Chapter 5 – In-stream Flow

The techniques found in the in-stream flow chapter are standard protocols for measuring stream flow using a flow meter or current velocity meter (Gordon et al. 2004; Bain and Stevenson 1999). However, some aspects of the standard protocols presented are specific to Michigan. In Michigan, volunteers wishing to operate the flow meter must be certified in measuring stream flow by the Michigan Department of Natural Resources and Environment and the United States Geological Survey (MI DNRE/USGS). This certification is specific to Michigan. In other parts of the country program coordinators should contact pertinent local agencies about criteria required for those agencies to utilize volunteer collected flow data.

5.1 Justification

Stream flow can be a good indicator of stream degradation due to water withdrawal. In most coldwater streams groundwater input is a very important factor in keeping water levels up and keeping water temperature low. Therefore, changes in stream flow can indicate negative impacts due to groundwater or surface water withdrawal.

The Great Lakes compact requires that Great Lakes states develop a framework for preventing adverse resource impacts to streams due to large quantity water withdrawal. Michigan currently has a tool to predict the impact of groundwater withdrawals on stream flow, and the subsequent impact on fish. If stream flow is reduced enough to have a negative impact on the resident fish community the proposed withdrawal cannot be approved. The predictive tool relies on limited stream flow data to predict flow in Michigan streams. Gaps in data are currently filled with modeling of stream flow. There are currently many stream sections and even entire stream systems where all index flows are estimated through modeling. There is a great need for more flow data for Michigan streams; however, state agencies are unable to expand in-stream flow sampling at this time.

The MI DEQ/USGS have begun developing criteria and tools for using volunteer collected flow data to help improve flow predictions that determine policy. MITU volunteers can help collect this much needed data for coldwater streams in Michigan.

5.2 Objectives

The standard protocols for in-stream flow monitoring are intended to be used to increase the amount of stream flow data available for coldwater streams. This document is designed to provide standard protocols for monitoring in-stream flow that can be used by trained volunteers participating in the *River Stewards Program*.

This in-stream flow monitoring procedure is designed to address several objectives:

- Increase available in-stream flow data for Michigan's coldwater streams for use by the MI DEQ, the USGS, MITU, and other stakeholders.

- Provide consistent in-stream flow monitoring methods that follow the guidelines set forth by the MI DNREQE/USGS.
- Improve upon the data used in the "Water Withdrawal Assessment Tool".

5.3 Training

MI DEQ/USGS Stream Flow Monitoring Certification

The MI DEQ/USGS require anyone who will be directly measuring in-stream flow to attend USGS approved training. This training is sporadically offered. MITU is working with DEQ and other partners to improve the training program. If you are interested in this option please contact a MITU staff person.

MITU Training

MITU staff currently provide interested chapters with training on how to sample in-stream flow. Volunteers who go through MITU training are able to collect "Tier 1" flow data. "Tier 1" data is used to screen for problem sites. Sites that have much less baseflow than expected are flagged for "Tier 2" monitoring by a USGS trained individual. This method allows MITU to screen a large number of sites while focusing staff time on the highest priority areas.

The methods outlined below are generally accepted methods and can be found in Aquatic Habitat Assessment (Bain M.B. and Stevenson N.J. 1999. American Fisheries Society, Bethesda, Maryland) and Stream Hydrology: An introduction for ecologists 2nd Ed. (Gordon N.D., McMahon T.A., Finlayson B.L., Gippel C.J., and Nathan R.J. 2004. Jon Wiley and Sons, Ltd. West Sussex, England.).

5.4 Equipment

- Tape measure
- Stakes or rebar to anchor tape measure in stream banks
- Flow meter (Global Flow Probe)
- Calculator
- Clipboard
- Data sheets
- Pencils
- Waders

5.5 Preparation

a. When to Sample

The goal is to sample streams at low flow. In general, this will occur in July and August during dry hot periods. Scheduling flow monitoring can be challenging because we do want to sample at low flow. Therefore, flow should not be measured just after a large rain event or during a very wet time period. Wait until flow has receded after rain. If you are unsure about the water level in a particular stream you can check the USGS flow data for that stream, if available, or another stream in the watershed or area. This should give a good idea of the water level in the stream of interest. USGS real time flow data can be found at http://waterdata.usgs.gov/nwis/rt.

b. Site Selection

Stream flow data from any coldwater stream is of value. However, streams in which water level is a concern are especially good candidates for in-stream flow monitoring. For example, watersheds with large amounts of irrigation or industrial withdrawal and marginal coldwater (cold-transitional) streams are good candidates. MITU staff can help determine which steams in your area may be good candidates for stream flow monitoring.

5.6 Monitoring In-stream Flow

(Appendix 6A)

a. Site Selection

Choose a fairly straight section of stream for monitoring flow. Look for fairly uniform flow, depth, width, velocity, and slope. Avoid sites with extreme turbulence, upstream obstructions, divided channels, or dead water zones.

b. Site Preparation

Can be done by stream flow assistants

After selecting a site, string a measuring tape across the stream perpendicular to flow. Anchor the tape, so it is taught, at both ends. Do NOT cinch knots in the tape it will break.

Record the distance to the water's edge from the left bank (when looking upstream). This will be the "zero" value. Try to anchor the tape so that the water's edge is at an even foot – this will make things easier.

Divide the stream in at least 20 subsections from water's edge on one bank to water's edge on the opposite bank. You will measure flow in the middle of each section. Record the width of the sections on the data sheet.

Record points where flow readings will be taken on the data sheet. For example, if you have a 20 foot wide stream you will have 20 1 foot sections and will measure flow in the middle on each section, thus if the water's edge is at 0 on the tape measure, your points for recording flow will be 0.5, 1.5, 2.5, 3.5 etc.

Record the depth at each of these points on the data sheet.

Record the depth at which flow measurements will be taken at each point on the data sheet. You will measure flow at 60% depth from the surface in water that is less than 2.5 feet (29 ½ inches, 0.75 m), this number should be rounded to the nearest 0.1 inch. Flow will be measured at 20% and 80% depth from the surface in water that is greater than 2.5 feet (29 ½ inches, 0.75 m), this value should be rounded to the nearest 0.01 inch.

See example data sheet in Appendix 6B

c. Measuring Flow

An individual certified to collect flow data by the MI DEQ/USGS must operate the flow meter at all times.

Use a flow meter to measure stream flow at the pre-determined locations and depths. The recorder will tell the individual measuring flow at what distance across the stream and what depth to measure flow.

When using a Global Flow FP101 Flow Probe:

When the flow meter is in the water at the correct depth, hold the top button on the computer to reset the meter. Wait until the AVG. VELCOITY reading (bottom number) has stabilized to record flow. The top number is the instantaneous velocity and will continue to fluctuate. Remove the meter from the water and move on to the next point, and repeat each step.

Make sure to hold the flow meter away from your body. Do not stand in front of, behind, or very close to the flow meter, this can cause a disruption in normal stream flow.

For each subsection record:

- Distance from the left bank (facing upstream) along tape measure
- Water depth
- Water velocity

d. Calculating Discharge

The data sheet provides an easy format to calculate discharge. A chapter member can do this step OR can send the completed data sheet (without discharge calculated) to the MITU staff.

Measure depth and width in feet and water velocity in feet/second. This will yield a discharge in cubic feet per second (CFS).

References

Bain M.B. and Stevenson N.J. 1999. *Aquatic Habitat Assessment*. American Fisheries Society, Bethesda, Maryland.

Gordon N.D., McMahon T.A., Finlayson B.L., Gippel C.J., and Nathan R.J. 2004. *Stream Hydrology: An introduction for ecologists.* 2nd Ed. Jon Wiley and Sons, Ltd. West Sussex, England.

Appendix 5A – Sampling Protocol

Stream Flow Sampling Protocol

When to Sample

- We want to sample at low flow
- During hot dry periods
    - Likely in July and August
- Do not measure flow just after a large rain event
    - Wait until flow has receded – this could be a few days or a week or more
    - Check real time USGS flow data to get an idea of water level at the site you will be sampling
        - http://waterdata.usgs.gov/nwis/rt
        - For example if you are interested in Prairie Creek you can check water levels in the Grand River to get an idea about the level of Prairie Creek

Site Selection

- Choose a fairly straight reach
- Look for fairly uniform flow, depth, width, velocity, and slope
- Avoid sites with extreme turbulence, upstream obstructions, divided channels, or dead water zones

Site Preparation

- After selecting a site string a measuring tape across the section perpendicular to flow, anchor tape at both ends with stakes.
    - Do not cinch knots in the tape it will break
- Record the distance to the water's edge from the left bank (looking upstream) along the tape measure. This will be our "zero" value
        - Try to anchor tape so that the water's edge is at an even foot – this will make things easier
- Divide the stream into 20 subsections from water's edge on one bank to water's edge on the opposite bank.
    - You will measure flow in the middle of each section
    - Record the width of the sections on the data sheet
- Record points where flow readings will be taken on the data sheet
    - i.e. if you have a 20 foot wide stream you will have 20 1 foot sections and will measure flow in the middle of each section, thus if the water's edge is at 1 foot on the tape measure, your points for recording flow will be 1.5, 2.5, 3.5 etc. – see example data sheet
- Record the depth at each of these points on the data sheet
- Record the depth at which flow will be measured at each point.
    - 60% depth from the surface in water that is less than 2.5 ft (29 ½ inches, 0.75 m)
    - 20% and 80% depth from the surface in water that is greater than 2.5 ft (29 ½ inches, 0.75 m)

- See example data sheet

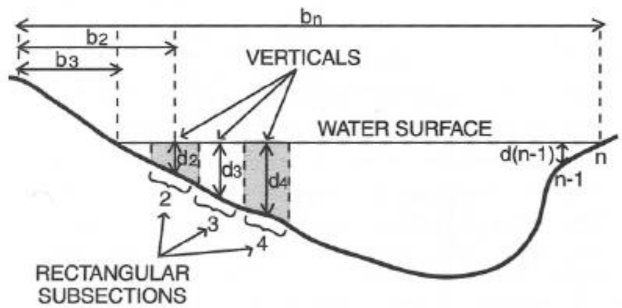

Figure 14.1 Cross section of a stream showing sampling locations for water depth (*d*) and velocity. Note that the interval represented is half the distance between adjacent measurement points except the first, and last interval, to the water edge.

Measuring Flow

- Use the current velocity meter to measure stream flow at pre-determined locations and depths
- The recorder will tell the individual measuring flow at what point and depth to measure flow
- When the flow meter is in the water at the correct depth hold the top button on the computer to reset the meter
- Wait until the AVG. VELOCITY reading (bottom number) has stabilized to record flow
  - The top number is the instantaneous velocity and will continue to fluctuate
  - Make sure to hold the flow meter away from your body, do not stand in front of, behind, or very close to the meter this can cause a disruption in normal stream flow.
- Remove meter from water, move on to next point, place meter in water at depth, and then hold the top button on the computer to reset the meter and begin measuring again
- For each subsection record
  - Distance from left bank (looking upstream) along tape measure
  - Water depth
  - Water velocity

Appendix 5B – Flow Datasheet

Flow Measurement Data Sheet

Assessment Site:	
Recorders:	Date and Time:
Streamflow Condition:	

Distance from left bank endpoint (ft;m)	Cell width (ft;m)	Water depth (ft;m)	Depth at which velocity is measaured	Water velocity (ft/s; m/s)	Cell area (ft^2;m^2) (water depth x cell width)	Cell discharge (ft^3/s;m^3/s) (cell area x water velocity)	Notes
1	-	0	-	0	-	-	Water edge
	0				0	0.00	
	Sum is the stream width				Sum is the cross section area	Sum is the stream discharge	

Appendix 5C – Example Datasheet

Flow Measurement Data Sheet - EXAMPLE

Assessment Site:	
Recorders:	Date and Time:
Streamflow Condition: High Average Low	

Distance from left bank endpoint (ft;m)	Cell width (ft;m)	Water depth (ft;m)	Depth at which velocity is measaured	Water velocity (ft/s; m/s)	Cell area (ft^2;m^2) (water depth x cell width)	Cell discharge (ft^3/s;m^3/s) (cell area x water velocity)	Notes
1	-	0	-	0	-	-	Water edge
1.5	1	0.8	0.48				
2.5	1	0.75	0.45				
3.5	1	0.9	0.54				
4.5	1	0.8	0.48				
5.5	1	1.1	0.66				
6.5	1	1.1	0.66				
7.5	1	0.9	0.54				
8.5	1	1	0.6				
9.5	1	1.3	0.78				
10.5	1	1.5	0.9				
11.5	1	1.7	1.02				
12.5	1	1.4	0.84				
13.5	1	1.6	0.96				
14.5	1	2	1.2				
15.5	1	2.6	0.52, 2				
16.5	1	2	1.2				
17.5	1	1.4	0.84				
18.5	1	1	0.6				
19.5	1	0.8	0.48				
20.5	1	0.6	0.36				
	-	0	-	0	-	-	Water Edge
	20						
	Sum is the stream width				Sum is the cross section area	Sum is the stream discharge	