DISCHARGE MONITORING

VELOCITY METERING: ADCP

PACIFIC SALMON FOUNDATION

Velocity metering is a method used to measure stream discharge (flow rate) that utilizes the velocity-area approach. It relies on the principle that discharge is the product of the average velocity of stream flow and the cross-sectional area of the flow. A current meter is used to determine the average velocity. Commonly, velocity metering is accomplished by a technician measuring velocity at specific points while wading across the stream (see velocity metering summaries for SonTek FlowTracker2 and OTT MF Pro); however, in streams that are unsafe for wading, velocity metering can be completed with an Acoustic Doppler Current Profiler (ADCP) mounted to a boat or suspended from a bridge. The ADCP can generate a velocity profile that is vertically and horizontally contiguous across the stream.

SUMMARY OF METHOD

There are four main steps involved with discharge measurement using ADCP:

1. **Site selection:** Identify suitable stream cross-section for metering. This step is critical to obtaining accurate and representative flow measurements. The ideal cross-section is on a straight section of stream with adequate flow depth and width, has steady and unobstructed flow, has a uniform flow profile across the stream, and lacks strong turbulence.
2. **Set-up:** Mount the ADCP to a small, autonomous boat or full size motorboat, or suspend it from a bridge, depending on the stream characteristics and availability of equipment.
3. **Measurement:** Ensure the ADCP is properly calibrated and has the necessary settings configured. Position the ADCP in the stream and activate the device. Navigate the ADCP from bank-to-bank across the stream (preferably multiple times). The device will measure velocities in both the horizontal and vertical directions, providing a comprehensive velocity profile.
4. **Data processing:** Download data from the ADCP. Use the associated software to calculate the velocity distribution across the stream, the average velocity, and the total discharge.

Photo credit: Flickr

IMPORTANT CONSIDERATIONS

The ADCP measures water velocity using hydroacoustic Doppler technology, which detects the Doppler shift of sound waves scattered by particles in the water and integrates velocities across the water column to compute flow. Clear water conditions can be problematic because particulate matter is required for the sensor to receive a signal. Aquatic vegetation can interfere with instrument measurement. Bedload transport can make it difficult for ADCPs to identify the streambed, impacting the calculation of cross-sectional area.

The software is somewhat complex and may require training. Data should be reviewed for completeness and quality. Some software platforms can automatically remove data noise or errors.

Autonomous boats can be self-propelled (e.g., remote controlled) or pulled across the stream with a tether (e.g., pre-installed cable pulley system). Ensure the ADCP is oriented in the correct direction, typically perpendicular to the flow direction. Misalignment can introduce errors in the velocity data.

The method can be used for measuring discharge under ice cover, requiring holes to be cored through the ice. Complete removal of the ice across the stream should be considered where contact between the ice and the water surface is discontinuous.

STREAM CHARACTERISTICS

- Range of measurable discharge is generally unlimited (constrained by other factors)
- Requires flow depth in the range of 0.1 m to 40 m, depending on ADCP model
- Performance can be impacted near aquatic vegetation and in highly turbulent flow, clear water, and moving streambed conditions
- Can be implemented under ice cover

MEASUREMENT CHARACTERISTICS

- Manual data acquisition
- Vertical and horizontal integration of measurements across stream
- Point measurement along stream network

SITE ACCESSIBILITY FACTORS

- Potentially suitable for remote foot access; amount of equipment for initial set up depends on specific application; see Considerations
- Ongoing monitoring may involve medium- or large-sized equipment (e.g., 2.4–3.0 m long autonomous boat, or full size motorboat)

SCALE OF EFFORT: INITIAL SET UP

Equipment cost: high
Field time: low or moderate, depending on specific application; see Considerations
Field expertise: moderate; see Considerations

SCALE OF EFFORT: ONGOING MONITORING

Equipment cost: negligible
Field time: low; ~1 hr
Field expertise: moderate; see Considerations
Analysis time: low; <1 hr
Analysis expertise: moderate; see Considerations

PRODUCTS TO CONSIDER

ADCP: SonTek-RS5 on SonTek HydroBoard II Micro; SonTek-M9 on SonTek HydroBoard II Max

ADDITIONAL RESOURCES

Dobriyal et al., 2017
Lapp, 2023
Resources Information Standards Committee, 2018
Water Survey of Canada, 2015b,c
Water Survey of Canada, 2021
World Meteorological Organization, 2010