Streams that drain urbanized watersheds tend to be in poor ecological health due to a myriad of environmental stressors. However, stream ecosystems are also naturally quite diverse. The topographic, geologic, climate, biological and even historical settings can all affect the ecological properties of these systems. Such diversity begs the question: do all streams respond to watershed urbanization in the same way? We posited that certain natural attributes of a stream might render an ecosystem more or less susceptible to environmental degradation.

To date, most ecological studies of urban streams have transpired within a single metropolitan area, thereby limiting inquiries that might ask what natural attributes might keep a stream healthy in an urban environment. However, a handful of studies that have operated at a larger spatial scale offer insight on how we might harness the natural attributes of a watershed to help protect it. Using published examples, we developed a set of testable hypotheses that identify natural attributes that could prove to be important factors when assessing or predicting the effects of urbanization on streams.

The topographic and geologic attributes of a watershed may affect the severity of flood responses to storms. By comparing the hydrologic impact of urbanization on streams in cities built on formerly glaciated landscapes (such as St. Paul, Boston, or Detroit), we see that the number of high-flow events seems to be much lower compared to streams in cities that are not located in formerly glaciated landscapes (Figure 1). Such disparities could be related to the highly permeable geologic layers where glaciers once carved through the landscape.

Even within a metropolitan area, streams seem to hydrologically respond in a manner specific to their watershed attributes. In the Seattle region, an urban stream draining watersheds with unconsolidated, permeable geologic layers with low topographic relief appeared to attenuate floods much more readily than watersheds with shallow bedrock (Figure 2).
Considering that changes to hydrologic regimes are among the most damaging to aquatic ecosystems, the fact that we see disparate responses to urbanization suggests that we could factor in landscape attributes when predicting or managing environmental degradation.

Geologic attributes may also determine how a stream channel responds to urbanization. We considered the degree of channel enlargement following urbanization between Kentucky streams, where shallow bedrock prevents substantial erosion, and semi-arid California lowland streams, where unconsolidated sediment can be easily washed away during floods. We therefore see some evidence that suggests that channel responses to urbanization may be idiosyncratic, again based on the geologic setting.

The other hypotheses we present address other important ecological attributes in streams. A high degree of connectivity among reaches may allow organisms to more readily recolonize formerly degraded streams in urban environments. The chemical effects of urbanization may not be so severe if the watershed naturally exports a high concentration of ions through groundwater flows. Streams with watersheds historically supporting agriculture may actually see concentrations of nitrate, a chemical that causes algae-blooms, decline if agriculture is replaced with well-managed urban land cover. Streams that naturally harbor more species of aquatic organisms could be buffered against changes in ecological processes, such as the processing of leaf litter, because they may end up with more species post-urbanization.

We do not feel as though our list of hypotheses is exhaustive and have therefore presented a framework to help future researchers consider the watershed characteristics that may shape an ecological response to urbanization (Figure 3). Streams are clearly heterogeneous: desert streams look and behave very different from streams draining rainforests, for instance. Because urbanization introduces heterogeneous environmental challenges to streams, we feel as though merging the two sources of heterogeneity when studying urban streams will prove a worthwhile endeavor.

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