Hixon Center for Urban Ecology
Student Research Fellows

Modeling the Hydraulic Effects of Instream Habitat Restoration

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Problem Investigated:

Every year, governments and organizations spend millions of dollars to restore and manage stream ecosystems, however the effectiveness of most approaches is poorly understood. Conventional stream restoration measures either re-grading stream banks and channel beds or redirecting flows toward the center of the channel. These practices both improve instream hydraulic conditions and create quality habitat for fish, macroinvertebrates and aquatic vegetation. However in most cases, contrary to the intended outcome, the restoration itself can cause river instability or does not meet long-term project goals and objectives. Often, the restoration is completed without a full understanding of processes, such as sediment transport, and ultimately violates the dimension, pattern and profile of a stable river.

Approach:

To test the effectiveness of an instream habitat restoration application prior to its actual installation, a 150m reach on a third-order, urban stream in Philadelphia, PA was modeled with and without a mock j-hook rock vane. This structure was chosen based on it's effectiveness in channel types similar to the study reach. To predict how the j-hook rock vane affects flow patterns within the channel, the two-dimensional hydrodynamic model, River2D, was used to model stream hydraulic conditions under the two scenarios. River2D also has a Physical Habitat Simulation (PHABSIM) component which was used to compare weighted usable area (WUA) for three functional invertebrate feeding groups representing a taxa found in third-order reference reaches in the Greater Philadelphia region.

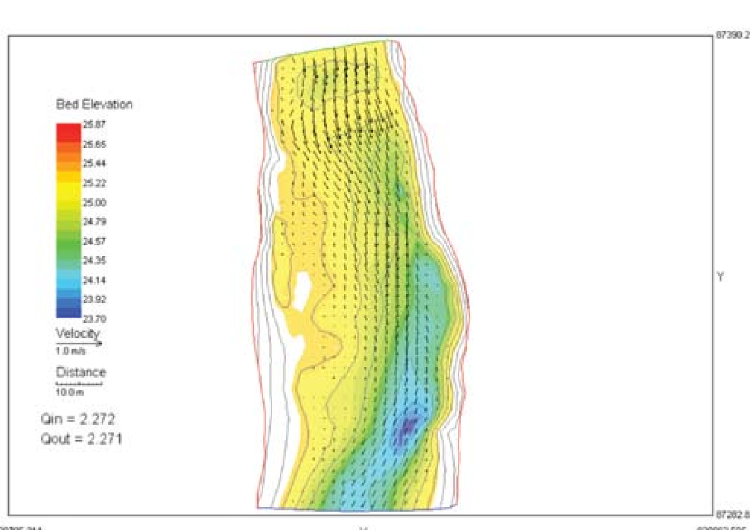


Figure 1.1 Pine Rd. plainbed simulation under bankfull flow conditions

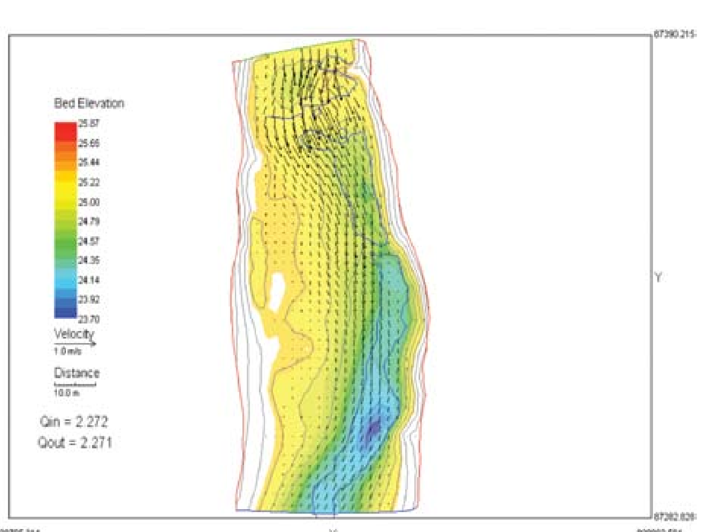


Figure 1.2 plainbed simulation under bankfull conditions

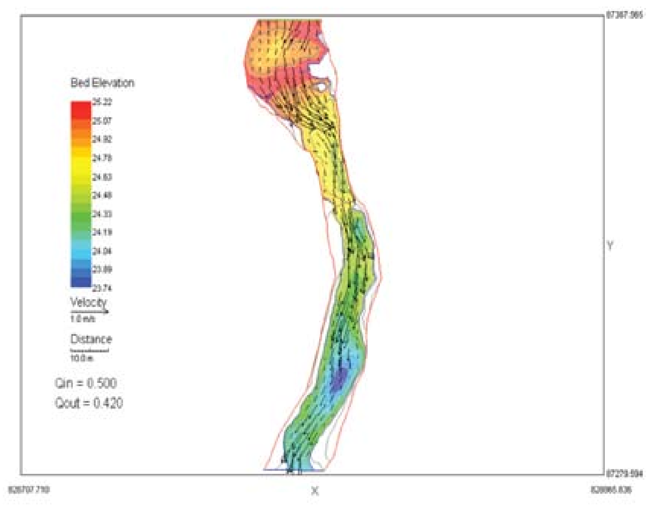


Figure 2.1 modified-bed simulation under low flow conditions

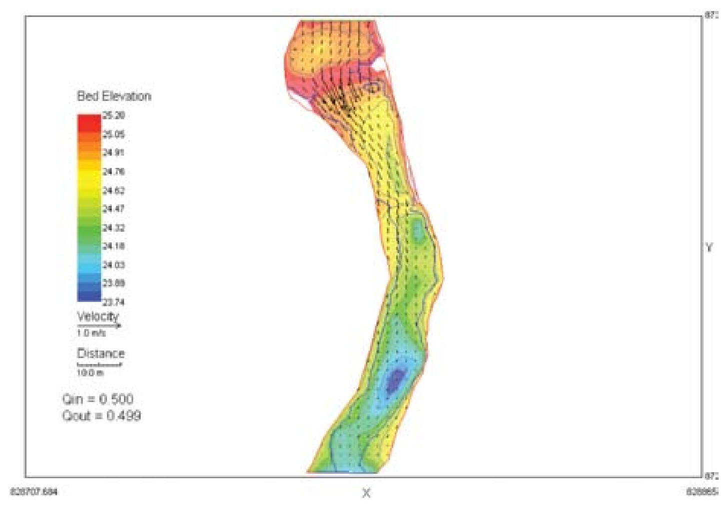
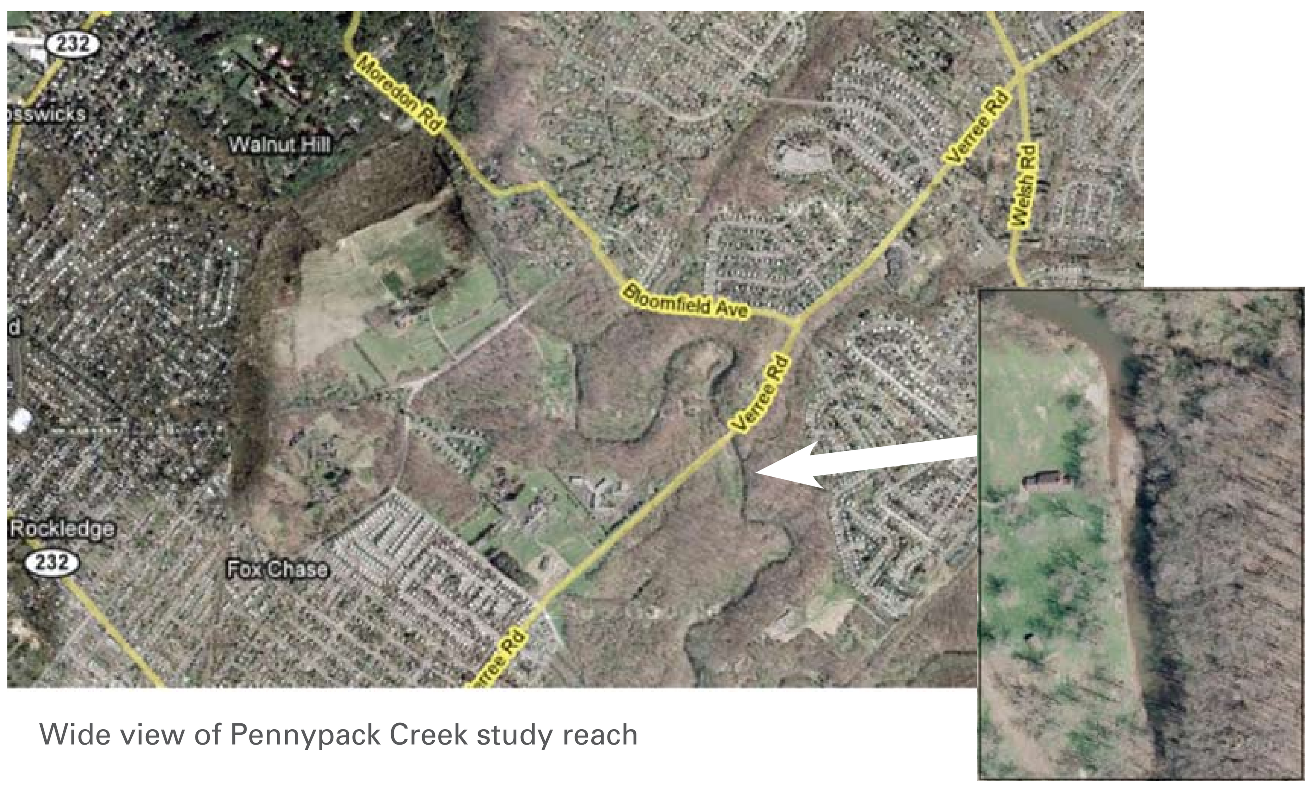


Figure 2.2 plainbed simulation under low-flow conditions



Wide view of Pennypack Creek study reach

Study reach within inset

Discussion:

Analysis of model outputs from the River2D hydrodynamic model yields promising conclusions as to the utility of modeling the effects instream habitat restoration structures. The model effectively displays the meso-scale alterations in flow and velocity due to the placement of a j-hook rock vane. Furthermore, the modeling also captures the alterations at a scale that can be ecologically important to macroinvertebrates inhabiting the reach. Natural and modified streambed simulations produced significant differences in WUA for each functional feeding group. The implications of these study results are that this methodology can have a significant role in evaluating the effects of reach-scale instream habitat restoration. However, it is also important to note that instream habitat and stream channel restoration practices cannot be the sole solution to stream urbanization and ecological degradation. Studies indicate that negative ecological impacts on biotic communities of degraded urban ecosystems are usually associated with urban storm water runoff. Thus, restoration attempts, by instream or riparian habitat enhancement, are likely to fail because the scale of restoration efforts do not match the scale of degradation caused by the water runoff. This finding signifies the magnitude of effort and cooperation that is needed to make lasting impacts upon the once pristine waterways that are now by-products of human population growth and subsequent urban sprawl.

Discharge (Q)	FFG	plainbed[1] (WUAavg)	plainbed[1] (Havg)	modified_bed[2] (WUAavg)	modified_bed[2] (Havg)	(WUAavg)[1]-(WUAavg)[2]
low	c-g	118.6441	0.0744	155.2903	0.1005	*-36.6462
high	c-g	231.3228	0.0538	222.1998	0.0522	*9.1229
low	c-net	103.4363	0.0649	116.8281	0.0756	*-13.3918
high	c-net	306.7243	0.0714	299.9003	0.0522	*6.8239
low	shr	71.0222	0.0445	108.1012	0.0700	*-37.079
high	shr	167.3190	0.0389	165.4495	0.0385	1.8695

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