



Data Quality Standards for Monitoring Stream Ecosystems in the Central Alaska Network

Natural Resource Report NPS/CAKN/NRR—2017/1525



ON THE COVER

Aquatic Ecologist Trey Simmons measuring channel characteristics at Amy Creek, Wrangell-St. Elias National Park and Preserve.

Photograph by: Tyler Logan, National Park Service

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Natural Resource Report NPS/CAKN/NRR—2017/1525

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Abstract

The purpose of this report is to document the standards used by the Central Alaska Inventory and Monitoring Network (CAKN) for activities related to the collection, processing, storage, analysis, and publication of monitoring data as described in the CAKN Stream Monitoring Protocol (Simmons 2017a). The policies and procedures documented in this quality-assurance plan for activities complement the quality-assurance plans for other monitoring activities conducted by the CAKN. The plan also serves as a guide for all CAKN 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.

Introduction

Protocol Overview

The CAKN Stream Monitoring Protocol Narrative (Simmons 2017a) describes the background, rationale, and sampling design for monitoring stream ecosystems in the three CAKN park units: Denali National Park & Preserve (DENA), Wrangell-St. Elias National Park & Preserve (WRST) and Yukon-Charley Rivers National Preserve (YUCH). The structure of this protocol follows the recommended framework and suggestions of Oakley et al. (2003). In this Protocol Narrative I provide an overview of the Central Alaska Network, as well as descriptions of the fluvial ecosystems of each of the three park units that constitute the network. I discuss the importance of fluvial systems and processes to network ecosystems and threats to the integrity of these systems due to the effects of climate change and other anthropogenic stressors. I provide an in-depth rationale for the selection of Vital Signs for the Stream Monitoring Program, which include hydrologic regime, composition and distribution of aquatic communities, and water quality. A set of 6 measurable objectives has been selected to address these Vital Signs:

- 1) Determine long-term trends for measures of water chemistry at sentinel sites and at larger spatial scales (ecoregion, park, network).
- 2) Determine long-term trends in measures of water temperature regime at sentinel sites.
- 3) Determine trends in annual and seasonal flow patterns for the Nabesna River.
- 4) Use RIVPACS biological assessment models to determine current ecological condition and water quality in selected streams and rivers.
- 5) Use RIVPACS biological assessment models to determine trends in ecological condition at sentinel sites and at larger spatial scales (ecoregion, park, network).
- 6) Document the range of chemical, physical, and biological attributes of streams and rivers in the network.

I then provide an overview of all aspects of the stream monitoring program, including survey design, training and field season preparation, field methods, laboratory methods, operational requirements, data management, and data analysis. The methods described in this protocol are designed to be compatible with protocols used by other water resource monitoring programs in Alaska, including the Alaska Department of Environmental Conservation, the U.S. Geological Survey, the U.S. Fish

and Wildlife Service, and the Bureau of Land Management. Specifically, the survey design, field methods, laboratory methods, and quality assurance/quality control standards described therein are identical to or similar to those spelled out for the Environmental Protection Agency's National Rivers and Streams Assessment program. A set of 18 Standard Operating Procedures, published as a separate document (Simmons 2017b), provides detailed instructions for implementing all aspects of the CAKN Stream Monitoring Program.

Protocol Activities and Modules

Data are collected or derived as a part of CAKN stream monitoring protocol – *Monitoring stream ecosystems in the Central Alaska Network: Protocol narrative* (Simmons 2017a) and *Monitoring stream ecosystems in the Central Alaska Network: Standard operating procedures version 1.0* (Simmons 2017b) in 17 different activities in 6 different modules (Table 1).

1. Site Recon, Establishment and Maintenance. Data associated with sampling locations (descriptions, locational data, navigation, surveying data). Sites could be sentinel sites, synoptic sites or judgment sites.
2. Field Data Collection. Measurements taken and recorded by IMD or cooperator staff. These should often be broken into activities based on implementation timing and/or scale of measurement (data collected in transects are a different activity than plot data).
3. Sensor data (instantaneous measurements). Includes any point-in-time data collected by sensors, including instantaneous data collected using a multiparameter sonde.
4. Sensor data (continuous measurements). Includes any continuous data collected by a temperature logger, information associated with logger deployment and retrieval, or post-processing.
5. Field Sample Data. Information related to samples collected during field sampling that will be processed and analyzed by NPS staff or contract laboratories. May include water chemistry samples, benthic or riparian macroinvertebrate samples, specimens, or vouchers, benthic diatom samples, or associated laboratory data.
6. QA/QC data. Data collected and managed as a part of the protocol when it is to be used as a part of a QC process. Includes activities such as equipment maintenance and lifecycle information, pre- and post-calibration data in cases where data are to be used to correct or flag data, proficiency testing data when comparing data collected before and after field seasons, or double-observation data when being used to evaluate whether inter-observer variability is within acceptable tolerance.

Table 1. Protocol activity matrix for stream monitoring in the Central Alaska Inventory & Monitoring Network (Simmons 2017a, 2017b).

Category	Activity Number	Activity	Description
Site Recon, Establishment, and Maintenance	1	Site recon and establishment	Locate or establish Site Marker and define appropriate sampling reach in accordance with SOP 8 (Simmons 2017b).
	2	Temperature datalogger maintenance	Visit datalogger deployment sites at least once per year to check logger condition. Download data and replace dataloggers once every 2 years.
	3	Equipment maintenance	Service and calibrate sondes and sensors in lab before field season in accordance with SOP 7 (Simmons 2017b). Sensors replaced when calibration checks do not meet criteria according to YSI (2012).
Field Observations	4	Site Notes	Site Notes are recorded in the Trimble data dictionary in accordance with SOP 6 and SOP 8 (Simmons 2017b). Site notes include qualitative information about current conditions (stage, water clarity, riparian forest health, etc.) and descriptive information about the sampling reach (channel configuration, slope, basin description, etc.).
	5	Habitat surveys	Channel observations are recorded in the Trimble data dictionary in accordance with SOP 6 and SOP 8 (Simmons 2017b). Channel observations include channel geometry (width/depth, thalweg profile), substrate size measurements, and canopy cover measurements.
	6	Site photos	Site photos used to document sampling reach in accordance with SOP 8 (Simmons 2017b).
	7	Spherical panorama	Photos for spherical panorama taken in accordance with SOP 9 (Simmons 2017b). GPS coordinates of panorama must be recorded with no less than 10m accuracy.
Sensor Data (instantaneous measurements)	8	pH	Instantaneous measurement made in thalweg at reach bottom in accordance with SOP 8 (Simmons 2017b). Sensor calibrated in laboratory or field prior to each field visit in accordance with SOP 7 (Simmons 2017b).
	9	Temperature	Instantaneous measurement made in thalweg at reach bottom in accordance with SOP 8 (Simmons 2017b). Sensor calibrated in laboratory or field prior to each field visit in accordance with SOP 7 (Simmons 2017b).
	10	Dissolved Oxygen (DO)	Instantaneous measurement made in thalweg at reach bottom in accordance with SOP 8 (Simmons 2017b). Sensor calibrated in laboratory or field prior to each field visit in accordance with SOP 7 (Simmons 2017b).

Table 1 (continued). Protocol activity matrix for stream monitoring in the Central Alaska Inventory & Monitoring Network (Simmons 2017a, 2017b).

Category	Activity Number	Activity	Description
Sensor Data (instantaneous measurements) (continued)	11	Conductivity	Instantaneous measurement made in thalweg at reach bottom in accordance with SOP 8 (Simmons 2017b). Sensor calibrated in laboratory or field prior to each field visit in accordance with SOP 7 (Simmons 2017b).
Sensor Data (continuous measurements)	12	Temperature	Dataloggers deployed and continuous measurements recorded once per hour in accordance with SOP 3 (Simmons 2017b). Data downloaded and loggers replaced every 2 years.
Field Sample Data	13	Water chemistry	Water samples collected, filtered and preserved (frozen or refrigerated) in accordance with SOP 8 (Simmons 2017b)
	14	Macroinvertebrates	Macroinvertebrate samples collected, decanted and preserved in 80% ethanol in accordance with SOP 8 (Simmons 2017b).
	15	Diatoms	Diatom samples collected, subsampled and preserved in Lugol's solution in accordance with SOP 8 (Simmons 2017b).
QA/QC Data	16	Multiparameter Sonde Calibration	Conductance, pH, and dissolved oxygen sensors calibrated prior to each field visit.
	17	Temperature datalogger	Datalogger checked at 0 °C and 20 °C prior to and following deployment.

Sampling Design

Information regarding the sampling design is provided in Table 2. Sentinel sites are chosen according to accessibility, are sampled annually, and are designed to maximize the ability to detect trends by reducing the effects of site-to-site variability. Synoptic sites are chosen using a probabilistic selection method to maximize inference to unsampled locations. Judgment sites are included to increase the representation of ecological gradients in the data, and thereby facilitate the development of robust models.

Table 2. Activity-level sample design matrix for all observations of stream ecosystem monitoring activities in the Central Alaska Inventory & Monitoring Network (Simmons 2017a, 2017b). GRTS algorithm is described in Kincaid & Olsen (2011).

Activity Number	Activity	Sampling Design	Revisit Design
1	Sentinel sites	Targeted; Chosen for accessibility along the DENA Park Road, the WRST Nabesna Road, the WRST McCarthy Road. 14 sites	Revisit annually.
2	Synoptic sites	Probabilistic. Chosen using the Generalized Random Tesselation Stratified (GRTS) algorithm to generate a spatially balanced, probabilistic sample. 110 sites (60 in WRST, 30 in DENA, 20 in YUCH).	Revisit once every 10 years.
3	Judgment sites	Targeted; Chosen for ecological attributes. Undefined number of sites.	None.

Data Quality Objectives

Data quality values and standards for implementation are provided in Table 3 through Table 9.

Table 3. Data Quality Values (DQVs) for stream ecosystem monitoring in the Central Alaska Inventory & Monitoring Network (Simmons 2017a, 2017b).

Category	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.	Multiparameter sondes are evaluated by YSI, Inc. prior to each field season. Sondes are calibrated prior to each field visit in accordance with SOP 7 (Simmons 2017b). Temperature loggers are tested at 0 °C and 20 °C prior to and following deployment in accordance with SOP 3 (Simmons 2017b) and Mauger et al. (2014). Water chemistry analyses performed by a qualified lab specializing in oligotrophic samples in accordance with SOP 12 (Simmons 2017b). Macroinvertebrate taxonomy analysis performed by a SFS-certified invertebrate taxonomist in accordance with SOP 14 (Simmons 2017b). Diatom taxonomy performed by a qualified taxonomist in accordance with SOP 13 (Simmons 2017b).
	Representativeness	Measurements represent conditions at the time of sampling. Combined with accuracy, leads to repeatable data collection.	Parameters and methods are chosen such that they measure representative conditions. Sampling reaches are selected to be representative of the larger stream section in which they occur, based on best professional judgment. Datalogger deployment sites are focused on well-mixed areas. Field sampling is focused on an index period at all sites, and sampling does not occur during high flow events.
Contextual Data Quality	Comparability	At all stations, data are collected using compatible field monitoring equipment. All stations are operated and maintained on a consistent schedule using standardized procedures.	Instrumentation, standard operating procedures, calibration procedures, and routine maintenance schedule is identical for all stream monitoring stations, including sentinel, synoptic and judgment sites, as well as sites for datalogger deployment. Data management and editing is conducted in accordance with standard operating procedures (SOPS 15 and 17) that are consistent between stations.

Table 3 (continued). Data Quality Values (DQVs) for stream ecosystem monitoring in the Central Alaska Inventory & Monitoring Network (Simmons 2017a, 2017b).

Category	Data Quality Value	Definition	Protocol Considerations
Contextual Data Quality (continued)	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.	Methods, sampling plans, and analyses are designed and implemented such that they result in a complete dataset across space and the planned period of record.
Representational Data Quality	Consistent Representation	Use of standard definitions when describing data quality or resource quality based on data	Standard definitions of data quality are provided. Provisional data indicate data that have been reviewed but not certified. Certified data are defined as those data that have been reviewed, QA/QC checked, and edited.
Data Accessibility	Secure	Access to data, products, and systems limited to appropriate audiences.	No protected data will be generated as part of the CAKN Stream Monitoring Protocol.

Table 4. Measurement Quality Objectives for stream monitoring in the Central Alaska Network (Simmons 2017a, 2017b). Activities (shaded cells) match those in the Protocol Activity Matrix Table (Table 1). Quality objectives for instantaneous sensor measurements are from YSI (2008). Quality objectives for continuous temperature measurements are from Onset (2016) and Mauger *et al.* (2014). Quality objectives for field habitat measurements are from Roper *et al.* (2002) and Kaufmann *et al.* (1999). Quality objectives for discharge are from Turnipseed & Sauer (2010). Quality objectives for water chemistry laboratory measurements are from the CCAL Water Analysis Laboratory QA Plan (CCAL 2013). Quality objectives for macroinvertebrate taxonomy are from Simmons (2017b). Quality objectives for diatom taxonomy are from Simmons (2017b).

Category	Measure / Quality Indicator	Quality Objective
Site Establishment	Location Accuracy	Sufficient GPS data (WGS84) will be recorded to attain an accuracy of +/-10 m during initial establishment of a Site Marker. Relationship of the designated sampling reach to the Site Marker coordinates will be carefully noted.
	Location Description Detail	GPS coordinates (WGS84 datum), maps, narrative directions, and site access descriptions are included in field folders for each sampling location.
pH (instantaneous field measurements)	Units	standard pH units
	Accuracy	+/- 0.2 units
	Resolution	0.01 units
	Range	0 to 14 units
	Reporting	Report to one decimal place
Temperature (instantaneous field measurements)	Units	degrees Celsius (°C)
	Accuracy	+/- 0.15°C
	Resolution	0.01°C
	Range	- 5 to 50 °C
	Reporting	Report to one decimal place
Dissolved Oxygen (instantaneous field measurements)	Units	milligrams per liter (mg/l)
	Accuracy	+/- 0.2 mg/L
	Resolution	0.1 mg/L
	Range	0 to 50 mg/l
	Reporting	Report to one decimal place
Specific Conductance (instantaneous field measurements)	Units	microSiemens per centimeter [µS/cm])
	Accuracy	0.5% within calibrated range
	Resolution	1 µS/cm
	Range	0 to 100,000 µS/cm
	Reporting	Report to whole number
Temperature (continuous field measurements)	Units	Degrees Celsius (°C)
	Accuracy	+/- 0.21 °C
	Resolution	0.02 °C
	Range	0 to 50 °C
	Reporting	Report to one decimal place

Table 4 (continued). Measurement Quality Objectives for stream monitoring in the Central Alaska Network (Simmons 2017a, 2017b). Activities (shaded cells) match those in the Protocol Activity Matrix Table (Table 1). Quality objectives for instantaneous sensor measurements are from YSI (2008). Quality objectives for continuous temperature measurements are from Onset (2016) and Mauger *et al.* (2014). Quality objectives for field habitat measurements are from Roper *et al.* (2002) and Kaufmann *et al.* (1999). Quality objectives for discharge are from Turnipseed & Sauer (2010). Quality objectives for water chemistry laboratory measurements are from the CCAL Water Analysis Laboratory QA Plan (CCAL 2013). Quality objectives for macroinvertebrate taxonomy are from Simmons (2017b). Quality objectives for diatom taxonomy are from Simmons (2017b).

Category	Measure / Quality Indicator	Quality Objective
Temperature (continuous field measurements) (continued)	Maximum allowable discrepancy from NIST-certified thermometer	± 0.25 °C
Depth (field habitat measurements)	Units	cm
	Precision	+/- 6.2 cm
	Reporting	Report to whole numbers
Wetted width (field habitat measurements)	Units	m
	Precision	+/- 0.89 m
	Reporting	Report to whole numbers
Substrate D50 (field habitat measurements)	Units	mm
	Precision	+/- 16.8 mm
	Reporting	Report to whole numbers
Discharge (field habitat measurements)	Units	Cubic feet per second
	Precision	+/- 5%
	Reporting	Report to whole numbers
Canopy Cover (field habitat measurements)	Units	%
	Precision	+/- 5.8%
	Reporting	Report to whole numbers
Nitrate+nitrite nitrogen (laboratory measurements)	Units	mg/L
	Method detection limit	0.001 mg/L
	Method quantification limit	0.003 mg/L
	Precision	+/- 0.001 mg/L
	Reporting	Report to three decimal places
Total nitrogen (laboratory measurements)	Units	mg/L
	Method detection limit	0.01 mg/L
	Method quantification limit	0.03 mg/L
	Precision	+/- 0.01 mg/L
	Reporting	Report to two decimal places
Total phosphorous (laboratory measurements)	Units	mg/L
	Method detection limit	0.002 mg/L
	Method quantification limit	0.006 mg/L
	Precision	+/- 0.002 mg/L
	Reporting	Report to three decimal places

Table 4 (continued). Measurement Quality Objectives for stream monitoring in the Central Alaska Network (Simmons 2017a, 2017b). Activities (shaded cells) match those in the Protocol Activity Matrix Table (Table 1). Quality objectives for instantaneous sensor measurements are from YSI (2008). Quality objectives for continuous temperature measurements are from Onset (2016) and Mauger *et al.* (2014). Quality objectives for field habitat measurements are from Roper *et al.* (2002) and Kaufmann *et al.* (1999). Quality objectives for discharge are from Turnipseed & Sauer (2010). Quality objectives for water chemistry laboratory measurements are from the CCAL Water Analysis Laboratory QA Plan (CCAL 2013). Quality objectives for macroinvertebrate taxonomy are from Simmons (2017b). Quality objectives for diatom taxonomy are from Simmons (2017b).

Category	Measure / Quality Indicator	Quality Objective
Orthophosphorous (laboratory measurements)	Units	mg/L
	Method detection limit	0.001 mg/L
	Method quantification limit	0.003 mg/L
	Precision	+/- 0.001 mg/L
	Reporting	Report to three decimal places
Ammonia nitrogen (laboratory measurements)	Units	mg/L
	Method detection limit	0.01 mg/L (CCAL able to achieve stated precision at MDL of 0.005 mg/L)
	Method quantification limit	0.032 mg/L
	Precision	+/- 0.003 mg/L
	Reporting	Report to two decimal places
	Units	mg/L CaCO ₃
	Method detection limit	0.2 mg/L
Alkalinity (laboratory measurements)	Method quantification limit	0.6 mg/L
	Precision	+/- 0.2 mg/L
	Reporting	Report to whole numbers
Calcium (laboratory measurements)	Units	mg/L
	Method detection limit	0.06 mg/L
	Method quantification limit	0.19 mg/L
	Precision	+/- 0.06 mg/L
	Reporting	Report to one decimal place
Organic carbon (laboratory measurements)	Units	mg/L
	Method detection limit	0.05 mg/L
	Method quantification limit	0.16 mg/L
	Precision	+/- 0.05 mg/L
	Reporting	Report to one decimal place
Chloride (laboratory measurements)	Units	mg/L
	Method detection limit	0.01 mg/L
	Method quantification limit	0.03 mg/L
	Precision	+/- 0.01 mg/L
	Reporting	Report to two decimal places

Table 4 (continued). Measurement Quality Objectives for stream monitoring in the Central Alaska Network (Simmons 2017a, 2017b). Activities (shaded cells) match those in the Protocol Activity Matrix Table (Table 1). Quality objectives for instantaneous sensor measurements are from YSI (2008). Quality objectives for continuous temperature measurements are from Onset (2016) and Mauger *et al.* (2014). Quality objectives for field habitat measurements are from Roper *et al.* (2002) and Kaufmann *et al.* (1999). Quality objectives for discharge are from Turnipseed & Sauer (2010). Quality objectives for water chemistry laboratory measurements are from the CCAL Water Analysis Laboratory QA Plan (CCAL 2013). Quality objectives for macroinvertebrate taxonomy are from Simmons (2017b). Quality objectives for diatom taxonomy are from Simmons (2017b).

Category	Measure / Quality Indicator	Quality Objective
Magnesium (laboratory measurements)	Units	mg/L
	Method detection limit	0.02 mg/L
	Method quantification limit	0.06 mg/L
	Precision	+/- 0.02 mg/L
	Reporting	Report to two decimal places
pH (laboratory measurements)	Units	pH units
	Method detection limit	0.1 pH units
	Method quantification limit	0.3 pH units
	Precision	+/- 0.1 pH units
	Reporting	Report to one decimal place
Potassium (laboratory measurements)	Units	mg/L
	Method detection limit	0.03 mg/L
	Method quantification limit	0.1 mg/L
	Precision	+/- 0.03 mg/L
	Reporting	Report to one decimal place
Silicon (laboratory measurements)	Units	mg/L
	Method detection limit	0.20 mg/L
	Method quantification limit	0.6 mg/L
	Precision	+/- 0.01 mg/L
	Reporting	Report to one decimal place
Sodium (laboratory measurements)	Units	mg/L
	Method detection limit	0.01 mg/L
	Method quantification limit	0.03 mg/L
	Precision	+/- 0.01 mg/L
	Reporting	Report to one decimal place
Specific conductance (laboratory measurements)	Units	µS/cm
	Method detection limit	0.4 µS/cm
	Method quantification limit	1.3 µS/cm
	Precision	+/- 2% µS/cm
	Reporting	Report to whole numbers
Sulfate (laboratory measurements)	Units	mg/L
	Method detection limit	0.01 mg/L
	Method quantification limit	0.03 mg/L

Table 4 (continued). Measurement Quality Objectives for stream monitoring in the Central Alaska Network (Simmons 2017a, 2017b). Activities (shaded cells) match those in the Protocol Activity Matrix Table (Table 1). Quality objectives for instantaneous sensor measurements are from YSI (2008). Quality objectives for continuous temperature measurements are from Onset (2016) and Mauger *et al.* (2014). Quality objectives for field habitat measurements are from Roper *et al.* (2002) and Kaufmann *et al.* (1999). Quality objectives for discharge are from Turnipseed & Sauer (2010). Quality objectives for water chemistry laboratory measurements are from the CCAL Water Analysis Laboratory QA Plan (CCAL 2013). Quality objectives for macroinvertebrate taxonomy are from Simmons (2017b). Quality objectives for diatom taxonomy are from Simmons (2017b).

Category	Measure / Quality Indicator	Quality Objective
Sulfate (laboratory measurements) (continued)	Precision	+/- 0.01 mg/L
	Reporting	Report to one decimal place
Macroinvertebrate sorting (laboratory measurements)	Units	Number of organisms
	Sorted sample size	500 organisms
	Sample size precision	+/- 25 organisms
	Removal accuracy	95% of organisms removed from sample
Macroinvertebrate taxonomy (laboratory measurements)	Units	Taxon (family, genus, species)
	Accuracy (internal)	95% taxonomic similarity between project and internal QC taxonomists
	Accuracy (internal)	95% agreement on enumeration
	Accuracy (external)	95% taxonomic similarity between project and external QC taxonomists
	External accuracy check interval	Once every 5 years
	Reporting	Lowest practicable taxonomic level
Diatom taxonomy (laboratory measurements)	Units	Taxon (genus, species, variety)
	Accuracy (external)	95% taxonomic similarity between project and external QC taxonomists
	External accuracy check interval	Every year
	Reporting	Lowest practicable taxonomic level

Table 5. Data Protection standards for stream monitoring in the Central Alaska Inventory & Monitoring Network (Simmons 2017a, 2017b). With the exceptions noted, all data collected are to be made publicly available in a timely fashion.

Category	Type of Data	Level of Protection	Rules for Dissemination
Continuous Water Quality Data and Information	Water Quality Data	Unprotected	Data available on-line as public information.
	Habitat Data	Unprotected	Data available on-line as public information.
	Biological Data	Unprotected	Data available on-line as public information.
Location Data and Information	Permanent Sampling Locations	Operationally protected	Provided upon request only. Shown in reports
Personally Identifiable Information	Non-NPS Staff Information	Legally Protected	All but first name and last initial redacted from public release

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