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Rapid Collection of Water Discharge, Depths, and Velocities Along Transects

Reducing the time required and the difficulty of collecting data on river depths, velocities, and discharge for input into the Physical Habitat Simulation (PHABSIM) system would encourage instream flow studies on larger rivers. The PHABSIM is used to predict the spatial and temporal distribution of water depths and velocities under different flows for the purpose of evaluating the effects of flow on aquatic habitat. The PHABSIM is a library of computer programs used to simulate the hydraulic condition of streams that can then be used to simulate habitat. The data required for the hydraulic simulations include measurements of water elevation, depths, and velocities along transects across a stream and perpendicular to the streamflow. These data are usually obtained by wading or by using boats maneuvered along the transect line and held in place while the measurements are taken. The process is time-consuming and usually represents the most expensive component of instream-flow studies. The logistics of collecting the data on wide, deep rivers seem daunting. As a result, instream-flow studies on larger rivers have been avoided.

A recent innovation in sonar technology enables the collection of extremely detailed water velocity information from a moving boat. An Acoustic Doppler Current Profiler (ADCP) uses the Doppler effect (the apparent change in the frequency of a wave resulting from relative motion of the source and the receiver) to measure the motion, direction, and depth of water from the echoes of a sonic pulse. The ADCP transmits pulses from four transducers (Figure) and transforms the echoes into water velocities segregated into user-defined "depth cells." The result is a profile of velocity and depth measurements at a single vertical along the transect. Verticals can be measured as frequently as every 6 to 8 s; the number of verticals obtained for each transect then becomes a function of boat

speed. As many as 128 depth cells from 5 cm to 3,200 cm (0.2 to 10.5 feet) long (depending on transducer frequency) can be measured at each vertical. An ADCP measures velocities as high as 10 m/s (33 feet/s) to compensate for boat speed and can be used in water depths from about 1 to 500 m (3.3 to 1,641 feet) depending on the frequency used.

The data processing software calculates river discharge as the data are collected. Thus, users know the river discharge when their transect measurements are taken. This enables the collection of water elevation and velocity information from rivers with rapidly fluctuating discharges.

Data Collection Was Fast

We collected the data necessary for input into the PHABSIM on 40 transects across the Columbia River, Washington, in less than 2 weeks. The transects ranged from 377 to 670 m (1,237 to 2,200 feet) long, and river discharges ranged from 1,556 to 3,368 m^3/s (54,960 to 118,960 $feet^3/s$). Establishing transect spacing, setting headpins, and surveying the bank profiles were relatively time-consuming, whereas collecting the depth, velocity, and discharge information with the ADCP took only 4 to 8 minutes per transect. We obtained a minimum of 22 verticals along each transect and exceeded the limit of 99 verticals imposed by the PHABSIM on several. River discharge fluctuated during each day, and we obtained at least three water elevation and discharge measurements for each transect with a difference of at least 285 m^3/s (10,000 $feet^3/s$) between measurements.

This technology allows the assessment of river discharge on aquatic habitat in medium and large rivers. The savings in data collection time enables more transects to be measured within a given reach, thus improving the accuracy of the hydraulic and habitat simulation models. The equipment is expensive (about $50,000) but the costs are offset by reduced time and labor to obtain the data, and additional benefits are realized by the ability to undertake studies previously believed to be too difficult.

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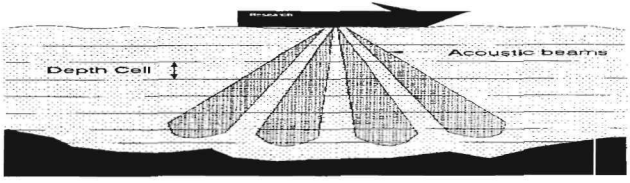

Figure. Collecting data with a boat-mounted Acoustic Doppler Current Profiler.