

# **Standard Operating Procedure: Stream Field Measurements, Version 1.0**

## *Arctic Inventory and Monitoring Network Stream Communities and Ecosystems Monitoring Protocol*

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The main Narrative for the Protocol for monitoring Stream Communities and Ecosystems for the National Park Service's (NPS) Arctic Inventory and Monitoring Network (ARCN) is available from the NPS ARCN website (<http://science.nature.nps.gov/im/units/arcn>).

# SOP: Field Measurements, Version 1.0

Version 1.0 (September 2018)

| Version No. | Revision Date | Author | Changes Made | Reason for Change |
|-------------|---------------|--------|--------------|-------------------|
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## Introduction

This Standard Operating Procedure (SOP) describes the methods for conducting field measurements of water quality, benthic algae, and habitat characterization for streams and rivers. This SOP is a component of the Stream Communities and Ecosystems Monitoring Protocol (O'Donnell and Miller 2018). Tasks associated with this SOP include (1) *in situ* measurements of water quality parameters, (2) qualitative discharge measurements, (3) measuring benthic algae abundance and composition, and (4) characterizing habitat in headwater streams and higher-order rivers.

## Field Measurements of Water Quality Parameters

1. Field measurements of the four main water quality parameters (temperature, pH, specific conductivity, and DO) are generally conducted using a multi-parameter sonde (e.g., YSI Professional Plus; see appendix).
2. For all streams and rivers, measurements should be co-located with the location of water sample collection (see SOP: *Chemical Characterization of Stream and Lake Water*).
3. For wadable streams, staff should measure water quality parameters in three locations along a cross-section of the stream channel. The three sections should represent locations where most the water is flowing within a reach.
4. For non-wadable streams or rivers, measurements should be conducted from the bank at a well-mixed location that is representative of most of the river flow (i.e. do not sample side channels, sloughs, or eddies). While the USGS recommends conducting such measurements from a bridge, cableway, or boat, these approaches are generally not an option in streams and rivers draining ARCN parklands.
5. When preparing to take a measurement, turn on the instrument and insert multi-parameter sonde in to stream water.
6. Wait for a couple minutes to allow all sensor readings to stabilize.
7. For temperature, read the temperatures to the nearest 0.2°C.
8. For pH, read the values to the nearest 0.01 pH unit.
9. For wadeable streams, record the three replicate readings for each water quality parameter, and then calculate the mean and median for each parameter. For non-wadeable streams, report the value for each parameter once readings have stabilized.

## Qualitative Discharge Assessment

1. Qualitative assessments of flow will be conducted at all study sites where discharge is not being monitored, following recommendations by the NPS Water Resources Division (WRD) (<http://www.nature.nps.gov/water/vitalsigns/assets/docs/wqPartC.pdf>).
2. WRD recommends classifying flow during site visits into one of four categories:
  - A. *low/base flow* - when < 25% of bank-full condition,
  - B. *intermediate* - from 25 to 75% of bank-full,
  - C. *high* - when >75% bank-full
  - D. *over bank/flood*
3. Fitzpatrick et al. (1998) provide suggestions for how to identify bank-full stage in the field using a range of indicators:
  - A. *Point bars* – Point bars accumulate on the inside of meander bends, and are typically a different texture than the sediment in the bank. The top of the point bar can serve as an indicator of minimum bank-full stage (see Figure 1)
  - B. *Vegetation patterns* – Patterns in riparian vegetation pattern can also be useful for determining bank-full stage. Look for (1) sudden changes in vegetation density, (2) distinct transitions from herbaceous vegetation to shrubs, or (3) lower limits of moss or lichen.
  - C. *Undercut banks* – The top of the undercut bank is usually slightly below bank-full stage.

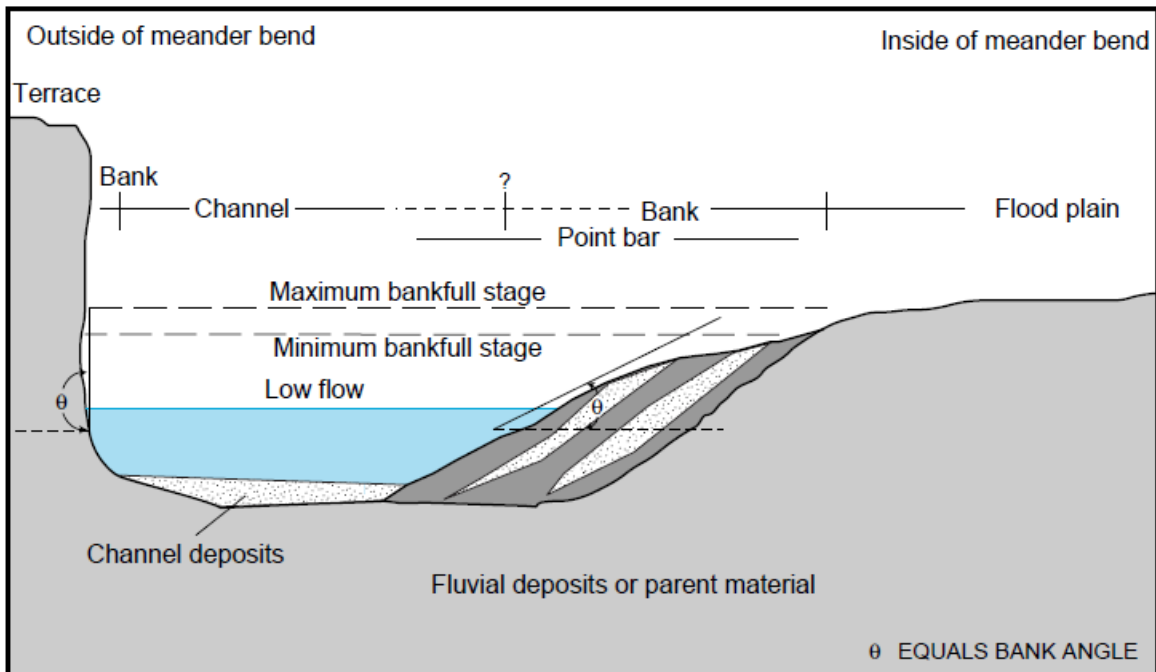
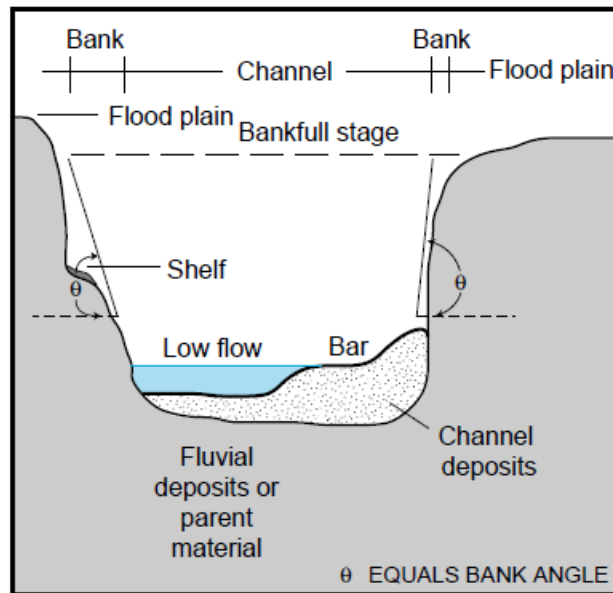
**A****B**

Figure 1. Stream cross-section example to aid with identification of bankfull stage (from Fitzpatrick et al. 1998).

## Measuring Benthic Algae Biomass and Composition

To characterize benthic algae abundance and composition, we will use the BenthosTorch (bbe Moldaenke GmbH, Germany; <http://www.bbe-moldaenke.de/en/>). The BenthosTorch is a fully

automated system that can be used in the field to directly measure algal biomass and community composition (green algae, blue-green algae, and diatoms). It functions as a fluorometer, emitting light at different wavelengths and recording excitation of algae at other wavelengths. Methods here have been adapted from Kahlert and McKie (2014).

1. Benthic algae measurements will only be made in wadeable streams. Three replicate measurements will be collected in a pool and in a riffle or run.
2. Power on the BenthoTorch.
3. Randomly select three rocks in each reach section to conduct BenthoTorch measurements. Take care not to avoid physical disturbance of the biofilm.
4. Conduct BenthoTorch measurement following instrument instruction manual.
5. Record site type (pool, riffle run), replicate number (1, 2, 3) on the field sheet and mark that the measurement was completed.
6. The BenthoTorch will internally log the biomass of each algal type along with the GPS coordinates of the measurement.
7. Upon returning from the field, transfer the data from the BenthoTorch to your computer.

## Habitat Characterization

### Valley Segment, Reach, and Channel Unit Survey

1. Start the survey near the mouth of the stream, and walk upstream from the starting point.
2. First, characterize the type of valley segment (following Bisson & Montgomery 1996):
  - A. *Colluvium* – sediment eroded and deposited from adjacent hillslopes
    - *Unchanneled colluvial valley* – no recognizable stream channel, but possess soils derived from erosional processes from adjacent hillslopes
    - *Channeled colluvial valley* – low-order stream, typically downslope from unchanneled colluvial valley. Flow is often shallow and ephemeral or intermittent.
  - B. *Alluvium* – sediment transported along the valley floor by stream or river flow. Alluvial valleys can be either
    - *confined* (narrow valley bottom) or
    - *unconfined* (wide valley bottom with floodplain).
  - C. *Bedrock* – little to no soil

3. If the valley segment is alluvial, next characterize the type of channel reach:
  - A. *Cascade reach* – characterized by steep gradient (8-30°), pools and waterfalls, and boulder stream beds.
  - B. *Step-pool reach* – characterized by moderately steep gradient (4-8°), alternating step (obstructions) and pool geomorphology, and cobble/boulder stream beds.
  - C. *Plane-bed reach* – characterized by relatively straight channels of uniform depth, moderate gradient (1-4°), and gravelly substrate.
  - D. *Pool-riffle reach* – common in small to mid-sized streams with low to moderate gradients. They are characterized by an undulating stream bed that forms riffles and pools associated with gravel bars. The channel shape is often sinuous.
  - E. *Regime reach* – characterized by low gradient, meandering channels, sand substrate, and most often in higher-order rivers.
  - F. *Braided reach* – typically occur in higher-order streams and rivers, and are characterized by gravel and sand bars scattered throughout the channel.
4. Next describe the channel units at, upstream, and downstream of the sampling location.
  - A. Start at the downstream end of the reach and work your way upstream. Channel unit classification along a reach of stream equal to 20 times the wetted channel width (Fitzpatrick et al. 1998).
  - B. Begin by classifying channel into either fast water (i.e. riffle) or slow water (i.e. pool).

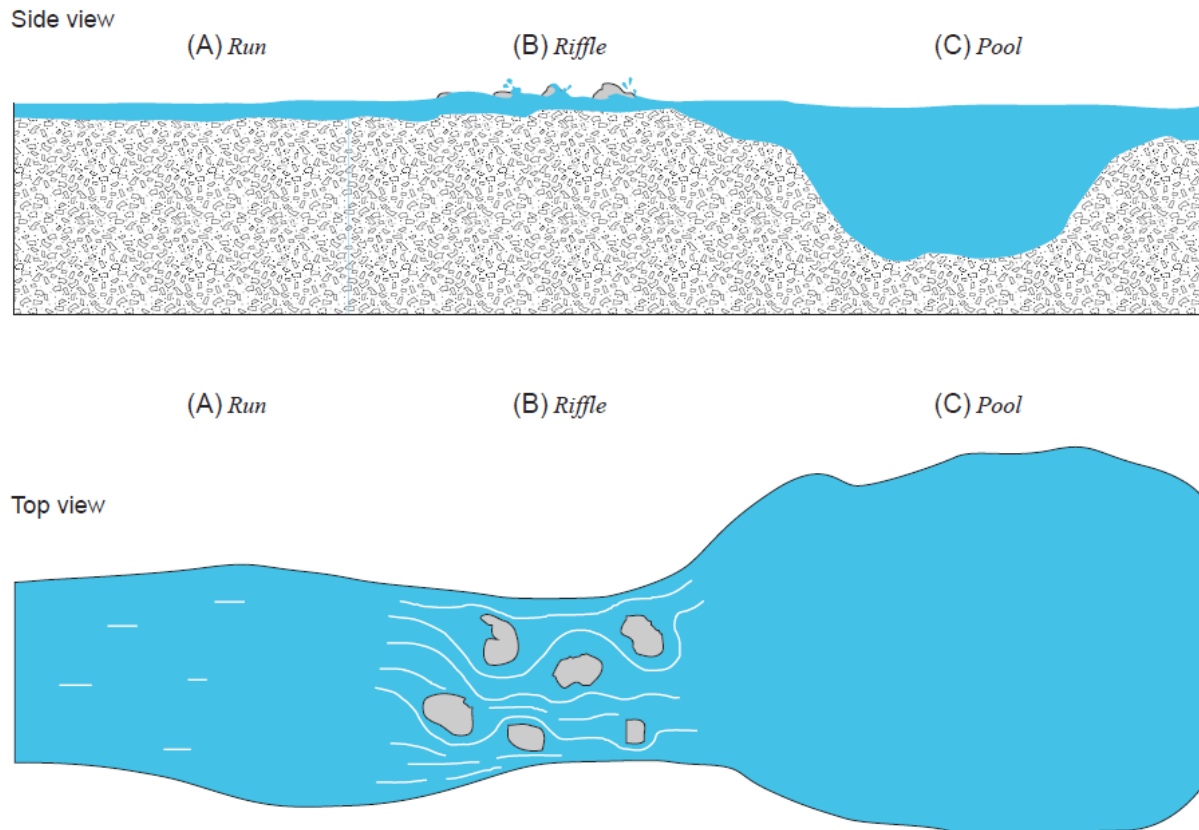


Figure 2. Diagram of three common channel units along ARCN stream reaches. Adapted from Fitzpatrick et al. (1998).

- C. Next, for fast water determine whether the fast water is turbulent (i.e. riffle) or non-turbulent (i.e. run).
- D. For turbulent water, characterize channel unit into one of five types (Hawkins et al. 1993:
  - *Falls* – vertical drops of water
  - *Cascade* – short falls and small scour basins
  - *Chute* – narrow, steep slots in bedrock
  - *Rapids* – moderately steep channel units with planar longitudinal profiles
  - *Riffles* – lower gradient turbulent channel unit
- E. If the fast water is non-turbulent, classify reach as a *Run*.
- F. For pools, note whether the pool is a *scour* pool or a *dammed* pool. If it is a dammed pool, describe the source of the impoundment (e.g. beaver dam, or logjam).

G. Record GPS coordinates of each channel unit along reach.

### Microhabitat Classification

Microhabitat classification has been adapted from the methods of Frissell et al. (1986).

1. The dominant underlying substrate should be described at all sampling locations. Substrate should be classified as one of the following
  - *Bedrock*
  - *Boulders*
  - *Cobbles*
  - *Wood*
  - *Gravel*
  - *Fine gravel, sand*
  - *Silt-clay*

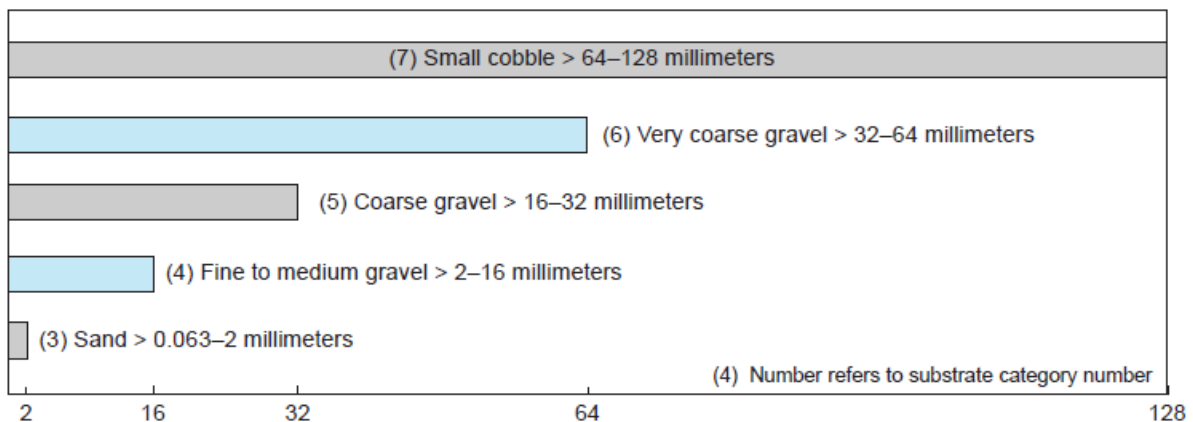


Figure 3. Field scale for identifying particle-size classes (Fitzpatrick et al. 1998).

2. The dominant overlying substrate should be categorized into one or more of the following:
  - *Cobbles*
  - *Wood*
  - *Large gravels*
  - *Fine gravel, sand*

- *Moss*
  - *Silt-clay*
  - *Fine particulate organic matter*
  - *Fresh soil peds*
3. Measure the water depth at the sampling location, and record in cm.
  4. Generally describe near-stream vegetation (tundra vs. forest).
  5. Note presence of coarse woody debris, defined as branches greater than 3 cm in diameter.

### **Site Photos**

1. Take photographs at sampling location, including
  - Looking upstream of the sampling location
  - Looking downstream of the sampling location
  - Looking across the stream cross section at the sampling location
  - Looking perpendicular away from the stream channel
2. Document presence and location (using GPS coordinates) of any other interest features, including new depositional zones, active bank erosion, odd coloration of surface water, groundwater seeps, etc.
3. Document presence and location (using GPS coordinates) of salmon carcasses, which would indicate spawning habitat.

## **Documentation and Prevention of Invasive Species Spread**

1. When working in the field, steps should be taken to document the presence of and reduce the spread of invasive species.
2. The Alaska Department of Fish & Game recommends the following guidelines to limit spread of aquatic invasive species (<http://www.adfg.alaska.gov/index.cfm?adfg=invasive.prevention>):
  - Clean all field gear that has been in contact with stream water.
  - Drain all water from coolers, buckets, or other sampling gear before leaving a monitoring site.
  - Dry out all field and sampling gear between trips to the field.

- Decontaminate field gear, either by freezing, washing at high temperatures, or rinsing with 2% bleach solution.
3. If an invasive species is identified in the field, it is critical for NPS to file a report to the Alaska Department of Fish and Game at [www.adfg.alaska.gov/index.cfm?adfg=invasive.report](http://www.adfg.alaska.gov/index.cfm?adfg=invasive.report).

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## Appendix: Field Sheet

### Stream Communities and Ecosystems Arctic Inventory and Monitoring Network

Site Name: \_\_\_\_\_ GPS

Coordinates: \_\_\_\_\_

Date/Time: \_\_\_\_\_ Personnel: \_\_\_\_\_

Park Unit \_\_\_\_\_

#### Field Measurements

|             | 1 | 2 | 3 |
|-------------|---|---|---|
| Temp (°C)   |   |   |   |
| pH          |   |   |   |
| SpC (µS/cm) |   |   |   |
| DO (% sat)  |   |   |   |
| DO (mg/L)   |   |   |   |

#### **BenthosTorch**

| Site Type | Rep ID | Cyanobacteria | Green Algae | Diatoms |
|-----------|--------|---------------|-------------|---------|
| Pool      | 1      |               |             |         |

|                   |          |  |  |  |
|-------------------|----------|--|--|--|
| <b>Riffle/Run</b> | <b>2</b> |  |  |  |
|                   | <b>3</b> |  |  |  |
|                   | <b>4</b> |  |  |  |
|                   | <b>5</b> |  |  |  |
|                   | <b>6</b> |  |  |  |

**Discharge:**

- ☐ **Low/Baseflow (<25% of bank full)**
- ☐ **Intermediate (25-75% of bank full)**
- ☐ **High (>75% of bank full)**
- ☐ **Flood (over bank)**

**Samples Collected**

- ☐ **500-mL Polycarbonate (filtered)**
- ☐ **250-mL Polycarbonate (unfiltered)**
- ☐ **125-mL Amber Glass (filtered)**
- ☐ **60-mL Syringe (unfiltered)**
- ☐ **Sestonic Chlorophyll a**
- ☐ **Other: \_\_\_\_\_**

**Habitat Characterization**

**Valley Segment**

- ☐ **Colluvium**
- ☐ **Alluvium**
- ☐ **Bedrock**

**If alluvial valley segment, describe channel reach as:**

- ☐ **Cascade Reach**
- ☐ **Step-pool Reach**
- ☐ **Plane-bed Reach**
- ☐ **Pool-riffle Reach**
- ☐ **Regime Reach**
- ☐ **Braided Reach**

**Wetted Channel Width: \_\_\_\_\_**

**Channel Unit Survey**

| <b>Waypoint</b> | <b>Channel Unit Type</b> | <b>Turbulent Type</b> | <b>Substrate</b> | <b>Vegetation / Woody Debris</b> |
|-----------------|--------------------------|-----------------------|------------------|----------------------------------|
|                 |                          |                       |                  |                                  |

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