Accounting for Maryland' s Ecosystem Services

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Maryland Department of Natural Resources

Roanoke River Basin's Natural Assets

March 6, 2019

Maryland Landcover: 2010

1973 45% Forest
40% Agriculture
10% Impervious

2010 42% Forest
33 % Agriculture
22% Impervious

Impervious
Agriculture
Forest
Wetland
Water
Beaches
Bare Rock
Bare Ground

| Landcover Change (acres)	Impervious	Agriculture	Forest	Wetland
1979	654,541	2,522,049	2,827,562	231,421
2010	1,353,535	2,050,049	2,588,129	230,301
Change 1979 - 2010	698,994	-472,000	-239,433	-1,120

0   12.5   25   50
Miles
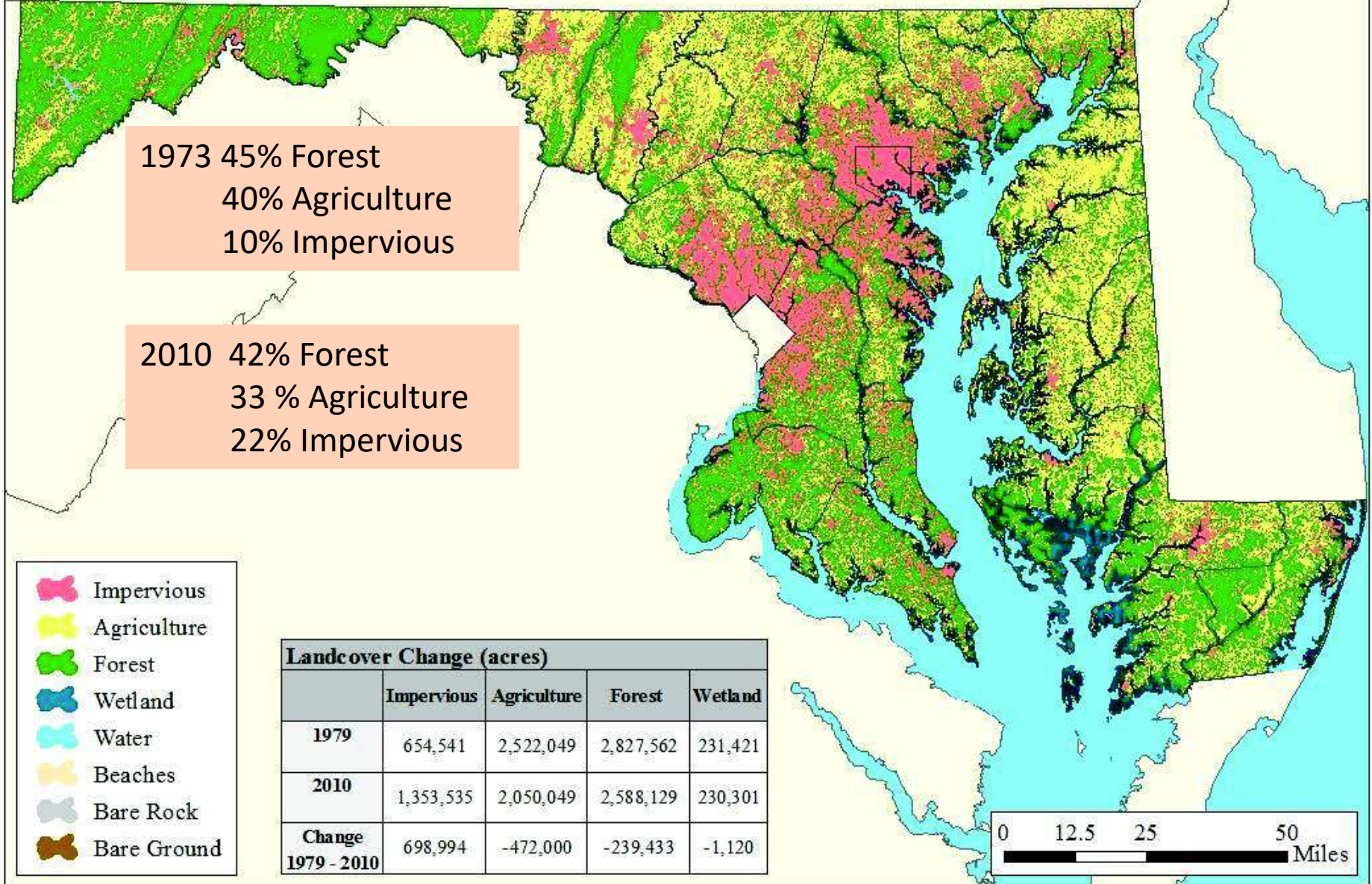
Ecosystem Services

Broadly- "*Benefits gained by people from the environment*"

Practical definition for inclusion in decision making-

"*Benefits gained by people from the environment that are not already being paid for in a market and are contributing to a marginal increase in human well-being*"

MD DNR has developed a tool to quantify Ecosystem Services from natural lands
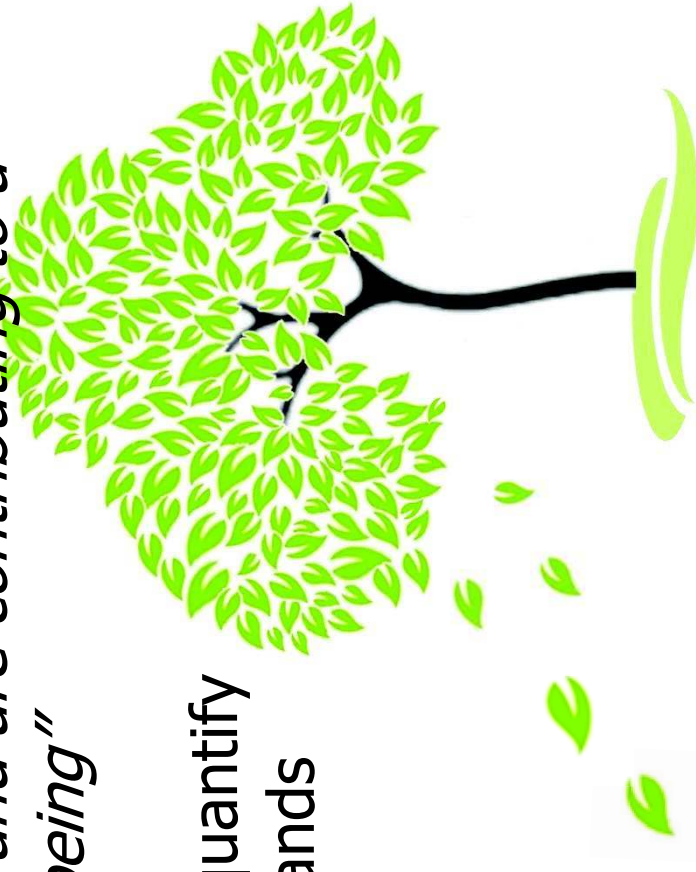
State of Ecosystem Services in Government

- Many federal agencies have efforts to quantify ecosystem services (e.g. EPA's EnviroAtlas, USGS's SoLVES, USDA OEM, NOAA, NESP Guidebook)
- Few states have similar efforts within state government (Oregon's Willamette Partnership)
- Maryland has maintained interest in ES (2011 Ecosystem Service Working Group Report)
- **Charge: Create tool to allow ES to be integrated into State of Maryland decision making**

Valuation Methodology: Eco-Price

- Ecosystem services are paid for in many different ways

- People view responsibility for providing ecosystem services to be a collective obligation

- We look at the many different ways society invests in protecting or replacing the environment

  - In a regulatory market
  - Cost of restoration
  - Through mitigation fees
  - Cost to regulate

Assesses the Social Value for decision making

≠ Market Value

Mapping Ecosystem Services

- Ecosystem Services vary spatially across the landscape

- ES vary in the biophysical supply of the service (e.g. amount of carbon that is sequestered, water being recharged to aquifers)

- ES vary in the way and amount that people benefit (e.g. number of people and value of infrastructure vulnerable to flooding)

- We consider both sources of variation when mapping ES in Maryland

Maryland Ecosystems

- Results Presented at 30 m Pixel Scale

- Forest Extent - 1 m LiDAR forest cover (UMD/NASA) downscaled to 30 m

- Wetland Extent- NWI (2006) + MD DNR wetlands, polygons converted to 30 m pixel

Ecosystem Services Mapped

Air pollution mitigation- USFS i-Tree landscape

Carbon sequestration- USFS i-Tree and MD DNR

Groundwater recharge- USGS National Hydrography Dataset (1 km)

Nitrogen Removal- USGS SPARROW model w/ literature removal rates by loading/ecosystem type

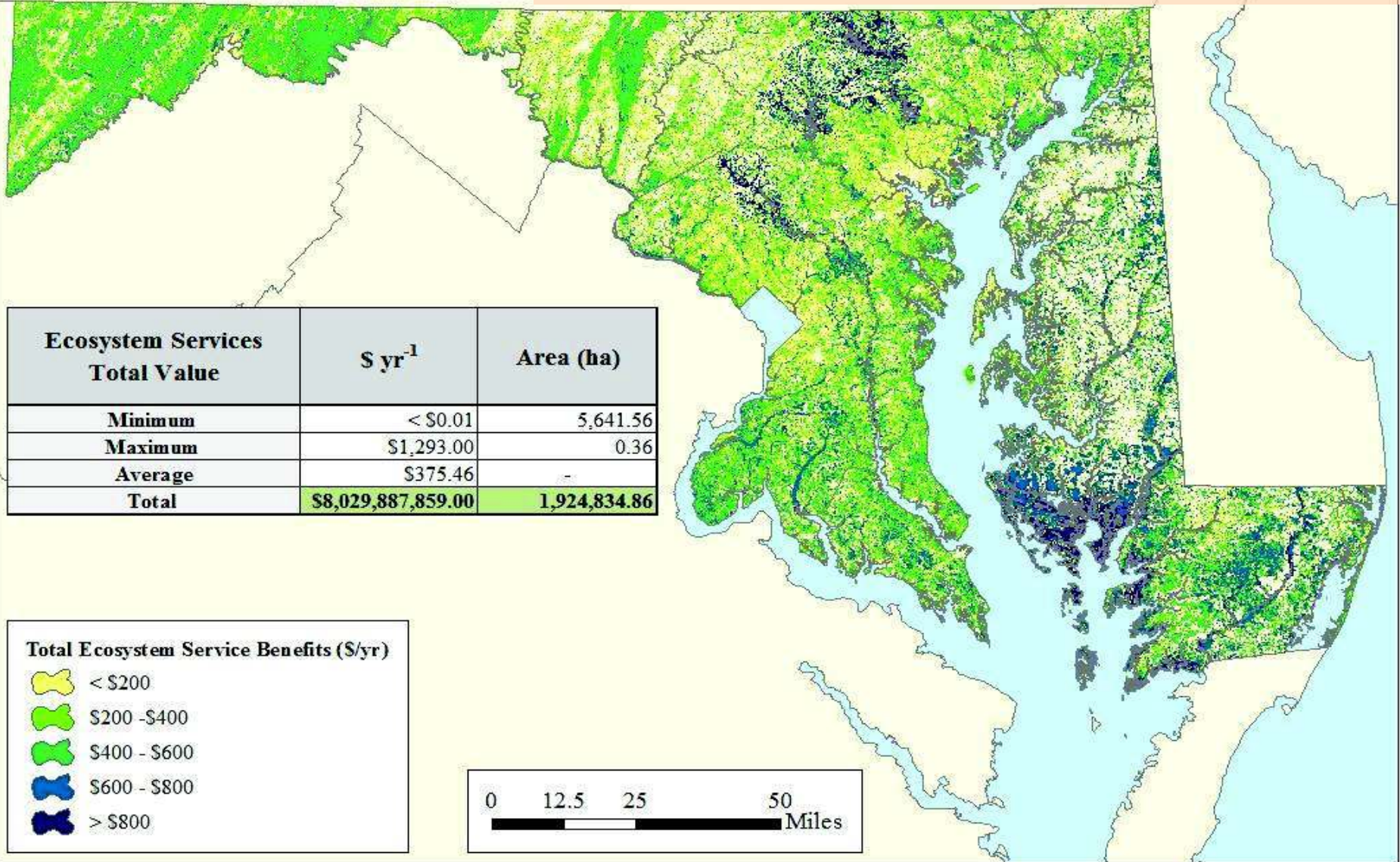**Flood Prevention/Stormwater mitigation-** Index of Mitigation Potential (EPA/MD DNR)

Wildlife- Habitat Quality Index, MD DNR
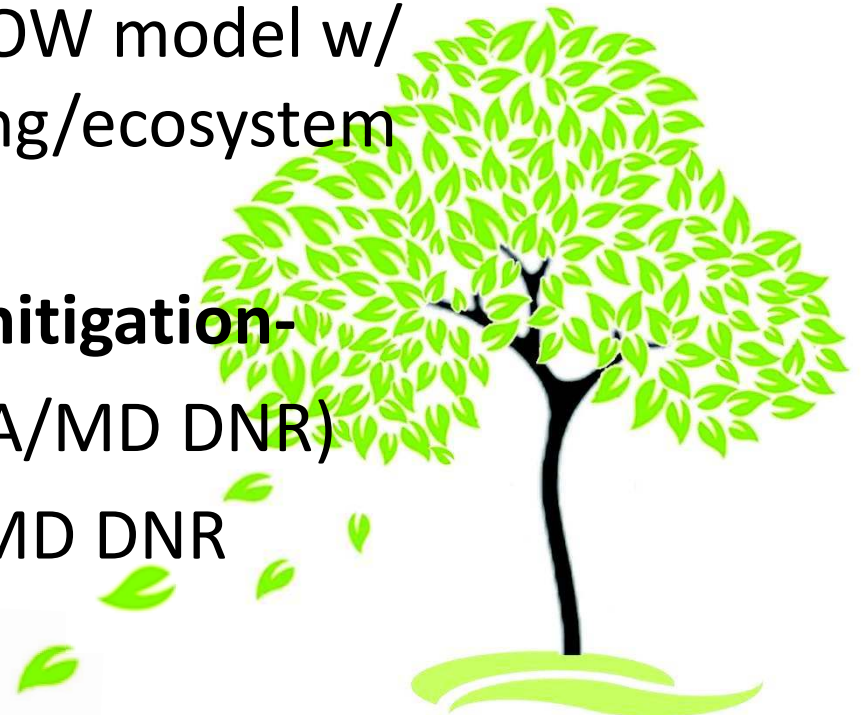
Total Ecosystem Service Benefits

Economic Value ($/yr)

$8 billion of ES Benefits per year!

Ecosystem Services Total Value	$ yr^{-1}	Area (ha)
Minimum	< $0.01	5,641.56
Maximum	$1,293.00	0.36
Average	$375.46	-
Total	$8,029,887,859.00	1,924,834.86

Total Ecosystem Service Benefits ($/yr)

- < $200
- $200 - $400
- $400 - $600
- $600 - $800
- > $800

0	12.5	25		50

Miles

Ecosystem Service Totals

149,228,585 239,660,000 247344000 417,000,000

3,110,000,000

1,260,000,000

2,644,000,000

- air pollutants
- Carbon
- Surfacewater Protection
- nitrogen removal
- Groundwater
- wildlife habitat
- Stormwater
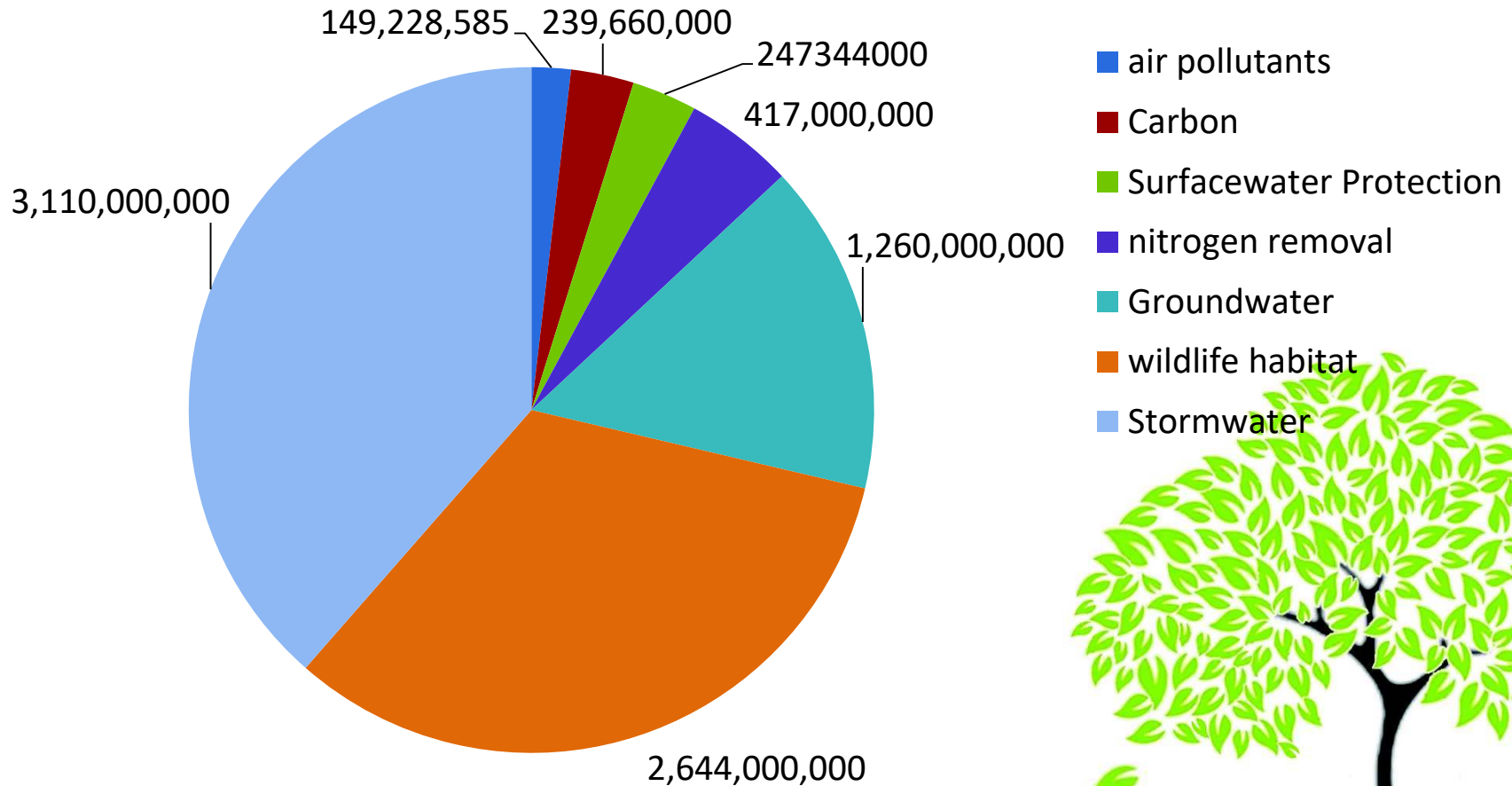
Units= $ per year

Land Use Comparisons

Floodplain Ecosystem Services

Total Ecosystem Service Benefits
Economic Value ($/yr)

Total Value of ES in MD Floodplains= **$1.9 billion per year**
This is 20% of the total ES value,
from only 14% of forests and wetlands

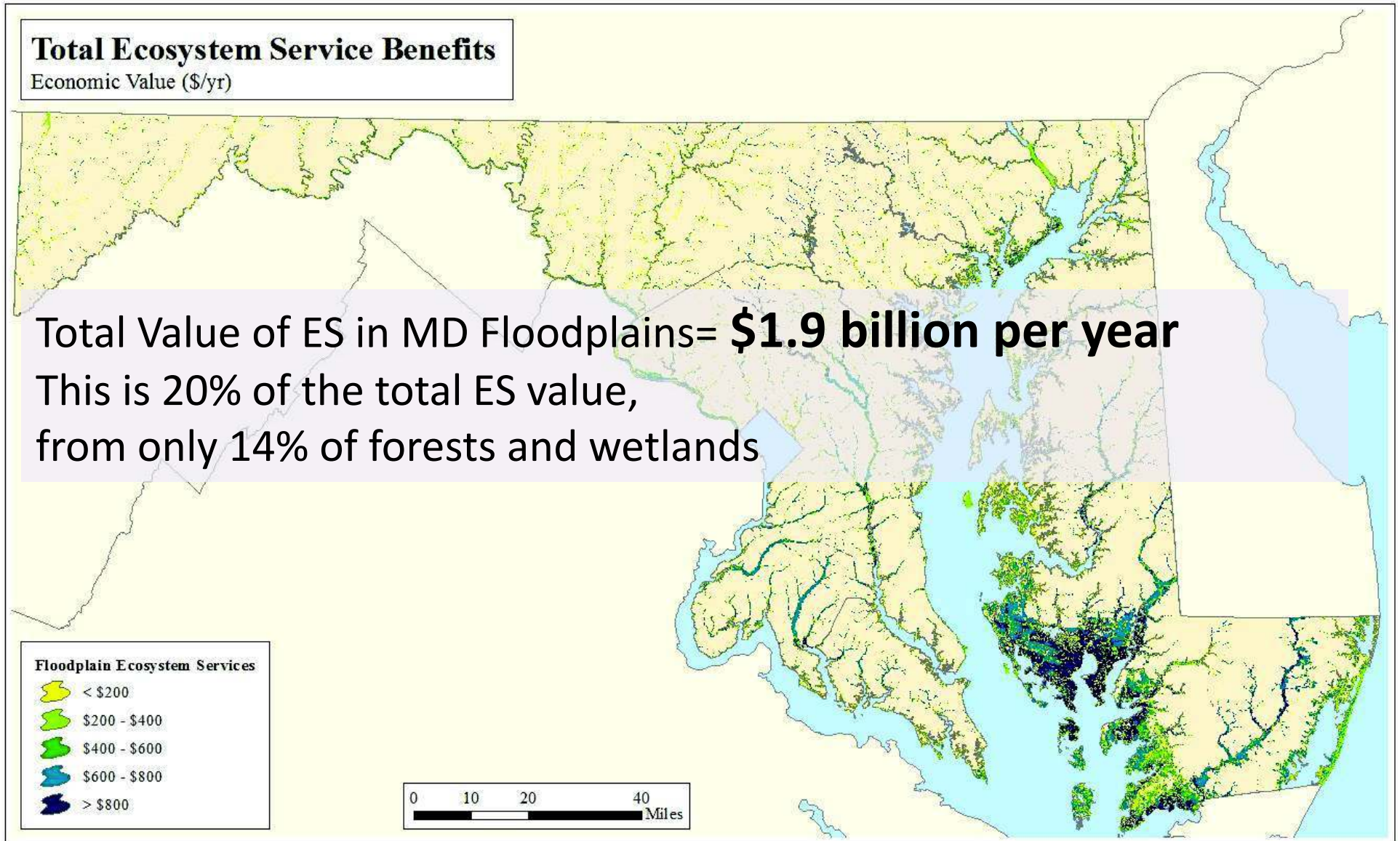**Floodplain Ecosystem Services**
- < $200
- $200 - $400
- $400 - $600
- $600 - $800
- > $800
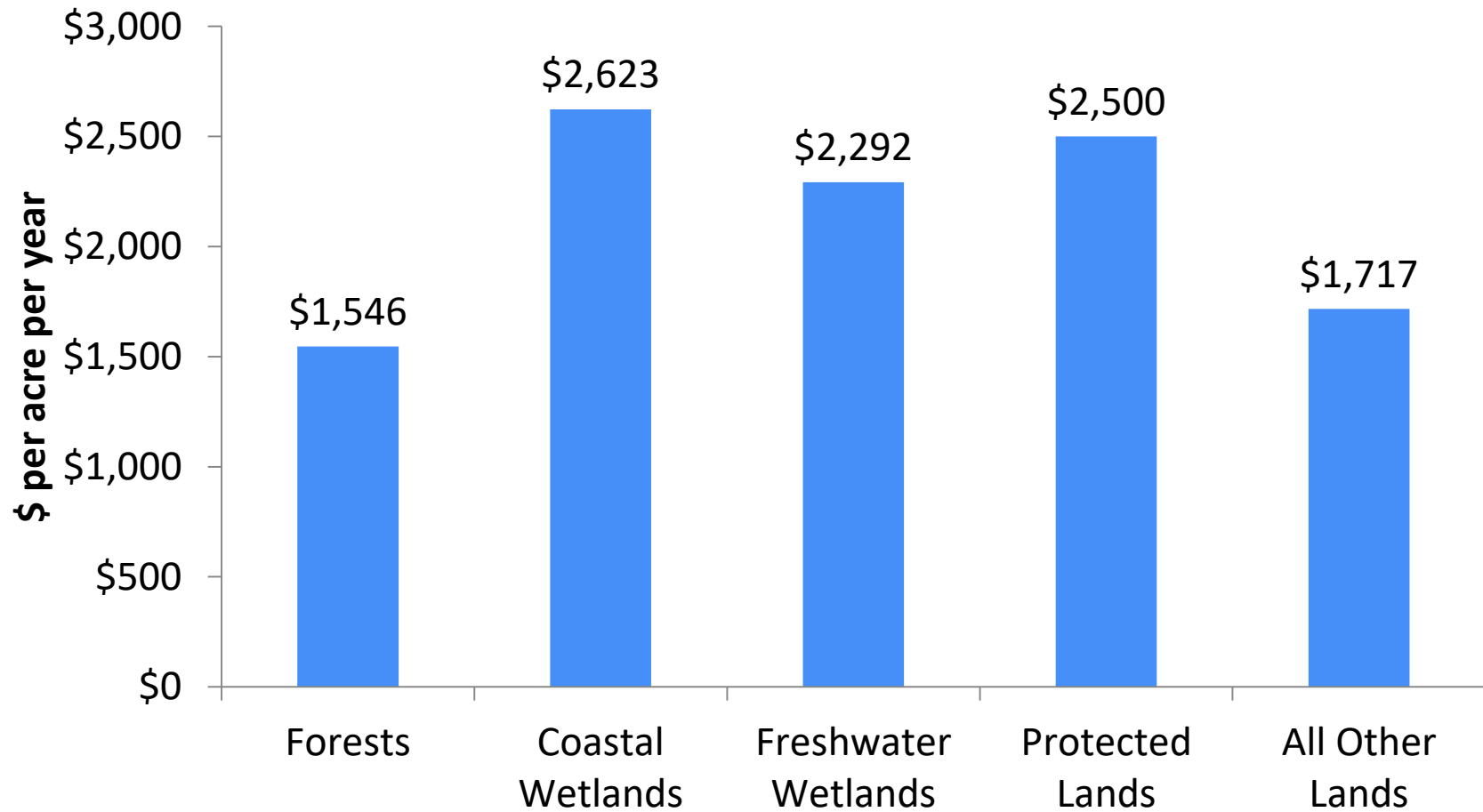
0   10   20   40
                Miles
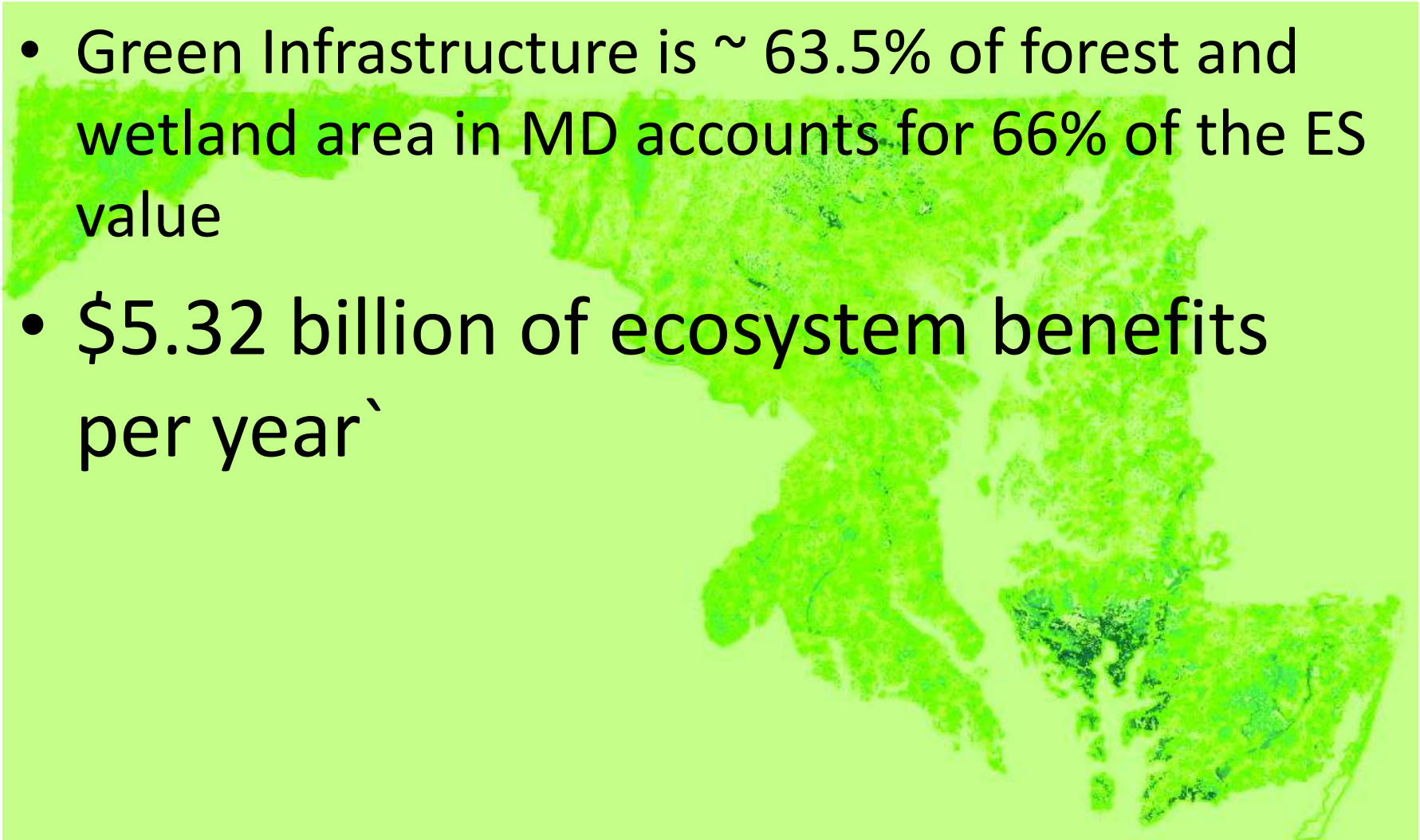
Ecosystem Benefits from Green Infrastructure

- Green Infrastructure is ~ 63.5% of forest and wetland area in MD accounts for 66% of the ES value

- $5.32 billion of ecosystem benefits per year`

Integrating Ecosystem Services in the Maryland DNR

Conservation

- Parcel Evaluation Tool on the Maryland GreenPrint Mapper
  - Program Open Space Investments –Totaled >$100 million for FY2018
  - Outreach events to Land Trust Community

Restoration

- Creating a tool to evaluate the ES benefits of ecological restoration
- Help to prioritize restoration opportunities
- Guide restoration requirements (fee in lieu, Critical Area)

Compensation

- Maryland has created a policy to base compensatory fees for impacts on state lands on the ecosystem services lost. The approach has been successfully applied to three natural gas line impacts, with over $500,00 in payments collected.

Next Steps

- Creating models for ecological restoration
- Include Services from Chesapeake Bay
- Incorporate new data
  - Wetland mapping
  - Higher resolution forest cover
  - New models
  - New eco-prices
- Collaborate with partners- Virginia, Delaware, Pennsylvania, Chesapeake Bay Program, EPA Reg. 3, counties.

Thank You!

Websites:

- http://geodata.md.gov/greenprint/
- http://dnr.maryland.gov/ccs/Pages/Ecosystem-Services.aspx

Webinar

- https://www.youtube.com/watch?v=56mDu3lH0-0

Contact:

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- Rachel.Marks@maryland.gov

Conservation and Resilience Targeting at the Regional and County Scale
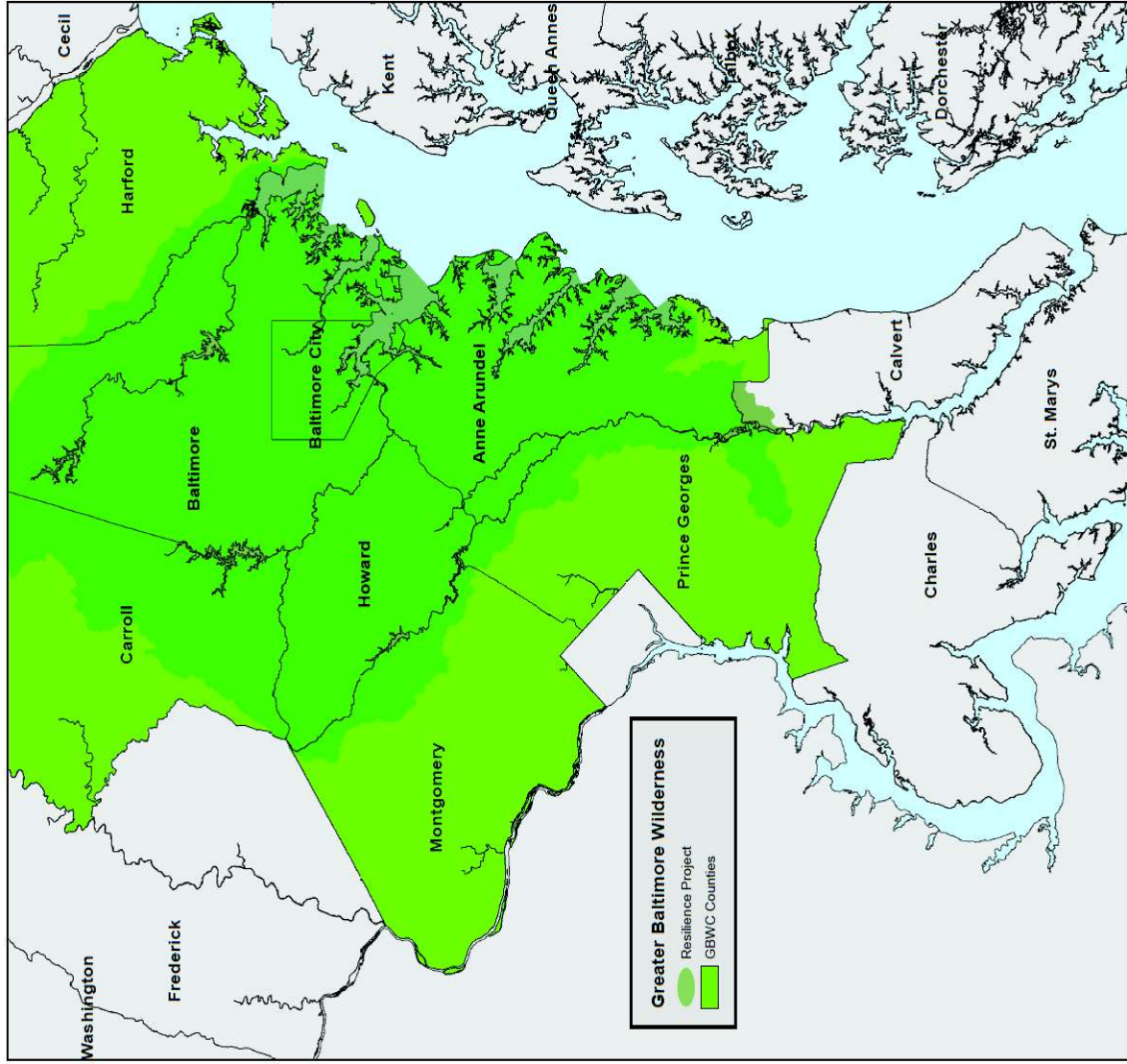
Ted Weber
Conservation Science Manager
The Conservation Fund

March 6, 2019

- Resilience
- Biodiversity
- Equity
- Discovery

Greater Baltimore Wilderness Coalition & Coastal Resilience Project

Greater Baltimore Wilderness

- Resilience Project
- GBWC Counties

Key Strategies for Green Infrastructure and Climate Resiliency

1) Natural resource protection, enhancement, or restoration

2) Tree canopy enhancement or restoration

3) Multiple benefit green stormwater infrastructure

4) Critical (built) infrastructure protection

5) Coastal defense

Go to http://www.baltimorewilderness.org and click on Resiliency, Maps

What is Green Infrastructure?

A strategically planned and managed network of natural lands, working landscapes, and other open spaces that conserves ecosystem values and functions and provides associated benefits to human populations

(Benedict & McMahon, 2006)

GREEN INFRASTRUCTURE APPROACH

LANDSCAPE   REGION   SITE

NETWORK DESIGN FOR SPECIES HABITAT
WILDLIFE CORRIDORS
COMPATIBLE WORKING LANDSCAPES

GREENSPACE FOR WATER
QUALITY AND SUPPLY
GREENWAYS FOR RECREATION

LOW IMPACT DEVELOPMENT
URBAN FORESTRY
STORMWATER MANAGEMENT

TRANSECT COURTESY OF THE CENTER FOR APPLIED TRANSECT STUDIES

URBAN

RURAL

Source:

THE
CONSERVATION FUND

What is Green Infrastructure?

GREEN INFRASTRUCTURE
NETWORK DESIGN COMPONENTS

LINK

CORE
HUB

LINK

HUB
CORE

CORRIDOR

CORRIDOR

CORE
HUB

LINK
TO OTHER
HUBS

Source: THE CONSERVATION FUND
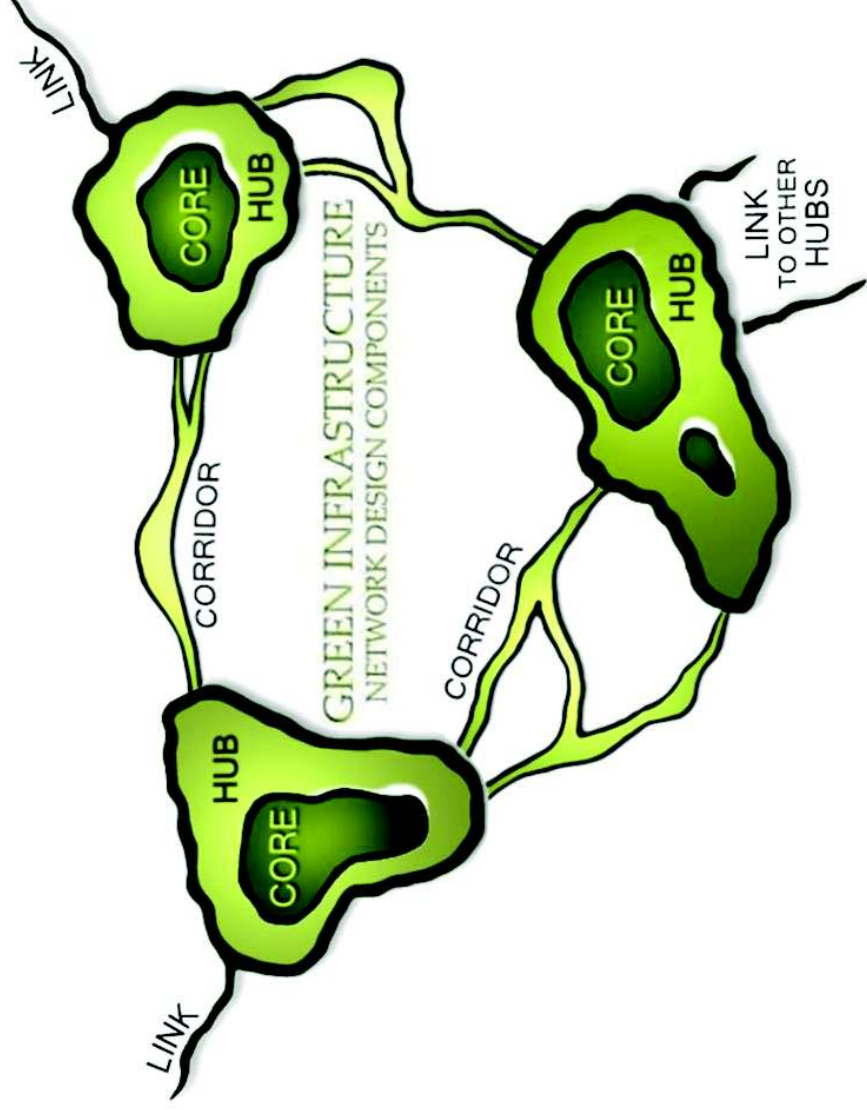
Cores:

- Contain fully functional natural ecosystems

- Provide high-quality habitat for native plants and animals

Hubs:

- Slightly fragmented aggregations of core areas, plus contiguous natural cover

Corridors:

- Link core areas together

- Allow animal movement and seed and pollen transfer between core areas

Sites:

- Important microhabitats not captured by network thresholds and criteria

Focal species

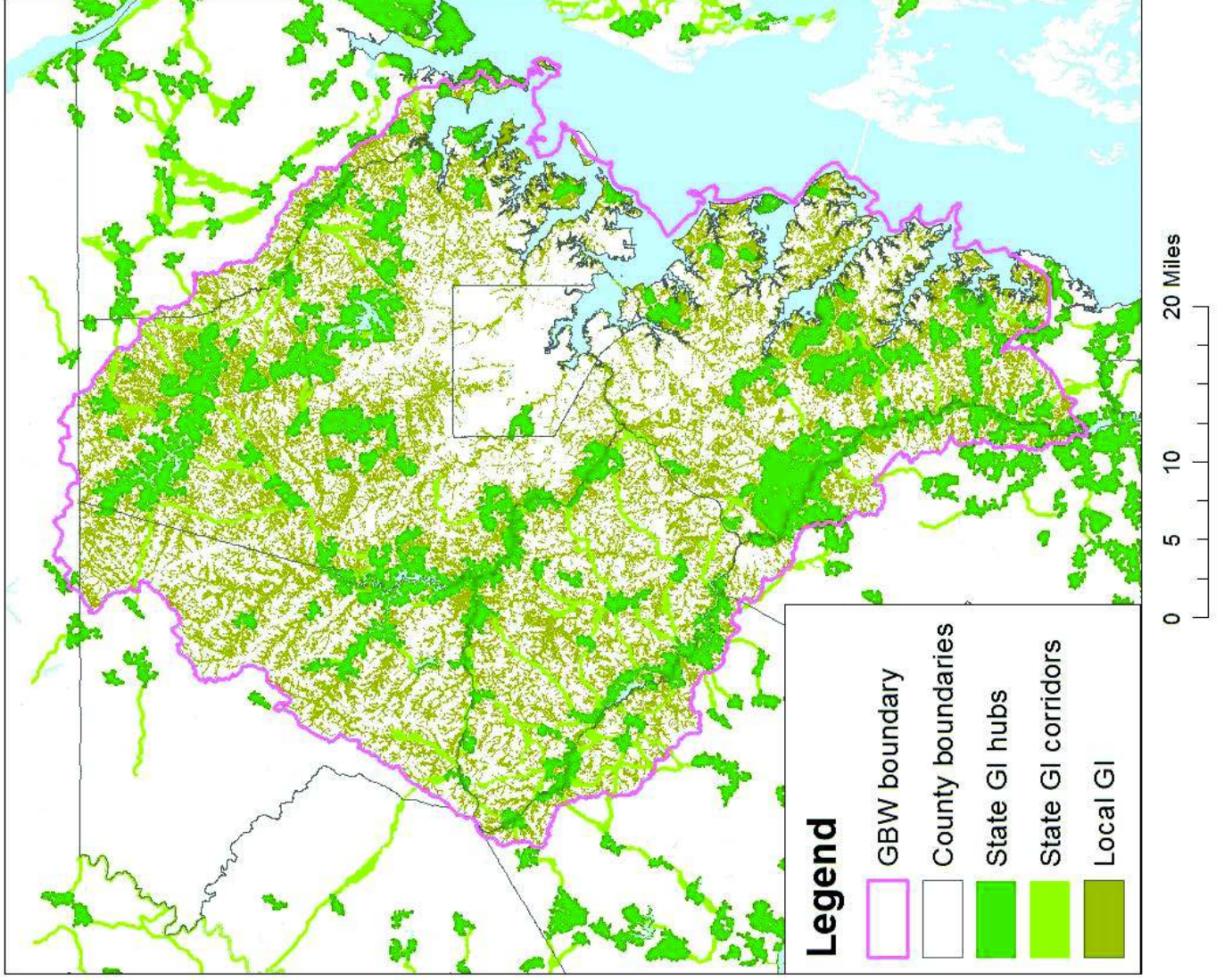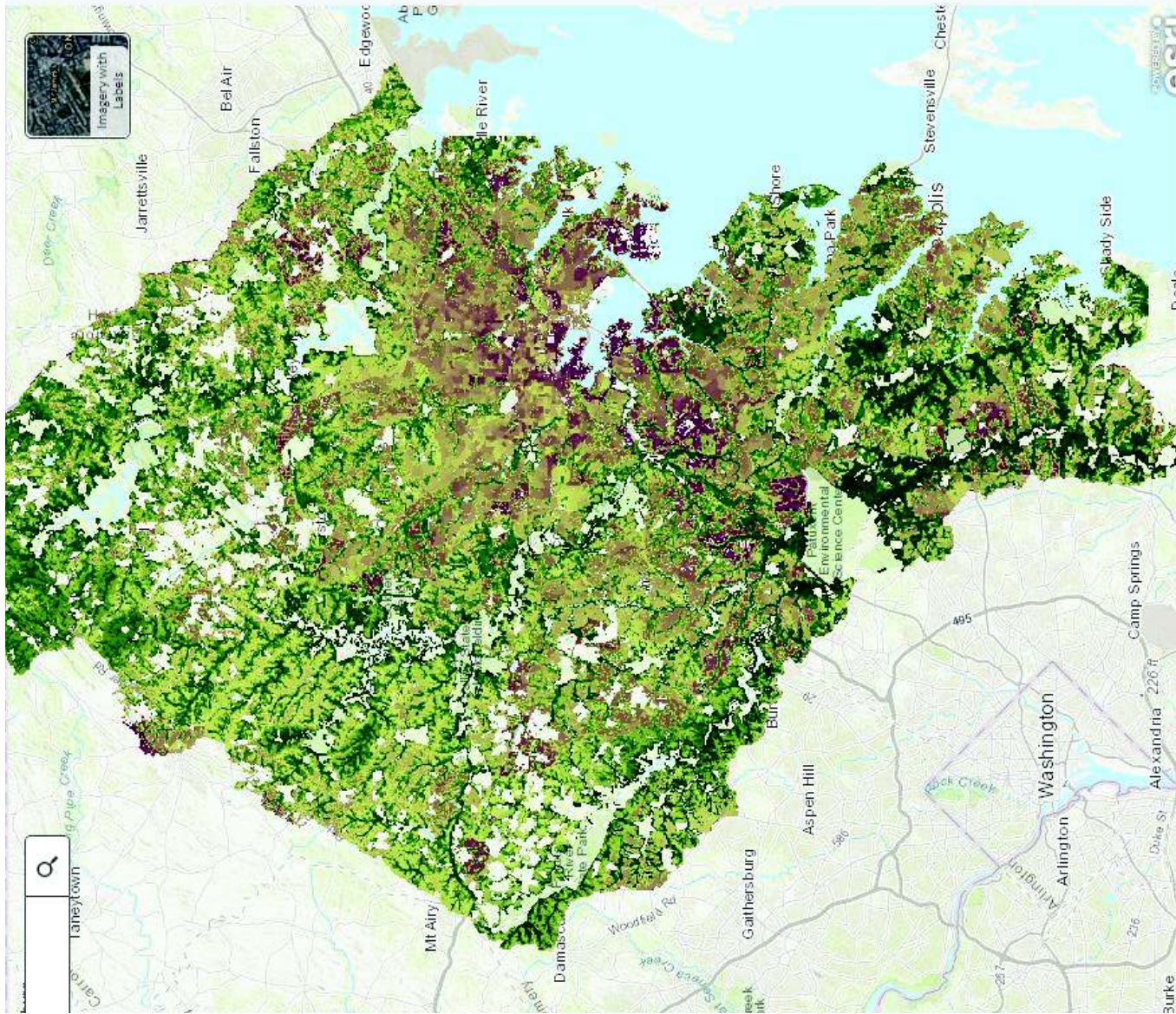- Identify native wildlife species

- Identify these species' habitat preferences and requirements, home range sizes, dispersal abilities, suitable landscape features for dispersal, barriers to dispersal, and roles in ecosystem functions

- Select umbrella, keystone, and other focal/surrogate species to determine size, connectivity, and other thresholds in the green infrastructure network design.

Greater Baltimore Wilderness Coastal Resiliency Project

Combining State and Local Green Infrastructure

Legend

- GBW boundary
- County boundaries
- State GI hubs
- State GI corridors
- Local GI

0   5   10   20 Miles

Resilient Strategy Opportunities:

- ○ No strategy map
- ● Protect Natural Resources
- ○ Enhance and Restore Tree Canopy
- ○ Implement Multi-Benefit Green Stormwater Infrastructure
- ○ Implement Multi-Benefit Green Stormwater Infrastructure - Baltimore
- ○ Protect Critical Infrastructure
- ○ Defend the Coast: Preservation
- ○ Defend the Coast: Restoration
- ○ Defend the Coast: Enhancement

← Less opportunity   More opportunity →

Reference maps:

▸ Boundaries and roads

  ○ Municipal boundaries
  ○ Protected lands
  ○ Roads

▸ Potential Stormwater BMP sites
▸ State green infrastructure
▸ County green infrastructure
▸ Forest cores/corridors
▸ Floodplains
▸ Projected sea-level rise (NOAA)
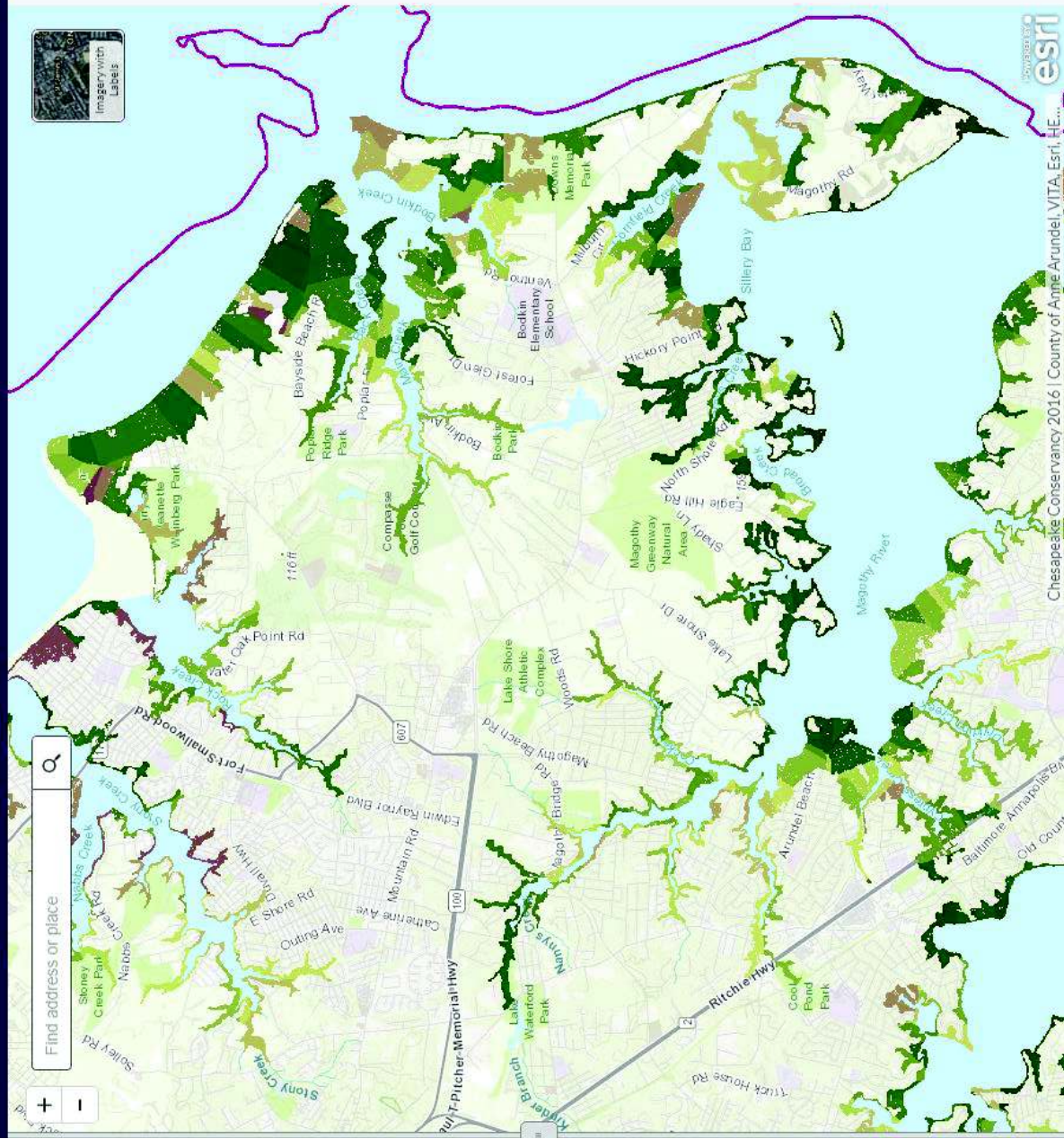▸ Other natural features/characteristics

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- Floodplains
- Projected sea-level rise (NOAA)
- Other natural features/characteristics

Find address or place

Imagery with Labels

Chesapeake Conservancy 2016 | County of Anne Arundel, VITA, Esri, HE...

esri

Proud Partners of the

Harford County Green Infrastructure Plan

Jean K. Akers, AICP, PLA

Green Infrastructure Plan

Harford County Core Areas

Core forest: Forest patches with at least 1 acre of interior conditions; and at least 100 acres in size, or overlapped core aquatic areas, core wetlands, or key biodiversity areas.

Core wetlands: Unimpaired wetlands with 100 ft buffers.

Core aquatic areas: Streams supporting sensitive fish and invertebrates, other high quality waters, important coastal areas, SAV beds, and anadromous fish spawning and juvenile habitat.

Core areas

Hubs (outside cores)

Corridors

Miles

0   2   4   6   8   10

Green Infrastructure Plan
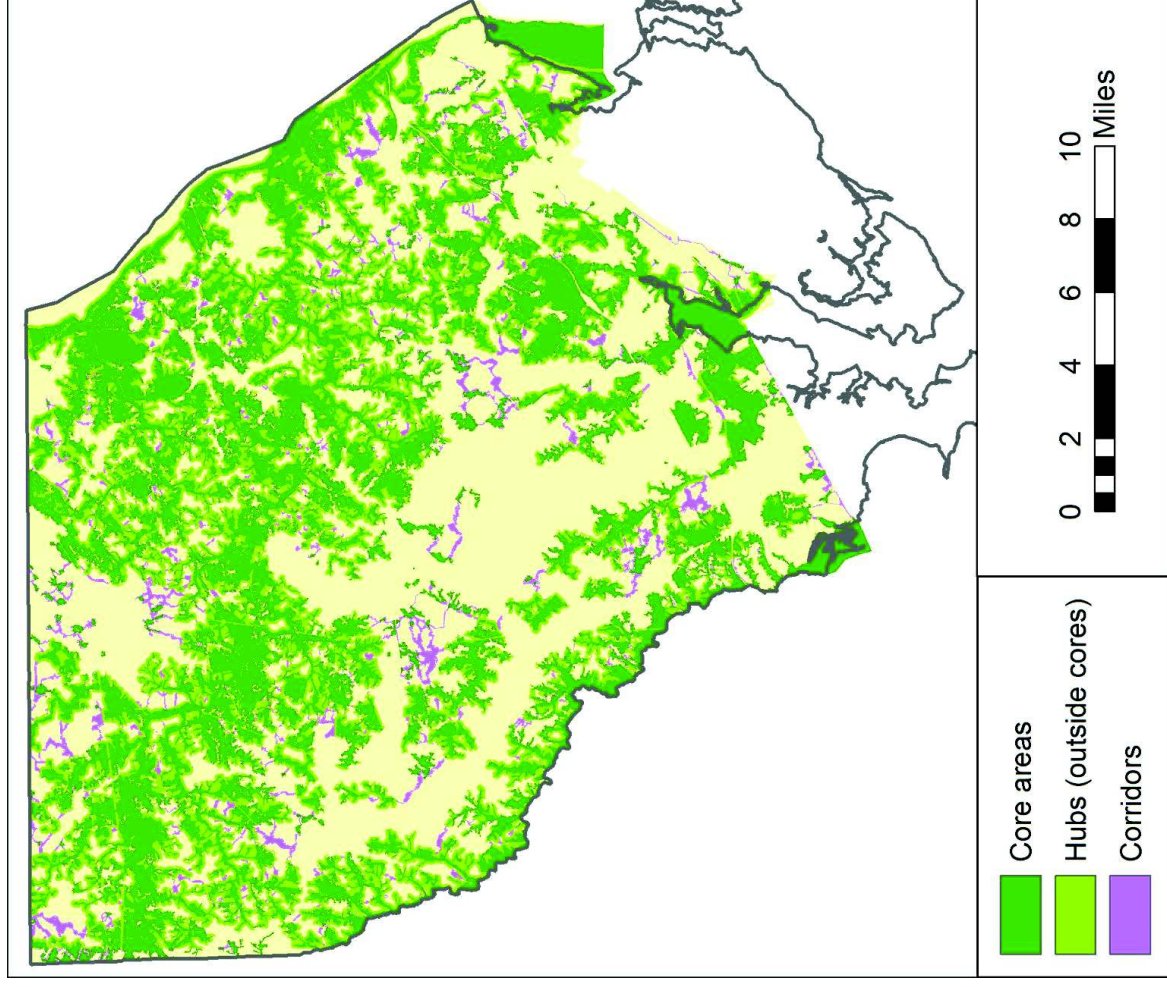
Harford County Corridors

To model landscape connectivity, we simulated the movement of animals through the landscape and identified the best connections between suitable habitat.

Connectivity was modeled separately for forest, wetland, and aquatic organisms.

Modeling included randomization to reflect uncertainties.

GI NETWORK WITH WATERSHEDS

% OF EACH WATERSHED IN THE GI NETWORK	
WATERSHED	%
BROAD CREEK	46%
BUSH RIVER	40%
BYNUM RUN	14%
CONOWINGO DAM SUSQUEHANNA RIVER	51%
DEER CREEK	51%
GUNPOWDER RIVER	35%
LITTLE GUNPOWDER FALLS	47%
LOCH RAVEN RESERVOIR	15%
LOWER SUSQUEHANNA RIVER	44%
SWAN CREEK	42%
WINTERS RUN	26%

GI NETWORK
- CORE AREAS
- CORRIDORS
- WATERSHEDS
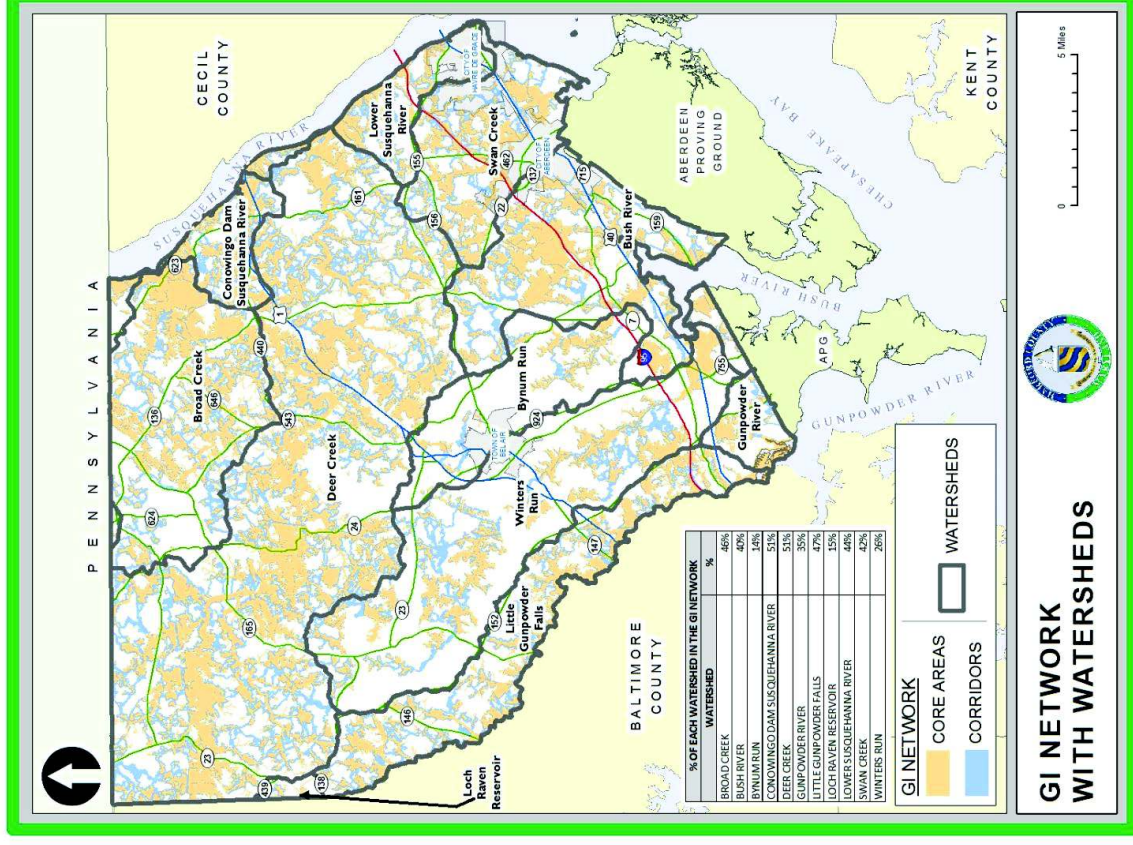
What are the priorities for Green Infrastructure?

On February 8, 2018, Harford County hosted a community meeting to seek input on green infrastructure goals and priorities. Over 60 participants shared their ideas.

Prioritization of GI Strategies

- Acquire key natural areas
- Acquire strategic connecting corridors
- Enhance tree canopy
- Connect greenway trails
- Add multi-benefit green stormwater projects
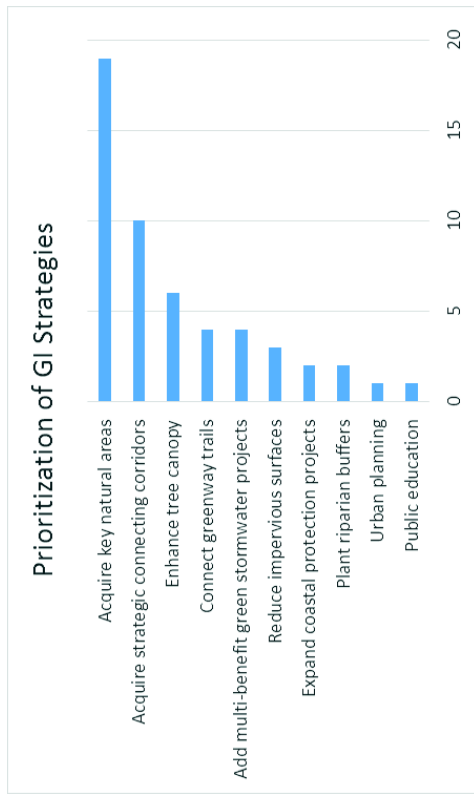- Reduce impervious surfaces
- Expand coastal protection projects
- Plant riparian buffers
- Urban planning
- Public education

Acquire key natural areas and strategic connecting corridors.

Prioritized Goals for Green Infrastructure

- Natural Resource Protection
- Wildlife Corridors / Habitat (preserve,...)
- Green Stormwater Management
- Preserve Water Resources
- Healthy Lifestyles/Recreation/Trails
- Critical Infrastructure Protection
- Heritage
- Urban Planning

Protect natural resources and wildlife corridors.

Green Infrastructure Plan

Ranking for Natural Resources Protection

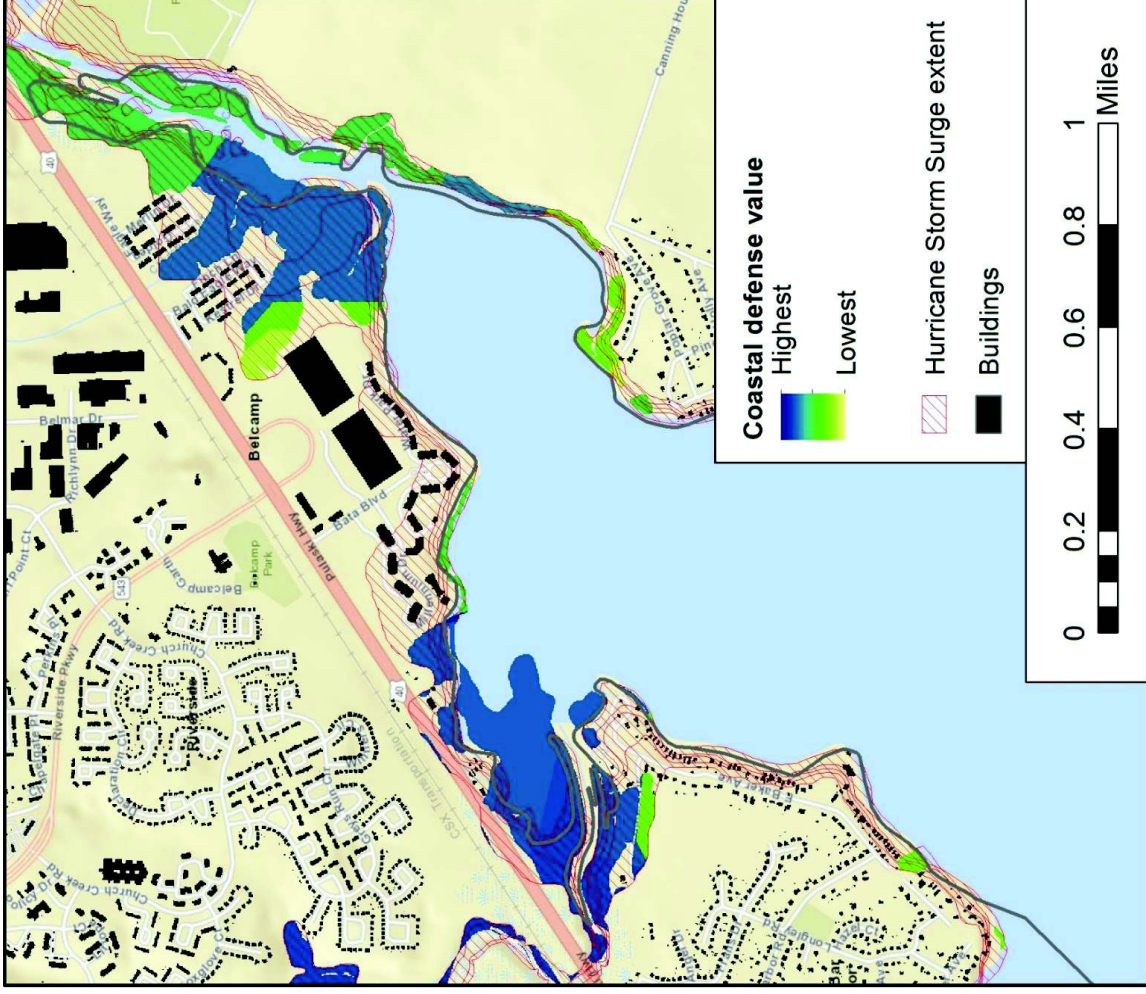| Mandatory criteria	Not already protected Not a building or paved Not open water
State-designated ecological significance	Statewide Green Infrastructure Hub-Corridor Network Targeted Ecological Areas Significant for Biodiversity Conservation Wetlands of Special State Concern + 100 ft buffer
Watershed characteristics (DNR 12-digit watersheds)	Percent forest cover (more forest preferred) Percent impervious surface 100-foot buffers of Stronghold Watershed streams, trout bearing streams, streams feeding municipal drinking water reservoirs, and Tier II High Quality Waters (Forests of Recognized Importance)
Harford County green infrastructure network	Core areas Hubs Aquatic movement importance Forest movement importance Wetland movement importance
County/Local Scale Resource Features	Wetlands + buffers Streams + buffers and floodplains Forest patches with at least 1 acre of interior Highly erodible soils
Population vulnerability	Population density (# per square mile) % Population with income below poverty % Population of non-proficient English speakers % Population <18 or ≥ 65 years of age
Park equity	Distance to nearest existing park
Ecosystem service values	Air Pollution Removal Carbon Sequestration Groundwater Recharge Surface Water Protection Nutrient Uptake Stormwater Mitigation Wildlife Habitat And Biodiversity
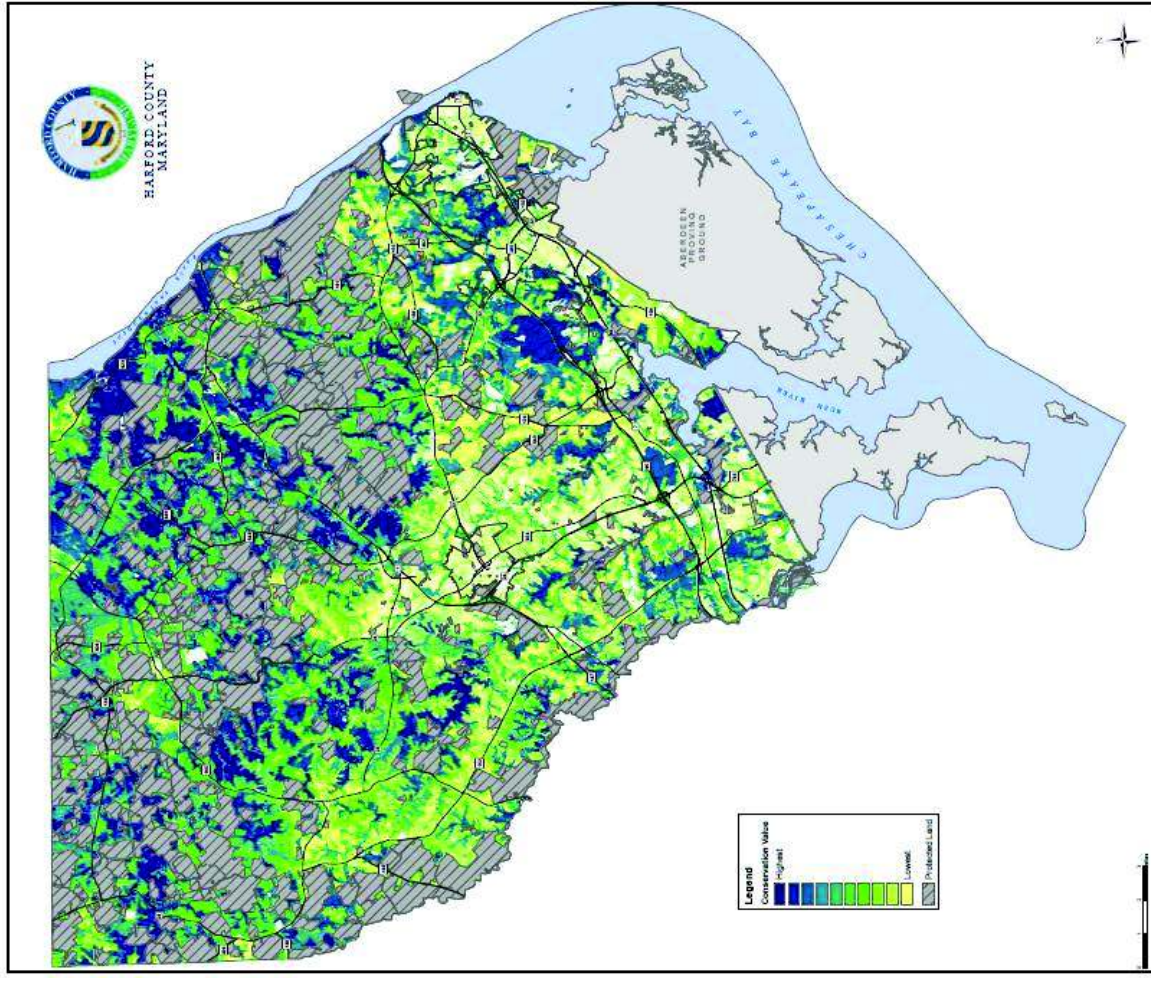
Ranking for Green Stormwater Infrastructure

Category	Criteria
Mandatory criteria	Suitable for bioretention, constructed wetland, dry pond, grassed swale, infiltration basin, infiltration trench, porous pavement, sand filter, vegetated filter strip, or wet pond
Land ownership	Public ownership preferred Privately owned with easement Privately owned with no easement
Potential for stormwater capture	Impervious area draining to the site Presence/absence of existing BMPs
Watershed characteristics (DNR 12-digit watersheds)	Percent forest cover Percent impervious surface Amount of older development (less likely to have any SW structures)
Nutrient loading by catchment	Non-point nitrogen runoff Non-point phosphorus runoff
County/Local Scale Resource Features	1% (100 year) floodplains 2% (500 year) floodplains Soil erodibility Slope
Population vulnerability	Population density % Pop. with income below poverty % Pop. non-proficient English % Pop. <18 or ≥65 years of age
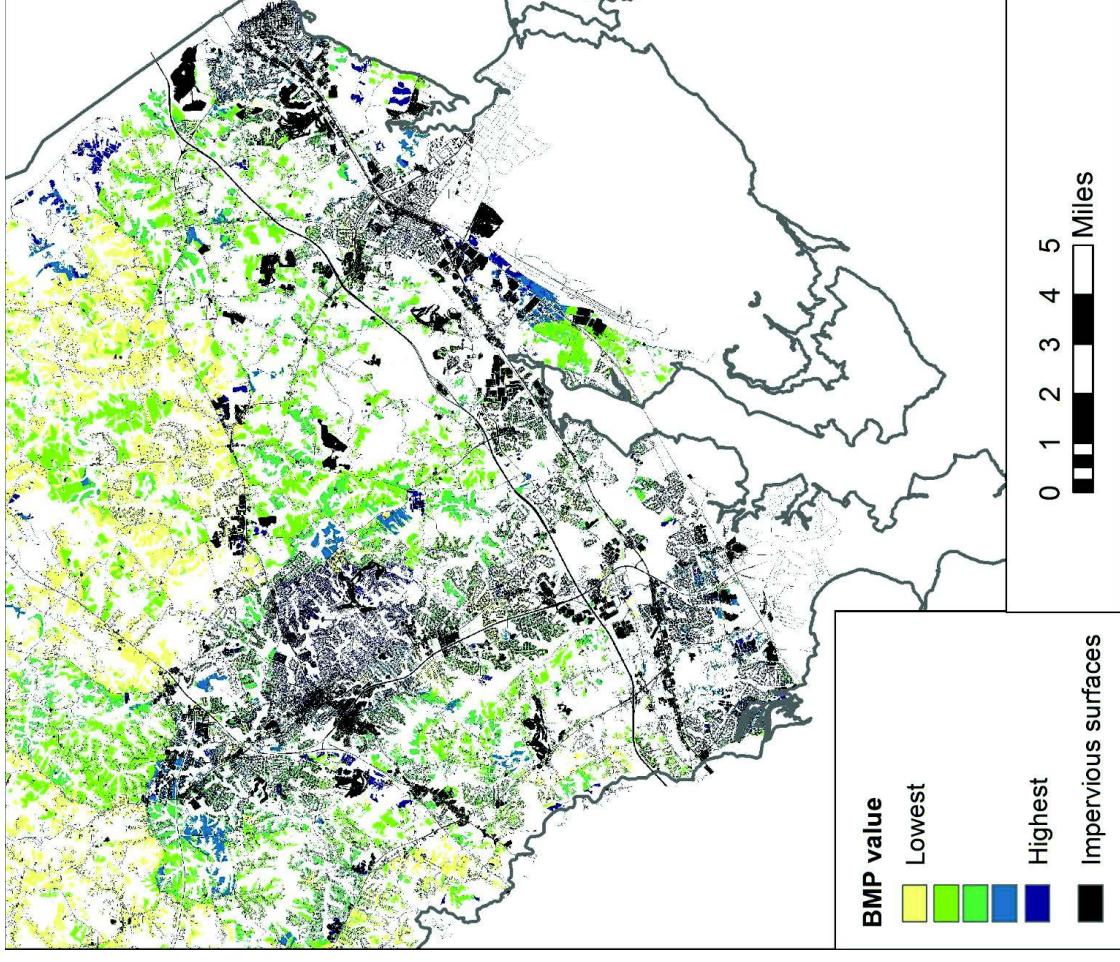
Ranking for Coastal Protection

Mandatory criteria	Not developed Not already protected Within coastal storm surge zone Existing natural features within storm surge zone (forest, wetlands, or underwater grass)
State-designated Blue Infrastructure shoreline segments	Blue Infrastructure total rank, allocated to nearest natural features in storm surge zone
Maryland Coastal Resiliency Assessment	Habitat role in hazard risk reduction (High/Moderate/Low or None)

Coastal defense value
Highest
Lowest

Hurricane Storm Surge extent
Buildings

0   0.2   0.4   0.6   0.8   1
Miles

Critical Infrastructure Protection

Facility	Threat	Current protection	Possible measures to increase protection
Sewer plant	In 0.2% floodplain and Category 4 storm surge zone	Existing forest provides some protection	Raise walls above flood height.
Electrical substation	In Category 4 storm surge zone	Existing forest provides some protection	Raise equipment above flood height
Electrical substation	In Category 3 storm surge zone	Little natural protection or space to restore	Little space to restore. Move substation or raise equipment.
Electrical substation	In 0.2% floodplain	Existing forest provides some protection	Plant more trees in the floodplain, maybe construct wetlands.
Water plant	In 1% floodplain and Category 3 storm surge zone	Existing forest provides some protection	Consider moving this facility.
Water tank	Possibly in 0.2% floodplain and Category 4 surge zone	Existing forest provides some protection	Raise tank above flood height.

Forest Assessment and Model Validation

Core forest at Anita C. Leight Estuary Center with no invasive exotic plants.

Edge-dominated, non-core forest in Dublin Park, overrun with exotic plants.

- Invasive exotic plants were a problem at all county parks, dominating the ground and shrub cover in half the plots.

- Core forest had, on average, significantly fewer invasive plants than non-core forest.

- Core forest scored higher for condition and habitat than non-core forest.

- Invasive plants were more common near forest edges than when >50 m from the edge.

- Wetter soils tended to have more invasives than drier soils

- Younger forest tended to have more invasives than older forest.

- Deer were overbrowsing some of the sites.

Summary of Wildlife Habitat Validation Tests

The research team from Susquehannock Wildlife Society (SWS) visited each of the four selected hub / corridor sites multiple times during the project period to document wildlife diversity and assess the quality of the habitat.

The four sites were chosen both geographically, to cover different regions of the county, and based on their connectivity through green corridors. All four were found to confirm use by a wide variety of species and showed the value of preserving core, hub and corridor sites to protect wildlife diversity and connectivity.

Surveys included recording the general status of the forest, plant diversity, presence of invasives and quality of the understory, mapping out what types of habitats were available for wildlife at each site, seasonal wetlands (vernal pools) were sought out during the spring surveys to capture the brief amphibian breeding season.
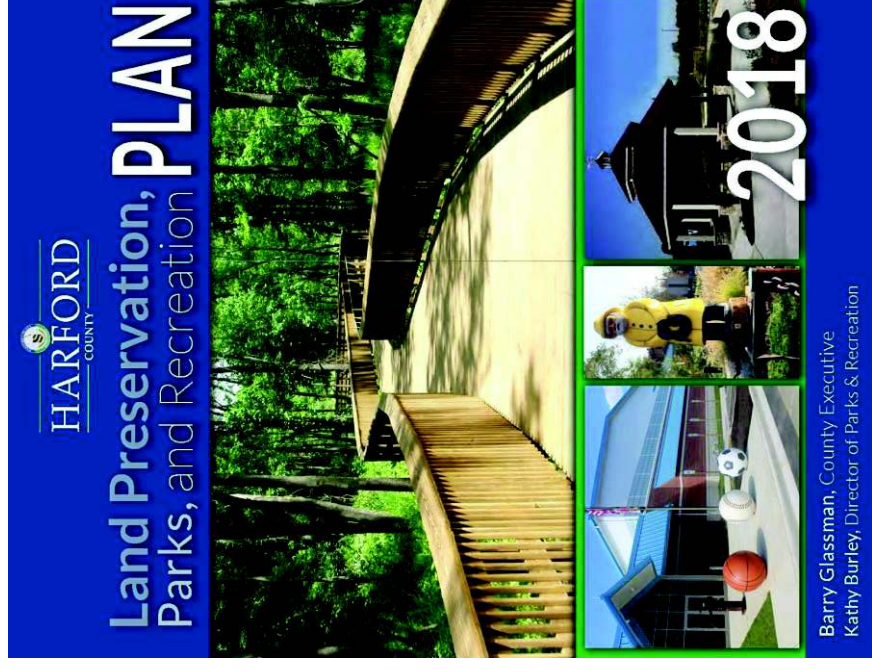

High resolution trail cameras with nighttime infrared illumination were placed at each site for a period of at least two weeks to record the diversity and density of species that might be nocturnal, weary of humans, or just not encountered during the on site visits
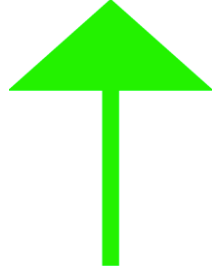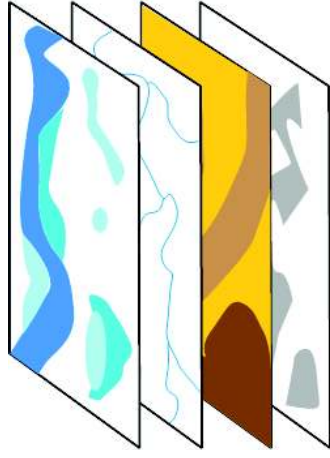

Green Infrastructure Plan

Where will the County add or enhance Green Infrastructure?

The County is updating their Land Preservation, Parks and Recreation Plan to help direct future acquisition of green infrastructure lands.

Land Preservation, Parks, and Recreation **PLAN**

HARFORD COUNTY

2018

Barry Glassman, County Executive
Kathy Burley, Director of Parks & Recreation

Green Infrastructure Plan

Green Infrastructure Demonstration Projects

As part of the Green Infrastructure Plan, the County explored potential sites on county-owned lands where methods for improving GI practices could be demonstrated.

&

Sites within Mariner Point Park and at the corner of the County Courthouse parking lot in Bel Air were selected as potential GI stormwater sites.

Green Infrastructure Implementation

County Actions

Stewardship on County-owned Lands
- Invasive Species Management Plans

Outreach and Education
- Web-based viewer / Story maps

Partnerships
- Harford Land Trust / MET / DNR Fisheries

Possible Regulatory Applications
- Tree Canopy Ordinance

Invasive Species Management Plans

NFWF
NATIONAL FISH AND WILDLIFE FOUNDATION
NATIONAL FISH AND WILDLIFE FOUNDATION

GRANTS

Green Infrastructure Plan

Green Infrastructure Implementation

Non-County Actions

Private Landowners & Non-Profit Organizations

- Conserve / Preserve / Restore GI lands

- Donate conservation easements

Agricultural Lands

- Encourage partnerships with NRCS

- Support the Harford Soil Conservation District and BMP's to improve GI resources

USDA

Natural Resources Conservation Service
United States Department of Agriculture

Landscape Conservation Initiatives

Conservation Beyond Boundaries

Cost-Share Opportunities

Green Infrastructure Plan