COLLECTING VALUABLE DATA FOR USEFUL STREAM ASSESSMENT AND RESTORATION DESIGN PROJECTS

E. Aylin Lewallen, E. Dale Jones, Andrew Bearden, and Erik Dilts

AUTHORS: ENTRIX, Inc., 621 North Avenue, NE, Atlanta, GA 30308. 404-881-5355. Email – **alewallen@entrix.com**
REFERENCE: *Proceedings of the 2003 Georgia Water Resources Conference*, held April 23-24, 2003, at the University of Georgia. Kathryn J. Hatcher, editor, Institute of Ecology, The University of Georgia, Athens, Georgia.

Abstract. Stream assessments and restoration projects are becoming increasingly important to meet water quality standards and protect biological health. Developing an assessment methodology that is both effective and efficient is the first crucial step in conducting a stream inventory to identify watershed based problems and develop restoration designs to improve stream system health. ENTRIX has worked on several projects involving stream assessment and restoration design and is continually improving on the type of data collected, how the data is collected, and how project benefits are quantified. This approach includes the following steps:

1) Field investigation to identify and assess watershed conditions
2) Data summary to prioritize and rank stream reaches based on the results of the field assessment
3) Develop a list of potential improvement projects
4) Quantify benefits and rank projects based on costs and benefits.

This presentation will focus on recent improvements in the methods used for stream assessment and restoration design projects.

INTRODUCTION

Stream assessments and restoration projects are becoming increasingly important to meet water quality standards and protect biological health. The purpose of this paper is to provide guidance on how to design stream assessment and restoration projects for collecting valuable data in the field. Collecting valuable data during the assessment stages is the backbone to providing effective restoration strategies.

BACKGROUND

Land-use activities such as road building, agriculture, residential and commercial development, and direct manipulation of stream channels often alter geomorphic processes by changing the equilibrium relationships between the hydrologic regime, sediment production, and sediment transport. Significant alteration of the equilibrium relationship will consequently alter channel morphology. Alterations may take the form of aggradation or degradation of the channel bed, lateral instability (bank erosion), and accelerated sediment production. The consequence for aquatic habitat and water quality may also be significant.

Accelerated fine sediment addition to streams can adversely affect aquatic habitat and water quality. Excess fine sediment impairs successful reproduction of many fishes and reduces fish habitat by filling interstitial spaces in coarse substrates and reducing water depth in pools (Waters 1995). Excess fine sediment can also reduce macroinvertebrate abundance and adversely affect species diversity, both of which are correlated with substrate particle size (Waters 1995), and thereby reduce the fishery food base (Phillips 1971). Excess sediment loading in channels may also cause aggradation, increased bank erosion, and an overall reduction in channel stability.

Land-use activities such as urbanization cause hydrologic changes in a watershed that can in turn result in adjustment of the channel morphology. Peak flow increases over pre-development conditions of two-to-three fold have been documented in areas with even relatively low-level suburban development (Booth 1990). Generally, channel instability following urbanization will take the form of either channel incision or an increase in channel width and depth. As channels incise, they become disconnected from adjacent floodplain areas, reducing the frequency and extent of over-bank flows. As a consequence, the composition of floodplain vegetation may be altered, the nutrient stripping, sediment deposition, and other water quality benefits associated with floodplain inundation are limited, and additional sediment is delivered to the channel as the bed and banks are eroded.

Metro-Atlanta has grown rapidly over the past decade, and stream alterations are occurring across the area. Several municipalities around metro Atlanta have recognized the importance of stream assessments as a part of implementing watershed management recommendations, identifying illicit discharges (for TMDL implementation and Storm water NPDES permitting), and storm water master planning.

It has become increasingly apparent that the data collection phase is a crucial element of the whole stream assessment process. From working on a variety of stream assessment projects, ENTRIX has worked towards cost and time effective ways of collecting the data, so that transfer and use of the data after field work has fewer errors and is easily organized in a Geographic Information System for analysis.

ASSESSMENT DESIGN STRATEGIES

ENTRIX staff have worked on a number of projects around metro Atlanta and refined a stream assessment approach to include the following steps:

1) Field investigation to identify and assess watershed conditions
2) Data summary to prioritize and rank stream reaches based on the results of the field assessment
3) Develop a list of potential improvement projects
4) Quantify benefits and rank projects based on costs and benefits.

Field investigations are designed to identify a variety of different sources of stream degradation. Stream degradation can fall under one or more categories, which include bank erosion, excessive sedimentation, channel morphology shifts, water quality impairments, and habitat alteration. Parameters that are investigated in the field to accurately assess streams include but are not limited to:

- Percentage and length of stream bank erosion;
- Channel bed and floodplain roughness estimated using Manning's n;
- Large obstructions in the channel that cause unnatural conditions (local flooding upstream of obstruction);
- Inventory of potential pollution sources (broken or leaking sewer lines, poor agricultural practices, illicit discharges, illicit dumping, confined animal areas, and suspect odors); and
- Potential maintenance issues (blocked or damaged culverts, bridge crossings, or storm drains; broken water or sewer lines; SSOs; sediment and erosion control violations; and illegal dumping.

At each location where a problem area is identified an attempt should be made to attribute the likely source of the problem to some causative factor (Table 1). Potential restoration measures that could be used to correct or improve the observed problem areas should be also identified during the stream walks

Data is collected in two main categories–problem assessment and cause assessment.

Table 1. Problem and Cause Assessments Categories

Problem Assessment Categories	**Cause Assessment Categories**
Bank erosion	Bridge/Culvert crossing
Channel morphology	Erosion and sediment control
Debris dams	Hydrologic alteration
Dumping/Trash	Impervious area
Excessive sedimentation	Construction/ Land clearing
Foul odors	Point source discharge
Illicit discharge	Reduced riparian zone
Water clarity	Storm drains
Other problems	Other or unknown

Aquatic ecosystem habitat is assessed according to the Georgia Department of Natural Resources Standard Operating Procedure for riffle/run prevalent streams (GADNR 2002). This methodology assesses the physical characteristics of a stream and places emphasis on the most biologically significant parameters. The habitat assessment is broken into ten parameters that evaluate the instream physical characteristics, channel morphology, and riparian vegetation and bank structure.

Stream channel morphologic data is collected at each point where a physical habitat assessment is obtained. This data is collected to assist in later hydrologic modeling and preliminary restoration design efforts.

Morphologic features that are indicative of the bankfull elevation (e.g., inside tops of point bars, tops of undercut banks, topographic flats adjacent to the channel) should be identified. Morphologic measurements collected include top of bank widths and depths, bankfull discharge widths and depths, and floodprone area widths and depths (Rosgen 1996).

The habitat and morphologic data are used to help prioritize basins for restoration projects. Poor habitat and morphologic measurements, which show degradation of the channel, are ranked higher for restoration.

All data collected in the field are stored on a handheld computer that is connected to a GPS, so a location can be connected to all data collected (Figure 1). All data collected is easily imported into a Geographic Information System for spatial analysis. By developing quantitative criteria and using the spatial information collected on streams within sub-basins, watersheds can be ranked based on stream degradation.

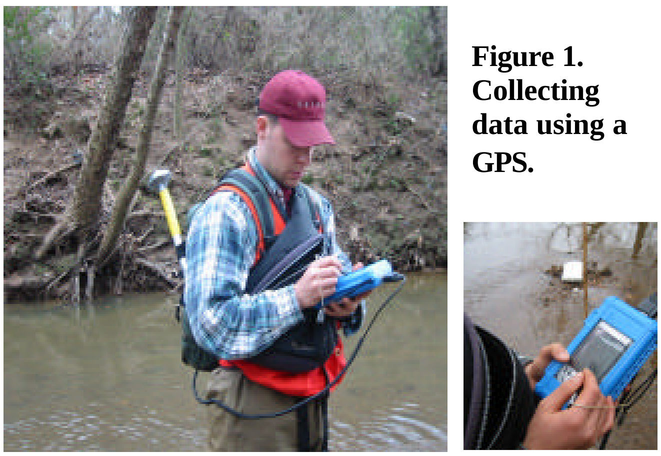

Figure 1. Collecting data using a GPS.

Once data is collected, stream reaches are prioritized using the data collected during the stream walks. Habitat and water quality improvements are then measured as potential benefits for the projects.

QUANTIFYING DATA FOR RESTORATION PROJECTS

Once the field data is collected, the next step is to quantitatively rank and categorize subwatersheds based on priorities for restoration. Each watershed is divided into subwatersheds that are delineated for each tributary within a watershed. Subwatersheds can be further divided based on major road crossings that mark substantial changes in habitat. These subwatersheds are scored for individual metrics, including habitat scores, bank erosion, channel alteration, excessive sedimentation, Rosgen classification, and surrounding landuse. It is important to compare the results from the quantitative ranking criteria to qualitative field observation by the field team to validate the proposed ranking approach.

Once watersheds are prioritized based on collected field data, restoration projects can be specifically designed for the high (highest score for stream degradatioon) ranked subwatersheds. Field visits should be done and aimed at specifically recommending the type of Rosgen stream restoration (priority level 1 restoration to priority level 4 restoration) and the specific measures that we would recommend at each restoration site. Stream restoration refers to the process of adjusting channel dimension, pattern, and/or profile of altered streams to create a stable channel that transports the sediment load delivered by its watershed without aggrading or degrading over time. Rosgen (1996) described a priority system of restoration measures for incised streams (F and G stream types; Rosgen 1996) that considers a range of stream restoration measures based on a variety of factors including existing channel condition, restoration objectives, land requirements, floodplain function, and aesthetics.

Rosgen's priority system is divided into four levels, ranging from Priority 1 restoration, which constructs a new bankfull channel and restores stream-floodplain connectivity, to Priority 4, which stabilizes the existing stream channel in place (Rosgen, 1996). Each level of restoration offers specific advantages and disadvantages are addressed in detail below.

In addition to determining the appropriate priority levels for restoration, a site map or drawing while in the field showing the location, numbers, and extent of various restoration measures (i.e. rock vane, cross vanes, j-hook vanes, bioengineered bank stabilization, hard bank stabilization, root-wads and other habitat enhancements) should be prepared.

DESIGN RECOMMENDATIONS

When designing field methods and completing stream assessments and restoration projects, it is crucial that the following items are taken into account:

- Reconnaissance efforts – Prior to conducting the study, set aside time to perform reconnaissance field observations in order to effectively map out your fieldwork. This will help to focus the effort of prioritizing the subwatersheds where data is collected. In addition, during the reconnaissance, take notes on the land use and potential problems observed.
- Geographic Information Systems – During this age of growing technology, it is crucial to link all data

collected to a spatial database for more effective analysis.

- Connect cause and effect – Use personnel that understand how to assess stream degradation and isolate potential causes of the degradation. For example, the hydrology of a reach could be altered by larger scale watershed conditions (high impervious area) or may the result of a localized impact (stream straightening for space constraints on a development site).
- Other factors - It is important to investigate a watershed for problems knowing that factors, such as access to the stream and available space, play a role in determining where it is most cost-effective to focus restoration strategies.

ACKNOWLEDGEMENTS

ENTRIX would like to thank the Gwinnett County Public Utility Department and the United States Army Corps of Engineers, Mobile District for providing project work for us to develop and refine our stream assessment methodology.

REFERENCES CITED

Booth, D. B., 1990. Stream-channel incision following drainage basin urbanization. Water Resources Bulletin, vol. 26, No. 3, American Water Resources Association, June 1990.

Georgia Department of Natural Resources. 2002. Standard Operating Procedures: Freshwater Macroinvertebrate Biological Assessment.

Phillips, R. W., 1971. Effects of sediments on the gravel environment and fish production. *In* J.T. Krygier and J.D. Hall, eds, *Forest Land Uses and Stream Environments*. Continuing Education Publications, Oregon State University Corvallis, Oregon, pp. 64-74.

Rosgen, D.L. 1996. Applied River Morphology. Wildland Hydrology, Pagosa Springs, CO.

Waters, T. F. 1995. *Sediment in Streams: Sources, Biological Effects and Control*. American Fisheries Society, Bethesda, MD.

RELATED REFERENCES

In addition to the references cited in this paper, these references have been used to aid in our evolving stream assessment protocols. When designing your stream assessment program and restoration projects, the following references can provide useful information:

Atlanta Regional Commission. 2001. Georgia Stormwater Technical Handbook, vol. 2. Atlanta, GA.

Brown, K.B. 2000. Urban Stream Restoration Practices: An Initial Assessment. The Center for Watershed Protection. Elliot City, MD.

Federal Interagency Stream Restoration Working Group (FISRWG). 1998. Stream Corridor Restoration: Principles, Processes, and Practices.

Georgia Adopt-A-Stream. 2000. Stream Visual Survey. Georgia Environmental Protection Division. Atlanta, GA.

Georgia Adopt-A-Stream. 2001. Getting to Know Your Watershed. Georgia Environmental Protection Division. Atlanta, GA.

Gwinnett County, GA. 2001. Stormwater Design Manual, Chapter 8. Lawrenceville, GA.

Newton, B., C.M. Pringle, and R. Bjorkland. 1999. Stream Visual Assessment Protocol (SVAP). Part 601: In National Water Quality Handbook. USDA Natural Resources Conservation Service.

Yetman, K.T. 2001. Stream Corridor Assessment Survey: SCA Survey Protocols. Maryland Department of Natural Resources, Annapolis, MD.