

# Green Infrastructure Tools for Coastal Conservation

Presentation to the Virginia Coastal  
Zone Partners Workshop

Dec. 6, 2007

Karen E. Firehock, Director  
Green Infrastructure Center





Local land use planning impact on environment

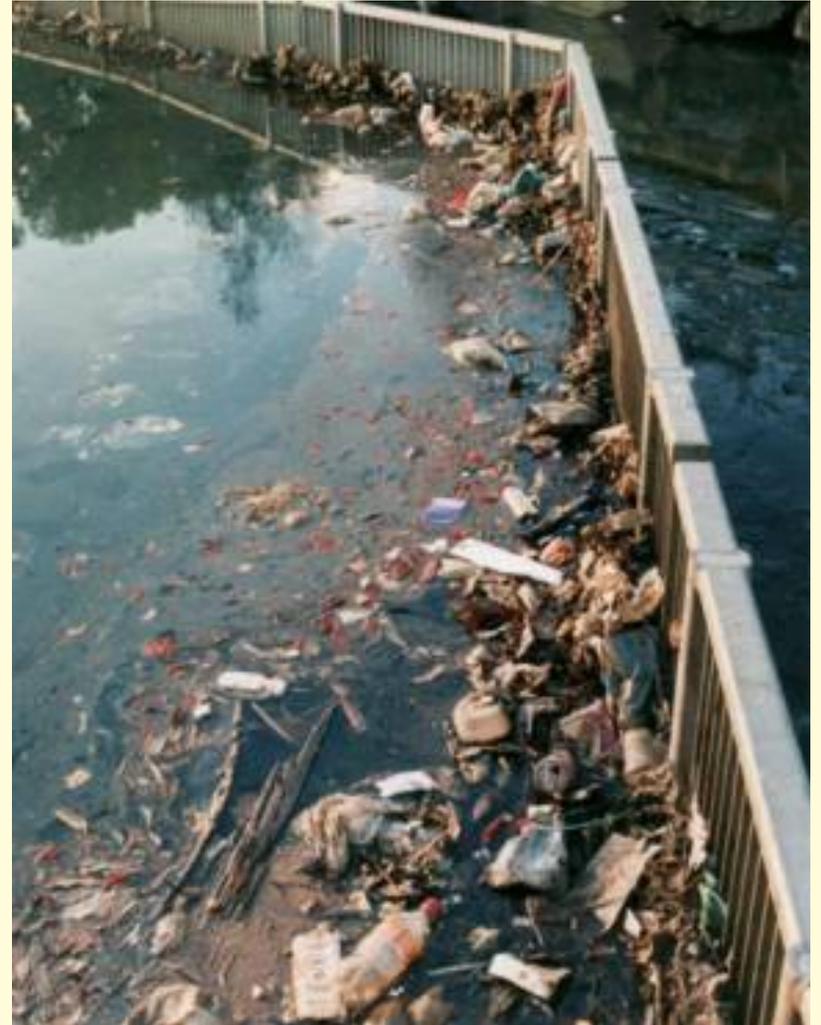
## Traffic congestion



Local land use planning impact on environment

Traffic congestion

Water quality



Local land use planning impact on environment

Traffic congestion

Water quality

Air quality



Local land use planning impact on environment

Traffic congestion

Water quality

Air quality

Loss of critical habitat



Local land use planning impact on environment

Traffic  
congestion

Water quality

Air quality

Loss of critical  
habitat

Loss of working  
lands



While you viewed this slide, America lost another 3 acres of open space

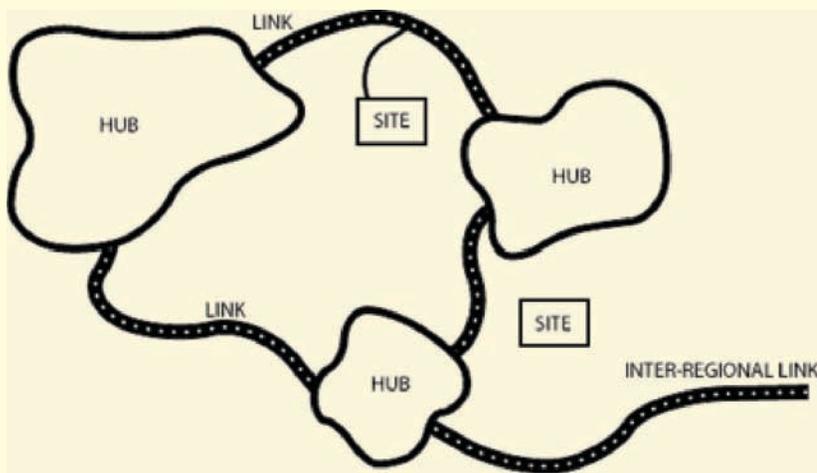
# Our Focus:

Local Land Use Planning



# What is Green Infrastructure Planning?

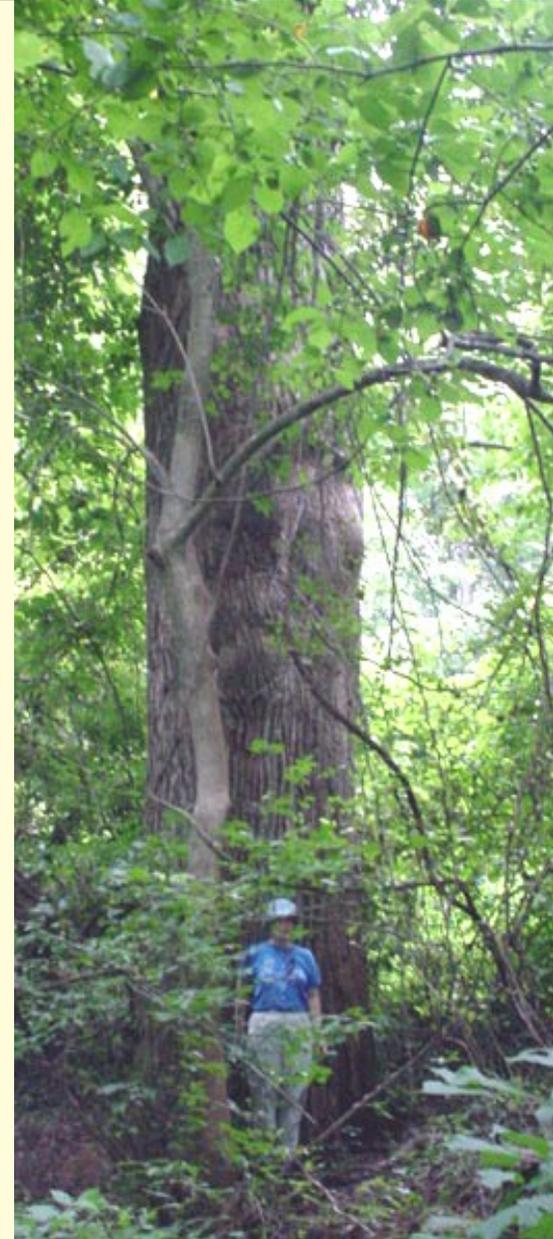
“Strategically planned and managed networks of natural lands, working landscapes and other open spaces that conserve ecosystem values and functions and provide associated benefits to human populations”



Graphic Credit: Conservation Fund

# Benefits

- Combating global warming (carbon sequestration) and improving air quality.



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- Protecting and preserving local water quality and supply.



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- Preserving biodiversity and wildlife habitat.



# Benefits

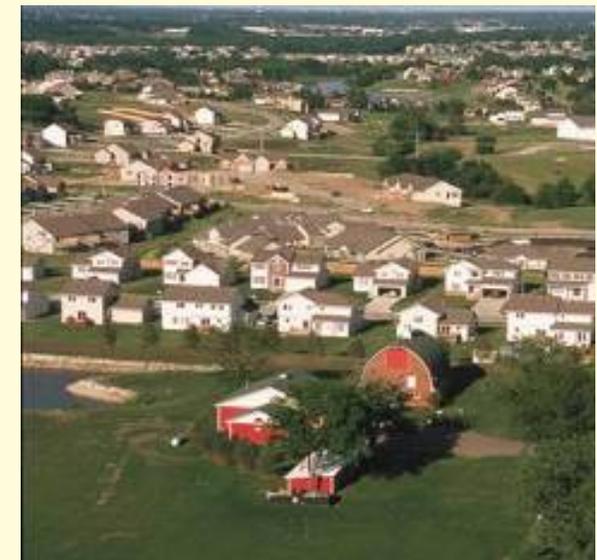
- Combating global warming (carbon sequestration) and improving air quality.
- Protecting and preserving water quality and supply.
- Providing cost-effective stormwater management and hazard mitigation.
- Preserving biodiversity and wildlife habitat.
- Improving public health, quality of life and recreation networks.



# Why Now?

## Growth and land use conflicts

U. S. Region	Pop. Change	Change in urbanized land
Midwest	7.06%	32.3%
Northeast	6.91%	39.10%
<b>South</b>	<b>22.23%</b>	<b>59.61%</b>
West	17.02%	48.94%
Total U.S.	17.02 %	47.14%



# How Does GI Get Implemented?

- Incorporate green infrastructure approach into existing local land use planning process such as the comprehensive plan, open space plans, zoning (proffers, PDRs, TDRs, etc.)
- Land use planning that is based on managing and harnessing the enormous benefits provided by natural systems will be a major step towards creating a sustainable economy in the 21st century



# What Are GIC Goals?



Make the economic case for green asset planning.

Develop new methods and tools for green infrastructure planning and implementation.

Provide communities with technical assistance for green infrastructure planning.

Expand the use of green infrastructure planning by promoting awareness and understanding of the purpose and methods.

# VIRGINIA FOREST TRENDS

## FORESTED LAND

With 15.77 million acres of forested land, Virginia is 61.5% forested. From 2001 to 2004, urban growth and development resulted in an average net loss of 26,100 acres per year, an accelerating rate of loss when compared to the 20,000 acres per year estimate for the 1992 – 2001 period. More acres of forest are developed each year but reversion of some agricultural land to forest partially offsets the loss. If current development trends continue, it has been projected that Virginia will lose a million acres of forest in the next 25 years.

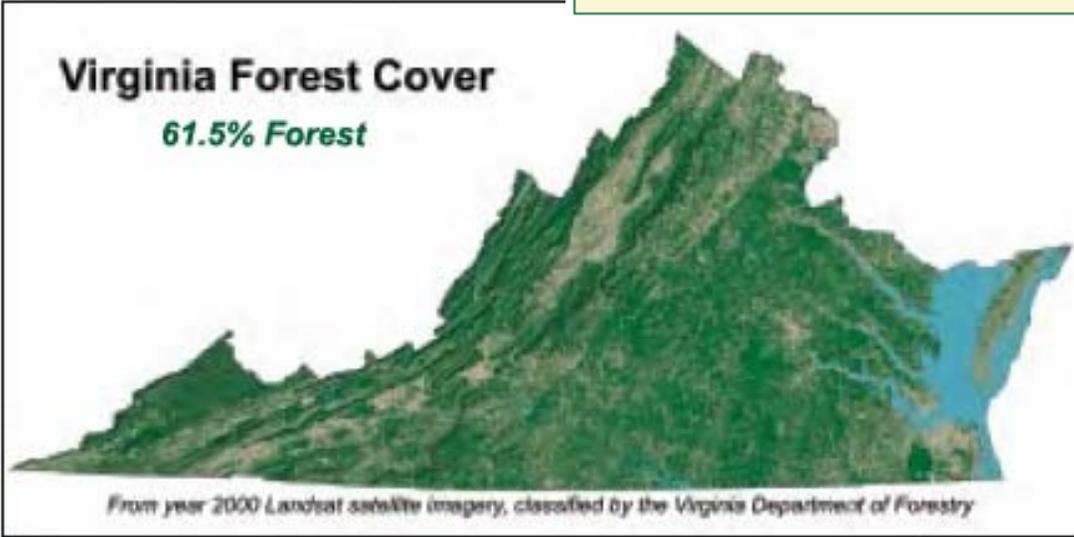


TABLE 6  
POLLUTANT REMOVAL BY VIRGINIA'S FORESTS

Pollutant	Tons Removed Per Year	Value (\$)
Carbon Monoxide	23,766	\$21,864,727
Ozone	217,063	\$106,360,805
Nitrogen Dioxide	87,934	\$387,965,813
Particulate Matter	200,427	\$261,957,649
Sulfur Dioxide	76,843	\$125,562,155
<b>TOTAL</b>	<b>606,033</b>	<b>\$903,771,149</b>

VA will develop more land in the next 40 years than the last 400!

Source: State of The Forest, VA DOF 2006

## Mayor's Climate Change Agreement = Impetus for GI

“We urge the federal government and state governments to enact policies and programs **to meet or beat the target of reducing global warming pollution levels to 7 percent below 1990 levels by 2012**, including efforts to: reduce the United States' dependence on fossil fuels and accelerate the development of clean, economical energy resources and fuel-efficient technologies such as conservation, methane recovery for energy generation, waste to energy, wind and solar energy, fuel cells, efficient motor vehicles, and biofuels.”

**Virginia Signatories** = Alexandria, Blacksburg, Charlottesville, Newport News, Richmond, Virginia Beach and Williamsburg

<http://www.usmayors.org/climateprotection/ClimateChange.asp>

## **Traditional Development Approach**

## **Green Infrastructure Based-Development**

Plan for grey infrastructure first (roads, stormwater pipes)

First, assess natural features and functions and protect them.

Green spaces in leftover lands (e.g. steep slopes and floodplains)

Plan for parks, trails, habitat connections before siting buildings.

Work within confines of parcel = pocket parks, inner trails, gated systems

Connect land and water habitats to region and across ownerships

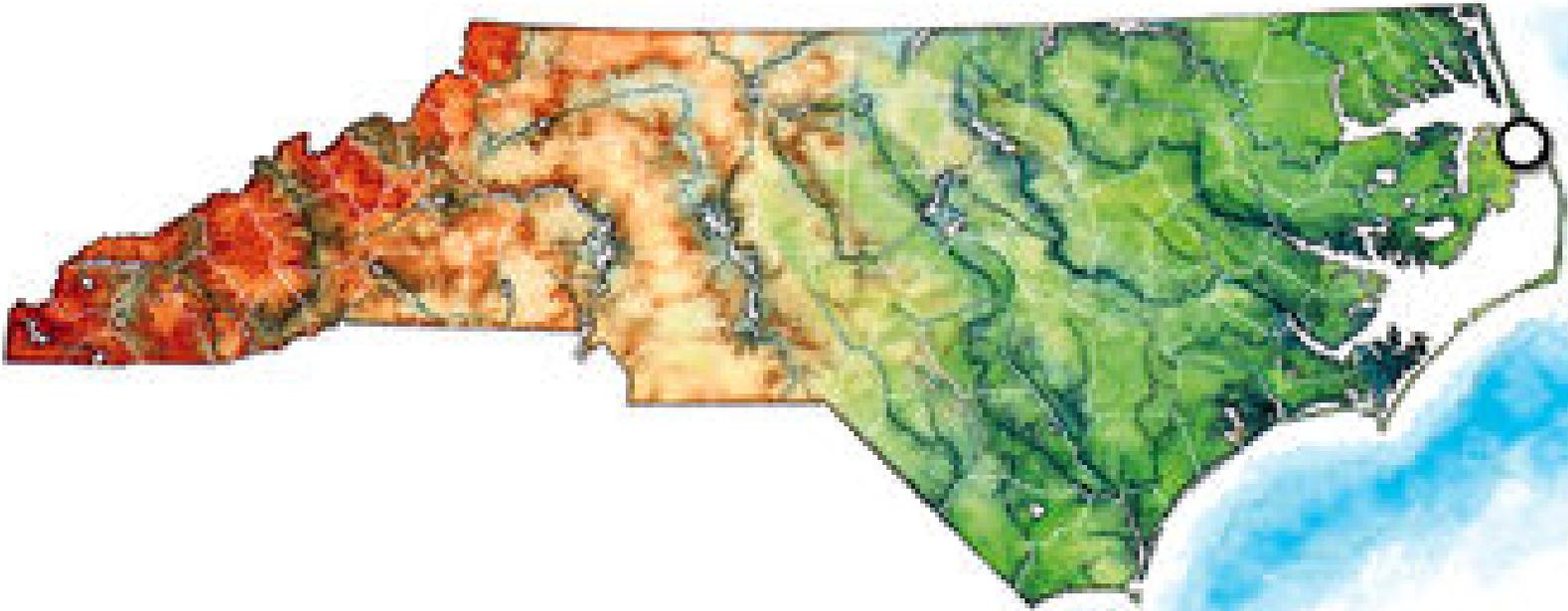
## Green Infrastructure Principles

“An interconnected network of a wide range of landscape elements that

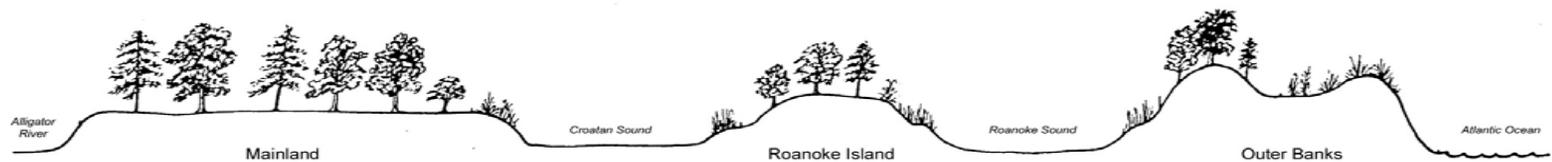
- support native species,
- maintain natural ecological processes,
- sustain air and water resources, and
- contribute to the health and quality of life for communities and people.”

*Source: Green Infrastructure: Linking Landscapes and Communities, Benedict and McMahon (2006)*

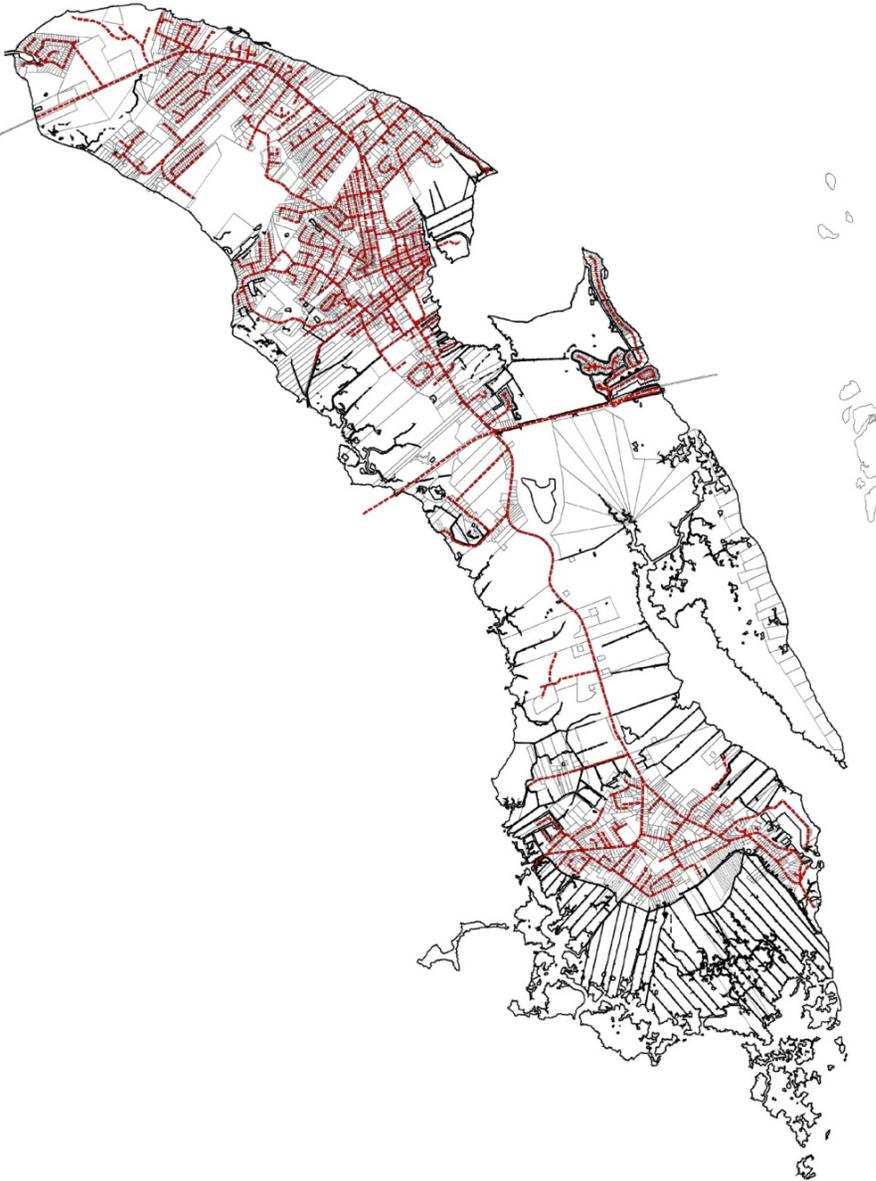
## Case Example: Roanoke Island, NC



by Alisa Hefner, GIC Projects Manager







## Roanoke Island

Available data:

Aerial photographs

Parcel data

Roads

Soils

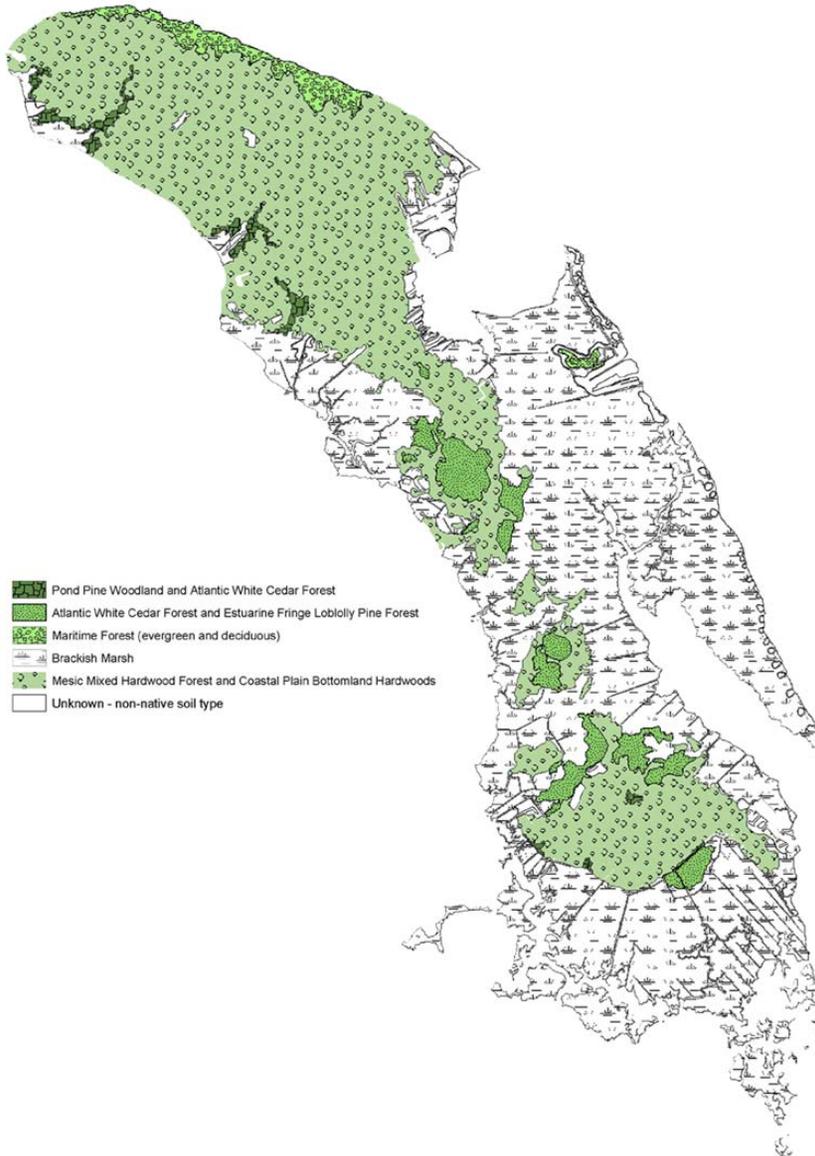
Zoning

RTE species

## Natural Plant Community Potential

Inferred from plants that  
occur on present soil  
types

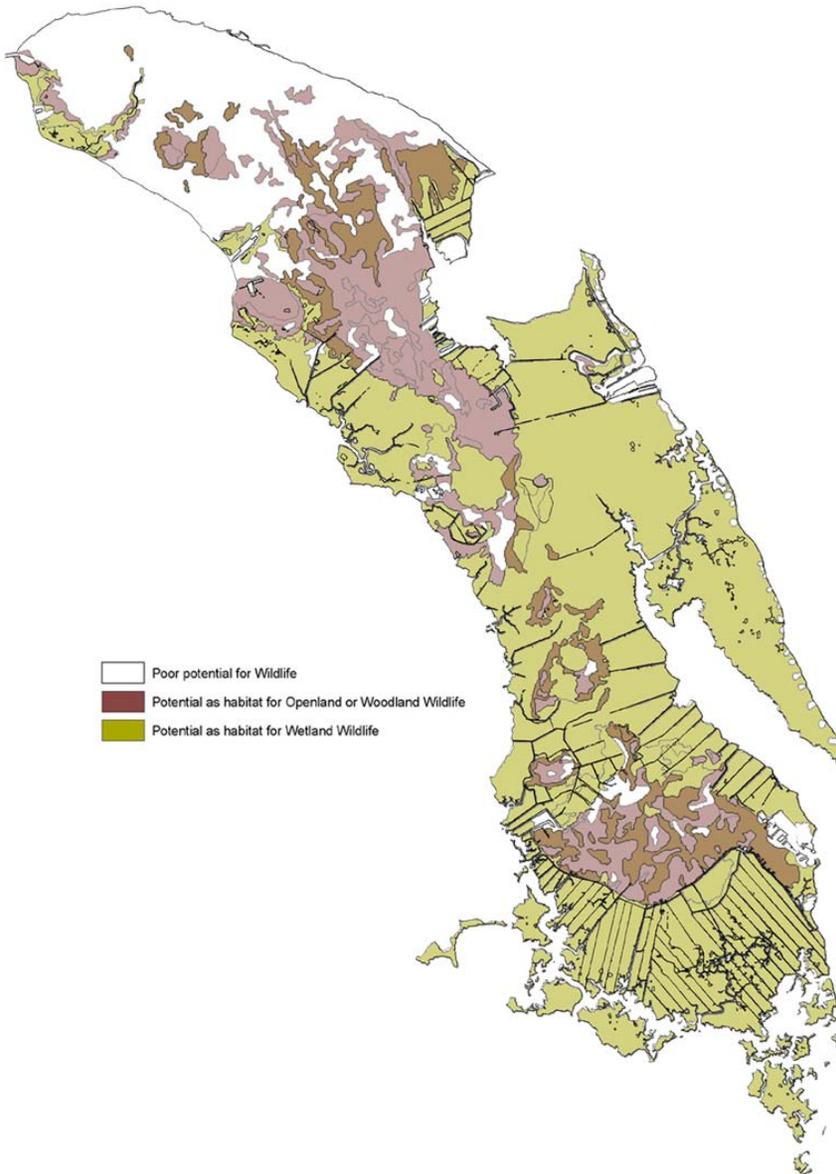
Classification based on  
*Classification of the  
Natural Communities of  
North Carolina Third  
Approximation*: Schafale  
and Weakly



## Wildlife Habitat Potential

Gain better understanding of ecological opportunities

Begin to determine species of concern for habitat conservation

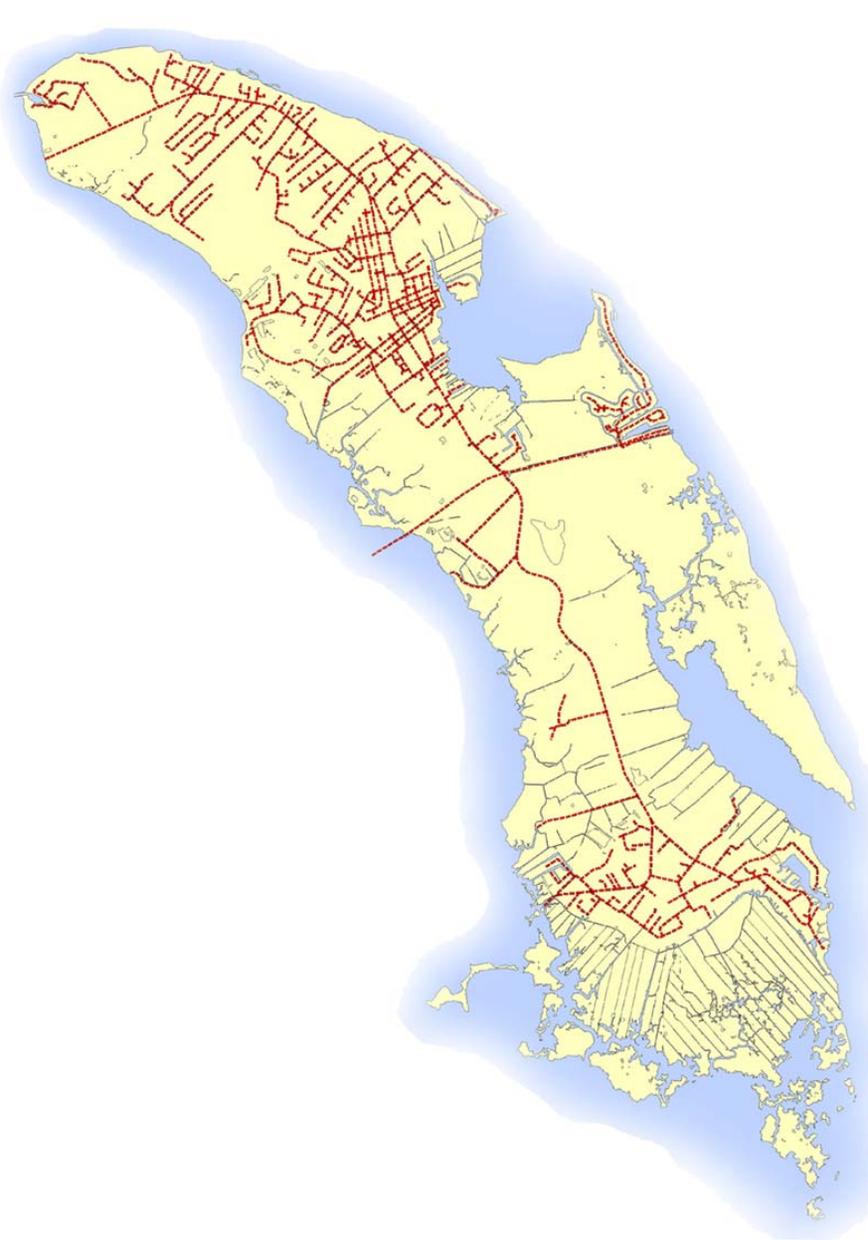


## Pathways Analysis

Two main corridors exist:

Human Movement  
– includes roads, streets, paths, trails

Waterways –  
canals both natural and manmade



## Wildlife ~ Birds



Photo by Fred Fallon



Photo by George Janssen

Major Group	Scientific Name	Common Name	State Status	Habitat
Bird	Anhinga anhinga	Anhinga	SR	wooded lakes or ponds, or open swamps (for nesting)
Bird	Circus cyaneus	Northern Harrier	SR	extensive brackish marshes (for nesting)
Bird	Egretta caerulea	Little Blue Heron	SC	forests or thickets on maritime islands
Bird	Egretta thula	Snowy Egret	SC	forests or thickets on maritime islands
Bird	Egretta tricolor	Tricolored Heron	SC	forests or thickets on maritime islands
Bird	Falco peregrinus	Peregrine Falcon	E	coastal ponds and mudflats (for foraging in winter)
Bird	Pelecanus occidentalis	Brown Pelican	SR	maritime islands
Bird	Plegadis falcinellus	Glossy Ibis	SC	forests or thickets on maritime islands



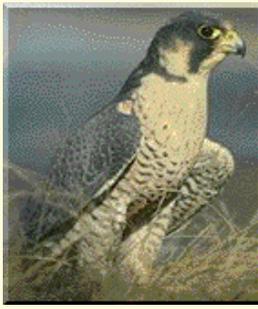
Photo by Jim Zingo



Photo by Sharon Martin



Photo by Rob Barnetts



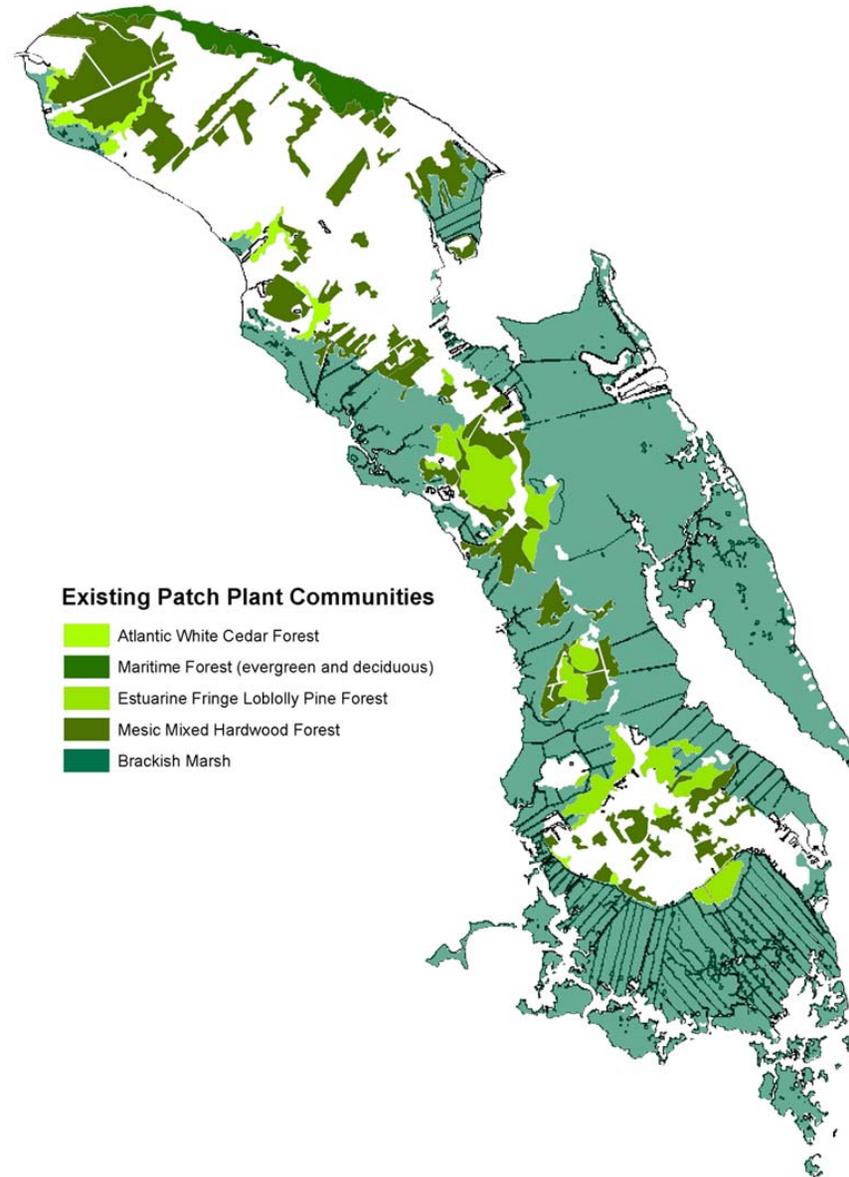
## Patch Analysis: Identify special sites

Atlantic White Cedar Forest is of critical concern due to rarity and slow recovery rate.

Brackish Marsh is legally protected by law.

### Existing Patch Plant Communities

- Atlantic White Cedar Forest
- Maritime Forest (evergreen and deciduous)
- Estuarine Fringe Loblolly Pine Forest
- Mesic Mixed Hardwood Forest
- Brackish Marsh

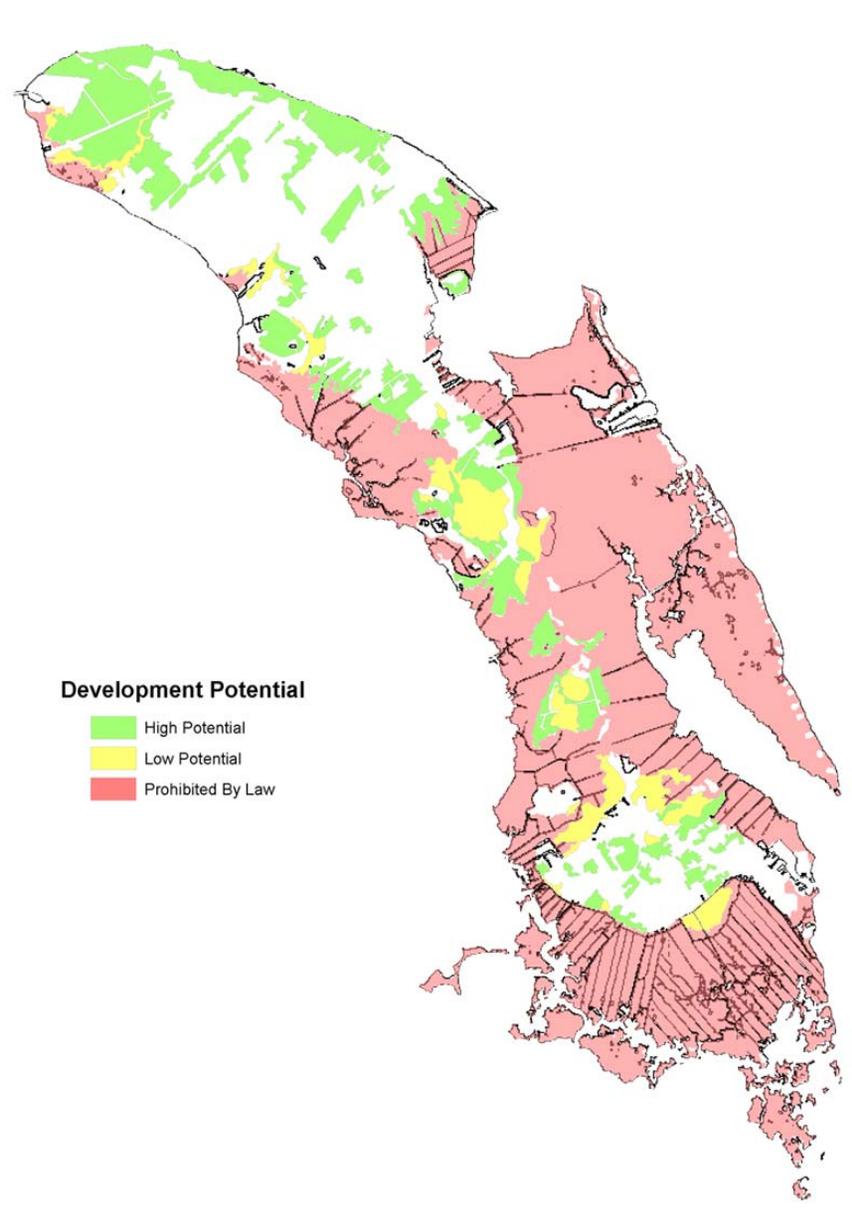


## Development Potential

Development potential based on soil suitability and capacity for development.

### Development Potential

- High Potential
- Low Potential
- Prohibited By Law

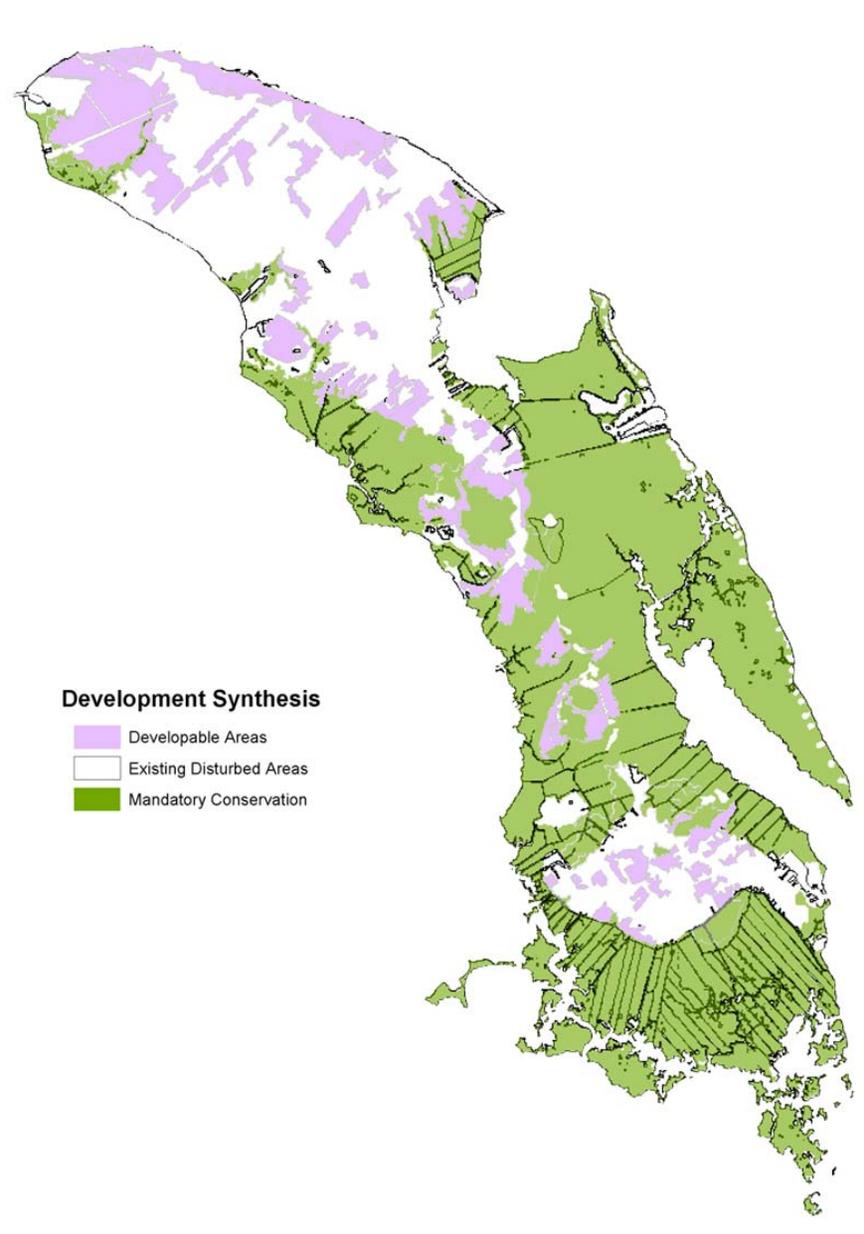


## Development Synthesis

Areas of low potential for development and those prohibited by law were combined to create mandatory conservation areas.

### Development Synthesis

-  Developable Areas
-  Existing Disturbed Areas
-  Mandatory Conservation



## Highest Conservation

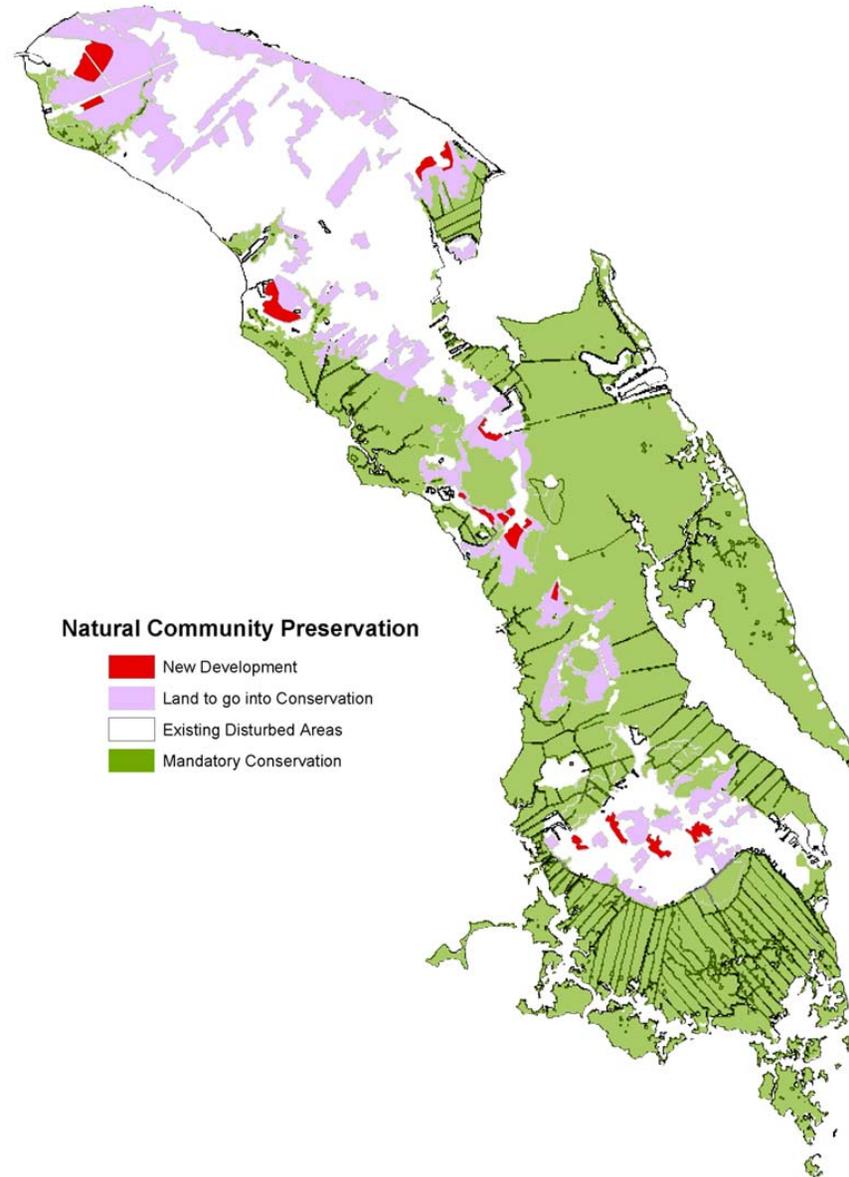
High conservation and moderate development

Protects key ecological areas and guides

Development to red areas on map that are patches that can be developed.

### Natural Community Preservation

-  New Development
-  Land to go into Conservation
-  Existing Disturbed Areas
-  Mandatory Conservation



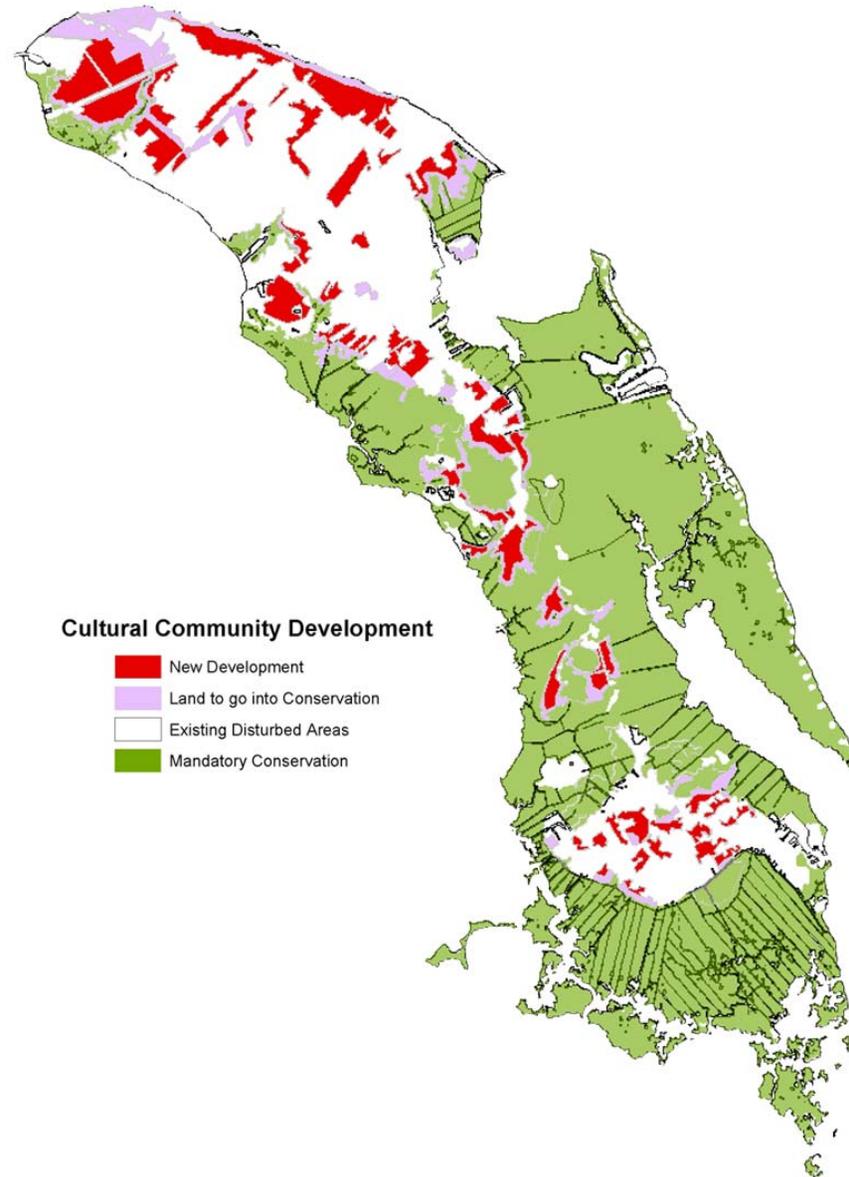
## Moderate Conservation

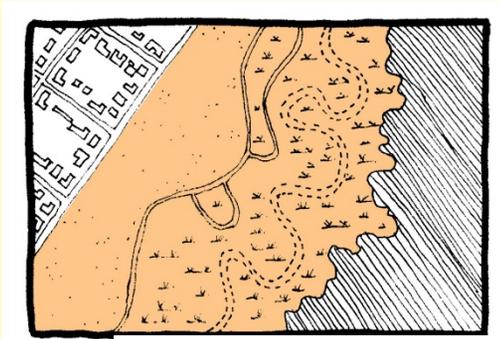
Moderate conservation  
and high development

Increase of red =  
developable areas

### Cultural Community Development

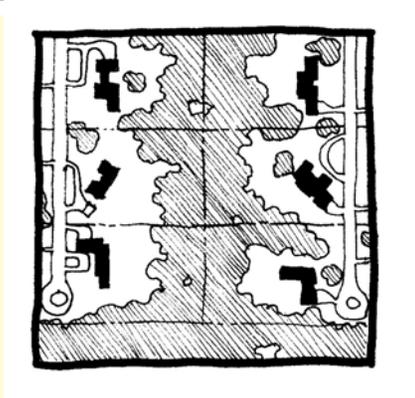
-  New Development
-  Land to go into Conservation
-  Existing Disturbed Areas
-  Mandatory Conservation



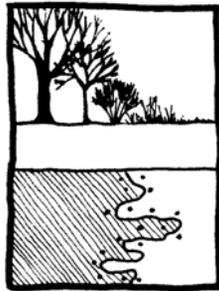


## Implementation

Buffer to protect biodiversity of nature reserve from damage of urbanization



Continuous corridor maintained through backyards, minimum setback to maximize distance from corridor



Use of native vegetation to provide vertical structure and curvilinear edges to facilitate movement

## Site Development

Reduce ecological footprint by using renewable resources.

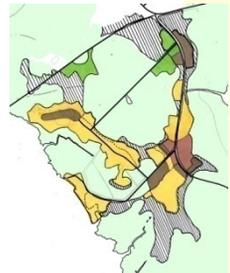
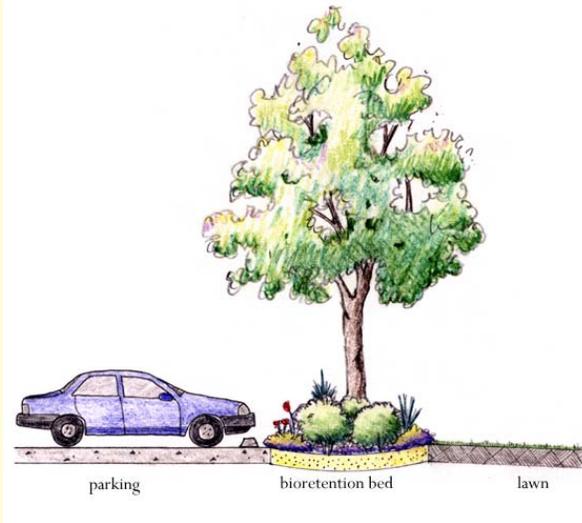
Utilize existing buildings and paved surfaces.

Take advantage of passive solar energy and natural bay breezes.

Restore the natural integrity of the site.

Capture all run-off and filter.

Create a community gathering area.



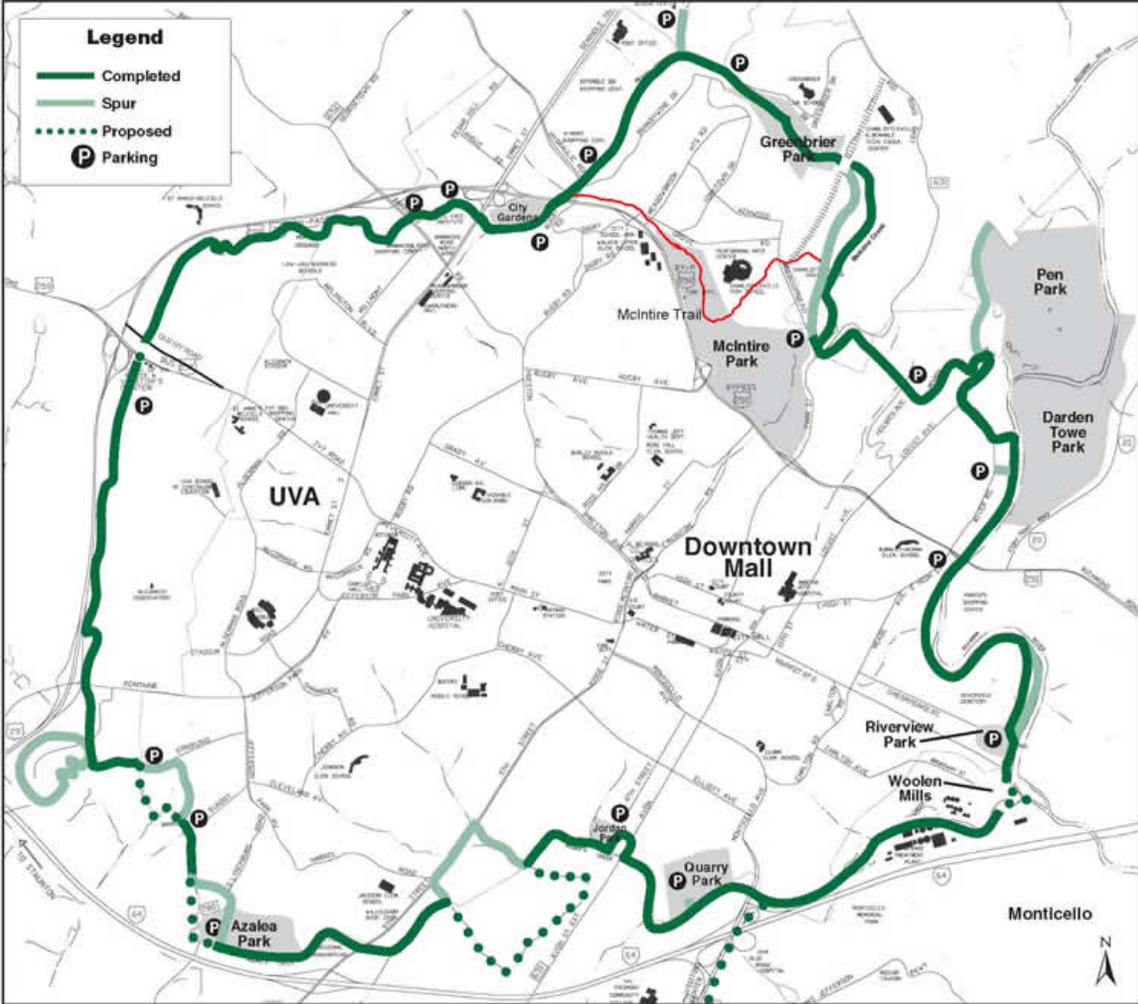
## Case Example: Urban Charlottesville City

Fall 2006 partnership with **UVA**  
Class, **GIC** and **E<sup>2</sup> Inc.** for city  
comprehensive planning

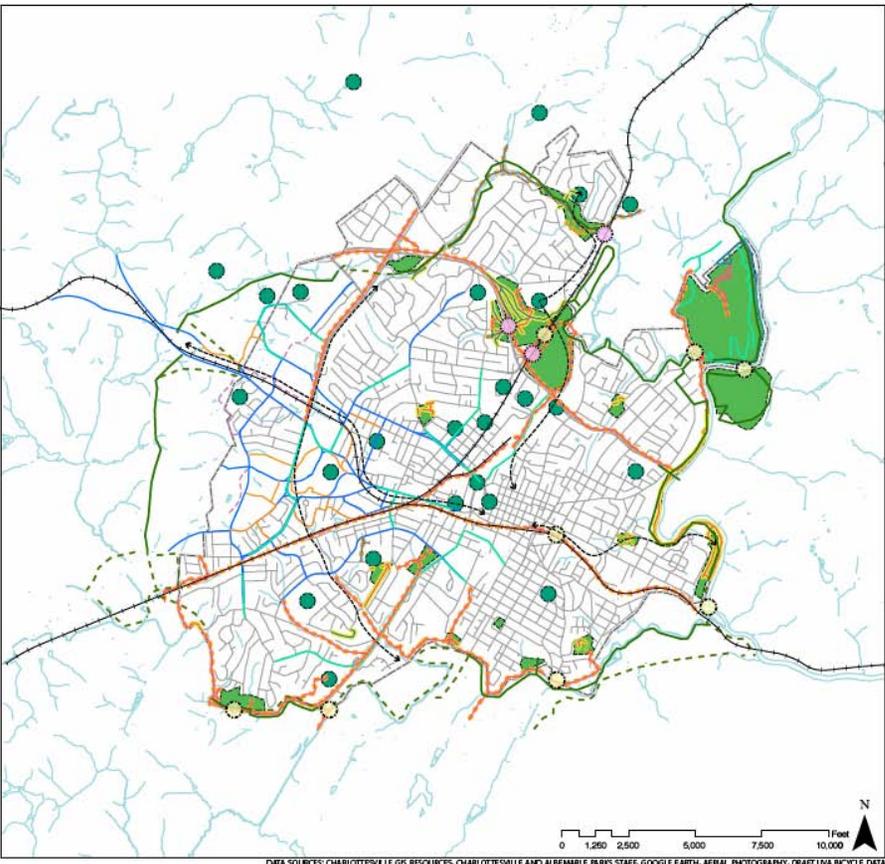


- Tree Canopy and Street Trees
- Streams and Stormwater
- Trails and Linkages
- Green Building

# Trails: Linkages for people and wildlife



# Proposed Linkages & Connectivity



**Legend**

City Boundary	<b>City Trails</b>	← Possible Links (not actual alignments)	Potential route extensions and new linkage development Include proposed expansion of the Rivanna Trail and city trails. Much of the proposed trail development targets riparian corridors, while some proposed city trails parallel streets and rail routes.
Roads	<b>TYPE</b>	█ Parks	
Creeks and Rivers	Boardwalk	█ Floodway	
Bike Routes Existing (CITY DATA)	Hard Surface	▨ Floodplain	
Main Bike Routes Existing (DRAFT UVA DATA)	Park Path	● Schools, Colleges, Universities	
Quiet Bike Routes Existing (DRAFT UVA DATA)	Soft Surface	○ Suggested Pedestrian Bridge	
Bike Routes Proposed (DRAFT UVA DATA)	<b>STATUS</b>	○ Suggested Pedestrian Tunnel Underpass	
Rivanna Trail Proposed	Existing		
Rivanna Trail Existing	Proposed		

How can we create new linkages and for what purpose?

How can we get land donations? e.g. offer trails as proffers.

## Stream buffers

Green Infrastructure also includes stream corridors for water quality and wildlife.



Meadow Creek



Moore's Creek



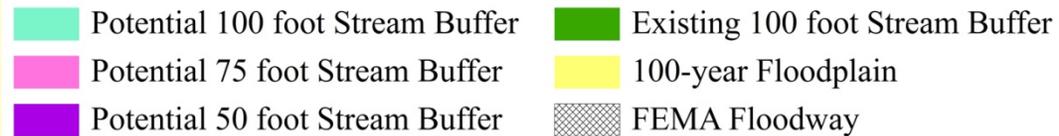
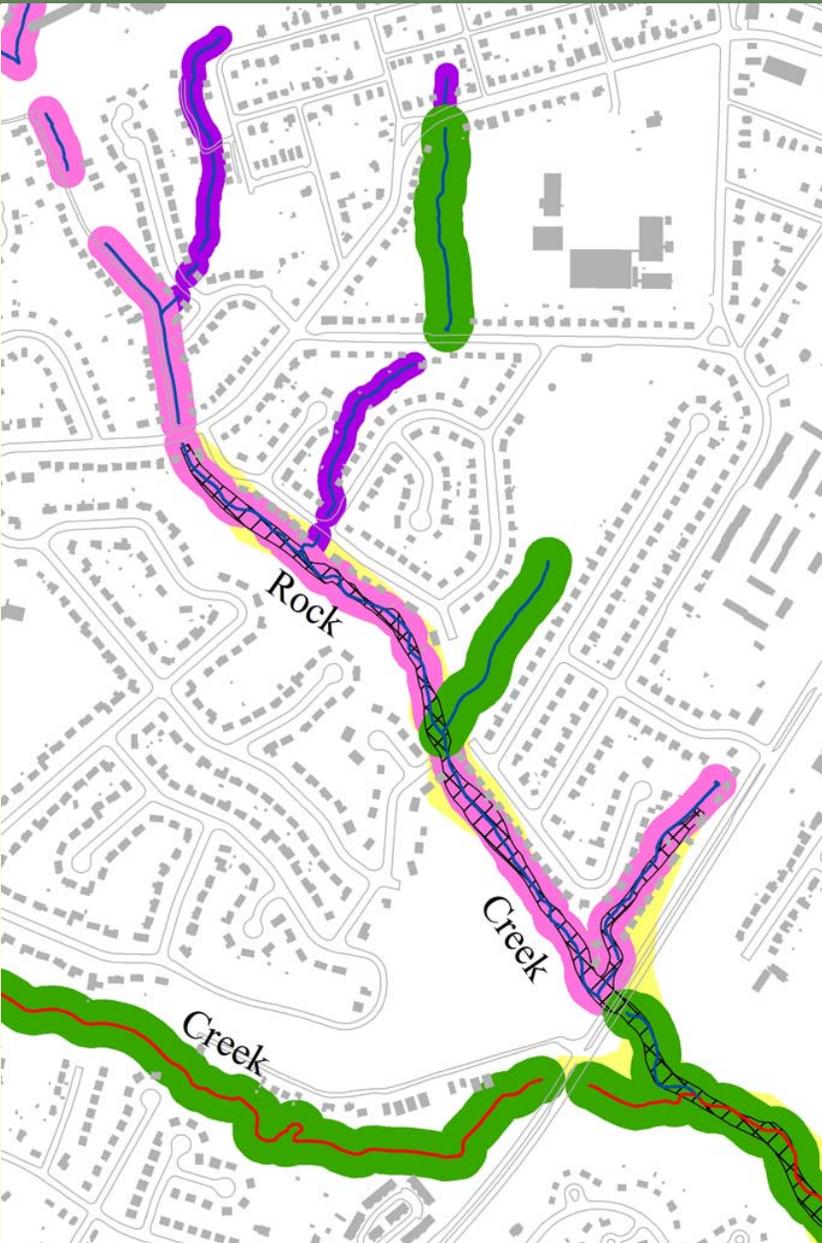
Rivanna River

# Urban Buffer Plan

Goal: 100 foot buffer

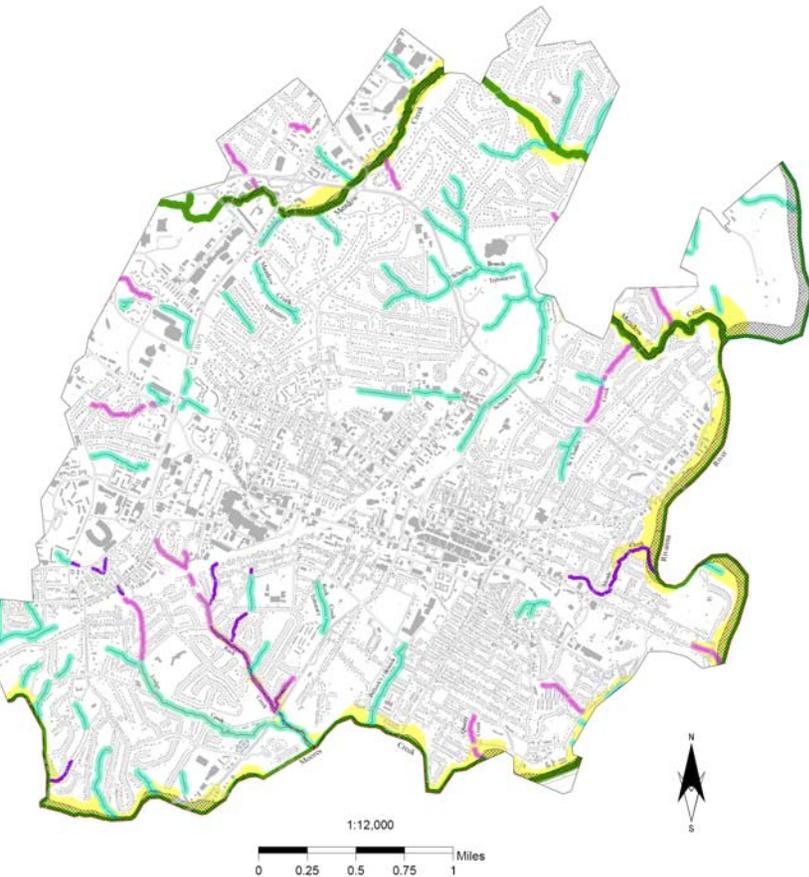
GIS to evaluate impacts based on buffer widths of 50, 75 or 100 feet.

Not to impact > 30% existing structures.



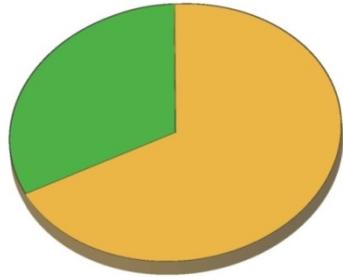
## Potential Stream Buffers, Fall 2006

Charlottesville, Virginia



# Stream Buffers

- Mapped rest of potential buffers.
- Buffer map added to comprehensive plan.
- City now drafting this into an ordinance.



Land Cover Type	% Land C
Urban land uses (All city areas not covered by trees)	68.4%
Tree canopy	31.6%

# Tree Canopy



Mapped forest canopy in GIS by digitizing aerial photos.

Set goals for future canopy  
Today = 31.6 %  
Future = 40 %

Next: Where can we put new trees to get to 40%?



## Street Trees

Street tree inventory and gap list for 5 neighborhoods.

484 new locations for trees found.



LocCode	Street	Median	Yard	Com Name	Sci Name	Circum	DBH	Good	Fair	Poor	Photo #
6NW07			X	American Basswood	Tilia americana	50.0	15.9			X	227
6NW09			X	Tree of Heaven	Ailanthus altissima	110.0	35.0	X			228;229
6NW10			X	Dogwood	Cornus florida	10.0	3.2	X			230;231;232
6NW13			X	Black Cherry	Prunus serotina	8.0	2.5	X			235;236
6NW11			X	Japanese Maple	Acer palmatum	15.0	4.8	X			
6NW14			X	Dogwood	Cornus florida	12.0	3.8	X			237;238
7NW01			X	English Elm	Ulmus procera	5.0	1.6	X			149;150;151
7NW02			X	Red Oak	Quercus rubra	87.0	27.7		X		152;153;154
7NW05			X	Silver Maple	Acer saccharinum	75.0	23.9			X	155;156;157;160
7NW04			X	Tree of Heaven	Ailanthus altissima	10.0	3.2			X	158;159
7NW03			X	Pine	Pinus	30.0	9.6		X*		161;162;163
7NW06			X	Dead	NA	10.0	3.2			X	

# CITYgreen for Site Level Plans

Developed by [American Forests](#)

- Land cover distribution
- Air pollution removal
- Carbon storage and sequestration
- Stormwater management savings
  - Water quantity (runoff)
  - Water quality (contaminant loading)
- Alternate scenarios

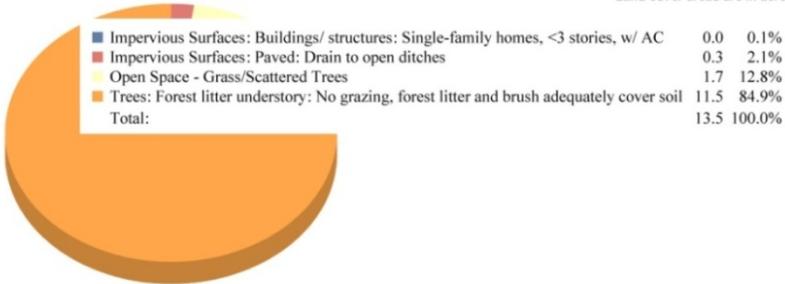




Analysis Report  
for  
Greenleaf Boundary



Land cover areas are in acres.



Total Tree Canopy: 11.5 acres (84.9%)

Air Pollution Removal

By absorbing and filtering out nitrogen dioxide (NO2), sulfur dioxide (SO2), ozone (O3), carbon monoxide (CO), and particulate matter less than 10 microns (PM10) in their leaves, urban trees perform a vital air cleaning service that directly affects the well-being of urban dwellers. CITYgreen estimates the annual air pollution removal rate of trees within a defined study area for the pollutants listed below. To calculate the dollar value of these pollutants, economists use "externality" costs, or indirect costs borne by society such as rising health care expenditures and reduced tourism revenue. The actual externality costs used in CITYgreen of each air pollutant is set by the each state, Public Services Commission.

Nearest Air Quality Reference City: **Roanoke**

	Lbs. Removed/yr	Dollar Value
Carbon Monoxide:	20	\$9
Ozone:	471	\$1,446
Nitrogen Dioxide:	102	\$314
Particulate Matter:	409	\$840
Sulfur Dioxide:	113	\$84
<b>Totals:</b>	<b>1,116</b>	<b>\$2,694</b>

Carbon Storage and Sequestration

Trees remove carbon dioxide from the air through their leaves and store carbon in their biomass. Approximately half of a tree's dry weight, in fact, is carbon. For this reason, large-scale tree planting projects are recognized as a legitimate tool in many national carbon-reduction programs. CITYgreen estimates the carbon storage capacity and carbon sequestration rates of trees within a defined study area.

<b>Total Tons Stored:</b>	<b>494.08</b>
<b>Total Tons Sequestered (Annually):</b>	<b>3.85</b>

# Pollution Removal Values

- 84.9% of 13.5-acre park is covered by trees
- Pollution removal value: \$2,694/year
- Stormwater control value: \$15,000/year

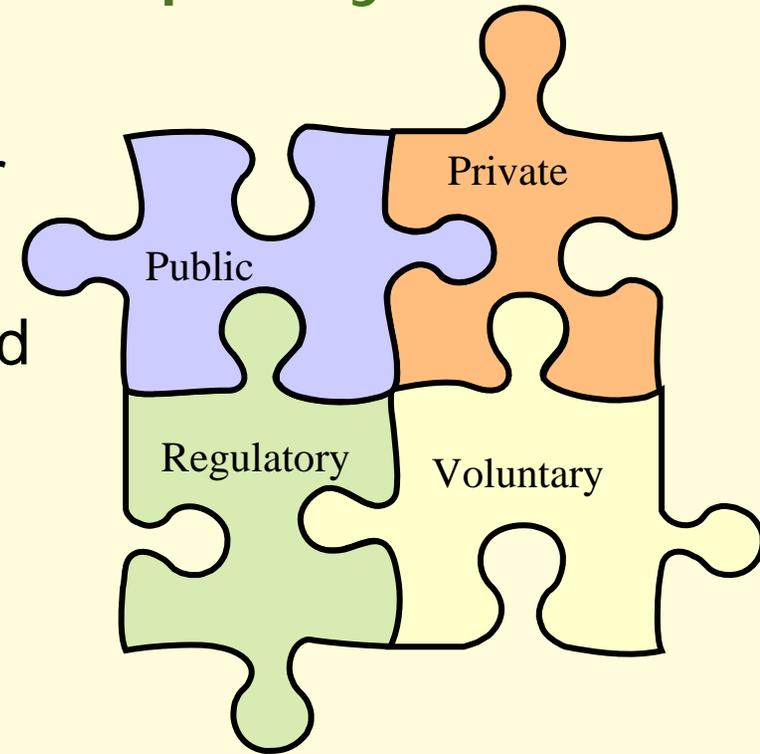
# Summary of Charlottesville Results

- ✓ Tree canopy assessment and canopy goals
- ✓ “Tree City USA” and DOF urban forest management plan grant
- ✓ Tree survey and gap analysis methods
- ✓ Forested stream buffer protection expanded
- ✓ DOF adopts city as 1 of 5 Ches. Bay Model Cities
- ✓ New trails connections and trail design standards to protect water quality.
- ✓ New stormwater requirements and programs and green building goals too!



# Steps to get from data to GI policy....

1. Fit GI into existing plans, e.g. the comprehensive plan or park master planning processes.
2. Correlate GI plans with other related plans such as, road plans (e.g. ECOLogic Program).
3. Determine appropriate scales and collect, review and ground truth available data.
4. Enlist diverse stakeholders in reviewing and adding to data.
5. Educate decision makers who have never heard of GI!



# 5 GIC Field Tests to Develop Implementation Methods

## Phase One – Data Collection

Collect available local data

Merge local data with VA Conservation Lands Ecological and Cultural Models, Forest Economics etc.

Overlay land use and zoning, where are conflicts?

## Phase Two – Community Input

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community do we want?

What strategies will help to achieve desired futures?



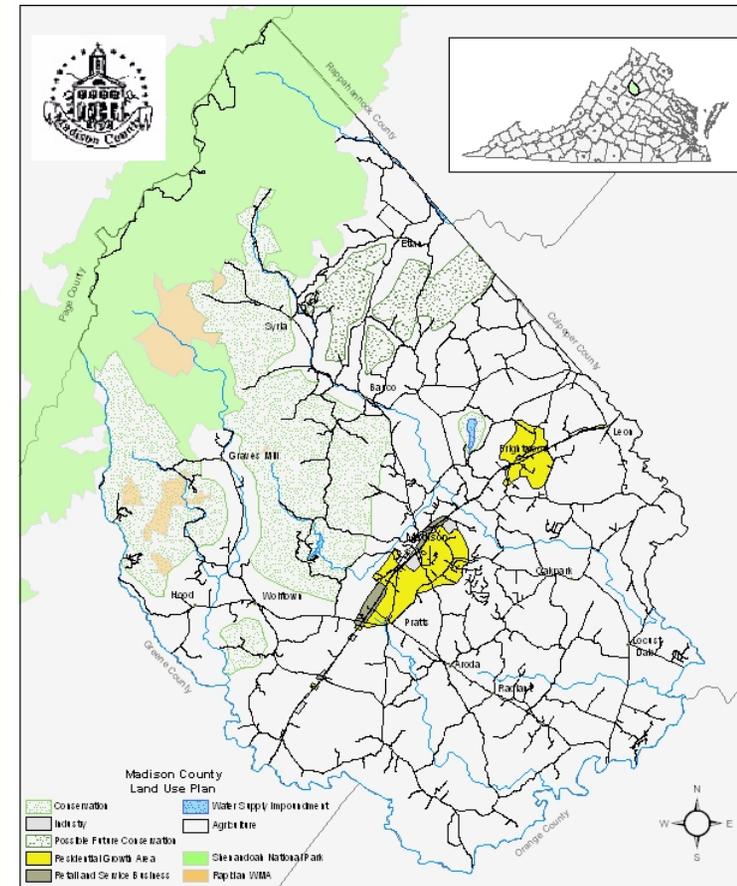
## Field Test #1: Madison County Comprehensive Plan Goals for Green Infrastructure

**Goal:** Maintain agriculture and forestry as the primary land use.

**Goal:** Protect and enhance the natural ecosystems and working lands that support the County's quality of life and economic base

**Next:** So find out what are their assets, what is at risk and where, what strategies can be done?

Madison County Land Use Plan



Support provided by

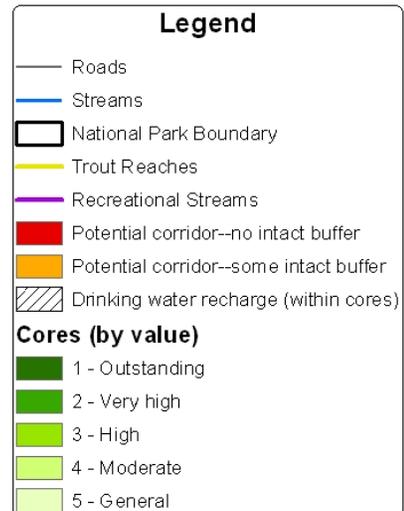


## Simplified Steps:

1. Need to determine what is protected and/or managed.
2. How is land zoned?
3. What is at risk?
4. What can be saved or restored?
5. What does community want?

= Strategy

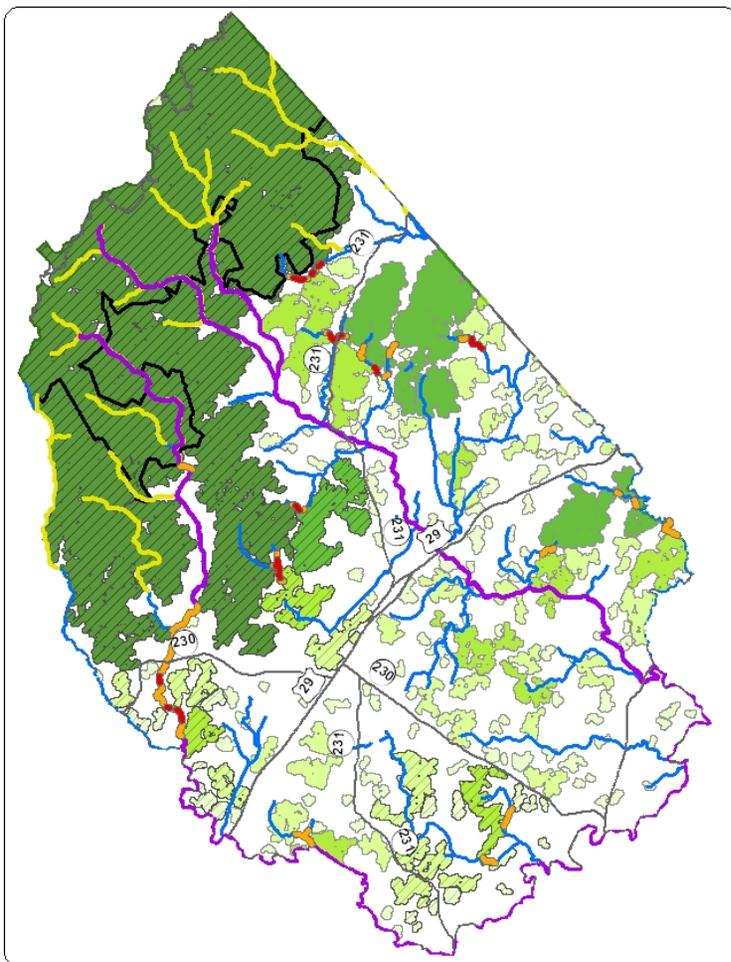
### Water Resource Assets in Madison County



0 0.5 1 2 3 4 Miles



Review Draft: 12/5/2007



# Next field test regions

*Madison County (done 06/08)*

*Richmond Region (start 03/08)*

*Coastal Zone*

*The Valley*

# GIC Tools for Implementation

- ✓ Field tests of new planning methods
- ✓ Economic studies
- ✓ Handbooks, manuals and college curricula
- ✓ Web tools and software
- ✓ Presentations to promote GI

There are many opportunities to participate in or fund field tests, research or educational tools!



A large red boat hull is the central focus, showing signs of wear and peeling paint. In the foreground, a black sign on a post is partially visible. The background shows other boats and a clear sky.

**The  
End**

**GIC Inc.**

921 Second St. SE

Charlottesville, VA

22902

434-975-6700,  
#222

[info@gicinc.org](mailto:info@gicinc.org)

[www.gicinc.org](http://www.gicinc.org)