

EUSE: Effects of Urbanization on Stream Ecosystems

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EUSE studies

- Started in 1999 (BOS, BIR, SLC)
- Responses to urbanization....
 - Biological (fish, invertebrates algae)
 - Physical (hydrology, temperature, habitat)
 - Chemical (nutrients, pesticides, organics)
- Identify the primary environmental factors associated with these responses
- Develop predictive models

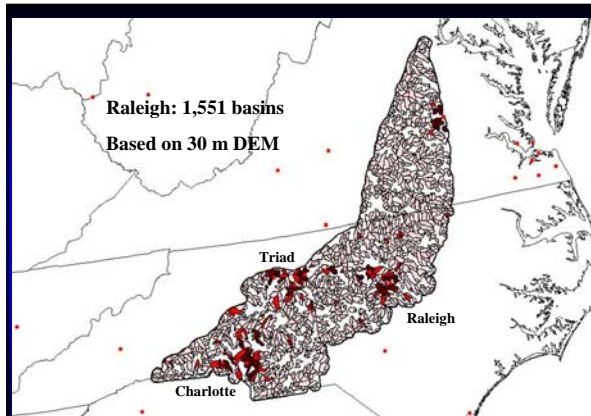
EUSE: Nine metropolitan areas



Study design

- Define a population of basins of similar size (2-3 order) within a study area (Piedmont of NC).
- Divide basins into groups with similar natural environmental features (environmental setting).
- Calculate urban intensity index for each candidate basin.
- Select 30 sites to obtain a representation of the gradient of urban intensity within as homogenous a natural environmental setting as possible.

Raleigh: 1,551 basins
 Based on 30 m DEM



Raleigh Urban Study Area



Verify conditions with field reconnaissance



USGS

Characterizing Urban Intensity

Locally-scaled multimetric index
Nationally-scaled multimetric index

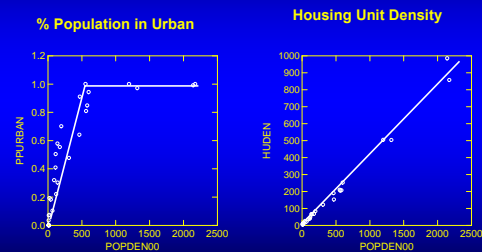
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Variables Considered for Urban Intensity Indices

- **Census variables: 66**
- **Land cover: 87**
 - % Basin area
 - % Buffer area
 - Distance weighted
 - Stream segment
 - Fragmentation (FragStats)
- **Infrastructure: 6**

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Selecting UII variables



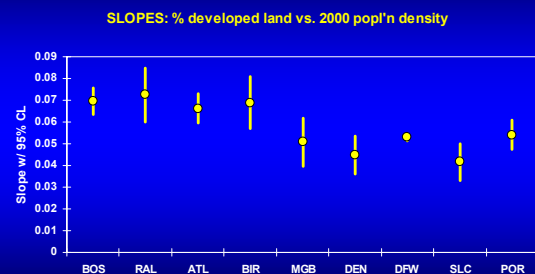
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National Index Variables

- 3-Variables in index:
 - **Housing Unit Density: Census variable**
 - **% Developed Lands: Land cover variable**
 - **Road Density: Infrastructure**
- Range standardized index: 0-100 in each metropolitan area.
- Metropolitan area national urban intensity index (MA-NUII)

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Rates differ by metro area



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Need to adjust urban intensity indices to reflect differences among metropolitan areas

Convert index variables to percentage of values at maximum observed population density



National Index Variables

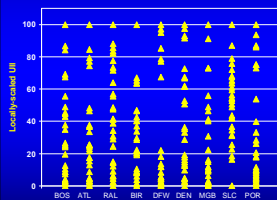
Two indices with different scaling....

- Metropolitan area national urban intensity index (MA-NUII): scaled 0-100 for each metropolitan area.
- National urban intensity index (NUII): scaled 0-100 for all 9 cities based on maximum 2000 population density.

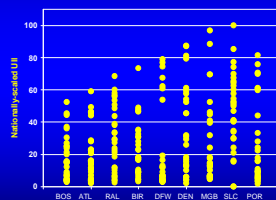


Indicators of Urban Intensity

Local: MA-NUII



National: NUII



Disappearing headwaters: patterns of stream burial due to urbanization

Andrew J Elmore* and Sujay S Kaushal

Headwater streams provide important ecosystem services, including clean drinking water; habitat for aquatic life, and rapid processing and uptake of nutrients, which can reduce delivery of nitrogen and phosphorus to downstream coastal waters. Despite their importance to ecosystem functioning, very little research has addressed the extent to which headwater streams are buried beneath the land surface during urbanization. We measured the occurrence of stream burial within a major tributary to the Chesapeake Bay, for streams with catchment areas ranging from 10 ha to 10⁶ ha. We used hydrologic modeling to identify where streams should be and then calibrated a map of impervious surface area using high-resolution aerial photography to build a stream channel decision-tree classification. We found that 20% of all streams were buried, with streams in low-residential and suburban areas outside Baltimore City exhibiting 19% burial rates. Smaller headwater streams were more extensively buried than larger streams, and this difference increased with increasing impervious surface area. Within Baltimore City, 66% of all streams and 70% of streams in catchments smaller than 260 ha (1 mi²) were buried. In this densely urbanized city, headwater streams are buried to the same extent as is dry land.

Front Ecol Environ 2008, 6, doi:10.1890/070101

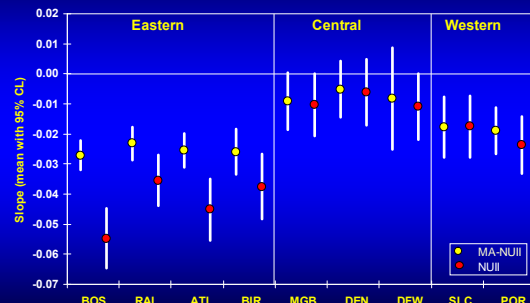


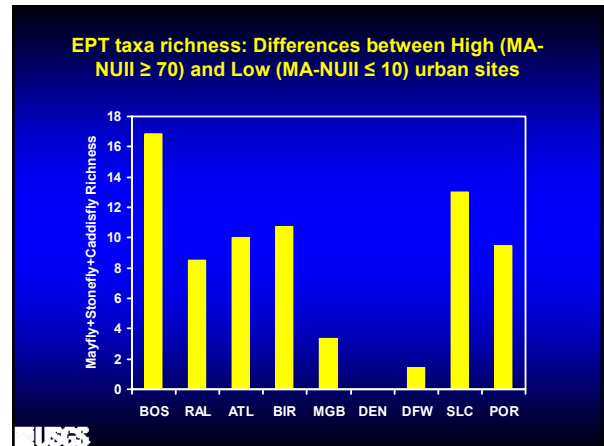
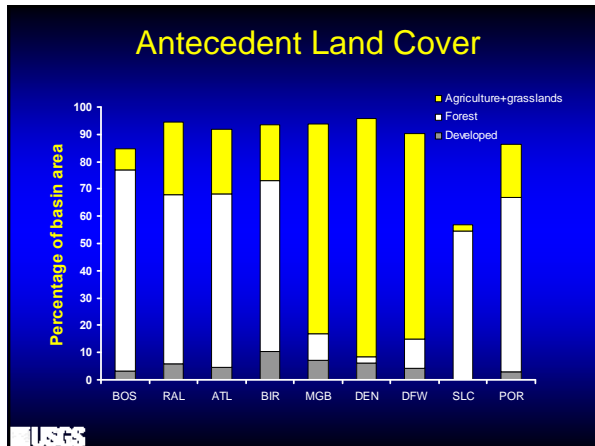
Sampling

- Biota (invertebrates, fish, algae) once at summer low flow.
- Water chemistry:
 - low- and high-base flow sampling (nutrients, pesticides, field parameters).
 - Semi-permeable membrane devices (SPMD): lipophilic compounds (pesticides, PAHs, etc.): 4-6 week deployment
- Hydrology: continuous stage.
- Water temperature: continuous.
- Habitat: once at 11 transects.



Invert Response: MA-NUII & NUII





Environmental variables strongly correlated with invertebrate responses

Census	Chemistry
Popl'n density (5/9)	Conductivity (3/9)
Housing density (5/9)	Sulfate (3/9)
% popl'n in urban (5/9)	Pesticides detected (4/9)
Land cover	Toxicity: TEQ (4/9)
% developed (5/9)	Hydrology
% impervious (5/9)	Flashiness: rise/fall (2/9)
Infrastructure	Temperature
Roads (5/9)	Summer average (3/9)
	Habitat (1/9)

Urbanization and responses to urbanization are strongly affected by local and regional scale variables

Need a relatively straight forward method of incorporating local and regional predictors

Hierarchical Multilevel Modeling

Cooperative project between USGS and Duke University

- Overview: Song Qian
- Invertebrate responses: Roxolana Kashuba and Boknam Lee
- Fish and algae: Ibrahim Alameddine and Yoon Kyung Cha