



Quality Assurance Plan for Trail Monitoring at Grand Portage National Monument

Natural Resource Report NPS/GLKN/NRR—2018/1736



ON THE COVER

An NPS biologist retrieving a trail asset during an inventory of trail conditions at Grand Portage National Monument (NPS photo).

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September 2018

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

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Please cite this publication as:

Gafvert, U., and B. Seitz. 2018. Quality assurance plan for trail monitoring at Grand Portage National Monument. Natural Resource Report NPS/GLKN/NRR—2018/1736. National Park Service, Fort Collins, Colorado.

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Abstract

In accordance with guidelines set forth by the National Park Service Inventory and Monitoring Division, a quality-assurance plan has been created for use by the Great Lakes Inventory and Monitoring Network in the implementation of trails monitoring. This quality-assurance plan documents the standards, policies, and procedures used by the Great Lakes Network for activities related to the collection, processing, storage, analysis, and publication of monitoring data. The policies and procedures documented in this quality-assurance plan for activities complement the quality-assurance plans for other monitoring activities conducted by the Great Lakes Network and supplement the National Inventory and Monitoring Division Quality Management Plan.

List of Terms

Accepted Data: Data that have undergone all QA and QC procedures as defined in a published protocol and associated SOPs. Used in cases where a Quality Assurance Plan has not been developed and approved.

Accreditation: A formal recognition that an individual or organization (e.g., laboratory) is competent to carry out specific tasks or specific types of tests, and/or meets predetermined qualifications or standards. For labs, this is typically done on an analyte basis for a limited/specific period of time.

Accuracy: A measure of the degree of conformance of the values generated by a specific method or procedure with the true value. The concept of accuracy includes both bias (systematic error) and precision (random error). EPA recommends that this term not be used and that precision and bias be used to convey the information usually associated with accuracy. See Precision and Bias.

Bias: Systematic error that is manifested as a consistent positive or negative deviation from the known or true value. It differs from random error which shows no such deviation.

Calibration: Determination, by measurement or comparison with a standard, the correct value of each measure on a meter or other device, or the correct value for each setting of a control knob. The levels of the calibration standards should bracket the range of planned measurements.

Certified Data: Certified data are those data that a) have been through all QA/QC procedures as outlined in the QAP, b) meet expected quality standards, or are appropriately identified and annotated at the record level in cases where they do not meet those standards, c) have documented procedures for data collection, processing, and transformation in appropriate metadata formats, and d) are suitable for use.

Comparability: The degree to which different methods, data sets and/or decisions agree or can be represented as similar; a data quality indicator.

Data Quality Objectives (DQOs): Qualitative and quantitative statements that clarify the objectives of observations, define the appropriate type of data, and specify levels of uncertainty that are acceptable to managers when using data. DQOs provide the statistical framework for planning data collection and management, and are used as the basis for establishing the quality and quantity of data needed to support decisions. Includes Qualitative Data Quality Values (DQVs), and informs development of Measurement Standards (or Measurement Quality Objectives; MQOs), Performance Standards, Accreditation Standards, and Policy Standards.

Data Quality Values (DQVs): Desired qualitative characteristics of data and datasets related to intrinsic data quality (reasonability, accuracy, objectivity, credibility), contextual data quality (relevance, timeliness, completeness, comparability), representational data quality (interpretability, understandability, consistency), and data accessibility (security, discoverability, utility).

Data Validation: Quality Control tools or processes designed to evaluate legitimacy of data as they proceed through the data management lifecycle. Typically data that do not pass validation procedures are either corrected using prescribed methods or flagged/graded to inform data users as to their appropriate use.

Data Verification: Quality Assurance tools or processes where data are checked for accuracy and inconsistencies as they migrate through the data management lifecycle. Data Verification helps to ensure that data are complete, properly formatted so that they can be processed, and accurately translated when transferred from one source to another.

Data Flagging / Data Qualification: A code or annotation that signals that data do not meet specified data quality standards so as to inform appropriate use.

Minimum Detection Limit (MDL): The minimum concentration of an analyte that, in a given matrix and with a specific method, has a 99% probability of being identified, qualitatively or quantitatively measured, and reported to be greater than zero.

Minimum Quantification Limit (MQL): The concentration of analyte in a specific matrix for which the probability of producing analytical values above the method detection limit is 99 percent.

Precision: The degree of similarity among independent measurements of the same quantity, without reference to the known or true value.

Provisional Data: Provisional data are those data that have undergone incomplete QA/QC procedures as defined in the QAP and are not suitable for general use. Provisional data may be used in some cases, however, depending on the amount of QA/QC completed, and the intended use.

Quality Assurance (QA): The set of activities designed to ensure that data, products, or services meet defined standards of quality with a stated level of confidence. Quality Assurance focuses on ensuring that data are collected to and managed to the highest practicable quality, at or above stated data quality standards.

Quality Assurance Plan (QAP): Documentation of Quality Assurance and Quality Control procedures for a protocol, program (inventory and overall I&M), and national database application (i.e., Data Store).

Quality Control (QC): Operational techniques and activities that are used to ensure that data or products meet designated requirements for quality. Quality Control procedures focus on testing data for quality and can include both an evaluation of whether data quality meet data quality objectives and/or procedures to correct data.

Raw Data: Data in their state of original collection, either in the form of paper or electronic field forms, electronic sensor files, or digital media (photo, video, or audio). These data generally have been collected following some QA procedures, but have not undergone any QC procedures.

Sensitivity. The ability of a method or instrument to discriminate between minimally different levels of a variable of interest by producing a noticeably different measurement response.

Standards, Measurement (also Measurement Quality Objectives): Data quality requirements specifying the level of precision, bias, sensitivity, resolution, etc. that data must meet to be accepted for use in analysis.

Standards, Performance: Data quality requirements specifying the detection ability, sensitivity, variability, etc., of equipment, sensors, or observers to reliably measure characteristics within target populations.

Standards, Accreditation: Data quality requirements related to individuals or organizations involved with data collection, analysis or processing to ensure desired data credibility and defensibility. Examples include professional accreditation/certificates, required training, chain-of-custody requirements and others.

Standards, Policy: Data quality requirements related to ensuring appropriate management, use, dissemination, qualification, and documentation of data.

Introduction

This quality assurance plan documents the standards used by the National Park Service's (NPS) Great Lakes Inventory and Monitoring Network (GLKN) for activities related to the collection, processing, storage, and analysis of trail monitoring data, as described in the Trail Monitoring Protocol for Grand Portage National Monument (Gafvert and Seitz 2018). The policies and procedures documented in this quality-assurance plan for activities complement the quality-assurance plans for other monitoring activities conducted by the GLKN and supplement National Inventory and Monitoring Division Quality Management Plan (unpublished document). The plan also serves as a guide for all GLKN personnel who are involved in protocol/program activities and as a resource for identifying memoranda, publications, and other literature that describe associated techniques and requirements in more detail. Much of the verbiage contained within this standard operating procedure (SOP) was first written in the protocol narrative and other SOPs, and we wish to thank the authors of those sections.

Protocol Overview

The GLKN has developed a prioritized list of indicators, termed 'Vital Signs,' for monitoring long-term ecosystem health in nine NPS units in the Great Lakes ecoregion. While trail conditions were not identified by parks as a 'vital sign' for monitoring, trails are both a significant component of the infrastructure of all parks in the Great Lakes Network and the principal resource of Grand Portage National Monument (GRPO). Terrain, soil properties, and vegetation influence trail stability and erosion potential. Climatic conditions, trail siting, and amount and type of use contribute to overall trail condition, the visitor experience and user satisfaction. Often times trail management in GLKN parks requires interdivisional coordination and communication with outside partners. Some of these parks may have a combination of limiting human, financial and trail resources significant enough that a qualitative trail condition assessment is required to justify and rank trail work among other projects and/or needs. Other parks, like Grand Portage National Monument, may have a singular focus on the trail as a resource and require only a census of trail conditions and needs to address. While this data quality assurance plan is meant to inform trail monitoring in all GLKN parks, it is specific to a census based, quantitative inventory of trail conditions implemented at GRPO.

Monitoring problem areas along the entire trail in census format at GRPO is cost-effective and provides the park with data to effectively manage the trail. The census results in less detailed metrics about overall condition but can capture specific locations of degrading trail conditions and potential causes as well as monitor areas of recent restoration, such as new puncheon or water diversion bars, to assist with alerting management and to focus restoration and maintenance efforts.

A census approach at GRPO can also inform park managers of problem areas before they become severe. This is of particular importance in managing a trail that cannot be diverted or altered, in part due to the narrow park boundary (300 feet either side of trail), but primarily due to the interest in maintaining the historic trail traverse.

This census based approach results in a set of predefined problem impacts (Cole 1983, Leung and Marion 1999a, Marion 2001) closely following the "Trail Problem-Assessment Method" (TPAM)

(Marion 2009). This monitoring program will also document design problems (excessive trail grades), and maintenance features, such as number and relative effectiveness of water bars or check dams. The Grand Portage, being a historic trail, cannot be re-routed to avoid design problems, so management options are somewhat limited. Nonetheless, identifying potential problems such as erosive slopes or depressions can highlight areas of concern that warrant close attention.

Implementation at GRPO includes a trail inventory that uses mapping grade GPS to accurately map the trail and corresponding attributes of trail type, substrate class, any trail or road crossings, bridges, or treadway structures. The result of implementation is a georeferenced data layer that conforms to current NPS Trails Data Standard (FGDC 2011). The data layer, when viewed in an ArcGIS, is a product by which park management can spatially assess trail condition problems and expeditiously scope work to address any needs identified by the inventory.

The overall program goal is to design and implement an inventory and monitoring program that will track changes in the condition of GRPO's trail and associated assets over time, identify conditions that meet the threshold for management action and document the success or failure of management action through time.

Protocol Activities and Modules

Data are collected or derived as a part of the Grand Portage National Monument Trail Monitoring Protocol (Gafvert and Seitz 2018) in nine different activities or modules (Table 1).

Table 1. Protocol Activity Matrix.

Activity Group	Number	Activity	Description	QA/QC Procedure
Prepare for Conduct of Inventory	1	Prepare geodatabase	In ArcGIS upload the latest georeferenced, spatial data layer of trails with park boundary and any other pertinent data such as road crossings.	Establish appropriate map datum. Ensure any projections are consistent with NPS guidelines, NAD83.
	2	Upload from FMSS	Access FMSS and export data table of assets with corresponding x,y coordinates. Exclude any data that predates a previous inventory. Upload data into geodatabase. Geoprocess FMSS data by excluding all assets not geospatially coincident with trails. Save as new data layer in geodatabase.	Ensure inclusion of all FMSS assets by employing a generous buffer around trails.
	3	Confer with park	Export geodatabase as a map package to park and discuss deficiencies of geodatabase such as missing or otherwise unrepresentative trail segments and assets.	Exporting as map package ensures all symbology is in common between park observer and GLKN observer.
	4	Scope Work	In coordination with the park, discuss hours required to access and traverse trail segments. Informally develop a work plan sufficient to coordinate any scheduling and travel plans.	N/A
	5	Ready GPS	Upload shapefiles and data dictionary to GPS.	Ensure shapefiles and GPS have map datum in common, (NAD83).
Conduct Inventory	6	Document and Inspect	While traversing the trail, utilize the data dictionary loaded onto the GPS to document inspection of existing trail conditions and assets. Add any new records to condition assessment feature class ad hoc.	Data dictionary settings provide quality assurance as all data must be collected by observer before closing file.
Upload GPS Data to GIS	7	Process	Differentially correct GPS data, export to shapefile or geodatabase, and upload to ArcGIS.	Repair and improve data through differential correction process by removing any geospatial outliers.
	8	Upload	Upload all data collected in the field from GPS to ArcGIS. Go through QA/QC steps, finalize, and upload authoritative geodatabase and map package to IRMA	Heads-up digitize grossly erroneous geospatial features that were not fixed in the differential correction process.
Cross-reference with FMSS	9	Output Table	Export excel spreadsheet of all assets that are both new and already identified in FMSS to park FMSS data clerk. This enables park to update location data for all known assets, add new assets where appropriate and remove or otherwise update assets no longer present.	N/A

Sampling Design

Information regarding the sampling design is provided in Table 2.

Table 2. Activity-level design matrix. Numbers correspond to those in the Protocol Activity Matrix (Table 1).

Activity Group	Protocol Activity Matrix Number	Activity	Description	Revisit Design
Prepare for Conduct of Inventory	1	Prepare geodatabase	In ArcGIS upload the latest georeferenced, spatial data layer of trails with park boundary and any other pertinent data such as road crossings for import into mapping grade GPS unit	Every 6 years
	2	Download from FMSS	Access FMSS and export data table of assets with corresponding x,y coordinates. Exclude any data that predates a previous inventory. Upload data into geodatabase. Geoprocess FMSS data by excluding all assets not geospatially coincident with trails. Save as new data layer in geodatabase.	Every 6 years
	3	Confer with park	Export geodatabase as a map package to park and discuss deficiencies of geodatabase such as missing or otherwise unrepresentative trail segments and assets.	Every 6 years
	4	Scope Work	In coordination with the park, discuss hours required to access and traverse trail segments. Informally develop a work plan sufficient to coordinate any scheduling and travel plans.	Every 6 years
	5	Ready GPS	Upload shapefiles from trail inventory and condition assessment and data dictionary, along with pertinent FMSS assets to GPS.	Every 6 years
Conduct Inventory	6	Document and Inspect	While traversing the trail, utilize the data dictionaries loaded onto the GPS to document inspection of existing trail conditions and assets. Add any new records to condition assessment feature class ad hoc.	Every 6 years
Upload GPS Data to GIS	7	Process	Differentially correct GPS data and upload to ArcGIS.	Every 6 years
	8	Upload	Upload all data collected in the field from GPS to ArcGIS. Upload authoritative geodatabase to IRMA	Every 6 years
Cross-reference with FMSS	9	Output Table	Export Excel spreadsheet of all assets that are both new and already identified in FMSS to park FMSS data clerk. This enables park to update location data for all known assets, add new assets where appropriate and remove or otherwise update assets no longer present.	Every 6 years

Data Quality Objectives

The following data quality values for implementation are detailed in Table 3. Data quality objectives are detailed in Table 4.

- **Representativeness.** When not conducting a census, the collected population of data must be powerful enough to represent the total population surveyed and make inferences. Of particular importance for panel or GRTS-type designs where missing data can affect analysis and inference.
- **Data Comparability.** The data must be comparable over time in order to avoid committing errors of omission, to identify change and be representative of the total population.
- **Completeness.** A population of data must be collected completely in order to avoid errors of omission in any one data variable, and be representative of the total population.
- **Timeliness.** A population of data must be representative of the total population in both time and space. Timeliness, or temporal integrity, is the ability of the data to be representative in time.
- **Accuracy.** The difference between what is reported and the true value of what is being measured.

Table 3. Data Quality Values (DQVs) developed by the NPS Inventory and Monitoring Division.

Data Quality Value Type	Data Quality Value	Definition	Protocol Considerations
Intrinsic Data Quality	Accuracy	Measurements reflect the true value of the parameter being observed. This applies to measures (length, width, position) or classes (species, types, or categories). Includes components of precision and bias.	Use mapping grade GPS for all measurements of trail centerline and condition deficiencies, to ensure better than 1m positional accuracy. Map datums chosen are most representative of space encompassed by park boundary, typically UTM, NAD83.
	Representativeness	Measurements represent conditions at the time of sampling. Combined with accuracy, leads to repeatable data collection.	Photo-documentation of conditions serves as check on observer.
Contextual Data Quality	Comparability	The degree to which data can be compared among sample locations, data sources, observers, or periods of time.	Data collected conforms to NPS Trails Data Standard (FGDC 2011).
	Timeliness / Currency	How recent the data need to be to be considered valid for their intended use. Data represents conditions and/or is available and in a format for use at the appropriate time in the decision-making process.	6-year return interval for sampling is long enough in duration to capture 5-year management planning cycle. The return interval is also soon enough to be sensitive to degradation that may threaten adjacent resources.
	Completeness	All data/ measures required to evaluate accuracy representativeness are present; incomplete data sets (either at a location, across sampling locations, or over time) lose utility or relevance. Data records contain values as planned across the period of record.	Data dictionary settings demand complete population of each data field before file can be closed.
Representational Data Quality	Consistent Representation	Use of standard definitions when describing data quality or resource quality based on data	Data collected conforms to the "Trail Problem-Assessment Method (TPAM) (Marion 2009).
Data Accessibility	Secure	Access to data, products, and systems limited to appropriate audiences.	Data collected is not sensitive and can be archived according to standard GLKN data practices and disseminated to the public.

Measurement Quality Objectives for activities that involve quantitative measurements taken by field personnel are detailed in Table 4.

Table 4. Data Quality Objectives for protocols implemented by the NPS Inventory & Monitoring Division.

Measure	Quality Indicator	Quality Objective
Inventory of Trail Features	Line features (e.g., trail tread, puncheon, bridge, road crossing and water bars)	Accuracy ≤ 0.5 m
	Puncheon	Record number of planks, width and length.
	Bridges	Record number of planks, width and length.
	Water bars	Record number of bars
Trail Condition Assessment: Natural Features	Erosion	>15 cm (6") for >2 m in length
	Exposed roots	1 m^2
	Exposed rocks	1 m^2
	Multiple treads	Number of treads.
	Excessive trail width	Defined as $>1\text{m}$ width for X distance
	Depression	1m^2
Trail Condition Assessment: Man-made Features	Puncheon	Categorical - partially rotten, completely rotten
	Bridge	Categorical - partially rotten, completely rotten
	Drainage dip	Categorical - Partially effective, ineffective
	Water bar	Categorical - Partially effective, ineffective
	Check dam	Categorical - Partially effective, ineffective
	Debris pile	GPS location, ± 0.5 m
	Social trails	GPS location, ± 0.5 m
	Signage	Record GPS location, to ± 0.5 m, only when in poor condition

Data Standards

The Federal Geographic Data Committee, or FGDC, is a committee that fosters coordinated development, dissemination, sharing and use of geospatial data. In November of 2011, FGDC published Federal Trail Data Standards (FGDC 2011) in order to standardize the collection, storage and management of trail related data.

In 2006 NPS established policy for real property asset management in Director's Order #80 (NPS 2006). The corresponding reference manual (NPS 2003) addresses standards for collection, storage and management of real property assets in a proprietary information management system called FMSS, or Facility Management Software System. FGDC standards are incorporated by reference into Director's Order #80 in order to inform data and metadata content standards. In the case of geospatial data collection, another policy requirement is for all data collected to be in North American Datum, 1983 (NPS 2006).

Table 5. Example activity-level sample design matrix to be included in Quality Assurance Plans for protocols implemented by the NPS Inventory & Monitoring Division. Numbers should match those in the Protocol Activity Matrix Table (Table 1) and may be combined as appropriate.

Activity Group	Protocol Activity Matrix Number	Activity	Description	Reference/Authority
Prepare for Conduct of Inventory	1	Prepare geodatabase	In ArcGIS upload the latest georeferenced, spatial data layer of trails with park boundary and any other pertinent data such as road crossings.	FGDC Trails Data Standard (FGDC 2011)
	2	Upload from FMSS	Access FMSS and export data table of assets with corresponding x,y coordinates. Exclude any data that predates a previous inventory. Upload data into geodatabase. Geoprocess FMSS data by excluding all assets not geospatially coincident with trails. Save as new data layer in geodatabase.	Director's Order #80 and corresponding Reference Manual. Appendix 1 of Trail Monitoring Protocol (Gafvert and Seitz 2018).
	3	Confer with park	Export geodatabase as a map package to park and discuss deficiencies of geodatabase such as missing or otherwise unrepresentative trail segments and assets.	Simple ArcGIS function
	4	Scope Work	In coordination with the park, discuss hours required to access and traverse trail segments. Informally develop a work plan sufficient to coordinate any scheduling and travel plans.	Trails protocol
	5	Ready GPS	Upload shapefiles and data dictionary to GPS.	Using GPS SOP
Conduct Inventory	6	Document and Inspect	While traversing the trail, utilize the data dictionaries loaded onto the GPS to document inspection of existing trail conditions and assets. Add any new records to condition assessment feature class ad hoc.	Field operations SOP
Upload GPS Data to GIS	7	Upload	Upload all data collected in the field from GPS to ArcGIS. Upload authoritative geodatabase to IRMA	Using GPS SOP
	8	Process	Differentially correct GPS data and upload to ArcGIS.	Using GPS SOP
Cross-reference with FMSS	9	Output Table	Export excel spreadsheet of all assets that are both new and already identified in FMSS to park FMSS data clerk. This enables park to update location data for all known assets, add new assets where appropriate and remove or otherwise update assets no longer present.	Director's Order #80 and corresponding Reference Manual. Appendix 1 of Trail Monitoring Protocol (Gafvert and Seitz 2018).

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NPS 398/148449, September 2018

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