



# Urbanization and Stream Ecosystem Sustainability

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- How do stream ecosystems (biophysical and chemical environment) respond to land-use changes associated with urbanization?
- How can this information and knowledge be used to promote sustainability of urban environments and stream ecosystems?



# Streams with high levels of urbanization



Salt Lake City, UT



Boston, MA



Birmingham, AL



Pilot study areas

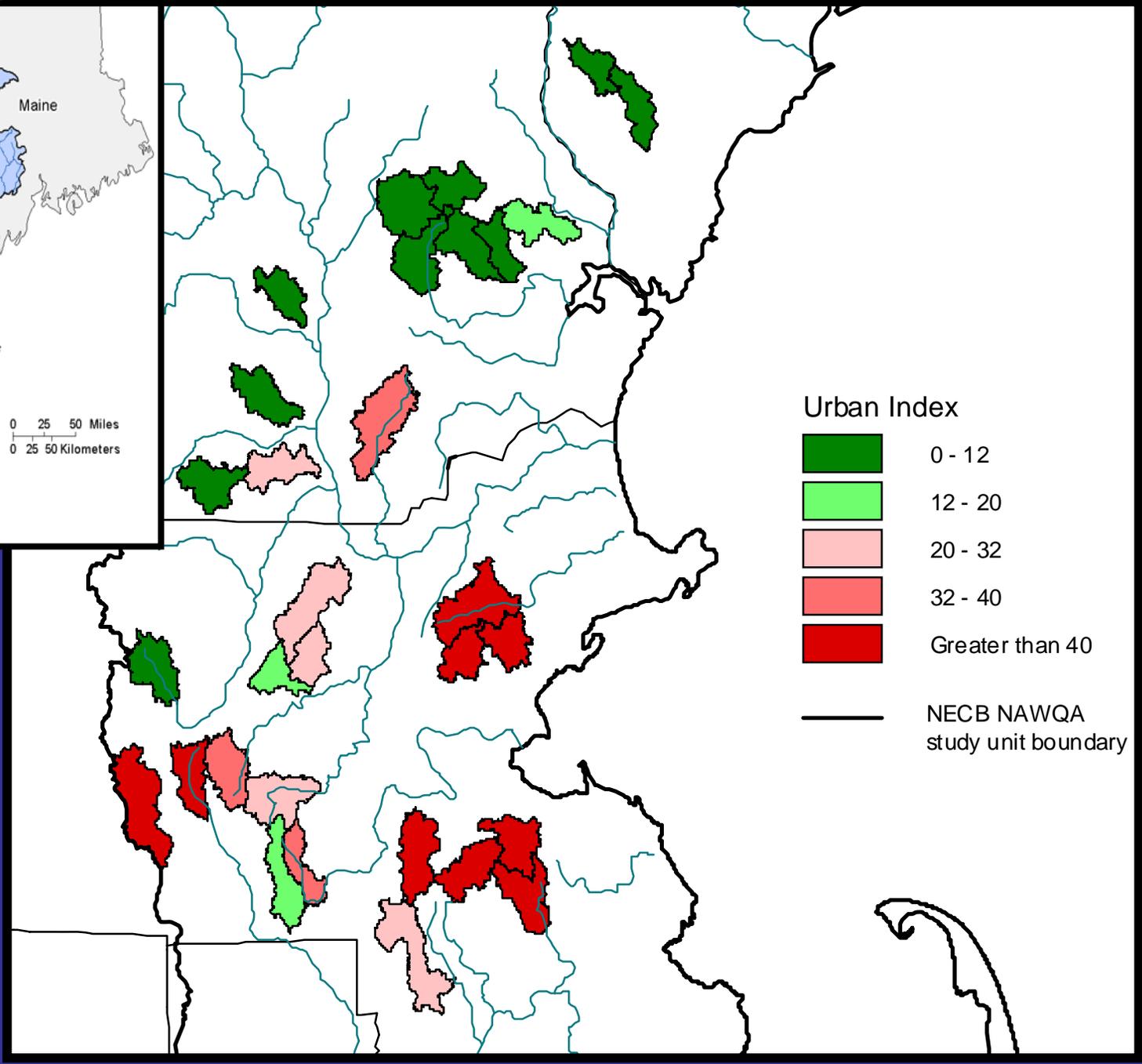
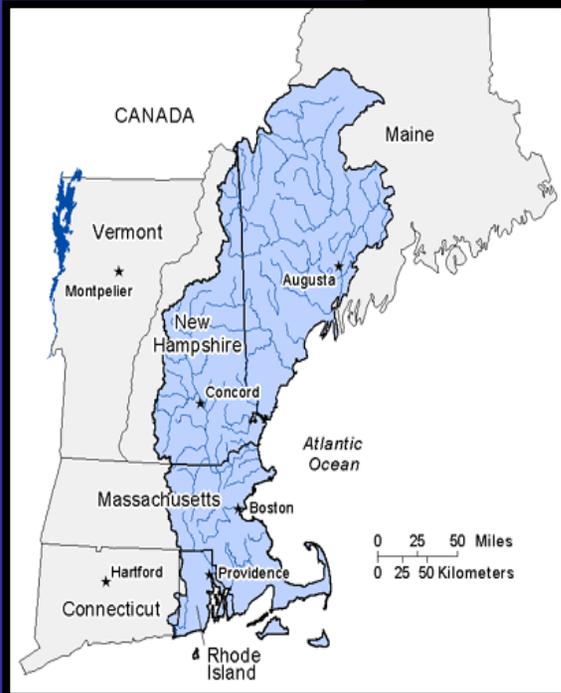


# Urban Intensity Index

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- Multimetric index based on population density, infrastructure, socioeconomic factors, and land-cover\*. Range of values increase with urbanization from 1 to 100
- Consistent and objective indicator of urbanization for site selection and data analysis.

\* McMahan and Cuffney, 2000 <http://water.usgs.gov/nawqa/ecology/pubs/index.html>

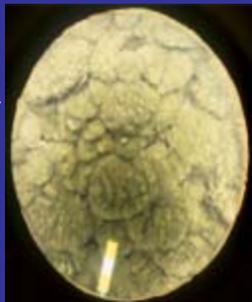




# Physical and Chemical Responses to Urbanization

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- **Habitat quality declined with urbanization due to increases in siltation and embeddedness**
- **Specific conductance and the number of pesticides detected increased in all studies**
- **Total nitrogen increased in Boston**
- **Total phosphorus increased in Salt Lake City and Boston**
- **No nutrient response in Birmingham.**

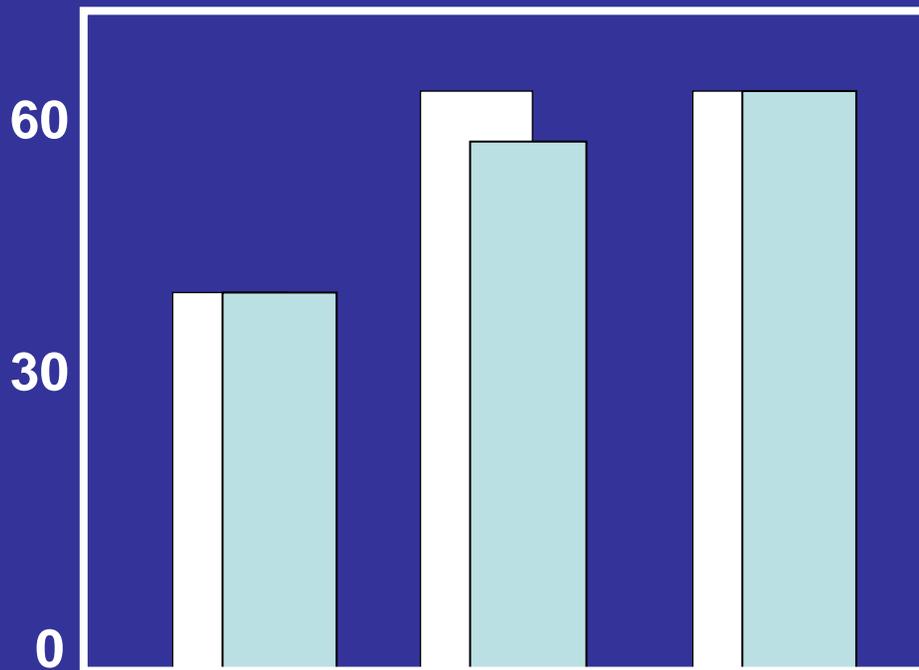


**Siltation**

**Substrate  
Embeddedness**



**Siltation (%)**



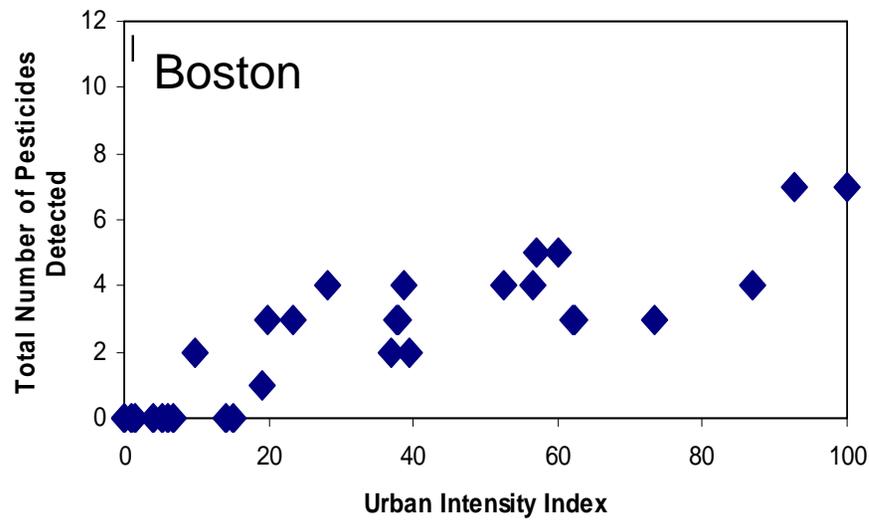
**Embeddedness (%)**

**Urban Intensity Index**

**Low <30**

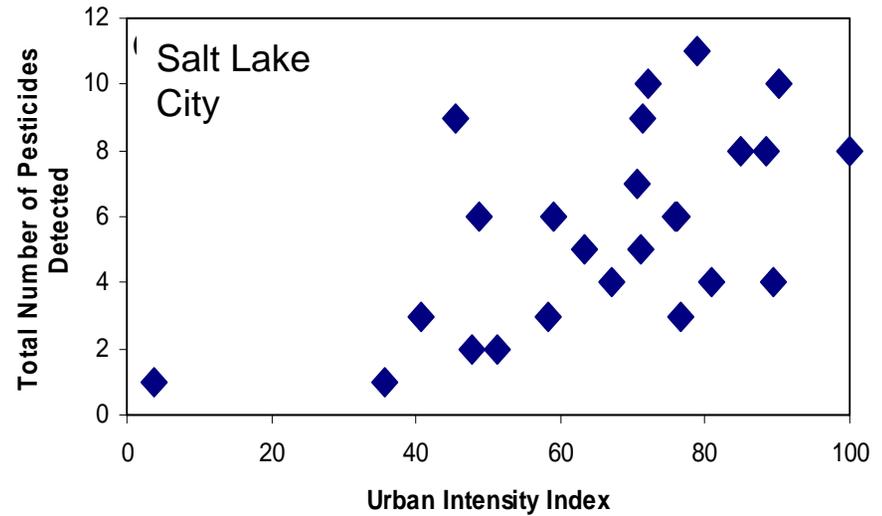
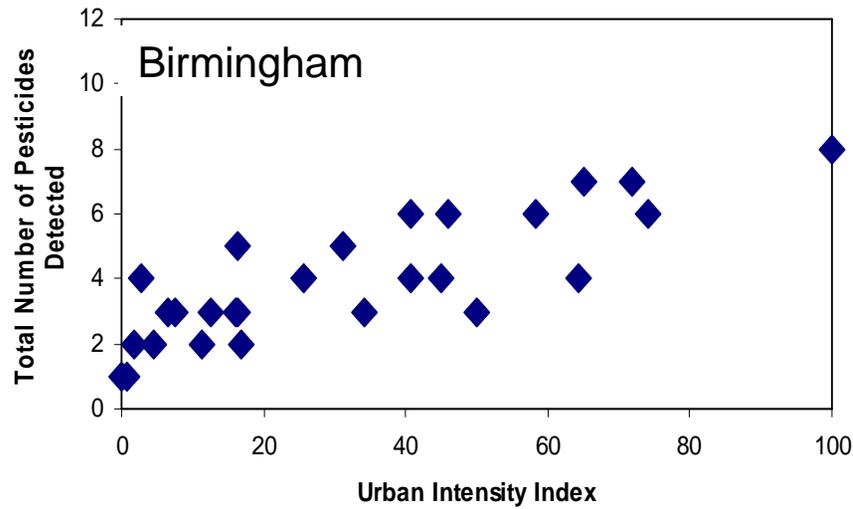
**Moderate 30-60**

**High >60**



**Total number of pesticides increased with urbanization**

**Common insecticides were diazinon and chlorpyrifos**



**Spearman rank correlations**



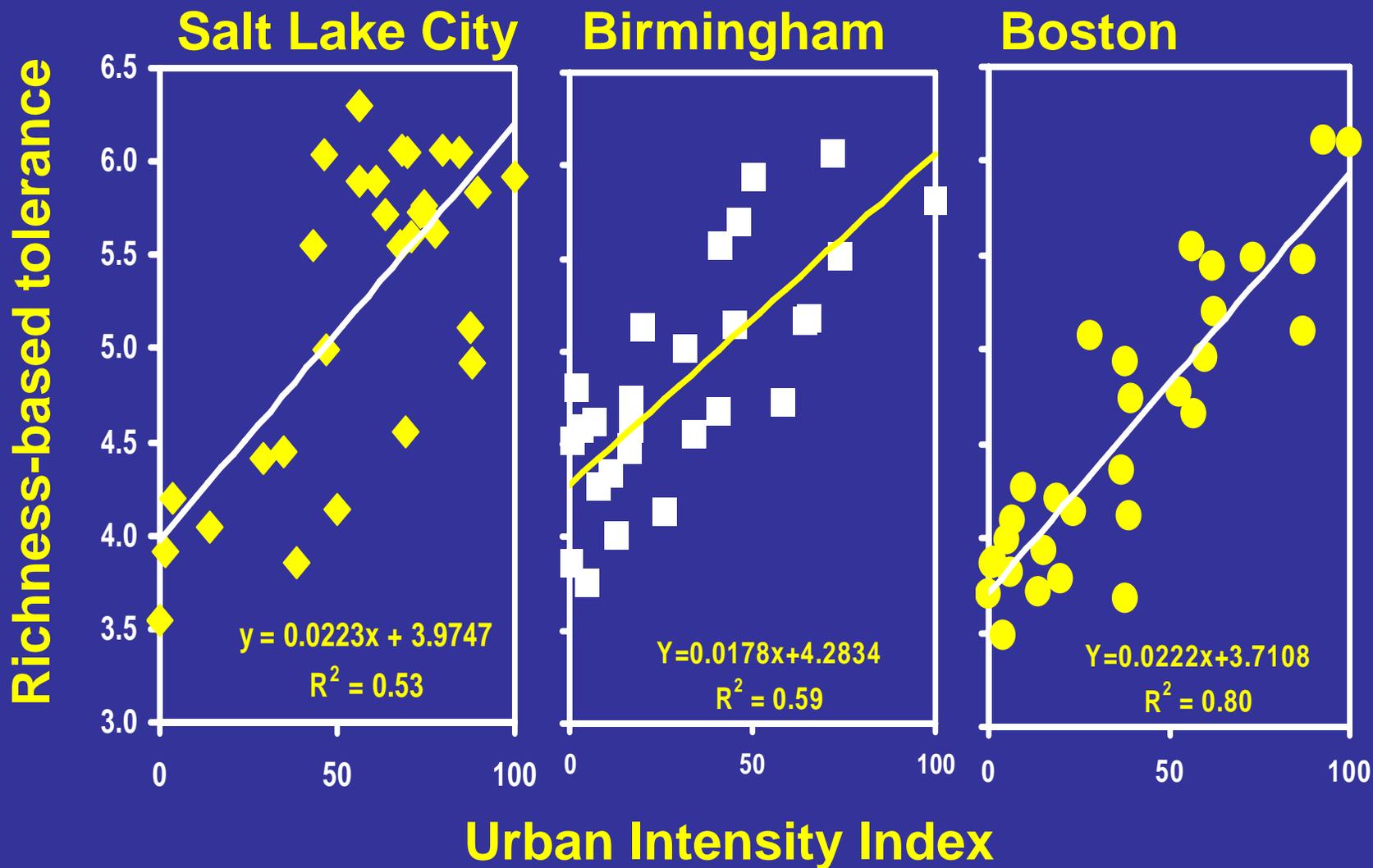
# Response of Aquatic Invertebrates and Fish to Urbanization

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- **The number of pollution tolerant aquatic invertebrate species increased with urbanization.**
- **Fish species richness declined with urbanization in Boston and Birmingham**



The number of tolerant aquatic invertebrate species increased with increased urban intensity



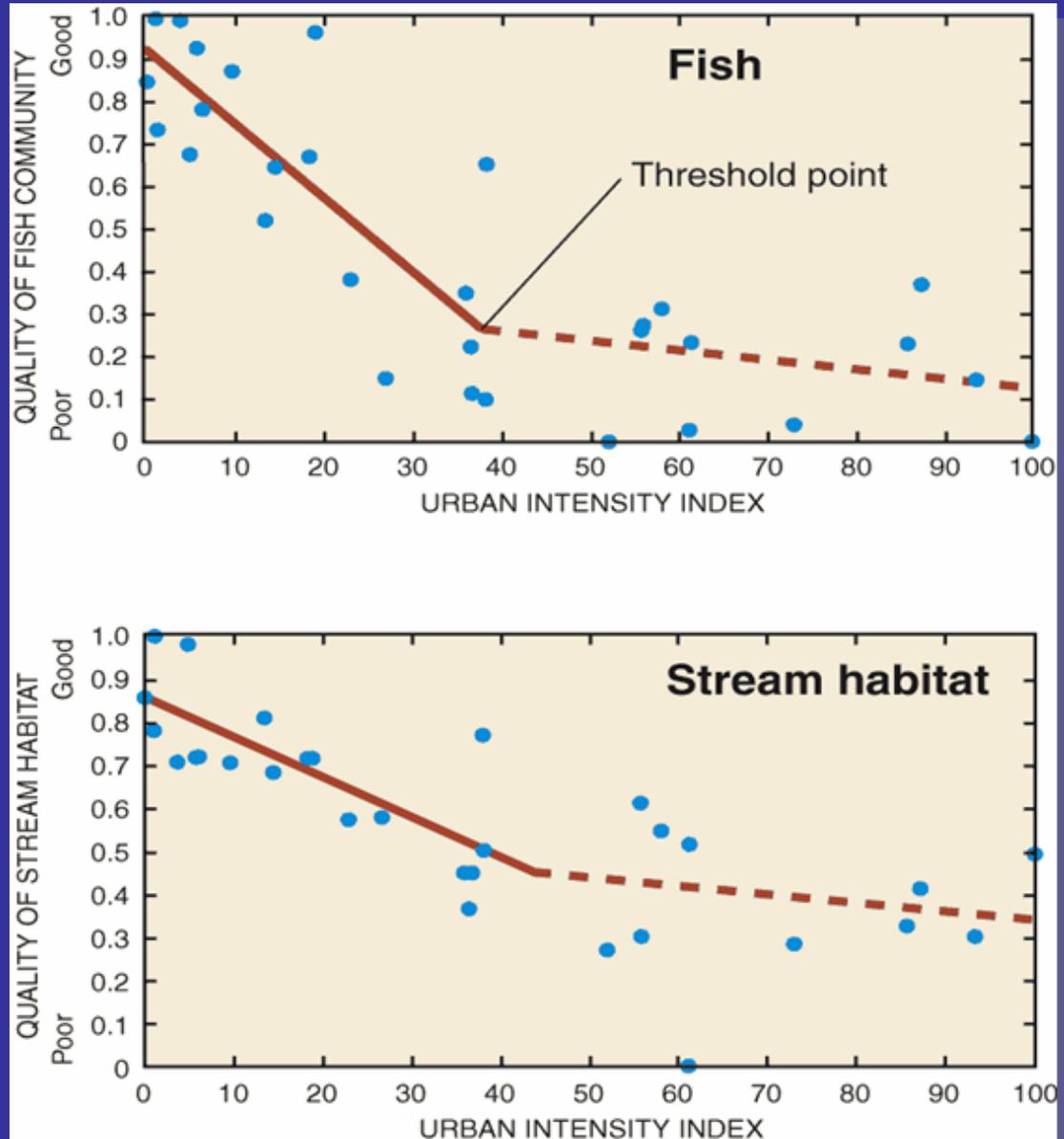


# Boston

- Stream ecosystems showed change with as little as 3-4% urbanization in the watershed

- From 3-20% urbanization, significant changes occurred**

- Greater than 20% urbanization, the change slowed or stopped – this was the threshold point**





# Summary

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- **Urbanization negatively affects stream ecosystems through alteration of physical habitat, increases in contaminants, and negative responses in aquatic communities.**
- **This negative effect begins at very low levels of urbanization and responses vary regionally and among aquatic organism groups**



*“A Decision Support System (DSS) is a spatially based computer application or data that assists a researcher or manager in making decisions”* (UMESC, 2003)

...decision support, not decision making...

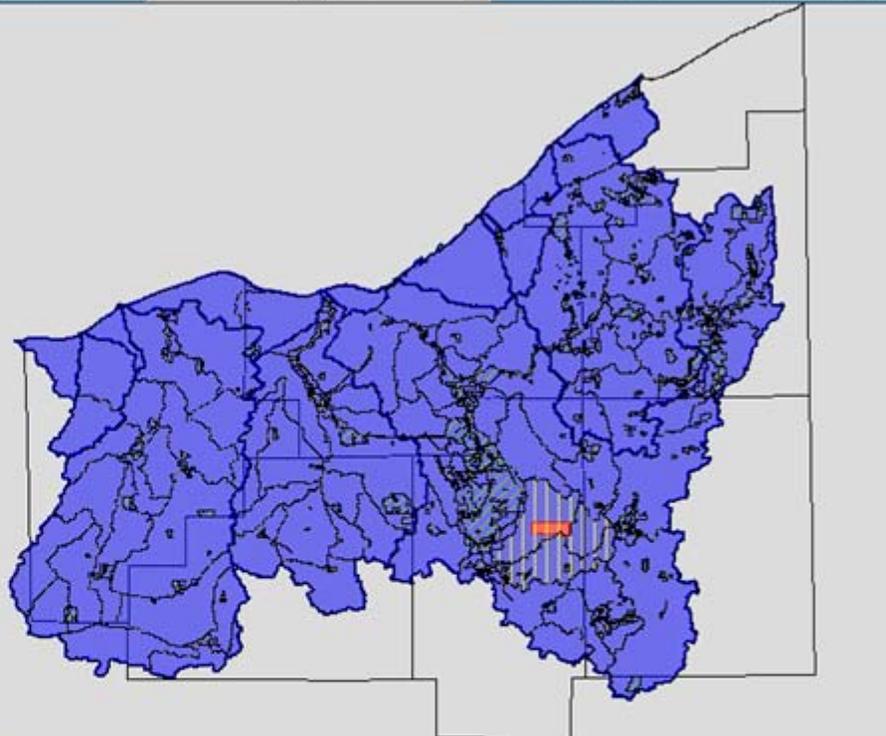


information or labels Layer Fields Scale 1: 805,906 Y: 466,904.70

- Counties
- Federal Highways
- Townships
- State Roads
- Local Roads

- STUDY\_STEWARD
- STUDY\_HUC14
- STUDY\_MAJ-HUC
- STUDY\_COUNTIES

- CNA\_1004 (Cna\_des)
- 100-year floodpl
- SB/WB steep sk
- WB 100-year flo
- SB/WB forest
- SB 100-year floo
- WB 100-year flo
- WB 100-year flo
- WB 100-year flo
- SB/WB 100-year
- SB 100-year floo
- SB/WB wetland:
- SB/WB wetland:
- SB steep slopes
- SB/WB 100-year
- SB forest
- WB steep slopes
- SB 100-year floo
- WB forest
- wetlands buffer (
- SB/WB 100-year
- SB/WB 100-year
- WB 100-year flo
- SB/WB 100-y
- SB forest/steep



Cancel DSS

Project Shape:

Clear Shape

Polygon

Select Shape

Show BMPs

Line

Select County

Zoom!

or

Select Township

Zoom!

or

Select Watershed

Zoom!

The study area may affect wetlands. See the wetlands web links in the documents section for further information about wetlands.

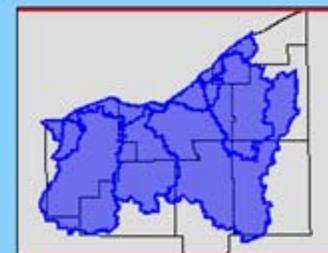
Field: units (layer name, field name)

04110002-040-020 Mud Brook  
04110002-030-030 Fish Creek  
04110002-030-010 Cuyahoga River below Breakneck Cr. to above L

Watershed Scale

- Project area
- Tributary-level watershed (14-digit Hydrologic Unit (HU))
- Mainstem-level watershed

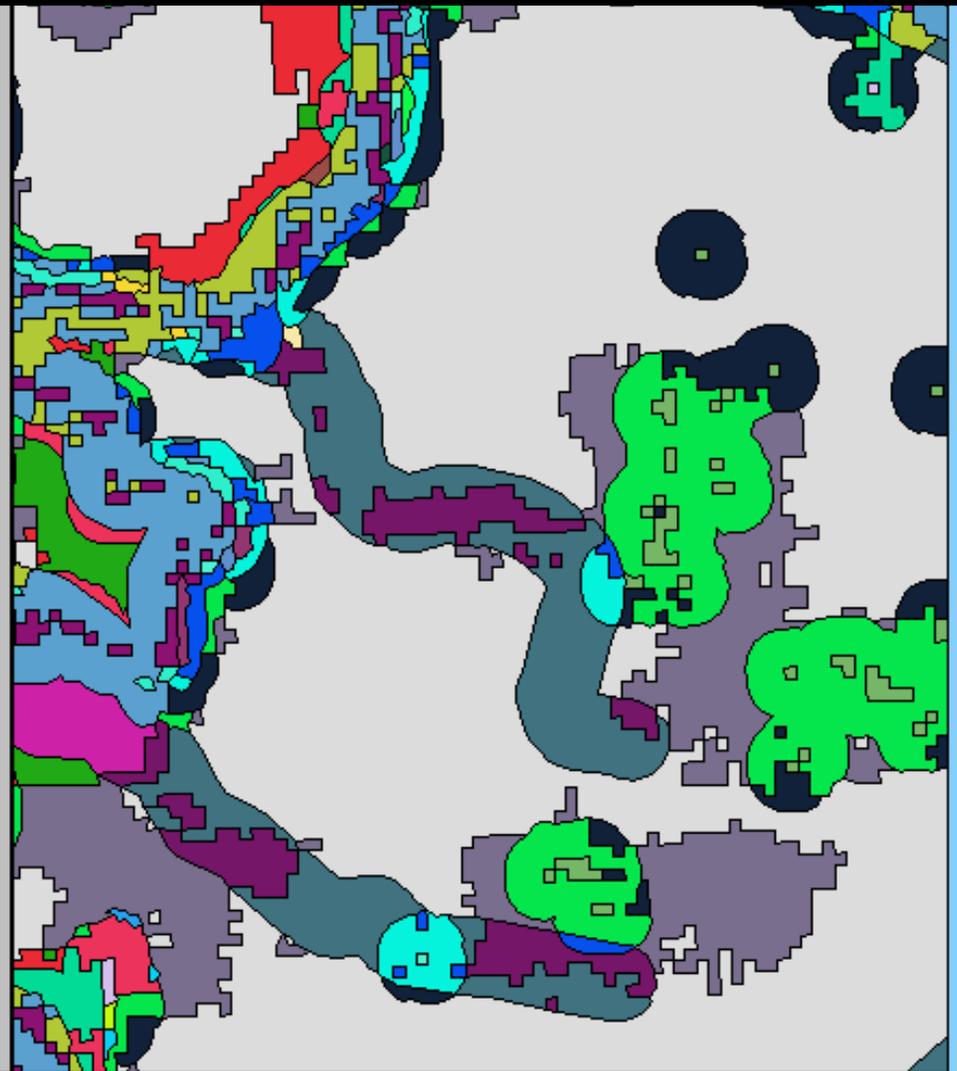
Export 14-digit HU List and Map



Single click to highlight watershed. Double click to open report.

# A GIS Data Viewer shows where sensitive environmental layers are located within a planning area

- CNA\_1004 (CNA\_DESCRI)
- 100-year floodplain/steep slopes (>15%)
  - SB/WB steep slopes (>15%)
  - WB 100-year floodplain/wetlands
  - SB/WB forest
  - SB 100-year floodplain
  - WB 100-year floodplain/steep slopes (>15%)
  - WB 100-year floodplain/wetlands/steep slopes (>15%)
  - WB 100-year floodplain/forest
  - SB/WB 100-year floodplain/wetlands/steep slopes (>15%)
  - SB 100-year floodplain/forest
  - SB/WB wetlands/steep slopes (>15%)
  - SB/WB wetlands
  - SB steep slopes (>15%)
  - SB/WB 100-year floodplain/forest/steep slopes (>15%)
  - SB forest
  - WB steep slopes (>15%)
  - SB 100-year floodplain/forest/steep slopes (>15%)
  - WB forest
  - wetlands buffer (WB) only
  - SB/WB 100-year floodplain/wetlands
  - SB/WB 100-year floodplain/forest
  - WB 100-year floodplain/forest/steep slopes (>15%)
  - SB/WB 100-year floodplain/steep slopes (>15%)
  - SB forest/steep slopes (>15%)
  - stream buffer (SB) only
  - forest only
  - forest/steep slopes (>15%)
  - SB/WB forest/steep slopes (>15%)
  - WB wetlands
  - 100-year floodplain only
  - stream buffer (SB) /wetland buffer (WB) only
  - SB 100-year floodplain/steep slopes (>15%)
  - WB forest/steep slopes (>15%)
  - SB/WB 100-year floodplain
  - 100-year floodplain/forest/steep slopes (>15%)
  - WB 100-year floodplain





# Best Management Practices (BMP) Report

## New & Improvements

Project increases impervious surface or size of footprint in the watershed.

Impact: Potential for significant impact on watershed with changes to hydrology, resultant run-off of pollutants, and habitat alterations.

### *Planning*

- Using the DSS tool
- Project need should be carefully evaluated
- Project planning for alternative routes is recommended
- Manage changes to hydrology

### *Construction*

#### Changes to Water Quality

-Maintain erosion and sediment controls to protect stream quality and prevent turbidity.

#### *Good Housekeeping:*

- General construction site waste management
- Spill prevention and control plan
- Vehicle maintenance and washing area
- Contractor certification and inspector training

- Planning, Construction, Post-Construction Phases
- Reports designed to be first step, not conclusive BMP manual