



# The Stephen Mather Wilderness

## *Wilderness Character Baseline Assessment*

Natural Resource Report NPS/NOCA/NRR—2020/2164



**ON THE COVER**

Pelton Basin, North Cascades National Park Service Complex  
Photo: Ben Riegel

---

# **The Stephen Mather Wilderness**

## *Wilderness Character Baseline Assessment*

Natural Resource Report NPS/NOCA/NRR—2020/2164

Ben Riegel,<sup>1</sup> Jack Oelfke<sup>2</sup>

<sup>1</sup> Interagency Wilderness Fellow  
National Park Service  
Pacifica, CA

<sup>2</sup> Chief, Natural and Cultural Resources  
North Cascades National Park Service Complex  
810 S.R. 20, Sedro-Woolley, WA, 98284

August 2020

U.S. Department of the Interior  
National Park Service  
Natural Resource Stewardship and Science  
Fort Collins, Colorado

The National Park Service, Natural Resource Stewardship and Science office in Fort Collins, Colorado, publishes a range of reports that address natural resource topics. These reports are of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

The Natural Resource Report Series is used to disseminate comprehensive information and analysis about natural resources and related topics concerning lands managed by the National Park Service. The series supports the advancement of science, informed decision-making, and the achievement of the National Park Service mission. The series also provides a forum for presenting more lengthy results that may not be accepted by publications with page limitations.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

This report received formal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data, and whose background and expertise put them on par technically and scientifically with the authors of the information.

Views, statements, findings, conclusions, recommendations, and data in this report do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U.S. Government.

This report is available in digital format from the [Natural Resource Publications Management website](#). If you have difficulty accessing information in this publication, particularly if using assistive technology, please email [irma@nps.gov](mailto:irma@nps.gov).

Please cite this publication as:

Riegel, B., and J. Oelfke. 2020. The Stephen Mather Wilderness: Wilderness character baseline assessment. Natural Resource Report NPS/NOCA/NRR—2020/2164. National Park Service, Fort Collins, Colorado.

This report is part of a national initiative to establish Wilderness Character Baseline Assessments for all national park units with wilderness. The measures within this report were developed by park staff and reviewed at the national level.



A handwritten signature in black ink, appearing to read "Karen Taylor-Godrich".

---

Karen Taylor-Godrich, Superintendent  
North Cascades National Park Service Complex

7/1/2020

Date

# Contents

	Page
Figures.....	vii
Tables.....	vii
Appendices.....	x
Abstract.....	xi
Acknowledgments.....	xii
Introduction.....	1
Background.....	1
Qualities of Wilderness .....	1
Monitoring Strategy.....	2
Wilderness Character Baseline Assessments .....	3
Wilderness Character Trend Assessment .....	4
Wilderness Character Monitoring Database.....	4
Wilderness Character Assessments and Park Planning.....	5
Wilderness Character Monitoring Key Terms and Definitions .....	7
Background on the Stephen Mather Wilderness.....	9
Administrative History .....	9
Geographic Setting .....	9
Ecological Setting.....	10
Wilderness Recreation Setting.....	10
Process Used to Select Measures .....	11
Details of Selected Measures .....	12
Untrammeled Quality .....	14
Measure 1-1: Five-year average of the annual number of authorized actions that intentionally manipulate vegetation, fish and wildlife, and naturally occurring fires.....	15
Measure 1-2: Five-year average of the annual number of unauthorized actions that intentionally manipulate the biophysical environment.....	24

## Contents (continued)

	Page
Natural Quality .....	26
Measure 2-1: Index of non-native plant species in wilderness.....	27
Measure 2-2: Index of non-native aquatic species (non-native fish, amphibians) .....	31
Measure 2-3: Index of non-native terrestrial animal species detected .....	36
Measure 2-4: Ozone exposure to vegetation .....	39
Measure 2-5: Wet nitrogen deposition .....	41
Measure 2-6: Wet sulfur deposition .....	43
Measure 2-7: Visibility.....	45
Measure 2-8: Departure from the natural fire regime in the frequent fire interval region since 1960.....	47
Undeveloped Quality.....	49
Measure 3-1: Number of scientific structures, installations, or developments.....	50
Measure 3-2: Number of administrative structures, installations, or developments .....	52
Measure 3-3: Acres of inholdings .....	55
Measure 3-4: Five-year average of the annual number of helicopter landings and deliveries.....	57
Solitude or Primitive and Unconfined Recreation Quality.....	59
Measure 4-1: Percent of campsites that meet wilderness management privacy standards .....	61
Measure 4-2: Percent time externally derived noise is audible in the Wilderness .....	63
Measure 4-3: Five-year average of the annual number of hours of NPS use of aircraft.....	65
Measure 4-4: Number of all recreational structures associated with wilderness camps.....	68
Measure 4-5: Number of designated camps where campfires are prohibited .....	70
Measure 4-6: Number of designated camps or cross-country zones where bear canisters are required.....	71

# Contents (continued)

	Page
Measure 4-7: Percent of wilderness available for unconfined camping opportunities.....	72
Other Features of Value Quality.....	74
Measure 5-1: Average condition value of listed or eligible structures.....	75
Measure 5-2: Average condition value of listed or eligible archeological sites.....	78
Measure 5-3: Average cumulative annual mass balance of four monitored glaciers.....	80
Priority Measures for Future Use in Wilderness Character Monitoring.....	82
Measures Not Used for Wilderness Character Monitoring.....	85
References.....	86

# Figures

	Page
<b>Figure 1.</b> Wilderness Stewardship Planning Framework.....	6
<b>Figure 2.</b> Deriving the <b>Overall</b> Trend for Wilderness Character – Example.....	96

# Tables

	Page
<b>Table 1.</b> Categories of Data Quantity.....	7
<b>Table 2.</b> Categories of Data Quality.....	8
<b>Table 3.</b> Overview of Selected Measures.....	12
<b>Table 4.</b> Overview of Selected Measures under the Untrammelled Quality.....	14
<b>Table 5.</b> Initial Attack Codes and Suppression Classification.....	17
<b>Table 6.</b> Annual Number of Authorized Actions Taken to Remove Non-Native Vegetation.....	19
<b>Table 7.</b> Annual Number of Authorized Actions Taken to Restore Native Vegetation.....	19
<b>Table 8.</b> Summary of Authorized Actions that Intentionally Manipulate Vegetation for Purposes Other than Fire Suppression.....	19
<b>Table 9.</b> Authorized Actions Taken to Remove Non-Native Fish at Wilderness Lakes.....	20
<b>Table 10.</b> Annual Number of Authorized Actions that Intentionally Manipulate Wildlife.....	20
<b>Table 11.</b> Annual Number of Authorized Actions that Intentionally Manipulate Fish or Wildlife.....	21
<b>Table 12.</b> Annual Number of Authorized Actions Taken to Suppress Naturally Occurring Fires.....	21
<b>Table 13.</b> Five Year Averages of the Annual Number of Authorized Actions Taken to Suppress Naturally Occurring Fires.....	22
<b>Table 14.</b> Summary of All Authorized Actions that Intentionally Manipulate Vegetation, Fish and Wildlife, and Naturally Occurring Fires.....	22
<b>Table 15.</b> Annual Number of Unauthorized Trammeling Actions.....	25
<b>Table 16.</b> Overview of Selected Measures under the Natural Quality.....	26

## Tables (continued)

	Page
<b>Table 17.</b> Trail segments and Number of Unique Non-native Species Found (as of 2006 and 2019 surveys). .....	28
<b>Table 18.</b> Invasive species, I-rank or Professional Judgement Value, and Summed Index – as of 2019.....	29
<b>Table 19.</b> Lakes identified with non-native fish populations in 2015.....	33
<b>Table 20.</b> Non-native aquatic species, distribution rating, impact rating, and index score.....	34
<b>Table 21.</b> Non-native terrestrial animal species, distribution rating, impact rating, and index score.....	38
<b>Table 22.</b> Most Recently Available Ozone Exposure to Vegetation Data in 2015.....	40
<b>Table 23.</b> Most Recently Available Wet Nitrogen Deposition Data in 2015.....	42
<b>Table 24.</b> Most Recently Available Wet Sulfur Deposition in 2015.....	44
<b>Table 25.</b> Most Recently Available Visibility Data in 2015.....	46
<b>Table 26.</b> Fire Regime Departure Classes.....	48
<b>Table 27.</b> Departure from Natural Fire Regime in Frequent Fire Interval Region as of 2015.....	48
<b>Table 28.</b> Overview of Selected Measures under the Undeveloped Quality.....	49
<b>Table 29.</b> Scientific Installations in 2015.....	51
<b>Table 30.</b> Administrative Structures, Installations, and Developments in 2015.....	53
<b>Table 31.</b> Wilderness Inholdings in 2015.....	56
<b>Table 32.</b> Annual Number of Helicopter Landings and Deliveries in Wilderness.....	58
<b>Table 33.</b> Overview of Measures under the Solitude or Primitive and Unconfined Recreation Quality.....	59
<b>Table 34.</b> Soundscapes Monitoring Location and Data in 2015.....	64
<b>Table 35.</b> Annual Number of Hours of NPS Use of Aircraft.....	66
<b>Table 36.</b> Recreational Structures in Wilderness Camps in 2015.....	69
<b>Table 37.</b> Percent of Wilderness Available for Unconfined Camping Opportunities in 2015.....	73
<b>Table 38.</b> Overview of Selected Measures under the Other Features of Value Quality.....	74

## Tables (continued)

	Page
<b>Table 39.</b> Most Recent Condition Values for Listed or Eligible Structures in 2015.....	76
<b>Table 40.</b> Average of the Most Recent Condition Values of Listed or Eligible Structures in 2015. ....	76
<b>Table 41.</b> Most Recent Condition Values for Listed or Eligible Archeological Sites in 2015.....	79
<b>Table 42.</b> Average of the Most Recent Condition Values of Listed or Eligible Archeological Sites in 2015. ....	79
<b>Table 43.</b> Cumulative Volume Change for the Four Monitored Glaciers.....	81
<b>Table 44.</b> Examples of Actions that Likely Are, and Likely Are Not, Trammeling Actions. ....	92
<b>Table 45.</b> List of Wilderness Character Monitoring Qualities, Monitoring Questions, and Indicators.....	94
<b>Table 46.</b> Deriving Trends for <b>Indicators</b> from Trends for Measures (using Natural Quality as Example).....	95
<b>Table 47.</b> Non-native plant species along major Wilderness trails, Stephen Mather Wilderness (2006, 2019).....	97
<b>Table 48.</b> Summary of trail segment descriptions. ....	101
<b>Table 49.</b> 2015 Management Requirements for Wilderness Camps. ....	103
<b>Table 50.</b> 2015 Management Requirements for Cross-Country Zones. ....	106

# Appendices

	Page
Appendix A. What Is A Trammeling Action? .....	88
Appendix B. Deriving the Overall Trend in Wilderness Character .....	94
Appendix C. Summary of Trail and Backcountry Camps Survey of Non-Native Plant Species, 2006 and 2019.....	97
Appendix D. Wilderness Camps and Cross-Country Zones.....	103

## **Abstract**

The Wilderness Act of 1964 created a legislative mandate to preserve wilderness character on protected federal lands encompassed under the law, leading to the network of lands managed as wilderness that exist today within the National Wilderness Preservation System. Wilderness management policy and practice has evolved to focus on wilderness character monitoring as a means of understanding if the preservation of wilderness character is being achieved.

This report is a baseline assessment of wilderness character for the Stephen Mather Wilderness in the North Cascades National Park Service Complex, WA. It is intended to serve as a standalone document that outlines a framework and monitoring protocol for ongoing wilderness character monitoring within the Park Complex. The report fulfills the first step of the directive in the National Park Service Director's Order 41 to develop a wilderness character assessment, establishes 2015 data as the baseline year for most measures, and provides for the ongoing monitoring of trends in wilderness character. The 24 measures identified in this report form the basis for this long-term monitoring program that, through repeated monitoring and trend analysis, will track wilderness character in the Park Complex. The report is also intended to provide a foundation for the future creation of a wilderness stewardship plan for the Stephen Mather Wilderness.

## Acknowledgments

The following individuals were instrumental in providing information or access to information that was used in various stages of this report. Their help was greatly appreciated.

Hugh Anthony	Aquatic Ecologist, North Cascades National Park Service Complex
Kevorck Arackellian	Climbing Ranger, North Cascades National Park Service Complex
Mignonne Bivin	Plant Ecologist (retired), North Cascades National Park Service Complex
Elizabeth Boerke	(former) Environmental Protection Specialist and Planner, North Cascades National Park Service Complex
Sean Boerke	(former) Backcountry Patrol Lead Ranger, North Cascades National Park Service Complex
Anne Braaten	GIS Specialist, North Cascades National Park Service Complex
Kelly Bush	Wilderness District Ranger (retired), North Cascades National Park Service Complex
Dan Campbell	(former) Exotic Plant Management Specialist, North Coast and Cascades Network Exotic Plant Management Team
Kim Kwargsick Diczno	Archeologist, North Cascades National Park Service Complex
Eric Gabriel	(former) Chief of Visitor & Resource Protection, North Cascades National Park Service Complex
Vicki Gempko	Natural Resource Manager, North Cascades National Park Service Complex
Karen Kopper	Fire Ecologist, North Cascades National Park Service Complex
Peter Landres	Ecologist (retired), Aldo Leopold Wilderness Research Institute
Mike Larrabee	Physical Science Technician, North Cascades National Park Service Complex
Jordan Mammel	Wilderness District Ranger, North Cascades National Park Service Complex
Don Mann	Trails Foreman (retired), North Cascades National Park Service Complex
Stacy McDonough	Horticulturist, North Cascades National Park Service Complex
Todd Neel	(former) Exotic Plant Management Specialist and Liaison, North Coast and Cascades Network Exotic Plant Management Team
Ellen Porter	Scientist (retired), National Park Service Air Resources Division
Jason Ransom	Wildlife Biologist, North Cascades National Park Service Complex
Ashley Rawhouser	Lead Aquatic Ecologist, North Cascades National Park Service Complex
Jon Riedel	Geologist, North Cascades National Park Service Complex
Regina Rochefort	Science Advisor (retired), North Cascades National Park Service Complex
Sharon Sarantonio	Geologist, North Cascades National Park Service Complex
Rosemary Seifried	(former) Wilderness Information Center Supervisor, North Cascades National Park Service Complex
Rodney Siegel	Executive Director, The Institute for Bird Populations
Carmen Welch	Aquatic Ecologist, North Cascades National Park Service Complex
Bob Wilkerson	Staff Biologist, The Institute for Bird Populations
Roy Zipp	(former) Environmental Protection Specialist, North Cascades National Park Service Complex

# Introduction

## Background

With the passage of the Wilderness Act of 1964 (16 U.S.C. § 1131), federal land managers were charged with managing those lands encompassed under the Act for their long-term preservation as an enduring resource of wilderness. As wilderness management has evolved since that time, the concept of managing to “preserve wilderness character”, discussed in more detail in the following sections, has become a focus for managers. Although such efforts began earlier, the federal agencies who manage wilderness united in signing the 2020 Vision guidance (BLM et al. 2014) by calling for the completion of “wilderness character inventories” across the National Wilderness Preservation System by 2020 in order to establish baselines and track wilderness character over time.

“Wilderness character baseline assessments” are intended to formalize and document the process of wilderness character inventory and monitoring at the local wilderness scale. Much of what is contained in this report reflects a typical approach used in other wilderness areas, while addressing the issues specific to the Stephen Mather Wilderness in the North Cascades National Park Service Complex (“NOCA”, or “Park Complex”). This assessment identifies specific monitoring issues relevant to the Stephen Mather wilderness and describes the monitoring and reporting strategy for the future. Organization of the document, and monitoring strategy, is based on the five qualities of wilderness character, described in the next section.

## Qualities of Wilderness

The Wilderness Act of 1964 places on federal land management agencies the responsibility of “preserving the wilderness character” of each wilderness area under its jurisdiction. The Wilderness Act did not, however, provide a definition of wilderness character, and for over forty years, the four federal land management agencies lacked consistent criteria for determining whether the mandate to preserve wilderness character was being fulfilled. To remedy this situation, an interagency team established a formal definition of wilderness character that would apply to all wilderness areas:

*Wilderness character is a holistic concept based on the interaction of (1) biophysical environments primarily free from modern human manipulation and impact, (2) personal experiences in natural environments relatively free from the encumbrances and signs of modern society, and (3) symbolic meanings of humility, restraint, and interdependence that inspire human connection with nature.*

Taken together, these tangible and intangible values define wilderness character and distinguish wilderness from all other lands.

This interagency definition includes five fundamental and tangible qualities of wilderness: untrammeled, natural, undeveloped, solitude or primitive and unconfined recreation, and other features of value. These five qualities derive from descriptions of wilderness found in Section 2(c) of the Wilderness Act:

1. *Untrammeled*: Wilderness is “an area where the earth and its community of life are untrammeled by man.” When the untrammeled quality is preserved, wilderness ecological

systems are essentially unhindered and free from the actions of modern human control or manipulation.

2. *Natural*: Wilderness “is protected and managed so as to preserve its natural conditions.” When the natural quality is preserved, wilderness ecological systems have not been substantially modified by modern civilization.
3. *Undeveloped*: Wilderness is “an area of undeveloped Federal land . . . without permanent improvements or human habitation.” When the undeveloped quality is preserved, wilderness retains its primeval character and influence and is essentially without permanent improvement or modern human occupation.
4. *Solitude or Primitive and Unconfined Recreation*: Wilderness “has outstanding opportunities for solitude or a primitive and unconfined type of recreation.” When this quality is preserved, wilderness retains opportunities for solitude or primitive and unconfined recreation.
5. *Other Features of Value*: Wilderness “may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value.” When this quality is preserved, wilderness retains these scientific, educational, scenic, and historical values, when present.

In addition to the five tangible qualities of wilderness character, wilderness has important intangible qualities that are difficult or impossible to quantify or monitor. These intangible qualities are diverse and can include the spiritual experience and the opportunity for self-discovery, self-reliance, and challenge that comes from wilderness settings. Currently, these intangible aspects of wilderness can only be addressed in narrative form.

### **Monitoring Strategy**

The framework for wilderness character monitoring, followed in this document for development of the NOCA wilderness character monitoring program, is outlined in *Keeping It Wild 2: An Updated Interagency Strategy to Monitor Trends in Wilderness Character Across the National Wilderness Preservation System* (Landres et al. 2015). This framework is based on the tangible 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 2015). While the qualities, monitoring questions, and indicators are nationally consistent, measures are specific and sometimes unique to the individual wilderness areas.

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 wilderness areas, comparing wilderness character itself among different wilderness areas 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.

This wilderness character baseline information for the Park Complex, in conjunction with the Park's Wilderness Character Narrative (in draft), will 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. Trends can be monitored through the online interagency Wilderness Character Monitoring Database which includes entries for all measures and baseline data specific to this wilderness. In order to assure that data will be collected and entered into the interagency Wilderness Character Monitoring Database in the future, it is recommended that wilderness character monitoring be added to annual workload planning.

### **Wilderness Character Baseline Assessments**

The first step in wilderness character monitoring is to select a set of wilderness character measures and collect initial baseline data for each measure. The wilderness character monitoring measures are intended to be locally relevant; however, the selection of measures is guided by three factors: agency policy, wilderness character monitoring definitions, and wilderness character monitoring rules. The four federal land management agencies give local managers varying degrees of flexibility in the selection of measures. The National Park Service allows wilderness parks to create measures that are unique to its specific wilderness. The selection of measures is also guided by various wilderness character definitions, such as the definition of trammeling (see Appendix A) and definitions of "installation" and "development," which may not correspond to how local managers are using these terms. These wilderness character definitions are intended to be nationally consistent, and local managers do not have the flexibility to revise them. The selection of measures is also guided by various wilderness character monitoring rules. These include the following:

- Each indicator must have at least one measure.
- Preferably, measures should have adequate baseline data and an established monitoring protocol, but in rare cases a measure may be selected for which no baseline data currently exists.
- Measures should only be included if the managing unit can make a commitment to monitoring that measure in the future.

This document contains descriptions of the wilderness character monitoring measures selected for the Stephen Mather Wilderness. It also contains baseline data for measures that will be used to assess trends in wilderness character.

The baseline year for wilderness character monitoring is the year in which baseline data for all selected measures is complete. For the Stephen Mather Wilderness, the baseline year is 2015. Even though measures were selected and some data was compiled in 2014, there are a few measures for

which baseline data was not fully collected by 2015. Some selected measures have multi-year collection schedules and did not produce a value for 2015. For these measures, the wilderness character monitoring baseline value will be the value of the most recent year in which data has been produced. For one measure, a change in protocol methodology in 2019 means the baseline value will not be identified until 2020. Data for years prior to the wilderness character monitoring baseline year is called legacy data. Legacy data, where available, has been compiled in this report to provide context for the selected wilderness character measures, and is used in some measures to also provide the baseline value.

### **Wilderness Character Trend Assessment**

After the initial selection of measures and the collection of baseline data, wilderness character monitoring will be repeated every five years (although some measures require annual monitoring and data are averaged for the 5-year reporting period). The trends for measures will be used to determine trends for their respective indicators, the trends for the indicators will be used to determine trends for their respective qualities, and the trends for the qualities will be used to determine an overall trend in wilderness character. See Appendix B for more information on how trends for measures are rolled up to determine an overall trend in wilderness character.

Following direction in *Keeping it Wild 2* (Landres, et al, 2015), trend in wilderness character is derived by comparing the most recent data for each measure with the baseline (i.e., 2015). The overall trend in wilderness character is determined and reported by comparing the most recent data with the 2015 baseline data to prevent slow, incremental degradation of wilderness character.<sup>1</sup>

### **Wilderness Character Monitoring Database**

An online Wilderness Character Monitoring Database (WCMD) (<https://wc.wilderness.net/>) has been developed to store information about selected measures, data sources, data adequacy, wilderness character monitoring data frequency, wilderness character monitoring trend assessment rules, and collected measure values. Measure data should be compiled and entered into the WCMD in accordance with the wilderness character monitoring data frequency for each measure. Annually reported data should be entered into the database on an annual basis. Data reported every five years should be entered every five years, and so on. The WCMD will eventually have the capability to determine trends automatically.

A Park Complex-specific database will be developed to store all annual and 5-year data collected. That database will reside with the Park's Wilderness Coordinator. Park Complex data will also be added to the WCMD database.

---

<sup>1</sup> Because wilderness character monitoring is still a relatively new initiative and requirement for park wilderness areas, guidance on long-term trend calculation in measures may change. At the time of this baseline assessment (2020), thresholds for change are in alignment with national guidance. Any changes to how trends are calculated will follow national change management protocols, as is appropriate for any long-term monitoring program.

## **Wilderness Character Assessments and Park Planning**

National Park Service policy affirms the mandate of the Wilderness Act to preserve wilderness character. The National Park Service (NPS) *Management Policies 2006* assert that the preservation of wilderness character is one of the first and foremost directions. It also cites wilderness character as a consideration for a range of actions spanning resource management, environmental compliance, analysis of minimum requirements, cultural resources, management of facilities and signs, and interpretation and education.

Director's Order 41: Wilderness Stewardship, signed in 2013, provides specific direction for the preservation of wilderness character. It states that each wilderness park:

- “will integrate the concept of wilderness character into park planning, management, and monitoring”,
- “should develop a wilderness character narrative”, and
- “will conduct a wilderness character assessment, which includes identifying what should be measured, establishing baseline data, and conducting ongoing monitoring of trends”

Director's Order 41 also references the five tangible qualities of wilderness character, which likewise form the basis of this document.

In 2014, the National Park Service Wilderness Character Integration Team published *Keeping It Wild in the National Park Service: A User Guide to Integrating Wilderness Character into Park Planning, Management, and Monitoring* (hereafter referred to as the *User Guide*). The purpose of the *User Guide* is to provide a NPS-specific reference tool to help managers “integrate wilderness character into park planning, management, and monitoring.” Specific guidance for wilderness management (stewardship) has recently been provided by the NPS Wilderness Stewardship Division through the *Wilderness Stewardship Plan Handbook 2014* (henceforth: *Handbook*). A Wilderness Character Baseline Assessment is one part of the Wilderness Stewardship Planning Framework, as seen in Figure 1 (below), taken from the *Handbook*. A wilderness character baseline assessment is one of the key “Building Blocks for Wilderness Character”, essentially forming the basis for a park to monitor the status and trends of a number of indicators that represent the different qualities of wilderness character.

This wilderness character baseline assessment for the Stephen Mather Wilderness is intended to fulfill the first step of the directive in Director's Order 41 to develop a wilderness character assessment, establish baseline data, and conduct ongoing monitoring of trends. It is also intended to provide a foundation for the future creation of a wilderness stewardship plan for the Stephen Mather Wilderness.

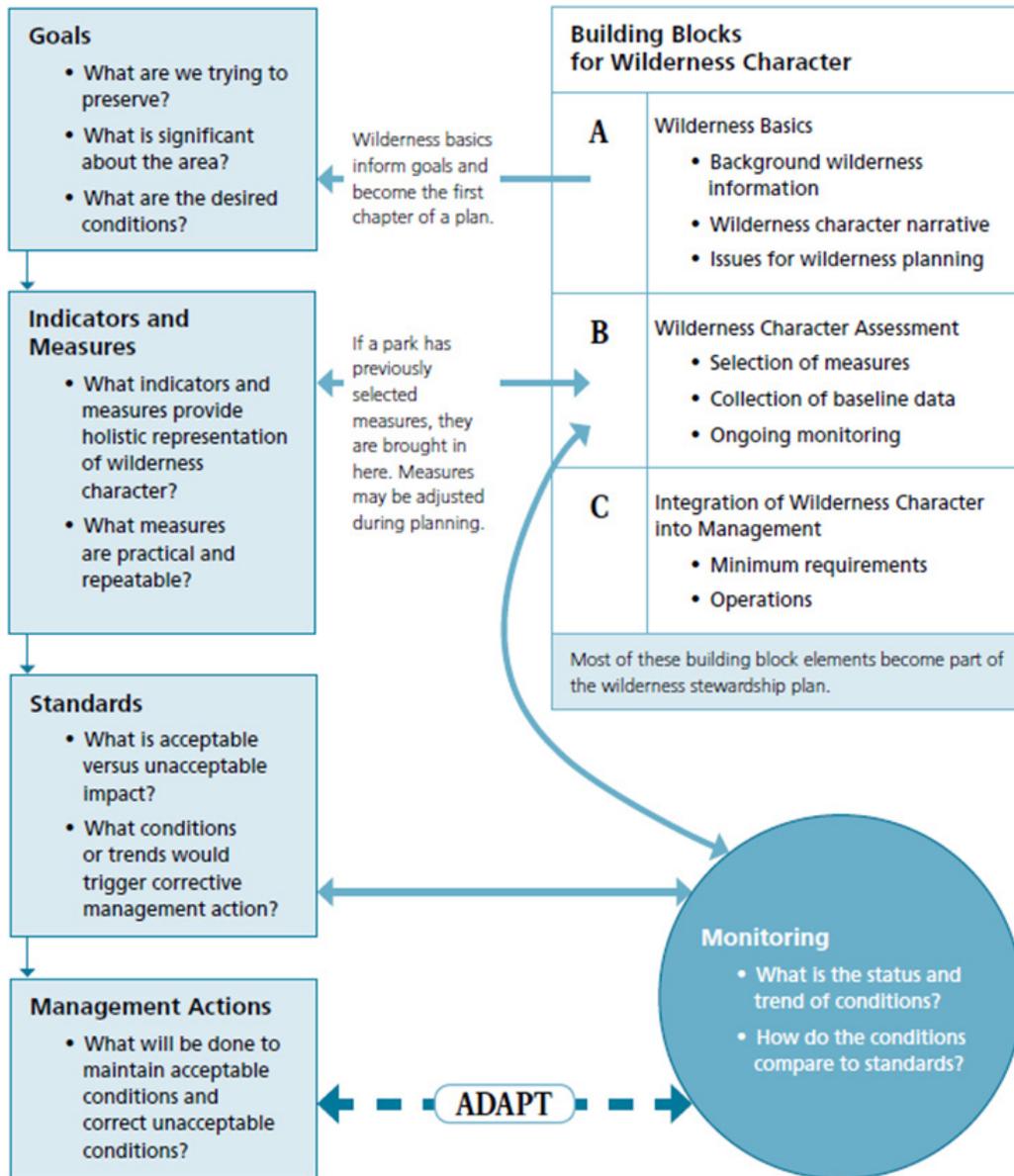


Figure 1. Wilderness Stewardship Planning Framework.

# Wilderness Character Monitoring Key Terms and Definitions

The following headings are used in the descriptions of the measures selected for the Stephen Mather Wilderness:

- **Measure Definition:** Describes what the measure is intending to track and the meaning of a particular data year’s value. Also included under this heading are definitions for any key terms as well as any necessary rules for calculating the measure value.
- **Data Source:** Describes the format and location, if known, of the raw data used to calculate the measure value. Also described under this heading, if known, is the location of the protocol for collecting raw data in the field.
- **Data Adequacy:** Describes the overall reliability of a measure’s data. Measures may be assigned data adequacy ratings of high, medium, or low. This rating is a function of a measure’s data quantity and data quality. Data quantity refers to the level of confidence that all appropriate data records have been gathered (Table 1). 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 (Table 2). Subjective evaluation of these two aspects is used to determine the overall data adequacy rating. Please note that the WCMD refers to data adequacy as “data confidence.”
- **Data Frequency:** Describes the frequency with which a measure value is reported for the purpose of wilderness character monitoring. Typical monitoring frequencies are one year or five years. To the extent that it is possible, the data for a measure should be entered into the WCMD as soon as it becomes available. The WCM data frequency need not be the frequency that data values are calculated for other purposes.
- **Trend Assessment:** Describes the rules for assigning a trend to a measure when wilderness character monitoring is repeated every five years.

**Table 1.** Categories of Data Quantity.

Category	Description
Complete	This category indicates a high degree of confidence that all data records have been gathered. For example, to assess the occurrence of non-indigenous invasive plants, a complete inventory of the wilderness was conducted or all likely sites were visited.
Partial	This category indicates that some data are available, but are generally considered incomplete (such as with sampling). For example, to assess the occurrence of non-indigenous invasive plants, a partial inventory was conducted or a sampling of sites was conducted where these plants are likely to occur.
Insufficient	This category indicates even fewer data records have been gathered or perhaps this measure is not dependent on actual field data. For example, no inventory for non-indigenous invasive plants has been conducted.

**Table 2.** Categories of Data Quality.

Category	Description
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.
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.
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.



Hikers in the Stephen Mather Wilderness, North Cascades National Park Service Complex.

# **Background on the Stephen Mather Wilderness**

## **Administrative History**

North Cascades National Park, Ross Lake National Recreation Area, and Lake Chelan National Recreation Area encompass 681,158 acres in the northern Cascade Range of Washington State. The three units were established by a single act of Congress in 1968 (PL 90-544) and are managed jointly as the North Cascades National Park Service Complex (Park Complex). The protection of wilderness was a central goal in the creation of a national park in the North Cascades (Louter, 1988). The Park Complex's status as a "wilderness park" was formalized with the passage of the Washington Park Wilderness Act (PL 100-668) in 1988. The Act created the Stephen Mather Wilderness, named after the National Park Service's first director, and initially encompassed 634,614 acres over all three units of the Park Complex.

The Washington Park Wilderness Act also created two potential wilderness areas in the Park Complex, one in the lower Big Beaver valley (1,667 acres) and one in the lower Thunder Creek valley (3,559 acres). Areas of potential wilderness are lands that qualify as wilderness except for the existence of non-conforming uses or non-federal interests. The two potential wilderness areas were so-designated due to long-standing proposals by Seattle City Light to expand hydropower production in the two valleys. In 2008, Seattle City Light formally abandoned plans to develop in the lower Thunder Creek valley, and the Lower Thunder Creek Potential Wilderness area was added to the Stephen Mather Wilderness by administrative action in 2012 (Federal Register Notice for Thunder Creek Wilderness Designation, 2012). This increased the size of the Stephen Mather Wilderness to over 638,000 acres, approximately 94% of the total area of the Park Complex.

In 1989, a wilderness management plan was developed for the Stephen Mather Wilderness. This plan, still in use, focuses heavily on visitor use management and lacks the holistic view necessary to protect all five qualities of wilderness described above. The 1989 plan was not created through a public review process through the National Environmental Policy Act, and lacks clear management guidelines for resolving current controversies regarding stewardship of the Stephen Mather Wilderness (Stephen Mather Wilderness Management Plan, 1989). A new Wilderness Stewardship Plan for the Park Complex is expected to begin in 2020.

## **Geographic Setting**

The North Cascades National Park Service Complex is located in the North Cascade physiographic province in northwestern Washington. It is bounded on the west, south, and east by 4.7 million acres of National Forest lands, of which 1.9 million acres are designated wilderness. The Park Complex's northern boundary is the international boundary with the Canadian province of British Columbia. The Park Complex spans the Cascade crest, placing within its boundary two major biogeographic zones: temperate marine and semi-arid continental. The climatic and biotic diversity are further increased by a transitional zone, roughly the lower elevations of the Ross Lake drainage. The third zone is created by an orographic divide west of the crest. Vegetal and climatic characteristics within this zone are intermediate between the mild, wet conditions typical of the west side and the semi-arid conditions typical of the east side of the Complex.

The Park Complex is characterized by deep, forested valleys between high, glaciated mountain peaks. The local topographic relief is 8800 ft. with the lowest point being 400 ft along the Skagit River and the highest elevations occurring on several mountain peaks over 9000 ft. The Park Complex contains 312 glaciers, more than all of the other national parks within the conterminous states combined. From the glaciers, permanent snowfields, and 530 lakes flow approximately 4039 mi of rivers and streams. Several major rivers are present in the Park Complex, including the Chilliwack River, the Nooksack River, the Skagit River, the Baker River, and the Stehekin River.

### **Ecological Setting**

The abundance of water and the wide variation in landforms, precipitation gradient, soil types, elevation, slope, and aspect create many types of habitat that support a diversity of flora and fauna. There are as many as 75 mammal, 200 bird, 27 fish, 17 reptile and amphibian, and approximately 1400 vascular plant species within the Park Complex. The Skagit River system is one of the few watersheds within the Puget Sound area that is managed for natural production of salmon. All the high lakes in the Complex were devoid of fish due to natural barriers to fish migration in their outlet streams.

In a broad sense, the vegetation of the Park Complex is typical of the vegetation found throughout mountainous areas of the Pacific Northwest. Douglas-fir (*Pseudotsuga menziesii*), Western Hemlock (*Tsuga heterophylla*), and Pacific Silver Fir (*Abies amabilis*) dominate the lower and montane slopes of the west side of the Complex. The east side is drier and dominated by dry Douglas-fir and Ponderosa Pine (*Pinus ponderosa*) forests. Riparian zones throughout the Complex are dominated by deciduous trees including alder (*Alnus rubra*) cottonwood (*Populus balsamifera trichocarpa*), and willow (*Salix* spp.). The upper elevations of the Park Complex are primarily Subalpine Fir (*Abies lasiocarpa*) and Mountain Hemlock (*Tsuga mertensiana*) forests. The eastern mountain slopes have those components as well as Subalpine Larch (*Larix lyallii*), Whitebark Pine (*Pinus albicaulis*), and Engelmann Spruce (*Picea engelmannii*). Above forestline, moist to dry subalpine meadows dominate. Roughly 230 species of non-native plants are found within the Complex, including Diffuse (*Centaurea diffusa*) and Spotted Knapweed (*Centaurea stoebe*), Rush Skeletonweed (*Chondrilla juncea*), St. John's Wort (*Hypericum perforatum*), Scotch Broom (*Cytisus scoparius*), Japanese Knotweed (*Fallopia japonicus*), Cheatgrass (*Bromus tectorum*), Common Mullein (*Verbascum thapsus*), and Herb Robert (*Geranium robertianum*).

### **Wilderness Recreation Setting**

The North Cascades National Park Service Complex and Stephen Mather Wilderness provides the wilderness user with great challenges of physical endurance, route finding, snow and ice travel, and navigation through on- and off-trail hiking. The Park Complex contains climbing routes of high quality and aesthetic appeal, guarded by remote, rugged terrain and volatile weather that provide mountaineering experiences of solitude, mental and physical challenge, and fulfillment. Overnight use of the Wilderness was approximately 30,000 visitors in 2015; significant day use of Wilderness occurs throughout the Park Complex as well. Park trails within Wilderness total approximately 350 miles, and 95 designated campgrounds are spread throughout the Wilderness.

## Process Used to Select Measures

The process of selecting wilderness character measures for the Stephen Mather Wilderness began in May, 2012 with a workshop at the Park Complex hosted by Dr. Peter Landres (Ecologist, Aldo Leopold Wilderness Research Institute, retired). At this workshop, Park staff developed a preliminary list of wilderness character monitoring measures. Additional work on selection of wilderness character monitoring measures began in July, 2014. At this time, the Wilderness Fellow met with Park staff, researched possible additional measures, and acquired relevant data. Some of the preliminary wilderness character monitoring measures had to be removed from the list of measures because they lacked sufficient baseline data or were not compliant with the guidelines set forth in *Keeping It Wild 2*. Other measures were added to the list if they were considered important for wilderness character and if adequate baseline data was available.

In October 2014, a wilderness committee meeting was held at the Park Complex. At this meeting, staff helped to refine the list of possible measures. Several measures were added to the list based on staff suggestions. Several measures were removed from the list because they either were not central to the character of the Stephen Mather Wilderness or because collecting reliable data was determined to be unfeasible (see section titled “Measures Not Used for Wilderness Character Monitoring”). Several other measures were placed on a list of priority measures for future use in wilderness character monitoring. These measures were determined to be important for monitoring wilderness character, but it was unclear whether the Park would be able to monitor them successfully in the future (see section titled “Priority Measures for Future Use in Wilderness Character Monitoring”). If and when this uncertainty has been resolved and the Park has established a monitoring protocol and is collecting adequate data, these measures can be incorporated into the wilderness character monitoring framework.

The final list of wilderness character measures was submitted to Peter Landres for review. A report was then written containing descriptions of the individual measures along with baseline and legacy data. This report was then submitted to Park staff and to Peter Landres for comments. Comments and other feedback were used to revise the wilderness character report. In April, 2016 Park staff met to again review the current list of measures and incorporate the updated guidance for selecting measures provided in *Keeping it Wild 2*; that meeting led to paring the selected measures list from 33 to 26. That list of 26 wilderness character measures was finalized and approved by Park managers in 2016. Staff have continued to work on finalizing this report since 2016 and have continued to collect data for each measure. In 2020, the final list of wilderness character measures (Table 3) was reduced to 24 simply to combine three separate measures that tracked authorized trammeling measures into one single measure (but retaining all the data).

## Details of Selected Measures

Table 3 below lists all 24 wilderness character measures selected to monitor the Stephen Mather Wilderness. Each measure is described in more detail in its respective section later in the report.

**Table 3.** Overview of Selected Measures.

Quality	Indicator	Measure Number	Measure	Weight (%)	2015 Baseline Value
Untrammeled	Actions authorized by the federal land manager that intentionally manipulate the biophysical environment	1-1	Five-year average of the annual number of authorized actions that intentionally manipulate vegetation, fish and wildlife, and naturally occurring fires.	100	12.2 actions
	Actions not authorized by the federal land manager that intentionally manipulate the biophysical environment	1-2	Five-year average of the annual number of unauthorized actions that intentionally manipulate the biophysical environment	100	0.4 actions
Natural	Plants	2-1	Index of non-indigenous plant species	100	TBD <sup>a</sup>
	Animals	2-2	Index of non-native aquatic species (non-native fish, amphibians)	50	28
		2-3	Index of non-native terrestrial animal species detected	50	10
	Air and Water	2-4	Ozone exposure to vegetation	25	2.0 ppm-hrs
		2-5	Wet Nitrogen Deposition	25	3.4 kg/ha
		2-6	Wet Sulfur Deposition	25	2.1 kg/ha
		2-7	Visibility – haze on mid-range days	25	3.4 deciviews
	Ecological Processes	2-8	Departure from the natural fire regime in the frequent fire interval region since 1960	100	3.45 return intervals
Undeveloped	Presence of non-recreational structures, installations, and developments	3-1	Number of scientific structures, installations, or developments	50	239 installations
		3-2	Number of administrative structures, installations, or developments	50	57 installations

Note: data is reported on a calendar year basis for measures unless noted otherwise.

<sup>a</sup> Value to be determined after additional data are collected

<sup>b</sup> mwe = meter water equivalent

**Table 3 (continued).** Overview of Selected Measures.

Quality	Indicator	Measure Number	Measure	Weight (%)	2015 Baseline Value
Undeveloped (continued)	Presence of inholdings	3-3	Acres of inholdings	100	147.42 acres
	Use of motor vehicles, motorized equipment, or mechanical transport	3-4	Five-year average of the annual number of helicopter landings and deliveries	100	183 landings/deliveries
Solitude or Primitive and Unconfined Recreation	Remoteness from sights and sounds of human activity inside wilderness	4-1	Percent of campsites that meet wilderness management privacy standards	100	45%
	Remoteness from sights and sounds of human activity outside wilderness	4-2	Percent time externally derived noise is audible in the Wilderness	50	10%
		4-3	Five-year average of the annual number of hours of NPS use of aircraft	50	TBD <sup>a</sup>
	Facilities that decrease self-reliant recreation	4-4	Number of all recreational structures associated with wilderness camps	100	589 structures
	Management restrictions on visitor behavior	4-5	Number of designated camps where campfires are prohibited	33.3	25 camps
		4-6	Number of designated camps or cross-country zones where bear canisters are required	33.3	15 camps/zones
		4-7	Percent of wilderness available for unconfined camping opportunities	33.3	70%
Other Features of Value	Deterioration or loss of integral historic or cultural features	5-1	Average condition value of listed or eligible structures	50	2.08 condition value
		5-2	Average condition value of listed or eligible archeological sites	50	3 condition value
	Iconic Features	5-3	Average cumulative volume change of four monitored glaciers	100	-10.27 mwe <sup>b</sup>

Note: data is reported on a calendar year basis for measures unless noted otherwise.

<sup>a</sup> Value to be determined after additional data are collected

<sup>b</sup> mwe = meter water equivalent

## Untrammeled Quality

The Untrammeled Quality includes two indicators and two selected measures (Table 4). The first indicator focuses on actions authorized by the federal land manager that intentionally manipulate the biophysical environment. Under this indicator, one measure (Measure 1-1) has been selected. This measure identifies known authorized trammeling actions and actions that may be forthcoming (e.g. mammal reintroductions or future widespread hazard tree removals). The measure documents authorized actions that intentionally manipulate vegetation that are done for purposes other than fire suppression, actions that intentionally manipulate fish or wildlife, and actions undertaken to suppress naturally occurring fires.

The second indicator focuses on actions *not* authorized by the federal land manager that intentionally manipulate the biophysical environment. Under this indicator, there is only one selected measure (Measure 1-2), which tracks all unauthorized trammeling actions that occur in the wilderness. These events are rare in the Stephen Mather Wilderness; however, this measure is included to comply with the requirement that each indicator have at least one measure.

**Table 4.** Overview of Selected Measures under the Untrammeled Quality.

<b>Indicator</b>	<b>Measure Number</b>	<b>Measure</b>	<b>Weight</b>
Actions authorized by the federal land manager that intentionally manipulate the biophysical environment	1-1	Five-year average of the annual number of authorized actions that intentionally manipulate vegetation, fish and wildlife, and naturally occurring fires.	100%
Actions not authorized by the federal land manager that intentionally manipulate the biophysical environment	1-2	Five-year average of the annual number of unauthorized actions that intentionally manipulate the biophysical environment	100%

**Measure 1-1: Five-year average of the annual number of authorized actions that intentionally manipulate vegetation, fish and wildlife, and naturally occurring fires.**

*Untrammelled Quality ~ Actions authorized by the federal land manager that manipulate the biophysical environment*

Measure Definition

This measure is intended to track over time changes in the number of trammeling actions that are undertaken that manipulate vegetation, fish and wildlife, and naturally occurring fires. The measure value for a particular reporting year is the average number of such actions that occurred per year during a five-year interval that includes the reporting year and the previous four calendar years (e.g. the five-year average for 2015 is the average number of actions that occurred per year during calendar years 2011 through 2015).

Trammeling actions and considerations are described in detail for each resource or process below.

**Vegetation:** Authorized trammeling actions that intentionally manipulate vegetation for purposes other than fire suppression include, but are not limited to, non-native plant removal projects, native plant restoration projects, and systematic hazard tree removal projects. For guidance on whether an authorized action that is not listed above counts as a trammeling action for the purpose of wilderness character monitoring, see Appendix A.

The following rules should be applied when counting the total number of authorized actions that intentionally manipulate vegetation for purposes other than fire suppression:

- To tally the number of authorized actions taken to remove non-native vegetation in a particular year, count one action for each general location at which one or more non-native plant species are treated. Ignore the total number of spot treatments. Judgment will be required to distinguish when treatments are made in different locations. One should consider geographic location as well as the history of the invasive outbreak. Hand pulling a small number of invasive plants would not be considered a trammeling action; spraying any area with herbicides would.
- To tally the number of authorized actions taken to restore native vegetation in a particular year, count one action for each general location at which plants are planted or soil is disturbed. Do not count the collection of seeds or the propagation of plants in a greenhouse outside of wilderness. Ignore the total number of plants planted, and do not count multiple actions if more than one plant species is planted.
- To tally the number of authorized actions taken to remove hazard trees in a particular year, count one action for each location at which hazard trees over a large area are removed. Removing one or a few hazard trees that threaten designated campsites, or are along a trail, are not counted as a trammeling action (Appendix A). Do not count the number of trees removed. Only count hazard tree removal as a trammeling action if there is a management decision to systematically remove hazard trees from wilderness camps. See Appendix A for more information on what constitutes trammeling regarding hazard tree removal.

**Fish and Wildlife:** Authorized actions that intentionally manipulate fish or wildlife include, but are not limited to, fish removal projects, fish stocking projects, and actions taken to restore or control the populations of mammals. For guidance on whether an action that is not listed above counts as a trammeling action for the purposes of wilderness character monitoring, see Appendix A.

The following rules should be applied when counting the total number of authorized actions that intentionally manipulate wildlife:

- To tally the number of authorized actions taken to remove fish in a particular year, count one action for each water body (lake or stream) in which gillnetting or chemical treatments are used to remove fish. Do not count initial assessment or monitoring treatment activities.
- To tally the number of authorized actions taken to stock fish in a particular year, count one action for each water body (lake or stream) in which fish are stocked.
- To tally the number of authorized actions taken to restore or control the populations of mammals, count one action for each location or incidence at which one or more mammals are introduced, removed, hazed, or killed. For example, five animals released one day, 10 animals released a second day, and seven animals released a third day, all at the same location, would count as three actions. Ignore the total number of mammals involved. Include introductions in non-wilderness areas if the intent is for them to move into the Wilderness. Do not count the isolated removal, hazing, or killing of problem animals. Only count removal, hazing, or killing actions if there is a management decision to perform such actions systematically throughout the Wilderness.

**Naturally Occurring Fires:** To tally the number of authorized actions taken to suppress naturally occurring fires in a particular year, count the suppression of each lightning-caused fire as a separate action. Do not count the suppression of human-caused fires. For the purposes of wilderness character monitoring, a fire is considered suppressed if managers perform one or more actions that intentionally manipulate the biophysical environment (trammeling actions) in the process of managing the fire. These actions include, but are not limited to the following: constructing fireline, installing hoselays (whether or not a fireline is cut), dropping water or retardant from aircraft, performing burnouts or back burns, and cutting trees or manipulating the ground surface to enable helicopter landing or sling drop (whether or not other direct suppression efforts listed above are taken). For the purpose of this measure, fires will be classified as suppressed based on the Initial Attack (IA) codes listed in the DOI Wildlife Fire Management Information database. See Table 5 (below) for a list of IA type codes and whether they count as a suppression (trammeling) action.

**Table 5.** Initial Attack Codes and Suppression Classification.

<b>IA Type Code</b>	<b>Initial Attack Type Description</b>	<b>Suppression Action?</b>
A	Explosives	Yes
B	Plows or trenchers	Yes
C	Light engines (Type 6 or 7)	Yes
D	Medium engines (Type 3, 4, or 5)	Yes
E	Heavy engines (Type 1 or 2)	Yes
F	Handcrew – Type 2	Yes
G	Smokeyjumper	Yes
H	Helitack crew	Yes
I	Light airtanker (Type 3 or 4)	Yes
J	Medium airtanker (Type 2)	Yes
K	Heavy airtanker (Type 1)	Yes
L	Light helicopter (Type 3 or 4)	Maybe
M	Medium helicopter (Type 2)	Maybe
N	Heavy helicopter (Type 1)	Maybe
O	Light dozer (Type 4, 5, or 6)	Yes
P	Medium dozer (Type 2)	Yes
Q	Heavy dozer (Type 1)	Yes
R	Watertenders	Yes
S	Monitoring fire by air	No
T	Monitoring fire by ground	No
U	Reconnaissance aircraft	No
V	Handcrew – Type 1	Yes
W	Overhead with own vehicle	No
X	Other equipment (describe in remarks)	Maybe
Y	Other firefighters (describe in remarks)	Maybe
Z	Other (none of the above, describe in remarks)	Maybe

#### Data Sources

**Vegetation:** The Geographic Positioning System (GPS) locations of spot treatments are recorded and are stored in Geographic Information System (GIS) datasets that are maintained by North Coast and Cascades Network (NCCN) Exotic Plant Management Specialists. Information about native plant restoration activities is stored in electronic files in possession of the Park Complex’s Horticulturist. If they occur in the future, information about systematic hazard tree removal activities will be provided by the Park Complex’s Trails Foreman.

**Fish and Wildlife:** Only non-native fish removal and fish stocking projects have been carried out in the Wilderness as of 2015. Information about fish removal activities is stored in electronic files in

possession of the Park Complex's Aquatic Ecologist. If they occur in the future, information about mammal restoration activities will be provided by the Park Complex's Wildlife Biologist.

**Naturally Occurring Fires:** Information on wildfire locations and management responses are stored in the DOI Wildland Fire Management Information database (<https://wfmi.nifc.gov>). Queries of this database can be performed by the Park Complex's Fire Ecologist.

#### Data Adequacy

For the measure as a whole, data adequacy is high because data quantity is complete and data quality is high.

#### Data Frequency

For the purpose of wilderness character monitoring, a measure value will be reported for the 2015 baseline year and for every fifth subsequent calendar year. The raw data used to calculate the measure value might be collected on a different schedule or schedules.

#### Trend Assessment

At the end of each five-year wilderness character monitoring cycle, a trend in wilderness character (upward, downward, or stable) will be reported for this measure. This trend will be determined in the following way: The measure value for the current assessment year (2020, 2025, etc.) will be compared to the 2015 baseline measure value. An upward trend in wilderness character will be reported for this measure if there is a 5% decrease in the measure value between 2015 and the current assessment year. A downward trend in wilderness character will be reported if there is a 5% increase in the measure value between 2015 and the current assessment year. A stable trend in wilderness character will be reported if there is less than 5% change in either direction in the measure value between 2015 and the current assessment year.

#### Compiled Data

Data compiled for each resource is described in the tables that follow.

**Vegetation:** Table 6 contains annual data on the number of non-native plant removal actions in the Wilderness. Each action listed in the table included one or more spot treatments that occurred inside the Wilderness boundary. This was verified using GIS software. The locations specified in the table are intended to be approximate. To provide context for this measure, annual data for years prior to 2011 have been included in Table 6. These data values will not be used to calculate the measure value for the 2015 baseline year or to assess wilderness character monitoring trends. Table 7 contains annual data on the number of native plant restoration projects. Table 8 contains annual data for 2011 through 2015 on the total number of authorized actions that intentionally manipulate vegetation for purposes other than fire suppression.

**Table 6.** Annual Number of Authorized Actions Taken to Remove Non-Native Vegetation.

Data Year	Number of Authorized Trammeling Actions	Target Species (Location)
2004	1	Japanese knotweed (Weaver Point)
2005	0	–
2006	0	–
2007	0	–
2008	0	–
2009	1	Japanese knotweed (Weaver Point)
2010	0	–
2011	0	–
2012	1	Cheatgrass (Stehekin)
2013	2	Cheatgrass (Stehekin), Japanese knotweed (Weaver Point)
2014	1	Cheatgrass (Stehekin)
2015	4	Cheatgrass (Rainbow Bridge fire – twice); Scotch Broom (Four-Mile Crk); Canada Thistle (Boulder Crk Trail)

**Table 7.** Annual Number of Authorized Actions Taken to Restore Native Vegetation.

Data Year	Number of Authorized Trammeling Actions	Description
2011	0	–
2012	1	144 <i>Vaccinium deliciosum</i> planted at Cascade Pass
2013	0	–
2014	0	–
2015	1	Campsite planting, South Fork (Bridge Crk)

**Table 8.** Summary of Authorized Actions that Intentionally Manipulate Vegetation for Purposes Other than Fire Suppression.

Data Year	Number of Native Plant Restoration Actions	Number of Non-Native Plant Removal Actions	Number of Hazard Tree Removal Actions	Total
2011	0	0	0	0
2012	1	1	0	2
2013	0	2	0	2
2014	0	1	0	1
2015	1	4	0	5
Total	2	8	0	10

**Fish and Wildlife:** From 2007–2015, fish removal projects were initiated at 11 lakes in the Wilderness. Table 9 lists the management actions that have occurred at each of those lakes. Table 10 summarizes the management actions that have occurred that manipulate wildlife. Table 11 also includes those lakes where authorized fish stocking was completed per the 2014 NOCA Fish Stocking Act and summarizes by year the total number of authorized actions that intentionally manipulate fish or wildlife. To provide context for this measure, data for years prior to 2011 have been included in Tables 9 and 11. These data values will not be used to calculate the measure value for the 2015 baseline year or to assess wilderness character monitoring trends.

**Table 9.** Authorized Actions Taken to Remove Non-Native Fish at Wilderness Lakes.

Year	Jeanita	Upper Triplet	Lower Triplet	Diobsud #1	Diobsud #2	Sour-dough	Middle Blum	Lower Blum	Kettling	Skymo Upper & Lower
2007	IA	–	–	–	–	–	–	–	–	–
2008	–	IA	IA	IA	IA	–	IA	IA	–	–
2009	–	GN	GN	GN	GN	–	CT	CT	–	–
2010	–	GN	GN	GN	GN	IA	MT, GN	MT, GN	IA	IA
2011	–	GN	GN	GN	GN	IA, GN	MT, GN	MT, GN	–	–
2012	GN	GN	GN	MT	GN	MT	MT, GN	MT, GN	–	–
2013	GN	GN	GN	MT	GN	CT	MT, GN	MT, GN	–	–
2014	MT	MT	GN	MT	GN	MT	MT, GN	MT, GN	CT	–
2015	–	MT	MT	MT	MT	MT	GN	GN	CT	CT

IA = initial assessment (not a trammeling action)

GN = active gillnetting (trammeling action)

CT = chemical treatment (trammeling action)

MT = monitoring treatment (not a trammeling action)

**Table 10.** Annual Number of Authorized Actions that Intentionally Manipulate Wildlife.

Data Year	Number of Authorized Trammeling Actions	Comments
2011–2015	0	No actions; table provided primarily for future accounting of trammeling actions related to wildlife

**Table 11.** Annual Number of Authorized Actions that Intentionally Manipulate Fish or Wildlife.

Data Year	Number of Authorized Trammeling Actions	Comments
2009	6	GN at 4 lakes; CT at 2 lakes
2010	6	GN at 6 lakes
2011	7	GN at 7 lakes
2012	6	GN at 6 lakes
2013	7	GN at 6 lakes; CT at 1 lake
2014	5	GN at 4 lakes; CT at 1 lake
2015	7	GN at 2 lakes; CT at 2 lakes; ST at 3 lakes (Willow, Ridley, Middle Thornton)

GN = active gillnetting (trammeling action)

CT = chemical treatment (trammeling action)

ST = stocking of lakes with fish (trammeling action)

**Naturally occurring fires:** Table 12 lists the number of naturally occurring fires per year that were suppressed. Table 13 summarizes this information in five-year intervals. To provide context for this measure, data for years prior to 2011 have been included in Tables 12 and 13. These data values will not be used to calculate the measure value for the 2015 baseline year or to assess wilderness character monitoring trends.

**Table 12.** Annual Number of Authorized Actions Taken to Suppress Naturally Occurring Fires.

Data Year	Number Suppressed
1989	8
1990	21
1991	4
1992	11
1993	0
1994	14
1995	0
1996	0
1997	6
1998	0
1999	6
2000	3
2001	2
2002	5

**Table 12 (continued).** Annual Number of Authorized Actions Taken to Suppress Naturally Occurring Fires.

<b>Data Year</b>	<b>Number Suppressed</b>
2003	9
2004	16
2005	2
2006	4
2007	4
2008	3
2009	16
2010	1
2011	0
2012	1
2013	4
2014	1
2015	13

**Table 13.** Five Year Averages of the Annual Number of Authorized Actions Taken to Suppress Naturally Occurring Fires.

<b>Data Year</b>	<b>Five-Year Interval</b>	<b>Total Number Suppressed</b>	<b>Ave Number Suppressed (rounded)</b>
1995	1991–1995	29	6
2000	1996–2000	15	3
2005	2001–2005	34	7
2010	2006–2010	28	6
2015	2011–2015	19	4

**Table 14.** Summary of All Authorized Actions that Intentionally Manipulate Vegetation, Fish and Wildlife, and Naturally Occurring Fires.

<b>Data Year</b>	<b>Vegetation</b>	<b>Fish and Wildlife</b>	<b>Suppressed Fires</b>	<b>Total</b>
2011	0	7	0	7
2012	2	6	1	9
2013	2	7	4	13
2014	1	5	1	7
2015	5	7	13	25
<b>Total</b>	–	–	–	61

### 2015 Baseline Value

The 2015 baseline value for the five-year average (2011–2015) for the annual number of authorized actions that intentionally manipulate vegetation, fish and wildlife, and naturally occurring fires within wilderness is 12.2.



Flick Creek Fire: suppression actions within wilderness, above the Stehekin Landing, 2006.

**Measure 1-2: Five-year average of the annual number of unauthorized actions that intentionally manipulate the biophysical environment**

*Untrammeled Quality ~ Actions **not** authorized by the federal land manager that manipulate the biophysical environment*

Measure Definition

This measure is intended to track over time changes in the number of a specific subset of all trammeling actions—unauthorized actions that intentionally manipulate the biophysical environment. The measure value for a particular reporting year is the average number of such actions that occurred per year during a five-year interval that includes the reporting year and the previous four calendar years (e.g. the five-year average for 2015 is the average number of actions that occurred per year during calendar years 2011 through 2015). The measure value should be rounded to the nearest whole number.

Examples of prior unauthorized actions that intentionally manipulate the biophysical environment include, but are not limited to unsanctioned fish stocking, poaching, and marijuana cultivation. For guidance on whether an action that is not listed above counts as a trammeling action for the purposes of wilderness character monitoring, see Appendix A.

Data Sources

When unauthorized trammeling actions come to the attention of Park staff, information about such events will be recorded in files in possession of relevant law enforcement personnel (either the Chief Ranger or Law Enforcement Specialist).

Data Adequacy

Data adequacy is medium because data quantity is partial because some unauthorized trammeling actions may have escaped detection and data quality is high. It is acknowledged that unauthorized actions initially may go unnoticed or unreported, but because the typical incidents identified here eventually become known due to staff activity and diligence, this measure remains viable for tracking unauthorized actions

Data Frequency

For the purpose of wilderness character monitoring, a measure value will be reported for the 2015 baseline year and for every fifth subsequent calendar year. The raw data used to calculate the measure value might be collected on a different schedule or schedules.

Trend Assessment

At the end of each five-year wilderness character monitoring cycle, a trend in wilderness character (upward, downward, or stable) will be reported for this measure. This trend will be determined in the following way: The measure value for the current assessment year (2020, 2025, etc.) will be compared to the 2015 baseline measure value. An upward trend in wilderness character will be reported for this measure if there is a decrease in the measure value between 2015 and the current assessment year. A downward trend in wilderness character will be reported if there is an increase in the measure value between 2015 and the current assessment year. A stable trend in wilderness

character will be reported if there is no change in the measure value between 2015 and the current assessment year.

Compiled Data

To provide context for this measure, data for years prior to 2011 have been included in Table 15. These data values will not be used to calculate the measure value for the 2015 baseline year or to assess wilderness character monitoring trends.

**Table 15.** Annual Number of Unauthorized Trammeling Actions.

Data Year	Number of Unauthorized Trammeling Actions	Comments
2008	1	Marijuana cultivation
2009	2	Illegal fish stocking at Middle and Lower Blum Lakes
2010	0	–
2011	0	–
2012	0	–
2013	0	–
2014	1	Illegal fish stocking at Vulcan Lake
2015	1	Illegal fish stocking at Azure Lake

2015 Baseline Value

The 2015 baseline value for the five-year average (2011–2015) for the number of unauthorized actions that intentionally manipulate the biophysical environment within wilderness is 0.4.



Illegal marijuana cultivation site and trash, 2008.

## Natural Quality

The Natural Quality includes four indicators and eight selected measures (Table 16). Several of these measures were taken from existing inventory and monitoring programs so that wilderness character monitoring would not place additional work burdens on Park Complex staff. The opinions of Park Complex staff were used to determine which existing measures best track the naturalness of Park resources and ecological processes.

The first indicator (“Plants”) includes one selected measure. Measure 2-1 quantifies the number of known non-indigenous plant species that are found within the Wilderness which are then indexed to account for the potential impact of each invasive species.

The second indicator (“Animals”) includes two selected measures that focus on non-native fish and wildlife species. The first (Measure 2-2) quantifies the number of non-native aquatic species within Wilderness which are then indexed to account for the distribution and potential impact of each non-native species, reflecting the emphasis within the Park Complex on managing aquatic systems for native species. This measure was assigned a weight of 50%. The second measure (Measure 2-3) quantifies the number of non-native terrestrial animal species that have been detected within Wilderness which are then indexed to account for the distribution and potential impact of each non-native species. This measure was assigned a weight of 50%.

The third indicator (“Air and Water”) includes four selected measures. These measures (Measures 2-4 through 2-7) under the “Air and Water” indicator focus on air quality. These four measures are intended to be used in wilderness character monitoring by all Park Service units with wilderness. Each was assigned a weight of 25%.

The fourth indicator (“Ecological Processes”) includes one measure (Measure 2-8), which tracks the departure from the natural fire regime in the region of the Wilderness marked by historically frequent fires. This measure focuses on just the frequent fire region because this is the region where fire suppression and the resulting build-up of fuels would likely have the greatest ecological effects.

**Table 16.** Overview of Selected Measures under the Natural Quality.

Indicator	Measure Number	Measure	Weight
Plants	2-1	Index of non-indigenous plant species	100%
Animals	2-2	Index of non-native aquatic species (non-native fish, amphibians)	50%
	2-3	Index of non-native terrestrial animal species detected	50%
Air and Water	2-4	Ozone exposure to vegetation	25%
	2-5	Wet Nitrogen Deposition	25%
	2-6	Wet Sulfur Deposition	25%
	2-7	Visibility – haze on mid-range days	25%
Ecological Processes	2-8	Departure from the natural fire regime in the frequent fire interval region since 1960	100%

## **Measure 2-1: Index of non-native plant species in wilderness**

### *Natural Quality ~ Plants*

#### Measure Definition

This measure is intended to track over time the number and impact of non-native plant species found along the trail system in wilderness. Trails selected for this measure include a mix of horse and hiker use trails, occur across multiple ecosystem types on both the east and west sides of the Cascades, and span the designated wilderness from north to south. Invasive species are defined in Executive Orders 13112<sup>2</sup> and 13751<sup>3</sup>.

The index is based upon the list of invasive plant species that are present in the wilderness, which is then modified to account for the potential impact of each invasive species. Potential impact is determined by consulting the NatureServe Explorer database to determine the Invasive Species Rank (“I-rank” and then converting the I-rank to a value where High=3, Medium=2, and Low/Unknown=1. If the NatureServe Explorer database does not list the species and provide a rank, or professional judgement of NPS staff feel a potential impact score should be elevated, then reliance on local NPS knowledge for the ranking will be followed. “Professional judgement” by NPS staff could involve such things as consideration of the amount of area infested, especially if it is known to be increasing, or the presence of federally-listed species or other species of concern near the invasive species infestations.

#### Data Sources

Weed populations were documented along trails and within camps in many parts of the Stephen Mather Wilderness in a 2006 survey (Appendix C). Most trails were surveyed except for those closed by fire at that time (Purple, Boulder and Lake Shore trails within the Stehekin Valley) and a few other trails. Additional surveys for those trails not surveyed in 2006 were begun in 2019 and will be completed in 2020 to complete the baseline surveys. Methods were developed to track non-native plants in a simple repeatable protocol. Data reside with the NOCA Plant Botanist and are summarized in Appendix C.

#### Data Adequacy

Data adequacy is high, because data quantity is partially complete and data quality is high.

#### Data Frequency

For the purpose of wilderness character monitoring, once the 2020 baseline value is determined, a measure value will be reported for the 2020 baseline year and for each subsequent 5-year monitoring cycle.

---

<sup>2</sup> Federal Register / Vol. 64, No. 25 / Feb. 8, 1999: <https://www.govinfo.gov/content/pkg/FR-1999-02-08/pdf/99-3184.pdf>

<sup>3</sup> Federal Register / Vol. 81, No. 236 / Dec. 8, 2016: <https://www.govinfo.gov/content/pkg/FR-2016-12-08/pdf/2016-29519.pdf>

### Trend Assessment

At the end of each five-year wilderness character monitoring cycle, a trend in wilderness character (upward, downward, or stable) will be reported for this measure. This trend will be determined in the following way: The measure value for the current assessment year (2025, 2030 etc.) will be compared to the 2020 baseline measure value (based on the 2006 and 2019–2020 survey data). An upward trend in wilderness character will be reported for this measure if there is a 5% decrease in the measure value between 2020 and the current assessment year. A downward trend in wilderness character will be reported if there is a 5% increase in the measure value between 2020 and the current assessment year. A stable trend in wilderness character will be reported if there is less than 5% change in either direction in the measure value between 2020 and the current assessment year.

### Compiled Data

The number of species found on trail segments in the 2006 and 2019 survey years, and the number of total unique non-native species found in this survey, are provided in Table 17. Any additional unique species found in 2020 will be added to the list. Table 18 lists the individual non-native species found and the I-rank or professional judgement score assigned to each species, which are then summed to reach the index score for this measure. A list of each species found for each of the trail segments in this table is found in Appendix C.

**Table 17.** Trail segments and Number of Unique Non-native Species Found (as of 2006 and 2019 surveys).

<b>Trail name*</b>	<b>Number of non-native species</b>	<b>Number of additional unique species</b>
1. Big Beaver	12	12
2. East Bank	5	2
3. Ruby Arm	4	1
4. Panther to Thunder from State Highway 20	5	2
5. Cascade Pass, from parking lot to pass	3	1
6. Chilliwack	6	0
7. Copper Ridge	3	1
8. Brush Creek-Stillwell CG	8	1
9. Easy Pass-Fisher Creek – Thunder Creek – Colonial CG)	16	6
10. Park Creek-Fisher Creek, including Meadow Cabin spur trail	11	1
11. Bridge Creek	13	3
12. Rainbow Creek-McAlester Pass	11	5
13. Boulder Creek-War Creek Pass	5	0
14. McGregor Mtn	3	0
15. Purple Creek-War Creek Pass	7	0
16. Fireweed Camp-McAlester Pass-South Pass	8	0
<b>Total number of unique species</b>	–	<b>35</b>

**Table 18.** Invasive species, I-rank or Professional Judgement Value, and Summed Index – as of 2019.

Common name	Species name	I-rank	Professional judgement rank
Red top	<i>Agrostis alba</i>	2	–
Hair grass	<i>Aira caryophyllea</i>	1	–
Cheatgrass	<i>Bromus tectorum</i>	3	–
Knapweed	<i>Centaurea</i> sp.	3	–
Sticky chickweed	<i>Cerastium glomeratum</i>	not yet assessed	1
Canada thistle	<i>Cirsium arvensis</i>	3	–
Bull thistle	<i>Cirsium vulgare</i>	2	–
Scotch broom	<i>Cystisus scoparius</i>	2	–
Orchard grass	<i>Dactylis glomerata</i>	not yet assessed	2
Herb Robert	<i>Geranium robertianum</i>	not yet assessed	3
St. John's wort	<i>Hypericum perforatum</i>	3	–
Prickly lettuce	<i>Lactuca serriola</i>	1	–
Wall lettuce	<i>Mycelis muralis</i>	not yet assessed	1
Timothy	<i>Phleum pratense</i>	2	–
English plantain	<i>Plantago lanceolata</i>	2	–
Common plantain	<i>Plantago major</i>	not yet assessed	1
Annual bluegrass	<i>Poa annua</i>	1	–
Bulbous bluegrass	<i>Poa bulbosa</i>	not yet assessed	3
Compressed bluegrass	<i>Poa compressa</i>	2	–
Perennial bluegrass	<i>Poa pratensis</i>	2	–
Creeping buttercup	<i>Ranunculus repens</i>	3	–
Cut leaved blackberry	<i>Rubus laciniatus</i>	not yet assessed	3
Sheep sorrel	<i>Rumex acetosella</i>	2	–
Curly dock	<i>Rumex crispus</i>	1	–
Sand spurrey	<i>Spergularia rubra</i>	not yet assessed	1
Spiny sow thistle	<i>Sonchus asper</i>	not yet assessed	2
Common chickweed	<i>Stellaria media</i>	1	–
Common tansy	<i>Tanacetum vulgare</i>	1	–
Dandelion	<i>Taraxacum officinale</i>	not yet assessed	1
Salsify	<i>Tragopogon dubius</i>	2	–
Red clover	<i>Trifolium pratense</i>	1	–
White clover	<i>Trifolium repens</i>	2	–
Speedwell	<i>Veronica</i> sp.	not yet assessed	1
Vicia	<i>Vicia</i> sp.	not yet assessed	1
Six-week brome	<i>Vulpia</i> sp.	not yet assessed	1
Column subtotal score	–	42	21
<b>Total index score</b>	–	–	<b>TBD in 2020</b>

### 2015 Baseline Value

The 2020 baseline value (using 2006 and 2019–2020 survey data) will be determined for the index of non-native plant species within wilderness. This number will be reported in the Trend Assessment report following the 2020 reporting year.



Cheatgrass treatment in wilderness, Stehekin Valley

## **Measure 2-2: Index of non-native aquatic species (non-native fish, amphibians)**

### *Natural Quality ~ Animals*

#### Measure Definition

This measure is intended to track changes in the number and impact of non-native fish and aquatic amphibian species in Wilderness lakes. The measure value for a particular data year is the index value of non-native aquatic species detected during that calendar year. All mountain lakes within the Park Complex were naturally fish-free, thus any fish found within them are considered non-native. These non-native fish species were purposefully stocked in the Park Complex waters prior to establishment in 1968, and since 2008 the Park has been working to remove individual lake populations from priority lakes as funding allows. Due to legislation passed in 2014, some lakes may continue to be stocked, following NPS guidelines to minimize negative impacts.

The index measure value is based on the list of non-native aquatic fish and amphibian species that are present in the wilderness, which is then modified to account for the distribution and potential impact of each non-native species. To calculate the index value, categories for species distribution and impact are assigned to each species.

Species distribution is assigned to an estimated percent distribution, as follows:

- Reference – the species is not present in any lakes in a wilderness. Numerical rating = 0
- Low – the species occupies up to 5% of the total area of lakes in a wilderness. Numerical rating = 1.
- Moderate – the species occupies 6–10% of the total area of all waterbodies in a wilderness. Numerical rating = 2.
- Wide – the species occupies more than 11% of the total area of all waterbodies in a wilderness. Numerical rating = 3.

Impact is the estimated relative effect of each non-native species on the Natural Quality. An impact category is assigned to each non-native species, as follows:

- Low – the species has a relatively small or localized impact on the natural ecosystems and plant or animal communities either in the lake or downstream. Impact category = 1.
- Moderate – the species has a noticeable effect on plant and animal communities, or natural ecosystems and eradication efforts may or may not be in place because of uncertainty of impact. Impact category = 2.
- High – the species has a large or significant impact on plant or animal communities or natural ecosystems and plans for eradication or reduction are likely in place because of the known large impact of the species. Impact category = 3.

To determine the index value for this measure, for each species multiply the species distribution rating and impact rating to determine a score for each species, and then add the species' scores up to determine a total index value. Professional judgement of Park staff (Aquatic Ecologist) is used to determine the distribution and impact ratings for each species.

### Data Sources

As of 2008, 62 mountain lakes had been surveyed and found to contain non-native fish; as of 2015 six species of non-native fish were found in these mountain lakes. Lakes with non-native fish may have populations that reproduce or are maintained by stocking. Information on the number of mountain lakes with non-native fish is stored in electronic files in possession of the Park Complex's Aquatic Ecologist.

As of 2015, no populations of non-native amphibian have been reported in the Wilderness. If found in the future, information on the number of mountain lakes with non-native amphibians and species names will be stored in electronic files in possession of the Park Complex's Aquatic Ecologist.

Systematic surveys for non-native fish and amphibians are not currently conducted in the Wilderness. However, detections are reported on an opportunistic basis by the Washington State Trail Blazers, the Washington State High Lakers, the Washington Department of Fish and Wildlife, and Park visitors. When funding is available, the NOCA Aquatics Program conducts surveys in lakes that have been identified in the Mountain Lakes Fishery Management Plan and EIS; however, a comprehensive survey of non-native fish and amphibians in mountain lakes has not been completed since the 1990's and the streams and rivers in the Park have never been comprehensively surveyed for non-native fish or amphibians.

### Data Adequacy

Data adequacy is moderate, because data quantity is partial and data quality is moderate.

### Data Frequency

For the purpose of wilderness character monitoring, a measure value will be reported for the 2015 baseline year and for each subsequent calendar year.

### Trend Assessment

At the end of each five-year wilderness character monitoring cycle, a trend in wilderness character (upward, downward, or stable) will be reported for this measure. This trend will be determined in the following way: The measure value for the current assessment year (2020, 2025, etc.) will be compared to the 2015 baseline measure value. An upward trend in wilderness character will be reported for this measure if there is a 5% decrease in the measure value between 2015 and the current assessment year. A downward trend in wilderness character will be reported if there is a 5% increase in the measure value between 2015 and the current assessment year. A stable trend in wilderness character will be reported if there is less than a 5% change in either direction in the measure value between 2015 and the current assessment year.

### Compiled Data

Table 19 identifies the known populations of non-native aquatic species known to occur within the Park Complex in 2015; Table 20 lists the six known species of non-native fish found in lakes within wilderness and their associated score based on their distribution and potential impact.

**Table 19.** Lakes identified with non-native fish populations in 2015.

<b>Lake Name</b>	<b>Lake Code</b>	<b>Condition</b>
Azure	MP-09-01	Reported Illegally Stocked
Battalion	MLY-02-01	Reproducing Population
Bear	MC-12-01	Reproducing Population
Berdeen	M-08-01	Reproducing Population
Berdeen, Lower	M-07-01	Reproducing Population
Berdeen, Upper	M-09-01	Reproducing Population
Blum, Lower	LS-07-01	Illegally Stocked
Blum, Middle	M-11-01	Illegally Stocked
Bouck, Lower	DD-04-01	Reproducing Population
Dagger	MR-04-01	Reproducing Population
Dee Dee, Upper	MR-15-01	Reproducing Population
Dee Dee/Tamarack, Lower	MR-15-02	Reproducing Population
Diobsud, No. 2, Middle	LS-02-01	Reproducing Population
Doubtful	CP-01-01	Reproducing Population
Doug's Tarn	M-21-01	Reproducing Population
Firn	MP-02-01	Reproducing Population
Green	M-04-01	Reproducing Population
Hanging	MC-08-01	Reproducing Population
Hidden	SB-01-01	Reproducing Population
Howard	MM-10-01	Reproducing Population
Hozomeen	HM-02-01	Reproducing Population
Ipsoot	LS-06-01	Reproducing Population
Jeanita	DD-01-01	Reproducing Population
Kettling	MR-05-01	Treated 2014
McAlester	MR-10-01	Reproducing Population
Monogram	M-23-01	Reproducing Population
Rainbow	MR-14-01	Reproducing Population
Ridley	HM-03-01	Legally Stocked 2015
Skymo, Lower	PM-03-01	Treated 2015
Skymo, Upper	PM-04-01	Treated 2015
Stiletto	MR-01-01	Reproducing Population
Stout	EP-09-02	Reproducing Population
Stout, Lower	EP-09-01	Reproducing Population
Thornton, Lower	M-20-01	Reproducing Population
Thornton, Middle	M-19-01	Legally Stocked 2015
Trapper	GM-01-01	Reproducing Population

**Table 19 (continued).** Lakes identified with non-native fish populations in 2015.

Lake Name	Lake Code	Condition
Triplet, Lower	SM-02-01	Reproducing Population
Unnamed (Rainbow Wall)	MR-16-01	Reproducing Population
Vulcan	ML-04-01	Reported Illegally Stocked
Wilcox/Lillie, Upper	EP-06-01	Reproducing Population
Wilcox/Sandie, Lower	EP-05-01	Reproducing Population
Willow	HM-04-01	Legally Stocked 2015

**Table 20.** Non-native aquatic species, distribution rating, impact rating, and index score.

Aquatic species	Distribution rating	X the Impact rating	= index score
Rainbow trout	2	3	6
Westslope Cutthroat Trout	3	3	9
Yellowstone Cutthroat Trout	1	3	6
Brown Trout	1	3	3
Golden Trout	1	1	1
Brook Trout	1	3	3
<b>Total – index measure value</b>	–	–	28

2015 Baseline Value

The 2015 baseline value for the index of non-native aquatic species (non-native fish, amphibians) within wilderness is 28.



European Brown Trout, Middle Blum Lake.

### **Measure 2-3: Index of non-native terrestrial animal species detected**

#### *Natural Quality ~ Animals*

##### Measure Definition

This measure is intended to track changes in the number and impact of non-native terrestrial animal species in the Wilderness. The measure value for a particular data year is the index value of non-native terrestrial animal species detected during that calendar year.

The index measure for this value is based on the list of non-native terrestrial species that are present in wilderness, which is then modified to account for the distribution and potential impact of each non-native species on the Park ecosystem. To calculate the index value, categories for species distribution and impact are assigned to each species.

Species distribution is assigned to an estimated percent distribution, as follows:

- Trace – the species occupies less than 1 percent of wilderness. Numerical rating = 1.
- Sparse – the species occupies 1–5% of wilderness. Numerical rating = 2
- Moderate – the species occupies 6–25% of wilderness. Numerical rating = 3.
- Wide – the species occupies more than 25% of wilderness. Numerical rating = 4.

Impact is the estimated relative effect of each non-native species on the Natural Quality. An impact category is assigned to each non-native species, as follows:

- Low – the species has a relatively small or localized impact on the natural ecosystems and plant or animal communities. Impact category = 1.
- Moderate – the species has a noticeable effect on plant and animal communities, or natural ecosystems and eradication efforts may or may not be in place because of uncertainty of impact. Impact category = 2.
- High – the species has a large or significant impact on plant or animal communities or natural ecosystems and plans for eradication or reduction are likely in place because of the known large impact of the species. Impact category = 3

To determine the index value for this measure, for each species multiply the species distribution rating and impact rating to determine a score for each species, and then add the species' scores up to determine a total index value (see Table 21 below). Professional judgement of Park staff (Wildlife Biologist) is used to determine the distribution and impact ratings for each species.

##### Data Sources

There are no systematic surveys for non-native terrestrial animal species in the Park. Information about avian species presence and abundance is collected in accordance with the North Coast and Cascade Network's (NCCN) Landbird Monitoring Protocol (<https://irma.nps.gov/DataStore/DownloadFile/153845>), and includes non-native bird species. Raw monitoring data is stored in a database maintained by the National Park Service. Landbird monitoring is conducted at a series of monitoring locations in the Park Complex. Most of these locations are inside the Wilderness. For the purpose of this measure, it will be assumed that all detected landbird

species either were detected in the Wilderness or have distributions that extend into the Wilderness. The number of native species detected is calculated by counting any native species identified through point count observation, rare bird observations, periodic owl surveys, or incidental observations.

Non-native terrestrial mammal detections are opportunistically reported to staff by visitors, researchers, and NPS staff and stored in the NOCA wildlife observations database. Not all of those observations arise from wilderness areas, but the data are described with geographic location and can be assessed annually.

There are no regular herpetofaunal surveys in the Park, except for community surveys of amphibians described in Measure 2-2. Any non-native terrestrial species detected from those surveys inform this measure. Herpetofaunal species are rarely reported as opportunistic wildlife observations by visitors and staff.

#### Data Adequacy

Data adequacy is moderate because data quantity is partial and data quality is moderate.

#### Data Frequency

For the purpose of wilderness character monitoring, a measure value will be reported for the 2015 baseline year and for each subsequent calendar year.

#### Trend Assessment

At the end of each five-year wilderness character monitoring cycle, a trend in wilderness character (upward, downward, or stable) will be reported for this measure. This trend will be determined in the following way: The measure value for the current assessment year (2020, 2025, etc.) will be compared to the 2015 baseline measure value. An upward trend in wilderness character will be reported for this measure if there is any decrease in the measure value between 2015 and the current assessment year. A downward trend in wilderness character will be reported if there is any increase in the measure value between 2015 and the current assessment year. A stable trend in wilderness character will be reported if there is no change in the measure value between 2015 and the current assessment year. The 2015 baseline measure value and the measure values for all subsequent years up to and including the current assessment year will be used to determine this trend. Any measure values for years prior to the 2015 baseline will not be used.

#### Compiled Data

As of 2015 the following non-native terrestrial animal species have been documented in the Park Complex and are assumed to be present within wilderness. Table 21 lists the five known species of non-native terrestrial animals (all birds) within wilderness and their associated score based on their distribution and potential impact to Park ecosystems and the Natural Quality.

**Table 21.** Non-native terrestrial animal species, distribution rating, impact rating, and index score.

Terrestrial animal species	Distribution rating	X the Impact rating	= index score
Brown-headed cowbird	1	1	1
European starling	1	1	1
Barred owl	3	2	6
House sparrow	1	1	1
Eurasian collared dove	1	1	1
<b>Total – index measure value</b>	–	–	<b>10</b>

2015 Species list:

Brown-headed cowbird (*Molothrus ater*)

European starling (*Sturnus vulgaris*)

Barred owl (*Strix varia*)

House sparrow (*Passer domesticus*)

Eurasian collared dove (*Streptopelia decaocto*)

2015 Baseline Value

The 2015 baseline value for the index value of non-native terrestrial animal species detected within wilderness is 10.



European starling

## **Measure 2-4: Ozone exposure to vegetation**

*Natural Quality ~ Air and Water*

### Measure Definition

This measure is intended to track over time changes in ozone exposure to vegetation in the Wilderness. Ground-level ozone is not emitted directly into the air but is created by chemical reactions between oxides of nitrogen (NO<sub>x</sub>) and volatile organic compounds (VOC). NO<sub>x</sub> and VOC are pollutants emitted by cars, industrial facilities, and other sources. They react chemically in the presence of sunlight to form ozone. Long-term exposures to ground-level ozone can cause injury to ozone-sensitive plants. Over the course of a growing season, ozone can damage plant leaf tissues that decreases photosynthetic capacity, weakens plants, and makes them less resistant to disease and insect infestations. The W126 metric is a biologically relevant measure that focuses on plant response to continuous ozone exposure. This measure is a better predictor of vegetation response than the metric used for the human health standard (4<sup>th</sup>-highest daily maximum 8-hour average ozone concentration) because damage slowly develops when under continuous exposure. Vegetation health risk from ozone is evaluated using the maximum 3-month 12-hour W126 index in parts per million-hours (ppm-hrs). W126 index estimates are derived from spatial interpolation of ozone data averaged over 5-years from the 12 closest ozone monitoring sites in the contiguous U.S. Estimated or measured values for individual park units represent wilderness areas.

### Data Sources

NPS Air Resources Division reports 5-year ozone averages for park units on an annual basis. Note that due to quality assurance and data analysis procedures, there is usually a 1 year lag time between the current year and the most recent available 5-year average value. To get data values:

- Go to <https://www.nps.gov/subjects/air/park-conditions-trends.htm>
- Select “North Cascades National Park” from the Park drop-down.
- Select *Ozone*, then *View Data* from the Parameter drop-down.

Look for the table for Ozone/Vegetation Health and click on the “Rationale+” button. Ozone exposure to **vegetation** is reported in the *Condition* text. Report the numeric value for ppm-hrs in the second sentence from the *Condition* text.

The raw air quality data takes several years to process, and as a result the mostly recently available estimate of the five-year average may be for several years prior to the current reporting year. The baseline value (2.0 parts per million-hours (ppm-hrs)) for this parameter reflects the period from 2011–2015. A risk assessment concluded that plants at North Cascades NP were at low risk for ozone damage. Note that in these reports, air quality values are listed for all three units of the North Cascades National Park Service Complex. For the purpose of this measure, the data value for North Cascades National Park (referred to in the reports as “North Cascades NP”) will be used.

### Data Adequacy

The nearest AQS sensor is located in Custer, WA, which is approximately 45 miles from the Wilderness boundary. Data quality is moderate (score=2) given the distance of the ozone monitor to

the wilderness boundary and data quantity is complete (score=3) because the measured 5-year average values are derived from ozone data that meet required completeness criteria of the NPS Air Resources Division. Data adequacy is thus moderate (sum score=5 for data quality and quantity).

#### Data Frequency

For the purpose of wilderness character monitoring, a measure value will be reported for the 2015 baseline year and for every fifth subsequent calendar year. The raw data used to calculate the measure value might be collected on a different schedule or schedules.

#### Trend Assessment

Any change of 2 parts per million-hours or more in either direction from the baseline data value is considered significant. This threshold was developed by the NPS Air Resources Division.

At the end of each five-year wilderness character monitoring cycle, a trend in wilderness character (upward, downward, or stable) will be reported for this measure. This trend will be determined in the following way: The raw measure values for the current assessment year (2020, 2025, etc.) and the 2015 baseline year will be compared. An upward trend in wilderness character will be reported for this measure if there is a net decrease of 2 parts per million-hours or more in the value between 2015 and the current assessment year. A downward trend in wilderness character will be reported if there is a net increase of 2 parts per million-hours or more in the value between 2015 and the current assessment year. A stable trend in wilderness character will be reported if there is less than a 2 parts per million-hours change in either direction between 2015 and the current assessment year.

#### Compiled Data

Table 22 records the most recently available measure value as of December 31, 2015.

**Table 22.** Most Recently Available Ozone Exposure to Vegetation Data in 2015.

<b>Data Year</b>	<b>Averaging Period</b>	<b>Ozone (ppm-hrs)</b>
2015	2011–2015	2.0

#### 2015 Baseline Value

The 2015 baseline value for ozone exposure to vegetation within wilderness is 2.0 ppm-hrs.

## **Measure 2-5: Wet nitrogen deposition**

*Natural Quality ~ Air and Water*

### Measure Definition

This measure is intended to track over time changes in wet nitrogen deposition in the Wilderness. Airborne nitrogen, in the form of nitrate and ammonium, is deposited to the earth's surface through a process called atmospheric deposition. When nitrogen is removed from the atmosphere with rain, snow, or other precipitation it is called wet nitrogen deposition; dry deposition occurs when nitrogen is removed by gravitational settling, impaction, or absorption. Excess nitrogen deposited from the air may have harmful effects on nature, including acidification, nutrient imbalances, and loss of biodiversity of microorganisms, fish, amphibians, and plants. Excess nitrogen comes from a variety of air pollution sources including power plants, industrial facilities, and agriculture. While ecosystems respond to total (wet and dry) deposition, wet nitrogen deposition is used as a surrogate for total deposition, because wet deposition is the most widely available source of measured nitrogen deposition data.

Reporting units for wet deposition are kilograms per hectare per year (kg/ha/yr). In the contiguous U.S., wet nitrogen deposition estimates are derived from spatial interpolation of 5-year average concentration of nitrogen from nitrate and ammonium from the 12 closest deposition monitoring sites. Wet deposition concentrations are multiplied by modeled 30-year average precipitation.

### Data Sources

NPS Air Resources Division reports 5-year deposition averages for park units on an annual basis. Note that due to quality assurance and data analysis procedures, there is usually a 1 year lag time between the current year and the most recent available 5-year average value. To get data values:

- Go to <https://www.nps.gov/subjects/air/park-conditions-trends.htm>
- Select “North Cascades National Park” from the Park drop-down.
- Select “Nitrogen Deposition” from the Parameter drop-down
- In the Summary tab, click on the “Rationale +” button. Nitrogen deposition is reported in the Condition text, and the maximum value in the range is reported as the baseline value for wilderness character here.

Wet nitrogen deposition warrants significant concern at North Cascades NP. This status is based on NPS Air Resources Division benchmarks and the 2011–2015 estimated wet nitrogen deposition of 3.4 kilograms per hectare per year (kg/ha/yr). Ecosystems in the Park were rated as having very high sensitivity to nutrient-enrichment effects relative to all Inventory & Monitoring parks (Sullivan et al. 2011a; Sullivan et al. 2011b).

Note: in these reports, air quality values are listed for all three units of the North Cascades National Park Service Complex. For the purpose of this measure, the data value for North Cascades National Park (referred to in the reports as “North Cascades NP”) will be used.

### Data Adequacy

There are no NADP monitoring stations in the Wilderness, but there is one station located in Marblemount, WA, that is approximately five miles from the Wilderness boundary, which provides for a high degree of confidence in the data. Data adequacy is high (sum score=6) because data quantity is complete (values are derived from nitrogen deposition data that meet required completeness criteria of the NPS Air Resources Division, score=3) and data quality is high (data is monitored within 16 km of the Park boundary, score=3).

### Data Frequency

For the purpose of wilderness character monitoring, a measure value will be reported for the 2015 baseline year and for every fifth subsequent calendar year. The raw data used to calculate the measure value might be collected on a different schedule or schedules.

### Trend Assessment

Any change of 0.5 kg/ha/yr or more in either direction from the baseline data value is considered significant. This threshold was developed by the NPS Air Resources Division

At the end of each five-year wilderness character monitoring cycle, a trend in wilderness character (upward, downward, or stable) will be reported for this measure. This trend will be determined in the following way: The raw measure values for the current assessment year (2020, 2025, etc.) and the 2015 baseline year will be compared. An upward trend in wilderness character will be reported for this measure if there is a net decrease of 0.5 kg/ha/yr or more between 2015 and the current assessment year. A downward trend in wilderness character will be reported if there is a net increase of 0.5 kg/ha/yr or more between 2015 and the current assessment year. A stable trend in wilderness character will be reported if a change of less than 0.5 kg/ha/yr in either direction between 2015 and the current assessment year is reported.

Caution: Note that the methodology for assessing nitrogen deposition will be improved in coming years by including local ecosystem responses to total deposition (wet and dry).

### Compiled Data

Table 23 records the most recently available measure value as of December 31, 2015.

**Table 23.** Most Recently Available Wet Nitrogen Deposition Data in 2015.

<b>Data Year</b>	<b>Averaging Period</b>	<b>Wet N Deposition (kg/ha)</b>
2015	2011–2015	3.4

### 2015 Baseline Value

The 2015 baseline value for wet nitrogen deposition within wilderness is 3.4 kg/ha.

## **Measure 2-6: Wet sulfur deposition**

*Natural Quality ~ Air and Water*

### Measure Definition

This measure is intended to track over time changes in wet sulfur deposition in the Wilderness. Sulfur, in the form of sulfate, is deposited to the earth's surface through a process called atmospheric deposition. When sulfur is removed from the atmosphere via rain, snow, or other precipitation it is called wet sulfur deposition; dry deposition occurs when sulfur is removed by gravitational settling, impaction, or absorption. Excess sulfur deposited from the air may have harmful effects on nature, including acidification and loss of biodiversity of microorganisms, fish, amphibians, and plants. The largest sources of sulfur dioxide emissions are from fossil fuel combustion at power plants and other industrial facilities. While ecosystems respond to total (wet and dry) deposition, wet sulfur deposition is used as a surrogate for total deposition, because wet deposition is the most widely available source of measured sulfur deposition data.

Reporting units for wet deposition are kilograms per hectare per year (kg/ha/yr). In the contiguous U.S., wet sulfur deposition estimates are derived from spatial interpolation of 5-year average concentration of sulfur from sulfate from the 12 closest deposition monitoring sites. Wet deposition concentrations are multiplied by modeled 30-year average precipitation.

### Data Sources

NPS Air Resources Division reports 5-year deposition averages for park units on an annual basis. Note that due to quality assurance and data analysis procedures, there is usually a 1 year lag time between the current year and the most recent available 5-year average value. To get data values:

- Go to <https://www.nps.gov/subjects/air/park-conditions-trends.htm>
- Select “North Cascades National Park” from the Park drop-down.
- Select “Sulfur Deposition” from the Parameter drop-down.
- In the Summary tab, click on the “Rationale +” button. Sulfur deposition is reported in the Condition text, and the maximum value in the range is reported as the baseline value for wilderness character here.

Wet sulfur deposition warrants significant concern at North Cascades NP. This status is based on NPS Air Resources Division benchmarks (at <https://www.nps.gov/subjects/air/analysis-methods.htm>) and the 2011–2015 estimated wet sulfur deposition of 2.1 kilograms per hectare per year (kg/ha/yr), a level that normally warrants moderate concern. However, the status has been elevated to significant concern because ecosystems at North Cascades NP may be very highly sensitive to acidification effects relative to all Inventory & Monitoring parks (Sullivan et al. 2011a; Sullivan et al. 2011b). There are 12 plant species sensitive to the effects of acidification in the Park.

Note: in these reports, air quality values are listed for all three units of the North Cascades National Park Service Complex. For the purpose of this measure, the data value for North Cascades National Park (referred to in the reports as “North Cascades NP”) will be used.

### Data Adequacy

There are no NADP monitoring stations in the Wilderness, but there is one station located in Marblemount, WA, that is approximately five miles from the Wilderness boundary, which provides for a high degree of confidence in the data. Data adequacy is high (sum score=6) because data quantity is complete (values are derived from sulfur deposition data that meet required completeness criteria of the NPS Air Resources Division, score=3) and data quality is high (data is monitored within 16 km of the Park boundary, score=3).

### Data Frequency

For the purpose of wilderness character monitoring, a measure value will be reported for the 2015 baseline year and for every fifth subsequent calendar year. The raw data used to calculate the measure value might be collected on a different schedule or schedules.

### Trend Assessment

Any change of 0.5 kg/ha/yr or more in either direction from the baseline data value is considered significant. This threshold was developed by the NPS Air Resources Division.

At the end of each five-year wilderness character monitoring cycle, a trend in wilderness character (upward, downward, or stable) will be reported for this measure. This trend will be determined in the following way: The raw measure values for the current assessment year (2020, 2025, etc.) and the 2015 baseline year will be compared. An upward trend in wilderness character will be reported for this measure if there is a net decrease of 0.5 kg/ha/yr or more between 2015 and the current assessment year. A downward trend in wilderness character will be reported if there is a net increase of 0.5 kg/ha/yr between 2015 and the current assessment year. A stable trend in wilderness character will be reported if there is a change of less than 0.5 kg/ha/yr in either direction between 2015 and the current assessment year.

### Compiled Data

Table 24 records the most recently available measure value as of December 31, 2015.

Caution: Note that the methodology for assessing sulfur deposition will be improved in coming years by including local ecosystem responses to total deposition (wet and dry).

**Table 24.** Most Recently Available Wet Sulfur Deposition in 2015.

<b>Data Year</b>	<b>Averaging Period</b>	<b>Wet S Deposition (kg/ha)</b>
2015	2011–2015	2.1

### 2015 Baseline Value

The 2015 baseline value for wet sulfur deposition within wilderness is 2.1 kg/ha.

## **Measure 2-7: Visibility**

### *Natural Quality ~ Air and Water*

#### Measure Definition

This measure is intended to track over time changes in visibility conditions in the Wilderness. Particles in the atmosphere—from both natural and human-caused sources (e.g., wildfire smoke, power plants)—scatter and absorb light, creating a haze that limits how far and how well we can see. Unfortunately, the clarity of Park views is affected by human-caused pollution in virtually all national parks, including wilderness areas, across the country. Mid-range days capture overall trends in human-caused contributions to haze by reducing the influence of episodic natural events such as wildfires and dust. These natural events often dominate the 20% haziest days in the Western US.

This measure tracks haze on mid-range days expressed using the haze index in deciviews. Mid-range days are sampled days with haze levels between the 40th and 60th percentiles of days sampled in a given year. Haze index estimates are derived from spatial interpolation of visibility data averaged over 5-years from the 12 closest visibility monitoring sites in the contiguous U.S.

#### Data Sources

NPS Air Resources Division reports 5-year visibility averages for park units on an annual basis. Note that due to quality assurance and data analysis procedures, there is usually a 1 year lag time between the current year and the most recent available 5-year average value. To get data values:

- Go to <https://www.nps.gov/subjects/air/park-conditions-trends.htm>
- Select “North Cascades National Park” from the Park drop-down.
- Select “Visibility” from the Parameter drop-down.
- In the Summary tab, click on the “Rationale +” button. Haze on mid-range days is reported in the Condition text. Report the first numeric for deciviews from the Condition text.

Visibility warrants moderate concern at North Cascades NP. This status is based on NPS Air Resources Division benchmarks (<https://www.nps.gov/subjects/air/analysis-methods.htm>) and the 2011–2015 estimated visibility on mid-range days of 3.4 deciviews (dv) above estimated natural conditions. “Natural conditions” are estimated to be 4.1 dv. Thus, the recorded baseline value for wilderness character (value above estimated natural conditions) is 3.4 dv.

Note: in these reports, air quality values are listed for all three units of the North Cascades National Park Service Complex. For the purpose of this measure, the data value for North Cascades National Park (referred to in the reports as “North Cascades NP”) will be used.

#### Data Adequacy

Data quality is based on the availability of a representative air quality monitor in or near a NPS unit. All estimated 5-year average values have moderate (score=2) data quality unless there is a representative monitor within 150 kilometers of park boundaries and within +/- 100 feet or 10% of maximum and minimum park elevation. Units with a measured 5-year average or a representative monitor have high (score=3) data quality. Data quantity is complete (score=3) for available estimated

or measured 5-year average values because they are derived from visibility data that meet required completeness criteria of the NPS Air Resources Division.

There are no IMPROVE stations in the Stephen Mather Wilderness, but there is one station located at a non-wilderness site in the Ross Lake National Recreation Area that is less than one mile from the Wilderness boundary.

The NPS Air Quality Division considers data quality to be “high” (score=3) and data quantity as “complete” (score=3) given the in-Park location of the monitoring station. Data adequacy is high (score=6) because data quantity is complete and data quality is high.

#### Data Frequency

For the purpose of wilderness character monitoring, a measure value will be reported for the 2015 baseline year and for every fifth subsequent calendar year. The raw data used to calculate the measure value might be collected on a different schedule or schedules.

#### Trend Assessment

Any change of one deciview or more in either direction from the baseline data value is considered significant. This threshold was developed by the NPS Air Resources Division.

At the end of each five-year wilderness character monitoring cycle, a trend in wilderness character (upward, downward, or stable) will be reported for this measure. This trend will be determined in the following way: The raw measure values for the current assessment year (2020, 2025, etc.) and the 2015 baseline year will be compared. An upward trend in wilderness character will be reported for this measure if there is a net decrease of one deciview between 2015 and the current assessment year. A downward trend in wilderness character will be reported if there is a net increase of one deciview between 2015 and the current assessment year. A stable trend in wilderness character will be reported if there is less than one deciview change (positive or negative) between 2015 and the current assessment year.

#### Compiled Data

Table 25 records the most recently available measure value as of December 31, 2015.

**Table 25.** Most Recently Available Visibility Data in 2015.

<b>Data Year</b>	<b>Averaging Period</b>	<b>Visibility (dv) above estimated natural conditions</b>
2015	2011–2015	3.4

#### 2015 Baseline Value

The 2015 baseline value for visibility within wilderness is 3.4 dv above estimated natural conditions.

## **Measure 2-8: Departure from the natural fire regime in the frequent fire interval region since 1960**

*Natural Quality ~ Ecological Processes*

### Measure Definition

This measure is intended to track over time the extent to which fire suppression has disrupted natural fire regimes in the part of the Wilderness where the accumulation of fuels is likely to have the most impact ecologically. The measure value for a particular reporting year is the number of fire intervals missed in the frequent fire interval region between 1960 and December 31 of the reporting year. The frequent fire interval region is the part of the Wilderness with climate and forest type such that fires would be expected to return on a frequent basis (10–70 year mean fire interval). Using Landscape Fire and Resource Management Planning Tools (LANDFIRE) data and local fire history studies, the Park Complex’s Fire Ecologist has mapped the Park’s forests into areas with frequent, moderate, and long natural fire intervals. The frequent fire interval region includes approximately 24,608 acres of the Wilderness, mostly in the Lake Chelan National Recreation Area.

The number of fire returns missed is calculated by dividing the modern mean fire return interval by the historical mean fire return interval. The historical mean fire return interval for the frequent fire region is estimated to be 29 years, based on the findings of a current fire history study for Stehekin (Kopper *in draft*. Defining and Interpreting Fire Regime Characteristics in Pacific Northwest Forests. Ph.D. Dissertation. University of Washington, Seattle.). The modern mean fire return interval for the frequent fire region is calculated by dividing the number of years in which data are available by the percentage of the frequent fire interval that has burned during that time span. Data for this measure will include wildfire data collected from 1960 through the current reporting year. Thus, data for 2015 will include data for 56 years (1960 through 2015). Data for 2020 will include data for 61 years (1960 through 2020), and so on.

### Data Sources

Wildfire data used to calculate the total area of the frequent fire region is stored in the DOI Wildland Fire Management Information database. Queries of this database can be performed by the Park Complex’s Fire Ecologist. The Park Complex’s Fire Ecologist has written metadata that will be used to guide future calculations of this measure. This measure is based on data collected prior to wilderness designation and prior to the creation of the Park Complex.

### Data Adequacy

Data adequacy is high because data quantity is complete and data quality is high.

### Data Frequency

For the purpose of wilderness character monitoring, a measure value will be reported for the 2015 baseline year and for every fifth subsequent calendar year. The raw data used to calculate the measure value might be collected on a different schedule or schedules.

### Trend Assessment

At the end of each five-year wilderness character monitoring cycle, a trend in wilderness character (upward, downward, or stable) will be reported for this measure. This trend will be determined in the following way: The raw measure values for the current assessment year (2020, 2025, etc.) and the 2015 baseline year will first be converted to departure classes using the thresholds listed in Table 26. The departure classes for the current assessment year and the 2015 baseline year will then be compared. An upward trend in wilderness character will be reported for this measure if there is a change from a higher departure class to a lower departure class between 2015 and the current assessment year. A downward trend in wilderness character will be reported if there is a change from a lower departure class to a higher departure class between 2015 and the current assessment year. A stable trend in wilderness character will be reported if there is no change in the departure class between 2015 and the current assessment year.

**Table 26.** Fire Regime Departure Classes.

<b>Number of Fire Returns Missed</b>	<b>Departure Class</b>
value < 2	Low
2 <= value < 3	Moderate
value >= 3	High

### Compiled Data

Table 27 records the measure value as calculated using data collected through 2015.

**Table 27.** Departure from Natural Fire Regime in Frequent Fire Interval Region as of 2015.

<b>Data Year</b>	<b>Data Analysis Years</b>	<b>Modern Mean Fire Return Interval</b>	<b>Number of Fire Returns Missed</b>	<b>Departure Class</b>
2015	1960–2015	99.99 years	3.45	High

### 2015 Baseline Value

The 2015 baseline value for the calculated departure from the natural fire regime in the frequent fire interval region since 1960 is 3.45 (High).

## Undeveloped Quality

The Undeveloped Quality includes three indicators and four selected measures (Table 28). The first indicator focuses on the presence of non-recreational structures, installations, and developments. There are two selected measures under this indicator, each focusing on a different category of non-recreational structures, installations, and developments. The first (Measure 3-1) tracks the number of such objects in the Wilderness that are used for gathering scientific data. The second measure (Measure 3-2) tracks the number of such objects in the Wilderness that are used for administrative purposes other than scientific research. Each of these measures was assigned a weight of 50%.

The second indicator focuses on the presence of inholdings in wilderness. Inholdings are pieces of land within the wilderness boundary that are owned by private citizens or by state agencies. These lands have fewer environmental protections than they would have if they were owned by the NPS. As such, the presence of inholdings is a threat to wilderness character. Inholdings within the Stephen Mather Wilderness have been the object of considerable controversy (see *Contested Terrain*, chapter 10, for details). This controversy remains unresolved through the present day. Under this indicator, there is one measure (Measure 3-3), which tracks the number of acres of inholdings remaining in the Stephen Mather Wilderness.

The third indicator focuses on the use of motor vehicles, motorized equipment, or mechanical transport in wilderness. There is one selected measure under this indicator that tracks the Park Complex's use of aircraft in the Wilderness, a subject that is becoming increasingly controversial. Measure 3-4 focuses on the number of helicopter landings and deliveries in wilderness.

**Table 28.** Overview of Selected Measures under the Undeveloped Quality.

Indicator	Measure Number	Measure	Weight
Presence of non-recreational structures, installations, and developments	3-1	Number of scientific structures, installations, or developments	50%
	3-2	Number of administrative structures, installations, or developments	50%
Presence of inholdings	3-3	Acres of inholdings	100%
Use of motor vehicles, motorized equipment, or mechanical transport	3-4	Five-year average of the annual number of helicopter landings and deliveries	100%

### **Measure 3-1: Number of scientific structures, installations, or developments**

*Undeveloped Quality ~ Presence of non-recreational structures, installations, and developments*

#### Measure Definition

This measure is intended to track over time changes in the number of human-made objects in the Wilderness that are used for gathering scientific data. The measure value for a reporting year is the number of scientific structures, installations, or developments located in the Wilderness as of October 1 (approximately the end of that year's field season). Data collected most recently to October 1 of that data year should be used to calculate the measure value. For the purpose of wilderness character monitoring, an installation is any human-made object that is left in the Wilderness for at least three months at a time. Scientific installations include, but are not limited to, the following: weather stations, water gauges, water temperature sensors, wildlife cameras, radio-telemetry/GPS transmitters on animals, and sampling plots that have permanent markers such as tree tags or locations marked with rebar or wooden stakes. Sampling plots should be counted as a single installation regardless of the number of permanent markers at that site. Radio telemetry/GPS transmitters should be counted for each animal outfitted (e.g., 5 collared wolves would count as "5").

#### Data Sources

Information on the locations of weather stations in the Park Complex is found in the Park Complex's Natural Resource Condition Assessment (Hoffman, et al, 2015). Information on the number of water gauges and water temperature sensors in the Wilderness is stored in electronic files in possession of the Park Complex's Aquatic Ecologist. Information on the number of glacier monitoring plots in the Wilderness is stored in electronic files in possession of the Park Complex's Geologist. Information on the number of forest and subalpine sampling plots in the Wilderness is stored in electronic files in possession of the Park Complex's Plant Ecologist. Information on the number of fire effects and fire ecology plots in the Wilderness is stored in electronic files in possession of the Park Complex's Fire Ecologist. Information on the number of Forest Service Inventory and Analysis (FIA) plots in the Wilderness is stored in electronic files in possession of the USDA Forest Service. This information can be provided by the Park Complex's Research Permit administrator.

#### Data Adequacy

Data adequacy is high because data quantity is complete and data quality is high.

#### Data Frequency

For the purpose of wilderness character monitoring, a measure value will be reported for the 2015 baseline year and for every fifth subsequent calendar year.

#### Trend Assessment

At the end of each five-year wilderness character monitoring cycle, a trend in wilderness character (upward, downward, or stable) will be reported for this measure. This trend will be determined in the following way: The measure value for the current assessment year (2020, 2025, etc.) will be compared to the 2015 baseline measure value. An upward trend in wilderness character will be reported for this measure if there is a 5% decrease in the measure value between 2015 and the current assessment year. A downward trend in wilderness character will be reported if there is a 5% increase

in the measure value between 2015 and the current assessment year. A stable trend in wilderness character will be reported if there is less than 5% change in either direction in the measure value between 2015 and the current assessment year.

Compiled Data

Table 29 records the most recent data for this measure relative to October 1, 2015.

**Table 29.** Scientific Installations in 2015.

Type	Subtype	Number	Locations
Weather Stations	SC	10	Beaver Creek, Beaver Pass, Brown Top, Easy Pass, Jasper Pass, Meadow Cabins, Mount Blum, Park Creek, Thunder Basin, Hozomeen Lake
	SNOTEL	5	Beaver Pass, Brown Top, Easy Pass, Park Creek, Thunder Basin
	NPS	2	Noisy Glacier, Silver Glacier
Water Gauges	–	1	Thunder Creek
Water Temp Sensors	Streams	18	North Fork Cascade River, Thunder Creek, Little Beaver Creek (2), Bridge Creek, Big Beaver Creek, Pierce Creek, Sulphide Creek, McAllister Creek, Fisher Creek, Skagit Queen, Lightning Creek, Perry Creek (2), Panther Creek, Silver Creek, Luna Creek, West Fork Thunder Creek
	Lakes	13	Easy Ridge Lake, Lower East Lake, Lower Blum Lake, Lower Silent Lake, Upper Triplet Lake, Bowan Lake, Upper Skymo Lake, Lower Skymo Lake, Sourdough Lake, Willow Lake, Ridley Lake, Kettling Lake, Middle Thornton Lake
Air Temp Sensors*	Alpine talus	12	Cascade Pass, Thornton Lakes, Fisher Creek, Lone Mtn, Reynolds Peak, Sourdough Mtn, Monogram Lake, Ross Lake Overlook, Thunder Creek
Wildlife cameras	–	6	Various locations
Sampling Plots	Glaciers	4	Noisy Creek Glacier, Silver Glacier, North Klawatti, Sandalee Glacier
	FIA	46	Unspecified
	Forest	12	Unspecified
	Subalpine	9	Unspecified
	Whitebark Pine Legacy	35	Unspecified
	Fire Effects	22	designated Wilderness surrounding Stehekin
	Fire Ecology	45	Unspecified
Total	–	239	–

SNOTEL = SNOWpack TELEmetry; SC = Snow Course; FIA = Forest Service's Forest Inventory and Analysis

\* = some locations have more than one installation site

2015 Baseline Value

The 2015 baseline value for the number of scientific installations within wilderness is 239.

### **Measure 3-2: Number of administrative structures, installations, or developments**

*Undeveloped Quality ~ Presence of non-recreational structures, installations, and developments*

#### Measure Definition

This measure is intended to track over time changes in the number of human-made objects in the Wilderness that are used for administrative purposes other than gathering scientific data. The measure value for a particular reporting year is the number of administrative structures, installations, or developments located in the Wilderness as of October 1 (approximately the end of that year's field season). Data collected most recently to October 1 of that data year should be used to calculate the measure value. For the purpose of wilderness character monitoring, an installation is any human-made object that remains in the Wilderness for at least three months at a time. Administrative structures, installations, and developments include, but are not limited to, the following: administrative structures, developed administrative camps, radio repeaters, roads, developed helipads, and Knaack boxes. Structures, installations, and developments relating to recreational or visitor use are counted in the Solitude or Primitive and Unconfined Recreation Quality, to avoid double counting.

#### Data Sources

Information on the number of the number of administrative structures, developed administrative camps, radio repeaters, and developed helipads is stored in electronic files in possession of the Park Complex's Wilderness District Ranger. Information on the number of Knaack boxes is stored in the Wilderness Camp Inventory, which was completed in 2015 and corrected in 2016. Park Complex staff will complete a new survey of Knaack boxes every five years. Access to information in the Wilderness Camp Inventory can be provided by the Park Complex's Wilderness District Ranger.

#### Data Adequacy

Data adequacy is high because data quantity is complete and data quality is high.

#### Data Frequency

For the purpose of wilderness character monitoring, a measure value will be reported for the 2015 baseline year and for every fifth subsequent calendar year.

#### Trend Assessment

At the end of each five-year wilderness character monitoring cycle, a trend in wilderness character (upward, downward, or stable) will be reported for this measure. This trend will be determined in the following way: The measure value for the current assessment year (2020, 2025, etc.) will be compared to the 2015 baseline measure value. An upward trend in wilderness character will be reported for this measure if there is a 5% decrease in the measure value between 2015 and the current assessment year. A downward trend in wilderness character will be reported if there is a 5% increase in the measure value between 2015 and the current assessment year. A stable trend in wilderness character will be reported if there is less than 5% change in either direction in the measure value between 2015 and the current assessment year.

Compiled Data

Table 30 records the most recent data for this measure relative to October 1, 2015.

**Table 30.** Administrative Structures, Installations, and Developments in 2015.

Type	Number	Locations
Administrative Structures	5	Copper Lookout, Desolation Lookout, Sourdough Lookout, Meadow Cabin East, Meadow Cabin West
Developed Administrative Camps	10	Boston Basin, Boundary, Fireweed, Juanita Lake, Luna, McAlester, Pelton Basin, Skagit Queen, Stiletto, Thornton Lake
Radio Repeaters	4	Desolation, McGregor, Ruby, Copper Ridge
Developed Helipads	1	Fireweed
Roads	1	Thornton Lakes road (1 mile)
Knaack Boxes	36	Desolation Lookout, 39 Mile Stock, Luna Admin, Beaver Pass Stock, Stillwell (2), Twin Rock Stock, Boundary Admin, Copper Lookout, US Cabin Stock (2), Indian Creek, Graybeal Stock (2), Thornton Lake Trail, McAllister Stock Camp (2), Junction Stock Camp, Skagit Queen Admin, Thunder Basin Stock (2), Thunder Basin Hiker, Fisher Admin, Five Mile Camp, Fireweed Admin, Stiletto Admin, Boston Basin Admin, McAlester Pass Admin, McAlester Stock Camp, Bench Creek, Rainbow Meadows Group, Rainbow Lake Admin, Juanita Lake Admin, Pelton Basin Admin, Pelton Basin Camp (2)
<b>Total</b>	<b>57</b>	–

2015 Baseline Value

The 2015 baseline value for the number of administrative structures, installations, or developments within wilderness is 57.



Sourdough Lookout.

### **Measure 3-3: Acres of inholdings**

*Undeveloped Quality ~ Presence of inholdings*

#### Measure Definition

This measure is intended to track over time changes in threats of development that derive from the presence of Wilderness inholdings. The measure value for a particular reporting year is the total acres of inholdings in the Wilderness as of October 1 of that year. For the purposes of this measure, an inholding is defined as any piece of land for which the NPS does not have complete ownership.

#### Data Sources

Inholding acquisitions are stored in agency files when they occur. The Park Complex Environmental Protection Specialist can provide information about which inholding parcels have not yet been acquired. The 1994 State of the Wilderness Report contains a table (Table 5-3, page 5-6) listing the number of acres of these parcels; in 1994, there were 231.31 acres of inholdings within the Stephen Mather Wilderness. Table 31 shows the inholding acreage and parcels remaining as of 2015.

#### Data Adequacy

Data adequacy is high because data quantity is complete and data quality is high.

#### Data Frequency

For the purpose of wilderness character monitoring, a measure value will be reported for the 2015 baseline year and for every fifth subsequent calendar year.

#### Trend Assessment

At the end of each five-year wilderness character monitoring cycle, a trend in wilderness character (upward, downward, or stable) will be reported for this measure. This trend will be determined in the following way: The measure value for the current assessment year (2020, 2025, etc.) will be compared to the 2015 baseline measure value. An upward trend in wilderness character will be reported for this measure if there is any decrease in the measure value between 2015 and the current assessment year. A downward trend in wilderness character will be reported if there is any increase in the measure value between 2015 and the current assessment year. A stable trend in wilderness character will be reported if there is no change in the measure value between 2015 and the current assessment year.

#### Compiled Data

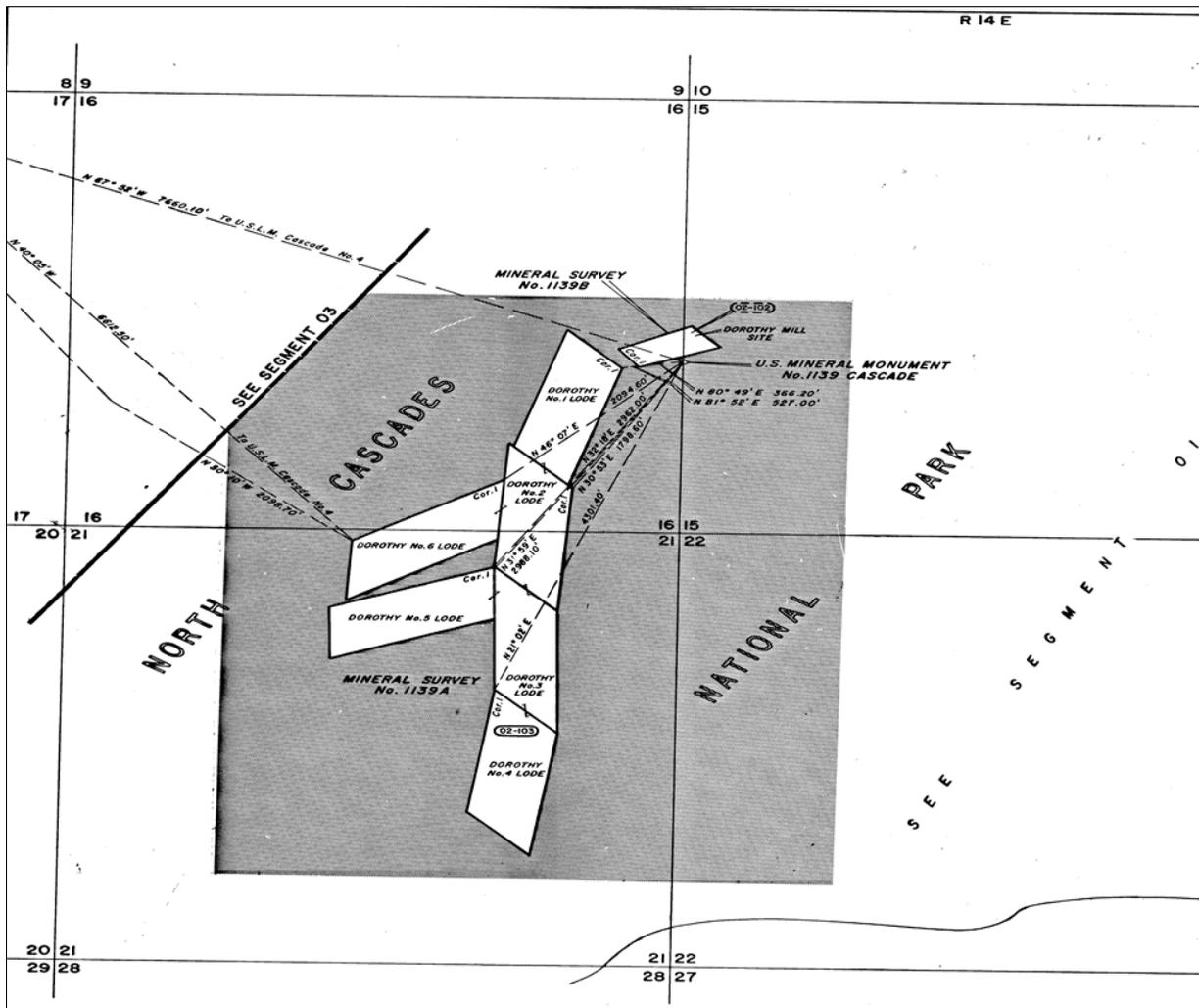
Table 31 records the most recent data for this measure relative to October 1, 2015. As of 2015, there were three parcels in the Stephen Mather Wilderness that meet the criterion listed above for being inholdings. Two parcels are owned by a single private landowner (the Webster family).

**Table 31.** Wilderness Inholdings in 2015.

Inholding	Acres	Comment
Webster 1	4.98	–
Webster 2	121.78	–
Boston Lode	20.66	NPS owns 50% share in property
Total	147.42	–

2015 Baseline Value

The 2015 baseline value for the number of private inholdings within wilderness is 147.42 acres.



Webster 1 (4.98 acres) and 2 (121.78 acres) inholdings.

**Measure 3-4: Five-year average of the annual number of helicopter landings and deliveries**  
*Undeveloped Quality ~ Use of motor vehicles, motorized equipment, and mechanical transport*

Measure Definition

This measure is intended to track over time changes in the number of helicopter landings in the Wilderness. NPS Reference Manual 41 defines landings as “Bringing down to the surface of the earth (land, water, snow, or ice) any aircraft or anything attached or carried by an aircraft, during or after a flight.” Thus, delivery by long line of materials into a wilderness area by a helicopter is considered a “landing” and is reported here. For purposes of tracking they are separately noted in this measure but summed for a total count of “landings”. For the purposes of this measure, delivering water bucket drops for fire suppression is not considered a delivery; fire suppression actions are accounted for elsewhere in this monitoring program.

Data Sources

Data on NPS use of aircraft are recorded by staff on flight request forms, which are stored in files held by the Park Complex’s Aviation Manager. The value for this measure can be acquired from the Park Complex’s Aviation Manager.

Data Adequacy

Data adequacy is high because data quantity is complete and data quality is high.

Data Frequency

For the purpose of wilderness character monitoring, a measure value will be reported for the 2015 baseline year and for each subsequent calendar year.

Trend Assessment

At the end of each five-year wilderness character monitoring cycle, a trend in wilderness character (upward, downward, or stable) will be reported for this measure. This trend will be determined in the following way: The measure value for the current assessment year (2020, 2025, etc.) will be compared to the 2015 baseline measure value. An upward trend in wilderness character will be reported for this measure if there is any decrease in the measure value between 2015 and the current assessment year. A downward trend in wilderness character will be reported if there is any increase in the measure value between 2015 and the current assessment year. A stable trend in wilderness character will be reported if there is no change in the measure value between 2015 and the current assessment year.

Compiled Data

The 2015 baseline value is the average of the number of helicopter landings for 2013–2015, the time period for the recorded data, plus the 2015 value for “deliveries”, given that is the first year the Complex recorded data for deliveries (Table 32).

**Table 32.** Annual Number of Helicopter Landings and Deliveries in Wilderness.

<b>Data Year</b>	<b>Number of Aircraft Landings</b>	<b>Number of Deliveries by Aircraft</b>	<b>Total Landings</b>
2013	88	Unknown	–
2014	165	Unknown	–
2015	114	61	175

2015 Baseline Value

The 2015 baseline value for the number of helicopter landings (2013–2015 average = 122) and deliveries (61 for 2015) within wilderness is 183.



Helicopter support for monitoring work at Silver Glacier.

## Solitude or Primitive and Unconfined Recreation Quality

The Solitude or Primitive and Unconfined Recreation Quality includes four indicators and seven selected measures (Table 33). The first indicator focuses on the degree to which the Wilderness is remote from sights and sounds of human activity inside wilderness. One measure (Measure 4-1) was selected for this indicator. It tracks the degree to which campers at wilderness campsites are shielded from other visitors.

**Table 33.** Overview of Measures under the Solitude or Primitive and Unconfined Recreation Quality.

Indicator	Measure Number	Measure	Weight
Remoteness from sights and sounds of human activity inside wilderness	4-1	Percent of campsites that meet wilderness management privacy standards	100%
Remoteness from sights and sounds of human activity outside wilderness	4-2	Percent time externally derived noise is audible in the Wilderness	50%
	4-3	Five-year average of the annual number of hours of NPS use of aircraft	50%
Facilities that decrease self-reliant recreation	4-4	Number of all recreational structures associated with wilderness camps	100%
Management restrictions on visitor behavior	4-5	Number of designated camps where campfires are prohibited	33.3%
	4-6	Number of designated camps or cross-country zones where bear canisters are required	33.3%
	4-7	Percent of wilderness available for unconfined camping opportunities	33.3%

The second indicator focuses on the degree to which the Wilderness is remote from sights and sounds of human activity outside wilderness. Two measures were selected for this indicator. Measure 4-2 tracks the frequency with which human-caused sounds originating outside the Wilderness can be heard inside the Wilderness, and Measure 4-3 tracks the annual number of hours of NPS use of aircraft. Each measure is assigned a weight of 50%

The third indicator focuses on facilities that decrease self-reliant recreation. One measure (Measure 4-4) was selected for this indicator. It tracks the sum total of recreational structures (e.g. toilets, food storage facilities, hitch rails, etc.) associated with wilderness camps.

The fourth indicator focuses on management restrictions on visitor behavior. Under this indicator, there are three selected measures, each of which tracks a different management restriction. The chosen restrictions were those that satisfy the following criteria: 1) they are restrictions over which the Park has discretion, 2) they are restrictions that visitors might find burdensome, and 3) there is a reasonable possibility that they might change over time. The first measure (Measure 4-5) tracks the number of wilderness camps where campfires are prohibited. The second measure (Measure 4-6) tracks the number of camps or cross-country zones where bear canisters are required. The third

measure (Measure 4-7) tracks the percent of the Wilderness where visitors are not confined to designated campsites. Each of these measures was assigned a weight of 33.3%



Wilderness trip planning, Marblemount Wilderness Information Center

**Measure 4-1: Percent of campsites that meet wilderness management privacy standards**  
*Solitude or Primitive and Unconfined Recreation Quality ~ Remoteness from sights and sounds of human activity inside wilderness*

Measure Definition

This measure is intended to track over time changes in the degree to which visitors at Wilderness campsites are shielded from visitors at other campsites or on main trails. The measure value for a particular reporting year is the percent, rounded to the nearest whole number, of all designated campsites in the Wilderness that meet wilderness management privacy standards. A campsite meets wilderness management privacy standards if it is out of sight of both the main trail and other campsites. Data collected most recently to October 1 of that data year should be used to calculate the measure value. The privacy standard measure is assessed for each campsite during the primary recreation season (July through September). Only the privacy standards of designated recreational wilderness campsites should be used. As of 2015 there were 188 individual designated campsites in Wilderness. Because this measure tracks the **percent** of campsites that meet wilderness management privacy standards (rather than a simple count of the number of campsites), an increase or decrease of designated campsites will not affect the baseline standard to compare against. Do not count ranger camps or administrative sites. See Appendix D for a list of all recreational wilderness campsites.

Data Sources

Data for this measure are stored in the Wilderness Camp Inventory, which was completed in 2015. Park Complex staff will complete a new survey of wilderness camps every five years. Access to these data can be provided by the Park Complex's Wilderness District Ranger.

Data Adequacy

Data adequacy is high because data quantity is complete and data quality is high.

Data Frequency

For the purpose of wilderness character monitoring, a measure value will be reported for the 2015 baseline year and for every fifth subsequent calendar year.

Trend Assessment

At the end of each five-year wilderness character monitoring cycle, a trend in wilderness character (upward, downward, or stable) will be reported for this measure. This trend will be determined in the following way: The measure value for the current assessment year (2020, 2025, etc.) will be compared to the 2015 baseline measure value. An upward trend in wilderness character will be reported for this measure if there is a 5% increase in the measure value between 2015 and the current assessment year. A downward trend in wilderness character will be reported if there is a 5% decrease in the measure value between 2015 and the current assessment year. A stable trend in wilderness character will be reported if there is less than 5% change in either direction in the measure value between 2015 and the current assessment year.

Compiled Data

Wilderness ranger staff completed monitoring at the recreational wilderness campsites in 2013–2015 to compile the necessary data.

2015 Baseline Value

The 2015 baseline value for the percent of campsites that meet wilderness management privacy standards is calculated at 45%.



Designated campsite.

## **Measure 4-2: Percent time externally derived noise is audible in the Wilderness**

*Solitude or Primitive and Unconfined Recreation Quality ~ Remoteness from sights and sounds of human activity outside wilderness*

### Measure Definition

This measure is intended to track over time changes in the amount of time externally derived noise is audible in the Wilderness. Although the Park collects soundscape data at multiple sites within the Complex, the Boundary Camp site will be used for this measure. This site reflects a mix of remote wilderness with some commercial aircraft overflight noise. Audio data was collected beginning in 2015 at this site. The Park will report on an annual basis the percent time, rounded to the nearest whole number, extrinsic sounds are audible at this site. The percent time extrinsic sounds are audible will be defined by the Park Complex's natural soundscapes monitoring program.

### Data Sources

Data will be collected in accordance with the Park Complex's natural soundscapes monitoring program. Access to these data can be provided by the Park Complex's Physical Sciences Branch or the Skagit District Environmental Protection Specialist.

### Data Adequacy

Data adequacy is high because data quantity is complete and data quality is high.

### Data Frequency

For the purpose of wilderness character monitoring, the site value will be reported for the 2015 baseline year and for each subsequent calendar year.

### Trend Assessment

At the end of each five-year wilderness character monitoring cycle, a trend in wilderness character (upward, downward, or stable) will be reported for this measure. For the first two monitoring cycles (i.e. 5 years and 10 years), this trend will be determined in the following way: the data value for the current assessment year (2020, 2025, etc.) will be compared to the 2015 baseline data value. An upward trend in wilderness character will be reported for this measure if there is a net whole number decrease between 2015 and the current assessment year in the percent time extrinsic sounds are audible. A downward trend in wilderness character will be reported if there is a net whole number increase between 2015 and the current assessment year in the percent time extrinsic sounds are audible. A stable trend in wilderness character will be reported for this measure in all other cases.

The trend assessment method outlined above is provisional and subject to change as new analytical methods emerge. After the first two monitoring cycles are complete, ten years of annual sampling will have been collected for the site. These data may be used to establish a range of variability for the site, which may then be incorporated into a new trend assessment method (e.g. regression analysis) for the third and subsequent monitoring cycles.

### Compiled Data

Table 34 shows 2015 monitoring data for the Boundary Camp site.

**Table 34.** Soundscapes Monitoring Location and Data in 2015.

Monitoring Location	Sound Source	24 hour % time audible
Boundary Camp – NOCA007	Total aircraft	10.0
<b>Total Non-Natural</b>		<b>10.0</b>

2015 Baseline Value

The 2015 baseline value for the percent time externally derived noise is audible in the Wilderness is 10%.



Natural soundscape monitoring equipment.

**Measure 4-3: Five-year average of the annual number of hours of NPS use of aircraft**  
*Solitude or Primitive and Unconfined Recreation Quality ~ Remoteness from sights and sounds of human activity outside wilderness*

Measure Definition

This measure is intended to track over time changes in the NPS use of aircraft over the entire Park Complex, given so much (94%) of the Complex is designated Wilderness and that virtually all overflights over the Complex will be heard within some part of the designated Wilderness. The measure value for a particular reporting year is the number of hours of NPS use of aircraft that occurs during that calendar year. For the purposes of this measure, all hours of flight time that occur over any part of the Park Complex will be counted; ferry time outside of the Park Complex boundaries will not be counted. Because of a change in methodology in how to record the overflight hours (begun in 2019) there is no 2015 baseline value for this measure. Thus, the baseline value will be established after the 2019–2020 data years. “Aircraft” includes helicopters and fixed-wing aircraft; at this time, because no drone use over wilderness has occurred, they are not counted in this “Solitude” quality. Inclusion of drone use into this measure will be reevaluated if it occurs and is considered an impact to this quality.

The Park considered trying to include flight hours for non-NPS agency flight time over the Park Complex, but the ability to consistently and accurately document those hours has been problematic. For reference, in recent years those hours are estimated to be between 10–25 hours annually. Examples of non-agency flights over the Park Complex include those for completing monitoring and maintenance for snow surveys and related installations.

Data Sources

Data on NPS use of aircraft is recorded by staff on flight request forms, which are stored in files held by the Park Complex’s Aviation Manager. The value for this measure can be acquired from the Park Complex’s Aviation Manager.

Data Adequacy

Data quantity will be complete; data quality will be high given all flight time hours over the entire Park Complex will be counted, rather than attempting to discern whether the aircraft is precisely over designated Wilderness or not. Overall data adequacy will be high.

Data Frequency

For the purpose of wilderness character monitoring, once the 2020 baseline value is determined, a measure value will be reported for the 2020 baseline year and for each subsequent calendar year.

Trend Assessment

At the end of each five-year wilderness character monitoring cycle, a trend in wilderness character (upward, downward, or stable) will be reported for this measure. This trend will be determined in the following way: The measure value for the current assessment year (2025, 2030, etc.) will be compared to the 2020 baseline measure value. An upward trend in wilderness character will be reported for this measure if there is a 5% decrease in the measure value between 2020 and the current

assessment year. A downward trend in wilderness character will be reported if there is a 5% increase in the measure value between 2020 and the current assessment year. A stable trend in wilderness character will be reported if there is less than 5% change in either direction in the measure value between 2020 and the current assessment year.

Compiled Data

Note: to provide context for this measure, data for years prior to 2019 have been included in Table 35. The years of 2019–2020 will be used to calculate the measure value for the 2020 baseline year to assess wilderness character monitoring trends. The substantial difference in annual hours from any given year to the next is largely due to which years have major fire events or years when fires last for long periods. More recently, the increasing number of Search and Rescue incidents (SAR) has added to NPS aircraft use.

**Table 35.** Annual Number of Hours of NPS Use of Aircraft .

<b>Data Year</b>	<b>Total Flight Hours – NPS</b>
2002	87.5
2003	181.1
2004	311
2005	219.9
2006	134.7
2007	305.6
2008	157.3
2009	243.2
2010	430.2
2011	90.9
2012	101.6
2013	97.6
2014	275.3
2015	149.1
2016	17.9
2017	31.7
2018	73.3
*2019	74.9
*2020	–

\* Note: Annual number of hours from 2002–2018 was an estimate of the number of flight hours over **designated wilderness**; annual number of hours in 2019–2020 reflects all flight time over the **Park Complex boundary**. Any flight time over the Complex will be heard somewhere within designated wilderness, given 94% of that land base is designated wilderness. This approach is also more accurate to estimate/measure for the range of employees who will be reporting.

### 2020 Baseline Value

The 2020 baseline value will be determined based on the 2019–2020 calendar years for the average number of hours of NPS aircraft use over the Park Complex. That number will be reported in the Trend Assessment report following the 2020 reporting year.



Helicopter support for NPS operations

**Measure 4-4: Number of all recreational structures associated with wilderness camps**  
*Solitude or Primitive and Unconfined Recreation Quality ~ Facilities that decrease self-reliant recreation*

Measure Definition

This measure is intended to track over time changes in the number of recreational structures that decrease self-reliance and reduce the primitive experience within wilderness camps. The measure value for a particular reporting year is the sum total of all recreational structures in designated camps in the Wilderness. For the purpose of this measure, recreational wilderness camp structures will include the sum of all: 1) toilet facilities (wallowa or composter), 2) food storage installations (wire or locker), 3) hitch rails, 4) camp signs, and 5) metal fire rings. Do not include trail signs. Do not count rock-only fire rings, even if provided by the Park Complex. Data collected most recently to October 1 of that data year should be used to calculate the measure value.

Data Sources

Data on the total number of camp structures are stored in the Wilderness Camp Inventory, which was completed by 2015. Park Complex staff will complete a new survey of wilderness camps every five years. Access to these data can be provided by the Park Complex's Wilderness District Ranger.

Data Adequacy

Data quantity is complete, data quality is high, and overall data adequacy is high.

Data Frequency

For the purpose of wilderness character monitoring, a measure value will be reported for the 2015 baseline year and for every fifth subsequent calendar year.

Trend Assessment

At the end of each five-year wilderness character monitoring cycle, a trend in wilderness character (upward, downward, or stable) will be reported for this measure. This trend will be determined in the following way: The measure value for the current assessment year (2020, 2025, etc.) will be compared to the 2015 baseline measure value. An upward trend in wilderness character will be reported for this measure if there is a 5% decrease in the measure value between 2015 and the current assessment year. A downward trend in wilderness character will be reported if there is a 5% increase in the measure value between 2015 and the current assessment year. A stable trend in wilderness character will be reported if there is less than 5% change in either direction in the measure value between 2015 and the current assessment year.

Compiled Data

Wilderness ranger staff completed monitoring at the recreational wilderness campsites in 2013–2015 to compile the necessary data. Recreational structures associated with wilderness camps are shown in Table 36 below.

**Table 36.** Recreational Structures in Wilderness Camps in 2015.

<b>Data Year</b>	<b>Toilet facilities</b>	<b>Food storage installations</b>	<b>Hitch rails</b>	<b>Camp signs</b>	<b>Metal fire rings</b>	<b>Total</b>
2015	93	35	44	312	105	589

2015 Baseline Value

The 2015 baseline value for the number of recreational structures associated with wilderness camps is 589.



Bear resistant food storage locker, Fireweed Camp.

**Measure 4-5: Number of designated camps where campfires are prohibited**

*Solitude or Primitive and Unconfined Recreation Quality ~ Management restrictions on visitor behavior*

Measure Definition

This measure is intended to track over time changes in the number of campfire restrictions at wilderness camps. The measure value for a particular reporting year is the number of designated camps where campfires are prohibited according to policies in effect on June 1 (approximately the beginning of the backcountry use season). For the purpose of this measure, only designated camps are included in the count of campfire prohibitions. Cross-country zones (areas of the Complex/wilderness with undesignated camping) are not included.

Data Sources

Information about the number of designated camps where campfires are prohibited is stored in electronic files in possession of the Wilderness District Ranger.

Data Adequacy

Data quantity is complete, data quality is high, and overall data adequacy is high.

Data Frequency

For the purpose of wilderness character monitoring, a measure value will be reported for the 2015 baseline year and for every fifth subsequent calendar year.

Trend Assessment

At the end of each five-year wilderness character monitoring cycle, a trend in wilderness character (upward, downward, or stable) will be reported for this measure. This trend will be determined in the following way: The measure value for the current assessment year (2020, 2025, etc.) will be compared to the 2015 baseline measure value. An upward trend in wilderness character will be reported for this measure if there is a 5% decrease in the measure value between 2015 and the current assessment year. A downward trend in wilderness character will be reported if there is a 5% increase in the measure value between 2015 and the current assessment year. A stable trend in wilderness character will be reported if there is less than 5% change in either direction in the measure value between 2015 and the current assessment year.

Compiled Data

See Appendix D for a detailed list of management requirements for designated wilderness camps in 2015, including the identification of those designated camps where campfires are prohibited.

2015 Baseline Value

The 2015 baseline value for the number of designated wilderness camps where campfires are prohibited is 25.

**Measure 4-6: Number of designated camps or cross-country zones where bear canisters are required**

*Solitude or Primitive and Unconfined Recreation Quality ~ Management restrictions on visitor behavior*

Measure Definition

This measure is intended to track over time changes in the number of restrictions on the use of food-storage methods. The measure value for a particular reporting year is the number of designated camps or cross-country zones where bear canisters are required according to policies in effect on June 1 (approximately the beginning of the backcountry use season). A camp or cross-country zone should be counted in the tally if a bear canister is required in any portion of a designated camp or cross-country zone and for any portion of the year.

Data Sources

Information about the number of designated camps or cross-country zones where bear canisters are required is stored in electronic files in possession of the Wilderness District Ranger.

Data Adequacy

Data quantity is complete, data quality is high, and overall data adequacy is high.

Data Frequency

For the purpose of wilderness character monitoring, a measure value will be reported for the 2015 baseline year and for every fifth subsequent calendar year.

Trend Assessment

At the end of each five-year wilderness character monitoring cycle, a trend in wilderness character (upward, downward, or stable) will be reported for this measure. This trend will be determined in the following way: The measure value for the current assessment year (2020, 2025, etc.) will be compared to the 2015 baseline measure value. An upward trend in wilderness character will be reported for this measure if there is a 5% decrease in the measure value between 2015 and the current assessment year. A downward trend in wilderness character will be reported if there is a 5% increase in the measure value between 2015 and the current assessment year. A stable trend in wilderness character will be reported if there is less than 5% change in either direction in the measure value between 2015 and the current assessment year.

Compiled Data

See Appendix D for a detailed list of management requirements for designated camps and cross-country zones in 2015, including the number of designated camps or cross-country zones where bear canisters are required.

2015 Baseline Value

The 2015 baseline value for the number of designated camps or cross-country zones where bear canisters are required within wilderness is 15.

**Measure 4-7: Percent of wilderness available for unconfined camping opportunities**  
*Solitude or Primitive and Unconfined Recreation Quality ~ Management restrictions on visitor behavior*

Measure Definition

This measure is intended to track over time changes in opportunities for unconfined camping in the Wilderness. For the purpose of this measure, unconfined camping opportunities are defined to exist in areas where camping is not limited to designated campsites. The measure value for a particular reporting year is calculated by dividing the total area of the Wilderness zoned Cross-Country I or II by the total area of the Wilderness. The policies in effect on June 1 (approximately the beginning of the backcountry use season) of that particular data year will be used to determine the total area of the cross-country zones. The measure value should be rounded to the nearest whole number. Spatial data for the wilderness management zones should be updated if there are changes to locations of designated camps or any other management changes that affect the size of the cross-country zones. Note that future GIS mapping efforts may provide increasingly detailed and improved boundary measurements, which would result in slight changes to the total Wilderness acreage. In this case, all numbers should be updated using the latest boundary, to avoid the appearance of a shrinking (or growing) Wilderness.

Data Sources

Information about trail and cross-country zone definitions can be obtained from the Wilderness District Ranger. The Park Complex's GIS Specialist maintains spatial data for all wilderness management zones.

Data Adequacy

Data quantity is complete, data quality is high, and overall data adequacy is high.

Data Frequency

For the purpose of wilderness character monitoring, a measure value will be reported for the 2015 baseline year and for every fifth subsequent calendar year.

Trend Assessment

At the end of each five-year wilderness character monitoring cycle, a trend in wilderness character (upward, downward, or stable) will be reported for this measure. This trend will be determined in the following way: The measure value for the current assessment year (2020, 2025, etc.) will be compared to the 2015 baseline measure value. An upward trend in wilderness character will be reported for this measure if there is any whole number increase in the measure value between 2015 and the current assessment year. A downward trend in wilderness character will be reported if there is any whole number decrease in the measure value between 2015 and the current assessment year. A stable trend in wilderness character will be reported if there is no change in the measure value between 2015 and the current assessment year.

Compiled Data

Table 37 records the most recent data for this measure relative to June 1, 2015.

**Table 37.** Percent of Wilderness Available for Unconfined Camping Opportunities in 2015.

<b>Data Year</b>	<b>Total Area of Wilderness Zoned Cross-Country I or II</b>	<b>Total Area of Wilderness</b>	<b>Percent of Wilderness Available for Unconfined Camping Opportunities</b>
2015	449,239	642,763	70%

2015 Baseline Value

The 2015 baseline value for the percent of wilderness available for unconfined camping opportunities is 70%.



Boston Basin cross-country zone camping.

### Other Features of Value Quality

The Other Features of Value Quality includes two chosen indicators and three measures (Table 38). The first indicator focuses on the deterioration or loss of integral historic or cultural features. The Stephen Mather Wilderness contains 12 structures that are listed or have been determined to be eligible to be listed on the National Register of Historic Places. These include six cabins, three lookouts, two shelters, and one historic mine. The Wilderness also contains three archeological sites that are listed or have been determined to be eligible to be listed. These structures and archeological sites are legacies of uses that predate the establishment of the Park and the formal wilderness designation. The characteristics that make these cultural resources eligible to the National Register contribute to the unique quality of wilderness character in the Stephen Mather Wilderness. The first measure (Measure 5-1) tracks the average condition value of the listed or eligible historic structures, and the second measure (Measure 5-2) tracks the average condition value of the listed or eligible archeological sites. Each measure was assigned a weight of 50%.

The second indicator tracks the degree to which the average volume of four monitored glaciers has increased or decreased over time (Measure 5-3). Glaciers are an iconic feature within the Stephen Mather Wilderness, and are identified within the Park Complex enabling legislation as important resources.

**Table 38.** Overview of Selected Measures under the Other Features of Value Quality.

Indicator	Measure Number	Measure	Weight
Deterioration or loss of integral historic or cultural features	5-1	Average condition value of listed or eligible structures	50%
	5-2	Average condition value of listed or eligible archeological sites	50%
Deterioration or Loss of Iconic Features	5-3	Average cumulative annual mass balance of four monitored glaciers	100%

### **Measure 5-1: Average condition value of listed or eligible structures**

*Other Features of Value Quality ~ Deterioration or loss of integral historic or cultural features*

#### Measure Definition

This measure is intended to track over time changes in the conditions of structures with significant cultural resources value. The measure value for a particular reporting year is the average of the most recently assessed (relative to October 1 of that data year) condition values of structures that are listed or have been determined by Park Complex staff to be eligible to be listed on the National Register of Historic Places. The condition value of a listed or eligible structure is a numerical score that is intended to approximate the overall condition of the structure. A condition value of three corresponds to a “good” overall condition, a two corresponds to a “fair” overall condition, a one corresponds to a “poor” overall condition (“poor” includes a structure that may be demolished/collapsed but is expected to be repaired by the NPS), and a zero is assigned to a structure if it is “destroyed” (“destroyed” involves a structure that has been demolished/collapsed and is not expected to be repaired). This system of evaluating the conditions of listed or eligible structures is uniform across the National Park system. For more information on how the condition values are assigned, see the NPS List of Classified Structures metadata.

#### Data Sources

The conditions of listed or eligible structures are monitored periodically by Park Complex staff. Due to the large number of listed or eligible structures in the Park Complex (Table 39), monitoring is typically done on a rolling basis (i.e. not every structure is assessed in the same year). Park Complex staff will complete a new round of assessments every five years. The condition values of listed or eligible structures are stored in the NPS List of Classified Structures database. Queries of this database can be performed by the Park Complex’s Archeologist.

#### Data Adequacy

Data quantity is complete, data quality is high, and overall data adequacy is high.

#### Data Frequency

For the purpose of wilderness character monitoring, a measure value will be reported for the 2015 baseline year and for every fifth subsequent calendar year. The raw data used to calculate the measure value might be collected on a different schedule or schedules.

#### Trend Assessment

At the end of each five-year wilderness character monitoring cycle, a trend in wilderness character (upward, downward, or stable) will be reported for this measure. This trend will be determined in the following way: The measure value for the current assessment year (2020, 2025, etc.) will be compared to the 2015 baseline measure value. An upward trend in wilderness character will be reported for this measure if there is any increase in the measure value between 2015 and the current assessment year. A downward trend in wilderness character will be reported if there is any decrease in the measure value between 2015 and the current assessment year. A stable trend in wilderness character will be reported if there is no change in the measure value between 2015 and the current assessment year.

Compiled Data

Table 39 lists the most recent condition values of all listed and eligible structures as of 2015. Table 40 records the average condition value of all listed and eligible structures using 2015 data.

**Table 39.** Most Recent Condition Values for Listed or Eligible Structures in 2015.

<b>Structure Name</b>	<b>Number</b>	<b>Condition Value</b>	<b>Condition Class</b>	<b>Year Assessed</b>
Copper Mountain Lookout	1228	3	Good	2009
Desolation Peak Lookout	1227	3	Good	2010
Sourdough Mountain Lookout	1226	2	Fair	2011
Beaver Pass Shelter	1209	2	Fair	2011
Perry Creek Shelter	1208	1	Poor	2011
Deer Lick Cabin	1219	2	Fair	2011
Gilbert's Cabin	1024	1	Poor	2011
Meadow Cabin, East	1218	3	Good	2011
Meadow Cabin, West	1217	2	Fair	2011
Rock Cabin	1216	2	Fair	2011
Sulphide Cabin	1212	1	Poor	2011
Black Warrior Mine	22	3	Good	2010

**Table 40.** Average of the Most Recent Condition Values of Listed or Eligible Structures in 2015.

<b>Data Year</b>	<b>Data Collection Years</b>	<b>Average Condition Value</b>
2015	2009–2011	2.0833

2015 Baseline Value

The 2015 baseline value for the average condition value of listed or eligible structures within wilderness is 2.08.



Perry Creek Shelter, Little Beaver trail.

## **Measure 5-2: Average condition value of listed or eligible archeological sites**

*Other Features of Value Quality ~ Deterioration or loss of integral historic or cultural features*

### Measure Definition

This measure is intended to track over time changes in the conditions of archeological sites with significant cultural resources value. The measure value for a particular data year is the average of the most recently assessed (relative to October 1 of that data year) condition values of archeological sites that are listed or have been determined by Park Complex staff to be eligible to be listed on the National Register of Historic Places. The condition value of a listed or eligible archeological site is a numerical score that is intended to approximate the overall condition of the site. A condition value of three corresponds to a “good” overall condition, a condition value of two corresponds to a “fair” overall condition, a condition value of one corresponds to a “poor” overall condition, and a condition value of zero is assigned to a site if it is “destroyed.” This system of evaluating the conditions of listed or eligible structures is uniform across the National Park system. For more information on how the condition values are assigned, see the NPS Archeological Sites Management Information System metadata.

### Data Sources

The conditions of listed or eligible archeological sites are monitored periodically by Park Complex staff. The monitoring schedule for a particular listed or eligible archeological site depends on the type and severity of threats to the site as well as the difficulty of physically accessing the site. There are currently three listed or eligible archeological sites. Two of these are monitored annually, and the third is monitored every five years (Table 41). The condition values of listed or eligible archeological sites are stored in the NPS Archeological Sites Management Information System database. Queries of this database can be performed by the Park Complex’s Archeologist.

### Data Adequacy

Data quantity is complete, data quality is high, and overall data adequacy is high.

### Data Frequency

For the purpose of wilderness character monitoring, a measure value will be reported for the 2015 baseline year and for every fifth subsequent calendar year. The raw data used to calculate the measure value might be collected on a different schedule or schedules.

### Trend Assessment

At the end of each five-year wilderness character monitoring cycle, a trend in wilderness character (upward, downward, or stable) will be reported for this measure. This trend will be determined in the following way: The measure value for the current assessment year (2020, 2025, etc.) will be compared to the 2015 baseline measure value. An upward trend in wilderness character will be reported for this measure if there is any increase in the measure value between 2015 and the current assessment year. A downward trend in wilderness character will be reported if there is any decrease in the measure value between 2015 and the current assessment year. A stable trend in wilderness character will be reported if there is no change in the measure value between 2015 and the current assessment year.

Compiled Data

Table 41 lists the most recent condition values of all listed and eligible archeological sites as of 2015. Table 42 records the average condition value of all listed and eligible archeological sites using 2015 data.

**Table 41.** Most Recent Condition Values for Listed or Eligible Archeological Sites in 2015.

<b>Archeological Site Name</b>	<b>Number</b>	<b>Condition Value</b>	<b>Condition Class</b>	<b>Year Assessed</b>	<b>Assessment Frequency</b>
Cascade Pass #01	45CH221	3	Good	2014	1 Year
Copper Ridge #7	45WH484	3	Good	2014	5 Years
Desolation Chert Quarry	45WH224	3	Good	2014	1 Year

**Table 42.** Average of the Most Recent Condition Values of Listed or Eligible Archeological Sites in 2015.

<b>Data Year</b>	<b>Data Collection Years</b>	<b>Average Condition Value</b>
2015	2014	3.0000

2015 Baseline Value

The 2015 baseline value for the average condition value of listed or eligible archeological sites is 3.0.

### **Measure 5-3: Average cumulative annual mass balance of four monitored glaciers**

*Other Features of Value Quality ~ Deterioration or Loss of Iconic Features*

#### Measure Definition

This measure is intended to track over time the effect of climate change on glaciers in the Wilderness. It reflects a decades-long commitment to document climate change impacts for high-elevation resources such as glaciers that are featured in the Park's enabling legislation. The measure value for a particular reporting year is the average cumulative volume change of the four monitored glaciers as observed at the end of the corresponding water year. For each glacier, the cumulative volume change is measured relative to a baseline year. For Noisy Creek Glacier, Silver Glacier, and North Klawatti Glacier, the baseline year was 1992. For Sandalee Glacier, the baseline year was 1993. For a particular reporting year, the corresponding water year is the period from October 1 of the previous calendar year through September 30 of the current reporting year (e.g., water year 2015 is October 1, 2014 through September 30, 2015). The average cumulative volume change value is in units of meters of water equivalent (mwe).

#### Data Sources

Glacier monitoring data is collected in accordance with the Park Complex's glacier monitoring protocol (<http://irmafiles.nps.gov/reference/holding/152599>) and is stored in electronic files in possession of the Park Complex's Geologist. Data from the previous five years are provisional and subject to future revision.

#### Data Adequacy

Data quantity is complete, data quality is high, and overall data adequacy is high.

#### Data Frequency

For the purpose of wilderness character monitoring, a measure value will be reported for the 2015 baseline year and for every fifth subsequent calendar year. The raw data used to calculate the measure value might be collected on a different schedule or schedules.

#### Trend Assessment

At the end of each five-year wilderness character monitoring cycle, a trend in wilderness character (upward, downward, or stable) will be reported for this measure. This trend will be determined in the following way: for each assessment year (2020, 2025, etc.) the measured value for that assessment year will be evaluated to determine if the four glaciers have, on average, increased or decreased in volume since the baseline year value of  $-10.27$  in 2015, which is the cumulative annual net value for these four glaciers since the start of the glacier monitoring program in 1993. A downward trend in wilderness character will be reported for this measure if the measure value shows a further decrease in mwe of  $> -3$  mwe compared to the 2015 value (thus, greater than  $-13.27$  mwe); a stable trend will be reported if there is a change in mwe between  $-3$  to  $+3$  mwe compared to the 2015 value; and a positive trend reported if the measured value has moved  $> +3$  mwe in a positive direction from the 2015 value (i.e.  $-7.27$  mwe). A range of  $-3$  to  $+3$  mwe for a stable trend is necessary because it is acknowledged that there are measurement errors, and that data is provisional for 5 years until new mapping can be completed for each glacier.

## Compiled Data

Data for years prior to 2015 have been included in Table 43.

**Table 43.** Cumulative Volume Change for the Four Monitored Glaciers.

Data Year	Noisy Creek Glacier	Silver Glacier	N. Klawatti Glacier	Sandalee Glacier	Average
1992	0.00	0.00	0.00	n/a	–
1993	-0.70	-0.45	-1.12	0.00	-0.75
1994	-1.82	-1.01	-2.94	-1.12	-1.72
1995	-2.59	-1.09	-3.15	-1.00	-1.96
1996	-2.29	-0.79	-2.59	-0.74	-1.60
1997	-1.37	-0.29	-1.01	0.00	-0.67
1998	-2.87	-2.02	-2.60	-1.26	-2.19
1999	-1.64	-1.66	-1.00	-0.13	-1.10
2000	-1.26	-1.08	-0.18	0.45	-0.52
2001	-2.54	-2.48	-1.73	-0.73	-1.87
2002	-2.22	-2.14	-1.53	-0.25	-1.53
2003	-3.44	-3.59	-2.79	-1.66	-2.87
2004	-4.82	-4.25	-3.95	-3.20	-4.06
2005	-6.98	-5.47 <sup>a</sup>	-5.74	-5.78	-6.00 <sup>a</sup>
2006	-7.41	-6.84 <sup>a</sup>	-6.84	-6.58	-6.92 <sup>a</sup>
2007	-7.76	-7.46 <sup>a</sup>	-7.43 <sup>a</sup>	-6.67 <sup>a</sup>	-7.33 <sup>a</sup>
2008	-8.04	-7.69 <sup>a</sup>	-7.52 <sup>a</sup>	-6.74 <sup>a</sup>	-7.50 <sup>a</sup>
2009	-9.20	-9.67 <sup>a</sup>	-9.26 <sup>a</sup>	-7.39 <sup>a</sup>	-8.88 <sup>a</sup>
2010	-9.27	-8.98 <sup>a</sup>	-8.98 <sup>a</sup>	-7.82 <sup>a</sup>	-8.76 <sup>a</sup>
2011	-8.03 <sup>a</sup>	-8.26 <sup>a</sup>	-8.22 <sup>a</sup>	-6.66 <sup>a</sup>	-7.79 <sup>a</sup>
2012	-7.41 <sup>a</sup>	-7.77 <sup>a</sup>	-7.75 <sup>a</sup>	-5.96 <sup>a</sup>	-7.22 <sup>a</sup>
2013	-8.18 <sup>a</sup>	-8.13 <sup>a</sup>	-8.66 <sup>a</sup>	-6.25 <sup>a</sup>	-7.80 <sup>a</sup>
2014	-8.37 <sup>a</sup>	-8.39 <sup>a</sup>	-8.87 <sup>a</sup>	-6.47 <sup>a</sup>	-8.03 <sup>a</sup>
2015	-11.92 <sup>a</sup>	-9.51 <sup>a</sup>	-11.20 <sup>a</sup>	-8.47 <sup>a</sup>	-10.27 <sup>a</sup>

<sup>a</sup> Provisional data. Cumulative balance values subject to remapping of glacier surfaces, data will be updated and finalized following remapping.

**Note:** Volume change values are in units of meter water equivalent (mwe)

## 2015 Baseline Value

Because this data record reflects the cumulative annual net balance record from the original projects start date (1992 and 1993 for the four monitored glaciers), the 2015 cumulative average net balance value of -10.27 will be used as the 2015 baseline value, as all future measurements relate to this ongoing cumulative value. For this measure, the baseline value will be the four-glacier average measure value for data year 2015, which is -10.27 mwe (meter water equivalents).

## **Priority Measures for Future Use in Wilderness Character Monitoring**

The measures listed below are ones that Park staff identified as being desirable for use in wilderness character monitoring but for which it is not possible to include immediately due to the lack of adequate baseline data or to uncertainty about whether the Park Complex will be able to monitor them in the future. Once the uncertainty has been resolved and adequate baseline data acquired, these measures are eligible to be incorporated into the wilderness character monitoring framework.

### **Measure P-1: Number of miles of undesignated trails**

#### ***Indicator(s):***

Plants (Natural) or Presence of recreational structures, installations and developments (Undeveloped) or Facilities that decrease self-reliant recreation (Solitude or Primitive and Unconfined Recreation)

#### ***Rationale:***

In the opinion of the Park Complex Science Advisor, the number of miles of undesignated trails is useful for tracking recreational impacts to fragile sub-alpine vegetation. In addition, undesignated trails count as recreational developments and facilities that decrease self-reliant recreation.

#### ***Issue(s):***

The current GIS data are not complete. For most undesignated trails, the year of data collection is unknown. Further, there is no established protocol for monitoring undesignated trails, and regular monitoring is uncertain.

### **Measure P-2: Number of fixed anchors (both bolts and pitons) on climbing routes**

#### ***Indicator(s):***

Presence of recreational structures, installations, and developments (Undeveloped) or Facilities that decrease self-reliant recreation (Solitude or Primitive and Unconfined Recreation)

#### ***Rationale:***

Fixed climbing anchors are both recreational installations and facilities that decrease self-reliant recreation. The issue of fixed anchors in Wilderness is controversial, and it would be good for the Park Complex to monitor the number of these over time.

#### ***Issue(s):***

No current baseline data. Process of monitoring is not yet established.

### **Measure P-3: Number of other non-recreational structures, installations, or developments**

#### ***Indicator(s):***

Presence of non-recreational structures, installations, and developments

***Rationale:***

Staff would like to track the number of other significant human-created objects (e.g. mouldering cabins) in the Wilderness.

***Issue(s):***

Currently, the Park Complex lacks the staff necessary to monitor these objects periodically.

**Measure P-4: Number of days in which any trail crew member uses motorized equipment**

***Indicator(s):***

Use of motor vehicles, motorized equipment, or mechanical transport (Undeveloped)

***Rationale:***

This measure tracks a non-conforming administrative use in Wilderness.

***Issue(s):***

No current baseline data. Process of monitoring is not yet established.

**Measure P-5: Number of times per year that any wilderness camp or cross-country zone is full on any night**

***Indicator(s):***

Remoteness from sights and sounds of human activity inside the wilderness (Solitude or Primitive and Unconfined Recreation)

***Rationale:***

The number of times that camps or zones are full provides information on opportunities for solitude.

***Issue(s):***

Data for this measure come from the permit database; however, there is currently no easy method for calculating measure values in the future.



Tapto Lakes area. Note social trail along left side of the lake in foreground.

## Measures Not Used for Wilderness Character Monitoring

The following measures were considered but ultimately not used in the wilderness character monitoring framework. The measure and the rationale for excluding it are described below.

### **Measure E-1: Average barren core area for wilderness campsites**

***Indicator:***

Plants (Natural)

***Rationale:***

This measure would provide information on recreational impacts on vegetation; however, measurements of barren core area were determined to be not sufficiently reliable.

### **Measure E-2: Cumulative area where work was done to restore native vegetation to impacted sites**

***Indicator:***

Plants (Natural)

***Rationale:***

Staff thought there were too many difficulties associated with data collection.

### **Measure E-3: Number of non-recreational trail structures (culverts)**

***Indicator:***

Presence of non-recreational structures, installations, and developments (Undeveloped)

***Rationale:***

This measure would provide information about culverts, of which there are many in Wilderness; however, the data on the number of culverts was determined to be not sufficiently reliable.

### **Measure E-4: Number of observed or heard uses of power tools in Wilderness per hour of observation**

***Indicator:***

Remoteness from sights and sounds of human activity inside wilderness (Solitude or Primitive and Unconfined Recreation)

***Rationale:***

The data available for this measure is based on ranger observations; however, it was determined that these data are not a good proxy for visitor experiences.

## References

### Wilderness Character Monitoring Documents

- Bureau of Land Management, National Park Service, US Fish and Wildlife Service, US Forest Service, and US Geological Survey. 2014. 2020 Vision. Interagency Stewardship Priorities for America's National Wilderness Preservation System. Interagency guidance signed at the 2014 National Wilderness Conference in Albuquerque, NM. Available online: [https://winapps.umn.edu/winapps/media2/wilderness/toolboxes/documents/50th/2020\\_Vision.pdf](https://winapps.umn.edu/winapps/media2/wilderness/toolboxes/documents/50th/2020_Vision.pdf)
- Landres, P., C. Barns, J. G. Dennis, T. Devine, P. Geissler, C. S. McCasland, L. Merigliano, J. Seastrand, and R. Swain. 2008. Keeping It Wild: An Interagency Strategy to Monitor Trends in Wilderness Character across the National Wilderness Preservation System. USDA Forest Service RMRS-GTR-212, Fort Collins, CO.
- Landres, P., C. Barns, S. Boucher, et al. Draft dated April 30, 2014. Keeping It Wild 2: An Updated Interagency Strategy to Monitor Trends in Wilderness Character Across the National Wilderness Preservation System
- Landres, P., S. Boutcher, T. Blett, D. Bumpus, T. Carlson, D.N. Cole, L. Dean, T. Hall, C. Hardy, A. Leach, A. Mebane, L. Merigliano, S. Rinehart, and P. Wright. 2009. Technical Guide for Monitoring Selected Conditions Related to Wilderness Character. USDA Forest Service Report WO-80. Washington, DC.
- National Park Service Wilderness Character Integration Team. 2014. Keeping It Wild in the National Park Service, A User Guide to Integrating Wilderness Character into Park Planning, Management, and Monitoring. WASO 909/121797. Lakewood, CO.
- ### North Cascades National Park Documents
- Federal Register Notice for Thunder Creek Wilderness Designation (2012).
- Hoffman, R. L., A. Woodward, P. Haggerty, K. Jenkins, P. Griffin, M. J. Adams, J. Hagar, T. Cummings, D. Duriscoe, K. Kopper, J. Riedel, L. Marin, G. S. Mauger, K. Bumbaco, and J. S. Littell. 2015. North Cascades National Park Service Complex: Natural Resource Condition Assessment. Natural Resource Report NPS/NOCA/NRR-2015/901. National Park Service, Fort Collins, CO.
- Louter, D. 1998. Contested Terrain: North Cascades National Park Service Complex: An Administrative History.
- National Park Service. 1989. Stephen Mather Wilderness Management Plan. Unpublished Report. North Cascades National Park, Sedro-Woolley, WA.
- National Park Service. 1994. State of the Stephen Mather Wilderness. Unpublished Report. North Cascades National Park, Sedro-Woolley, WA.

National Park Service. 2013. North Cascades National Park Complex: Foundation Document. Unpublished Report. North Cascades National Park, Sedro-Woolley, WA.

### **Other Documents**

National Park Service. 2006. Chapter 6: Wilderness Preservation and Management. Pages 77–88 *in*: Management Policies 2006. Available online: [https://www.nps.gov/policy/MP\\_2006.pdf](https://www.nps.gov/policy/MP_2006.pdf).

National Park Service. 2013. Director's Order #41: Wilderness Stewardship. Available online: [https://www.nps.gov/subjects/policy/upload/DO\\_41\\_5-13-2013.pdf](https://www.nps.gov/subjects/policy/upload/DO_41_5-13-2013.pdf).

National Park Service Wilderness Character Integration Team. 2014. Wilderness Stewardship Plan Handbook: Planning to Preserve Wilderness Character. U.S. Department of the Interior, National Park Service, Wilderness Stewardship Division. WASO 909/122875.

North Cascades National Park Enabling Legislation (PL 90-544, October 2, 1968).

Sullivan, T. J. and others. 2011a. Evaluation of the sensitivity of inventory and monitoring national parks to acidification effects from atmospheric sulfur and nitrogen deposition: main report. Natural Resource Report. NPS/NRPC/ARD/NRR—2011/349. National Park Service, Natural Resource Program Center. Denver, Colorado. Available at: <https://irma.nps.gov/DataStore/Reference/Profile/2170555>.

Sullivan, T. J. and others. 2011b. Evaluation of the sensitivity of inventory and monitoring national parks to acidification effects from atmospheric sulfur and nitrogen deposition: North Coast and Cascades Network (NCCN). Natural Resource Report. NPS/NRPC/ARD/NRR—2011/365. National Park Service, Natural Resource Program Center. Denver, Colorado. Available at: <https://irma.nps.gov/DataStore/Reference/Profile/2170593>.

Taylor, K. A. 2017. National Park Service Air Quality Analysis Methods: August 2017. Natural Resource Report NPS/NRSS/ARD/NRR-2017/1490. National Park Service, Fort Collins, Colorado.

Washington Parks Wilderness Act (PL 100-668, Nov. 16, 1988).

## Appendix A. What Is A Trammeling Action?

The following appendix is excerpted from *Keeping It Wild 2*, Appendix 2.

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 Untrammeled 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 Untrammeled 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 Untrammeled 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 that 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 from the Lessons Learned Workshop was 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:
  - a. Removing or killing native vegetation or fish and wildlife
  - b. Adding or restoring native vegetation or fish and wildlife
  - c. Adding non-native vegetation for erosion control
  - d. Adding non-native fish and wildlife
  - e. Spraying chemicals to control non-native vegetation or fish and wildlife
  - f. Releasing biocontrol agents to control non-native vegetation or fish and wildlife
  - g. Collecting vegetation for scientific study
  - h. Collecting or capturing and releasing fish and wildlife for scientific study
  - i. Collecting vegetation or fish and wildlife for commercial purposes
  - j. 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
  - k. 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:
  - a. Suppressing naturally-ignited fire
  - b. Lighting fire (under management prescription) to reduce fuels or for other purposes
  - c. Constructing or maintaining a dam or diversion structure to alter the quantity or seasonal flow of water
  - d. 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:

- a. Installing a gate across a cave that will protect bats but exclude other animals from using the cave
  - b. Constructing or maintaining a range allotment fence
  - c. Constructing a dam to exclude non-native species from moving up or down a stream
  - d. Installing guzzlers to provide water for wildlife
  - e. Lighting fire (under management prescription) or any other vegetation manipulation to improve wildlife habitat
  - f. 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:
- a. Cloud seeding that occurs above the wilderness, and is therefore outside it, to intentionally increase precipitation inside the wilderness
  - b. Damming a river outside a wilderness to intentionally create a lake or water storage area inside the wilderness
  - c. Killing fish and wildlife outside the wilderness to intentionally affect the population or distribution of this species inside the wilderness
  - d. 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:
  - a. Adding vegetation or fish and wildlife by a federal agency (other than the federal land managing agency), a state agency, or the public
  - b. Removing vegetation or fish and wildlife by a federal or state agency or the public
  - c. Enclosing or excluding fish and wildlife to study the effects of enclosing 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:
  - a. Modifying water flow to store water or alter the timing of water flow
  - b. 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:

- a. 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:
  - a. Releasing species outside a wilderness with the intention to affect a population whose range expands into the wilderness
  - b. 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 44 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 44.** Examples of Actions that Likely Are, and Likely Are Not, Trammeling Actions.

Action	Likely Not A Trammeling Action	Likely A Trammeling Action
Building system trail	<ul style="list-style-type: none"> <li>• Routing a trail around a rock slide that obliterated the former trail</li> <li>• Building a bridge across a stream to prevent stream bank erosion</li> <li>• Installing a small section of corduroy across a wet area to prevent trenching</li> <li>• Installing in water bars</li> <li>• Removing rock in a trail</li> <li>• Building rock-cribbing to support a trail</li> </ul>	<ul style="list-style-type: none"> <li>• Routing a trail through an area of endangered alpine butterfly habitat</li> <li>• Building a large amount of new trail to go around a section of a river or a cliff</li> <li>• Building a trail that requires extensive earth movement or tree cutting</li> </ul>

**Table 44 (continued).** Examples of Actions that Likely Are, and Likely Are Not, Trammeling Actions.

Action	Likely Not A Trammeling Action	Likely A Trammeling Action
Obliterating non-system trail	<ul style="list-style-type: none"> <li>• Piling vegetation or rocks at the beginning and end of trail sections that cut a switchback</li> <li>• Piling vegetation or rocks to block social trails around campsites</li> </ul>	<ul style="list-style-type: none"> <li>• Obliterating a large section of non-system trail that requires extensive earth movement</li> </ul>
Restoring campsites	<ul style="list-style-type: none"> <li>• Restoring a single, isolated campsite</li> <li>• 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</li> </ul>	<ul style="list-style-type: none"> <li>• Restoring a number of campsites that does require moving a significant amount of soil or number of plants in the surrounding area</li> </ul>
Closing caves	<ul style="list-style-type: none"> <li>• Installing a bat gate across one or a few caves of many in the area</li> </ul>	<ul style="list-style-type: none"> <li>• Installing bat gates across all the caves in an area</li> </ul>
Removing hazard trees	<ul style="list-style-type: none"> <li>• Removing one or a few hazard trees that threaten designated campsites or that are along a trail</li> </ul>	<ul style="list-style-type: none"> <li>• Removing all of the hazard trees over a large area</li> </ul>
Treating non-native plants	<ul style="list-style-type: none"> <li>• Hand pulling a small area of nonnative invasive plants</li> </ul>	<ul style="list-style-type: none"> <li>• Spraying any herbicide</li> </ul>
Permitting scientific activities	<ul style="list-style-type: none"> <li>• Installing research plot monumentation, such as rebar stakes or nails</li> <li>• Installing most scientific instrumentation</li> <li>• Collecting a limited number of voucher specimens with no impact on species distribution or abundance</li> </ul>	<ul style="list-style-type: none"> <li>• Installing enclosures or exclosures that affect the movement of fish and wildlife</li> <li>• Installing instrumentation that disrupts the movement or behavior of plants, or fish and wildlife</li> <li>• Collecting voucher specimens that does affect the species distribution or abundance</li> </ul>

## Appendix B. Deriving the Overall Trend in Wilderness Character

The overall trend in wilderness character is a function of the trends in the five qualities, which in turn are functions of the trends in their respective monitoring questions, which in turn are functions of the trends in their respective indicators, which in turn are functions of the trends in their respective measures. Table 45 contains a list of all five wilderness character qualities, and associated monitoring questions, and indicators. See Table 3 for a list of all measures selected for the Stephen Mather Wilderness.

**Table 45.** List of Wilderness Character Monitoring Qualities, Monitoring Questions, and Indicators.

Quality	Monitoring Question	Indicator
Untrammeled	What are the trends in actions that intentionally control or manipulate the “earth and its community of life” inside wilderness?	<ul style="list-style-type: none"> <li>• Actions authorized by the federal land manager that intentionally manipulate the biophysical environment</li> <li>• Actions not authorized by the federal land manager that intentionally manipulate the biophysical environment</li> </ul>
Natural	What are the trends in the natural environment from human-caused change?	<ul style="list-style-type: none"> <li>• Plants</li> <li>• Animals</li> <li>• Air and Water</li> <li>• Ecological Processes</li> </ul>
Undeveloped	What are the trends in physical development?	<ul style="list-style-type: none"> <li>• Presence of non-recreational structures, installations, and developments</li> <li>• Presence of inholdings</li> </ul>
	What are the trends in mechanization?	<ul style="list-style-type: none"> <li>• Use of motor vehicles, motorized equipment, or mechanical transport</li> </ul>
Solitude or Primitive and Unconfined Recreation	What are the trends in outstanding opportunities for solitude?	<ul style="list-style-type: none"> <li>• Remoteness from sights and sounds of human activity inside wilderness</li> <li>• Remoteness from sights and sounds of human activity outside wilderness</li> </ul>
	What are the trends in outstanding opportunities for primitive and unconfined recreation?	<ul style="list-style-type: none"> <li>• Facilities that decrease self-reliant recreation</li> <li>• Management restrictions on visitor behavior</li> </ul>
Other Features of Value	What are the trends in the unique features that are tangible and integral to wilderness character?	<ul style="list-style-type: none"> <li>• Deterioration or loss of integral historic or cultural features or iconic features</li> <li>• Condition of iconic physical features (glaciers) within the wilderness</li> </ul>

The first step in deriving the overall trend in wilderness character is to derive trends for indicators. Table 46 (below) provides a hypothetical example in which trends for indicators under the Natural Quality are derived from trends for their respective measures. This example uses the measures and weighting scheme chosen for the Stephen Mather Wilderness (see Table 3). For each measure, a

trend description is determined using the rules described above under the “WCM Trend Assessment” heading for each measure. The trend description is then converted to a trend value as follows: stable (0), upward (+1), downward (−1). The trend values are then weighted by multiplying the trend value by the measure’s weight percentage. For each indicator, a trend value is calculated by adding the weighted trend value for each measure under the indicator. If this resulting value is zero, the trend for the indicator is defined as stable; if this value is positive, the trend is defined as upward; and if this result is negative, the trend is defined as downward. Note: There are two possible ways that a stable result can occur: from adding together all zeros (e.g. 0, 0, 0), or from adding together positive and negative values (e.g. +1, −1, 0). Both are described as “stable” although different types of arrows are used to differentiate them (↔ for adding together all zeros, and  $\updownarrow$  for adding together positive and negative values that cancel one another).

This process would be replicated for each Quality.

**Table 46.** Deriving Trends for **Indicators** from Trends for Measures (using Natural Quality as Example).

Indicator	Measure					Indicators	
	Num	Weight	Trend Description	Trend Value	Weighted Trend Value	Trend Value	Trend
Plants	2-1	100%	Upward	1	1.00	1.00	↑
Animals	2-2	50%	Downward	−1	−0.50	−	−
	2-3	50%	Stable	0	0.00	−	−
	Overall Animals	n/a	n/a	n/a	n/a	−0.50	↓
Air and Water	2-4	25%	Stable	0	0.00	−	−
	2-5	25%	Upward	1	0.25	−	−
	2-6	25%	Downward	−1	−0.25	−	−
	2-7	25%	Upward	1	0.25	−	−
	Overall Air and Water	n/a	n/a	n/a	n/a	0.25	↑
Ecological Processes	2-8	100%	Upward	1	1.00	1	↑

The resulting trends for the indicators are then used to derive the trend for the monitoring question, and likewise through the qualities and finally to wilderness character. In these derivations, lower-order trends are all weighted equally. For example, when deriving the trend for a particular monitoring question, the trends for all indicators under the monitoring question are weighted equally. To derive a higher-order trend (e.g. for a monitoring question) from lower-order trends (e.g. for indicators), the lower order trends are first converted to numerical values and then added together using the process described above. Figure 2 (below) shows a hypothetical example in which the overall trend for wilderness character is derived for the Stephen Mather Wilderness.

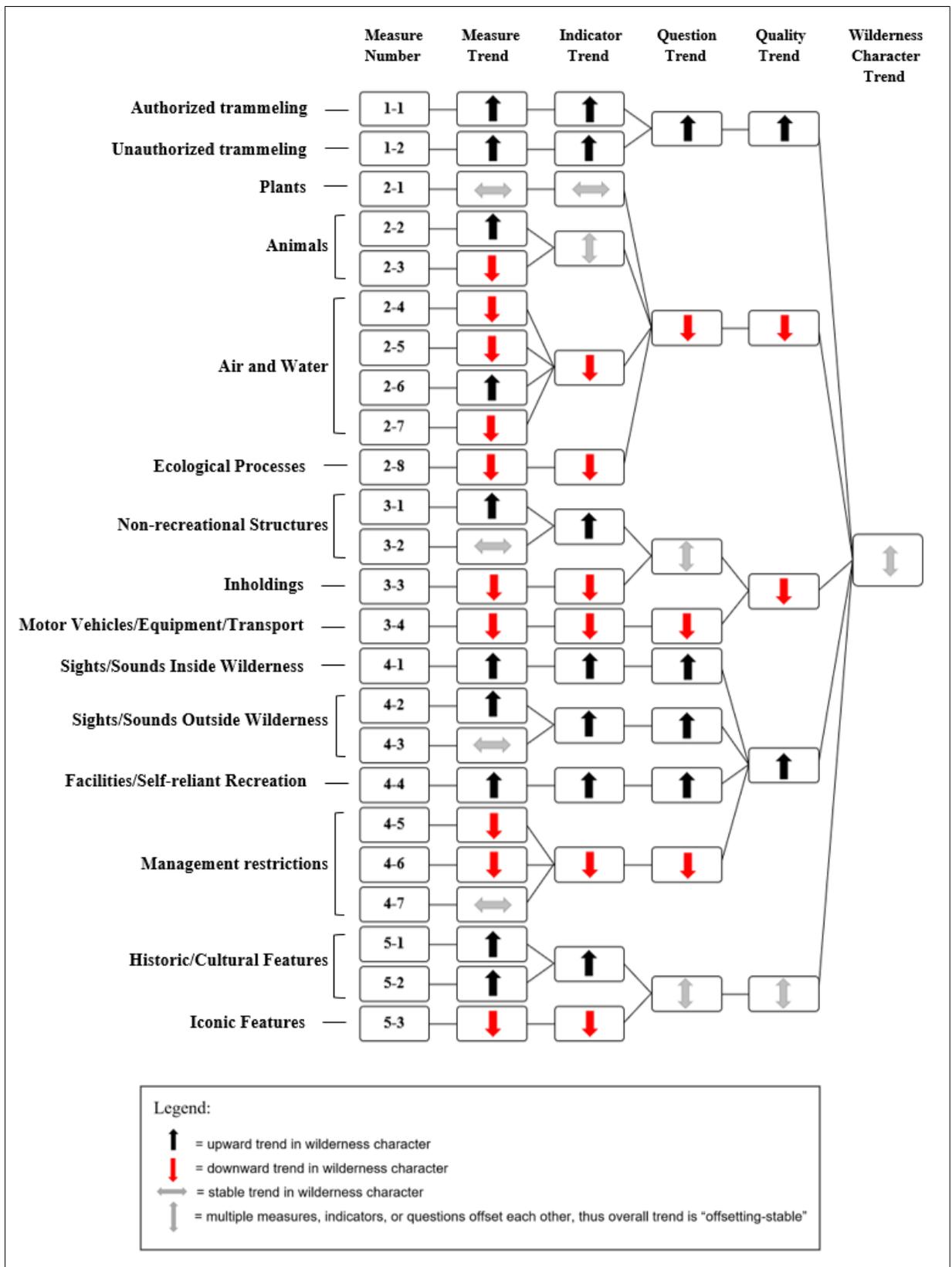


Figure 2. Deriving the Overall Trend for Wilderness Character – Example.

## Appendix C. Summary of Trail and Backcountry Camps Survey of Non-Native Plant Species, 2006 and 2019

**Table 47.** Non-native plant species along major Wilderness trails, Stephen Mather Wilderness (2006, 2019). Impact risk determined either from NatureServe or professional judgement from local botanists.

Trail	Common name	Species name	Percent Cover/Area surveyed	Invasive species Impact Risk low=1, 2=medium, 3=high	Professional judgement
1. Big Beaver	Wall lettuce	<i>Mycelis muralis</i>	<1%	not yet assessed	1
	English plantain	<i>Plantago lanceolata</i>	<1%	2	–
	Common plantain	<i>Plantago major</i>	<1%	not yet assessed	1
	Annual bluegrass	<i>Poa annua</i>	1–25%	1	–
	Compressed bluegrass	<i>Poa compressa</i>	1–25%	2	–
	Perennial bluegrass	<i>Poa pratensis</i>	1–25%	2	–
	Creeping buttercup	<i>Ranunculus repens</i>	<1%	3	–
	Cut leaved blackberry	<i>Rubus laciniatus</i>	<1%	not yet assessed	3
	Sheep sorrel	<i>Rumex acetosella</i>	<1%	2	–
	Red clover	<i>Trifolium pratense</i>	26–50%	1	–
	White clover	<i>Trifolium repens</i>	26–50%	2	–
	Speedwell	<i>Veronica</i> sp.	<1%	not yet assessed	1
2. East Bank	Cheatgrass	<i>Bromus tectorum</i>	<1%	3	–
	St. John's wort	<i>Hypericum perforatum</i>	1–25%	3	–
	Common plantain	<i>Plantago major</i>	<1%	not yet assessed	1
	Annual bluegrass	<i>Poa annua</i>	<1%	1	–
	Red clover	<i>Trifolium pratense</i>	<1%	1	–
3. Ruby Arm	Annual bluegrass	<i>Poa annua</i>	1–25%	1	–
	Red clover	<i>Trifolium pratense</i>	<1%	1	–
	White clover	<i>Trifolium repens</i>	<1%	2	–
	Six-week brome	<i>Vulpia</i> sp.	<1%	not yet assessed	1
4. Panther	Herb Robert	<i>Geranium robertianum</i>	–	not yet assessed	3
	Wall lettuce	<i>Mycelis muralis</i>	–	not yet assessed	1
	Annual bluegrass	<i>Poa annua</i>	<1%	1	–
	Perennial bluegrass	<i>Poa pratensis</i>	–	2	–
	Spiny sow thistle	<i>Sonchus asper</i>	–	not yet assessed	2

**Table 47 (continued).** Non-native plant species along major Wilderness trails, Stephen Mather Wilderness (2006, 2019). Impact risk determined either from NatureServe or professional judgement from local botanists.

Trail	Common name	Species name	Percent Cover/Area surveyed	Invasive species Impact Risk low=1, 2=medium, 3=high	Professional judgement
5. Cascade Pass	Orchard grass	<i>Dactylus glomerata</i>	<1%	not yet assessed	2
	Annual bluegrass	<i>Poa annua</i>	<1%	1	–
	White clover	<i>Trifolium repens</i>	<1%	2	–
6. Chilliwack	Common plantain	<i>Plantago major</i>	<1%	not yet assessed	1
	Annual bluegrass	<i>Poa annua</i>	<1%	1	–
	Perennial bluegrass	<i>Poa pratensis</i>	1–25%	2	–
	Red clover	<i>Trifolium pratense</i>	26–50%	1	–
	White clover	<i>Trifolium repens</i>	–	2	–
	Six-week brome	<i>Vulpia</i> sp.	<1%	not yet assessed	1
7. Copper Ridge	Perennial bluegrass	<i>Poa pratensis</i>	<1%	2	–
	Curly dock	<i>Rumex crispus</i>	<1%	1	–
	Red clover	<i>Trifolium pratense</i>	<1%	1	–
8. Brush Creek-Stillwell CG	Wall lettuce	<i>Mycelis muralis</i>	–	not yet assessed	1
	English plantain	<i>Plantago lanceolata</i>	<1%	2	–
	Common plantain	<i>Plantago major</i>	<1%	not yet assessed	1
	Annual bluegrass	<i>Poa annua</i>	<1%	1	–
	Perennial bluegrass	<i>Poa pratensis</i>	–	2	–
	Sheep sorrel	<i>Rumex acetosella</i>	–	2	–
	Dandelion	<i>Taraxacum officinale</i>	–	not yet assessed	1
	Red clover	<i>Trifolium pratense</i>	<1%	1	–
9. Easy Pass-Fisher Creek-Thunder Crk-Colonial CG)	Hair grass	<i>Aira caryophylla</i>	<1%	1	–
	Knapweed	<i>Centaurea</i> sp.	<1%	3	–
	Sticky chickweed	<i>Cerastium glomeratum</i>	<1%	not yet assessed	1
	Prickly lettuce	<i>Lactuca serriola</i>	<1%	1	–
	English plantain	<i>Plantago lanceolata</i>	<1%	2	–
	Common plantain	<i>Plantago major</i>	<1%	not yet assessed	1
	Annual bluegrass	<i>Poa annua</i>	<1%	1	–
	Compressed bluegrass	<i>Poa compressa</i>	<1%	2	–
	Perennial bluegrass	<i>Poa pratensis</i>	<1%	2	–
	Creeping buttercup	<i>Ranunculus repens</i>	<1%	3	–
	Sheep sorrel	<i>Rumex acetosella</i>	<1%	2	–

**Table 47 (continued).** Non-native plant species along major Wilderness trails, Stephen Mather Wilderness (2006, 2019). Impact risk determined either from NatureServe or professional judgement from local botanists.

Trail	Common name	Species name	Percent Cover/Area surveyed	Invasive species Impact Risk low=1, 2=medium, 3=high	Professional judgement
9. Easy Pass-Fisher Creek-Thunder Crk-Colonial CG) (continued)	Common chickweed	<i>Stellaria media</i>	<1%	1	–
	Common tansy	<i>Tanacetum vulgare</i>	<1%	1	–
	Red clover	<i>Trifolium pratense</i>	<1%	1	–
	White clover	<i>Trifolium repens</i>	<1%	2	–
	Speedwell	<i>Veronica sp.</i>	<1%	not yet assessed	1
10. Park Creek-Fisher Creek Jct, including Meadow Cabin spur tail	Wall lettuce	<i>Mycelis muralis</i>	<1%	not yet assessed	1
	English plantain	<i>Plantago lanceolata</i>	<1%	2	–
	Annual bluegrass	<i>Poa annua</i>	<1%	1	–
	Perennial bluegrass	<i>Poa pratensis</i>	<1%	2	–
	Creeping buttercup	<i>Ranunculus repens</i>	<1%	3	–
	Sheep sorrel	<i>Rumex acetosella</i>	<1%	2	–
	Common chickweed	<i>Stellaria media</i>	<1%	1	–
	Red clover	<i>Trifolium pratense</i>	<1%	1	–
	White clover	<i>Trifolium repens</i>	<1%	2	–
	Speedwell	<i>Veronica sp.</i>	<1%	not yet assessed	1
	Vicia	<i>Vicia sp.</i>	<1%	not yet assessed	1
11. Bridge Creek	Red top	<i>Agrostis alba</i>	<1%	2	–
	Orchard grass	<i>Dactylus glomerata</i>	<1%	not yet assessed	2
	Timothy	<i>Phleum pratense</i>	<1%	2	–
	English plantain	<i>Plantago lanceolata</i>	<1%	2	–
	Common plantain	<i>Plantago major</i>	<1%	not yet assessed	1
	Annual bluegrass	<i>Poa annua</i>	1–25%	1	–
	Canada bluegrass	<i>Poa compressa</i>	–	2	–
	Perennial bluegrass	<i>Poa pratensis</i>	<1%	2	–
	Sheep sorrel	<i>Rumex acetosella</i>	<1%	2	–
	Sand spurrey	<i>Spergularia rubra</i>	<1%	not yet assessed	1
	Dandelion	<i>Taraxacum officinale</i>	–	not yet assessed	1
	White clover	<i>Trifolium repens</i>	<1%	2	–
	Speedwell	<i>Veronica sp.</i>	<1%	not yet assessed	1
12. Rainbow Creek-McAlester Pass	Cheatgrass	<i>Bromus tectorum</i>	–	3	–
	Canada thistle	<i>Cirsium arvensis</i>	–	3	–
	Bull thistle	<i>Cirsium vulgare</i>	–	2	–

**Table 47 (continued).** Non-native plant species along major Wilderness trails, Stephen Mather Wilderness (2006, 2019). Impact risk determined either from NatureServe or professional judgement from local botanists.

Trail	Common name	Species name	Percent Cover/Area surveyed	Invasive species Impact Risk low=1, 2=medium, 3=high	Professional judgement
12. Rainbow Creek-McAlester Pass (continued)	Scotch Broom	<i>Cystisus scoparius</i>	–	2	–
	Orchard grass	<i>Dactylis glomerata</i>	–	not yet assessed	2
	St. John's wort	<i>Hypericum perforatum</i>	–	3	–
	Wall lettuce	<i>Mycelis muralis</i>	–	not yet assessed	1
	Bulbous bluegrass	<i>Poa bulbosa</i>	–	not yet assessed	3
	Salsify	<i>Tragopogon dubius</i>	–	2	–
	Red clover	<i>Trifolium pratense</i>	–	1	–
	White clover	<i>Trifolium repens</i>	–	2	–
13. Boulder Creek-War Creek Pass	Cheatgrass	<i>Bromus tectorum</i>	–	3	–
	Wall lettuce	<i>Mycelis muralis</i>	–	not yet assessed	1
	Bulbous bluegrass	<i>Poa bulbosa</i>	–	not yet assessed	3
	Red clover	<i>Trifolium pratense</i>	–	1	–
	White clover	<i>Trifolium repens</i>	–	2	–
14. McGregor Mtn	Cheatgrass	<i>Bromus tectorum</i>	–	3	–
	Red clover	<i>Trifolium pratense</i>	–	1	–
	White clover	<i>Trifolium repens</i>	–	2	–
15. Purple Creek-War Creek Pass	Cheatgrass	<i>Bromus tectorum</i>	–	3	–
	Orchard grass	<i>Dactylis glomerata</i>	–	not yet assessed	2
	Wall lettuce	<i>Mycelis muralis</i>	–	not yet assessed	1
	Bulbous bluegrass	<i>Poa bulbosa</i>	–	not yet assessed	3
	Salsify	<i>Tragopogon dubius</i>	–	2	–
	Red clover	<i>Trifolium pratense</i>	–	1	–
	White clover	<i>Trifolium repens</i>	–	2	–
16. Fireweed Camp – McAlester Lake to South Pass	Orchard grass	<i>Dactylis glomerata</i>	<1%	not yet assessed	2
	English plantain	<i>Plantago lanceolata</i>	<1%	2	–
	Common plantain	<i>Plantago major</i>	<1%	not yet assessed	1
	Annual bluegrass	<i>Poa annua</i>	1–25%	1	–
	Perennial bluegrass	<i>Poa pratensis</i>	<1%	2	–
	Sheep sorrel	<i>Rumex acetosella</i>	<1%	2	–
	Sand spurrey	<i>Spergularia rubra</i>	<1%	not yet assessed	1
	White clover	<i>Trifolium repens</i>	1–25%	2	–

### Trail and Camp Survey Methods:

Prior to the end of the 5-year monitoring cycle, all trails listed in Table 48 will be surveyed. For the purposes of this wilderness character measure, trails are defined as the trail and areas adjacent to the trail within 5 meters either side of the trail tread. If weed populations can be observed beyond this defined corridor these should also be documented. All non-native plants will be documented from the beginning to the end of the trail segment, as described in Table 48. Although not necessary for wilderness character monitoring, an estimate of the percent cover of each non-native species within the area surveyed should be recorded, if possible. Backcountry campgrounds along the trail segments will also be surveyed and non-native species recorded for this measure for the appropriate trail segment.

Data sheets include the following: the location of the species encountered, the trail or camp name, the date, observer(s), and the feature type (if linear, along the edges of trails, stream or lake margins and if a polygon, record the species that are occupying campsites or non-linear populations). Record the exact location such as a horse camp vs. a hiker camp. For discrete populations not associated with a trail or camp, record the UTM at a site/location or record the trail segment while traveling. Record the approximate area surveyed, 5 meters on either side of a trail, or the size of a camp area. Record the species found in a 6-letter code.

**Table 48.** Summary of trail segment descriptions.

Trail Name	Description
1. Big Beaver	From Big Beaver campground over Beaver Pass to Stillwell campground
2. East Bank	From SR20 to Lightning Creek trail junction
3. Ruby Arm	From East Bank trail to end of Ruby Arm trail
4. Panther	From SR20 Over 4 <sup>th</sup> of July Pass to Thunder Creek trail junction
5. Cascade Pass	From Wilderness boundary near parking lot to Cascade Pass
6. Chilliwack	From Hannegan Pass, down Hannegan trail to junction with Copper Ridge trail
7. Copper Ridge	From junction near Boundary Camp along the Copper Ridge trail to junction at the Chilliwack River
8. Brush Creek-Stillwell	From junction of Hannegan Trail over Whatcom Pass to Stillwell campground
9. Easy Pass-Fisher Creek-Thunder-Colonial	From Easy Pass to Colonial Creek campground
10. Park Creek-Fisher Creek	From Park Creek campground over Park Creek Pass to Fisher Creek trail junction, including the trail down to the Meadow Cabins
11. Bridge Creek	From NPS boundary near SR20 to Bridge Creek campground (all part of PCT trail)
12. Rainbow Creek-McAlester Pass	From wilderness boundary above Stehekin Valley up to McAlester Pass
13. Boulder Creek-War Creek Pass	From the start of the Boulder Creek trail at junction with Rainbow Loop trail, up to War Creek Pass
14. McGregor Mtn	From Old Wagon Trail (PCT) to McGregor Mtn (end of trail)

**Table 48 (continued).** Summary of trail segment descriptions.

Trail Name	Description
15. Purple Crk trail-War Creek Pass	From Wilderness boundary above the Stehekin Landing to War Creek Pass
16. Fireweed camp-McAlester Pass-South Pass	From Fireweed campground to South Pass, including the trails into McAlester Lake and to Hidden Meadows

## Appendix D. Wilderness Camps and Cross-Country Zones

Table 49 below contains a list of all 95 Wilderness camps. These include camps that are either in designated or potential wilderness. There are several camps near Ross Lake for which it is unclear whether they are in designated wilderness or not. The wilderness boundary in this area is along the 550-meter elevation contour, and the exact elevations of these camps are uncertain. These camps are all managed as wilderness camps and are thus included in the list of all Wilderness camps. There are 188 associated Wilderness campsites. Table 50 lists the Management Requirements for Cross-Country camping zones.

**Table 49.** 2015 Management Requirements for Wilderness Camps.

Name	Number of Campsites	Capacities	Total Capacity	Bear Canisters Required	Campfires Prohibited
39 Mile	3	4,4,4	12	No	No
39 Mile Stock	1	12	12	No	No
Basin Creek	3	4,4,4	12	No	Yes
Bear Creek	1	4	4	No	No
Beaver Pass	2	8,4	12	No	No
Beaver Pass Stock	1	4	4	No	No
Bench Creek	3	4,4,4	12	No	No
Boundary	3	4,4,4	12	No	Yes
Bowan	2	4,4	8	No	No
Copper Creek	5	4,4,4,4,4	20	No	No
Copper Lake	3	4,4,4	12	No	Yes
Cosho	3	4,4,4	12	No	No
Dagger Lake	1	12	12	No	No
Dagger Lake Stock	1	12	12	No	No
Dan's	1	4	4	No	No
Deerlick Stock	2	6,6	12	No	No
Desolation	1	8	8	Yes	Yes
Devil's Creek	3	4,4,4	12	No	No
Devil's Creek Stock	1	12	12	No	No
Egg Lake	3	4,4,4	12	No	Yes
Fireweed	2	6,6	12	No	No
Fireweed Stock	2	8,12	20	No	No
Fisher	3	4,4,4	12	Yes	Yes
Five Mile Stock	3	4,4,8	16	No	No
Flat Creek	2	6,6	12	No	No
Fourth of July	3	4,4,4	12	No	Yes

**Table 49 (continued).** 2015 Management Requirements for Wilderness Camps.

<b>Name</b>	<b>Number of Campsites</b>	<b>Capacities</b>	<b>Total Capacity</b>	<b>Bear Canisters Required</b>	<b>Campfires Prohibited</b>
Graybeal	3	4,4,4	12	No	No
Graybeal Stock	1	12	12	No	No
Grizzly Creek	3	4,4,4	12	No	No
Heaton Stock	1	12	12	No	No
Hidden Hand	1	12	12	No	No
Hidden Hand Stock	1	8	8	No	No
Hidden Meadows Stock	1	12	12	No	No
Hideaway	1	12	12	No	No
High	1	4	4	No	Yes
Hooter	1	4	4	Yes	Yes
Hozomeen Lake	3	4,4,12	20	No	No
Indian Creek	3	4,4,4	12	No	No
Johannesburg	3	4,4,4	12	No	Yes
Juanita Lake	2	4,4	8	No	Yes
Juanita Lake Stock	1	12	12	No	Yes
Junction	3	4,4,4	12	No	No
Junction Stock	1	12	12	No	No
Little Chilliwack	3	4,4,4	12	No	No
Luna	2	4,4	8	No	No
May Creek Stock	1	8	8	No	No
McAlester Lake	2	4,8	12	No	No
McAlester Lake Stock	1	8	8	No	No
McAllister	5	4,4,4,4,12	28	No	No
McAllister Stock	1	12	12	No	No
Monogram Lake	2	4,4	8	Yes	Yes
Neve	3	4,4,4	12	No	No
Nightmare	1	12	12	No	No
North Fork	2	4,12	16	No	No
Panther	2	6,6	12	No	No
Pelton Basin	3	4,4,4	12	No	Yes
Pelton Basin Group	1	8	8	No	Yes
Perry Creek	3	4,4,12	20	No	No
Pierce Mountain	1	4	4	Yes	Yes

**Table 49 (continued).** 2015 Management Requirements for Wilderness Camps.

<b>Name</b>	<b>Number of Campsites</b>	<b>Capacities</b>	<b>Total Capacity</b>	<b>Bear Canisters Required</b>	<b>Campfires Prohibited</b>
Pumpkin Mountain	2	4,4	8	No	No
Rainbow Bridge	2	4,4	8	No	No
Rainbow Ford	1	4	4	No	No
Rainbow Lake	2	4,4	8	No	Yes
Rainbow Meadows	1	8	8	No	No
Rainbow Meadows Group	1	12	12	No	No
Rainbow Meadows Stock	1	12	12	No	No
Rennie	1	4	4	No	No
Reynolds	1	4	4	No	No
Reynolds Stock	1	12	12	No	No
Roland Creek	3	8,4,4	16	No	No
Ruby Pasture	1	6	6	No	No
Sahale Glacier	6	4,4,4,4,4,4	24	Yes	Yes
Silesia	2	4,4	8	No	Yes
Six Mile	1	12	12	No	No
Skagit Queen	3	4,4,4	12	No	No
Sourdough	1	4	4	Yes	Yes
South Fork	2	4,4	8	No	No
South Fork Stock	1	12	12	No	No
Stillwell	4	4,4,4,4	16	No	No
Sulphide Creek	2	8,8	16	No	No
Thornton Lakes	3	4,4,4	12	Yes	Yes
Thunder	3	4,4,12	20	No	No
Thunder Basin	2	4,4	8	Yes	Yes
Thunder Basin Stock	1	4	4	No	No
Trapper Inlet	1	4	4	Yes	Yes
Trapper Outlet	2	4,4	8	No	Yes
Tricouni	2	4,4	8	No	No
Twin Rocks	2	6,6	12	No	No
Twin Rocks Stock	1	12	12	No	No
Two Mile	1	6	6	No	No
U.S. Cabin	4	4,4,4,4	16	No	No
U.S. Cabin Stock	1	12	12	No	No
Walker Park Stock	1	12	12	No	No
Whatcom	3	4,4,4	12	No	Yes
Willow Lake	1	4	4	No	No

**Table 50.** 2015 Management Requirements for Cross-Country Zones.

<b>Name</b>	<b>Type</b>	<b>Max Party Size</b>	<b>Max Number of Parties</b>	<b>Total Capacity</b>	<b>Bear Canisters Required</b>	<b>Campfires Prohibited</b>
Arriva	II	6	6	36	No	Yes
Bacon Peak	II	6	3	18	No	Yes
Battalion	II	6	2	12	No	Yes
Bear Mountain	II	6	6	36	No	Yes
Benzarino	II	6	3	18	No	Yes
Berdeen	II	6	3	18	No	Yes
Blum	II	6	2	12	No	Yes
Boston Basin	I	12	6	72	Yes, in portions	Yes
Boston Glacier	II	6	6	36	No	Yes
Bouck	II	6	6	36	No	Yes
Buckner	II	6	6	36	No	Yes
Castle Rock	II	6	2	12	No	Yes
Challenger	II	6	6	36	No	Yes
Colonial	II	6	6	36	No	Yes
Copper Mountain	II	6	2	12	No	Yes
Crescent Creek	II	6	6	36	No	Yes
Davis Peak	II	6	3	18	No	Yes
Dee Dee Lakes	II	6	1	6	No	Yes
Depot	II	6	6	36	No	Yes
Despair	II	6	3	18	No	Yes
Easy Ridge	II	6	4	24	No	Yes
Eldorado	I	12	6	72	Yes, in portions	Yes
Elephant Butte	II	6	6	36	No	Yes
Elija Ridge	II	6	2	12	No	Yes
Forbidden	I	12	6	72	No	Yes
Goode	II	6	6	36	No	Yes
Hidden Lake	I	12	3	36	Yes	Yes
Hock	II	6	2	12	No	Yes
Hozomeen	II	6	3	18	No	Yes
Icy	I	12	6	72	No	Yes
Inspiration	I	12	6	72	No	Yes
Johannesburg	II	6	6	36	No	Yes
Kettling	II	6	2	12	No	Yes
Klawatti	II	6	6	36	No	Yes
Little Chilliwack	II	6	6	36	No	Yes

**Table 50 (continued).** 2015 Management Requirements for Cross-Country Zones.

<b>Name</b>	<b>Type</b>	<b>Max Party Size</b>	<b>Max Number of Parties</b>	<b>Total Capacity</b>	<b>Bear Canisters Required</b>	<b>Campfires Prohibited</b>
Little Jack	II	6	1	6	No	Yes
Logan	II	6	6	36	No	Yes
Luna	II	6	6	36	No	Yes
Marble Creek	II	6	3	18	No	Yes
McGregor	II	6	6	36	No	Yes
Middle Lakes	II	6	3	18	No	Yes
Newhalem Creek	II	6	2	12	No	Yes
Nooksack	I	12	6	72	No	Yes
Perfect Pass	II	6	1	6	No	Yes
Pioneer Ridge	II	6	2	12	No	Yes
Price Lake	I	12	6	72	No	Yes
Prophet	II	6	3	18	No	Yes
Purple	II	6	3	18	No	Yes
Ragged Ridge	II	6	3	18	No	Yes
Rainbow Ridge	II	6	2	12	No	Yes
Rennie	II	6	3	18	No	Yes
Ruby	II	6	3	18	No	Yes
Snowfield	II	6	6	36	No	Yes
Sourdough	II	6	6	36	No	Yes
Spickard	II	6	3	18	No	Yes
Starvation Ridge	II	6	3	18	No	Yes
Stiletto	II	6	3	18	No	Yes
Stout Lake	II	6	3	18	No	Yes
Sulphide Glacier	I	12	6	72	Yes, in portions	Yes
Tapto Lakes	II	6	3	18	Yes	Yes
Teebone	II	6	3	18	No	Yes
Terror Basin	II	6	6	36	No	Yes
Tolo	II	6	2	12	No	Yes
Torment Basin	I	12	6	72	No	Yes
Triad	I	12	6	72	No	Yes
Triplet Lakes	II	6	2	12	No	Yes
Triumph	II	6	2	12	No	Yes



The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS 168/171517, August 2020

National Park Service  
U.S. Department of the Interior



---

[Natural Resource Stewardship and Science](#)

1201 Oakridge Drive, Suite 150  
Fort Collins, CO 80525