RAN Fact Sheet

Redesigning the American Neighborhood

Watershed Urbanization and the Energy Cycle of Streams

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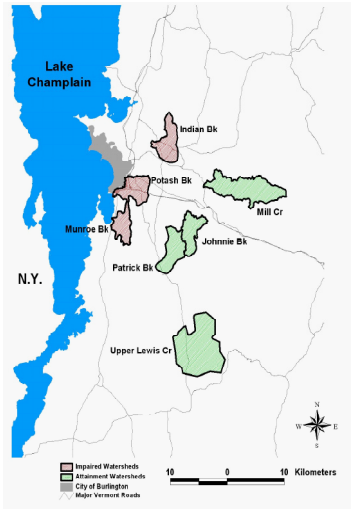
Project Overview

Stormwater-impaired stream near Burlington, Vermont



Locations of study watersheds near Burlington, Vermont

Watershed urbanization may cause an entire suite of impairments to the biological, chemical, and physical conditions of streams and rivers. Yet, despite decades of research, very little is known about how watershed urbanization affects fundamental processes in these important ecosystems.

A purpose of this project has been to determine whether or not differences exist in the *energy cycles* of suburban stormwater-impaired streams and their more pristine rural counterparts.

For two years, we studied both the *structural* (biological communities, water chemistry, habitat, and physical geometry) and *functional* characteristics of seven such streams in Vermont.

So, what is the energy cycle of a stream, and why is it important?

Stream Metabolism

Like the human body, the health of streams and rivers depends on obtaining and processing food resources into usable energy. *Food* for a stream comes from two main sources: (1) material from the surrounding landscape (e.g. leaves), and (2) material that is produced *within* the stream itself. The latter consists primarily of photosynthesizing algae, which are a critical resource for micro-organisms and insects near the bottom of the food web.

While photosynthesis *releases* oxygen and raises its concentration in stream water, respiration *consumes* oxygen as food is converted into energy. Like humans, the plants, insects, fish, and most other organisms in a stream all perform this basic function to sustain life.

The delicate balance between terrestrial and in-stream food resources is important for stream health in Vermont.

If urbanization affects other measures of stream health, how is stream metabolism impacted? To date, scientists have not had a clear answer.

We used a technique known as *whole-ecosystem metabolism* to measure the rate of photosynthesis and respiration in our seven study streams. This technique involves intensive monitoring and construction of a dissolved oxygen budget for a stream segment which determines the contribution from photosynthesis and subtraction by respiration. Thus, we are able to understand the basic relationship between food production and consumption – or the energy cycle of a stream.

RAN researcher measures stream flow, and a stream gauge monitors water level of study streams.

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Results

We observed *accelerated* metabolism in impaired streams which is likely caused by a number of factors (e.g. excess nutrients and sunlight), and may be in part responsible for other degraded conditions in urban and suburban streams in Vermont.

At our suburban stream sites, biological, physical, and chemical surveys provided clear evidence of stormwater-related impacts. The rural sites, on the other hand, were characterized by high biodiversity, stable banks, ample habitat, and good water quality. In addition, despite slower biological reactions, pristine rural streams *process* more organic matter on balance, likely helping to purify the water.

Researcher calibrates field equipment.

In summary, this study has contributed to our understanding of urban stream ecosystem function by demonstrating clear differences – for the first time – in the metabolism of suburban and rural streams.

Conclusions

Ecosystem processes are widely used as indicators of river health and integrity. Assessments of two ecological processes – primary productivity and respiration – are rapidly gaining acceptance as integral components of holistic evaluations of stream health around the world. It is our hope that this study will further encourage the use of ecosystem metabolism assessments in the evaluation of urban and suburban impacted streams.

In northwestern Vermont, we have identified clear differences between stormwater-impaired suburban and comparable rural/attainment condition streams. Results of this study thus provide a yardstick for comparison and future use. We believe stream ecosystem metabolism assessment should take its place with other more traditionally used and accepted biological, physical, and chemical measures of stream health.

Program Consultation and Support

U.S. Environmental Protection Agency
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