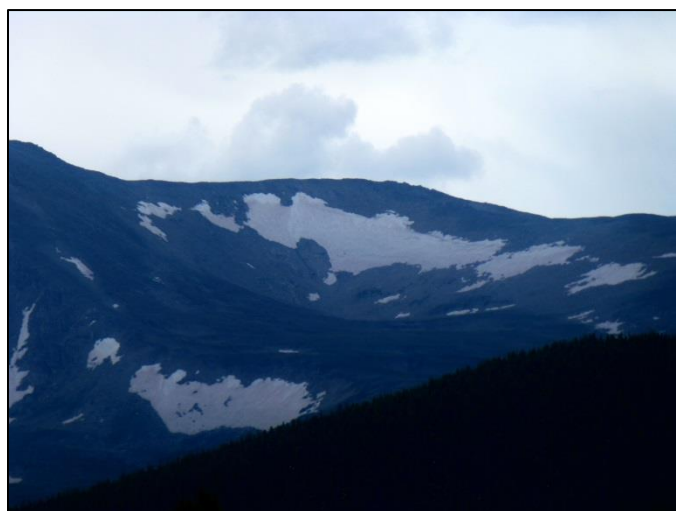


Figure 19. Current extent of Africa Bowl
 Photograph taken August 17, 2014 from the Sugar Loaf Dam commemorative marker at Turquoise Lake.

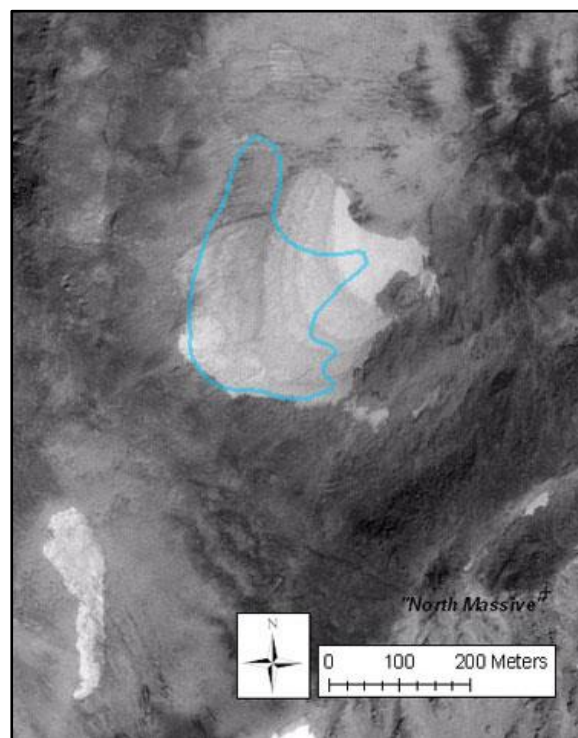


Figure 18. Africa Bowl permanent snowfield
 Retrieved from <http://glaciers.us/glaciers-colorado> on July 17, 2014. The aerial photograph is from the US Geological Survey (October 12, 1999); the blue outline is from the US Geological Survey's 1964 topography map. It appears that the snowfield grew in size from 1964-1999.

Snow (annual snow days)**2014 Data Value:** 0**Year(s) of Data Collection:** 2013 (regression, water years)

Measure Description and Collection Protocol: The percentage of days per year with snow. There are two SNOTEL monitoring sites within five miles of the wilderness boundary: Brumley (SNOTEL site; 39 5' north, 106 33' west; elevation: 10,600 feet) and Ivanhoe (SNOTEL site; 39 18' north, 106 33' west; elevation: 10,400 feet). For each site, the percentage of days per water year with a snow water equivalent greater than zero inches is calculated. The measure value is based off of regression analysis; each site with a statistically significant trend (whether increasing or decreasing) will be scored as one point (Table 36). An increase in the number of sites with a statistically significant trend would result in a downward trend in this measure, and would diminish the Natural Quality. This measure value is not expected to decrease (i.e. an upward trend in the measure is not anticipated).

Background and Context: As the climate changes, the timing and phase of precipitation may be altered to increase or reduce the amount that falls as snow. While rain is quickly transported out of the wilderness, precipitation that falls as snow is held in reserve into the summer months. Accumulated snow also contributes to avalanches which are a natural force of change in wilderness ecosystems. Even if the overall amount of precipitation does not change, climate change could alter the proportion of precipitation falling as rain versus as snow.

Data Source: Natural Resources Conservation Service (NRCS) Snow Telemetry (SNOTEL) data: <http://www.wcc.nrcs.usda.gov/snow/> (select Colorado, then select Ivanhoe (547) or Brumley (369); under Element Repots: report content: "snow water equivalent"; under "View Historic" select desired year, "water year", and "all days", then click "View Historic". Click "download" to generate an excel sheet—use the data column called "WTEQ.I-1 (in)".

Data Adequacy: High. Data is collected daily with highly reliable equipment. Data quantity is complete and data quality is high.

Frequency: Annually.

Significant Change: Any (Table 36); simple linear regression analysis, $\alpha = 0.05$, for all data 1981-present is used to determine if any site has a significant trend.

Table 36. Measure scoring protocol for significant trend of annual snow days	
Number of Sites with Statistically Significant Trend	Measure Value
0 sites with significant trend	0
1 site with significant trend	1
2 sites with significant trend	2

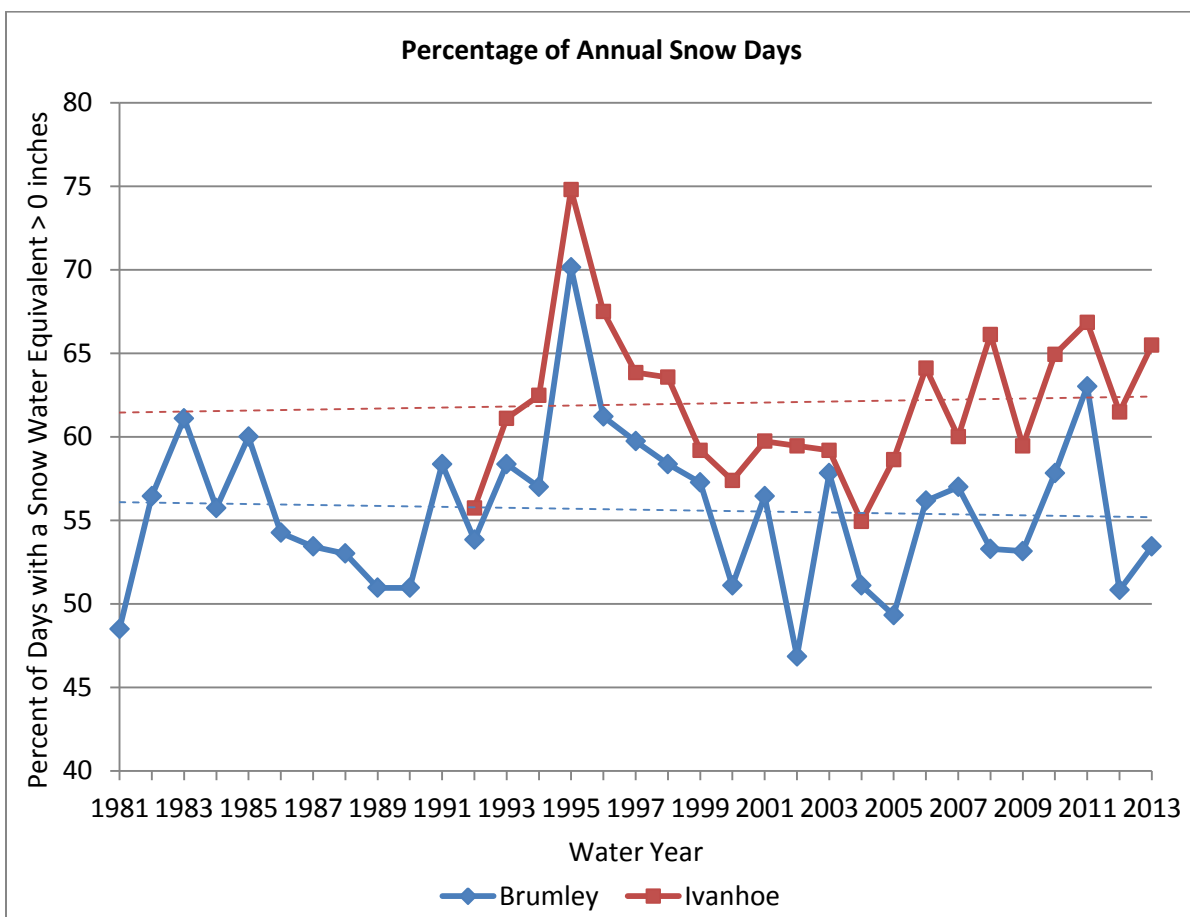


Figure 20. Percentage of annual snow days

Dashed lines indicate linear trendlines. Neither Brumley ($F = 0.11$; $P\text{-value} = 0.75$) nor Ivanhoe ($F = 0.04$; $P\text{-value} = 0.85$) have a statistically significant trend.

Snow seasonality

2014 Data Value: 0

Year(s) of Data Collection: 2013 (regression, water years)

Measure Description and Collection Protocol: The number of months with a statistically significant trend in snow cover. There are two SNOTEL monitoring sites within five miles of the wilderness boundary: Brumley (SNOTEL site; 39 5' north, 106 33' west; elevation: 10,600 feet) and Ivanhoe (SNOTEL site; 39 18' north, 106 33' west; elevation: 10,400 feet). The average snow water equivalent in inches is calculated for all months of a water year for each site. The measure value is based off of regression analysis; the number of months for each site that have a statistically significant trend are summed to attain the measure value (Table 37). An increase in the number of months for either site with a statistically significant trend would result in a downward trend in this measure, and would diminish the Natural Quality. This measure value is not expected to decrease (i.e. an upward trend in the measure is not anticipated).

Background and Context: In the past, the traditional winter months have generally had the greatest amount of snow cover; in recent years, however, many locals have observed a shift to greater snow cover in the early spring. This perceived change in when the most snow is falling may not necessarily reflect a change in total snowfall, but instead a change in snow seasonality. While the previous measure of annual snow days looks at the *amount* of precipitation falling as snow within a water year, this measure examines *what time of year* that snow is falling. Snow acts as an important insulator for soil, vegetation, and many alpine species; a loss of this insulating layer early in the winter could have a pronounced effect on winter survival rates and overall species abundance. In addition, postponement of the spring and summer thaw can delay vegetation growth, impacting birth and survival rates at this crucial time of year. At this time, no months for either site have a statistically significant trend.

Data Source: Natural Resources Conservation Service (NRCS) Snow Telemetry (SNOTEL) data: <http://www.wcc.nrcs.usda.gov/snow/> (select Colorado, then select Ivanhoe (547) or Brumley (369); under Element Repots: report content: "snow water equivalent"; under "View Historic" select desired year, "water year", and "all days", then click "View Historic". Click "download" to generate an excel sheet—use the data column called "WTEQ.I-1 (in)".

Data Adequacy: High. Data is collected daily with highly reliable equipment. Data quantity is complete and data quality is high.

Frequency: Annually.

Significant Change: Any (Table 37); simple linear regression analysis, $\alpha = 0.05$, for all data 1981-present is used to determine if any site or month has a significant trend.

Table 37. Measure scoring protocol for significant trend of monthly snow cover		
Brumley	+	Ivanhoe
Number of months with statistically significant trend	+	Number of months with statistically significant trend

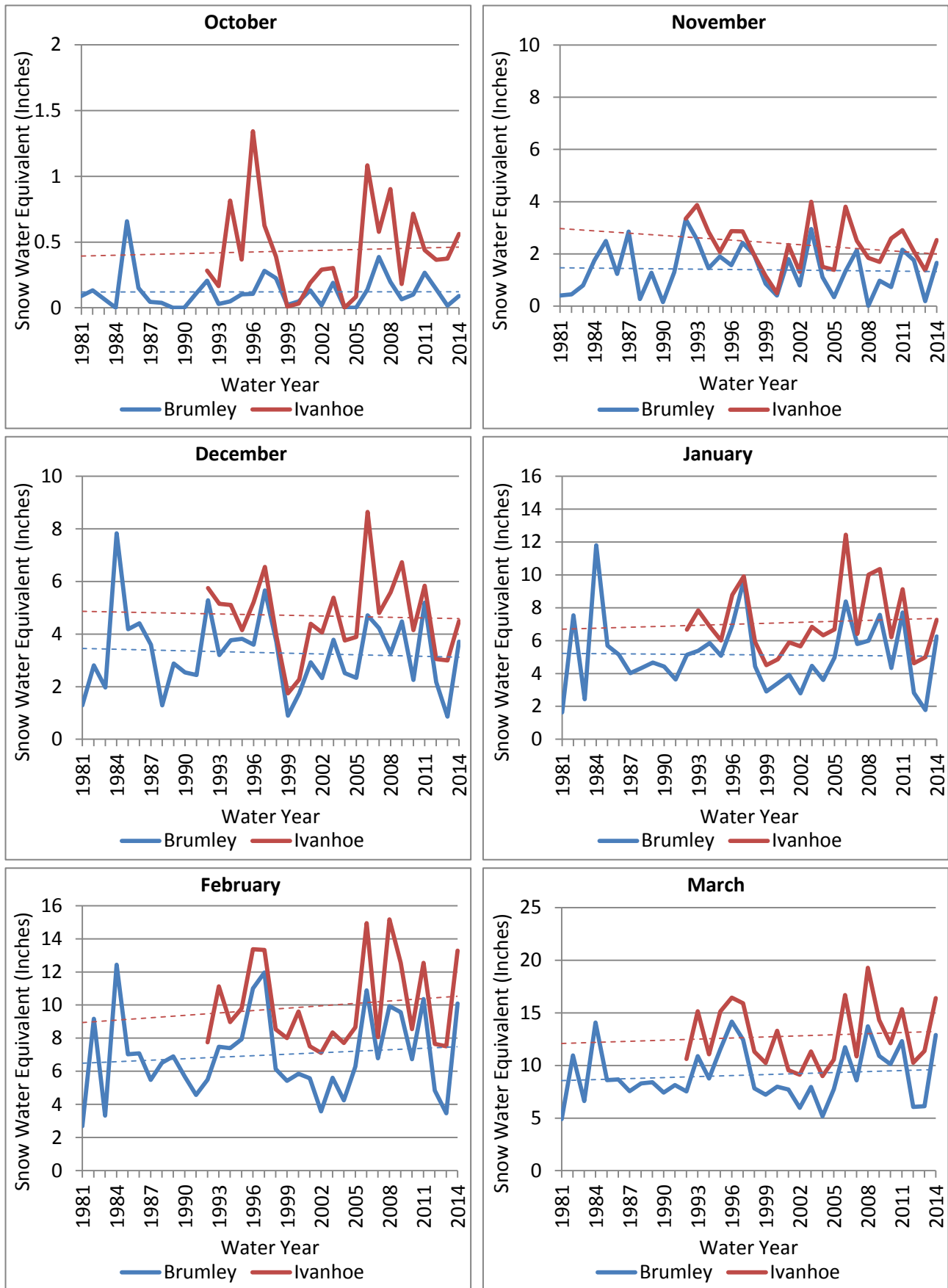


Figure 21. Monthly snow water equivalent: October-March

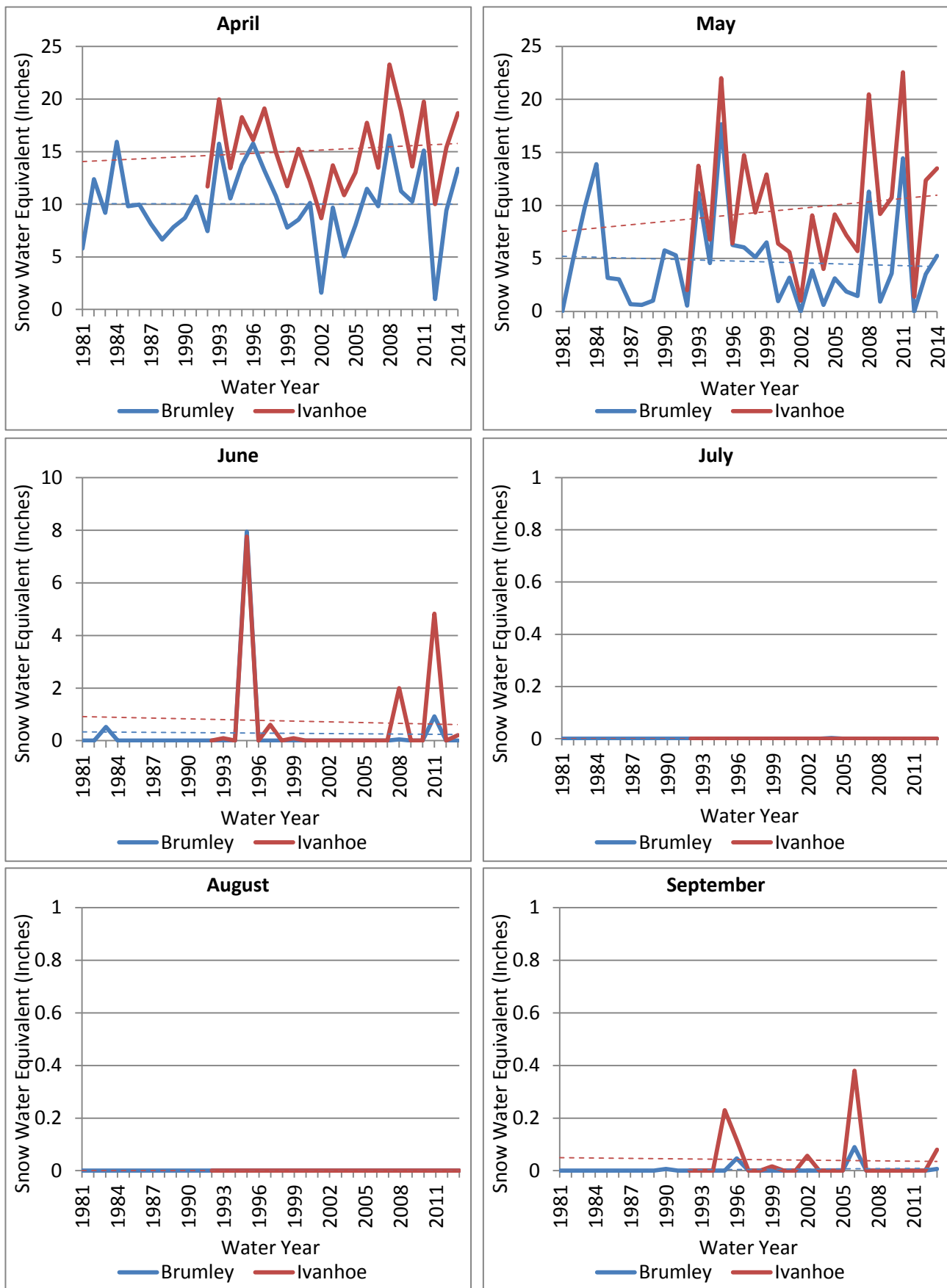


Figure 22. Monthly snow water equivalent: April-September

Average watershed condition class

2014 Data Value: 1.44

Year(s) of Data Collection: 2014

Measure Description and Collection Protocol: The average watershed condition class by acre within wilderness. The watershed condition class is obtained from the Forest Service Watershed Condition Framework data, which describe the condition of watersheds based on 12 different metrics (watershed quality, water quantity, aquatic habitat, aquatic biota, roads and trails, soils, riparian/wetland vegetation, fire regime or wildfire, forest cover, rangeland vegetation, terrestrial invasive species, and forest health). Under this national protocol, watersheds are classified as properly functioning, functioning at risk, or impaired. All acres classified as properly functioning are assigned a value of 1, those that are functioning at risk have a value of 2, and impaired have a value of 3. A decrease in the average value for the wilderness (indicating an improvement of the watershed condition) would result in an upward trend in this measure, and would benefit the Natural Quality.

Background and Context: There are five watersheds in the wilderness: North Fork Lake Creek, Halfmoon Creek, Willow Creek, City of Leadville—Arkansas River, and Turquoise Lake. Water quality is generally considered to be good due to the high elevations.

Definitions: From *Watershed Condition Framework* (USDA Forest Service 2011b)

Properly Functioning: high relative geomorphic, hydrologic, and biotic integrity (1)

Functioning at Risk: moderate relative geomorphic, hydrologic, and biotic integrity (2)

Impaired: low geomorphic, hydrologic, and biotic integrity relative to their natural potential condition (3)

Data Source: Forest Service Watershed Condition Framework Data:

<http://apps.fs.usda.gov/WCFmapviewer/>.

Data Adequacy: High. The Forest Service Watershed Condition Framework is a national dataset that is updated periodically; data quantity is complete and data quality is high.

Frequency: Every five years.

Significant Change: Any; change in this measure value should be interpreted carefully as the majority of the area in most of these watersheds is located outside of the wilderness.

Table 38. Watershed condition class by acre						
Watershed	Wilderness Acreage*	X	Condition Class	=	Acres x condition class	Average score/acre
North Fork Lake Creek	3,331.8	X	2	=	6,663.6	$\frac{38,204.6}{26,455}$ = 1.44
Halfmoon Creek	6,186.2		2		12,372.4	
Willow Creek	13,981.5		1		13,981.5	
City of Leadville—Arkansas River	723.9		1		723.9	
Turquoise Lake	2,231.6		2		4,463.2	
	Sum = 26,455 acres				Sum = 38,204.6	
*These acreage values come from the GIS subwatershed layer (T:\FS\Reference\GIS\r02_psicc\LayerFile\Water\HU12_Subwatershed_Forests.lyr) cropped to the wilderness boundary (T:\FS\NFS\PikeSanIsabel\Program\2300Recreation\GIS\Leadville\Wilderness\Wilderness Boundary.shp). This acreage is ~4,000 acres less than the true wilderness acreage; should the GIS layer be updated at some point in the future, these values should be re-calculated.						

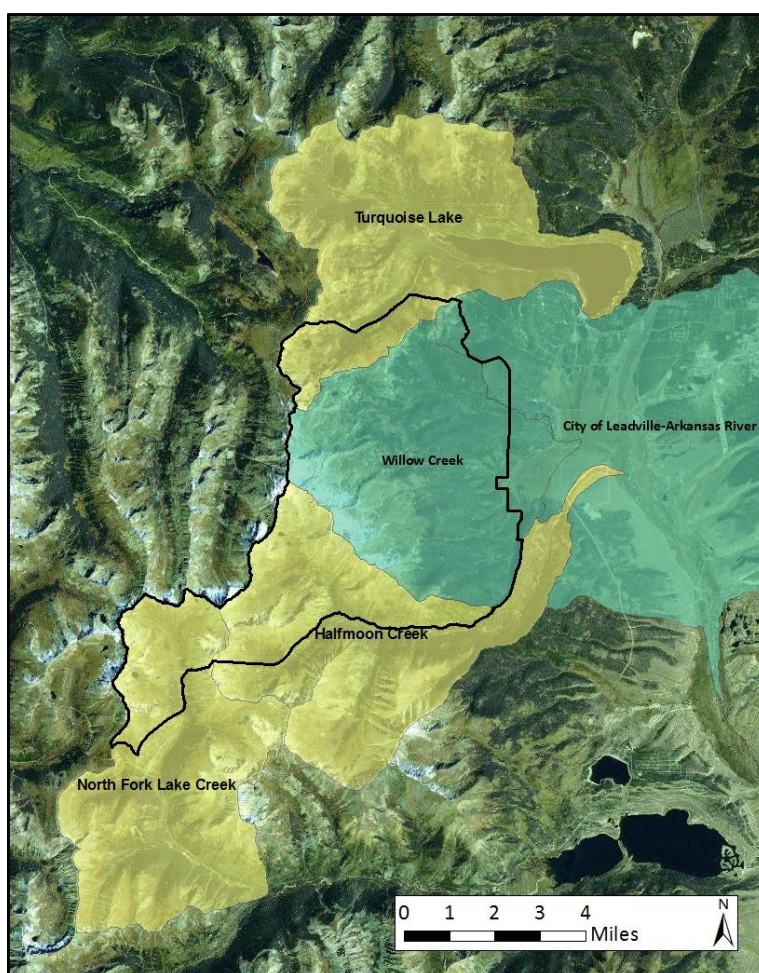


Figure 23. Watershed condition class
 Green watersheds are classified as properly functioning; yellow watersheds are functioning at risk.

Average natural fire regime condition class

2014 Data Value: 2.02

Year(s) of Data Collection: 2014

Measure Description and Collection Protocol: The average LANDFIRE vegetation condition class by acre within wilderness (representing the degree of departure from the historical fire regime). Under this national protocol, three vegetation classes are described, along with additional non-burnable classes. All acres designated as Class I are assigned a value of 1, those that are Class II have a value of 2, and Class III have a value of 3. “Non-burnable” classes are not included in this count; alpine tundra, although it does burn (rarely), is considered “non-burnable” for this measure. (See accompanying document on how to perform the GIS analysis). A decrease in the average natural fire regime condition class (indicating less of a departure from the historical or natural fire regime) would result in an upward trend in this measure, and would benefit the Natural Quality.

Background and Context: Changes to the natural fire regime often result in altered vegetation communities and structure, impacting wildlife and causing variation in the frequency of insect and disease epidemics. The majority of the forested part of the wilderness was logged in the 1800s, which has contributed to the current dominance of lodgepole pines. In contrast to a more historically mixed forest, homogenous stands tend to support larger fires of greater severity.

Definitions: From the Interagency Fire Regime Condition Class (FRCC) Guidebook, Version 3.0 (National Interagency Fuels, Fire, and Vegetation Technology Transfer Team 2010):

Vegetation Condition Class I: ≤33% departure from the reference (i.e. historic) condition; within the reference condition range of variability (1)

Vegetation Condition Class II: >33% and ≤66% departure from the reference condition (2)

Vegetation Condition Class III: >66% departure from the reference condition (3)

Data Source: LANDFIRE Vegetation Condition Class layer: online at <http://www.landfire.gov/index.php>, or on the FS hard drive:

T:\FS\Reference\RSImagery\ProcessedData\wo_nfs_rsac\LANDFIRE\LANDFIRE_Refresh_Nov2012draft\US_110_Mosaic_Refresh\US_110vcc\grid1). The link to the current data on the Forest Service hard drive will not reflect any updates made to this data—the link above provides information on the most recent data.

Data Adequacy: High. LANDFIRE is a national dataset that is updated periodically; data quantity is complete and data quality is high.

Frequency: Every 5 years.

Significant Change: Any change from one category to another (Table 39) is a significant change.

Table 39. Categories for significant change in fire regime condition class

Category	Etc.	Less departure	Baseline	More departure	Etc.
Measure Value	Etc.	1.95-1.99	2.00-2.04	2.05-2.09	Etc.

Table 40. Vegetation condition class by acre						
Vegetation Condition Class*	Count (from the Attribute Table)	X	Score	=	Count x Score	Average Score/ Burnable Acre
I—Low Departure	40,512	X	1	=	40,512	$\frac{451,465}{223,752} = 2.02$
II—Medium Departure	138,767		2		277,534	
III—High Departure	44,473		3		133,419	
	Sum = 223,752				Sum = 451,465	
*Non-burnable areas include the water, snow/ice, urban, barren, and sparsely vegetated classes. Do not include these acres in this measure.						

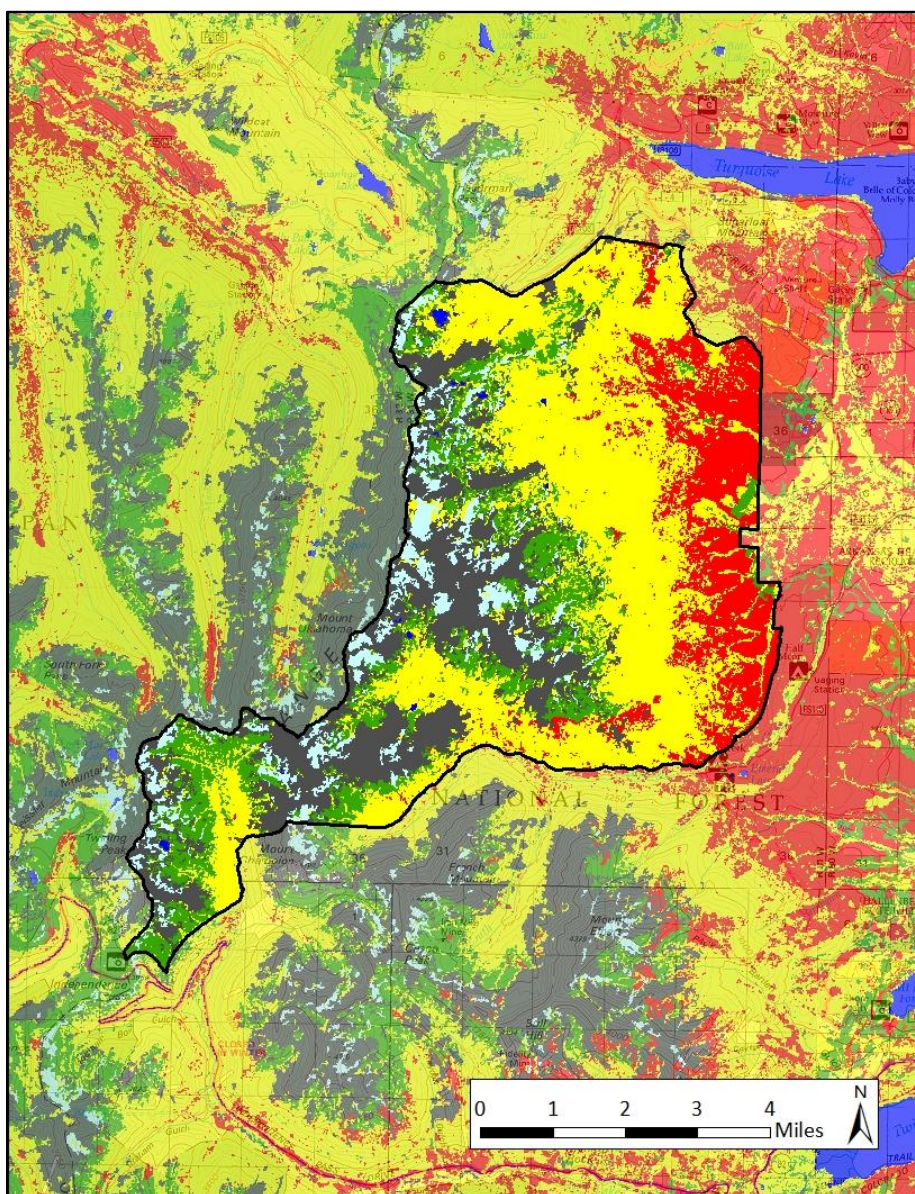


Figure 24. Fire regime condition class

Green pixels represent vegetation condition class 1, yellow pixels represent class 2, and red pixels represent class 3. Grey and blue pixels indicate non-burnable areas.

UNDEVELOPED

Wilderness retains its primeval character and influence, and is essentially without permanent improvement or modern human occupation

The Undeveloped Quality is the most familiar and recognizable quality of wilderness for many people. Without buildings, roads, evidence of other people, or improvements on the landscape, the Undeveloped Quality speaks to the idea that humans are visitors that do not remain. The Wilderness Act of 1964 makes the following allusions to the Undeveloped Quality of wilderness character:

- The National Wilderness Preservation System was created *“in order to assure that an increasing population, accompanied by expanding settlement and growing mechanization, does not occupy all areas within the United States”* (2a);
- Wilderness is *“in contrast with those areas where man and his own works dominate the landscape”* (2c);
- Wilderness should be managed in such a way that *“the imprint of man’s work is substantially unnoticeable”* (2c);
- And that *“there shall be no permanent road within any wilderness area...no temporary road, no use of motor vehicles, motorized equipment or motorboats, no landing of aircraft, no other form of mechanical transport, and no structure or installations within any such area”* (4c).

Table 41. Undeveloped Quality					
Indicator	Measure	Frequency in Years	Data Adequacy	Significant Change	2014 Data Value
Presence of non-recreational structures, installations, and developments	Index of authorized non-recreational physical development	1	High	Any	46
Presence of recreational structures, installations, and developments	Index of authorized recreational physical development	1	High	Any	42
Presence of inholdings	Index of inholdings	5	Medium	Any	6 acres
Use of motor vehicles, motorized equipment, or mechanical transport	Index of administrative authorizations to use motor vehicles, motorized equipment or mechanical transport	1	High	Any	0
	Percent of emergency incidents <i>not</i> using motor vehicles, motorized equipment, or mechanical transport	1	Medium	> 4	100%

Index of authorized non-recreational physical development

2014 Data Value: 46

Year(s) of Data Collection: 2014

Measure Description and Collection Protocol: An index of the quantity and type of non-recreational physical developments, installations, or structures that are currently in the wilderness. Developments, installations, and structures that are cultural sites are also included under this measure; this may include abandoned buildings constructed pre-wilderness designation, but would not include historic trash piles (e.g. cans, etc.) due to their small size and ubiquity across the wilderness.

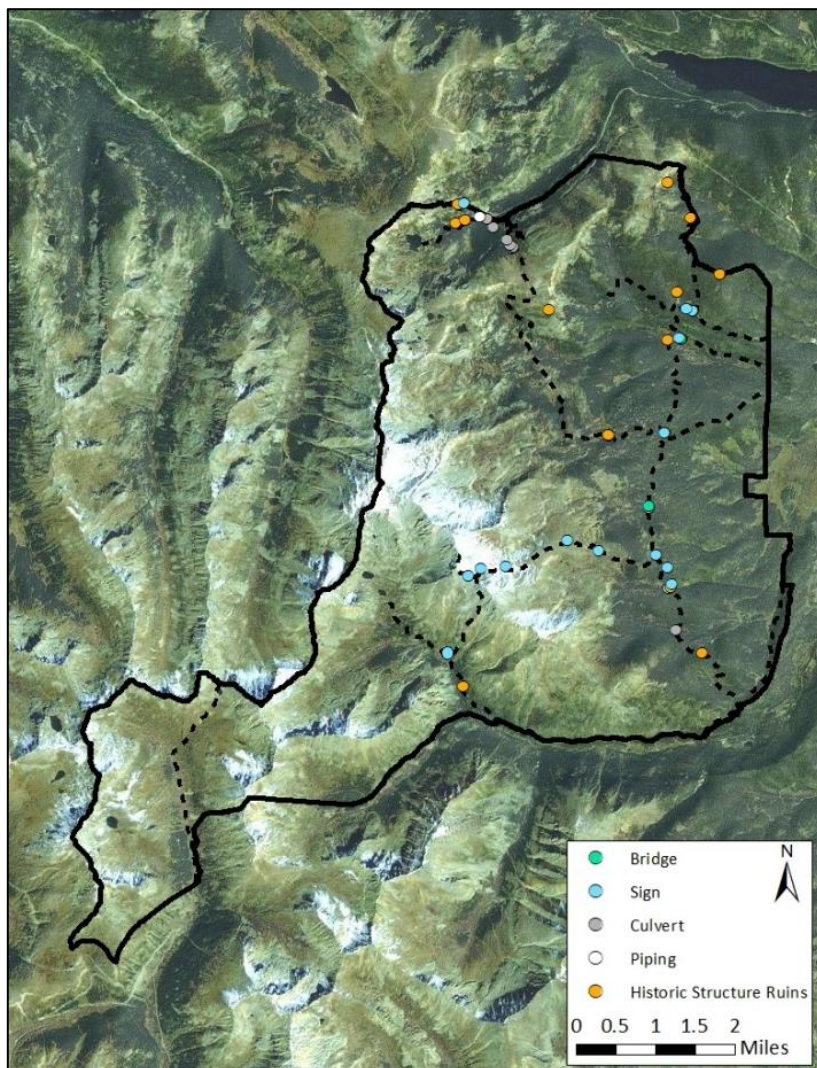


Figure 25. Developments in wilderness

This map includes many of the physical developments in the Mount Massive Wilderness, but is not exhaustive. Non-recreational developments shown here include historical ruins, piping, and some of the culverts; recreational developments include bridges, signs, and the remaining culverts.

Unauthorized developments (e.g. fencing installed inside wilderness by a neighboring private landowner) are not included here as these developments are removed as soon as possible by the Forest Service. The index is adapted from the *Forest Service Technical Guide* (Landres et al. 2009, pp. 138-168) and calculated by taking into account the level of development, physical size, materials used, etc. (Table 43). A decrease in the number of non-recreational physical developments would result in an upward trend in this measure, and would benefit the Undeveloped Quality.

Background and Context: Non-recreational developments counted under this measure include buildings, roads, dams or other water or irrigation developments, pipelines, fences, permanent flagging or other markers (i.e. not temporary flagging, such as for fires), tagged wildlife, research installations, game cameras, mines, etc. Mining was prevalent in the Leadville area, and there are some known non-hazardous prospect sites in the wilderness dating from before its designation. While there has been no active reclamation work

done on these mine sites, it is presumed that they have now been effectively naturally reclaimed and will not be included here. Most of the non-recreational developments currently present in the Mount Massive Wilderness are associated with historical and/or pre-designation sites and infrastructure. The state of Colorado also tags three species of wildlife which then travel to and reside in the wilderness, which are counted under this measure. The Fish and Wildlife Service has also been maintaining three thermographs in the wilderness at Cascade Creek, the inlet to Native Lake, and Elk Creek; this year, however, it was discovered that the thermographs had washed away, and it is unknown whether or not they will be replaced. Because the cables holding the thermographs are still in place, however, they will be counted in the baseline. A potential future source of developments is the proposed lynx regional research project that would also utilize game cameras in wilderness; should this be approved by the regional office, it will be necessary to confirm with the researchers from Colorado Parks and Wildlife on a yearly basis whether or not game cameras have been placed in Mount Massive Wilderness.

Data Source: Steve Sunday, Lead Wilderness Ranger; Brianna Boyd & Jacob Seidel, Wilderness Technicians; Jeni Windorski, Wildlife Biologist; Nick Gerich, Hydrological Technician; Ed Stege, Leadville National Fish Hatchery Project Leader; Jake Ivan, Colorado Parks and Wildlife Wildlife Researcher; USFS abandoned mine inventory.

Data Adequacy: High. Most of the data are commonly known by Forest Service personnel and documented in wilderness open files; the majority of developments were also confirmed by wilderness technicians conducting campsite inventories in Mount Massive Wilderness in 2014. Data quality is high and data quantity is complete.

Frequency: Annually.

Significant Change: Any.

Table 42. Index of authorized non-recreational physical developments						
Category	Development	Number of Developments	Category Weight	Weight of Level of Development		Total Score
				Development	Size/ Materials	
Buildings	Historic cabin foundations/ other dilapidated historic structures/developments	12	2	1	1	24
Dams	Headgates	4	3	1		12
Infrastructure	Historical pipes (Busk Creek) (approximately 5 pipes, 3 of which are in the ground)	1	3	1		3
Other	Culvert (assoc. w/headgate)	1	1	1		1
	Tagged bighorn sheep	1		1		1
	Tagged mule deer	1		1		1
	Tagged elk	1		1		1
	USFWS thermographs and cables (inlet to Native Lake Cascade Creek, & Elk Creek)	3		1		3
Total						46

Table 43. Weighting scheme for authorized non-recreational physical developments							
Category and Inherent Weight		X	Level of Development Multiplied by the Size and/or Materials if Necessary				
Buildings	2		Non-residential or abandoned	1	X	<500 sq. ft. of mostly man-made materials or <1000 sq. ft. of mostly natural materials	1
			Part-time (seasonal) residential	2		500-1000 sq. ft. of mostly man-made materials or ≥1000 sq. ft. of mostly natural materials	2
			Full-time (year-round) residential	3		≥1000 sq. ft. of mostly man-made materials	3
Dams	3		Dams not meeting National Inventory of Dams (NID) criteria (height less than 6 ft. or a maximum storage of less than 15 acre-ft.), or other instream features				1
			Dams meeting NID criteria (height at least 6 ft. and a maximum storage of at least 15 acre-ft.) made of native materials				2
			Dams meeting NID criteria (height at least 6 ft. and a maximum storage of at least 15 acre-ft.) made of non-native materials				3
Roads	3	X	Non-system roads, decommissioned roads, and existing system roads with level 1 operational maintenance	1	X	Road length less than ¼ mile	1
			Existing system roads with level 2 operational maintenance	2		Road length between ¼-1 mile	2
			Existing system roads with level 3+ operational maintenance	3		Road length more than 1 mile	3
Infrastructure (permanent utility lines, pipes, etc.)	3		Small scale (individual site less than 1 acre)				1
			Moderate scale (individual site bigger than 1 acre, or corridor 1 mile or less)				2
			Large scale (corridor longer than 1 mile)				3
Mines	3		Inactive				1
			Active and the disturbed area is less than 1 acre				2
			Active and the disturbed area is more than 1 acre				3
Other (culverts, fences, tagged wildlife...)	1		Small scale (individual or multiple sites that total less than 1 acre)				1
			Moderate scale (site(s) bigger than 1 acre, or corridor 1 mile or less)				2
			Large scale (corridor longer than 1 mile)				3

Index of authorized recreational physical development

2014 Data Value: 42

Year(s) of Data Collection: 2014

Measure Description and Collection Protocol: An index of the quantity and type of recreational physical developments, installations, or structures that are currently in the wilderness. Unauthorized structures (e.g. hunting structures, wickiups, etc.) are not included here as the Forest Service removes this type of development as soon as it is encountered. Plastic or metal blazes installed by entities other than the Forest Service or Fish and Wildlife Service (e.g. for the Colorado Trail or Continental Divide National Scenic Trail) are not included here as these are also removed as soon as possible; historical blazes installed pre-wilderness designation are also not included as they are, for the most part, grown into trees and impossible to remove. The index is adapted from the *Forest Service Technical Guide* (Landres et al. 2009, pp. 138-168) and calculated by taking into account the level of development, physical size, materials used, etc. (Table 45). A decrease in the number of recreational physical developments would result in an upward trend in this measure, and would benefit the Undeveloped Quality.

Background and Context: Recreation infrastructure is the most common type of development in wilderness. This measure tracks the impacts of recreation installations as permanent developments in wilderness; the impact of this infrastructure on self-reliant recreation is tracked under the Solitude or Primitive and Unconfined Recreation Quality. While in many cases the same infrastructure will be counted under both measures, not all recreation facilities are developments, and not all recreation developments are facilities. For example, plastic trail markers are both a development and a facility that decreases self-reliant recreation, but blazes cut into trees are only considered a facility, not a development; on the other hand, culverts under trails are recreational developments, but they are not considered facilities that decrease self-reliant recreation. Recreational infrastructure includes designated trails, bridges or water crossings, culverts, and signs or trail markers. Signs are counted per post, not per sign board (e.g. one sign post with a sign pointing towards the Colorado Trail and a sign pointing towards the Highline Trail still counts as one sign). Rock stairs are not included in this measure as these are considered a normal part of trail construction on steep, rocky/talus slopes (i.e. they are inherently counted as part of the trail and are not considered to be a separate feature).

Data Source: Steve Sunday, Lead Wilderness Ranger; Brianna Boyd & Jacob Seidel, Wilderness Technicians; Loretta McElhiney, Peak Manager; Adam Brown, Trails.

Data Adequacy: High. Most of the data are commonly known by Forest Service personnel and documented in wilderness open files; the majority of developments were also confirmed by wilderness technicians conducting campsite inventories in Mount Massive Wilderness in 2014. Data quality is high and data quantity is complete.

Frequency: Annually.

Significant Change: Any.

Table 44. Index of authorized recreational physical developments						
Category	Development	Number of Developments	Category Weight	Weight of Level of Development		Total Score
				Development	Size/ Materials	
Trails & Trail Features	Simple trails—9.01 miles	---	1	2	1	2
	Developed trails—29.53 miles	---		3	3	9
	Bridge over N. Willow on CT	1		2		2
	Rock Creek Bridge	1		2		2
Other	Culverts (assoc. w/trails)	7	1	1		7
	Rebar at old bridge sites	2		1		2
	Directional signs	10		1		10
	Restoration signs	7		1		7
	Plastic blazes—3.46 miles	---		1		1
Total						42

Table 45. Weighting scheme for authorized recreational physical developments							
Category and Inherent Weight		X	Level of Development Multiplied by the Size and/or Materials if Necessary				
Trails & Trail Features (major constructions, e.g. bridges, docks, boardwalks, stairways, etc.)	1	X	Primitive (trail class of 1)	1	X	Total trail length divided by 10 and rounded <i>up</i> to the nearest whole number (e.g. 3.46 miles=1)	
			Simple (trail class of 2)	2			
			Developed (trail class 3-5)	3			
			Primitive (native materials, e.g. log bridge)				1
			Developed (native materials processed to form dimensional materials, e.g. boards or stone hauled in)				2
			Constructed (non-native materials, e.g. bridge with steel supports)				3
Developed campsites (not including user-created sites)	1		Light impact (impact rating 1-3)				1
			Moderate impact (impact rating 4-6)				2
			Severe impact (impact rating 7-8)				3
Recreation-associated buildings	2		Non-residential or abandoned	1	X	<500 sq. ft. of mostly man-made materials or <1000 sq. ft. of mostly natural materials	1
			Part-time (seasonal) residential	2		500-1000 sq. ft. of mostly man-made materials or ≥1000 sq. ft. of mostly natural materials	2
			Full-time (year-round) residential	3		≥1000 sq. ft. of mostly man-made materials	3
Other (culverts, signs, fixed anchors...)	1		Small scale (individual or multiple sites that total less than 1 acre)				1
			Moderate scale (site(s) bigger than 1 acre, or corridor 1 mile or less)				2
			Large scale (corridor longer than 1 mile)				3
			Metal/plastic blazes: 1 x the total miles of trail with blazes divided by 10 and rounded <i>up</i> to the nearest whole number (e.g. 3.46 miles = 1)				

Index of inholdings

2014 Data Value: 6 acres

Year(s) of Data Collection: 2014

Measure Description and Collection Protocol: The acres of privately owned inholdings in wilderness. Private land on the border of wilderness (i.e. inholdings that are half in wilderness and half outside such that the wilderness boundary crosses the property line) are included under this measure. Inholdings purchased by organizations that intend to eventually transfer the land to the Forest Service or Fish and Wildlife Service (e.g. the Wilderness Land Trust) and that are held to the same standards of protection as wilderness are not included under this measure. Acreages are calculated from GIS data and rounded to the nearest whole number. A decrease in the acres of inholdings within the wilderness would result in an upward trend in this measure, and would benefit the Undeveloped Quality.

Background and Context: In general, inholdings in wilderness are extremely vulnerable to development that would likely have an adverse effect on the surrounding wilderness values. While some inholdings have been acquired by wilderness-friendly organizations with no plans to develop, these tend to be in the minority. At this time, the Wilderness Land Trust—a non-profit organization dedicated to purchasing inholdings in wilderness to ensure their preservation—has purchased and transferred 38 acres of inholdings in Mount Massive Wilderness to the Forest Service, and has purchased and still owns an additional 20.66 acres. It is assumed (based on GIS acreage calculations) that the 38 acres already transferred pertained to the former mine claim near North Halfmoon Lakes and that the 20.66 acres that remain protected in their custody pertain to the former mine claim near Blue Lake (Figure 25). There are two other properties that are considered inholdings—one near Lost Man Lake that is also in the Hunter-Fryingpan Wilderness, and one at the southern tip of the wilderness near Independence Pass. Although these lands are not completely surrounded by Mount Massive Wilderness, the wilderness boundary passes through them (instead of going around them) and therefore will still be included in this measure. The fact that the western-most of these is completely surrounded by wilderness also speaks to the necessity of its inclusion in this measure. Acres of inholdings and their protection status are given in Table 46.

Data Source: Wilderness Land Trust (<http://www.wildernesslandtrust.org/protected/colorado/>); USFS Land Status and Encumbrance Viewer (http://apps.fs.fed.us/fswebmapviewer/index.html?config=fsweb-config/ALP_StatusAndEncumbrance.xml); Forest Service GIS data (T:\FS\NFS\PikeSanIsabel\Program\7700TransportationSystem\GIS\SO\Lands - PSICC\PSICC_Lands20120213.mdb\PSICCLands20120213_Multipart); open wilderness files.

Data Adequacy: Medium. Although no purchase records or other documentation was found to definitively verify the status of inholdings in the wilderness, enough data was gathered from other sources to have a fairly high confidence in the determinations made. Overall, data quantity is partial, and data quality is moderate.

Frequency: Every five years.

Significant Change: Any.

Table 46. Inholdings and their protection status		
Inholdings	Acres	Protection Status
Northeast of Blue Lake (Sec. 33 & 34, T10S, R82W)	21 acres	Owned by the Wilderness Land Trust—protected
East of Lost Man Lake on the border of the Hunter-Fryingpan Wilderness (Sec. 28, T10S, R82W)	4 acres within wilderness	Privately owned—not protected
North of Independence Pass at the southern tip of the wilderness (Sec. 9, T11S, R82W)	2 acres within wilderness	Privately owned—not protected

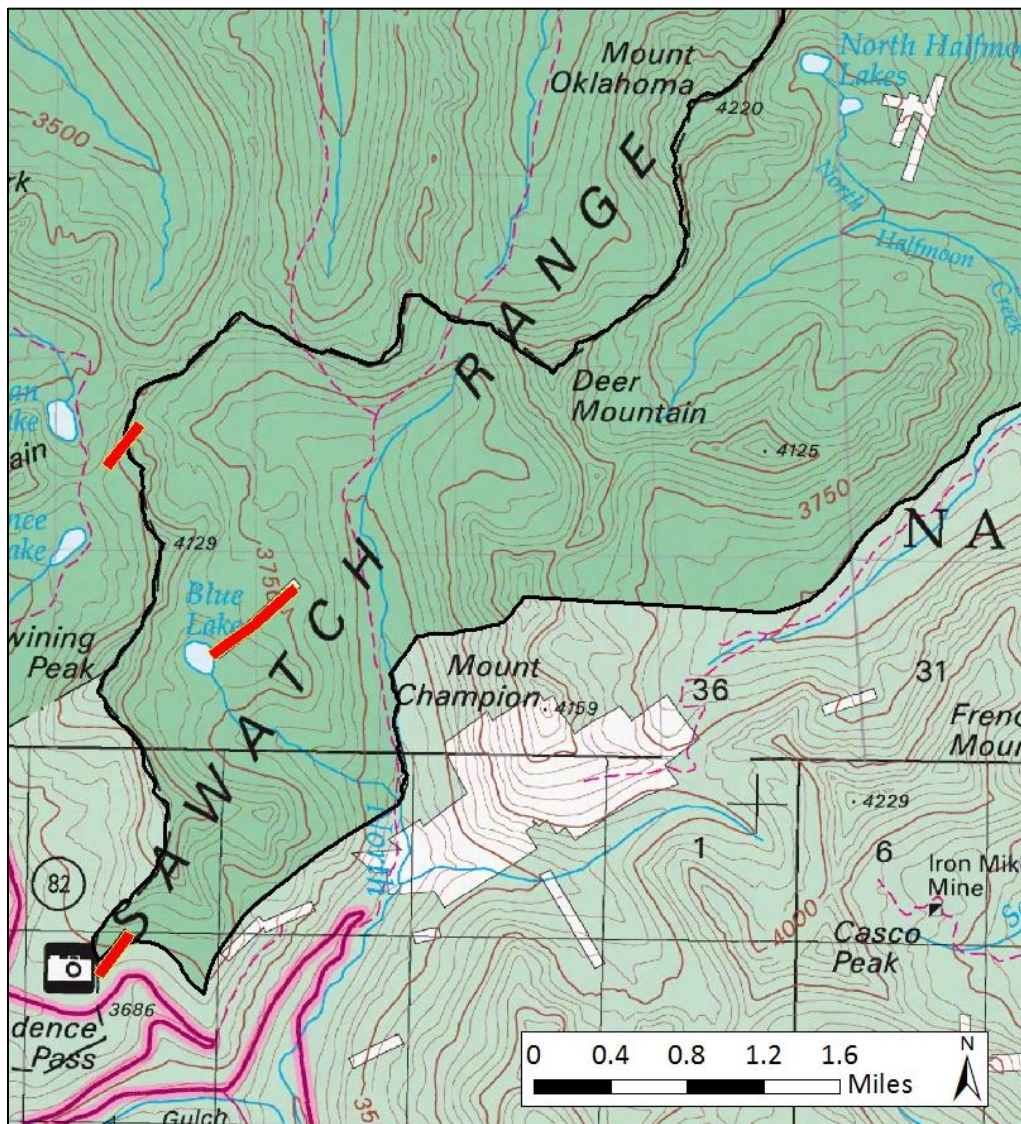


Figure 26. Wilderness inholdings

The northeast-most inholding (in white) was purchased and transferred to the Forest Service by the Wilderness Land Trust (the shape of this former inholding on this map may or may not be accurate). The largest red inholding (near Blue Lake) is the mine site that is still in the ownership of the Wilderness Land Trust. The other two smaller red inholdings are those on the boundary of wilderness that are still under private control; these are also likely to be mine claims.

Index of administrative authorizations to use motor vehicles, motorized equipment, or mechanical transport

2014 Data Value: 0

Year(s) of Data Collection: 2014 (fiscal year)

Measure Description and Collection Protocol: An index of authorized uses of motorized equipment or mechanical transport for administrative purposes. The index is adapted from the *Forest Service Technical Guide* (Landres et al. 2009, p. 170) and calculated by multiplying the inherent weight of the equipment (Table 48) by the number of pieces of equipment and the number of days for which they were used to get a score for each use. These are added together for the fiscal year to attain the measure value (a hypothetical example is shown in Table 47). A decrease in the number of administrative authorizations for the use of motor vehicles, motorized equipment, and/or mechanical transport would result in an upward trend in this measure, and would benefit the Undeveloped Quality.

Background and Context: There is typically more discretion in administrative authorizations to use motorized equipment or mechanical transport (as compared to emergency authorizations), and minimum requirements analyses limit unnecessary use. At this time, there are very few instances of administrative authorizations for prohibited uses in the wilderness. In the past, the Leadville National Fish Hatchery has used battery-powered backpack electrofishing equipment to survey Cascade Creek—this is considered administrative motorized use and should be counted if it occurs again in the future. Electrofishing performed by the state of Colorado is not included in this measure as it is considered unauthorized use, and not administrative.

Data Source: Steve Sunday, Lead Wilderness Ranger; Ed Stege, Leadville National Fish Hatchery Project Manager.

Data Adequacy: High. Any administrative authorizations for motorized or mechanical use are generally well documented through a minimum requirements analysis. Data quantity is complete and data quality is high.

Frequency: Annually.

Significant Change: Any.

Table 47. Hypothetical example of scoring administrative use

Situation	Equipment	Inherent weight	X	Pieces of equipment	X	Days used	=	Total
Electrofishing to survey stream	Battery-powered electrofishing equipment	1 (battery-powered tool)	X	3	X	1	=	3

Table 48. Inherent weights of various types of motorized and mechanical use				
Weight	Examples			
1	Battery-powered tool	Bicycle	Wheelbarrow	Wheeled litter
2	Air compressor	Generator	Motorized winch	Portable pump
3	Air tanker ATV Chainsaw	Concrete equipment Fixed-wing aircraft Float plane	Helicopter Motorcycle Motorized watercraft	Rock drill Snowmachine Truck
4	Heavy Equipment			

***Percent of emergency incidents not using motor vehicles, motorized equipment, or
mechanical transport*****2014 Data Value:** 100%**Year(s) of Data Collection:** 2014 (fiscal year)

Measure Description and Collection Protocol: The percent of emergency incidents in a fiscal year that do not use motor vehicles, motorized equipment, or mechanical transport. Emergency incidents include search and rescue (SAR), law enforcement, and fire suppression events, as well as aircraft crashes. Years for which there are no emergency incidents will be assigned a measure value of 100%. A decrease in the percent of emergency incidences using motorized equipment or mechanical transport would result in an upward trend in this measure, and would benefit the Undeveloped Quality.

Background and Context: Concerns about public health and safety in response to emergency requests often justify exemptions to the prohibition against use of motor vehicles, motorized equipment, or mechanical transport. In comparison to administrative uses of motorized equipment or mechanical transport, there is typically less discretion in the authorization for emergency purposes; while protecting human health and safety is non-negotiable, wilderness character should be preserved whenever feasible in emergency situations. Trends in this measure over time may be due to factors outside of agency control.

Data Source: Steve Sunday, Lead Wilderness Ranger.

Data Adequacy: Medium. Most of the data on fire suppression events, law enforcement activity, and aircraft crashes are, in general, well known and documented in open wilderness or fire files. Data quality is high and data quantity is complete for these types of emergency incidents. SAR events, however, are carried out by Lake County and not the Forest Service; although Lake County is supposed to inform the Forest Service or Fish and Wildlife Service of any SAR events on federal land, there is frequently a lack of communication between these agencies. For this type of emergency incident, therefore, data quality is moderate but data quantity is insufficient. Overall, data quantity is partial and data quality is moderate.

Frequency: Annually.

Significant Change: Any change from one category to another (Table 49) is a significant change.

Table 49. Categories for significant change in emergency motorized/mechanical use				
Category	Good	Caution	Poor	Etc.
Measure Value	0-4	5-9	10-14	Etc.

Table 50. Hypothetical example of scoring emergency use			
Year	Wilderness Situation	Motor vehicles, motorized equipment, or mechanical transport used?	Percent “No”
2014	Fire suppression—Blue Lake Fire	Yes	40%
	SAR—lost hiker	No	
	SAR—broken ribs	Yes	
	SAR—plane crash	Yes	
	SAR—sprained ankle	No	

SOLITUDE OR PRIMITIVE AND UNCONFINED RECREATION

Wilderness provides outstanding opportunities for solitude or primitive and unconfined recreation.

As populations increase and technology advances, wilderness provides opportunities for solitude and for a primitive or unconfined type of recreation that are not available in many other places. Wilderness is unique in that its managers are mandated to provide outstanding opportunities for a specific type of recreational experience. Although managers cannot guarantee or require that visitors experience solitude or primitive and unconfined recreation, they must protect and uphold the *opportunity* to have said experiences. The Solitude or Primitive and Unconfined Recreation quality focuses on the tangible aspects of the setting that affect the visitor experience, and not on the subjective nature of the visitor experience itself. There are many intangible aspects of wilderness recreation (challenge, self-reliance, self-discovery, etc.) that are not included under this quality but that are still integral to the wilderness experience.

Table 51. Solitude or Primitive and Unconfined Recreation Quality

Indicator	Measure	Frequency in Years	Data Adequacy	Significant Change	2014 Data Value
Remoteness from sights and sounds of people inside of wilderness	Travel route encounters	1	Low	> 5	5 people/day
	Visitation	1	Medium	< 6,000 or ≥ 7,500	6,113 visitors
	Area of wilderness away from access and travel routes and developments	5	High	Any	67.54%
	User-created campsites	5	High	< 340 or ≥ 360	364
	Miles of user-created trails	5	Medium	< 11 or > 20	36 miles
	Commercial use	5	High	< 1,600 or ≥ 1,700	1,657 days/year
Remoteness from sights and sounds of people outside of wilderness	Area of wilderness not affected by adjacent travel routes and developments	5	High	Any	93.94%
Facilities that decrease self-reliant recreation	Index of authorized recreation facilities	5	High	Any	42
	Miles of developed trails	5	High	Any	29.53 miles
Management restrictions on visitor behavior	Index of visitor management restrictions	5	High	Any	22

Travel route encounters

2014 Data Value: 5 people per day

Year(s) of Data Collection: 2013 (fiscal year)

Measure Description and Collection Protocol: The average number of visitors or groups encountered by wilderness rangers on established trails in the wilderness per day during the primary use season (May through September). This measure is intended to examine the number of other people a wilderness visitor is likely to see while traveling; therefore, days in which wilderness rangers are mostly stationary (e.g. to do a compliance survey on Mount Massive, to eliminate a user-created cabin, etc.), or are driving from trailhead to trailhead to pick up permits, are not counted. Days in which wilderness rangers were traveling in the wilderness but counted zero contacts are still included in the average. The number of contacts made is divided by the number of ranger-days traveling in wilderness to attain the average contacts per day. This is then rounded to the nearest whole number. A decrease in the average number of encounters per day would result in an upward trend in this measure, and would benefit the solitude aspect of this quality.

Background and Context: Opportunities to experience solitude are dependent on the absence of other people, particularly those outside one's immediate group; the number of other visitors encountered has a large impact on an individual's perception of solitude. The management prescriptions for the eastern side of Mount Massive call for fewer than 20 encounters with other parties per day, while prescriptions for the western side call for fewer than 6 encounters (USDA Forest Service 1988). The data adequacy of this measure will vary based on the number of wilderness personnel. At this time, the number of ranger-days in Mount Massive Wilderness is very low due to funding limitations resulting in a general lack of seasonal wilderness employees. The legacy data from 2006-2013 (Figure 26) is not considered to be accurate: stationary days and permit collection days are both included in these counts, all 2012 data is missing, and while 2009 and 2010 did have more than 20 ranger-days in wilderness, 2008 and 2013 each had less than 10 ranger-days. It is generally assumed that, if consistent data could be collected throughout the primary use season, the average number of visitor contacts per day would be considerably higher than indicated in recent years.

Data Source: Wilderness Ranger Reports.

Data Adequacy: Low. Due to the sampling nature of the data, data quality is moderate and data quantity is not complete. When the number of ranger-days traveling in wilderness is below 20, data quantity is insufficient; for numbers above 21, data quantity is partial. At this time, data quantity is insufficient.

Frequency: Annually.

Significant Change: Any change from one category to another (Table 52) is a significant change.

Table 52. Categories for significant change for visitor encounters					
Category	Excellent	Good	Caution	Poor	Etc.
Measure Value	0-10	11-20	21-30	31-40	Etc.

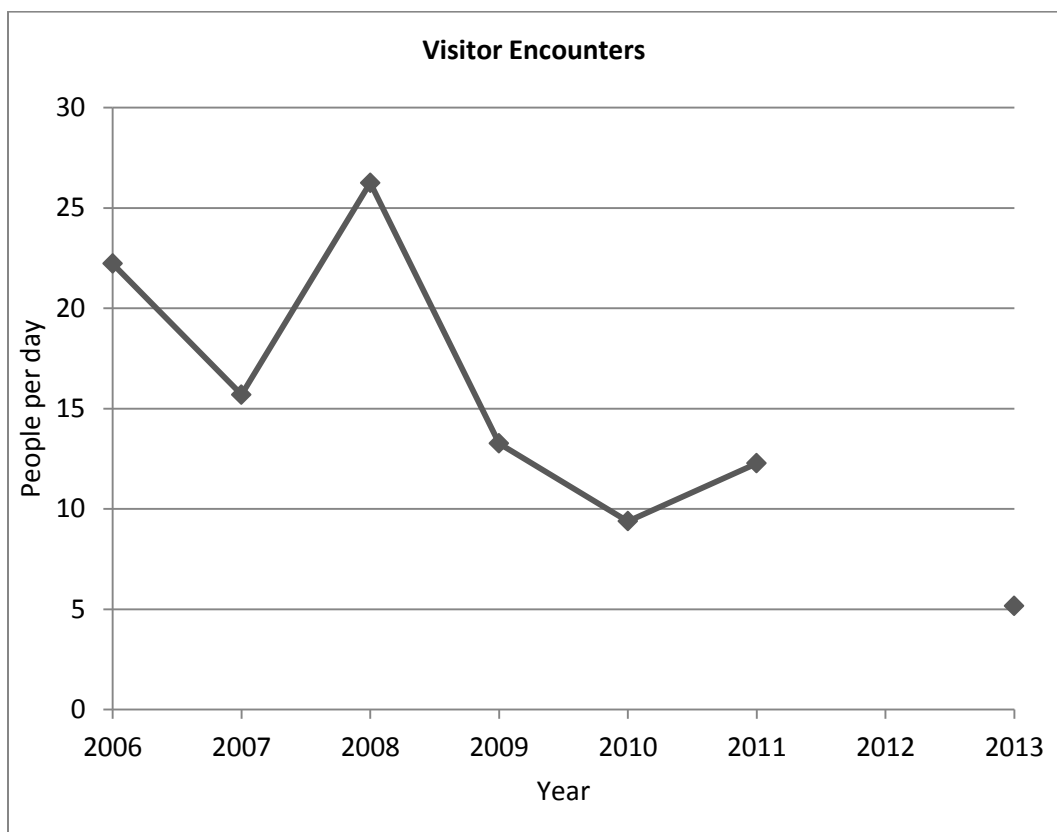


Figure 27. Visitor encounters 2006-2013

This data is generally considered to be inaccurate due to issues in data adequacy.



Figure 28. Visitors on the summit of Mount Massive

Photo by Emily Kuhs, August 2, 2014. At least 22 people are visible in this photograph.

Visitation

2014 Data Value: 6,113 visitors

Year(s) of Data Collection: 2013 (calendar year)

Measure Description and Collection Protocol: The number of visitors entering the wilderness during the calendar year. Data come from the required wilderness permits; permits missing information are still included in this count (e.g. a permit that failed to report the number of people is still counted as representing one visitor). A decrease in the total number of visitors would result in an upward trend in this measure, and would benefit the solitude aspect of this quality.

Background and Context: The number of visitors entering the wilderness relates to the number of encounters a visitor may have; the higher the levels of visitation, the more likely it will be to encounter many other visitors and be denied opportunities for solitude. A Recreation Capacity Analysis Summary (USDA Forest Service 1995) found that the maximum capacity for visitation in the Mount Massive Wilderness during the primary use season is 14,150 visitors (not including the lands belonging to the Leadville National Fish Hatchery). In actuality, a concentration of use on the summit trails means that even current visitation levels—well below the maximum capacity—can result in the management prescriptions for visitor encounters being exceeded. This measure therefore serves as a supplement to the “travel route encounters” measure in monitoring opportunities for solitude. While the data adequacy of both of these measures is not ideal, by including both permit data (visitation) and public contact data (encounters) a relatively complete assessment of the number of people in the wilderness will hopefully emerge. While no compliance surveys have been conducted recently, past surveys in 2007 and 2008 showed 70% and 87% compliance in filling out the required wilderness permits respectively. More recently, decreases in seasonal personnel have resulted in reduced enforcement, suggesting that current compliance would be much less than observed in 2008. Earlier surveys in 2005 and 2006 also revealed that permit compliance is lowest on days with the most use. In addition, public contacts with outfitters and guides have shown that these groups often fail to provide visitation data as they believe their special use permit exempts them from filling out a wilderness permit at the trailhead.

Data Source: Required wilderness permits. Each year, the hard data from collected permits are entered into an excel file by Steve Sunday, Lead Wilderness Ranger; these excel files are then stored on the annual wilderness flash drive. The summaries of these data can be found in the excel files themselves, in annual wilderness summary reports, and in other documents in the wilderness open files. For all years except 2013 (for which the only number reported is a calculation from the annual excel file), there are variations in the summary numbers reported in these documents. Figure 28 shows numbers re-calculated from the hard data in the annual excel files, while Figure 29 shows differences between the highest numbers reported and the re-calculated data. Legacy data entered into the Wilderness Character Monitoring Database uses the re-calculated numbers from the annual excel files.

Data Adequacy: Medium. Due to the mediocre visitor compliance in filling out wilderness permits, data quantity is partial and data quality is high.

Frequency: Annually.

Significant Change: Any change from one category to another (Table 53) is a significant change.

Table 53. Categories for significant change for visitation							
Category	Excellent	Good	Okay	Caution	Poor	Very Poor	Etc.
Measure Value	< 3,000	3,000-5,999	6,000-8,999	9,000-11,999	12,000-14,999	15,000-17,999	Etc.

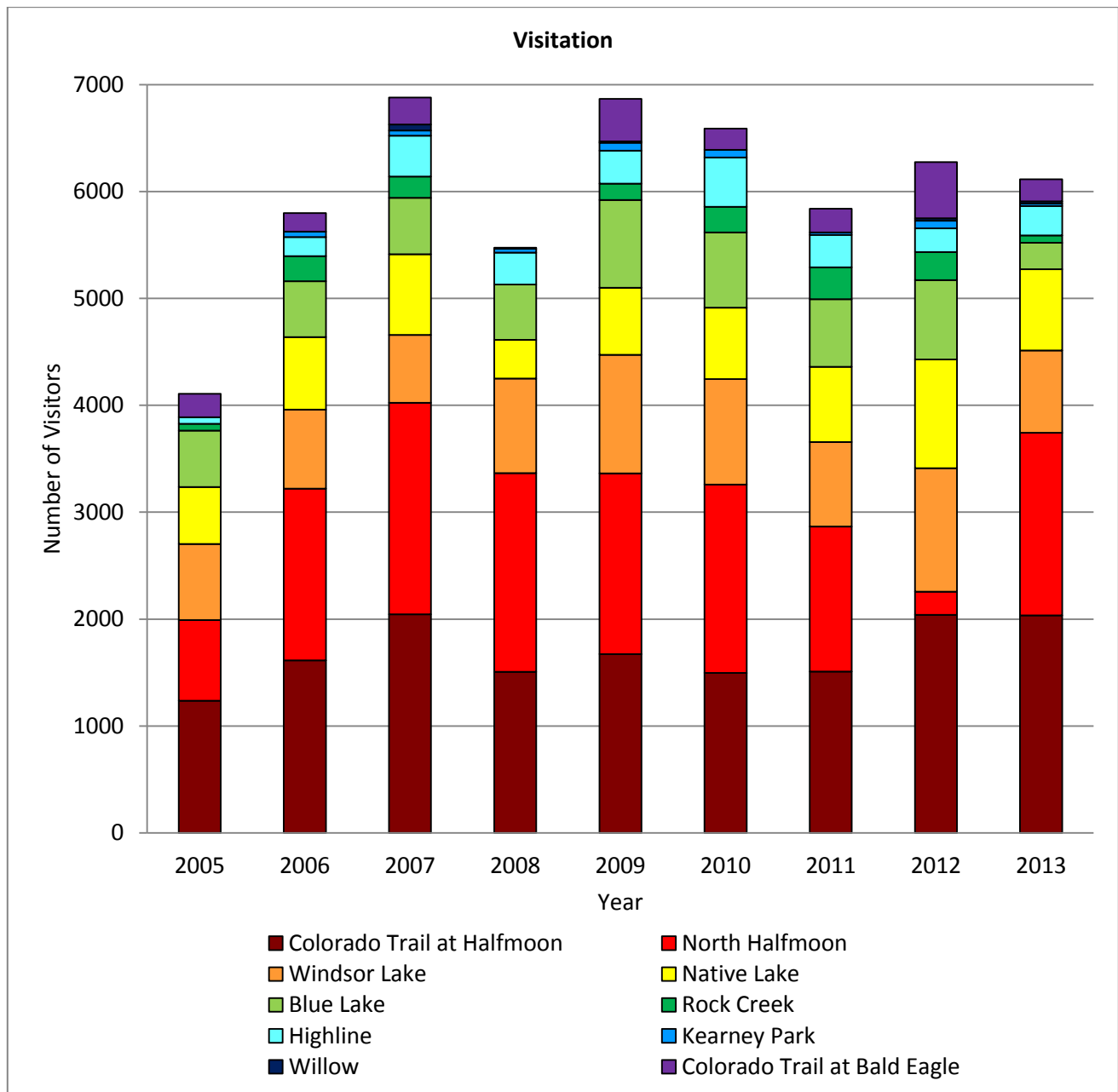


Figure 29. Annual visitation

Numbers are re-calculated from hard data in the annual excel files. All permit data are known to be incomplete for the Colorado Trail at Bald Eagle for 2010 and for the Highline Trail for 2011.

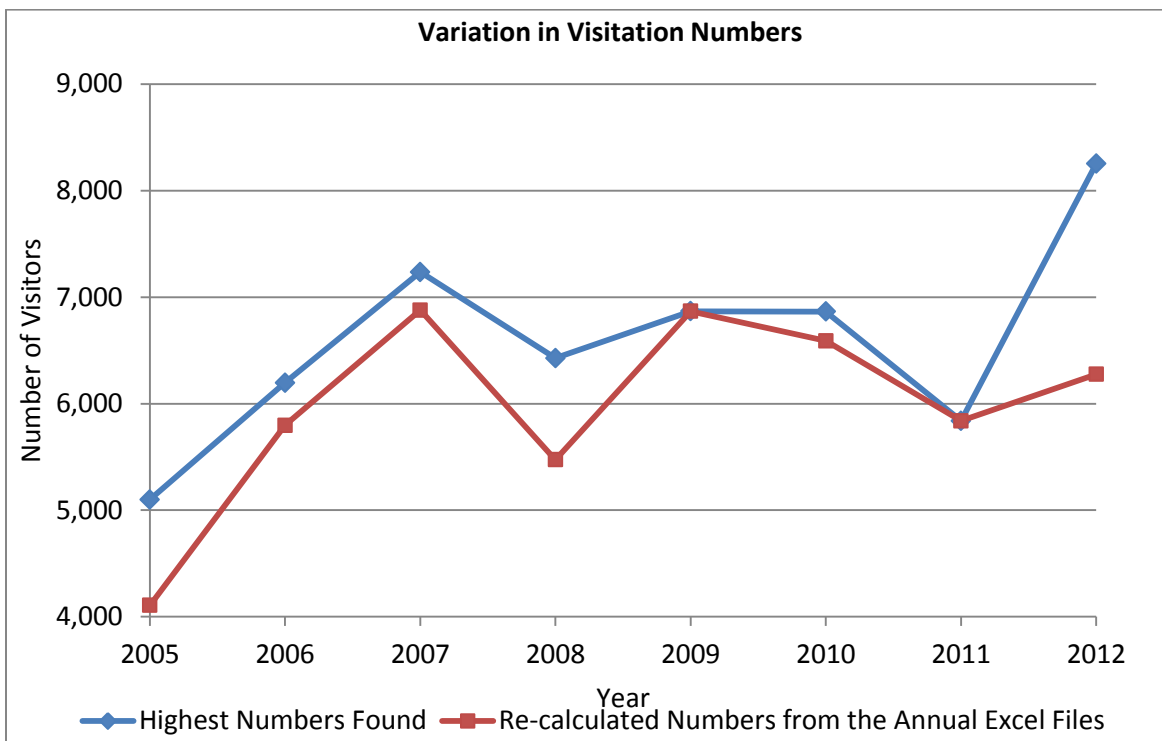


Figure 30. Variation in reported visitation numbers

2009 and 2011 have a negligible amount of data variation. All permit data are known to be incomplete for the Colorado Trail at Bald Eagle for 2010 and for the Highline Trail for 2011.

Area of wilderness away from access and travel routes and developments**2014 Data Value:** 67.54%**Year(s) of Data Collection:** 2014

Measure Description and Collection Protocol: The percent of wilderness located away from access points, travel routes, and developments that are located within or on the boundary of wilderness. This does not include air travel routes. Abandoned structures and historical sites (e.g. abandoned mines, cabins, etc.) are not included under this measure. All designated wilderness trails (system trails) are buffered by ¼ mile before being counted. User-created trails are not included under this measure as their impact is counted separately under the “miles of user-created trails” measure. The Colorado Midland Centennial (the loop trail north of Windsor Trail) also is not counted in this measure—although it is technically a system trail, the small portion of the trail in the wilderness is not being actively maintained at this time, nor is the wilderness mileage included in INFRA. (See accompanying document on how to perform the GIS analysis). An increase in the percentage of wilderness away from these features (due to trail closures or an increase in total wilderness acres) would result in an upward trend in this measure, and would benefit the solitude aspect of this quality.

Background and Context: Most wilderness use is concentrated within a few miles of trails. The Colorado Trail and the two trails to the summit of Mount Massive are some of the most popular trails in the wilderness. Traveling on the heavily trafficked designated trail system offers reduced opportunities for solitude in comparison to wilderness acres without access or travel routes. A percentage was used for this measure instead of acreage due to the fact that the area of the wilderness polygon used to both calculate the wilderness area and to clip the buffered trails layer (T:\FS\NFS\PikeSanIsabel\Program\2300Recreation\GIS\Leadville\Wilderness\Wilderness Boundary.shp) is incorrect by more than 4,000 acres.

Data Source: Forest Service GIS data

(T:\FS\NFS\PikeSanIsabel\Program\7700TransportationSystem\GIS\SO\SDE
Data\RoutedTrailsRev20091020\RoutedTrailsRev20091020.shp).

Data Adequacy: High. The Forest Service maintains fairly accurate GIS data on their trail systems; therefore data quality is high and data quantity is complete.

Frequency: Every five years.

Significant Change: Any.

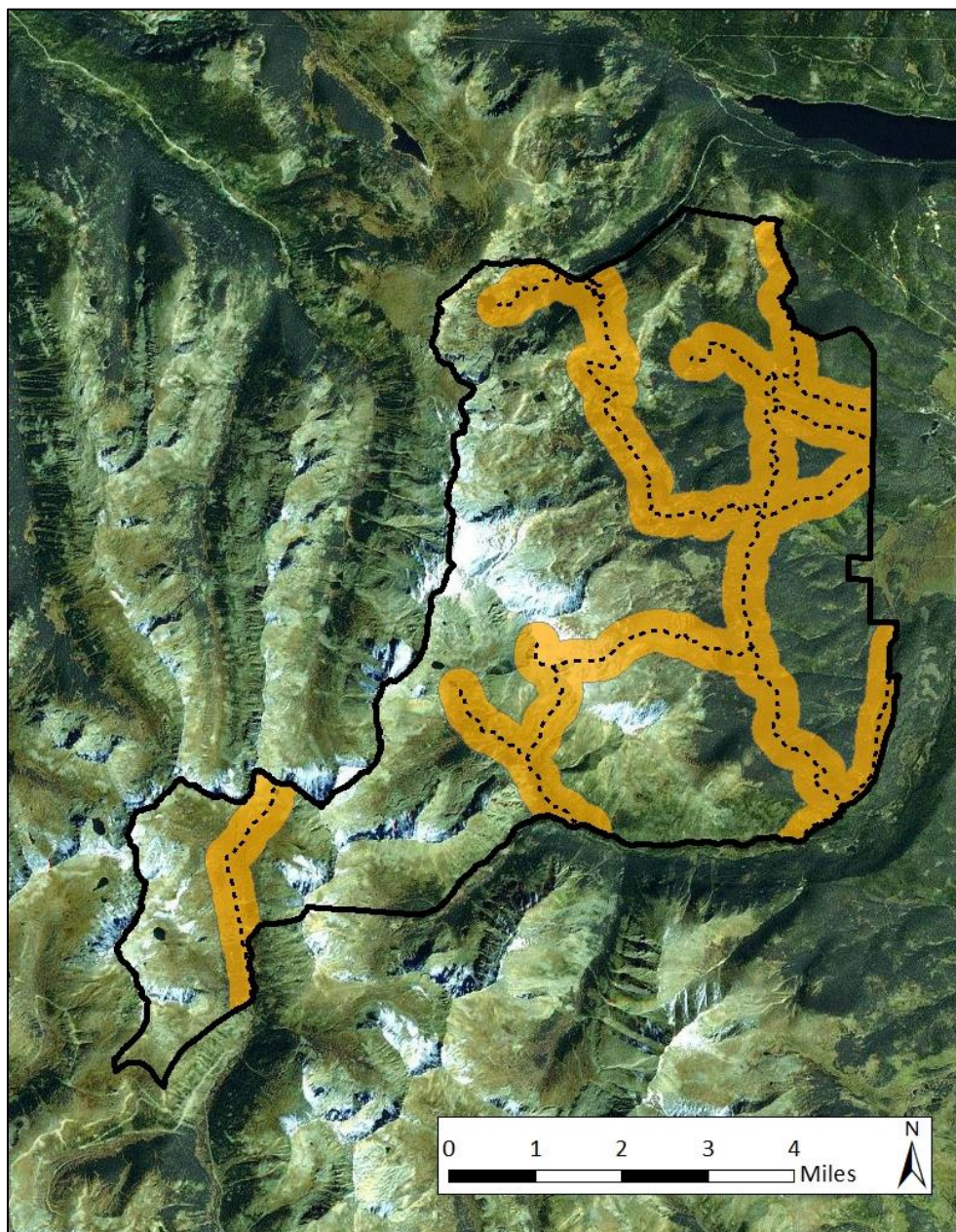


Figure 31. Travel routes in wilderness

8,595.95 acres of wilderness are within $\frac{1}{4}$ mile of designated trails per the GIS analysis.

User-created campsites

2014 Data Value: 364

Year(s) of Data Collection: 2014

Measure Description and Collection Protocol: An index of the condition of campsites located throughout the wilderness. Using the rapid assessment wilderness campsite Inventory form, user-created campsites are rated for their ground disturbance (0-4), tree damage (0-2), and disturbed area (0-2) and given an overall impact rating from 0-8. The measure value is the sum of the overall impact ratings for all campsites found during a single inventory. A decrease in the impact rating or in the number of user-created sites would result in an upward trend in this measure, and would benefit the solitude aspect of this quality.

Background and Context:

Recreation impacts at campsites are one of the most prevalent and obvious human impacts that visitors may encounter. All campsites in the Mount Massive Wilderness are user-created sites, but there can be large variation in the degree of development. The most popular area for camping is along the Colorado Trail.

Data Source: Wilderness campsite inventories (2014 inventory conducted by Brianna Boyd & Jacob Seidel, Wilderness Technicians).

Data Adequacy: High. As a standardized assessment tool that personnel are trained to complete, it is assumed that data will be collected in a consistent manner over time and by different people. It is also presumed that the majority of visible sites will be accounted for. The 2014 inventory was based on previous campsite inventories and locations likely to

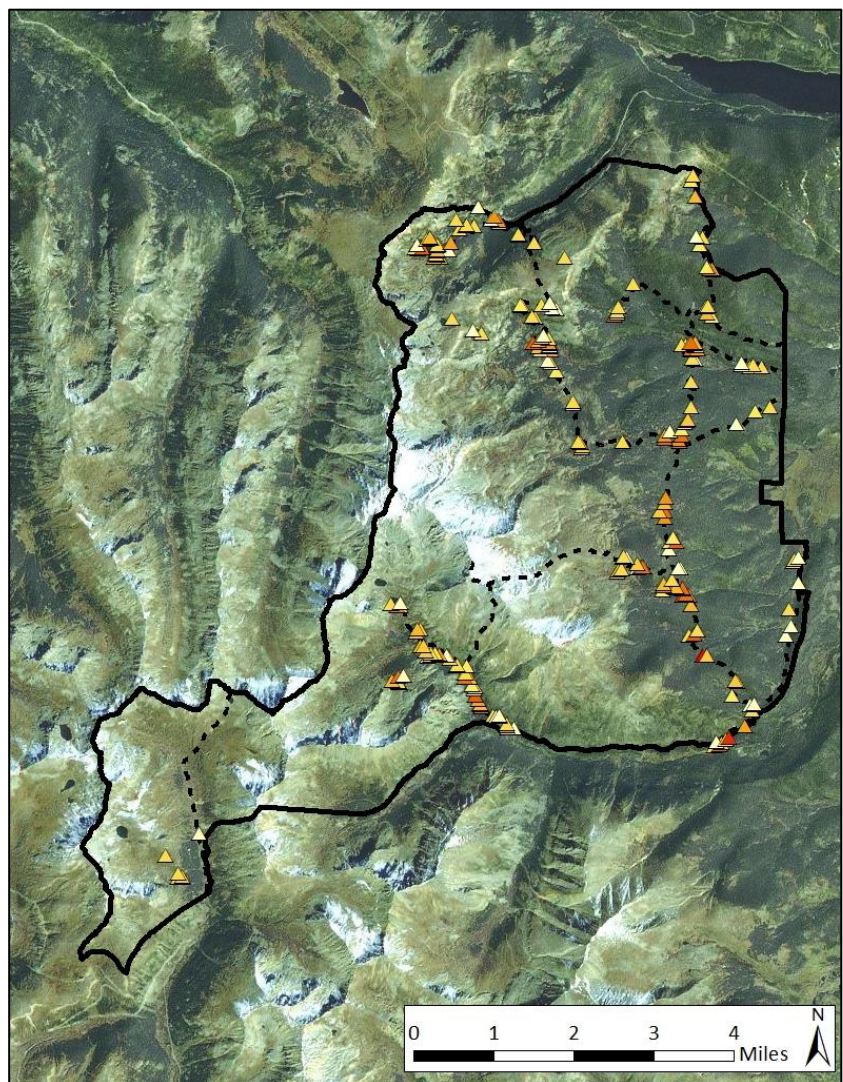


Figure 32. Campsite monitoring 2014

Campsites are colored from yellow to red with the lightest yellow indicating an overall impact rating of 0 and the darkest red indicating a rating of 7. User-created campsite locations were mainly found below treeline along designated trails.

have campsites (near trails and water); this inventory is considered to have been extremely thorough. Data quality is high and data quantity is complete.

Frequency: Data are collected at least once every 5 years. The most recent campsite assessment will be used for this measure.

Significant Change: Any change from one category to another (Table 54) is a significant change.

Table 54. Categories for significant change in user-created campsites					
Category	Etc.	Improving	2014 Level	Declining	Etc.
Measure Value	Etc.	340-359	360-379	380-399	Etc.

Table 55. User-created campsites impacts, 2009		
Overall Impact Rating	Number of Sites	Total
0	32	0
0.5	4	2
1	65	65
1.5	32	48
2	7	14
2.5	2	5
3	5	15
3.5	1	3.5
4	7	28
4.5	2	9
5	2	10
7	2	14
TOTALS	161	213.5

Table 56. User-created campsites impacts, 2014		
Overall Impact Rating	Number of Sites	Total
0	51	0
0.5	19	9.5
1	85	85
1.5	14	21
2	29	58
2.5	5	12.5
3	15	45
3.5	1	3.5
4	19	76
5	7	35
5.5	1	5.5
6	1	6
7	1	7
TOTALS	248	364

Miles of user-created trails

2014 Data Value: 36 miles

Year(s) of Data Collection: 2014

Measure Description and Collection Protocol: Miles of non-system routes in the wilderness. This measure includes routes created by outfitters and guides (i.e. any non-system wilderness route included on maps or itineraries in the special use permit files) and non-system trails that still occur on some forest maps (i.e. former roads and trails that are no longer managed by the Forest Service but are still in use by the general public). Social trails created by the general public are not included in this measure as no data currently exist on their extent or location, nor are any data likely to be collected in the future. The total mileage is calculated and rounded to the nearest whole number. (See accompanying document on how to perform the GIS analysis). A decrease in the miles of non-system commercial routes would result in an upward trend in this measure, and would benefit the solitude aspect of this quality.

Background and Context: The majority of user-created trails in Mount Massive Wilderness are from outfitters and guides. Outfitters and guides tend to travel in larger groups and generally have a greater impact than the average visitor; in addition, trails created by outfitters and guides tend to see a high amount of repeated use. As user-created trails are usually built in areas where official/maintained trails are absent, they decrease opportunities for solitude off the beaten path. Out of the 14 outfitters and guides that are approved for use in Mount Massive Wilderness, seven have reported use on non-system routes, four lack maps or other information on their routes, and three use only system trails. There are four other trails included in this measure: the west fork of the North Fork Lake Creek Trail to the Hunter-Fryingpan Wilderness, the portion of the Colorado Midland Centennial trail within the wilderness, and two trails that connect the Colorado Trail to the eastern boundary of the wilderness. All of these are old roads or trails that are no longer maintained by the Forest Service. According to the GIS analysis, outfitters and guides use 31.18 miles of non-system trails, and there are 4.57 miles of non-system former trails/roads (although there is a slight overlap in these two sets of routes). Overall, there are a total of 35.58 miles of non-system trails in use (Figure 31). It is assumed that this number is lower than the actual mileage of non-system trails due to both potential errors in drawing the precise locations of non-system trails in ArcMap and known errors in the GIS data (including the fact the area of the wilderness polygon is under-calculated by over 4,000 acres). Comparisons between INFRA data on systems trails and GIS analysis reveal that the GIS distance is just over 80% of the (more accurate) INFRA distance. It can therefore be estimated that the non-system trail mileage is likely closer to 44 miles (35.58 miles is 80% of 44.48 miles).

Data Source: Dave Lovato, Special Uses; special use permit files; Forest Service GIS data
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Data Adequacy: Medium. Currently, outfitters and guides that travel off trail are supposed to inform the Forest Service of their non-system routes; however, reporting and collection of this information is not always consistent. The Forest Service intends to rectify this by obtaining current information for all outfitters and guides this winter and creating corresponding shapefiles. In the future, therefore, this information will be collected more regularly, and current maps of off-system routes should be easily found

in the special use permit files; data quantity and quality are expected to be complete and high respectively. At this time, however, data quantity is partial and data quality is moderate.

Frequency: Every five years. The most recent information for each permit is used for this measure.

Significant Change: Any change from one category to another (Table 56) is a significant change.

Table 57. Categories for significant change in user-created trails						
Category	Excellent	Good	Caution	Poor	Very Poor	Etc.
Measure Value	0-10 miles	11-20 miles	21-30 miles	31-40 miles	41-50 miles	Etc.

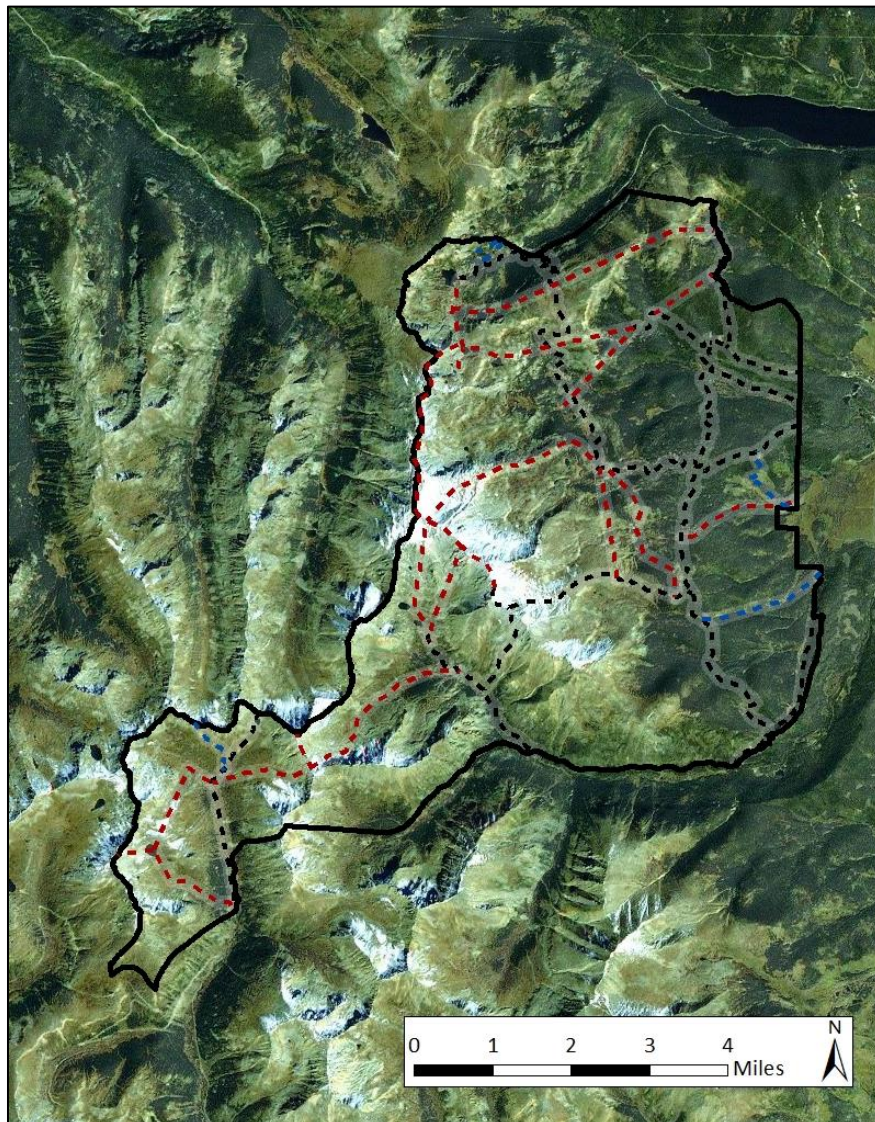


Figure 33. Outfitter and guide routes in wilderness

Black lines are system trails (which are not included in this measure), red lines are outfitter/guide created trails, and blue lines are non-system trails that are still included on some forest maps. There are 35.58 miles of non-system routes, per the GIS analysis.

Commercial use

2014 Data Value: 1,657 priority service days per year

Year(s) of Data Collection: 2014

Measure Description and Collection Protocol: The number of priority service days per year approved for outfitters and guides in Mount Massive Wilderness. This includes permits not administered by the Leadville Ranger District. Temporary permits that are authorized pending NEPA analysis and approval are also generally counted under this measure; however, one time temporary use is not included (e.g. an outfitter that is permitted for non-wilderness compartments who requests and is approved temporary use in wilderness for a specific trip would not be included; an outfitter that has been operating for 20 years under an annually renewed temporary permit would be included). All approved service days are counted for the following compartments: Windsor, Native, Swamp Lakes, Fish Hatchery, Africa Bowl, Main Massive, North Halfmoon, North Fork Lake Creek, and Willow. Service days for hunting outfitters and guides are counted for sheep compartment 66, goat compartment 17, and general hunting compartment 48. A decrease in the total commercial use priority service days would result in an upward trend in this measure, and would benefit the solitude aspect of this quality.

Background and Context: Commercial use by outfitters and guides is distinct from general use by visitors in both the magnitude of their impacts and the extent to which they can be controlled. Commercial outfitters and guides travel in larger groups that may regularly use non-system trails and repeatedly use the same campsites. In addition, commercial use may not be captured by visitation data—in recent years, it has come to light that many guides assume their special use permits exempt them from filling out the required wilderness permits; the Forest Service is actively working to correct this misconception. Federal land managers have much more control over outfitters and guides than they do over the general public. This measure does not capture *actual* use by outfitters and guides, but instead focuses on the amount of use *allowed* by the Forest Service. Because outfitters and guides have a greater impact on solitude than the average visitor, and because the Forest Service has a greater amount of control over their permitted use, the amount of approved priority service days is an excellent proxy for determining whether the agency is preserving opportunities for solitude. At this time, there are 14 outfitters and guides approved for use in Mount Massive Wilderness (Table 58); five of these (above the triple line) are managed by the Leadville Ranger District. No changes have been made in overall commercial use levels since the late 1990s (as NEPA analysis and approval is still pending for the majority of permits). A Recreation Capacity Analysis Summary (USDA Forest Service 1995) recommended limiting special uses to 10-15% of the total capacity in each wilderness compartment, with a total allocation capacity of 1,974 priority service days for the wilderness (just under 14% of the total capacity, not including the Fish Hatchery compartment). Significant change categories therefore are set at 15% of the “visitation” measure’s significant change categories.

Data Source: Dave Lovato, Special Uses; special use permit files.

Data Adequacy: High. The Forest Service keeps records of all permitted commercial use; data quantity is therefore complete and data quality is high.

Frequency: Every 5 years. The most recent information for each permit is used for this measure.

Significant Change: Any change from one category to another (Table 57) is a significant change.

Table 58. Categories for significant change in commercial use							
Category	Excellent	Good	Okay	Caution	Poor	Very Poor	Etc.
Measure Value	< 450	450-899	900-1,349	1,350-1,799	1,800-2,249	2,250-2,699	Etc.

Table 59. Outfitter and guide priority service days														
Permittee	Deer and Elk (Unit 48)	Lion (Unit 48)	Goat (Unit G17)	Sheep (Unit S66)	Africa Bowl	Fish Hatchery	Main Massive	Native	North Fork Lake Creek	North Halfmoon	Swamp Lakes	Willow	Windsor	Total
Colorado Mountain College—Leadville								65		13		31		109
Full Circle						30		13						43
High Mountain Institute							25				32	68		125
Horn Forks	15	30	12											57
Outward Bound						95	129	153	122	60	60	102	325	1,046
Anderson Camps							22							22
Aspen Alpine Guides							25							25
Aspen Trout Guides									8					8
Beaver Creek Associates							20	8	8					36
Crested Butte Mountain Guides (bought by Irwin Backcountry Guides)							24							24
Geneva Park Outfitters				9										9
Navigators							16							16
Rocky Mountain Outdoor Center							25							25
Sanborn Wilderness Camps							112							112
Total														1,657

Area of wilderness not affected by adjacent travel routes and developments**2014 Data Value:** 93.94%**Year(s) of Data Collection:** 2014

Measure Description and Collection Protocol: The percent of wilderness away from roads, structures, and other developments outside the wilderness. Aircraft travel routes, outside developments that are only visible from high peaks within the wilderness, and non-motorized trails are not counted under this measure. All roads, private land, mines, trailheads, and campgrounds, etc. adjacent to the wilderness are buffered by ¼ mile before being counted. (See accompanying document on how to perform the GIS analysis). An increase in the percentage of wilderness not affected by adjacent travel routes and developments would result in an upward trend in this measure, and would benefit the solitude aspect of this quality.

Background and Context: Adjacent travel routes and developments can result in significant sight and sound intrusions to the wilderness area. Although the majority of the adjacent area is National Forest or National Fish Hatchery land, there are some roads, private lands, and mines in close proximity (Figure 32). A percentage was used instead of acreage due to the fact that the area of the wilderness polygon used to both calculate the wilderness area and to clip the buffered travel routes and developments layers (T:\FS\NFS\PikeSanIsabel\Program\2300Recreation\GIS\Leadville\Wilderness\Wilderness Boundary.shp) is incorrect by more than 4,000 acres.

Data Source: Forest Service GIS data

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T:\FS\NFS\PikeSanIsabel\Program\7700TransportationSystem\GIS\SO\Lands - PSICC\PSICC_Lands20120213.mdb;

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Data Adequacy: High. The majority of adjacent travel routes are roads and the majority of developments are Forest Service facilities; for both of these, the Forest Service maintains fairly accurate GIS data. Data quality is high and data quantity is complete.

Frequency: Every five years.

Significant Change: Any.

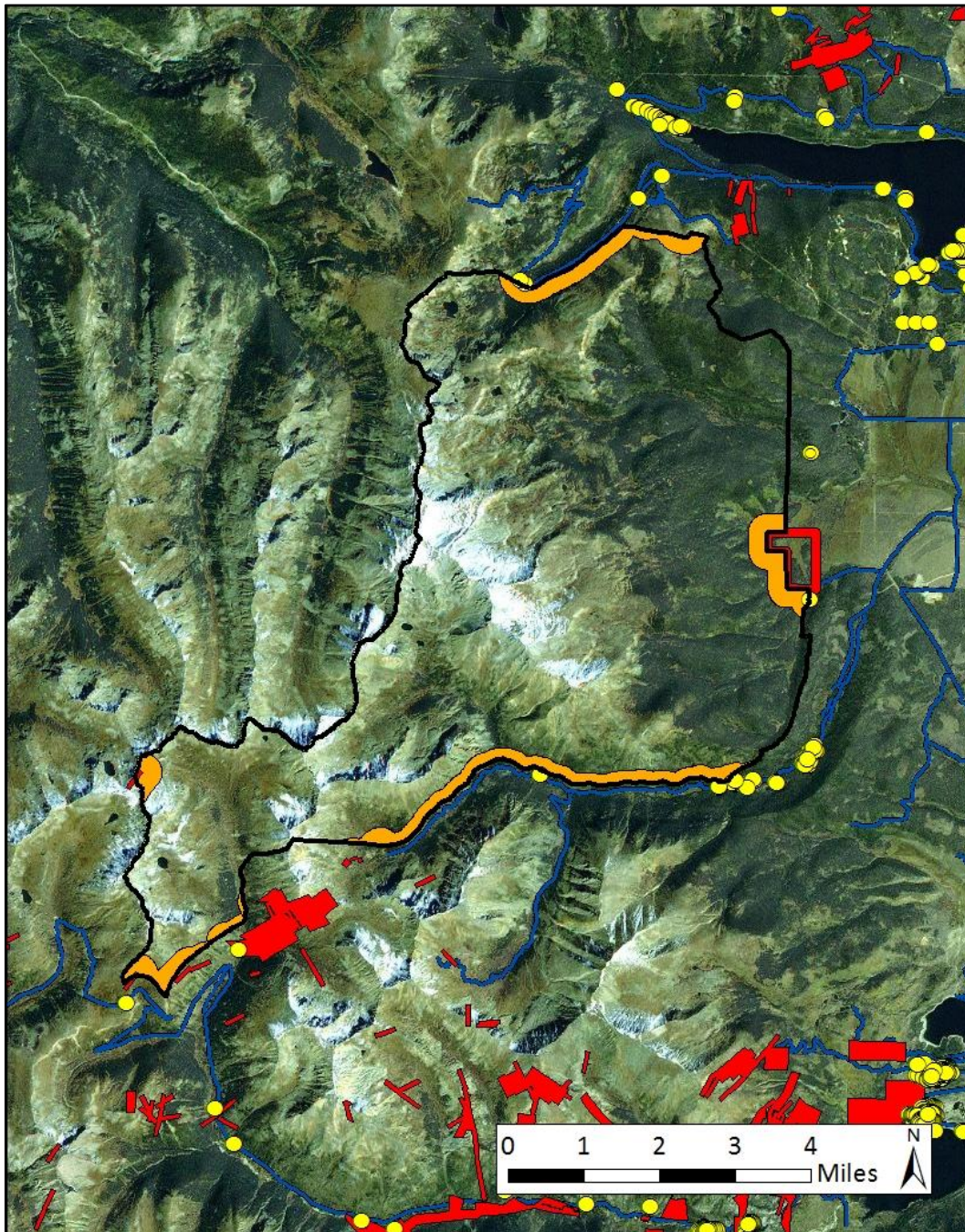


Figure 34. Adjacent roads and developments

1,604.93 acres of wilderness are within ¼ mile of adjacent roads and developments per the GIS analysis.

Index of authorized recreation facilities**2014 Data Value:** 42**Year(s) of Data Collection:** 2014

Measure Description and Collection Protocol: An index of authorized facilities that decrease self-reliant recreation. The index is adapted from the *BLM Implementation Guide* (Bureau of Land Management 2012, p. 45) and consists of a count of authorized recreation facilities in wilderness weighted by their impact (size, materials used, etc.) (Table 60). Rock stairs are not included in this measure as these are considered a normal part of trail construction on steep, rocky/talus slopes (i.e. they are not considered a facility in their own right but are counted as part of the trail distance); similarly, trail maintenance constructions (e.g. water bars, erosion checks, etc.) are also not counted under this measure. Unauthorized recreational facilities (e.g. Colorado Trail and/or Continental Divide National Scenic Trail markers, etc.) are removed as soon as they are noticed and likewise not included under this measure. A decrease in the number or size of authorized recreation facilities would result in an upward trend in this measure, and would benefit the primitive aspect of this quality.

Background and Context: The Forest Service installs and maintains several facilities within wilderness for resource protection. Although these facilities often make visitors' wilderness experiences easier or more comfortable, they also decrease opportunities for self-reliant recreation. Although many of these facilities are also counted under the "index of authorized recreational physical development" measure, this measure tracks their impact on visitors' opportunity to experience primitive recreation—not their effect as permanent developments in wilderness. Recreational developments that are not considered facilities that decrease self-reliant recreation include culverts and restoration signs (directional signs, however, are counted under this measure). In Mount Massive Wilderness, the primary recreation facilities are bridges, blazes (Table 61), and signs.

Data Source: Steve Sunday, Lead Wilderness Ranger; Brianna Boyd & Jacob Seidel, Wilderness Technicians; Loretta McElhiney, Peak Manager; Adam Brown, Trails; INFRA data; The Colorado Trail (Jacobs, 1992).

Data Adequacy: High. Most of the data are commonly known by Forest Service personnel and documented in wilderness open files; the majority of developments were also confirmed by wilderness technicians conducting campsite inventories in Mount Massive Wilderness in 2014. Data quality is high and data quantity is complete.

Frequency: Every five years.

Significant Change: Any.

Table 60. Index of authorized recreation facilities				
Facility		Number	Weight	Score
Trail markers or signs	Natural (bark) blazes—21.84 miles	3	1	3
	Plastic/metal blazes—3.46 miles	1	3	3
	Directional signs of native materials	10	3	30
Major trail features (i.e. bridge, stairs)	Bridge over N. Willow on CT	1	3	3
	Rock Creek Bridge	1	3	3
			Total	42

Table 61. Weighting scheme for authorized recreation facilities				
Category	Recreation Facility			Weight
Trail markers or signs	Blazes of native materials	X	Number = miles of trail divided by 10 and rounded <i>up</i> to the nearest whole number	1
	Blazes of non-native materials			3
	Signs of native materials			3
	Signs of non-native materials			5
Major trail features (i.e. bridges)	Primitive (built with raw, native materials)			1
	Constructed with native materials that have been processed and hauled in			3
	Constructed with nonnative materials			5

Table 62. Miles of trail with blazes				
Blaze Type	Trail	Miles	Total Miles	Number for Scoring
Plastic/Metal	The Colorado Trail from the Highline Trail to the Rock Creek Trail	1.68*	3.46	3.46 / 10 = 0.35; 0.35 rounded up = 1
	The Highline Trail east of the Colorado Trail	1.78*		
Natural	Colorado Trail	9.8	21.84	21.84 / 10 = 2.18; 2.18 rounded up = 3
	Highline Trail	9.4		
	Rock Creek Trail	1.3		
	Kearney Park Trail east of the Colorado Trail	1.34*		
*These mileages are partial trail distances (e.g. only part of the Highline Trail has plastic blazes, not all of the trail). The partial distances were determined through GIS analysis. To correct errors in the GIS data, each partial GIS distance was divided by the total GIS trail distance to obtain the percentage of each trail that has plastic blazes. These were then multiplied by the correct total trail mileages to find more accurate partial trail mileages.				

Miles of developed trails

2014 Data Value: 29.53 miles

Year(s) of Data Collection: 2014

Measure Description and Collection Protocol: The total miles of developed trails that are classified as condition classes three, four, or five in INFRA. Non-system routes are not included in this measure. The Colorado Midland Centennial (the loop trail north of Windsor Trail) is also is not counted in this measure—although it is technically a system trail, the small portion of the trail in the wilderness is not being actively maintained at this time, nor is the wilderness mileage included in INFRA. Either managing trails for a lower condition class or closing trails would result in an upward trend in this measure, and would benefit the primitive aspect of this quality.

Background and Context: In contrast to highly developed (sidewalk-like) trails, narrower and rockier trails allow for visitors to experience a more primitive type of recreation. Opportunities for primitive and self-reliant recreation are therefore increased by managing trails for lower condition classes. All designated trails in the wilderness are currently managed for either condition class two or three.

Definitions:

Trail Class 1: minimal/undeveloped trail

Trail Class 2: simple/minor development trail

Trail Class 3: developed/improved trail

Trail Class 4: highly developed trail

Trail Class 5: fully developed trail

Further descriptive information can be found in the USFS trail class matrix:

[http://www.fs.fed.us/recreation/programs/trail-management/trail-fundamentals/National Trail Class Matrix 10 16 2008.pdf](http://www.fs.fed.us/recreation/programs/trail-management/trail-fundamentals/National_Trail_Class_Matrix_10_16_2008.pdf).

Data Source: Adam Brown, Trails; INFRA data; The Colorado Trail (Jacobs, 1992); Forest Service GIS data (T:\FS\NFS\PikeSanIsabel\Program\7700TransportationSystem\GIS\SO\SDE Data\RoutedTrailsRev20091020\RoutedTrailsRev20091020.shp).

Data Adequacy: High. The Forest Service maintains data on the miles of trail and for which condition class they are managed; therefore, data quantity is complete and data quality is high.

Frequency: Every five years.

Significant Change: Any.

Table 63. Wilderness trails			
System Trails	Trail Number	Miles	Condition Class
Mount Massive/North Halfmoon (spur to summit)	1451	1.4	3
North Fork Lake Creek (including east leg to Hunter-Fryingpan)	1483	3.3	2
North Halfmoon Lakes	1485	2.73	3
South Willow Creek	1486	2.03	2
Mount Massive (spur to summit)	1487	3.68	2
Rock Creek	1488	1.3	3
Highline/Native Lake	1489	9.4	3
Windsor Lake	1490	1.6	3
Swamp Lake (a.k.a. Kearney Park)	1492	3.3	3
Colorado Trail	1776	9.8	3
Total condition class 3-5 trail mileage/Total trail mileage		29.53 / 38.54	

Index of visitor management restrictions**2014 Data Value:** 22**Year(s) of Data Collection:** 2014

Measure Description and Collection Protocol: This measure quantifies management restrictions that substantially restrict visitor behavior, access, or equipment in wilderness. The regulation categories are adapted from the *Forest Service Technical Guide* (Landres et al. 2009, p. 219) and assigned a score for severity (Table 64) and a weight of extent. The weight of extent is scored a one if the regulation applies to only a sub-area of wilderness and a two if it applies to the entire wilderness. The severity score and the weight of extent are multiplied for a total score for each regulation category; the index value is the sum of the total scores. A decrease in the severity or number of management restrictions would result in an upward trend in this measure, and would benefit the unconfined aspect of this quality.

Background and Context: Unconfined recreation is greatest when visitors have the most freedom over their actions and decisions. While restrictions on visitor behavior are generally intended to protect the resource or improve solitude, they also degrade the visitor opportunity for unconfined recreation. Recently, there has been discussion of changing the restriction on dogs from being leashed at all times to being under voice control; should this change be made, it would reduce the number of restrictions and improve opportunities for unconfined recreation.

Data Source: Required wilderness permits; open wilderness files.

Data Adequacy: High. Data are readily available to the public; data quantity is complete and quality is high.

Frequency: Every five years.

Significant Change: Any.

Table 64. Index of management restrictions in the Mount Massive Wilderness				
Type	Specifics	Severity Score	Weight of Extent	Total
Campfires	Campfires are prohibited within 100 feet of lakes, streams, or trails	1	2	2
Camping	Camping is prohibited within 100 feet of lakes, streams, trails, or restoration sites	1	2	2
Fees	No fees	0	0	0
Permits	Self-issued permits are required	2	2	4
Human waste	No regulation	0	0	0
Length of stay	Standard 14 day restriction	1	2	2
Stock use	Straw, hay, and unprocessed feed is prohibited; hitching stock within 100 feet of lakes, streams, and trails is prohibited	2	2	4
Swimming/bathing	No restrictions	0	0	0
Area closure	No restrictions	0	0	0
Group size limits	Limited to 15 people, or 25 total people and stock	1	2	2
Domesticated animals	Dogs must be on a 6 foot leash	2	2	4
Trails/travel	Cutting switchbacks is prohibited	1	2	2
Total				22

Table 65. Weighting scheme for wilderness regulations

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 closure to all stock
Swimming/bathing	0	No restrictions
	2	Prohibited
Area closure	0	No restrictions
	3	Prohibited
Group size limits	0	No restriction
	1	Group size limits in place
Dogs/domesticated animals	0	No restrictions
	1	Required to be under voice control
	2	Required to be on leash
	3	Prohibited
Trails/travel	0	No restrictions
	1	Cutting switchbacks prohibited
	2	Off-trail travel is prohibited

MEASURES NOT USED FOR WILDERNESS CHARACTER MONITORING

The measures described below were considered as measures for wilderness character monitoring but were ultimately not used. Descriptions of each measure and the rationales for exclusion are included in this section.

Natural Quality

Water quality statistics: The headwaters of the Arkansas River are located in the Mount Massive Wilderness and support several sensitive subspecies of cutthroat trout; as such, wilderness water quality is of prime importance for both the watershed and its aquatic ecosystems. The Leadville National Fish Hatchery was initially established to protect the water quality in the Rock Creek Drainage, and water quality is still considered to be the hatchery's primary concern in the wilderness. Since 2008 the Fish and Wildlife Service has maintained three small thermographs—in Cascade Creek, Elk Creek, and the Native Lake inlet—to assess cutthroat trout recruitment in these waters; although warming water resulting from climate change could have a significant effect on trout populations, 5 years of data collection is considered insufficient for examining trends in water temperature. While various short term water quality studies have been conducted by the Forest Service in the past, no long-term monitoring is currently established, nor are there any plans to initiate water quality monitoring for the Mount Massive Wilderness. Should additional monitoring ever begin, this measure should be re-considered for inclusion.

Undeveloped Quality

Number of non-authorized uses of motor vehicles, motorized equipment or mechanical transport: Non-authorized motorized or mechanical use has been a recurring problem in the Mount Massive Wilderness. Wilderness rangers have been working to prevent visitor use of snowmobiles and mountain bikes—the prime forms of non-authorized motorized and mechanical transport in the wilderness—for years. Because of the unauthorized nature of this measure, however, catching prohibited use tends to be haphazard and dependent upon the availability of wilderness personnel. The data adequacy for non-authorized prohibited uses is too low to be considered reliable at this time, nor is that likely to change in the near future. Should the amount of documented unauthorized motorized or mechanical use reach a point where it is considered an adequate reflection of actual use, this measure could be re-considered for inclusion.

Solitude or Primitive and Unconfined Recreation Quality

Soundscape: Sound pollution can have a large impact on wilderness character by reducing opportunities for solitude. Currently, the greatest source of noise pollution is from aircraft overflights. Military, commercial, and private aircraft frequently fly over the wilderness (often en route to and from Aspen, Colorado); due to the high elevations and mountain topography, aircraft are forced to fly at lower altitudes which increases their apparent noise levels. While annual reports from previous decades indicate that aircraft noise has been a concern for years, reductions in the number of field-going staff has caused this issue to drop in priority level. Although this measure is considered both significant and vulnerable, at this time monitoring is not feasible due to the limited number of wilderness personnel. Should sound pollution become a higher priority once again, this measure could be re-considered for inclusion.

CONCLUSIONS

The Mount Massive Wilderness is part of a regional network of wilderness areas across the Rocky Mountains that collectively make evident the enormity and importance of the National Wilderness Preservation System. Ten distinct wilderness areas lie within 40 miles of the Mount Massive Wilderness boundary—the Hunter-Fryingpan, Collegiate Peaks, Buffalo Peaks, Holy Cross, Maroon Bells-Snowmass, Raggeds, West Elk, Fossil Ridge, Eagles Nest, and Ptarmigan Peak Wildernesses. This consortium of wilderness areas acts as a sanctuary from human development in Vail, Aspen, and other mountain towns, and connects crucial alpine habitats to serve as refuges for plants and wildlife alike. While the Mount Massive Wilderness is small in comparison to its neighbors, it plays an important role in protecting the area's resources. From the clear-cut forests of a century ago, it is obvious that much progress has been made in our understanding and prioritization of wild places.

Since the 1980s, impacts to the wilderness resource and to wilderness recreation opportunities resulting from high levels of visitation have consistently been identified as the primary concern in the Mount Massive Wilderness. Today, increasing human use remains the greatest threat to wilderness character in the wilderness. With the highest wilderness elevation in the Sawatch Range and a reputation for easy summit access, visitation numbers are high. The Colorado Trail and Continental Divide National Scenic Trail, merged as they pass through the wilderness, bring even more people through the area. Like many 14,000 foot peaks, Mount Massive is in danger of being loved too much—resource damage from overuse has already resulted in additional management restrictions and the construction of a second trail to the summit. This appreciation by an increasing number of people frequently results in a

catch-22 for wilderness managers: while overuse results in resource damage and reduces opportunities for solitude and a wilderness type of recreation, the future of wilderness preservation depends on people forging connections with the land, and learning to respect and care for wild places through their recreational experiences in wilderness. Despite the conundrum this presents, the Wilderness Act is very clear: the National Wilderness Preservation System is meant to be an enduring resource for both current and future generations. The wilderness resource therefore cannot be sacrificed to appease current demands for use: wilderness character must be preserved. Managing to preserve wilderness character, however, often requires compromises. In the context of wilderness character monitoring, this generally is revealed through the prioritization of one quality, or a single aspect of a quality, over others. Impacts to the



Figure 35. Indian paintbrush off Windsor Trail

Untrammeled Quality, for example, are often considered an acceptable side effect of improving the Natural Quality. Similarly, limiting opportunities for primitive and unconfined recreation can sometimes be deemed appropriate if they result in the preservation of opportunities for solitude.

The goal of this report, the specific measures selected, and of wilderness character monitoring in general, is to help wilderness managers comprehend the holistic ramifications of actions and decisions in wilderness. The tangible vision of the wilderness described in this document is further intended to assist wilderness managers in evaluating the stewardship of the Mount Massive Wilderness through the lens of wilderness character. Through the framework of wilderness character monitoring, it is hoped that this report will support wilderness managers in protecting this unique wilderness into the future, and create a legacy of exceptional wilderness stewardship.

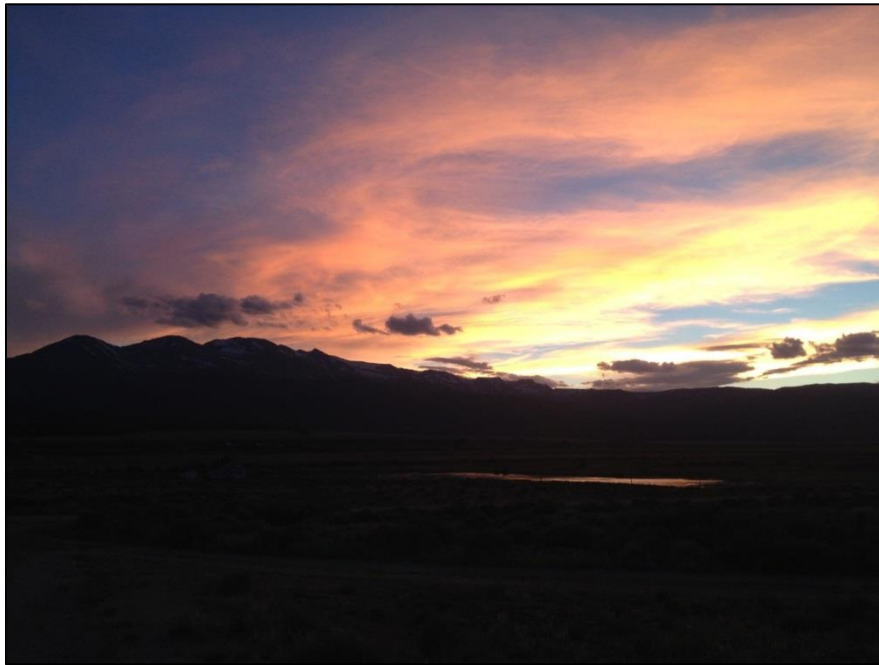


Figure 36. Sunset over Mount Massive Wilderness

REFERENCES

Bevenger, G. *In press*. Wilderness air quality values plan [July 2014 Draft] [Internal Report]. San Isabel National Forest.

Boutcher, S., P. Landres, L. Dean, L. Merigiano, T. Hall, K. Straley, and J. Bolis. *In press*. Keeping it wild in the Forest Service: A strategy to monitor wilderness character [September 2013 Draft]. USDA Forest Service.

Bureau of Land Management. 2012. Measuring attributes of wilderness character: BLM implementation guide, Version 1.5 [Internet]. Available from: <http://www.wilderness.net/character>.

Colorado [Map]. [Cited August 7, 2014]. Available from: www.google.com/maps.

Eide, G. March 16, 1983. Letter from Gene Eide, District Ranger—Leadville Ranger District San Isabel National Forest, to Duane Monk, Manager—Leadville National Fish Hatchery.

Hoffman, M. 2005; updated 2011. Glaciers of Colorado [Internet]. [Cited July 17, 2014]. Available from: <http://glaciers.us/glaciers-colorado>.

Landres, P., C. Barns, S. Boutcher, T. Devine, P. Dratch, C. Filardi, A. Lindholm, L. Merigiano, N. Roeper, and E. Simpson. *In press*. Keeping it wild 2: An updated interagency strategy to monitor trends in wilderness character across the National Wilderness Preservation System [April 2014 Draft]. General Technical Report RMRS-GTR-(unnumbered). Fort Collins, CO: USDA Forest Service, Rocky Mountain Research Station.

Landres, P., S. Boutcher, T. Blett, D. Bumpus, T. Carlson, D. Cole, L. Dean, T. Hall, C. Hardy, A. Leach, A. Mebane, L. Merigiano, S. Rinehart, and P. Wright. 2009. Technical guide for monitoring selected conditions related to wilderness character. USDA Forest Service General Technical Report WO-80. Washington, DC: Government Printing Office.

Landres, P., C. Barns, J.G. Dennis, T. Devine, P. Geissler, C.S. McCasland, L. Merigiano, J. Seastrand, and R. Swain. 2008. Keeping it wild: An interagency strategy to monitor trends in wilderness character across the National Wilderness Preservation System. General Technical Report RMRS-GTR-212. Fort Collins, CO: USDA Forest Service, Rocky Mountain Research Station.

Landres P., S. Boutcher, L. Merigiano, C. Barns, D. Davis, T. Hall, S. Henry, B. Hunter, P. Janiga, M. Laker, A. McPherson, D.S. Powell, M. Rowan, and S. Sater. 2005. Monitoring selected conditions related to wilderness character: A national framework. General Technical Report RMRS-GTR-151. Fort Collins, CO: USDA Forest Service, Rocky Mountain Research Station.

Lear, G. 1999. Inside rain: A look at the National Atmospheric Deposition Program. Champaign, IL: NADP Program Office.

Metcalf, J.L., S. Love Stowell, C.M. Kennedy, K.B. Rogers, D. McDonald, J. Epp, K. Keepers, A. Cooper, J.J. Austin, and A.P. Martin. 2012. Historical stocking data and 19th century DNA reveal human-induced changes to native diversity and distribution of cutthroat trout. *Molecular Ecology*. 21: 5194-5207. DOI: 10.1111/mec.12028.

Morgan, B.H. February 19, 1982. Letter from Bruce H. Morgan, Forest Supervisor—PSICC, to Gene Eide, District Ranger—Leadville Ranger District San Isabel National Forest.

National Interagency Fuels, Fire, and Vegetation Technology Transfer Team. 2010. Interagency fire regime condition class (FRCC) guidebook, Version 3.0 [Internet]. Available from: https://www.frames.gov/files/7313/8388/1679/FRCC_Guidebook_2010_final.pdf.

US Geological Survey. 1989. Mineral resource potential of Mount Massive Wilderness, Lake County, Colorado. U.S. Geological Survey Bulletin 1636.

USDA Forest Service. 1984. The Pike and San Isabel National Forests land and resource management plan [Internal Report]. Pike and San Isabel National Forests.

USDA Forest Service. 1988. Mount Massive Wilderness implementation schedule [Internal Report]. Leadville Ranger District, San Isabel National Forest.

USDA Forest Service. 1995. Recreation capacity analysis summary [Internal Report]. PSICC.

USDA Forest Service. 2003. Decision notice and finding of no significant impact for the Mount Massive route stabilization project. PSICC.

USDA Forest Service. 2009. White River National Forest air resource management plan [Internal Report]. White River National Forest.

USDA Forest Service. 2011a. Pike and San Isabel National Forests and Cimarron and Comanche National Grasslands annual monitoring report for fiscal year 2010 [Internal Report]. PSICC.

USDA Forest Service. 2011b. Watershed condition framework [Internet]. Report FS-977. Available from: http://www.fs.fed.us/publications/watershed/Watershed_Condition_Framework.pdf.

USDOI Fish and Wildlife Service, USDA Forest Service. 2004. Interagency agreement [regarding fire suppression in the Leadville National Fish Hatchery]. PSICC and the Leadville National Fish Hatchery.

APPENDIX A—Overview of the framework for wilderness character monitoring

An excerpt from Keeping it Wild (Landres et al. 2008, pp. 16-17)

This interagency monitoring Framework is based on hierarchically dividing wilderness character into successively finer elements. These elements, starting from wilderness character, are:

Qualities—primary elements of wilderness character that link directly to the statutory language of the 1964 Wilderness Act. In this Framework, all [five] qualities are necessary to assess trends in wilderness character and each wilderness would be required to report the trend for each quality.

Monitoring questions—major elements under each quality that are significantly different from one another. Monitoring questions frame this monitoring to answer particular management questions. In this context, monitoring questions are similar to monitoring goals. Each wilderness and agency would be responsible for reporting on the trend for all eight monitoring questions.

Indicators—distinct and important elements within each monitoring question. In nearly all cases, there is more than one indicator under a monitoring question. Each wilderness and agency would be responsible for reporting on the trend for all 13 indicators.

Measures—a specific aspect of wilderness on which data are collected to assess trend of an indicator. In nearly all cases, there is more than one measure to provide each agency (and potentially each wilderness within an agency) a range of options for assessing trend in the indicator. Some of these measures are more accurate and precise but costly, while others are less accurate and precise but easier and less expensive to monitor. For example, under the indicator “Remoteness from sights and sounds of people inside wilderness” (see page 28 table 7), the measure “amount of visitor use” requires substantial effort and cost but is fairly precise. On the other hand, the measure “area of wilderness affected by access or travel routes” is fairly easy to compute in a Geographic Information System, but is not very precise because it doesn’t assess the number of people inside the wilderness. This range of measures allows different agencies and wildernesses to choose the measure(s) that are relevant and practical. We recommend monitoring all the measures for which data are available to give the most accurate assessment possible and, if two or more measures are monitored, that they be equally weighted to prevent giving a biased trend in the indicator.

For a few measures, the use of an “index” is recommended. In these cases, several attributes are considered simultaneously to assess trend and the different attributes may be weighted differently. For example, the index of physical development would combine the type and number of structures. Developing an index typically requires subjective judgments about the types of attributes to include, their relative weighting (for example, a dam has more impact than an outhouse), and how they would be mathematically combined. In the detailed descriptions of the measures given in Appendix A, only the types of attributes are suggested—if this interagency strategy is implemented, each agency would need to develop these indexes based on their data capabilities and needs.

Each measure is used only once, under the quality that was deemed most relevant given the broad interagency perspective of this monitoring strategy. This approach avoids problems of double-counting some measures and the bias this would introduce. However, some measures are clearly relevant to more than one quality. Agency provided system trails, shelters, and toilets, for example, are relevant to both the undeveloped quality and the solitude or primitive and unconfined recreation quality. In such cases, different agencies (and different wildernesses if allowed by their home agency) may assign the measure to a different quality than what is presented in this framework. These differences are not

nearly as important as consistency over time within an agency or wilderness because this monitoring strategy is based on assessing how wilderness character is changing only within a single wilderness.

If none of the recommended measures under a particular indicator are relevant to an agency or wilderness, other measures may be used or developed as long as the rationale is made clear for how the new measure is relevant to the indicator and how it is measurable, credible, and repeatable. For example, a wilderness may develop a measure that is relevant for assessing place-based aspects or other special features. We recommend that a wilderness character monitoring team within each agency be tasked to approve the use of such measures and communicate this use with the other wilderness management agencies.

APPENDIX B—Priority ranking of all measures considered

Scoring Protocol:

Significance: the measure is highly relevant to the quality and indicator of wilderness character, and is highly useful for managing the wilderness

High = 3 points; Medium = 2 points; Low = 1 point

Vulnerability: the measure looks at an attribute of wilderness character that currently is at risk, or might likely be at risk over the next 10-15 years

High = 3 points; Medium = 2 points; Low = 1 point

Reliability: the measure can be monitored accurately with a high degree of confidence, and would yield the same result if measured by different people at different times

High = 3 points; Medium = 2 points; Low = 1 point

Feasibility: the measure is related to an existing effort or could be monitored without significant additional effort

High = 1 point; Medium = .5 points; Low = 0 point

Priority Levels:

High Priority (H): Measures with a score of 10

Medium Priority (M): Measures with a total score between 7.5 and 9.5

Low Priority (L): Measure with a total score of 7 or less.

No Priority (N/A): The measure was not assigned a priority level if significance and vulnerability each scored 1 point, or if a score of 0 was assigned for feasibility (indicated by red text)

Additional Notes:

All Forest Service recommended measures (from *Keeping it Wild in the Forest Service* (September 2013 Draft), updated to conform to *Keeping it Wild 2* (April 2014 Draft)) were included for prioritization. Measure classifications were denoted in the “Required?” column (R = Required; R* = Required if Relevant; O = Optional; --- = a new (non-Forest Service recommended) measure).

Measures that were included in wilderness character monitoring are marked with a green check; measures not included are marked with a red X. Explanations for inclusion or exclusion are given in the “Comments” column.

INDICATOR	POTENTIAL MEASURE	Significance	Vulnerability	Reliability	Feasibility	Total Score	Priority Level	Required?	Included?	COMMENTS
UNTRAMMELED										
Actions authorized by the federal land manager that intentionally manipulate the biophysical environment	Authorized actions and persistent structures designed to manipulate the plants, animals, pathogens, soil, water, or fire	1	2	3	.5	6.5	L	R	✓	Although this measure is considered a low priority, it is required and therefore will be included
	Percent of natural fires <i>not</i> receiving a suppression response (<i>Formerly: Percent of natural fire perimeters that were manipulated</i>)	1	2	3	1	7	L	R	✓	Although this measure is considered a low priority, it is required and therefore will be included
Actions not authorized by the federal land manager that intentionally manipulate the biophysical environment	Unauthorized actions by agencies, citizen groups, or individuals that manipulate plants, animals, pathogens, soil, water, or fire	3	1	1	.5	5.5	L	R*	✓	This measure is not vulnerable and data is limited; however, as it is considered the best option for the indicator, it will be included
	Fish stocking actions (<i>Formerly: Number of lakes and other water bodies stocked with fish</i>)	1	2	3	1	7	L	R*	✓	Although this measure is considered a low priority, it is relevant and therefore will be included
NATURAL										
Plants	Non-native invasive plant species	3	3	1	0	7	N/A	R	✓	Although this measure has extremely limited data and feasibility, it is required and must be included
	Index of plant species of concern	3	3	1	0	7	N/A	R	✓	Although this measure has extremely limited data and feasibility, it is required and must be included
	Acres of restored native plant communities	3	2	1	0	6	N/A	O	✗	Although significant and somewhat vulnerable, monitoring this measure is not considered feasible at this time

INDICATOR	POTENTIAL MEASURE	Significance	Vulnerability	Reliability	Feasibility	Total Score	Priority Level	Required?	Included?	COMMENTS
Animals	Non-native animal species	3	3	1	0	7	N/A	R	✓	Although this measure has extremely limited data and feasibility, it is required and must be included
	Index of animal species of concern	3	3	2	0	8	N/A	R	✓	Although this measure has extremely limited data and feasibility, it is required and must be included
	Index of stocked lakes	3	3	1	.5	7.5	M	R*	✓	
Air and water	Ozone exposure statistics N100 and W126	3	3	3	1	10	H	R	✓	
	Concentration of nitrogen in wet deposition	3	3	3	1	10	H	R	✓	
	Concentration of sulfur in wet deposition	3	3	3	1	10	H	R	✓	
	Visibility statistics	3	3	3	1	10	H	R	✓	
	Index of dams and other structures that alter water flow	1	1	3	1	6	N/A	R*	✗	There are no dams or other structures that alter water flow in the wilderness; this measure is neither significant nor vulnerable and will not be included
	Water quality statistics	3	2	1	0	6	N/A	O	✗	Although significant and somewhat vulnerable, monitoring this measure is not considered feasible at this time
	Pollutant sensitive lichen species	3	3	1	0	7	N/A	O	✗	Although significant and vulnerable, monitoring this measure is not considered feasible at this time
Climate change	Temperature	3	3	3	1	10	H	R	✓	
	Precipitation	3	3	3	1	10	H	R	✓	

INDICATOR	POTENTIAL MEASURE	Significance	Vulnerability	Reliability	Feasibility	Total Score	Priority Level	Required?	Included?	COMMENTS
	Phenophase onset/end dates	3	3	1	0	7	N/A	O	✗	Although significant and vulnerable, monitoring this measure is not considered feasible at this time
	Glaciers and permanent snowfields	3	3	2	.5	8.5	M	O	✓	
	Snow (annual snow days)	3	3	3	1	10	H	R*	✓	
	Severe weather events	2	2	2	1	7	L	O	✗	This measure is of low priority and optional, therefore it will not be included
	Snow seasonality	3	3	3	1	10	H	---	✓	
Ecological processes	Acres of active grazing allotments	1	1	3	1	6	N/A	R*	✗	No active grazing allotments exist in the wilderness; this measure is neither significant nor vulnerable and will not be included
	Average watershed condition class	3	1	3	1	8	M	R	✓	
	Average natural fire regime condition class	3	3	3	1	10	H	R	✓	
	Index of connectivity	1	1	2	1	5	N/A	O	✗	The wilderness is adjacent to or within 10 miles of 4 other wilderness areas; this measure is neither significant nor vulnerable and will not be included
UNDEVELOPED										
Presence of non-recreational structures, installations, and developments	Index of authorized non-recreational physical development	2	2	3	.5	7.5	M	R	✓	

INDICATOR	POTENTIAL MEASURE	Significance	Vulnerability	Reliability	Feasibility	Total Score	Priority Level	Required?	Included?	COMMENTS
Presence of recreational structures, installations, and developments	Index of authorized recreational physical development	3	3	3	1	10	H	R	✓	
Inholdings	Index of inholdings	1	1	1	0	3	N/A	R*	✓	There is one, rarely accessed inholding currently in the wilderness and it is not a concern at this time; however, as this measure is considered the best option for the indicator, it will be included
Use of motor vehicles, motorized equipment, or mechanical transport	Index of administrative authorizations to use motor vehicles, motorized equipment, or mechanical transport	3	1	3	1	8	M	R	✓	
	Percent of emergency incidents not using motor vehicles, motorized equipment, or mechanical transport	3	3	2	0	8	N/A	R	✓	Although this measure has extremely limited data and feasibility, it is required and must be included
	Number of non-authorized uses of motor vehicles, motorized equipment or mechanical transport	3	2	2	0	7	N/A	O	✗	Although significant and somewhat vulnerable, monitoring this measure is not considered feasible at this time
SOLITUDE OR PRIMITIVE AND UNCONFINED RECREATION										
Remoteness from sights and sounds of people inside of wilderness	Travel route encounters	3	3	1	0	7	N/A	R	✓	Although this measure has extremely limited data and feasibility, it is required and must be included
	Visitation	3	3	1	.5	7.5	M	---	✓	

INDICATOR	POTENTIAL MEASURE	Significance	Vulnerability	Reliability	Feasibility	Total Score	Priority Level	Required?	Included?	COMMENTS
	Number of occupied campsites within sight and sound	3	3	1	0	7	N/A	R*	✗	Although significant and vulnerable, monitoring this measure is not considered feasible at this time
	Area of wilderness away from access and travel routes and developments	3	3	2	.5	8.5	M	R	✓	
	User-created campsites	3	3	3	1	10	H	R	✓	
	Miles of user-created trails	3	3	2	.5	8.5	M	O	✓	
	Commercial Use	3	3	1	.5	7.5	M	---	✓	
Remoteness from sights and sounds of people outside of wilderness	Area of wilderness not affected by adjacent travel routes and human developments	3	3	2	.5	8.5	M	R	✓	
	Night sky light pollution	3	3	1	0	7	N/A	O	✗	Although significant and vulnerable, monitoring this measure is not considered feasible at this time
	Soundscape	3	3	1	0	7	N/A	---	✗	Although significant and vulnerable, monitoring this measure is not considered feasible at this time
	Viewshed affected by developments outside of wilderness	2	2	1	0	5	N/A	---	✗	Although somewhat significant and vulnerable, monitoring this measure is not considered feasible at this time
Facilities that decrease self-reliant recreation	Index of authorized recreation facilities	3	1	3	.5	7.5	M	R	✓	
	Miles of developed trails (condition classes 3-5)	3	1	3	.5	7.5	M	R	✓	

INDICATOR	POTENTIAL MEASURE	Significance	Vulnerability	Reliability	Feasibility	Total Score	Priority Level	Required?	Included?	COMMENTS
Management restrictions on visitor behavior	Index of visitor management restrictions	3	3	3	1	10	H	R	✓	
OTHER FEATURES QUALITY										
Deterioration or loss of integral historical or cultural features	Condition index for integral historical features	No integral historical or cultural features present				0	N/A	R*	✗	No other features of value were determined to be present in the wilderness for inclusion in wilderness character monitoring
	Number of authorized or unauthorized actions that damage or disturb integral historical features					0	N/A	R*	✗	
Deterioration or loss of integral geological or paleontological features	Condition index for integral geological or paleontological features	No integral geological or paleontological features present				0	N/A	R*	✗	
	Number of authorized or unauthorized actions that damage or disturb integral geological or paleontological features					0	N/A	R*	✗	
Deterioration or loss of other tangible and integral features of value	Condition index for other integral site-specific features	No other tangible and integral features of value present				0	N/A	R*	✗	

APPENDIX C—What is a trammeling action?

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April 30, 2014

This appendix provides guidelines and examples to clarify what is and is not a trammeling action. These guidelines and examples are intended to capture about 90% of the cases and provide sufficient guidance for local staff to figure out the novel and rarer cases as they occur. This appendix does not discuss how to weight such actions, how to find or record the data for these actions, or any other aspect of using this information in wilderness character monitoring.

The following definitions are used in this appendix:

Trammeling action—an action that intentionally manipulates “the earth and its community of life” inside a designated wilderness or inside an area that by agency policy is managed as wilderness.

Intentional—done on purpose; deliberate; willful.

Manipulation—an action that alters, hinders, restricts, controls, or manipulates “the earth and its community of life” including the type, amount, or distribution of plants, animals, or physical resources inside a designated wilderness or inside an area that by agency policy is managed as wilderness.

Intentional manipulation—an action that purposefully alters, hinders, restricts, controls, or manipulates “the earth and its community of life.”

Based on these definitions, trammeling occurs when a manager makes a decision and takes action that intentionally manipulates the Natural Quality. Once action is taken the effect on the Natural Quality cannot typically be halted or stopped or reversed, and therefore the effect typically persists from the moment of the action onwards over time. Because of this persistent or permanent effect on “the earth and its community of life,” managers need to think long and hard about these types of decisions.

Trammeling actions are often considered only in terms of how they degrade the Untrammelled Quality, but the agencies take such actions for many different reasons that support or sustain the other qualities of wilderness character. For example, actions taken to protect and sustain the Natural Quality include controlling or eradicating non-native species, restoring degraded habitat, or protecting species from harm such as installing gates across caves to prevent people from entering. Resource management actions in wilderness almost always involve tradeoffs, and while there may be valid and good reasons for taking trammeling actions, these actions nonetheless degrade the Untrammelled Quality. The framework of wilderness character simply allows agency staff to be transparent about these tradeoffs that might be involved in actions taken to improve the Natural Quality that degrade the Untrammelled Quality. The goal of using the framework of wilderness character is to help agency staff make the decision that is deemed best overall for preserving wilderness character.

The following sections describe three types of activities: those that are not trammeling actions, those that are trammeling actions, and those that may be trammeling actions.

ACTIVITIES THAT ARE NOT TRAMMELING ACTIONS

There are several types of activities that have caused considerable discussion about whether they are trammeling actions. Examples that have been discussed as possible trammeling actions include climate change, air pollutants that drift into a wilderness, escaped camp fires the burn in wilderness, and non-

native species that disperse into a wilderness. Intentionality and the opportunity for management restraint are central tenets of the Untrammeled Quality, so if there is no opportunity for management restraint and no intention to manipulate the earth and its community of life, there is no impact on the Untrammeled Quality. In all of the examples cited above, there is no opportunity for management restraint and no intention to manipulate, so none of these examples would be counted as trammeling actions. There are certainly effects on the Natural Quality from these, and monitoring could track these effects.

Another group of examples have also caused lots of discussion, including installing meteorological or other science instrumentation, landing a helicopter for search and rescue operations, and removing trash. In each of these cases there is an opportunity for management restraint, but because there is no intention to manipulate the earth and its community of life, these are not considered trammeling actions. One last group of examples, including camping violations and unauthorized motorized incursions, are not considered trammeling actions because there is no opportunity for management restraint and there was no intention to manipulate the ecological system. In all of these examples there may be impacts to the other qualities of wilderness character, but not to the Untrammeled Quality.

Sport hunting has provoked an enormous amount of discussion about whether it degrades the Untrammeled Quality. The consensus view is that sport hunting is not a trammeling action because individual hunters are taking individual animals without the intention to manipulate the wildlife population. Like the other examples above, however, sport hunting, by affecting the abundance, distribution, and sex ratio of wildlife populations, may affect the Natural Quality; the presence of hunters may affect the Solitude or Primitive and Unconfined Recreation Quality; and structures built by hunters may affect the Undeveloped Quality.

ACTIVITIES THAT ARE TRAMMELING ACTIONS

There are two broad classes of activities that are trammeling actions, those that are authorized by the federal wilderness manager and those that are not. Under each of these broad classes there are several subclasses that reflect whether the action is taken on a biological resource or a physical resource, and whether the effect of the action is on a biological or physical resource. (This might seem like an unnecessary nuance but experience has shown that these distinctions help staff understand what trammeling actions are.) Almost always the concern is for actions that occur inside a designated wilderness, but one subclass provides examples of actions taken outside a designated wilderness that would be included as a trammeling action because the intention is to affect biological or physical resources inside the wilderness.

In some situations, staff may assume that they do not have the opportunity for restraint and therefore assume that their actions do not degrade the Untrammeled Quality. Examples of such situations include restoring habitat for a listed endangered species, spraying herbicides to eradicate an invasive non-native plant that is degrading wildlife habitat, transplanting an extirpated species back into the wilderness, or suppressing a naturally-ignited fire to save timber or homes adjacent to the wilderness. However, even in these situations, staff are deciding to take action as well as the type and intensity of action. In some of the examples above, staff are taking an action that supports one law (such as the Endangered Species Act) that degrades another (in this case the Wilderness Act).

Agency authorized trammeling actions

These are actions that are authorized by the federal wilderness manager as well as actions by other agencies, organizations, or individuals that have been approved or permitted by the federal land manager.

1. Actions taken inside the wilderness on vegetation or fish and wildlife to intentionally and directly affect this vegetation or fish and wildlife. Examples include:
 - Removing or killing native vegetation or fish and wildlife
 - Adding or restoring native vegetation or fish and wildlife
 - Adding non-native vegetation for erosion control
 - Adding non-native fish and wildlife
 - Spraying chemicals to control non-native vegetation or fish and wildlife
 - Releasing biocontrol agents to control non-native vegetation or fish and wildlife
 - Collecting vegetation for scientific study
 - Collecting or capturing and releasing fish and wildlife for scientific study
 - Collecting vegetation or fish and wildlife for commercial purposes
 - Enclosing or excluding fish and wildlife from an area to protect vegetation or to study the effects of enclosing or excluding fish and wildlife on protecting vegetation or animals
 - Adding piscicides to water to eliminate non-native fish
2. Actions taken inside the wilderness on a physical resource to intentionally and directly affect this physical resource. Examples include:
 - Suppressing naturally-ignited fire
 - Lighting fire (under management prescription) to reduce fuels or for other purposes
 - Constructing or maintaining a dam or diversion structure to alter the quantity or seasonal flow of water
 - Constructing a road to allow access to mineral, oil, or gas leases; communication sites; or inholdings
3. Actions taken inside the wilderness on a physical resource that intentionally affects the physical resource to directly or indirectly affect vegetation or fish and wildlife. Examples include:
 - Installing a gate across a cave that will protect bats but exclude other animals from using the cave
 - Constructing or maintaining a range allotment fence
 - Constructing a dam to exclude non-native species from moving up or down a stream
 - Installing guzzlers to provide water for wildlife
 - Lighting fire (under management prescription) or any other vegetation manipulation to improve wildlife habitat
 - Adding acid-buffering limestone to water to neutralize the effects of acid deposition on aquatic flora and fauna
4. Actions taken outside the wilderness on a physical or biological resource to intentionally and directly affect that resource inside a wilderness. Examples include:
 - Cloud seeding that occurs above the wilderness, and is therefore outside it, to intentionally increase precipitation inside the wilderness
 - Damming a river outside a wilderness to intentionally create a lake or water storage area inside the wilderness
 - Killing fish and wildlife outside the wilderness to intentionally affect the population or distribution of this species inside the wilderness
 - Planting or stocking fish and wildlife outside the wilderness to intentionally or foreseeably affect the population or distribution of this species inside the wilderness because of known habitat inside the wilderness

Not authorized trammeling actions

These are citable and other actions taken by other agencies, organizations, or individuals that have not been authorized, approved, or permitted by the federal wilderness land manager.

1. Actions taken inside the wilderness on vegetation or fish and wildlife to intentionally and directly affect this vegetation or fish and wildlife. Examples include:
 - Adding vegetation or fish and wildlife by a federal agency (other than the federal land managing agency), a state agency, or the public
 - Removing vegetation or fish and wildlife by a federal or state agency or the public
 - Inclosing or excluding fish and wildlife to study the effects of inclosing or excluding on vegetation or fish and wildlife
2. Actions taken inside the wilderness on a physical resource to intentionally and directly affect this resource. Examples include:
 - Modifying water flow to store water or alter the timing of water flow
 - Setting arson fire
3. Actions taken inside the wilderness on a physical resource that intentionally affects the physical resource to intentionally (either directly or indirectly) affect vegetation or fish and wildlife. Examples include:
 - Modifying water resources to provide water for wildlife
4. Actions taken outside the wilderness on vegetation or fish and wildlife to intentionally and directly affect the occurrence or distribution of these or other species inside a wilderness. Examples include:
 - Releasing species outside a wilderness with the intention to affect a population whose range expands into the wilderness
 - Killing wildlife outside of the wilderness with the intention to affect populations whose ranges expand into the wilderness

ACTIVITIES THAT MAY BE TRAMMELING ACTIONS

In many cases deciding whether an activity is a trammeling action is straightforward, but in other cases this decision is more complex and nuanced. These nuanced cases typically involve some type of action where the intent is not to manipulate the “earth and its community of life” but some manipulation of the environment is required to produce a desired outcome, such as building a trail. These nuanced cases may be confusing because even though the primary intent is not to manipulate species or physical resources, action is intentionally being taken and this action may have a foreseeable and substantial effect on “the earth and its community of life.”

In Table 65 below, several hypothetical situations illustrate how an action may or may not be a trammeling depending on the scope and scale of the action and its effects. Each bullet in the table presents a situation where the action being taken likely would, or would not, be considered a trammeling. For every real situation, agency staff need to think through whether the proposed action will have a foreseeable and substantial effect on “the earth and its community of life” and if their answer is “yes” then it’s a trammeling action, and if the answer is “no” then it’s not a trammeling action. Also, in this table an action may not be a trammeling but it still may affect other qualities of wilderness character. For example, installing rebar monumentation for a science project would likely not be a trammeling, but such installations would likely degrade the Undeveloped Quality.

Table 66. Examples of actions that likely are, and likely are *not*, trammeling actions.

Action	Likely <i>Not</i> a Trammeling	Likely a Trammeling
Building system trail	<ul style="list-style-type: none"> ▪ Routing a trail needs around a rock slide that obliterated the former trail ▪ Building a bridge across a stream to prevent stream bank erosion ▪ Installing a small section of corduroy across a wet area to prevent trenching ▪ Installing in water bars ▪ Removing rock in a trail ▪ Building rock-cribbing to support a trail 	<ul style="list-style-type: none"> ▪ Routing a trail through an area of endangered alpine butterfly habitat ▪ Building a large amount of new trail to go around a section of a river or a cliff ▪ Building a trail that requires extensive earth movement or tree cutting
Obliterating non-system trail	<ul style="list-style-type: none"> ▪ Piling vegetation or rocks at the beginning and end of trail sections that cut a switchback ▪ Piling vegetation or rocks to block social trails around campsites 	<ul style="list-style-type: none"> ▪ Obliterating a large section of non-system trail that requires extensive earth movement
Restoring campsites	<ul style="list-style-type: none"> ▪ Restoring a single, isolated campsite ▪ Restoring a number of campsites (e.g. that are clustered around a lake) that doesn't require degrading the soil or vegetation in the surrounding area 	<ul style="list-style-type: none"> ▪ Restoring a number of campsites that does require moving a significant amount of soil or number of plants in the surrounding area
Closing caves	<ul style="list-style-type: none"> ▪ Installing a bat gate across one or a few caves of many in the area 	<ul style="list-style-type: none"> ▪ Installing bat gates across all the caves in an area
Removing hazard trees	<ul style="list-style-type: none"> ▪ Removing one or a few hazard trees that threaten designated campsites or that are along a trail 	<ul style="list-style-type: none"> ▪ Removing all of the hazard trees over a large area
Treating non-native invasive plants	<ul style="list-style-type: none"> ▪ Hand pulling a small area of non-native invasive plants 	<ul style="list-style-type: none"> ▪ Spraying any herbicide
Permitting scientific activities	<ul style="list-style-type: none"> ▪ Installing research plot monumentation, such as rebar stakes or nails ▪ Installing most scientific instrumentation ▪ Collecting a limited number of voucher specimens with no impact species distribution or abundance 	<ul style="list-style-type: none"> ▪ Installing enclosures or exclosures that affect the movement of fish and wildlife ▪ Installing instrumentation that disrupts the movement or behavior of plants, or fish and wildlife ▪ Collecting voucher specimens that does affect the species distribution or abundance

APPENDIX D—Counting authorized trammeling actions

Table 67. Counting trammeling actions

Type of Action	Reporting
Fire	<p>One action per fire related activity (e.g. prescription fire, fuel reduction actions, etc.).</p> <ul style="list-style-type: none"> ▪ Suppression of naturally ignited fire is counted as one trammeling action per fire, but is only included under the “percent of natural fires <i>not</i> receiving a suppression response” measure and not under the “authorized actions...” measure. ▪ Suppression of human-started fires (whether caused by accidents, willful disobedience of fire bans, or arson) is not considered a trammeling action because the fire itself is not natural.
Trail or campsite construction, rehabilitation, or removal	<p>One action per large-scale project.</p> <ul style="list-style-type: none"> ▪ Constructing a new trail, designated campsite, or road counts as one action regardless of the length or area. ▪ Restoring or removing a trail, designated campsite, or road counts as one action <i>only</i> if doing so requires extensive earth movement or extensive seeding or planting. ▪ Naturalizing or brushing in a social trail, unauthorized campsite, or roadbed without causing extensive earth movement and without moving an extensive amount of plants does not count as a trammeling action; restoring a trail or campsite by cutting vegetation back, etc. similarly does not count as an action. ▪ Re-routing trails around landslides, building steps or bridges on established trails, installing water bars, removing a rock, installing corduroy to prevent trenching, or building rock cribbing to support a trail are not considered trammeling actions. ▪ Removing hazard trees along designated trails or campsites is not considered a trammeling action; however, removing all hazard trees across the wilderness area would count as a cumulative trammeling action. ▪ Construction, restoration, and destruction of trails are all considered to be one type of action (trail work). Projects involving some or all of these activities (e.g. eliminating an eroding unauthorized trail using extensive earth movement and simultaneously constructing a new authorized trail to divert visitors) therefore count as one trammeling action. ▪ Moving plants or spreading seeds as part of a trail, designated campsite, or road construction, restoration, or destruction is included in the count or non-count of the action and is not considered an additional trammeling action (e.g. moving a few plants to help close a single designated campsite does not count as a trammeling action; extensively seeding a user-created trail to close it to visitor use is included in the count of one trammeling action).
Persistent structures built inside or outside the wilderness that intend to manipulate or alter wilderness hydrology	<p>One action per installation or maintenance of persistent structures (e.g. dams, water guzzlers, stock ponds, etc.). Actions are only counted the year the activity occurs.</p> <ul style="list-style-type: none"> ▪ The construction of dams, irrigation ditches, or other structures that are intended to manipulate the hydrology <i>outside</i> the wilderness do not count as trammeling actions.
Grazing and range allotment maintenance	<p>One action per new permit authorization. Authorization of new grazing permittees—including grazing permits that were sold to new owners—also counts as one trammeling action.</p>

Table 67. Counting trammeling actions

Type of Action	Reporting
	<ul style="list-style-type: none"> ▪ Allowing continued grazing where established prior to wilderness designation is provided for in the Wilderness Act of 1964 and as such is not a trammeling action (as there is no opportunity for restraint). ▪ The installation or maintenance of range fencing or water developments counts as one action the year the activity occurs. Irrigation ditches, dams, or other water developments constructed for the benefit of a range allotment follow the same reporting guidelines outlined above (see the section on <i>persistent structures built inside or outside the wilderness that intend to manipulate or alter wilderness hydrology</i>).
Research and other specially authorized activities involving the manipulation of wildlife distribution, movement, or abundance	<p>One action per trammeling research project.</p> <ul style="list-style-type: none"> ▪ Some research activities would not be considered trammeling actions (e.g. flagging or marking research plots, installing game cameras, observational research, collection of one or two voucher specimen, etc.). ▪ The disruption of normal animal movement patterns (e.g. by installing enclosures or exclosures that inhibit movement) is a trammeling action and is counted as one action the year the installation or maintenance of such structures occurs. ▪ Trapping wildlife is considered a trammeling action regardless of the success rate of that trapping, so long as the intent is to trap more than one or two voucher specimen. ▪ Fish assessments are considered trammeling actions if they involve gill netting or electrofishing; assessments using visual observation are not trammeling actions; assessments conducted via angling will generally be considered too small scale to be counted as a trammeling action (similar to the provision above regarding trapping a limited number of voucher specimen). Unauthorized fish assessments conducted by the state are counted under the “unauthorized actions...” measure, while authorized fish assessments conducted by the Fish and Wildlife Service would be included under the “authorized actions...” measure. ▪ Research projects involving more than one species (e.g. a project to trap both pikas and marmots) are counted as one action. ▪ Commercial collection and/or removal of wildlife counts as one trammeling action per permit authorization.
Wildlife management activities occurring inside or outside of the wilderness with the intent to change abundance, distribution, etc. within the wilderness	<p>One action per wildlife management activity. Releasing 5 animals is equivalent to releasing 500. Releasing wildlife directly inside the wilderness is equivalent to releasing wildlife outside of the wilderness with the intent that they will migrate into and populate the wilderness.</p> <ul style="list-style-type: none"> ▪ Actions to remove wildlife species (e.g. adding piscicides to a lake to remove non-native species, authorizing a hunt inside or outside of the wilderness with the specific intent to significantly reduce populations inside the wilderness, etc.) are also trammeling actions. ▪ Combined actions—such as the removal of non-native fish from a stream and the release of native fish to take their place—count as separate actions regardless of whether or not they are covered under the same MRA or NEPA analysis. ▪ Fish stocking is a trammeling action. Unauthorized stocking by the state is counted under the “fish stocking actions” measure, and not the “authorized actions...” measure. ▪ Recreational or sport hunting and fishing are not considered trammeling actions, unless specifically authorized with the intent to remove wildlife populations.

Table 67. Counting trammeling actions

Type of Action	Reporting
	<ul style="list-style-type: none"> ▪ Installing or maintaining enclosures or exclosures (e.g. to protect vegetation restoration areas, for range allotment containment, etc.) are also trammeling actions and are counted as one action the year installation or maintenance occurs. ▪ The installation of water guzzlers also counts as a trammeling action (see the section on <i>persistent structures built inside or outside the wilderness that intend to manipulate or alter wilderness hydrology</i>).
Collecting or removing plants, seeds, rocks, bones, minerals, fossils, etc.	<p>One action per large scale collection.</p> <ul style="list-style-type: none"> ▪ Collecting and removing the majority of seeds of a sensitive species for propagation efforts or scientific study is considered a trammeling action; for plant or seed collection that is authorized to occur indefinitely, each year of collection is counted as a separate trammeling action. ▪ Commercial collection authorized under a special use or other permit is counted as one trammeling action per permit; each year the permit is authorized or in effect it counts as one trammeling action. ▪ Individual collection for private use is not considered a trammeling action (e.g. individuals collecting shed antlers, amateur geologists collecting a small number of rock samples, etc.). ▪ Gathering of nearby plants or seeds for a rehabilitation or construction project is likewise not considered a trammeling action by itself (see the section on <i>restoring vegetation</i>).
Restoring vegetation	<p>One action per large-scale restoration event. Restoration projects encompassing multiple locations are counted as one action. The use of non-native seeds is equivalent to the use of native seeds, and the use of local seeds is equivalent to the use of imported seeds.</p> <ul style="list-style-type: none"> ▪ Small-scale vegetation restoration (e.g. moving a few local saplings to hide a campsite from view of the trail so that it will receive fewer visitors) does not count as a trammeling action. ▪ Restoration of vegetation as part of emergency stabilization and rehabilitation after a fire event counts as one action per fire. ▪ Moving established plants during trail or campsite construction or rehabilitation projects is not counted as a separate trammeling action—if the project is of sufficient scale, any vegetation restoration is included in that count (see the section on <i>trail or campsite construction, rehabilitation, or removal</i>).
Weeds treatments	<p>One action per treatment type. Treating multiple species in multiple locations is counted as one action. Each type of treatment action (e.g. using mechanical treatment, chemical herbicides, or biological control agents) counts as a separate trammeling action. Small-scale projects (e.g. hand pulling a few invasive species while restoring a campsite) do not count as trammeling actions.</p>
Controlling insects or disease	<p>One action per treatment type. Controlling multiple species in multiple locations counts as one action so long as it is covered under one treatment type.</p>
Other actions that intentionally manipulate the biophysical environment	<p>One action per large scale activity. Cloudseeding inside or outside of wilderness to increase precipitation inside the wilderness, adding acid-buffering limestone to water to neutralize the effects of acid deposition, and other activities intended to manipulate the biophysical environment each count as one action.</p>

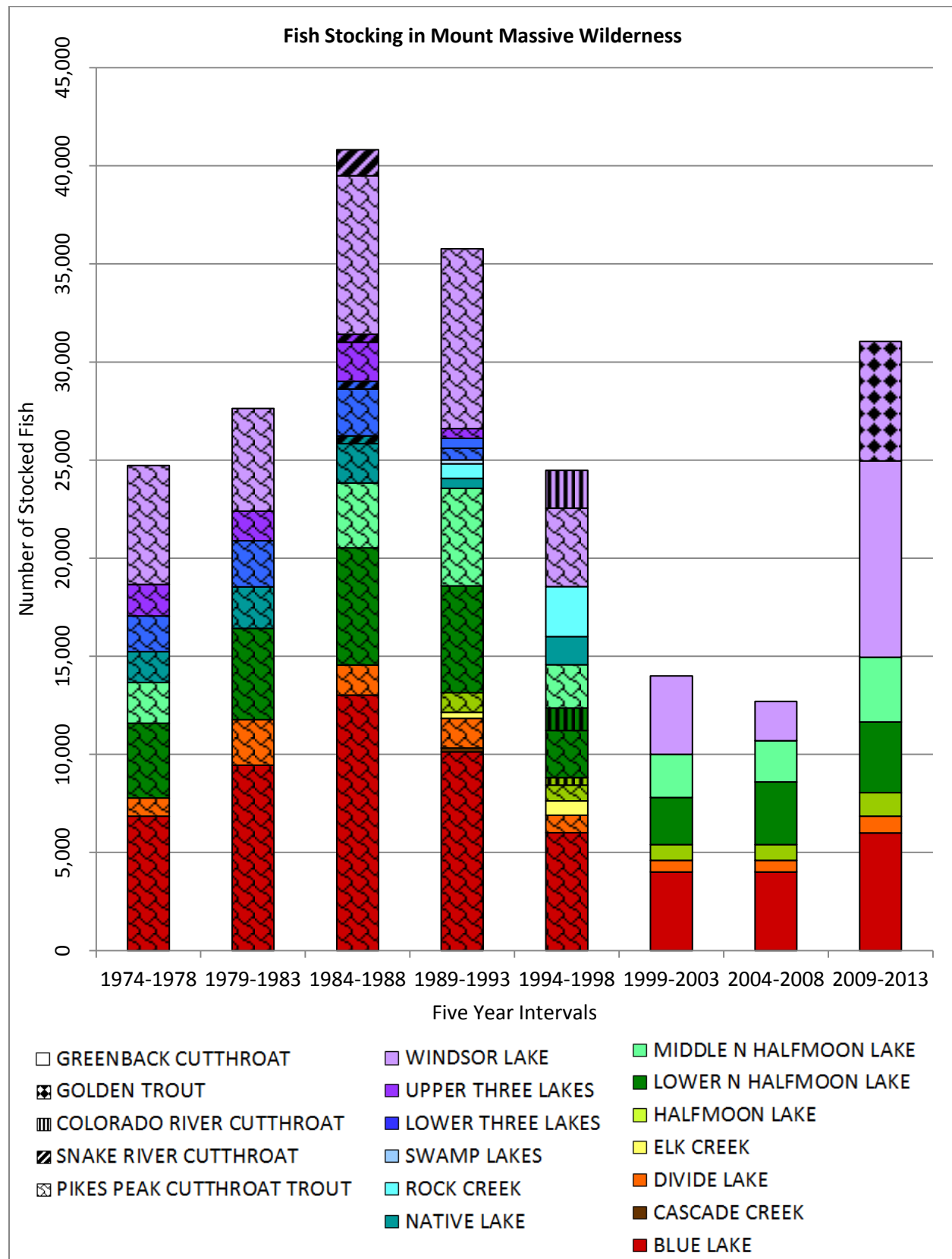


Figure 37. Fish stocking in Mount Massive Wilderness by lake and species

Table 68. Natural Quality index of fish stocking in Mount Massive Wilderness

Year	Lake*	Fish species stocked*	Score	X	Number of fish	Score	=	Sub-total	Total	5 Year
2013	Blue Lake	Greenback Cutthroat	1	X	2001	2	=	2	13	37.2
	Divide Lake	Greenback Cutthroat	1		251	0.3		0.3		
	Windsor Lake	Greenback Cutthroat	1		8001	8		8		
	Halfmoon Lake	Greenback Cutthroat	1		401	0.4		0.4		
	Lower N Halfmoon Lake	Greenback Cutthroat	1		1202	1.2		1.2		
	Middle N Halfmoon Lake	Greenback Cutthroat	1		1101	1.1		1.1		
2012	Windsor	Golden Trout	2	X	5000	5	=	10	10	
2011	Windsor Lake	Golden Trout	2	X	1085	1.1	=	2.2	7.2	
	Blue Lake	Greenback Cutthroat	1		2000	2		2		
	Middle N Halfmoon Lake	Greenback Cutthroat	1		1100	1.1		1.1		
	Lower N Halfmoon Lake	Greenback Cutthroat	1		1200	1.2		1.2		
	Divide Lake	Greenback Cutthroat	1		300	0.3		0.3		
	Halfmoon Lake	Greenback Cutthroat	1		400	0.4		0.4		
2010	N/A	N/A	0	X	N/A	0	=	0	0	
2009	Halfmoon Lake	Greenback Cutthroat	1	X	400	0.4	=	0.4	7	
	Windsor Lake	Greenback Cutthroat	1		2000	2		2		
	Divide Lake	Greenback Cutthroat	1		300	0.3		0.3		
	Blue Lake	Greenback Cutthroat	1		2000	2		2		
	Middle N Halfmoon Lake	Greenback Cutthroat	1		1101	1.1		1.1		
	Lower N Halfmoon Lake	Greenback Cutthroat	1		1200	1.2		1.2		
2008	N/A	N/A	0	X	N/A	0	=	0	0	
2007	Blue Lake	Greenback Cutthroat	1	X	2000	2	=	2	5	
	Lower N Halfmoon Lake	Greenback Cutthroat	1		1199	1.2		1.2		
	Middle N Halfmoon Lake	Greenback Cutthroat	1		1101	1.1		1.1		
	Divide Lake	Greenback Cutthroat	1		299	0.3		0.3		
	Halfmoon Lake	Greenback Cutthroat	1		400	0.4		0.4		
2006	N/A	N/A	0	X	N/A	0	=	0	0	
2005	Blue Lake	Greenback Cutthroat	1	X	2000	2	=	2	7.7	
	Middle N Halfmoon Lake	Greenback Cutthroat	1		1000	1		1		
	Lower N Halfmoon Lake	Greenback Cutthroat	1		2000	2		2		
	Windsor Lake	Greenback Cutthroat	1		2000	2		2		
	Divide Lake	Greenback Cutthroat	1		301	0.3		0.3		
	Halfmoon Lake	Greenback Cutthroat	1		400	0.4		0.4		
2004	N/A	N/A	0	X	N/A	0	=	0	0	
2003	Divide Lake	Greenback Cutthroat	1	X	300	0.3	=	0.3	7	
	Blue Lake	Greenback Cutthroat	1		2000	2		2		
	Lower N Halfmoon Lake	Greenback Cutthroat	1		1202	1.2		1.2		
	Middle N Halfmoon Lake	Greenback Cutthroat	1		1100	1.1		1.1		
	Windsor Lake	Greenback Cutthroat	1		2000	2		2		
	Halfmoon Lake	Greenback Cutthroat	1		400	0.4		0.4		
2002	N/A	N/A	0	X	N/A	0	=	0	0	
2001	N/A	N/A	0	X	N/A	0	=	0	0	
2000	Middle N Halfmoon Lake	Greenback Cutthroat	1	X	1097	1.1	=	1.1	7	

Table 68. Natural Quality index of fish stocking in Mount Massive Wilderness

Year	Lake*	Fish species stocked*	Score	X	Number of fish	Score	=	Sub-total	Total	5 Year
	Lower N Halfmoon Lake	Greenback Cutthroat	1		1205	1.2		1.2		
	Blue Lake	Greenback Cutthroat	1		2001	2		2		
	Windsor Lake	Greenback Cutthroat	1		2001	2		2		
	Divide Lake	Greenback Cutthroat	1		301	0.3		0.3		
	Halfmoon Lake	Greenback Cutthroat	1		397	0.4		0.4		
1999	N/A	N/A	0	X	N/A	0	=	0	0	
1998	Windsor Lake	Pikes Peak Cutthroat	2	X	1998	2	=	4	14	
	Halfmoon Lake	Pikes Peak Cutthroat	2		401	0.4		0.8		
	Lower N Halfmoon Lake	Pikes Peak Cutthroat	2		1202	1.2		2.4		
	Middle N Halfmoon Lake	Pikes Peak Cutthroat	2		1100	1.1		2.2		
	Divide Lake	Pikes Peak Cutthroat	2		299	0.3		0.6		
	Blue Lake	Pikes Peak Cutthroat	2		1998	2		4		
1997	N/A	N/A	0	X	N/A	0	=	0	0	
1996	Divide Lake	Pikes Peak Cutthroat	2	X	301	0.3		0.6	18.6	44
	Middle N Halfmoon Lake	Pikes Peak Cutthroat	2		1100	1.1		2.2		
	Lower N Halfmoon Lake	Pikes Peak Cutthroat	2		1198	1.2		2.4		
	Halfmoon Lake	Pikes Peak Cutthroat	2		400	0.4		0.8		
	Windsor Lake	Pikes Peak Cutthroat	2		2005	2		4		
	Blue Lake	Pikes Peak Cutthroat	2		2005	2		4		
	Rock Creek	Greenback Cutthroat	1		2548	2.5		2.5		
	Elk Creek	Greenback Cutthroat	1		728	0.7		0.7		
	Native Lake	Greenback Cutthroat	1		728	0.7		0.7		
	Native Lake	Greenback Cutthroat	1		700	0.7		0.7		
1995	N/A	N/A	0	X	N/A	0	=	0	0	
1994	Blue Lake	Pikes Peak Cutthroat	2	X	1999	2	=	4	11.4	
	Divide Lake	Pikes Peak Cutthroat	2		297	0.3		0.6		
	Halfmoon Lake	CO River Cutthroat	2		386	0.3		0.6		
	Windsor Lake	CO River Cutthroat	2		1930	1.9		3.8		
	Lower N Halfmoon Lake	CO River Cutthroat	2		1158	1.2		2.4		
1993	Windsor Lake	Pikes Peak Cutthroat	2	X	204	0.2	=	0.4	9.8	69
	Lower N Halfmoon Lake	Pikes Peak Cutthroat	2		630	0.6		1.2		
	Middle N Halfmoon Lake	Pikes Peak Cutthroat	2		560	0.6		1.2		
	Halfmoon Lake	Pikes Peak Cutthroat	2		210	0.2		0.4		
	Blue Lake	Pikes Peak Cutthroat	2		2006	2		4		
	Divide Lake	Pikes Peak Cutthroat	2		296	0.3		0.6		
	Blue Lake	Pikes Peak Cutthroat	2		95	0.1		0.2		
	Windsor Lake	Pikes Peak Cutthroat	2		869	0.9		1.8		
1992	Divide Lake	Pikes Peak Cutthroat	2	X	301	0.3	=	0.6	14	
	Blue Lake	Pikes Peak Cutthroat	2		2000	2		4		
	Halfmoon Lake	Pikes Peak Cutthroat	2		398	0.4		0.8		
	Windsor Lake	Pikes Peak Cutthroat	2		2000	2		4		
	Middle N Halfmoon Lake	Pikes Peak Cutthroat	2		1099	1.1		2.2		
	Lower N Halfmoon Lake	Pikes Peak Cutthroat	2		1199	1.2		2.4		

Table 68. Natural Quality index of fish stocking in Mount Massive Wilderness

Year	Lake*	Fish species stocked*	Score	X	Number of fish	Score	=	Sub-total	Total	5 Year
1991	Divide Lake	Pikes Peak Cutthroat	2	X	303	0.3	=	0.6	16.4	
	Blue Lake	Pikes Peak Cutthroat	2		2004	2		4		
	Middle N Halfmoon Lake	Pikes Peak Cutthroat	2		1100	1.1		2.2		
	Lower N Halfmoon Lake	Pikes Peak Cutthroat	2		1200	1.2		2.4		
	Halfmoon Lake	Pikes Peak Cutthroat	2		400	0.4		0.8		
	Windsor Lake	Pikes Peak Cutthroat	2		2000	2		4		
	Lower Three Lakes	Greenback Cutthroat	1		500	0.5		0.5		
	Swamp Lakes	Greenback Cutthroat	1		198	0.2		0.2		
	Native Lake	Greenback Cutthroat	1		500	0.5		0.5		
	Cascade Creek	Greenback Cutthroat	1		200	0.2		0.2		
	Rock Creek	Greenback Cutthroat	1		745	0.7		0.7		
	Elk Creek	Greenback Cutthroat	1		300	0.3		0.3		
1990	Divide Lake	Pikes Peak Cutthroat	2	X	313	0.3	=	0.6	13.4	
	Lower N Halfmoon Lake	Pikes Peak Cutthroat	2		1214	1.2		2.4		
	Blue Lake	Pikes Peak Cutthroat	2		2024	2		4		
	Middle N Halfmoon Lake	Pikes Peak Cutthroat	2		1122	1.1		2.2		
	Windsor Lake	Pikes Peak Cutthroat	2		2090	2.1		4.2		
1989	Upper Three Lakes	Pikes Peak Cutthroat	2	X	494	0.5	=	1	15.4	
	Lower Three Lakes	Pikes Peak Cutthroat	2		599	0.6		1.2		
	Windsor Lake	Pikes Peak Cutthroat	2		2008	2		4		
	Lower N Halfmoon Lake	Pikes Peak Cutthroat	2		1199	1.2		2.4		
	Middle N Halfmoon Lake	Pikes Peak Cutthroat	2		1094	1.1		2.2		
	Blue Lake	Pikes Peak Cutthroat	2		2002	2		4		
	Divide Lake	Pikes Peak Cutthroat	2		296	0.3		0.6		
1988	N/A	N/A	0	X	N/A	0	=	0	0	
1987	Middle N Halfmoon Lake	Pikes Peak Cutthroat	2	X	1100	1.1	=	2.2	9.2	
	Divide Lake	Pikes Peak Cutthroat	2		300	0.3		0.6		
	Lower N Halfmoon Lake	Pikes Peak Cutthroat	2		1200	1.2		2.4		
	Blue Lake	Pikes Peak Cutthroat	2		2000	2		4		
1986	Divide Lake	Pikes Peak Cutthroat	2	X	290	0.3	=	0.6	23.8	75.6
	Lower N Halfmoon Lake	Pikes Peak Cutthroat	2		1203	1.2		2.4		
	Native Lake	Pikes Peak Cutthroat	2		995	1		2		
	Middle N Halfmoon Lake	Pikes Peak Cutthroat	2		1102	1.1		2.2		
	Windsor Lake	Pikes Peak Cutthroat	2		4081	4.1		8.2		
	Lower Three Lakes	Pikes Peak Cutthroat	2		1185	1.2		2.4		
	Upper Three Lakes	Pikes Peak Cutthroat	2		995	1		2		
	Blue Lake	Pikes Peak Cutthroat	2		2001	2		4		
1985	Windsor Lake	Pikes Peak Cutthroat	2	X	4000	4	=	8	23.6	
	Lower Three Lakes	Pikes Peak Cutthroat	2		1200	1.2		2.4		
	Lower N Halfmoon Lake	Pikes Peak Cutthroat	2		1170	1.2		2.4		
	Native Lake	Pikes Peak Cutthroat	2		1000	1		2		
	Middle N Halfmoon Lake	Pikes Peak Cutthroat	2		1105	1.1		2.2		
	Upper Three Lakes	Pikes Peak Cutthroat	2		1000	1		2		

Table 68. Natural Quality index of fish stocking in Mount Massive Wilderness

Year	Lake*	Fish species stocked*	Score	X	Number of fish	Score	=	Sub-total	Total	5 Year
	Divide Lake	Pikes Peak Cutthroat	2		325	0.3		0.6		
	Blue Lake	Pikes Peak Cutthroat	2		2015	2		4		
1984	Divide Lake	Pikes Peak Cutthroat	2	X	615	0.6	=	1.2	19	
	Lower N Halfmoon Lake	Pikes Peak Cutthroat	2		2404	2.4		4.8		
	Blue Lake	Pikes Peak Cutthroat	2		4008	4		8		
	Windsor Lake	Snake River Cutthroat	2		1320	1.3		2.6		
	Lower Three Lakes	Snake River Cutthroat	2		400	0.4		0.8		
	Upper Three Lakes	Snake River Cutthroat	2		400	0.4		0.8		
	Native Lake	Snake River Cutthroat	2		400	0.4		0.8		
	1983	N/A	N/A		0	X		N/A		
1982	N/A	N/A	0	X	N/A	0	=	0	0	
1981	Divide Lake	Pikes Peak Cutthroat	2	X	1500	1.5	=	3	36	
	Blue Lake	Pikes Peak Cutthroat	2		4500	4.5		9		
	Lower N Halfmoon Lake	Pikes Peak Cutthroat	2		3000	3		6		
	Windsor Lake	Pikes Peak Cutthroat	2		4500	4.5		9		
	Upper Three Lakes	Pikes Peak Cutthroat	2		1500	1.5		3		
	Lower Three Lakes	Pikes Peak Cutthroat	2		1500	1.5		3		
	Native Lake	Pikes Peak Cutthroat	2		1500	1.5		3		
1980	N/A	N/A	0	X	N/A	0	=	0	0	
1979	Blue Lake	Pikes Peak Cutthroat	2	X	4950	5	=	10	19.2	
	Divide Lake	Pikes Peak Cutthroat	2		825	0.8		1.6		
	Lower N Halfmoon Lake	Pikes Peak Cutthroat	2		1650	1.7		3.4		
	Lower Three Lakes	Pikes Peak Cutthroat	2		612	0.6		1.2		
	Lower Three Lakes	Pikes Peak Cutthroat	2		245	0.2		0.4		
	Windsor Lake	Pikes Peak Cutthroat	2		735	0.7		1.4		
	Native Lake	Pikes Peak Cutthroat	2		612	0.6		1.2		
1978	N/A	N/A	0	X	N/A	0	=	0	0	49.2
1977	Native Lake	Pikes Peak Cutthroat	2	X	135	0.1	=	0.2	12.4	
	Middle N Halfmoon Lake	Pikes Peak Cutthroat	2		1200	1.2		2.4		
	Lower N Halfmoon Lake	Pikes Peak Cutthroat	2		1200	1.2		2.4		
	Divide Lake	Pikes Peak Cutthroat	2		600	0.6		1.2		
	Windsor Lake	Pikes Peak Cutthroat	2		315	0.3		0.6		
	Upper Three Lakes	Pikes Peak Cutthroat	2		180	0.2		0.4		
	Lower Three Lakes	Pikes Peak Cutthroat	2		180	0.2		0.4		
	Blue Lake	Pikes Peak Cutthroat	2		2400	2.4		4.8		
1976	N/A	N/A	0	X	N/A	0	=	0	0	
1975	Windsor Lake	Pikes Peak Cutthroat	2	X	1744	1.7	=	3.4	20.4	
	Lower Three Lakes	Pikes Peak Cutthroat	2		436	0.4		0.8		
	Divide Lake	Pikes Peak Cutthroat	2		327	0.3		0.6		
	Upper Three Lakes	Pikes Peak Cutthroat	2		436	0.4		0.8		
	Middle N Halfmoon Lake	Pikes Peak Cutthroat	2		872	0.9		1.8		
	Native Lake	Pikes Peak Cutthroat	2		436	0.4		0.8		
	Lower N Halfmoon Lake	Pikes Peak Cutthroat	2		2610	2.6		5.2		

Table 68. Natural Quality index of fish stocking in Mount Massive Wilderness

Year	Lake*	Fish species stocked*	Score	X	Number of fish	Score	=	Sub-total	Total	5 Year
	Blue Lake	Pikes Peak Cutthroat	2		3480	3.5		7		
1974	Windsor Lake	Pikes Peak Cutthroat	2	X	4000	4	=	8	16.4	
	Lower Three Lakes	Pikes Peak Cutthroat	2		1200	1.2		2.4		
	Upper Three Lakes	Pikes Peak Cutthroat	2		1000	1		2		
	Native Lake	Pikes Peak Cutthroat	2		1000	1		2		
	Blue Lake	Pikes Peak Cutthroat	2		975	1		2		
1973	Divide Lake	Pikes Peak Cutthroat	2	X	580	0.6	=	1.2	31.2	N/A
	Middle N Halfmoon Lake	Pikes Peak Cutthroat	2		1972	2		4		
	Lower N Halfmoon Lake	Pikes Peak Cutthroat	2		1972	2		4		
	Twin Lakes	Pikes Peak Cutthroat	2		1044	1		2		
	Native Lake	Pikes Peak Cutthroat	2		1044	1		2		
	Upper Three Lakes	Pikes Peak Cutthroat	2		1044	1		2		
	Lower Three Lakes	Pikes Peak Cutthroat	2		1044	1		2		
	Windsor Lake	Pikes Peak Cutthroat	2		3712	3.7		7.4		
	Windsor Lake	Lake Trout--Mackinaw	2		150	0.2		0.4		
	Blue Lake	Pikes Peak Cutthroat	2		3132	3.1		6.2		

*It is extremely unlikely that the fish listed here as “greenback cutthroats” were actually greenback cutthroats. “Greenback cutthroats” stocked within the last few years are likely to have been green lineage, while those stocked before likely to have been lineage—CR.

APPENDIX F—Summary of effort required for wilderness character monitoring

Note that the “hours to gather data” section below includes both time spent finding/gathering the data and time spent analyzing the data; it does not include time spent developing indices or counting/weighting protocols. Now that the baseline data have been collected, data sources have been determined, and analysis protocols have been established, future data gathering and analysis will require significantly less time.

MEASURE	TYPE OF DATA SOURCE	HOURS TO GATHER DATA	COMMENTS—FUTURE REQUIREMENTS
UNTRAMMELED			
Authorized actions and persistent structures designed to manipulate the plants, animals, pathogens, soil, water, or fire	Professional knowledge	1	The wilderness manager and/or staff officer should keep track of this annually. Check with various resource specialists, the regional office (for regional research projects), and the Leadville National Fish Hatchery.
Percent of natural fires <i>not</i> receiving a suppression response (<i>Formerly: Percent of natural fire perimeters that were manipulated</i>)	Office and computer files, professional knowledge	5	Check with fire.
Unauthorized actions by agencies, citizen groups, or individuals that manipulate plants, animals, pathogens, soil, water, or fire	Office and computer files, professional knowledge, state records	2	The wilderness manager and/or staff officer should keep track of any known unauthorized trammeling actions annually. Request fish assessment data from Colorado Parks and Wildlife (from the Aquatic Research Data Analyst). Check with the Leadville National Fish Hatchery.
Fish stocking actions (<i>Formerly: Number of lakes and other water bodies stocked with fish</i>)	Office files, professional knowledge, state records	2	Request fish stocking data from Colorado Parks and Wildlife (from the Aquatic Research Data Analyst). Check with the Leadville National Fish Hatchery.
NATURAL			
Non-native invasive plant species	Professional knowledge	1	Check with field-going personnel (mainly wilderness rangers).
Index of plant species of concern	Professional Knowledge	2	Check with the botanist.
Non-native animal species	Professional Knowledge	2	Check with the wildlife biologist.

MEASURE	TYPE OF DATA SOURCE	HOURS TO GATHER DATA	COMMENTS—FUTURE REQUIREMENTS
Index of animal species of concern	Professional Knowledge	4	Check with the wildlife biologist.
Index of stocked lakes	State records	2	Request fish stocking data from Colorado Parks and Wildlife (from the Aquatic Research Data Analyst). Check with the Leadville National Fish Hatchery.
Ozone exposure statistics N100 and W126	Internet	20	Pull data from CASTNET website, calculations required.
Concentration of nitrogen in wet deposition	Internet	4	Pull data from NADP/NTN website, minor calculations required.
Concentration of sulfur in wet deposition	Internet	4	Pull data from NADP/NTN website, minor calculations required.
Visibility statistics	Internet	10	Pull data from VIEWS website, minor calculations required.
Temperature	Internet	10	Pull data from SNOTEL and RAWS websites; regression analysis required.
Precipitation	Internet	10	Pull data from SNOTEL and RAWS websites; regression analysis required.
Glaciers and permanent snowfields	Photograph	3	Take annual photograph the last week in August.
Snow (annual snow days)	Internet	10	Pull data from SNOTEL website; regression analysis required.
Snow seasonality	Internet	10	Pull data from SNOTEL website; regression analysis required.
Average watershed condition class	Internet	1	Pull data from FS watershed condition class website.
Average natural fire regime condition class	Internet, GIS files	1	Pull data from LANDFIRE website (or identical FS GIS files). Minor GIS analysis is required.
UNDEVELOPED			
Index of authorized non-recreational physical development	Computer files, office files, professional knowledge	2	The wilderness manager and/or staff officer should keep track of any new developments or any loss of developments annually. Check with the Leadville National Fish Hatchery, various resource specialists, and the regional office (for regional research projects).
Index of authorized recreational physical development	Computer files, office files, professional knowledge	2	The wilderness manager and/or staff officer should keep track of any new developments or any loss of developments annually. Check with the Leadville National Fish Hatchery and various resource specialists.
Index of inholdings	Internet, GIS files	4	Check the lands specialist, GIS data, and the Wilderness Land Trust website.

MEASURE	TYPE OF DATA SOURCE	HOURS TO GATHER DATA	COMMENTS—FUTURE REQUIREMENTS
Index of administrative authorizations to use motor vehicles, motorized equipment or mechanical transport	Professional knowledge	1	The wilderness manager and/or staff officer should keep track of any administrative authorizations annually. Check with the Leadville National Fish Hatchery.
Percent of emergency incidents <i>not</i> using motor vehicles, motorized equipment, or mechanical transport	Professional knowledge	1	The wilderness manager and/or staff officer should keep track of any emergency authorizations annually, or call Lake County SAR.
SOLITUDE OR PRIMITIVE AND UNCONFINED RECREATION			
Travel route encounters	Office files	2	Pull data from the Wilderness Ranger Reports.
Visitation	Office and computer files	10	Pull data from wilderness permits.
Area of wilderness away from access and travel routes and developments	GIS files	5	GIS analysis is required.
User-created campsites	Office files, field work	3	Pull data from the most campsite inventory.
Miles of user-created trails	Office files, GIS files	10	Pull data from special use permits. Check with the special uses administrator. Outfitters/guides may need to be contacted for their information. GIS analysis is required.
Commercial use	Office files, professional knowledge	8	Pull data from special use permits. Check with the special uses administrator.
Area of wilderness not affected by adjacent travel routes and human developments	GIS files	5	GIS analysis is required.
Index of authorized recreation facilities	Computer files, office files, professional knowledge	2	The wilderness manager and/or staff officer should keep track of any new recreation facilities or any loss of recreation facilities annually. Check with the Leadville National Fish Hatchery and various resource specialists.
Miles of developed trails (condition classes 3-5)	Professional knowledge	2	Check with trails specialist.
Index of visitor management restrictions	Office files	1	Pull data from wilderness permits.

APPENDIX G—Data sources and protocols for all measures used

This appendix contains a brief summary of the data sources and collection protocols for each measure.

UNTRAMMELED

AUTHORIZED ACTIONS AND PERSISTENT STRUCTURES DESIGNED TO MANIPULATE PLANTS, ANIMALS, PATHOGENS, SOIL, WATER, OR FIRE: priority low, required.

Data Sources: Steve Sunday, Lead Wilderness Ranger; Michelle Mueggler, Acting Wilderness, Recreation, & Lands Staff Officer; Ed Stege, Leadville National Fish Hatchery Project leader, Nick Gerich, Hydrological Technician; Jeni Windorski, Wildlife Biologist.

Protocol: Count the number of trammeling actions authorized by the Forest Service or Fish and Wildlife Service. The trammeling action counting protocol is outlined in Table 8, and Appendix D offers examples of authorized trammeling actions and how to report them. Further explanations of what may or may not be considered a trammeling action can be found in Appendix C or at <http://ecos.fws.gov/ServCatFiles/Reference/Holding/26180>. *A decrease in the number of authorized actions intended to manipulate the biophysical environment in the wilderness would result in an upward trend in this measure, and would benefit the Untrammeled Quality.*

When to collect and report data: Report annually, data are cumulative for the fiscal year.

PERCENT OF NATURAL FIRES NOT RECEIVING A SUPPRESSION RESPONSE (FORMERLY: PERCENT OF NATURAL FIRE PERIMETERS THAT WERE MANIPULATED): priority low, required.

Data Sources: Steve Sunday, Lead Wilderness Ranger; open fire files on the USFS O drive.

Protocol: Calculate the percent of natural fires that are *not* suppressed in any way. Each naturally ignited fire that receives a suppression response, regardless of the magnitude of suppression, is counted as having been trammeled. Years in which there were no natural fires are counted as 100%. *Allowing naturally ignited fires to burn without suppression (thus increasing the percentage of fires not receiving a suppression response) would result in an upward trend in this measure, and would benefit the Untrammeled Quality.*

When to collect and report data: Report every five years, data are cumulative for the five calendar years.

UNAUTHORIZED ACTIONS BY AGENCIES, CITIZEN GROUPS, OR INDIVIDUALS THAT MANIPULATE PLANTS, ANIMALS, PATHOGENS, SOIL, WATER, OR FIRE: priority low, required if relevant.

Data Sources: Andrew Treble, Colorado Parks and Wildlife Aquatic Research Data Analyst; Doug Krieger, Colorado Parks and Wildlife Senior Aquatic Biologist; Ed Stege, Leadville National Fish Hatchery Project Leader; Steve Sunday, Lead Wilderness Ranger; Michelle Mueggler, Acting Wilderness, Recreation, & Lands Staff Officer.

Protocol: Count the number of trammeling actions not authorized by the Forest Service or Fish and Wildlife Service that are taken by individuals, citizen groups, or other agencies. The trammeling action counting protocol is outlined in Table 8, and Appendix D offers examples of authorized trammeling actions and how to report them. Further explanations of what may or may not be considered a trammeling action can be found in Appendix C or at <http://ecos.fws.gov/ServCatFiles/Reference/Holding/26180>. *A decrease in the number of unauthorized actions intended to manipulate the biophysical environment would result in an upward trend in this measure, and would benefit the Untrammeled Quality.*

When to collect and report data: Report every five years, data are cumulative for the five calendar years.

FISH STOCKING ACTIONS (FORMERLY: NUMBER OF LAKES AND OTHER WATER BODIES STOCKED WITH FISH): priority low, required if relevant.

Data Sources: Andrew Treble, Colorado Parks and Wildlife Aquatic Research Data Analyst; Ed Stege, Leadville National Fish Hatchery Project Leader.

Protocol: Count the number of fish stocking events undertaken by the state of Colorado without the knowledge and/or approval by the Forest Service or Fish and Wildlife Service. Data from Colorado Parks and Wildlife is taken as is (that is, each event they count separately is also counted separately here), and stocking the same lake multiple times in a given year count counts as multiple events. *A decreasing number of total stocking events would result in an upward trend in this measure, and would benefit the Untrammelled Quality.*

When to collect and report data: Report every five years, data are cumulative for the five calendar years.

NATURAL

NON-NATIVE INVASIVE PLANT SPECIES: priority not applicable, required.

Data Sources: Steve Sunday, Lead Wilderness Ranger; Michelle Mueggler, Acting Wilderness, Recreation, & Lands Staff Officer; monitoring of existing populations and observational evidence by wilderness rangers, technicians, and other agency personnel in the wilderness.

Protocol: Count the number of invasive and/or noxious weed species known to be currently present in the wilderness. Table 16 outlines the scoring protocols. *A decrease in the number of non-native invasive/noxious species would result in an upward trend in this measure, and would benefit the Natural Quality.*

When to collect and report data: Report every five years, data are instantaneous once every five years.

INDEX OF PLANT SPECIES OF CONCERN: priority not applicable, required.

Data Sources: Steve Olson, Botanist (Supervisor's Office).

Protocol: Count the number of sensitive or listed species known to be currently present in the wilderness. Any sensitive or listed plant species that has been discovered in the wilderness at any point in time counts in this measure. *An increase in rare, sensitive, or listed plant species known to exist in the wilderness would result in an upward trend in this measure, and would benefit the Natural Quality.*

When to collect and report data: Report every five years, data are instantaneous once every five years.

NON-NATIVE ANIMAL SPECIES: priority not applicable, required.

Data Sources: Jeni Windorski, Wildlife Biologist (with additional consultation with Jamin Grigg, Colorado Parks and Wildlife Terrestrial Biologist); Andrew Treble, Colorado Parks and Wildlife Aquatic Research Data Analyst; Ed Stege, Leadville National Fish Hatchery Project Leader.

Protocol: Count the number of non-native animal species that are known to be currently present in wilderness, or are extremely likely to be present. This includes all non-native fish species found in the last 10 years. Non-native wildlife species included in this count are determined by the wildlife biologist. *A decrease in the number of non-native species would result in an upward trend in this measure, and would benefit the Natural Quality.*

When to collect and report data: Report every five years, data are instantaneous once every five years.

INDEX OF ANIMAL SPECIES OF CONCERN: priority not applicable, required.

Data Sources: Jeni Windorski, Wildlife Biologist (the population status is based on available data from Colorado Parks and Wildlife as well as local knowledge and anecdotal information; the habitat threat score is based on existing conditions and considers immediate threats to these habitats).

Protocol: Calculate an index of animal species that are sensitive species or of local concern weighted by both the listing status of the animal and its current wilderness population status (Table 20). The scores for each species included in this count are determined by the wildlife biologist. *An improvement in a species listing status or an increase in its abundance or habitat would result in an upward trend in this measure, and would benefit the*

Natural Quality.

When to collect and report data: Report every five years, data are instantaneous once every five years.

INDEX OF STOCKED LAKES: priority medium, required if relevant.

Data Sources: Andrew Treble, Colorado Parks and Wildlife Aquatic Research Data Analyst; Ed Stege, Leadville National Fish Hatchery Project Leader.

Protocol: Calculate an index of the amount of non-native fish stocked into wilderness lakes and streams. An annual score (Table 23) is calculated based on the species of fish (Table 24) and the number of fish stocked in a calendar year; annual scores are then summed every five years to obtain the measure value. *A decrease in the measure value (indicating that fewer non-native fish are being stocked in the wilderness) would result in an upward trend in this measure, and would benefit the Natural Quality.*

When to collect and report data: Report every five years, data are cumulative for the five calendar years.

OZONE EXPOSURE STATISTICS N100 AND W126: priority high, required.

Data Sources: Forest Service Air Resource Management Site (home page: <http://webcam.srs.fs.fed.us/index.shtml>); site with an interactive map of monitoring sites: <http://webcam.srs.fs.fed.us/maps/>). Specific information for monitoring site 0805199911 can be found here: http://webcam.srs.fs.fed.us/results_o3/08/051/99911/ (Click “n100.csv” and report the value that is the first number/column after the desired year; go back and click “w126.csv,” and report the value that is the first number/column after the desired year); Air Resource Specialist—Bill Jackson.

Protocol: Calculate an index of the N100 and W126 ozone exposure statistics. The data collection site is located near Gothic Mountain in Gunnison County, Colorado (monitoring id: 0805199911; 38.95627 north, -106.98587 west; elevation: 9,563 feet). To calculate the measure value, scores are assigned to both the annual N100 and W126 values and then summed (Table 26). *A decrease in the N100 or W126 ozone exposure statistics would result in an upward trend in this measure, and would benefit the Natural Quality.*

When to collect and report data: Report annually, data are cumulative for the calendar year.

CONCENTRATION OF NITROGEN IN WET DEPOSITION: priority high, required.

Data Sources: National Atmospheric Deposition Program/National Trends Network (NADP/NTN) website: <http://nadp.sws.uiuc.edu/data/ntn/> (site: Gothic (CO10); data tab, annual data; select same start and end year, type of data: precipitation-weighted means (mg/L), report format: HTML table, seasons to return: water year (Oct.-Sept.); find values for NH₄ and NO₃). Accessing the data may require submitting additional information on the purpose of data collection, etc. to NADP/NTN.

Protocol: Calculate the precipitation weighted mean concentration of nitrogen that is added to the wilderness annually. The data collection site is located near Gothic Mountain in Gunnison County, Colorado (site id: CO10; 38.95627 north, -106.98587 west; elevation: 9,563 feet). The concentration of ammonium (NH₄) in wet deposition is multiplied by 0.7778 and the concentration of nitrate (NO₃) in wet deposition is multiplied by 0.2258 to find the concentrations of nitrogen (N) for each; these values are then summed to attain the total concentration of nitrogen in wet deposition. *A decrease in the concentration of nitrogen deposited through precipitation would result in an upward trend in this measure, and would benefit the Natural Quality.*

When to collect and report data: Report annually, data are cumulative for the water year.

CONCENTRATION OF SULFUR IN WET DEPOSITION: priority high, required.

Data Sources: National Atmospheric Deposition Program/National Trends Network (NADP/NTN) website: <http://nadp.sws.uiuc.edu/data/ntn/> (site: Gothic (CO10); data tab, annual data; select same start and end year, type of data: precipitation-weighted means (mg/L), report format: HTML table, seasons to return: water year (Oct.-Sept.); find value under SO₄). Accessing the data may require submitting additional information on the purpose of

data collection, etc. to NADP/NTN.

Protocol: Calculate the precipitation weighted mean concentration of sulfur that is added to the wilderness annually. The data collection site is located near Gothic Mountain in Gunnison County, Colorado (site id: CO10; 38.95627 north, -106.98587 west; elevation: 9,563 feet). The concentration of sulfate (SO_4) in wet deposition is multiplied by 0.3337 to attain the concentration of sulfur (S). *A decrease in the concentration of sulfur deposited through precipitation would result in an upward trend in this measure, and would benefit the Natural Quality.*

When to collect and report data: Report annually, data are cumulative for the water year.

VISIBILITY STATISTICS: priority high, required.

Data Sources: Visibility Information Exchange Web System (VIEWS): <http://views.cira.colostate.edu/fed/DataWizard/Default.aspx> (Reports: site data statistics; Dataset: IMPROVE aerosol; Site: White River NF; Dates: choose one year and select all months); create report and find the averages for the parameters: “NO3f” (“nitrate (fine)”) and “SO4f” (“sulfate (fine)”).

Protocol: Calculate the sum of the average annual anthropogenic fine nitrate and sulfate. Data are taken from a USFS communication facility located in the White River National Forest near Aspen (less than 20 miles away: 39.1536 north, -106.8209 west; elevation: 11,199 feet). The average annual fine sulfate and average annual fine nitrate are added to get a total annual sum for the calendar year. *A decrease in the sum of anthropogenic fine nitrate and sulfate would result in an upward trend in this measure, and would benefit the Natural Quality.*

When to collect and report data: Report annually, data are cumulative for the calendar year.

TEMPERATURE: priority high, required.

Data Sources:

SNOTEL sites: Natural Resources Conservation Service (NRCS) Snow Telemetry (SNOTEL) data: <http://www.wcc.nrcs.usda.gov/snow/> (select Colorado, then select Ivanhoe (547) or Brumley (369); under Element Repots: check the box for degrees Fahrenheit; report content: “air temperature”; under “View Historic” select desired year, “water year”, and “all days”, then click “View Historic”. Click “download” to generate an excel sheet—use the data column called “TAVG.D-1 (degF)”. Remember to replace missing data with blank cells before calculating the average in excel).

RAWS site: Remote Automatic Weather Station (RAWS) data: <http://www.raws.dri.edu/> (select Colorado, then select Lodge Pole Flats; select monthly summary time series, set starting and ending month and year, select “air temperature” only, select English, html, yes to applying physical limits QC to data, leave “represent missing data as” as is, and select yes to “include number of valid observations for each element, then click “submit info”—use the data called “Ave.” under average air temperature).

Protocol: Calculate average annual winter (December-February) and summer (June-August) temperatures. There are three monitoring sites within five miles of the wilderness boundary: Lodgepole Flats (RAWS site; 39 9' 12" north, 106 20' 59" west; elevation: 9,640 feet), Brumley (SNOTEL site; 39 5' north, 106 33' west; elevation: 10,600 feet), and Ivanhoe (SNOTEL site; 39 18' north, 106 33' west; elevation: 10,400 feet). For each of the three sites, the average temperature for December, January, and February, and the average temperature for June, July, and August, are calculated. Winter and summer average temperatures are counted for the water year (i.e. for 2014, data from December 2013 to February 2014 are used to calculate the average winter temperature, and data from June to August 2014 are used to calculate the average summer temperature). The measure value is based off of regression analysis; each site and season with a statistically significant trend (whether increasing or decreasing) will be scored as one point (Table 31). Sites will only be included in this measure once there are five years of data or more; summer temperatures for Lodgepole Flats, therefore, will only be considered starting next year (once the 2014 data has been collected). Sites and seasons are likewise not included in the regression analysis when

the number of missed days for either summer or winter and for any site exceeds 20% of the total days (i.e. 18 missing records or more; for example, Brumley summer 2009, Ivanhoe summer 1993, and Ivanhoe winter 1993 and 1997 all have less than complete data quantity, and are not included in the data analysis). *An increase in the number of sites and/or seasons with a statistically significant trend would result in a downward trend in this measure, and would diminish the Natural Quality. This measure value is not expected to decrease (i.e. an upward trend in the measure is not anticipated).*

When to collect and report data: Report annually, data are a regression analysis for all available years, annual data are cumulative for the water year.

PRECIPITATION: priority high, required.

Data Sources:

SNOTEL sites: Natural Resources Conservation Service (NRCS) Snow Telemetry (SNOTEL) data: <http://www.wcc.nrcs.usda.gov/snow/> (select Colorado, then select Ivanhoe (547) or Brumley (369); under Element Repots: report content: “precipitation accumulation”; under “View Historic” select desired year, “water year”, and “all days”, then click “View Historic”. Use the data column called “PREC.I-1 (in)” and scroll to the bottom—the last number is the cumulative precipitation for the water year).

RAWS site: Remote Automatic Weather Station (RAWS) data: <http://www.raws.dri.edu/> (select Colorado, then select Lodge Pole Flats; select monthly summary time series, set starting and ending month and year (for water year), select “precipitation” only, select English, html, yes to applying physical limits QC to data, leave “represent missing data as” as is, and select yes to “include number of valid observations for each element, then click “submit info”—use the data called “Total” under precipitation. Sum the monthly totals to obtain the cumulative precipitation for the water year).

Protocol: Calculate the total inches of annual precipitation falling in the wilderness. There are three monitoring sites within five miles of the wilderness boundary: Lodgepole Flats (RAWS site; 39 9’ 12” north, 106 20’ 59” west; elevation: 9,640 feet), Brumley (SNOTEL site; 39 5’ north, 106 33’ west; elevation: 10,600 feet), and Ivanhoe (SNOTEL site; 39 18’ north, 106 33’ west; elevation: 10,400 feet). Data are the annual sums of the cumulative daily (SNOTEL) or monthly (RAWS) precipitation. The measure value is based off of regression analysis; each site with a statistically significant trend (whether increasing or decreasing) will be scored as one point (Table 32). Sites will only be included in this measure once there are five years of data or more; Lodgepole Flats, therefore, will only be considered starting next year (once the 2014 data has been collected). Sites are likewise not included in the regression analysis when the number of missed days exceeds 20% of the total days (i.e. 73 missing records or more). *An increase in the number of sites with a statistically significant trend would result in a downward trend in this measure, and would diminish the Natural Quality. This measure value is not expected to decrease (i.e. an upward trend in the measure is not anticipated).*

When to collect and report data: Report annually, data are a regression analysis for all available years, annual data are cumulative for the water year.

GLACIERS AND PERMANENT SNOWFIELDS: priority medium, optional

Data Sources: Annual photographs taken from the Sugar Loaf Dam commemorative marker at Turquoise Lake during the last week in August.

Protocol: Calculate changes in the areal extent of the Africa Bowl permanent snowfield. Annual photographs are taken of the Africa Bowl at its smallest extent (during the last week in August); photographs are taken from a point directly in front of the Sugar Loaf Dam commemorative marker at Turquoise Lake. Every five years, the previous five photographs are compared for change over time (e.g. in 2019, photographs from 2014-2018 will be compared; in 2024, photographs from 2019-2023 will be compared, etc.). The amount of areal change accrued in the past five years is assessed by a visual examination and then assigned a score (Table 34). The measure value is the sum of the previous measure value and the change score (a hypothetical example is shown in Table 35). Measure values and change scores should also be checked with previous years to ensure consistent scoring over time. *A loss in snowfield area would result in a downward trend in this measure, and would diminish the Natural Quality.*

<p>When to collect and report data: Report every five years, data are cumulative for five years of instantaneous annual collection.</p>
<p>SNOW (ANNUAL SNOW DAYS): priority high, required if relevant.</p> <p>Data Sources: Natural Resources Conservation Service (NRCS) Snow Telemetry (SNOTEL) data: http://www.wcc.nrcs.usda.gov/snow/ (select Colorado, then select Ivanhoe (547) or Brumley (369); under Element Repots: report content: “snow water equivalent”; under “View Historic” select desired year, “water year”, and “all days”, then click “View Historic”. Click “download” to generate an excel sheet—use the data column called “WTEQ.I-1 (in)”.</p> <p>Protocol: Calculate the percentage of days per year with snow. There are two SNOTEL monitoring sites within five miles of the wilderness boundary: Brumley (SNOTEL site; 39 5’ north, 106 33’ west; elevation: 10,600 feet) and Ivanhoe (SNOTEL site; 39 18’ north, 106 33’ west; elevation: 10,400 feet). For each site, the percentage of days per water year with a snow water equivalent greater than zero inches is calculated. The measure value is based off of regression analysis; each site with a statistically significant trend (whether increasing or decreasing) will be scored as one point (Table 36). <i>An increase in the number of sites with a statistically significant trend would result in a downward trend in this measure, and would diminish the Natural Quality. This measure value is not expected to decrease (i.e. an upward trend in the measure is not anticipated).</i></p> <p>When to collect and report data: Report annually, data are a regression analysis for all available years, annual data are cumulative for the water year.</p>
<p>SNOW SEASONALITY: priority high, new.</p> <p>Data Sources: Natural Resources Conservation Service (NRCS) Snow Telemetry (SNOTEL) data: http://www.wcc.nrcs.usda.gov/snow/ (select Colorado, then select Ivanhoe (547) or Brumley (369); under Element Repots: report content: “snow water equivalent”; under “View Historic” select desired year, “water year”, and “all days”, then click “View Historic”. Click “download” to generate an excel sheet—use the data column called “WTEQ.I-1 (in)”.</p> <p>Protocol: Calculate the number of months with a statistically significant trend in snow cover. There are two SNOTEL monitoring sites within five miles of the wilderness boundary: Brumley (SNOTEL site; 39 5’ north, 106 33’ west; elevation: 10,600 feet) and Ivanhoe (SNOTEL site; 39 18’ north, 106 33’ west; elevation: 10,400 feet). The average snow water equivalent in inches is calculated for all months of a water year for each site. The measure value is based off of regression analysis; the number of months for each site that have a statistically significant trend are summed to attain the measure value (Table 37). <i>An increase in the number of months for either site with a statistically significant trend would result in a downward trend in this measure, and would diminish the Natural Quality. This measure value is not expected to decrease (i.e. an upward trend in the measure is not anticipated).</i></p> <p>When to collect and report data: Report annually, data are a regression analysis for all available years, annual data are cumulative for the water year.</p>
<p>AVERAGE WATERSHED CONDITION CLASS: priority medium, required.</p> <p>Data Sources: Forest Service Watershed Condition Framework Data: http://apps.fs.usda.gov/WCFmapviewer/.</p> <p>Protocol: Calculate the average watershed condition class by acre within wilderness. The watershed condition class is obtained from the Forest Service Watershed Condition Framework data. All acres classified as properly functioning are assigned a value of 1, those that are functioning at risk have a value of 2, and impaired have a value of 3. <i>A decrease in the average value for the wilderness (indicating an improvement of the watershed condition) would result in an upward trend in this measure, and would benefit the Natural Quality.</i></p> <p>When to collect and report data: Report every five years, data are instantaneous once every five years.</p>
<p>AVERAGE NATURAL FIRE REGIME CONDITION CLASS: priority high, required.</p> <p>Data Sources: LANDFIRE Vegetation Condition Class layer: online at http://www.landfire.gov/index.php, or on the FS hard drive: T:\FS\Reference\RSImagery\ProcessedData\wo_nfs_rsac\LANDFIRE\LANDFIRE_Refresh_Nov2012draft\US_110_Mosaic_Refresh\US_110vcc\grid1). The link to the current data on the Forest Service hard drive will not reflect any updates made to this data—the link above provides information on the most</p>

recent data.

Protocol: Calculate the average LANDFIRE vegetation condition class by acre within wilderness. All acres designated as Class I are assigned a value of 1, those that are Class II have a value of 2, and Class III have a value of 3. “Non-burnable” classes are not included in this count. (See accompanying document on how to perform the GIS analysis). *A decrease in the average natural fire regime condition class (indicating less of a departure from the historical or natural fire regime) would result in an upward trend in this measure, and would benefit the Natural Quality.*

When to collect and report data: Report every five years, data are instantaneous once every five years.

UNDEVELOPED

INDEX OF AUTHORIZED NON-RECREATIONAL PHYSICAL DEVELOPMENT: priority medium, required.

Data Sources: Steve Sunday, Lead Wilderness Ranger; Brianna Boyd & Jacob Seidel, Wilderness Technicians; Jeni Windorski, Wildlife Biologist; Nick Gerich, Hydrological Technician; Ed Stege, Leadville National Fish Hatchery Project Leader; Jake Ivan, Colorado Parks and Wildlife Wildlife Researcher; USFS abandoned mine inventory.

Protocol: Calculate an index of the quantity and type of non-recreational physical developments, installations, or structures that are currently in the wilderness. The index is adapted from the *Forest Service Technical Guide* (Landres et al. 2009, pp. 138-168) and calculated by taking into account the level of development, physical size, materials used, etc. (Table 43). *A decrease in the number of non-recreational physical developments would result in an upward trend in this measure, and would benefit the Undeveloped Quality.*

When to collect and report data: Report annually, data are instantaneous.

INDEX OF AUTHORIZED RECREATIONAL PHYSICAL DEVELOPMENT: priority high, required.

Data Sources: Steve Sunday, Lead Wilderness Ranger; Brianna Boyd & Jacob Seidel, Wilderness Technicians; Loretta McElhiney, Peak Manager; Adam Brown, Trails.

Protocol: Calculate an index of the quantity and type of recreational physical developments, installations, or structures that are currently in the wilderness. The index is adapted from the *Forest Service Technical Guide* (Landres et al. 2009, pp. 138-168) and calculated by taking into account the level of development, physical size, materials used, etc. (Table 45). *A decrease in the number of recreational physical developments would result in an upward trend in this measure, and would benefit the Undeveloped Quality.*

When to collect and report data: Report annually, data are instantaneous.

INDEX OF INHOLDINGS: priority not applicable, required if relevant.

Data Sources: Wilderness Land Trust (<http://www.wildernesslandtrust.org/protected/colorado/>); USFS Land Status and Encumbrance Viewer (http://apps.fs.fed.us/fswebmapviewer/index.html?config=fsweb-config/ALP_StatusAndEncumbrance.xml); Forest Service GIS data (T:\FS\NFS\PikeSanIsabel\Program\7700TransportationSystem\GIS\SO\Lands - PSICC\PSICC_Lands20120213.mdb\PSICCLands20120213_Multipart); open wilderness files.

Protocol: Calculate the acres of privately owned inholdings in wilderness. Inholdings purchased by organizations that intend to eventually transfer the land to the Forest Service or Fish and Wildlife Service (e.g. the Wilderness Land Trust) and that are held to the same standards of protection as wilderness are not included under this measure. Acreages are calculated from GIS data and rounded to the nearest whole number. *A decrease in the acres of inholdings within the wilderness would result in an upward trend in this measure, and would benefit the Undeveloped Quality.*

When to collect and report data: Report every five years, data are instantaneous once every five years.

INDEX OF ADMINISTRATIVE AUTHORIZATIONS TO USE MOTOR VEHICLES, MOTORIZED EQUIPMENT OR MECHANICAL TRANSPORT: priority medium, required.

Data Sources: Steve Sunday, Lead Wilderness Ranger; Ed Stege, Leadville National Fish Hatchery Project Manager.

Protocol: Calculate an index of authorized uses of motorized equipment or mechanical transport for administrative purposes. The index is adapted from the *Forest Service Technical Guide* (Landres et al. 2009, p. 170) and calculated by multiplying the inherent weight of the equipment (Table 48) by the number of pieces of equipment and the number of days for which they were used to get a score for each use. *A decrease in the number of administrative authorizations for the use of motor vehicles, motorized equipment, and/or mechanical transport would result in an upward trend in this measure, and would benefit the Undeveloped Quality.*

When to collect and report data: Report annually, data are cumulative for the fiscal year.

PERCENT OF EMERGENCY INCIDENTS NOT USING MOTOR VEHICLES, MOTORIZED EQUIPMENT, OR MECHANICAL TRANSPORT: priority not applicable, required.

Data Sources: Steve Sunday, Lead Wilderness Ranger.

Protocol: Calculate the percent of emergency incidents in a fiscal year that do not use motor vehicles, motorized equipment, or mechanical transport. Years for which there are no emergency incidents will be assigned a measure value of 100%. *A decrease in the percent of emergency incidences using motorized equipment or mechanical transport would result in an upward trend in this measure, and would benefit the Undeveloped Quality.*

When to collect and report data: Report annually, data are cumulative for the fiscal year.

SOLITUDE OR PRIMITIVE AND UNCONFINED RECREATION

TRAVEL ROUTE ENCOUNTERS: priority not applicable, required.

Data Sources: Wilderness Ranger Reports.

Protocol: Calculate the average number of visitors or groups encountered by wilderness rangers on established trails in the wilderness per day during the primary use season (May through September). The number of contacts made is divided by the number of ranger-days traveling in wilderness to attain the average contacts per day. This is then rounded to the nearest whole number. *A decrease in the average number of encounters per day would result in an upward trend in this measure, and would benefit the solitude aspect of this quality.*

When to collect and report data: Report annually, data are cumulative for the fiscal year.

VISITATION: priority medium, new.

Data Sources: Required wilderness permits. Each year, the hard data from collected permits are entered into an excel file by Steve Sunday, Lead Wilderness Ranger; these excel files are then stored on the annual wilderness flash drive. The summaries of these data can be found in the excel files themselves, in annual wilderness summary reports, and in other documents in the wilderness open files.

Protocol: Count the number of visitors entering the wilderness during the calendar year. Data come from the required wilderness permits; permits missing information are still included in this count (e.g. a permit that failed to report the number of people is still counted as representing one visitor). *A decrease in the total number of visitors would result in an upward trend in this measure, and would benefit the solitude aspect of this quality.*

When to collect and report data: Report annually, data are cumulative for the calendar year.

AREA OF WILDERNESS AWAY FROM ACCESS AND TRAVEL ROUTES AND DEVELOPMENTS: priority medium, required.

Data Sources: Forest Service GIS data (T:\FS\NFS\PikeSanIsabel\Program\7700TransportationSystem\GIS\SO\SDE

Data\RoutedTrailsRev20091020\RoutedTrailsRev20091020.shp).

Protocol: Calculate the percent of wilderness located away from access points, travel routes, and developments that are located within or on the boundary of wilderness. All designated wilderness trails (system trails) are buffered by ¼ mile before being counted. (See accompanying document on how to perform the GIS analysis). *An increase in the percentage of wilderness away from these features (due to trail closures or an increase in total wilderness acres) would result in an upward trend in this measure, and would benefit the solitude aspect of this quality.*

When to collect and report data: Report every five years, data are instantaneous once every five years.

USER-CREATED CAMPSITES: priority high, required.

Data Sources: Wilderness campsite inventories (2014 inventory conducted by Brianna Boyd & Jacob Seidel, Wilderness Technicians).

Protocol: Calculate an index of the condition of campsites located throughout the wilderness. Using the rapid assessment wilderness campsite Inventory form, user-created campsites are rated for their ground disturbance (0-4), tree damage (0-2), and disturbed area (0-2) and given an overall impact rating from 0-8. The measure value is the sum of the overall impact ratings for all campsites found during a single inventory. *A decrease in the impact rating or in the number of user-created sites would result in an upward trend in this measure, and would benefit the solitude aspect of this quality.*

When to collect and report data: Report every five years, data are instantaneous once every five years. The most recent campsite assessment will be used for this measure.

MILES OF USER-CREATED TRAILS: priority medium, optional.

Data Sources: Dave Lovato, Special Uses; special use permit files; Forest Service GIS data

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Protocol: A count of the miles of non-system routes in the wilderness. The total mileage is calculated and rounded to the nearest whole number. (See accompanying document on how to perform the GIS analysis). *A decrease in the miles of non-system commercial routes would result in an upward trend in this measure, and would benefit the solitude aspect of this quality.*

When to collect and report data: Report every five years, data are instantaneous once every five years.

COMMERCIAL USE: priority medium, new.

Data Sources: Dave Lovato, Special Uses; special use permit files.

Protocol: Count the number of priority service days per year approved for outfitters and guides in Mount Massive Wilderness. All approved service days are counted for the following compartments: Windsor, Native, Swamp Lakes, Fish Hatchery, Africa Bowl, Main Massive, North Halfmoon, North Fork Lake Creek, and Willow. Service days for hunting outfitters and guides are counted for sheep compartment 66, goat compartment 17, and general hunting compartment 48. *A decrease in the total commercial use priority service days would result in an upward trend in this measure, and would benefit the solitude aspect of this quality.*

When to collect and report data: Report every five years, data are instantaneous once every five years. The most recent information for each permit is used for this measure.

AREA OF WILDERNESS NOT AFFECTED BY ADJACENT TRAVEL ROUTES AND HUMAN DEVELOPMENTS: priority medium, required.

Data Sources: Forest Service GIS data

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T:\FS\NFS\PikeSanIsabel\Program\7700TransportationSystem\GIS\SO\Lands - PSICC\PSICC_Lands20120213.mdb;
T:\FS\NFS\PikeSanIsabel\Program\7700TransportationSystem\GIS\SO\Transportation_GIS\Base_Layers\Base_Layers\Transportation\Roads_Archive\PSICC_Legacy_Roads_Data\AllArc_Legacy_Apr05.shp).

Protocol: Calculate the percent of wilderness away from roads, structures, and other developments outside the wilderness. All roads, private land, mines, trailheads, and campgrounds, etc. adjacent to the wilderness are buffered by ¼ mile before being counted. (See accompanying document on how to perform the GIS analysis). *An increase in the percentage of wilderness not affected by adjacent travel routes and developments would result in an upward trend in this measure, and would benefit the solitude aspect of this quality.*

When to collect and report data: Report every five years, data are instantaneous once every five years.

INDEX OF AUTHORIZED RECREATION FACILITIES: priority medium, required.

Data Sources: Steve Sunday, Lead Wilderness Ranger; Brianna Boyd & Jacob Seidel, Wilderness Technicians; Loretta McElhiney, Peak Manager; Adam Brown, Trails; INFRA data; The Colorado Trail (Jacobs, 1992).

Protocol: Calculate an index of authorized facilities that decrease self-reliant recreation. The index is adapted from the *BLM Implementation Guide* (Bureau of Land Management 2012, p. 45) and consists of a count of authorized recreation facilities in wilderness weighted by their impact (size, materials used, etc.) (Table 60). *A decrease in the number or size of authorized recreation facilities would result in an upward trend in this measure, and would benefit the primitive aspect of this quality.*

When to collect and report data: Report every five years, data are instantaneous once every five years.

MILES OF DEVELOPED TRAILS (CONDITION CLASSES 3-5): medium priority, required.

Data Sources: Adam Brown, Trails; INFRA data; The Colorado Trail (Jacobs, 1992); Forest Service GIS data (T:\FS\NFS\PikeSanIsabel\Program\7700TransportationSystem\GIS\SO\SDE Data\RoutedTrailsRev20091020\RoutedTrailsRev20091020.shp).

Protocol: Count the total miles of developed trails that are classified as condition classes three, four, or five in INFRA. *Either managing trails for a lower condition class or closing trails would result in an upward trend in this measure, and would benefit the primitive aspect of this quality.*

When to collect and report data: Report every five years, data are instantaneous once every five years.

INDEX OF VISITOR MANAGEMENT RESTRICTIONS: high priority, required.

Data Sources: Required wilderness permits; open wilderness files.

Protocol: Count the number of management restrictions that substantially restrict visitor behavior, access, or equipment in wilderness. The regulation categories are adapted from the *Forest Service Technical Guide* (Landres et al. 2009, p. 219) and assigned a score for severity (Table 64) and a weight of extent. The weight of extent is scored a one if the regulation applies to only a sub-area of wilderness and a two if it applies to the entire wilderness. The severity score and the weight of extent are multiplied for a total score for each regulation category; the index value is the sum of the total scores. *A decrease in the severity or number of management restrictions would result in an upward trend in this measure, and would benefit the unconfined aspect of this quality.*

When to collect and report data: Report every five years, data are instantaneous once every five years.