Protocols for Studying Wet Weather Impacts and Urbanization Patterns

The research team conducted a pilot study of eight watersheds with a gradient of urban development in the North Carolina Piedmont and demonstrated that the hydrologic metric $T_{0.5}$ responds to changes in land use and to alternative runoff control scenarios. (The $T_{0.5}$ is defined as the percent of time that the flow is greater than the peak flow of the 0.5-year storm.)

This research explored the relationship of urbanization to ecology in the wadeable streams of developing watersheds.

The study also found that the ecological health of streams in the North Carolina Piedmont, as measured by macroinvertebrate indices, is responsive to the $T_{0.5}$ metric.

Furthermore, limited flow monitoring and macroinvertebrate data can be used in conjunction with hydrologic and hydraulic modeling to estimate how changes in land use patterns and runoff control scenarios affect the biotic integrity of streams in a developing watershed.

The team developed a protocol based on two key findings from the literature review:

- The biotic integrity of an urban stream, as measured by the benthic index of biological integrity (B-IBI), can be related directly to the hydrologic metrics, $T_{0.5}$ and TQmean, and these two metrics are in turn related to the intensity of urbanization on a watershed.
- The hydrologic metric $T_{0.5}$ can be computed using mathematical stormwater models, and $T_{0.5}$ is sensitive to alternative land use and runoff control scenarios.

This implies that land use planning and runoff control strategies can be related to biotic integrity in streams.

Overview of the Protocol

The protocol is illustrated on the next page. The black boxes portray the identification and collection of necessary biologic data. The white boxes are data analysis activities comprising hydrologic, geomorphic, and biotic analyses that define the baseline for stormwater management planning. They also form a basis for evaluating the relative impact of alternative stormwater management plans (land use patterns and/or runoff control strategies) on stream biota for developing watersheds.

The protocol focuses on the relationship of stormwater management practices in urbanizing watersheds to biologic health in the receiving streams, as represented by measures of the fish and aquatic macroinvertebrate communities. Water quality is not explicitly included in the protocol; however, it is included implicitly because the protocol requires stormwater treatment practices be employed as part of the hydrologic stability analysis.

Research Recommendations

A carefully conducted experiment should be conducted on an urbanizing watershed of 1–3 square miles, using runoff controls and BMPs designed according to the criteria recommended in this study (see conclusions in report) to relate macroinvertebrate health to $T_{0.5}$ as the watershed develops. This data needs to be compared to watersheds that are

BENEFITS

- Develops a protocol to evaluate the impacts of land use patterns and alternative stormwater management strategies on the biotic integrity of streams in urbanizing watersheds.
- Applies the protocol to urbanization questions in a pilot study area.

RELATED PRODUCTS

Research Needs: Physical Effects of Wet Weather Flows on Aquatic Habitats (00WSM4)

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Decentralized Stormwater Controls for Urban Retrofit and Combined Sewer Overflow Reduction (03SW3)

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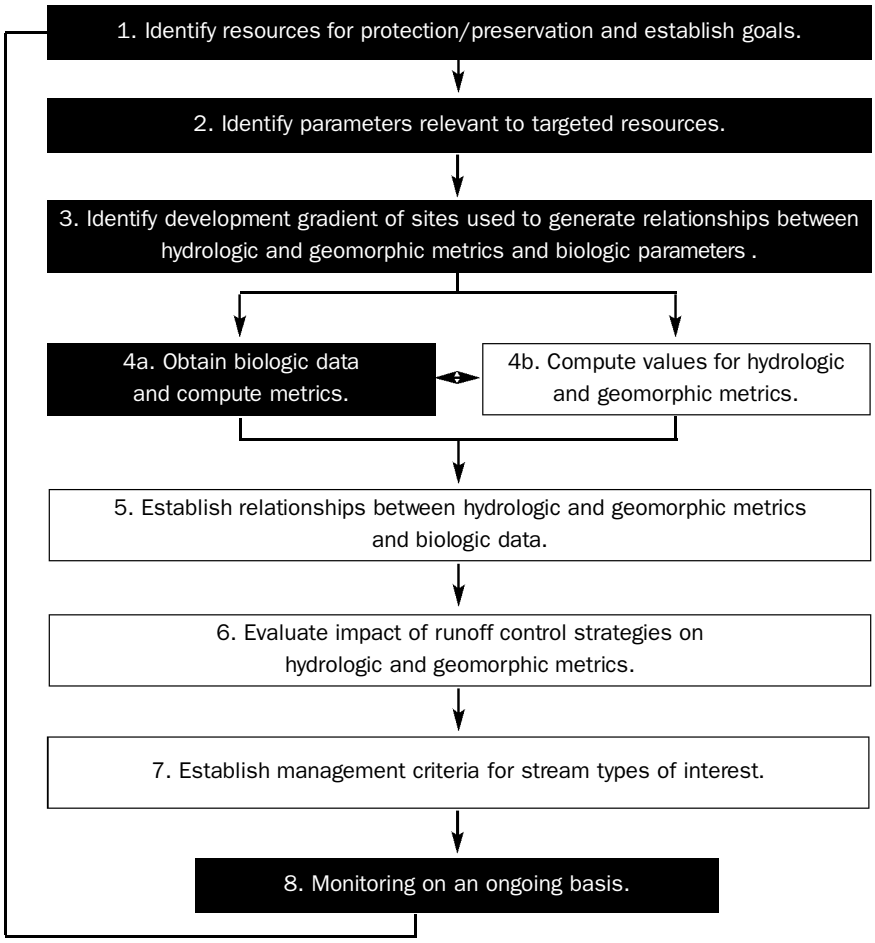
in various states of urbanization but that have no significant runoff controls. Care must be taken in this experiment to control runoff during the construction phase or the macroinvertebrate indices will reflect the construction impacts rather than the built environment impacts.

Water quality was not addressed in this work. From the standpoint of protecting the biotic integrity of receiving streams in urbanizing watersheds, the researchers in this study believe that the main issues are the runoff controls required to achieve hydrologic and geomorphic stability. (The controls must include BMPs.) If properly designed, the controls will remove pollutants from storm water runoff. Nevertheless, the federal Clean Water Act is based on water quality criteria in receiving streams, and stormwater regulations now require that TMDL calculations include storm water runoff. Therefore, it is recommended that future research build on this protocol, by adding water quality sampling of constituents identified in the water quality criteria applicable to the receiving stream, adding water quality to storm water models as a runoff parameter, and simulating the removal of pollutants by runoff control practices.

The researchers believe that implementation of storm water management practices that reduce the overall volume of runoff through infiltration or evapotranspiration will also aid in moving towards a more natural hydrologic flow regime that will allow for ecologically healthy receiving waters. The impact of such practices depends upon the extent to which they are implemented. Future research could quantify the biotic impacts of volume reduction through practices such as low impact development.

The Evaluation Protocol



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The research on which this report is based was funded in part by the U.S. Environmental Protection Agency (U.S. EPS) through Cooperative Agreement No. CRT-831559-01 with the Water Environment Research Foundation (WERF). Unless an U.S. EPS logo appears on the cover, this report is a publication of WERF, not U.S. EPS. Funds awarded under the agreement cited above were not used for editorial services, reproduction, printing, or distribution.

10/08