Protocol for Monitoring Fish Communities in Small Streams in the Heartland Inventory and Monitoring Network

SOP 6: Measuring Stream Discharge, Version 1.1

Revision History Log:

Previous Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #
1.0	7/22/2016	Dodd	Information on velocity meter more general and less specific to a particular model; Moved equipment list from SOP1 to this SOP	A particular model may be discontinued or functions may change	1.1

This SOP is guidance for measuring discharge in wadeable streams. The methods described in this SOP are specific to this protocol and do not conform to USGS methods for measurement and computation of streamflow. The SOP briefly describes conceptual information about how current meters work and describes sampling procedures, calibration processes, general maintenance procedures, and equipment needed for these procedures. This guidance is applicable to any meter commonly used to measure current velocity. Field personnel should review the instruction manual for instrument specific guidance on how to calibrate and operate specific meters.

Background Information

Stream discharge (Q) is the volume of water passing a cross-section per unit of time and is generally expressed in cubic feet per second (ft^3/s) or cubic meters per second (m^3/s). Discharge is the velocity multiplied by the cross-sectional area. Cross-sectional area is determined by first measuring the width of the stream channel. The cross section is then divided into smaller increments (usually 15 to 20 intervals) and depth and velocity are measured at each increment. The depth and width of the interval are multiplied to get an area for each interval and then each interval area and velocity is multiplied to produce a discharge for each interval. These discharges are summed to produce a total discharge for that cross section of the stream.

Velocity and depth are measured concurrently at each interval using a current meter attached to a wading rod. The rod allows for quick and easy measurements of depth with incremental markings and an adjustable arm that places the current meter at the proper depth for measuring velocity (60 percent of the depth from the surface of the water). Some current meters have rotating cups (AA and pygmy models) that use revolutions per second to calculate velocity. Others have a pair of electronic contacts on a small head (FLO-MATE 2000, FH950) with an electromagnetic coil that produces a

magnetic field. A pair of carbon electrodes measure the voltage produced by the velocity of the conductor, which in this case is the flowing water. Internal electronics process the measured voltages and output them as linear measurements of velocity. Velocity is displayed as either feet per second or meters per second.

Preparation and Meter Calibration

Prior to using the current meter, inspect the meter, cable, probe, and standard wading rod for obvious defects or damage. Batteries should be tested by turning the unit on and checking for the low battery display. The meter should be calibrated before measurements are taken. Frequency and method of calibration (daily, weekly, etc.) should follow the user manual for the velocity meter. Turning the meter off for short periods of time will not affect the meter's zero calibration as this is stored internally by the meter. To ensure there is no film on the sensor, clean the sensor before calibration using recommended methods and solutions described in the user manual. Typically, for zero-adjustment, the meter is turned on and the sensor is attached to the wading rod and placed in a 5 gallon bucket of water. A zero reading is taken after 10 to 15 minutes to ensure the water is not moving. Equipment needed for meter calibration and discharge measurements in the field is listed in Table 1 below.

Table 1. Equipment needed for collecting discharge.

Equipment	Units of measurement	Accuracy
Velocity meter	meters/second	±2% in temperatures between 0 - 72 °C.
Top-setting wading rod	meters or centimeters	
Tape measure	meters	
5 gallon bucket		
Batteries		
Log book		
Data sheets on waterproof paper		
Velocity meter manual		

Field Measurements

Discharge measurements should be made after other measurements such as temperature, dissolved oxygen, pH, and specific conductance are complete. Discharge measurements require wading across the stream and may cause sediments to stir up, disrupting accurate measurement of other water quality characteristics. First, the location where discharge will be measured must be determined. If possible, collect discharge near the upper reach boundary at an ideal cross section. An ideal cross section will have the following qualities: (1) the stream channel directly above and below the cross section are straight, (2) there is measurable streamflow, with a stream depth preferably greater than 0.15 m and velocities generally greater than 0.15 m/s, (3) the streambed is a uniform "U" shape, free of large boulders, woody debris, and dense aquatic vegetation, and (4) the streamflow is laminar and relatively uniform with no eddies, backwaters, or excessive turbulence. The cross section will not likely meet all these qualifications but the best location within the sample reach should be selected based on these standards. Any discrepancies with the cross section should be recorded or sketched on

the data sheet. Once the cross section is established, the stream width is measured with a tape measure (nearest 0.1 m) and the tape is secured across the stream for the duration of the measurements. The cross section is divided into equal intervals, usually 15 to 20 with a minimum of 10 intervals recommended. The number of intervals will be based on stream width; larger reaches will have more intervals. A velocity and depth measurement is recorded at the center of each interval. For example, if the stream is 5 m wide, 10 intervals at 0.5 m apart will be used with the first measurement of depth and velocity collected at 0.25 m from the water's edge (Figure 1).

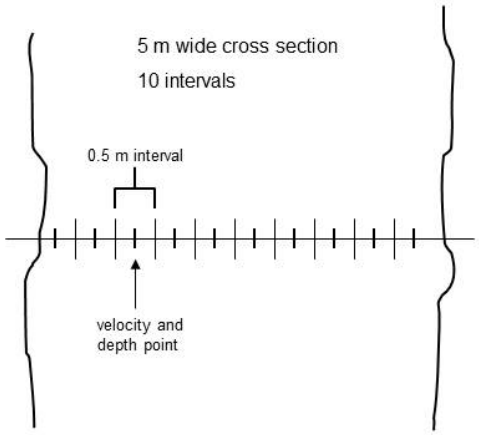

Figure 1. Points for measuring discharge at a hypothetical cross section.

To take a velocity reading, the current meter must be turned on and the sensor securely attached to the wading rod, facing upright. Consult the operator's manual for necessary changes in settings in fast or slow currents. During measurement, one person should be measuring discharge and one person should remain on the bank recording data. Measurements start near the water's edge and move to the center of the first interval. With the wading rod as level as possible and perpendicular to the water level, depth is read from the wading rod to the nearest centimeter. Once depth has been read, the arm of the rod with the attached sensor should be adjusted to the water depth which will place the sensor at 60 percent of the depth from the surface of the water, a standard depth for measuring velocity in streams. During velocity measurement, the person taking the reading should stand behind the sensor and make sure there is no disturbance (including the sensor cord) around the sensor that interferes with the measurement. It may be necessary for the meter to be adjusted slightly upstream or downstream to avoid boulders or other interferences. Precautions also should be taken to face the sensor directly into the flow of the water, which may not always be directly parallel with the water's edge. In this instance, the rod and sensor may need to be turned slightly with each measurement. If something happens during the measurement, such as movement of the wading rod, the meter can be cleared and the reading started again. Once the meter gives 3 velocity readings, the average of those readings is recorded. The crewmember calls out the distance from the water's edge, the depth, and then the average velocity to the person recording data on the field sheet (Figure 2). The crewmember will continue moving across the stream until measurements have been made at all intervals. When finished, the meter should be turned off and the sensor should be detached from the

wading rod. If the meter will not be used for several days, the meter sensor should be cleaned and stored properly, according to the operator's manual.

Discharge

Park: _____ Stream name:_____

Stream #:_____ Date:_____

Time (military):_____ Crew Initials:_____

Stream width(m):_____ Meter used:_____

Interval	Distance From Bank *m*	Depth *cm*	Velocity *m/s*
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

Notes:

Figure 2. Field sheet for recording depth and velocity measurements to calculate discharge.