Effects of Urbanization on Stream Ecosystems

Key Findings

Place matters: response to urban development depends on the region of the country

A stream's physical, chemical and biological characteristics will respond to changes in both urban and natural characteristics. Ecoregions reflect differences in climate, geology, natural vegetation, and historical land use patterns and provide a template that is more important for determining the overall composition of stream biota than the level of urban development. For example, when invertebrate community data from all 265 study watersheds from the nine studies were analyzed together, the most striking result was that the watershed-specific macroinvertebrate community composition scores did not group together by level of urban development, but by ecological region.

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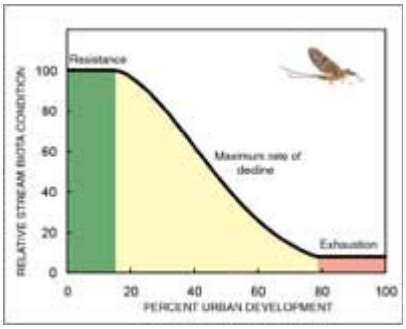
The hypothesized response of stream biota to urbanization



A commonly anticipated response of a stream biological community to urban development is a period of resistance to changes at low levels of urban development, a period of rapid change in the community as development increases until an exhaustion threshold is reached, at which point the biological community is composed mostly of tolerant organisms and little additional change is possible. For this reason, over the last decade many communities have developed land management practices that have limited development intensity, assuming that limiting impervious cover within a watershed to less than 10 percent of watershed area would be protective of stream biota.

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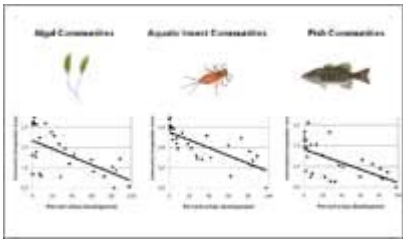
All biological communities showed signs of negative impacts from urban development



Urban development significantly affected one or more biological communities in eight of the nine metropolitan study areas, with Denver being the exception. The macroinvertebrate community showed a response to urban development in all study areas except Denver. In Portland, Birmingham, Atlanta, Raleigh, and Boston, either the algal or fish communities, or both, also showed a response to urban development. All three biological communities showed a response to urban development in Portland and Boston, and among the nine study areas, the responses of the three

communities were strongest in Boston.

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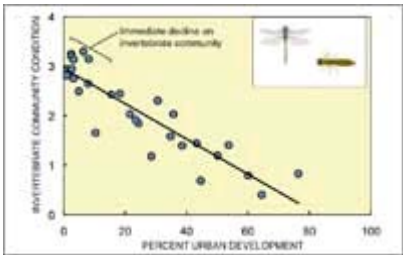
Immediate decline in macroinvertebrate community as urban development increases



Even small levels of urban development had an immediate negative effect on macroinvertebrates. This linear response pattern of macroinvertebrates to urbanization is illustrated by the immediate decline in a composite measure of the invertebrate community composition as the level of urban development in Boston watersheds increased. This response is continuous over the entire range of urban development and shows no period of resistance to the effects of urban development and never reaches a state of exhaustion.

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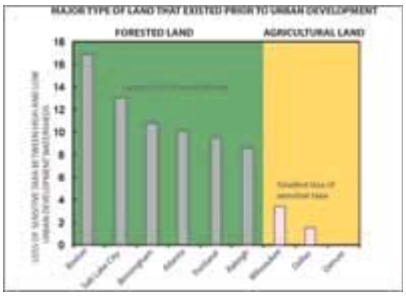
Urban development leads to a loss of sensitive species



Urban development was typically accompanied by a loss of pollution sensitive species and an overall shift in community composition to species that are more pollution tolerant. A substantial decline in EPT species richness occurred in all but the Denver, Dallas, and Milwaukee study areas. This figure indicates the difference in the number of sensitive EPT species found in watersheds at the high end of the urban gradient and at the low end. EPT richness represents the sum of sensitive macroinvertebrate species in the orders Ephemeroptera (mayflies) Plecoptera (stoneflies) and Trichoptera (caddis flies). Measures of EPT richness are commonly used to assess the biological condition of streams in state biomonitoring programs.

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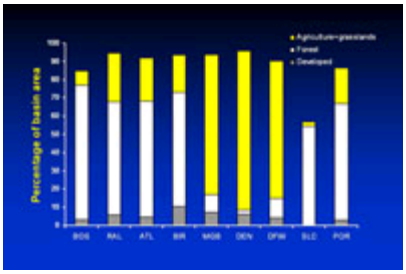
Regional differences exist in land types converted to urban uses



The land cover types being converted to urban uses varied among metropolitan areas. Forest is the predominant pre-urban development land in Portland, Salt Lake City, Birmingham, Atlanta, Raleigh, and Boston; whereas, in Denver, Dallas, and Milwaukee the predominant pre-urban development land cover is associated with some form of agriculture. The type of land cover that is being converted to urban uses is important, as the terrestrial characteristics and activities associated with these two land cover types may mask the influence urban development has on the stream ecosystem. For example, although agricultural practices have evolved dramatically in the last 100 years, nutrient enrichment, soil erosion, monoculture practices, and loss of natural habitat are still major concerns. Watersheds where the predominant pre-urban development land cover is agricultural land already have some degree of water quality impairment prior to urbanization that can obscure the effects of urbanization.

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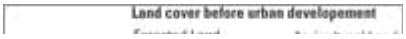
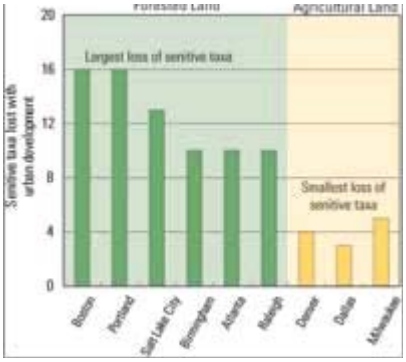
The response of biota was weaker where prior land use activities had already degraded streams



The importance of recognizing the influence of pre-urban



development land use is that the response of stream biota to the stresses associated with urban development is likely to be stronger when urban development occurs in watersheds that have natural flows and vegetation. In Dallas, Denver, and Milwaukee, little variability was seen in the composition of the invertebrate communities across the urban gradient and these communities generally lacked the more sensitive species. The weaker response pattern was not because the biological communities in these three study areas were more resilient to stressors from urban development. Instead, the communities had already endured some degree of degradation that was caused by underlying environmental factors that were associated with prior land use activities. In regions where the response to urban development was clear, much of the change to the invertebrate communities came from a loss of sensitive insect species as well as the increase in more tolerant non-insect species.

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