MULTI-ATTRIBUTE GEOVIDEO SURVEYING

of Stream and River Habitats

By integrating GPS, video, depth, and water chemistry sensors, it is now feasible to survey many miles of stream (15 miles typically) in a single day with data collected approximately every meter. With this multi-attribute data collection technique, you have the ability to change from guesses or broad extrapolations about the condition of your study stream to a high (1m) resolution map of the stream and stream channel. The range of data collected is highly useful for GIS mapping, hydrologic modeling, and habitat identification applications.

As water resource professionals, we develop models representing stream condition, stream bank and riparian condition, or habitat suitability as the basis for response to many management issues. However, most of these models are based on descriptions of short (several 100m) sections of stream or rivers. Field sites are distributed in various places within a stream or among streams and then conditions are extrapolated to represent a large portion of the stream system. It is typical to have direct field measurement on less than 5% (and in many cases < 1%) of the overall stream miles in a management area.

Dr. Paul Ayers, a Biosystems Engineering professor, at the University of Tennessee began the development of a georeferenced video mapping platform over 10 years ago. Over time and with the collaboration of colleagues and students, the technology, process, and validation of the techniques have advanced greatly. More recently, in conjunction with Trutta Consulting and Parham & Associates Environmental Consulting, this prototype survey technology is being made more standardized to directly support hydrological, fisheries, and habitat quality assessments.

As an example of the application potential of the geovideo technique, a number of recent studies in which we have been involved are highlighted. These projects address issues associated with

classifying stream bank erosion susceptibility, monitoring the effects of dam removal, assessing impacts associated with mining, and determining habitat loss for endangered species associated with reservoir drawdowns.

Streambank Erosion Susceptibility: Brett Connell, President of Trutta Consulting, recently published a description of the use of geovideo in surveying streambank conditions and showed the results of the method validation in comparison to traditional cross-sectional transect methods. Given that the geovideo methods are new, the techniques needed to be validated by comparison to current industry standards. To test the methods, approximately 5 mile reaches were surveyed on the New River and on Beaver Creek in Tennessee. For validation, Rosgen's Bank Erosion Hazard Index (BEHI) was applied at 38 different sites and then was compared to a similar index created from the geovideo where parameters included bank angle, bank height to bankfull ratio, surface protection, and riparian diversity. The geovideo method proved to have very similar results to the BEHI methods with only a 1.4% difference between the methods on average. While the geovideo methods were as accurate as the BEHI methods, the geovideo methods were far superior in the speed at which the field data were collected. The BEHI transects were collected on average every 400m and took 18 hours to collect between the 2 study reaches. In comparison, bank erosion susceptibility could be calculated by the geovideo approach for every meter of the stream and required only 6 hours to collect the data. Thus the geovideo surveying method gathered field data with 400X greater resolution in one third of the time. In addition to being faster and higher

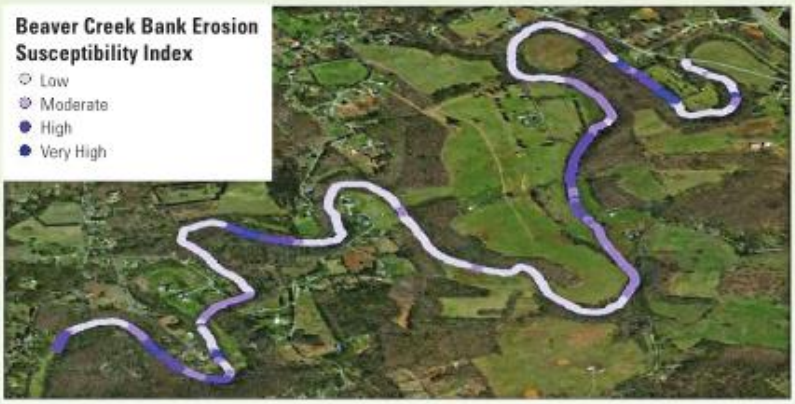

Figure 1: Results of the Bank Erosion Susceptibility Index that included bank angle, bank height to bank full ratio, surface protection, and riparian diversity.

resolution, geovideo mapping was boat mounted thus eliminating issues associated with access on private property as would be required for most transect methods.

Dam Removal:

In Alabama, Goodwin's Mill Dam is set to be removed from the Big Canoe Creek in order to remove the barrier to fish and mussel movement. Given the high cost of dam removal and subsequent stream restoration, it is important to monitor stream conditions to assure that improved habitat conditions have resulted from the dam removal actions. One problem when attempting to document changes resulting from dam removal using traditional transect surveys is that the changes to the stream can occur over a broad area up and downstream from the removal site. This makes determining the placement and number of transects subjective. More transects over a wider area will likely document changes more effectively, but this come with a high cost to the annual monitoring budget. To solve this problem, we used the high-definition geovideo surveying methods. In only 2 1/2 hours, this technique allowed us to quickly collect 1-meter resolution data of both stream banks and the stream bottom for over 3 miles of stream centered on the dam site. The geovideo surveying method was used to delineate pool-riffle-run sequencing, substrate type and embeddedness, depth, bank full depth, bank angle and height, bank erosion potential, and riparian diversity. This information will help show trends in sediment movement, stream geometry, and habitat conditions by comparing the results of annual surveys and to (hopefully) document improving conditions resulting from the dam removal effort.

Mining Impacts:

A mining company has a claim along the Weogufka Creek and needed to document baseline conditions prior to the mine opening. Many times this type of baseline documentation takes the form of a few transects near the project site and spot surveys at access locations in the larger area. Using traditional methods, the access points were too few and far between in this remote location to gain reliable data. This lack of access to appropriate sites would have made it difficult to pinpoint any direct impact on the creek due to the mining practices. In only one day, the geovideo survey techniques were used to collect a fully integrated suite of stream and streambank metrics for 17 miles of Weogufka Creek around the project location. Now regulators and the mining company can see any future direct impacts from the mining operation and work quickly and effectively to remedy any negative problems that may arise. An additional benefit arose from using the geovideo survey approach; the survey video forms a highly useful archive of the conditions when the mining company first began operations. Over time, as other development occurs within this stream reach, impacts such as increased sedimentation resulting from bank clearing by farmers or homeowners will not be attributed to the mining operation by default as the largest project in the area. The geovideo survey allows site-specific impacts to be separated from cumulative impacts associated with general on-going development.

Habitat Impacts during Reservoir Drawdowns:

For large dam operators, assessing the impacts of management actions on all of the competing uses for water can be a complex task. For the Alabama Power Company (APC), understanding the impact of a reservoir drawdown on potential habitat of endangered mussel species was one such problem. We used the survey platform to collect integrated shoreline and cross-sectional transects on a large section of the Coosa River. The data were used to update internal APC models to better assess habitat loss associated with various drawdown levels. In several related projects, river survey data was also used to model catastrophic flood impacts, as well as modeling flows at a potential intake and discharge sites for industrial plants. As in all of the other examples, better field data are essential to accurately understanding the impacts of various management actions.

In summary, by using georeferenced high-definition video of stream, streambank and streambed characteristics, the video can be assessed for many different characteristics. Integrating the video with other sensors allows a range of habitat conditions to be measured including:

- Right and left shoreline conditions, such as, bank height, bank angle, bank stability

Figure 2: Photos of GPS location, shoreline, and substrate of sites less than 1 mile apart. This is a great example of how stream conditions can vary within the same reach and highlights the need for surveys to cover more area than is typically sampled in a traditional transect survey.

and erodibility, surface protection, riparian diversity, legacy trees, woody debris, bankfull level, docks, boat ramps, bridges, power line crossings, pipes, and point source and non-point source pollution locations.

- Stream conditions, such as, habitat type (pool/riffle/run), stream width, depth, velocity classes, substrate, embeddedness, channel rugosity, cover, location of barriers, sinuosity, and slope.

All of the data collected is georeferenced and can be classified in GIS software to support multiple management objectives. For example, this information can be used to:

- Support the EPA wadeable stream habitat assessment approach.
- Provide broad coverage for habitat quality in IBI type assessments.
- Delineate Threatened and Endangered species habitat and find locations of optimum habitat for reintroduction.
- Help identify and prioritize restoration areas to increase the cost effectiveness of restoration efforts.
- Apply Bank Erosion Susceptibility Index (BESI) scores to support the EPA Watershed Assessment of River Stability & Sediment Supply (WARSSS) methods.
- Compare habitat conditions in different rivers as well as shows annual trends for the same river to see if river health is improving or declining.
- Provide a permanent database of stream conditions that is reviewable in meetings to show actual conditions to all participants (as opposed to trying to get everyone in the field).
- Collect information in both cross-sectional and river thalweg profiles.

In addition to streamlining both the shoreline and instream habitat surveying methods, we are working to combine video techniques with side-scan sonar to create even more habitat classification abilities at locations that are too turbid or too deep for using underwater video. Also, we are working with different water quality testing sensors to collect this information at high frequency during the stream surveys.

Overall, the geovideo surveying approach can rapidly and cost effectively transform the data poor stream reaches into multi-attribute, high resolution maps stream and stream channel conditions. This will allow resource managers to move from statistical assumptions about the 'average condition' of a stream based on a few small samples to a census of conditions with highly accurate, site specific data available.

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