

# Ecosystem Vulnerability: Assessment Approaches from EPA's Regional Vulnerability Assessment (ReVA) Program

***Betsy Smith, Ph.D.***

***Sustainable and Healthy  
Communities Research Program***

***CEC JPAC Workshop  
Merida, Yucatan, Mexico***



# *What Makes an Ecosystem “Vulnerable”?*

- Condition

Pristine, Good, Stressed, Degraded

- Sustainability

f (ecosystem sensitivity, resiliency; stressors affecting)

- Value to Society

Aesthetics, Economic Opportunities, Goods and Services

## *What Drives Risk Management Decisions?*

- Feasibility, Clear Options, Economics

What works where?, Range of method applicability

# ReVA Overview

## Problem

Given multiple stresses affecting multiple endpoints simultaneously, how can limited resources be targeted to maximize benefits and minimize problems?

How do we incorporate various perspectives to balance among competing priorities?

## Clients

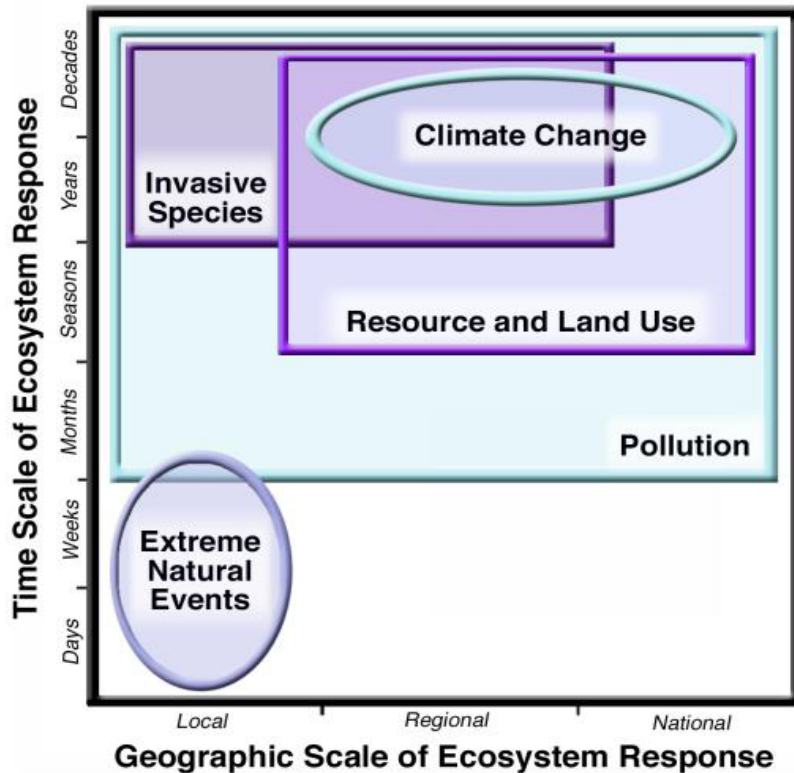
EPA Regional Offices (enforce regulations)

EPA Program Offices (set regulations)

State and Local Decision-makers (manage compliance with regulations)

*....Anyone faced with this and no tools at hand to do it well...*

# *Future Scenarios: Projections of Major Drivers of Ecological Change*



In the US, despite compliance with environmental regulations, biological populations are continuing to decline.

Major drivers of change include:

- Land use change

- Resource extractions

- Pollution and pollutants

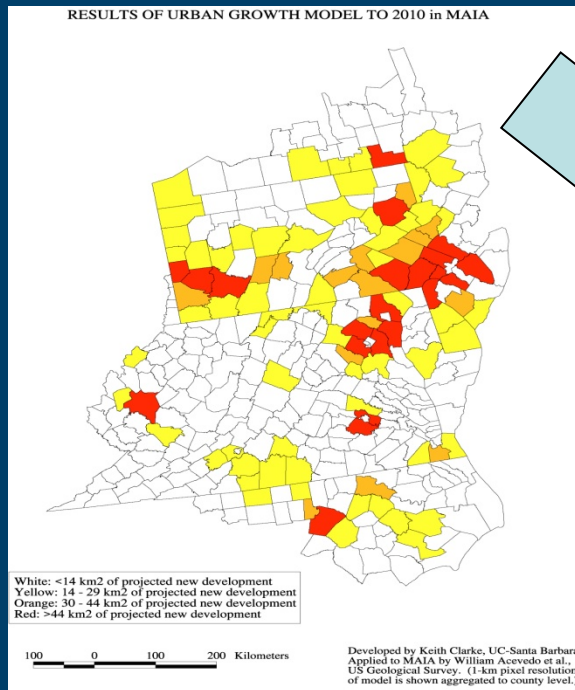
- Exotic invasive species

- Climate change

# Projecting Land Use Change

Suite of methods:

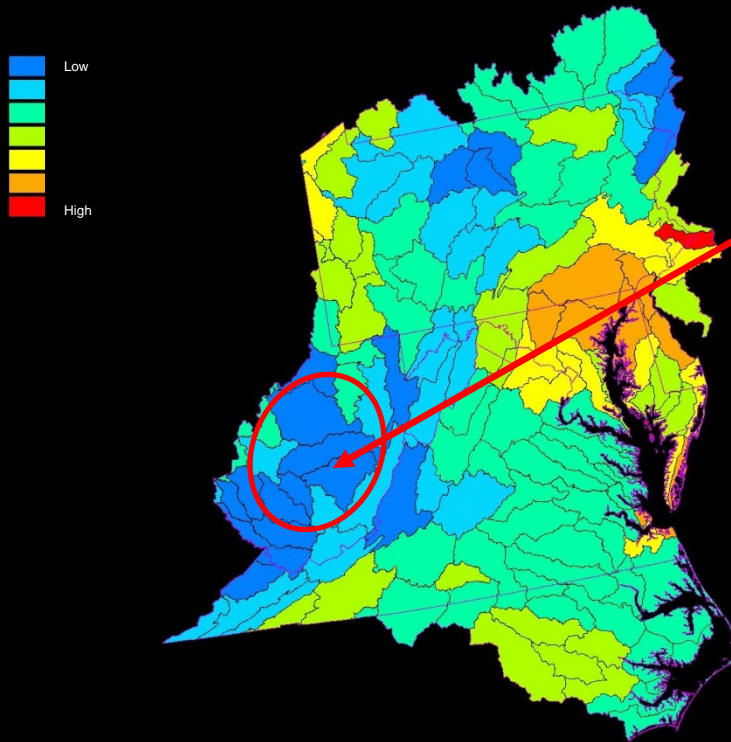
- Economics
- Planned roads, developments
- Rural and urban change



Input into decisions affecting

- Conservation of native biodiversity
- Increased risk of flooding
- Nonpoint source pollution
- Urban sprawl/quality of life
- Drinking water quality and supply
- Pests and pathogens in forests
- Economic opportunities

# Resource Extraction and Special Areas



Current patterns of forest fragmentation

Globally-unique area in terms of intact, deciduous, temperate forest

Among the most biodiverse areas  
Habitat for large migratory species

Highest unemployment in region

Targeted by

Mountain-top removal mining  
Expansion of chip mills from SE

Potential Impacts on

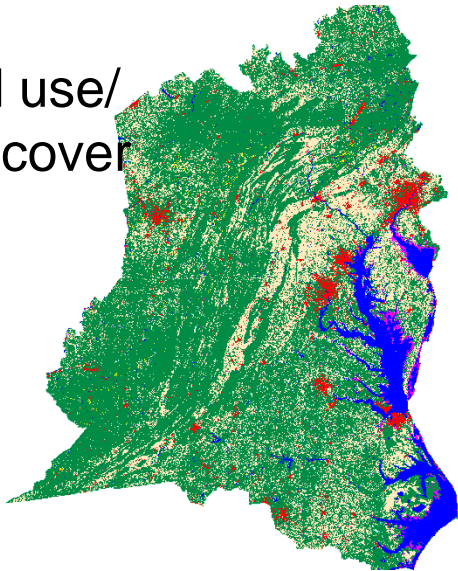
Native biodiversity  
Water quality  
Quality of life



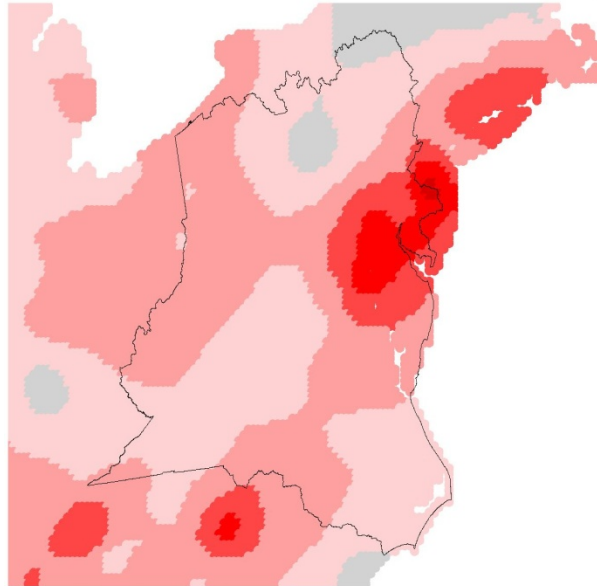
# Current and Future (2020) Projections for the Mid-Atlantic Region

## Drivers of Ecological Change

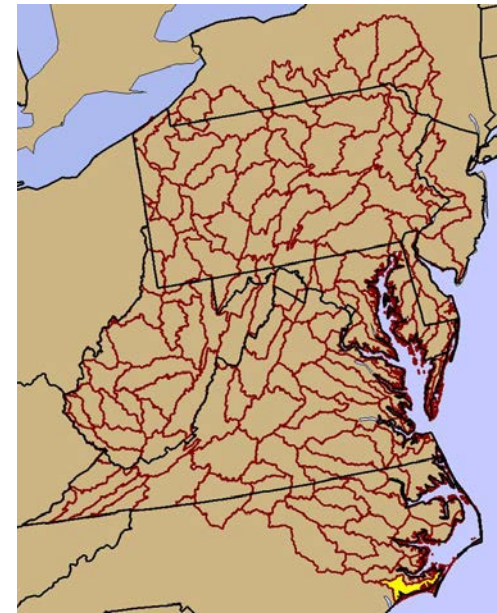
Land use/  
land cover



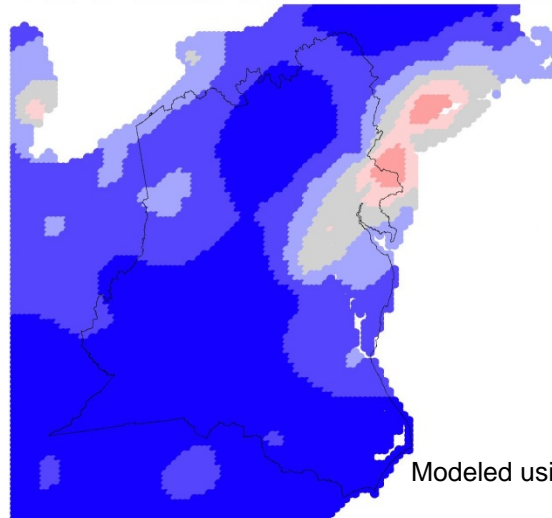
2001 Clear Skies Ozone Design Value



Giant Salvinia

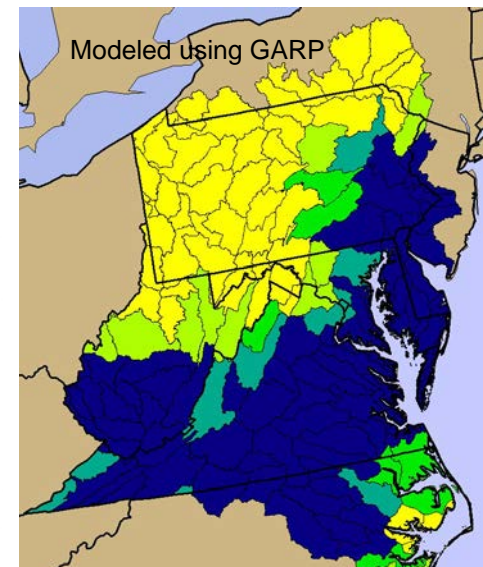


2020 Clear Skies Ozone Design Value

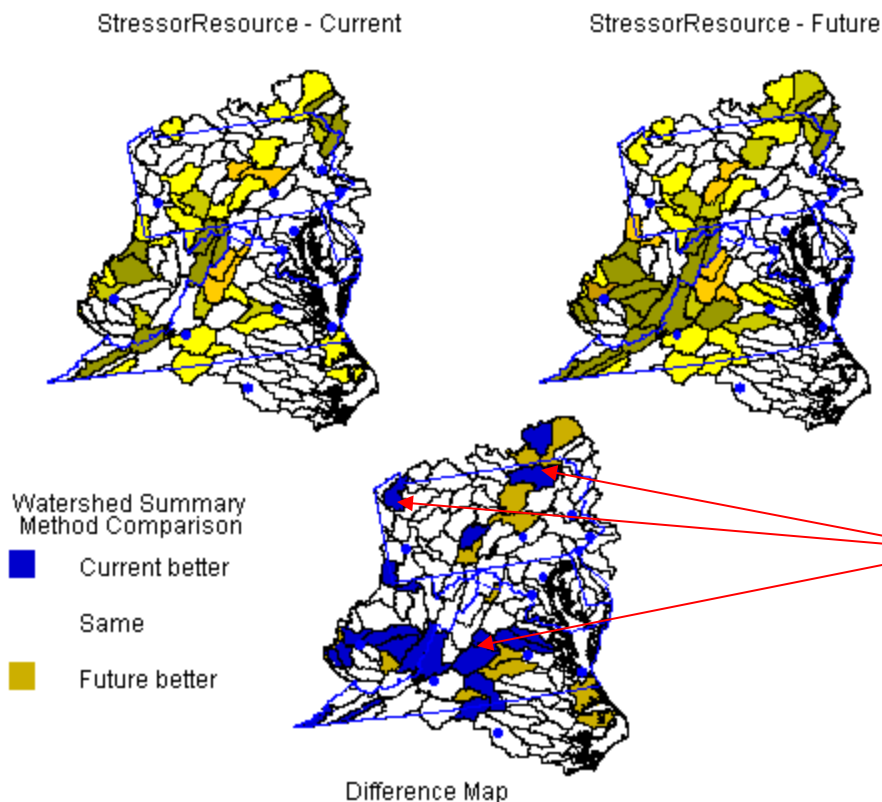


Modeled using SLEUTH

Modeled using CMAQ



# *Where will valued resources be subjected to additional stress?*



*Use by EPA  
Regional Offices to  
prioritize  
management  
options*

Watersheds in blue are candidates for use of Region 3's discretionary funds for water monitoring, continuing existing projects, initiating new projects, partnerships with local communities for responsible development.....



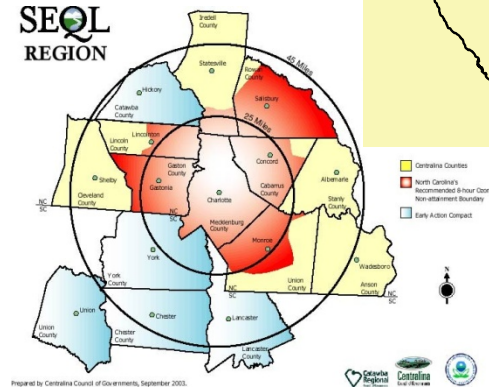


United States  
Environmental Protection  
Agency

# Demonstrating Trade-offs

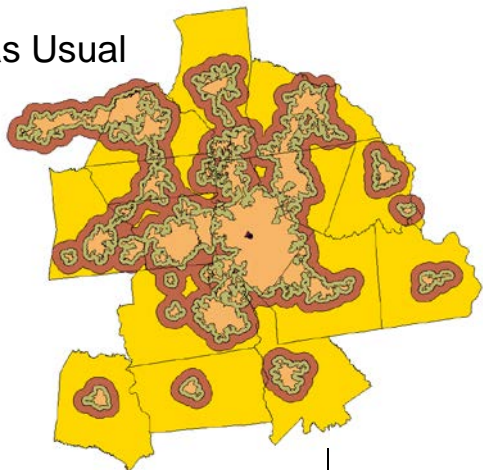
## Sustainable Environment for Quality of Life

- Promotes integrated planning to protect the environment and quality of life while promoting economic win-wins
- Landmark regional partnership for integrated planning
- One of the first of its kind in the nation
- 15-county region, encompassing approximately 10,000 square miles
- Federal, State, and Local Governments in partnership

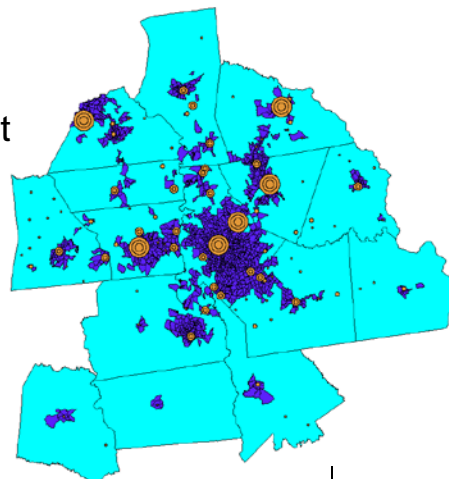


# Choices: Development Alternatives

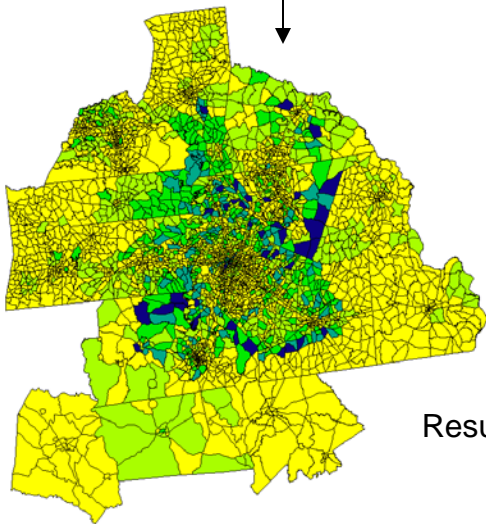
Growth as Usual



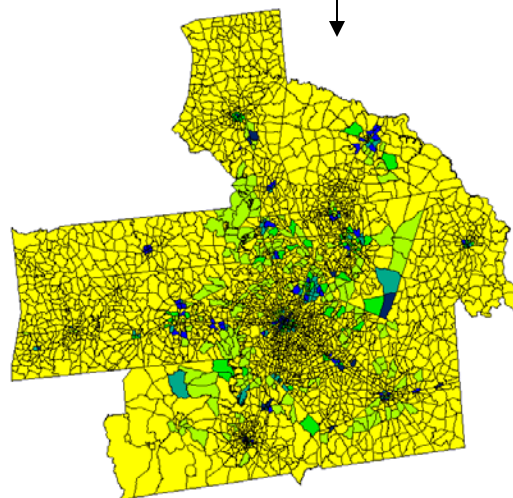
Centers of  
Development



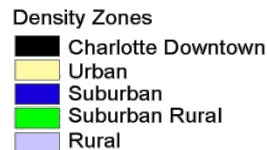
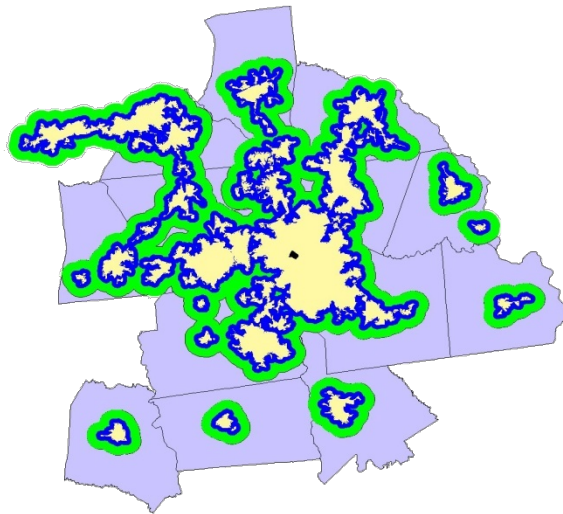
OR



Resulting patterns of land  
consumption

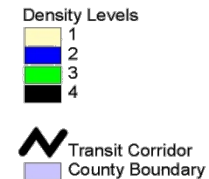
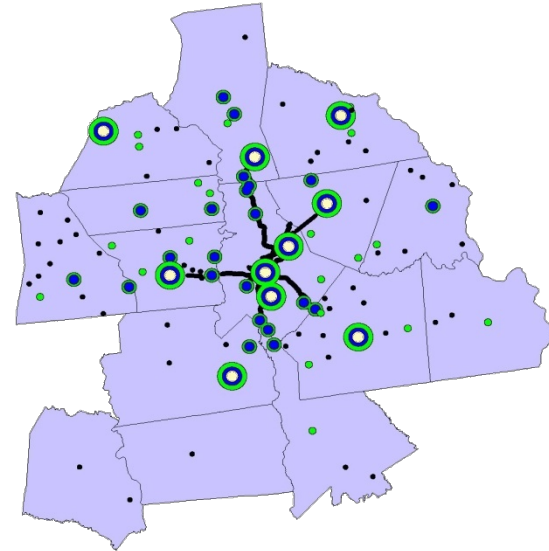


# Alternative Scenarios of Development



## Medium Density Development

- Fewer Houses per Acre
- More Land Consumption
- Decentralized Employment
- Growth Less Linked to Transit



## Compact Centers Development

- More Houses per Acre
- Less Land Consumption
- Centralized Employment
- Growth Linked to Transit

# Regional Growth Decision Tool

[About the RGDT](#)[How can I use the RGDT?](#)[Use the RGDT](#)[What is SEQL?](#)[What is ReVA?](#)[Home Page](#) > [Levels of Detail](#) > [Executive Summary](#) > [SEQL Overview Map](#)

## View Scenario Maps

Select Layers to Display:

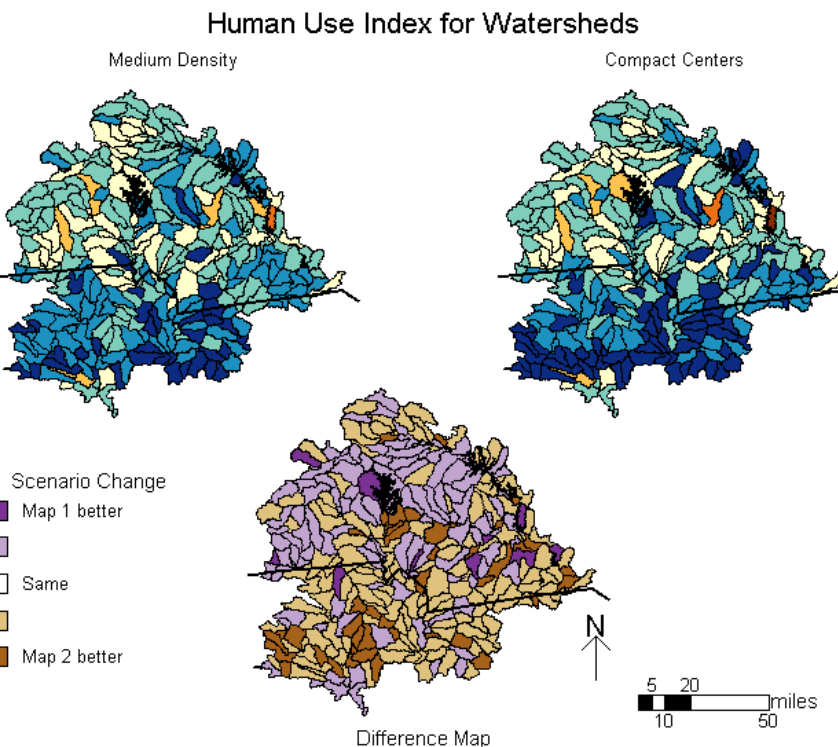
- ☐ County Lines
- ☐ Cities
- ☒ State Boundary
- ☐ Interstate Roads

[<< Back](#)[Redraw Map](#)

### Human Use Index for Watersheds

#### Variables

- Percent any agricultural land
- Total agriculture land on steep slopes (9% slope)
- Percentage of land that is edge forest class
- Road density
- Crop land cover along streams - 60 meters
- Percent urban landcover

[Print File](#)

If you would like more detailed data, please go to the [Management Summary page](#).

**Demonstrations - Display Maps Comparing Variables for All of SEQL - Microsoft Internet Explorer**

File Edit View Favorites Tools Help

Back Forward Stop Home Search Favorites Media Print Mail News RSS Feeds

Address <http://www.waratah.com/revanew/ToolkitDemonstrations/VariableSummaries/CompareIndMaps.asp?Indicator1=DISSOLVEDP&area=8&IndGroup1=W&Indicator2=DISSOLVI> Go Links

**Compare Variables**

First map groups Water

First map data Dissolved phosphorus

Data for second map Higher density scenario

Second map groups Water

Second map data Dissolved phosphorus

Construct Maps

**Low Density**  
Lower density scenario-Dissolved phosphorus (kg/ha/yr)

**High Density**  
Higher density scenario-Dissolved phosphorus

**Net Changes, all metrics combined**

Watersheds in yellow showed better overall conditions resulting from high density development over low density (sprawl)

**Watershed Summary Method Comparison**

- LHS +2 groups
- LHS +1 group
- Same
- RHS -1 group
- RHS -2 groups

**Difference Map**

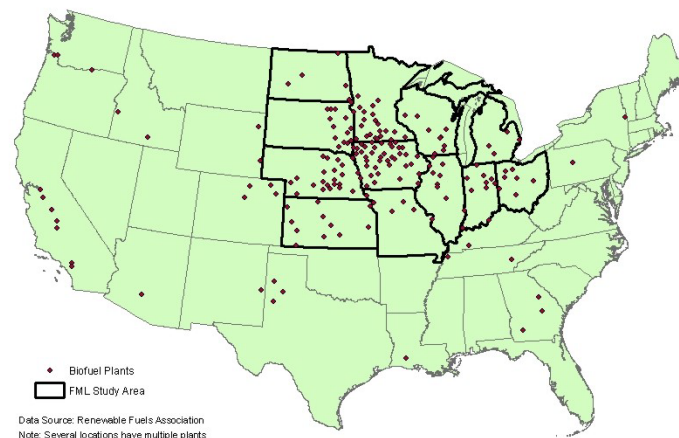
Done Internet



# Change drivers of interest for Midwestern place-based study

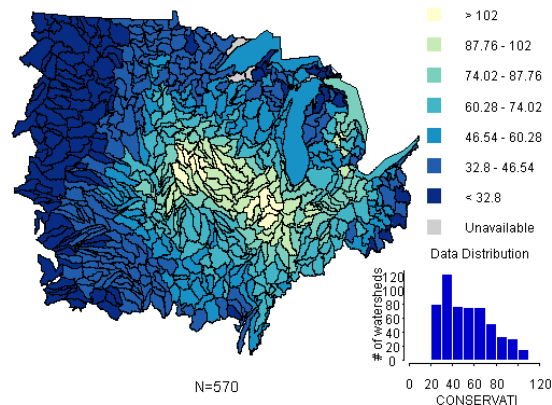
*Energy Independence and Security Act  
mandates increased production and use of  
biofuels*

- Biofuels
  - Potential for rapid, large-scale changes in land use or land management
  - Implicit trade-offs among ecosystem services
- Agricultural conservation practices
  - Existing area of large investment, uncertain benefit
  - Increasing interest in ecosystem service-based incentives and markets

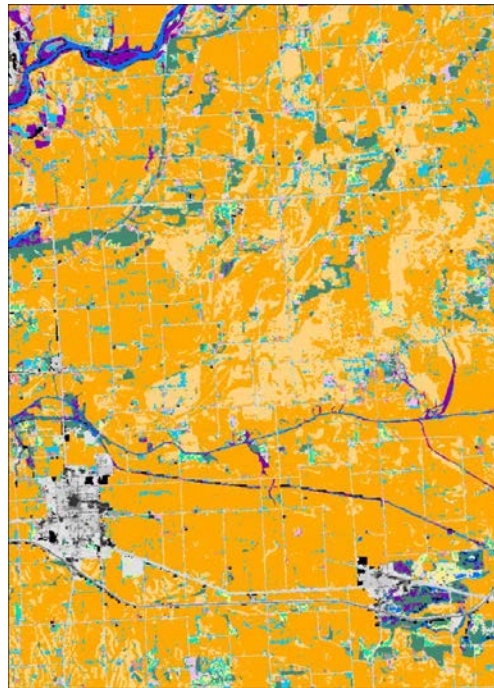


Locations of ethanol biorefineries and FML boundary

## Conservation Reserve Program Participation (\$/acre)



## Projection of 2022 landscape changes due to biofuel targets: Parcel change from corn/soybean to continuous corn



*Detail for Corn Belt area in Illinois*

In the Corn Belt, corn/soybean rotation will change to continuous corn, requiring greater chemical inputs and depleting soil productivity

Base Year (2001) Biofuel Targets (2022)



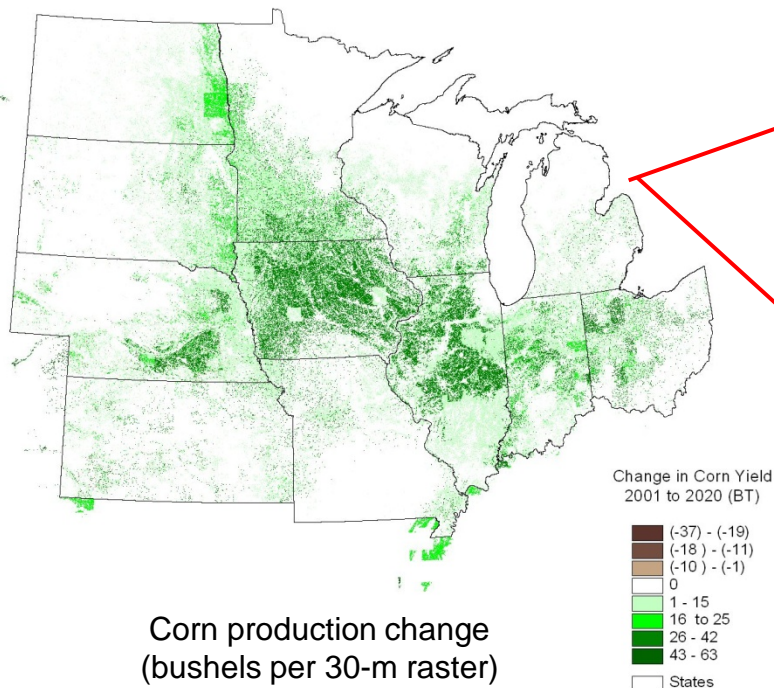
Corn/soybean  
rotation



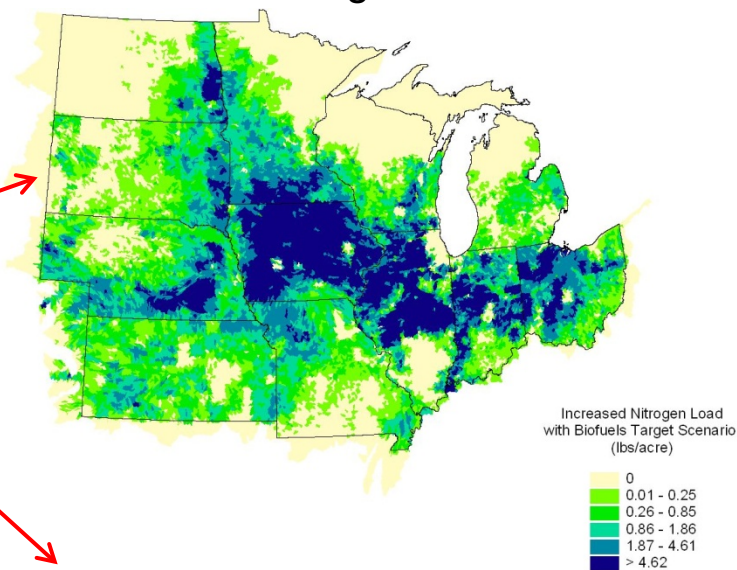
Continuous  
corn

# Implications of Forecast Change:

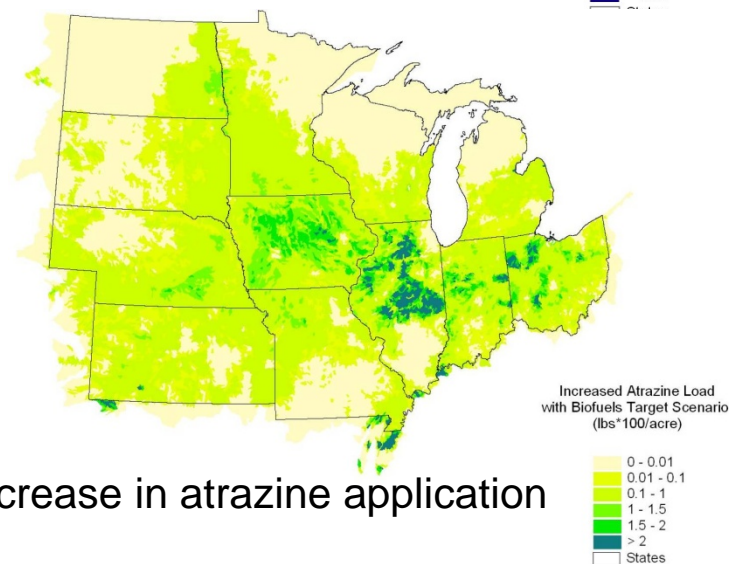
Increase in corn production



Increase in nitrogen fertilization

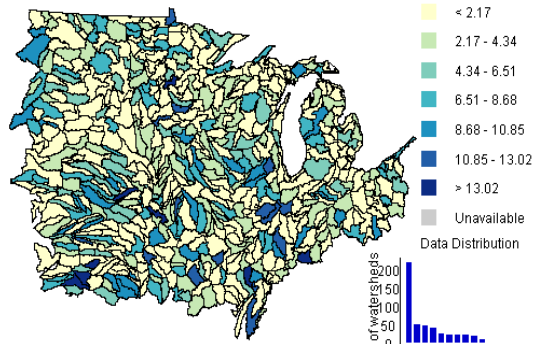


Increase in atrazine application

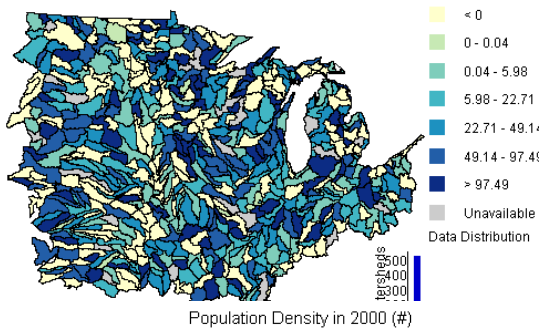




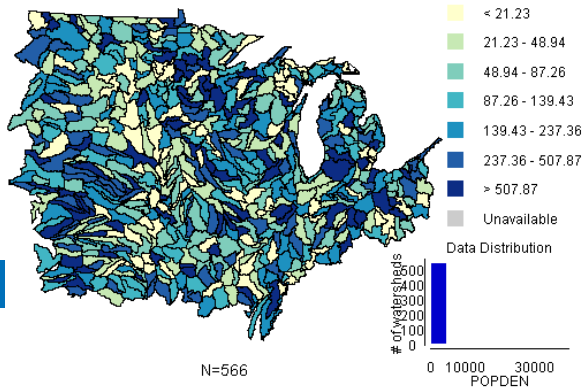
Mean of Atrazine Application (lbs per pixel)



Average surface water use per person (residential use) (gal/d/person)

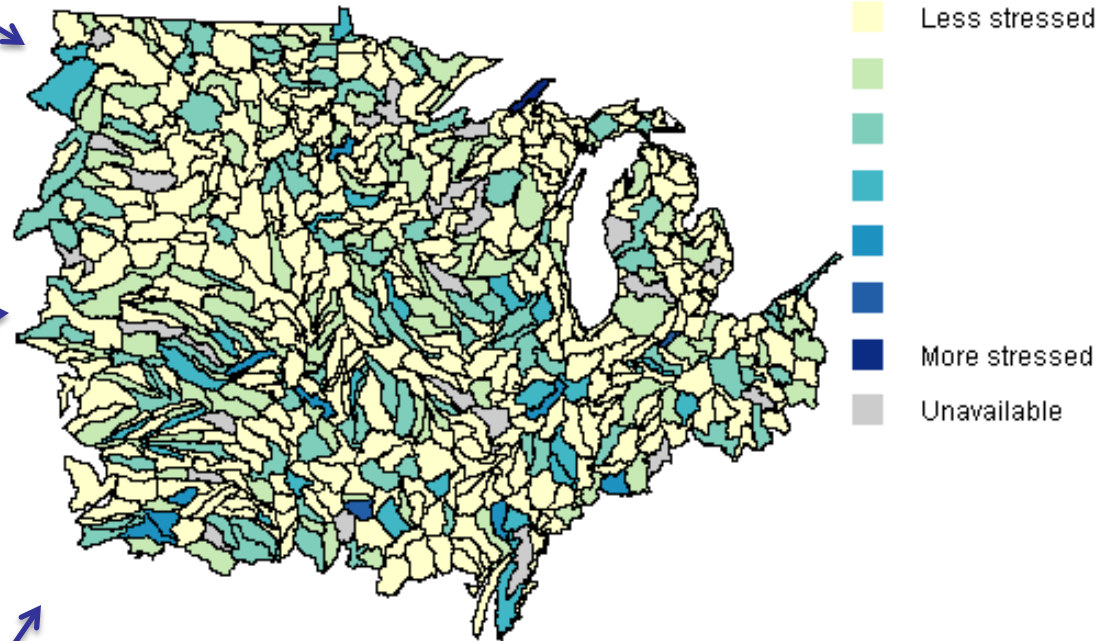


Population Density in 2000 (#)



# Combining spatial data to improve community exposure estimates

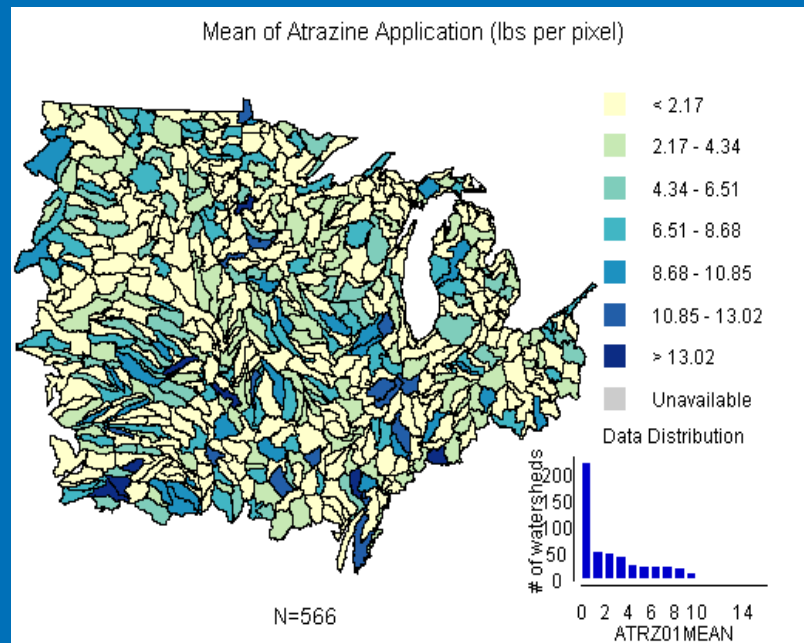
## Atrazine Exposure



Atrazine application + individual surface water use + population density

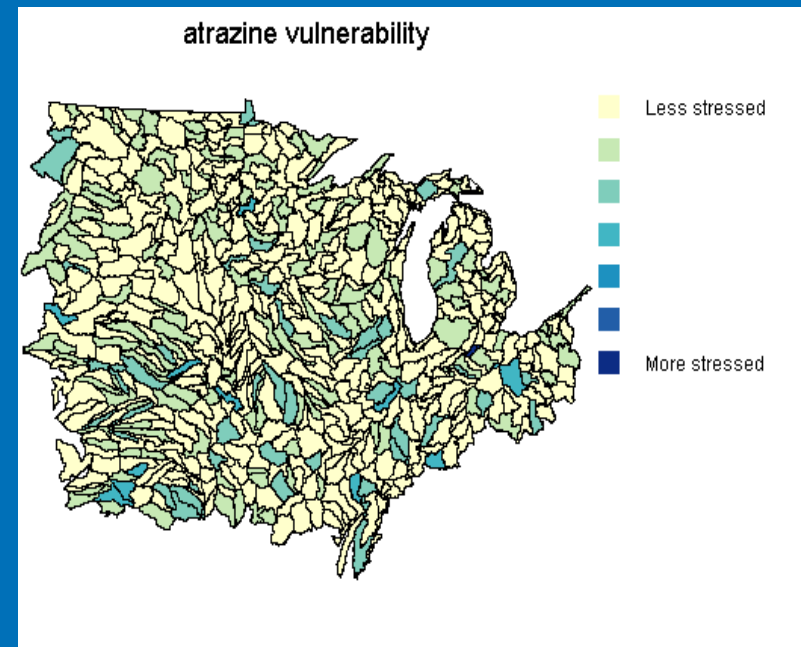
# Exposure: Service value is related to the ability to mitigate or reduce risk

Estimated Atrazine application  
for Base Year landscape



Potential risk only –  
incomplete endpoint

Combined index: Atrazine  
application and population  
using surface water supplies



Risk + Exposure –  
a better endpoint



All of these maps were produced using the same set of data; only the integration method differs

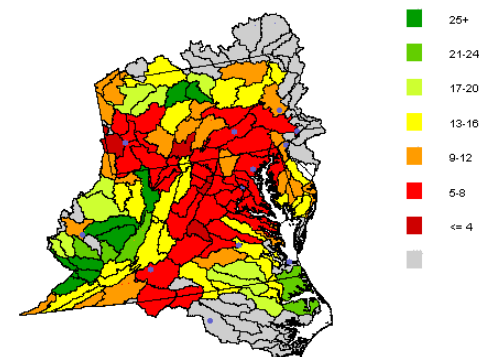
Should ask:

Is the method robust given the data being synthesized?

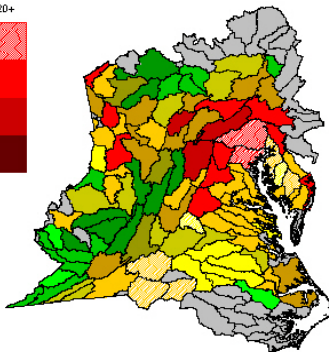
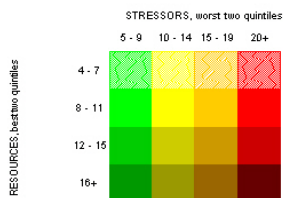
Is the method addressing the right question?

For more info on see [www.epa.gov/rev](http://www.epa.gov/rev) :  
*Guidelines to Assessing Regional Vulnerability*

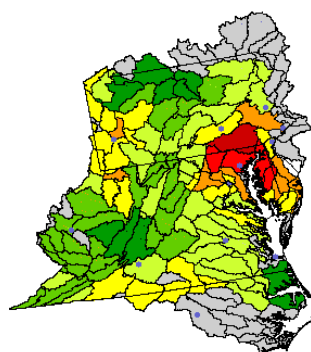
Best Quintile Counts



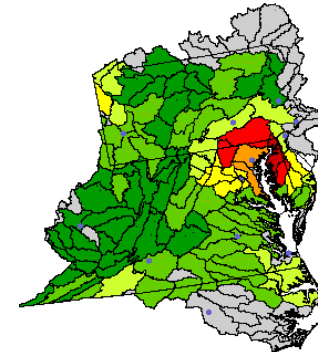
Stressor-Resource Overlay



Radar Area Summary



State Space

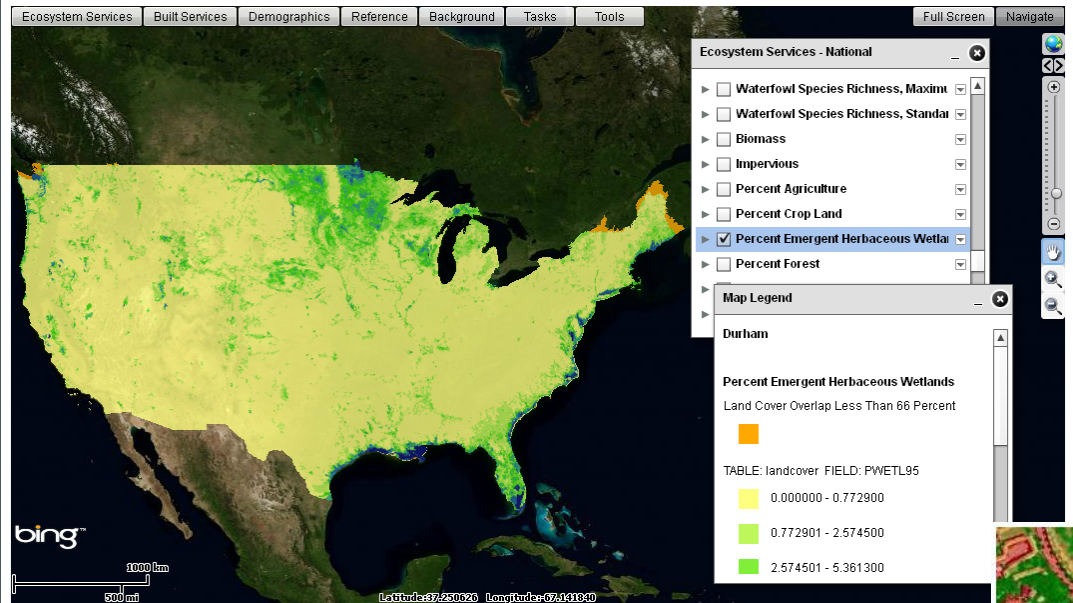


# EnviroAtlas

 **EPA** United States Environmental Protection Agency  
LEARN THE ISSUES | SCIENCE & TECHNOLOGY | LAWS & REGULATIONS | ABOUT EPA

## National Atlas for Sustainability

You are here: EPA Home » National Atlas for Sustainability » Interactive Map



## Hi-resolution classification and analysis for 250 urban areas across country

- linking ecosystem services to human health and well-being
- allowing queries on subpopulations of concern
- identifying actions to mitigate pollution and reduce energy costs

**National, coast-to-coast ,  
scalable coverage of metrics  
for:**

- ecosystem services
- built environment
- demographics
- drivers of change (e.g. pollution, population growth, development)

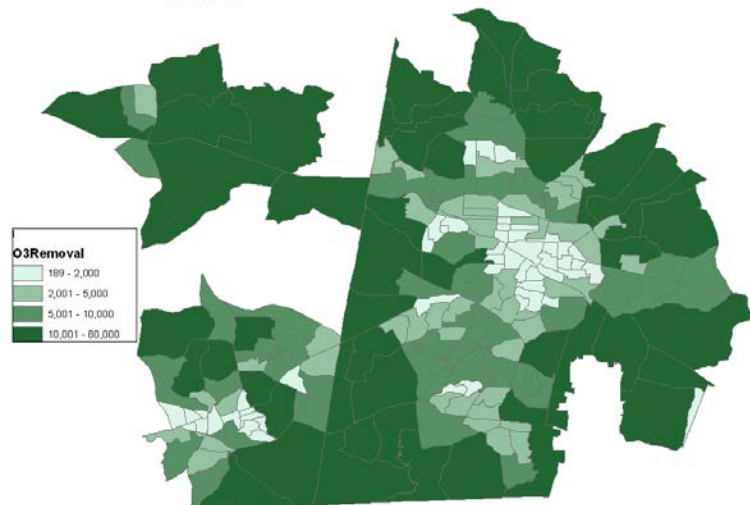
**Analytical tools to:**

- screen
- compare
- assess
- evaluate scenarios

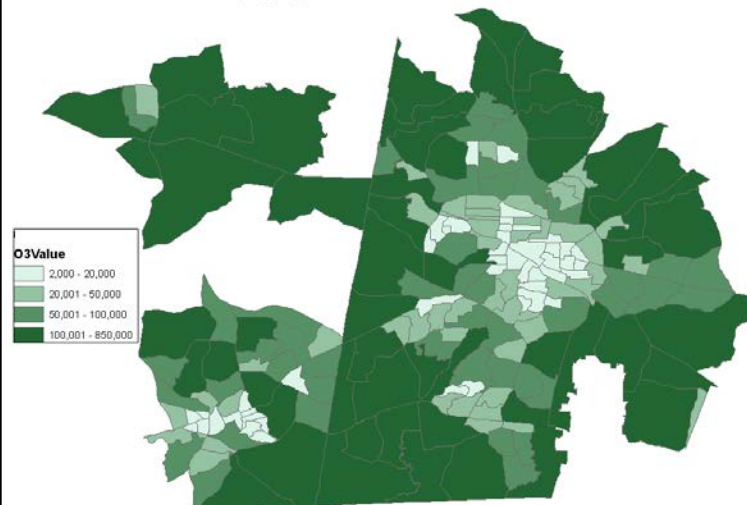


Aerial photography of downtown Portland, ME, classified into open space (greens), impervious surfaces (pink), and water (blue)

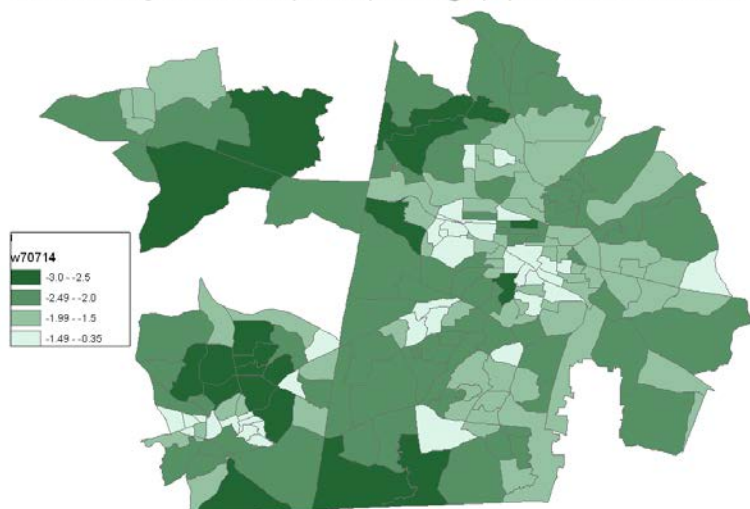
Ozone removal (kg/yr) by tree cover



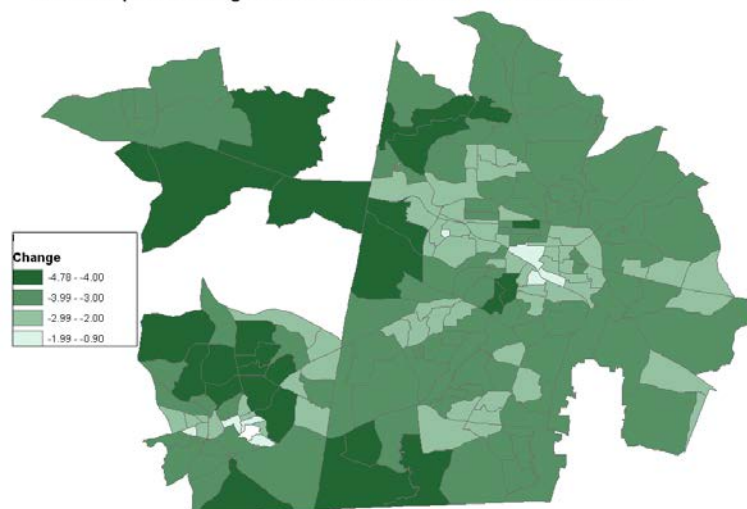
Value of Ozone removal (\$/yr) by tree cover



Estimated change in ambient temperature (07/07/10 @ 2 pm) due to amount of tree cover

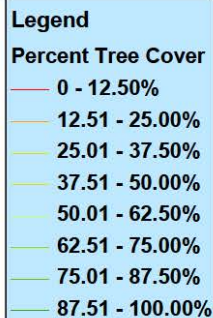
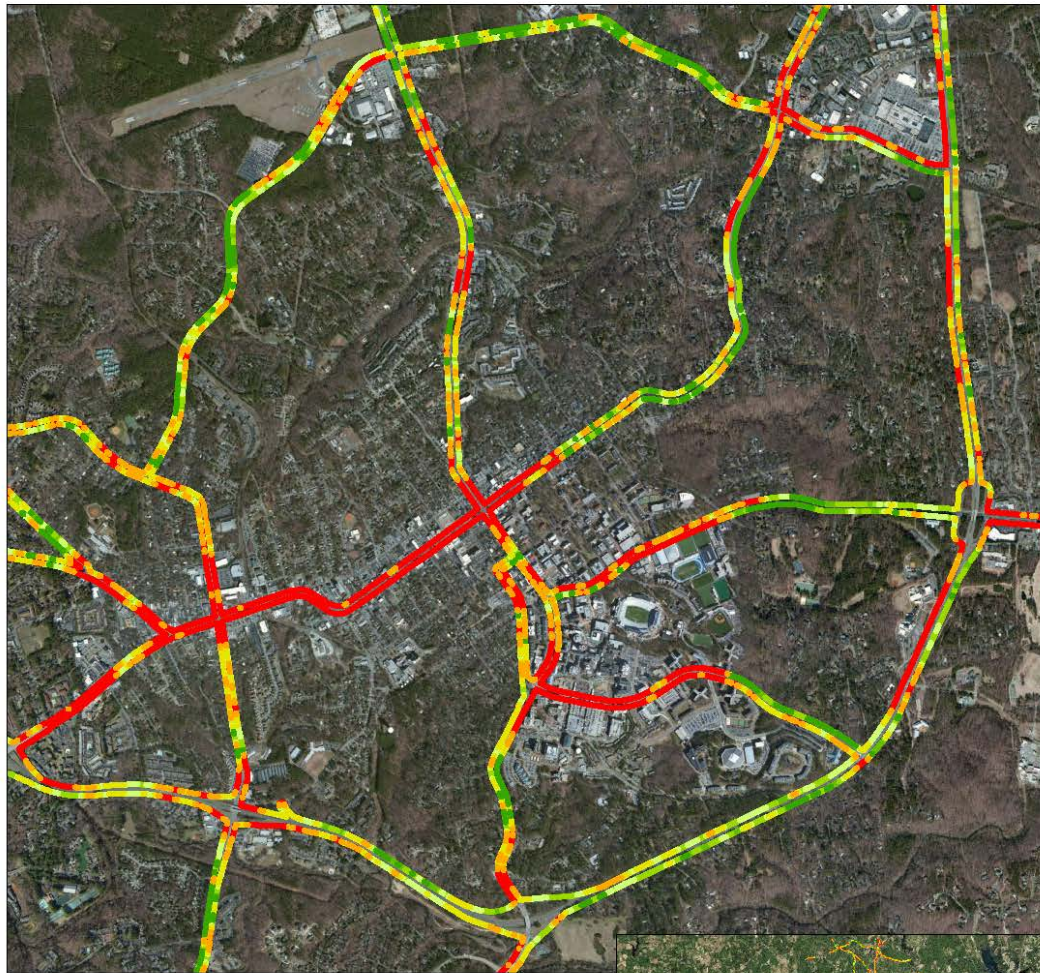


Estimated percent change in total streamflow due to amount of tree cover

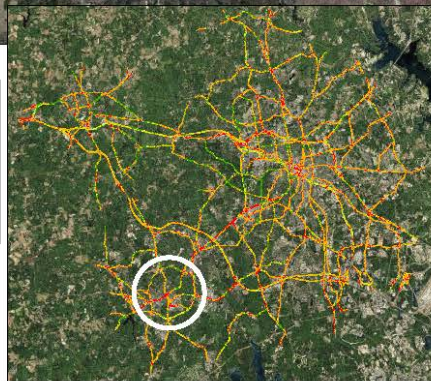




## Percent Tree Cover within 26m of Road Edges



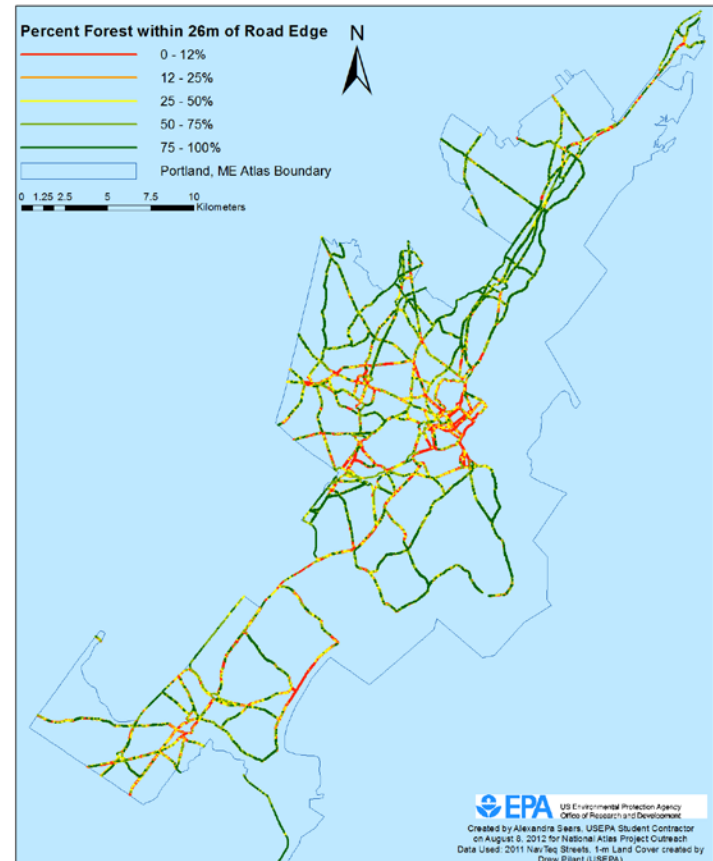
Created for the National Atlas for Sustainability  
and ESRI Mapping the Nation  
March 30, 2012  
Data Sources: USDA NAIP Imagery,  
NCDOT Road Classification Arcs,  
BING Aerial Photography, US Census Bureau.



## Potential for Tree Cover to Buffer Airborne Pollutants from Busy Roadways *(estimated threshold is > 25% cover within 26m of road edge)*

← Greater Durham, NC (Chapel Hill detail)

### Portland, ME - Near Road Tree Buffer







▼ Explore Data

Base Maps

Terrestrial Ecosystems

Marine Ecosystems

Pollution and Waste

Human Influence

Climate

► Customize Map



Legend

Land Cover

- Temperate or sub-polar needleleaf forest
- Sub-polar taiga needleleaf forest
- Tropical or sub-tropical broadleaf evergreen forest
- Tropical or sub-tropical broadleaf deciduous forest
- Temperate or sub-polar broadleaf deciduous forest
- Mixed forest
- Tropical or sub-tropical shrubland
- Temperate or sub-polar shrubland
- Tropical or sub-tropical grassland
- Temperate or sub-polar grassland
- Sub-polar or polar shrubland-lichen-moss
- Sub-polar or polar grassland-lichen-moss
- Sub-polar or polar barren-lichen-moss
- Wetland
- Cropland

Close





***Questions?***