

Standard Operating Procedure #4:

Site Establishment

Version 1.0

In Monitoring Protocol for Wadeable Streams of the Great Lakes Network

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Contents

	Page
Revision History Log.....	2
Acknowledgements.....	2
4.0 Introduction.....	1
4.0.1 Stream Terminology	1
4.1 Selection of Monitoring Reach	2
4.1.1 General Location of Reach	2
4.2 Establish Permanent Monitoring Reach.....	3
4.2.1 Preliminary Field Visits	3
4.2.2 Determine Length of Monitoring Reach.....	3
4.2.3 Permanent Site Marker	3
4.2.4 Determine Transect Spacing.....	3
4.2.5 Determine Multiprobe Measurement Locations	4
4.2.6 Photographic Documentation	4
4.2.7 Install Staff Gage	5
4.2.8 Create Field Binder	5
4.2.9 Enter Station Information into NPSTORET	6
4.3 Quality Assurance/Quality Control.....	6
4.4 Literature Cited	7

Revision History Log

The following table lists all edits and amendments to this document since the original publication date. Information entered in the log must be complete and concise. Users of this standard operating procedure will promptly notify the project manager and/or the Great Lakes Network (GLKN) data manager about recommended and required changes. The project manager must review and incorporate all changes, complete the revision history log, and change the date and version number on the title page and in the header of the document file. For complete instructions, please refer to Revising the Protocol, SOP #16.

Previous Version #	Revision Date	Author (with title and affiliation)	Location in Document and Concise Description of Revision	Reason for Change	New Version #
Add rows as needed for each change or set of changes tied to an updated version number					

Acknowledgements

Portions of this standard operating procedure (SOP) were drawn from a similar SOP on site establishment for water quality monitoring on large rivers by Magdalene et al. (2008). Also thanks to T. Lafrancois for discussions and advice.

4.0 Introduction

Two streams were selected in each of Pictured Rocks National Lakeshore, Sleeping Bear Dunes National Lakeshore, and Isle Royale National Park; and one stream was selected in each of Grand Portage National Monument and Indiana Dunes National Lakeshore for long-term monitoring. Each stream will have one monitoring reach, located in the downstream portion of the stream within park boundaries. The rationale for selecting streams for monitoring is described in the protocol narrative.

This standard operating procedure (SOP) describes the process of identifying and establishing a sampling reach within a given stream. The process begins with map work in the office, includes field work to establish the permanent sampling reach, and concludes with database documentation of the selected reach's location.

4.0.1 Stream Terminology

Throughout the protocol and SOP, we use several terms to orient ourselves in the stream and to describe in-stream habitat types. These terms are defined as follows:

- **Left Bank:** The stream bank to the left of a person standing in the stream while facing upstream.
- **Right Bank:** The stream bank to the right of a person standing in the stream while facing upstream.
- **Riffle:** A riffle is an area of shallow, broken or turbulent swiftly flowing water with relatively large substrate such as large gravel, cobble and/or boulders. Water may appear white in fast flowing or high gradient riffles, but may also be less obvious and discernable only by visual roughness on the aerial photos. Stream width is generally most narrow in riffle areas, but may be the same width as pools or runs.
- **Pool:** Pools are areas of deep, slow moving water, usually with fine substrate such as sand or silt. Pools tend to be depositional areas and may hold large snags or pieces of wood that serve as cover for several organisms. Pools often occur at the outside bend of a channel, but also occur in mid channel areas; they may be wider than the average stream width.
- **Run:** A run is an area of slowly flowing water that may be shallow or deep, but is generally deeper than riffles and not as deep as pools. A run may have a bedrock or gravel substrate, but more often has fine sediments similar to pools, and may have moderately flowing, but not turbulent, water. A run is usually similar in width to a riffle. If a run is immediately upstream of a riffle, an area of increasing flow and channel narrowing can often be seen at the downstream end of the run as it flows into the riffle. Water flowing in this area will often form a downstream facing “V” near the center of the channel that is often visible in aerial photos. A run will have laminar flow and is a good location for measuring flow rates due to the lack of agitated water.

4.1 Selection of Monitoring Reach

Each stream will have one monitoring reach that is 40 times as long as the average wetted width of the stream in that reach. This length of stream tends to encompass three replicates of riffle, run, and pool habitats, which allows a good assessment of habitat types and is comparable to the U.S. Environmental Protection Agency's nationwide assessment protocol (USEPA 2004).

4.1.1 General Location of Reach

Using aerial photos of the selected streams, existing park staff and partner knowledge, and field reconnaissance, determine gross habitat characteristics of downstream portions of the streams within park boundaries. Select locations that appear representative of the physical habitat of the downstream portion of the stream within park boundaries (see habitat descriptions in sidebar). Downstream monitoring reaches serve as integrators of conditions in the stream upstream of the monitoring location. Impacts of stresses that occur throughout the watershed (e.g., land use, point and non-point source contamination, atmospheric deposition, and climate change) can be monitored at an integrator site located in the lower reaches of a stream.

Downstream reaches that begin at the mouth of a selected stream should be avoided, as these locations may be affected by estuarine conditions or lake seiches. Areas where normal stream flow is affected by anything creating a hydraulic control such as a beaver dam, large bridge abutment, road culvert, low-head dam, or similar structure should also be avoided. Natural waterfalls within a monitoring reach are acceptable, but safety of the sampling personnel and overall effect of the falls on downstream habitat should be considered before the reach is selected. The monitoring reach should be located downstream of substantial tributaries in order to integrate the effects of the tributary inputs. Attempt to locate the monitoring reach such that the upstream terminus of the reach is well below any hydraulic influence that a tributary may have in the reach.

Using aerial photographs along with information from park staff, identify locations that appear to have close to a 1:1:1 ratio of riffles, pools and runs. Most stream sections will not have this perfect ratio, but areas that are predominantly one type of habitat should be avoided. In instances where much of the channel within park boundaries consists of only one or two types of habitat this may be unavoidable. For example, in the East Arm of the Little Calumet River much of the habitat is a slow meandering run, where pools or riffles do not occur in lengthy sections. In these situations, a monitoring reach that has at least one of each type of habitat unit should be selected.

4.2 Establish Permanent Monitoring Reach

4.2.1 Preliminary Field Visits

Preliminary field visits are required to formally establish the specific monitoring reaches. Detailed information on each sampling reach must be compiled into site binders and must include all material necessary for safe and efficient field operations.

Once a potential monitoring reach has been selected and its GPS location verified on a map, the reach should be visited to assess whether it is an appropriate monitoring location. Key concerns are accessibility and representativeness.

4.2.2 Determine Length of Monitoring Reach

Each monitoring reach will be 40 times the mean stream width (MSW). To determine mean width, determine the downstream end of the reach. Measure the wetted width of the channel in 10 locations within the expected reach length. Measurements should occur in each of the three different habitat types (run, riffle, and pool) so that variation in width is accounted for (WDNR 2002) and should be made during normal flow conditions (i.e., avoid low and high flow conditions). Record the measurements of stream wetted width, the mean stream width, and calculated monitoring reach length on the site establishment data sheet (Appendix A). You may round up the MSW before calculating the reach length (e.g., if MSW = 3.9 m, round up to 4.0 m and multiply by 40 to get a reach length of 160 m).

4.2.3 Permanent Site Marker

The location of each monitoring reach must be described and mapped, using GPS coordinates, compass directions, narratives, and photographs so that personnel can find the sites in the future even if they have never been to the site before.

If permission is granted by the park, install a permanent marker on one bank at the downstream end of the reach. The permanent marker could be rebar pounded into the ground, a tag on a tree, or something else that GLKN, the park or other landowner agree upon. Record the GPS location of the marker and write a detailed description of how to find the marker. If denied permission for a permanent marker, the combination of narrative descriptions, maps, photographs, and GPS coordinates will be relied upon to relocate the site.

4.2.4 Determine Transect Spacing

Eleven equally spaced transects will be located within the stream reach. Spacing between each transect will be determined by dividing the length of the sampling reach by 10. Determine the distance between transects and record on the site establishment data sheet. During each sampling visit, the field crew will measure from the downstream end of the monitoring reach upstream to the first transect location, and then from the first transect to the second, second to the third and so on. Transects will be numbered from downstream to upstream, T1 to T11, and will be oriented perpendicular to the flow. If the park or landowner allows, each transect may be individually marked with flagging or some similar method to allow the field crew to quickly relocate each transect.

4.2.5 Determine Multiprobe Measurement Locations

Select locations for multiprobe measurements at both the upstream and downstream ends of the stream reach, and document the locations with a GPS. Ensure that the start or end is not the shallowest or deepest area of the entire reach. If conditions change (fallen tree, beaver dam construction, or other habitat disturbance) document and adjust upstream or downstream as necessary, making sure to keep the measurement locations within the reach.

Multiprobe measurements of the core suite of water quality parameters are to be collected at mid-depth within the centroid of flow at both locations. The centroid of flow is the midpoint of streamflow, or the point on the stream's cross-section perpendicular to flow that has equal volumes of flow to the right and to the left sides. Monitoring at the centroid of flow assures that average water quality conditions are being sampled. In small wadeable streams, such as most of those included in this protocol, the centroid can usually be visually estimated, but should be confirmed with additional multiprobe measurements or by making flow measurements.

At every visit, the estimated centroid of flow should be confirmed to be representative of water quality conditions by taking a series of measurements at 5 to 7 points, depending on stream width and flow conditions with a multiprobe across the cross section of the stream at mid-depth, in addition to the measurement within the centroid. The specific conductance measurements at the estimated centroid of flow should not differ from the other points by more than 5 $\mu\text{S}/\text{cm}$ or $\pm 3\%$, whichever is larger.

If this criterion is not met, the visually estimated centroid is not in fact representative of stream conditions, and a flow meter can be used to determine the increment at which discharge in that increment is equal (approximately) on both sides of that point. This is the centroid of flow and the point at which water quality measurements should be obtained.

4.2.6 Photographic Documentation

Digital photographs are useful for documenting site conditions, assisting personnel in relocating sites, and documenting field conditions. Document each reach with photographs of:

- upstream, downstream, left bank, and right bank from the downstream start of the reach, midstream;
- the downstream start of the reach from a landmark on shore (e.g., boat landing, bridge, campsite);
- the permanent site marker (if installed);
- upstream, downstream, left bank, and right bank from the upstream end of the reach, midstream;
- the upstream end of the reach from a landmark on shore.

Label the photographs according to the following convention: park code_stream name and site number_subject matter (or transect number) _YYYYMMDD. For example, a picture of the left bank of the downstream end of the monitoring reach (transect #11) on the Miners River at Pictured Rocks National Lakeshore, site #01, would be “PIRO_Miners01_T11_LB_20120811”.

New photographs should be taken annually or whenever site conditions change substantially.

4.2.7 Install Staff Gage

Each newly established site must be evaluated for the availability of flow data. At some monitoring reaches where automated USGS flow gages are not located nearby, it may be desirable to install a staff gage for the purpose of developing a stage-discharge rating relationship or curve. Refer to Magdalene (2008) for an example of rating curve development in a GLKN park. A rating curve is established for a monitoring station by making a series of independent flow measurements and simultaneous staff gage measurements at different water levels. The rating curve converts stage height to discharge, enabling calculation of discharge volume from a simple stage height measurement. Refer to Rantz (1982) for complete details on the development of rating curves from staff gage readings.

If a USGS stream gage is not located on the selected stream, obtain permission from the park or landowner to install a staff gage. Locate the gage near the monitoring reach according to the steps below.

1. Select a stable location for the staff gage, such as a bridge structure or a sturdy fence post driven into the streambed that will not be damaged by debris carried in high flows.
2. Install the staff gage at an elevation that will measure the full range of stream stage expected for the site. A constricted channel will have a larger range between low and high flows than a wide channel unconstrained by stable banks.
3. Attach the staff gage to its structure with weather-resistant metal hardware so that it will not shift with time.

In some cases, two gages may be desired or even required. One gage may be placed so that it records the majority of flows that occur within the stream bank (within bankfull flow) and a second gage may be placed higher so that it measures flows outside of bank full flows (i.e., once flows are beyond the confined channel and onto the floodplain). In cases where two gages are necessary, a second rating curve must be developed to account for flow conditions higher than bank full.

4.2.8 Create Field Binder

Assemble a binder that includes a description of the sampling reach, maps and directions on how to locate the downstream end of the reach, data collected at the station previously, sampling instructions, and sample handling procedures. See SOP #1, Pre-Season Preparations, for more detailed information on preparing field binders.

4.2.9 Enter Station Information into NPSTORET

Create a new project in NPSTORET following the guidelines for establishing a new station record in GLKN's data management plan (Hart and Gafvert 2005). Station IDs should be assigned to new stations based on park unit, river name, and river mile. Prepare a description of the location and compile other required information (including digital photographs) for entry into NPSTORET.

Data collected at each reach (water quality, flow, macroinvertebrates, periphyton, and habitat), along with associated metadata, must be entered into NPSTORET. Follow details for data entry provided in SOP #11, Data Entry and Management.

4.3 Quality Assurance/Quality Control

Sampling reaches will be established at locations representative of the selected streams at downstream locations. Tributaries, seiche zones, bridge abutments, dams, and other areas where normal stream flow is affected will be avoided. Reaches with a ratio of 1:1:1, riffle-pool-run, will be selected if possible, and areas of predominantly one habitat type will be avoided. Detailed descriptions of each reach will be maintained in a field binder. See SOP #15, Quality Assurance and Quality Control, for more details.

4.4 Literature Cited

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