CHANGING LANDSCAPES **INITIATIVE**

Supporting Decision-making for Change

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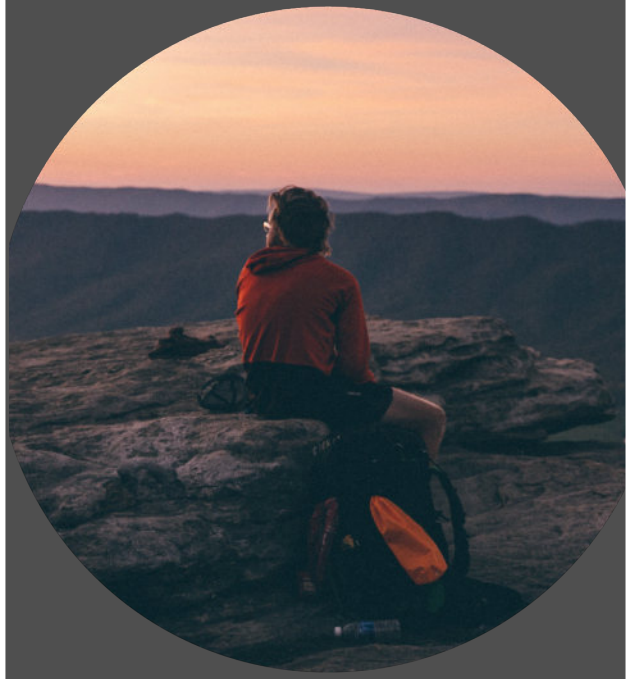
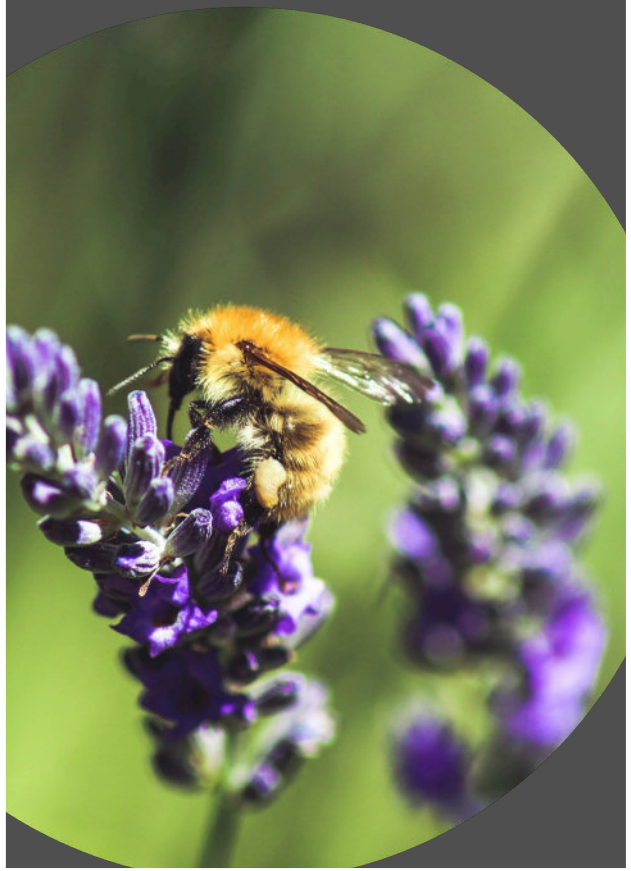
Smithsonian Conservation Biology Institute

Smithsonian
Conservation
Commons


• Introduction
• Goals of CLI
• Background
• Our approach
• Our research
• CLI as a resource/partner


The Changing Landscapes Initiative's mission is to combine scientific rigor and community wisdom to help secure a vibrant and healthy future for people and wildlife

Our Quality of Life is Securely tied to the Economic and Environmental Health of Where we Live


Ecosystem Services

What’s at stake: Shared natural resources

Natural processes, such as climate regulation, flood mitigation, and crop pollination

What’s at stake: Shared natural resources

Contributions to physical and mental health i.e. access to green spaces and genetic resources for medicines

What's at stake: Shared natural resources

Social, educational, and cultural benefits

What's at stake: Shared natural resources

Natural resources for basic survival, such as clean air and water

Where We Work

The Changing Landscapes Initiative focuses its efforts in Northwestern Virginia on the 10 counties and 5 independent cities surrounding the Shenandoah National Park.

Land Use/Land Cover (2011)

- Crops
- Developed
- Grass
- Open Space
- Forest
- Open Water

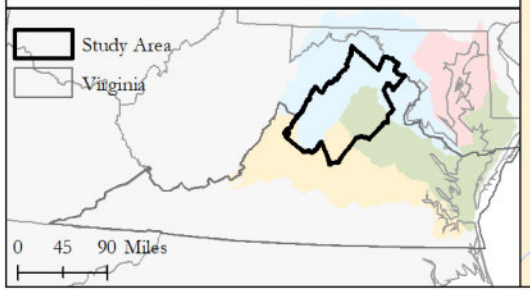
National Protected Lands

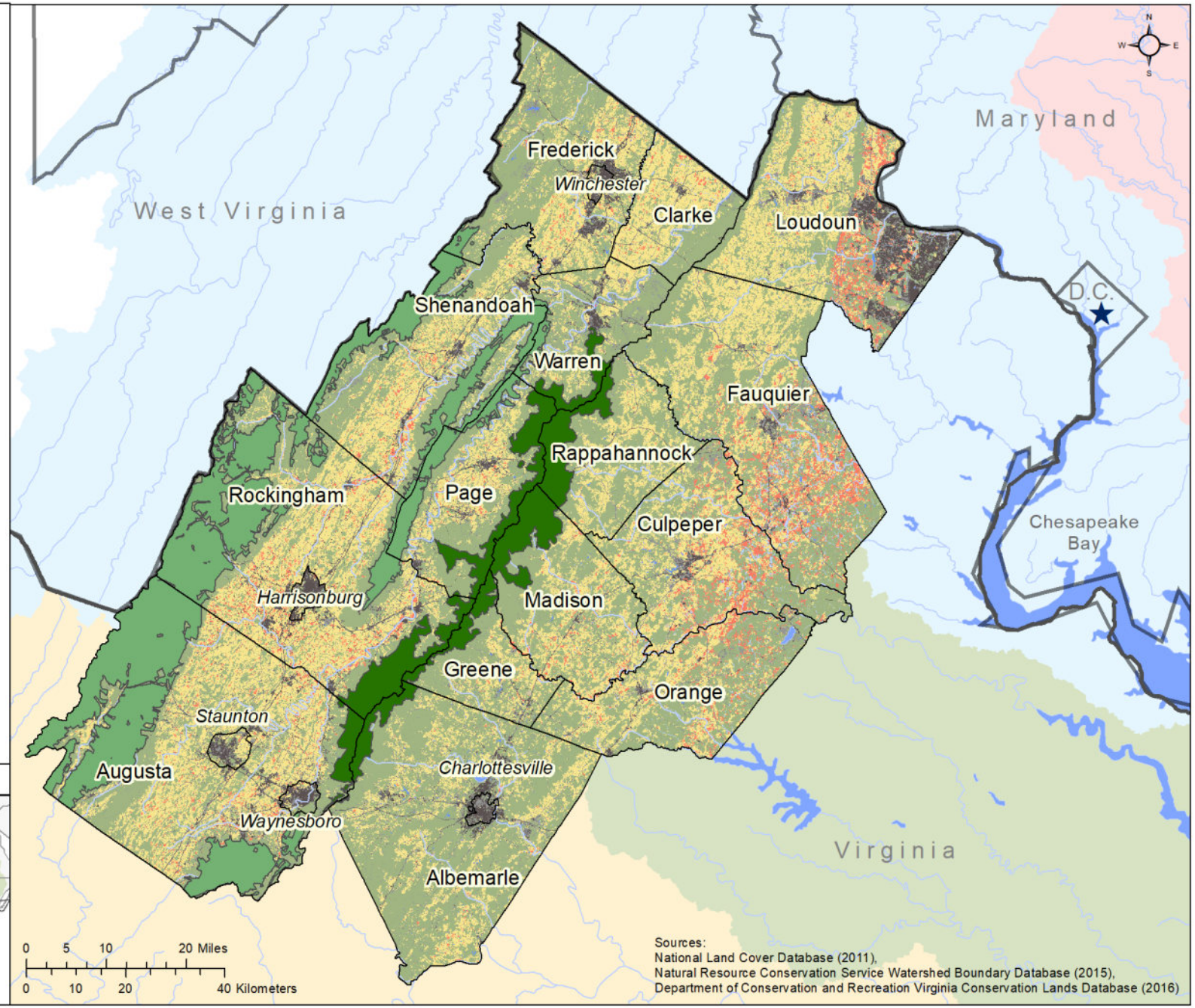
- George Washington National
- Shenandoah National Park

Watershed Basin

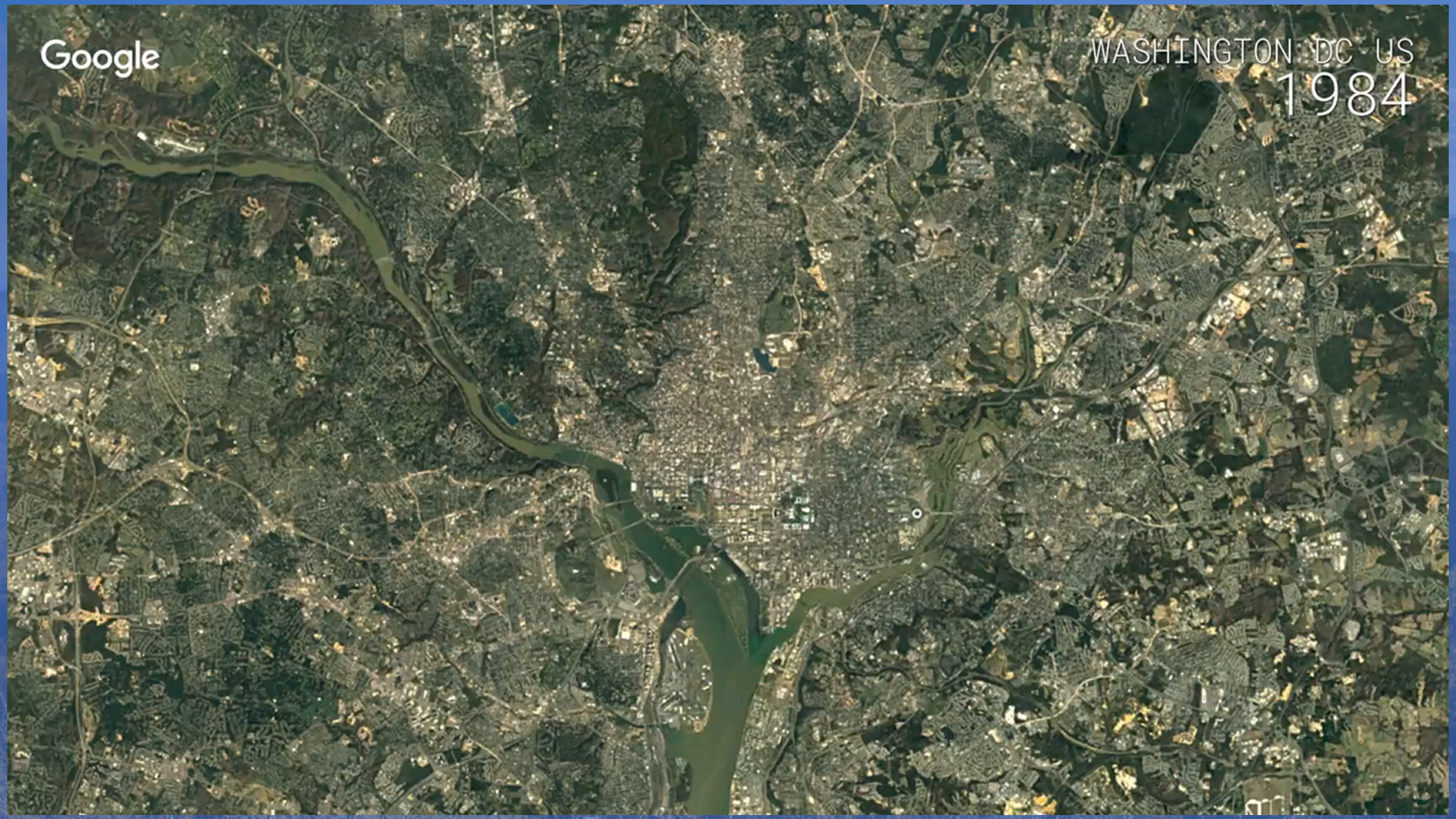
- James
- Potomac
- Lower Chesapeake
- Upper Chesapeake

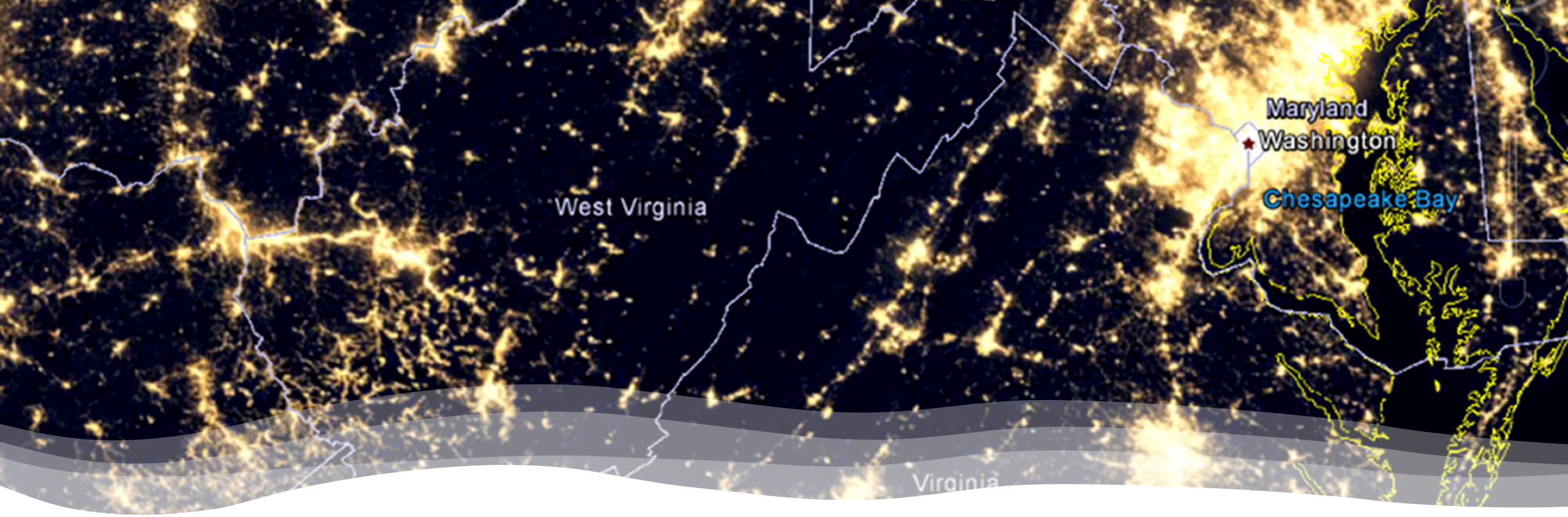
Hydrologic Units (HUC 6)





Sources:
National Land Cover Database (2011),
Natural Resource Conservation Service Watershed Boundary Database (2015),
Department of Conservation and Recreation Virginia Conservation Lands Database (2016)


Google
WASHINGTON DC US
1984

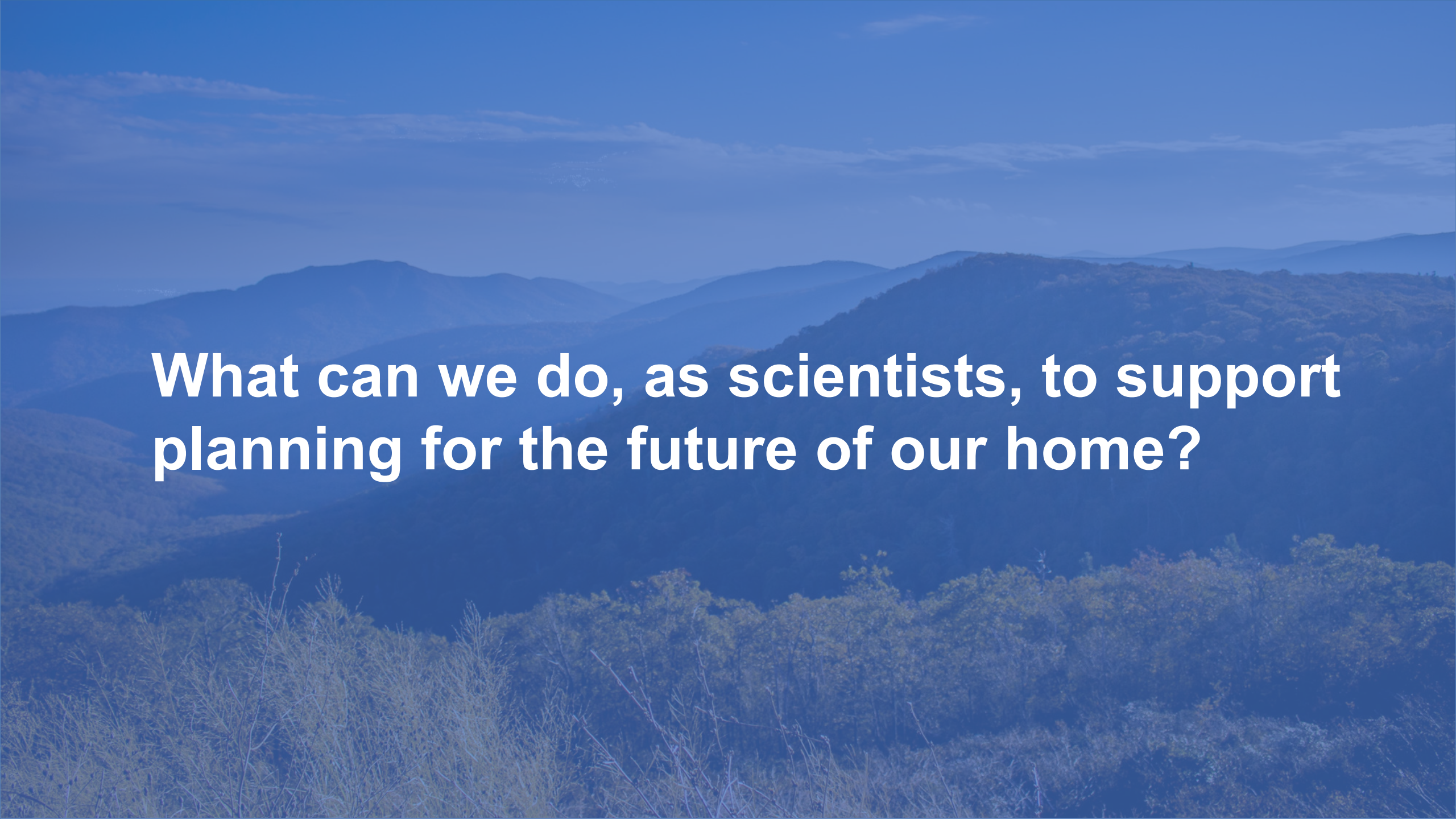


How will land use decisions we make today…

2020

2060

Impact the things we care about tomorrow?


What can we do, as scientists, to support planning for the future of our home?

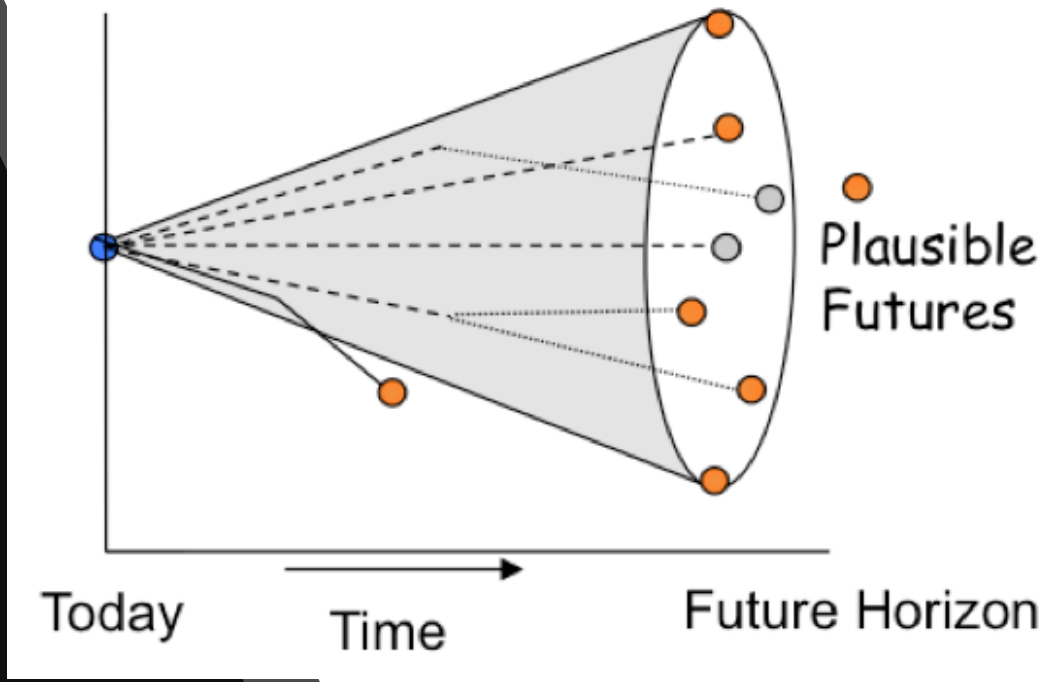
Goal of the Changing Landscapes Initiative

Provide objective information on the potential impacts of land use change on the local landscape


People + Science
Martinsburg
Winchester
Woodstock
Luray
Harrisonburg
Massanutten
Shenandoah National Park
Culpeper
Fredericksburg
Potomac River
Charlottesville
81
66
270
95

Framework: Scenario Planning

- Envisioning exercise
- Develop different narratives that describe potential futures
- Strategic forecasting & Long-term guiding framework
- Create robust strategies that consider consequences of alternative decisions
- Origin: Adaption of classic methods by military intelligence



Forbes

The Secret Of Successful Scenario Planning

Today almost no business operates without some kind of scenario planning.

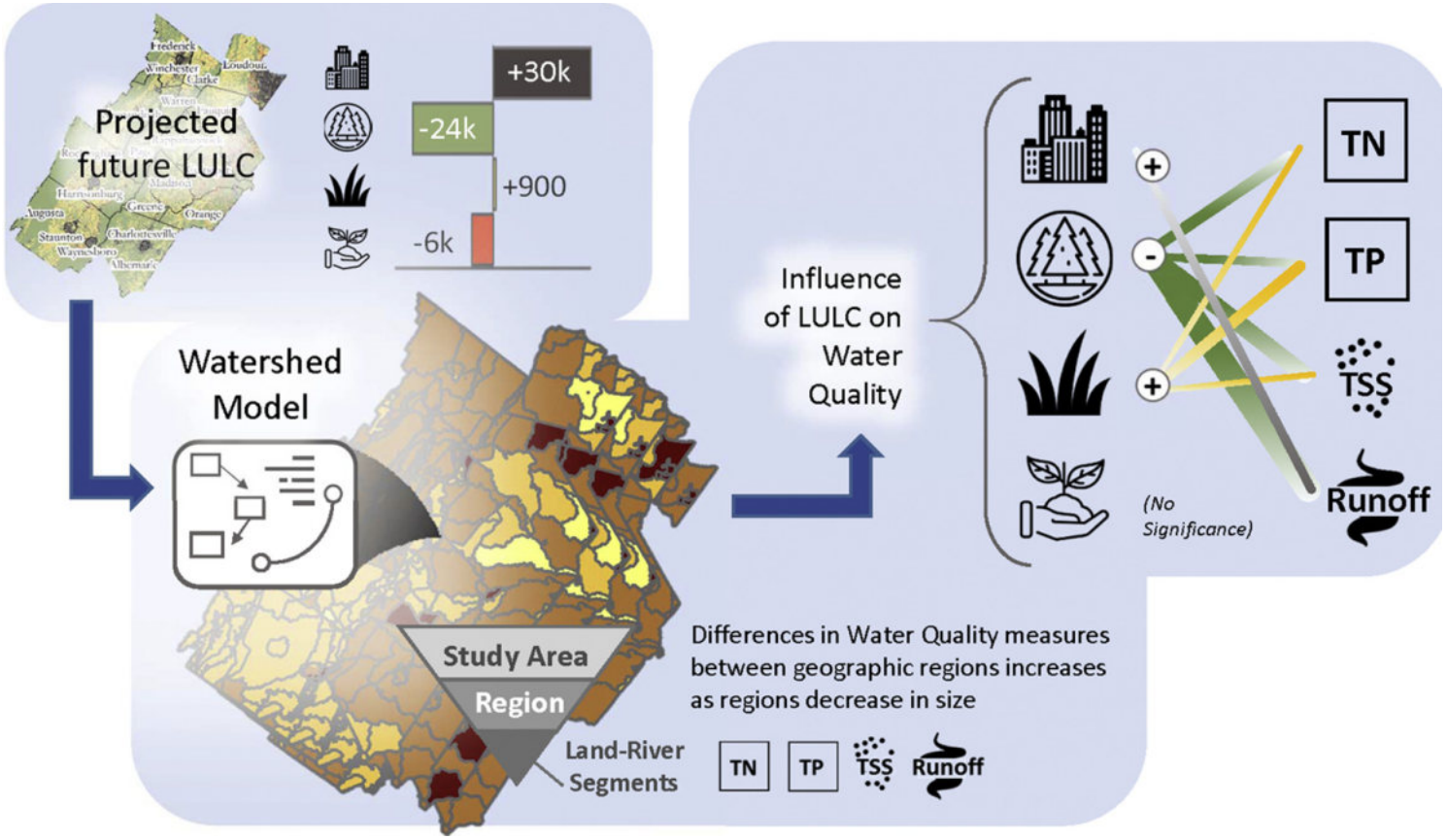
Convene regional experts and community leaders to develop scenarios of the future for 2060;

and to support those scenarios with science

The people we work with include:

- County & regional planning
- County committees
- Conservation and land management organizations
- Public lands
- Advocacy groups

Our scientific approach involves:



1. Understand the current landscape
2. Quantify historic change
3. Uncover primary drivers of change
4. Model future land use change
5. Evaluate impacts of land use change on ecosystems
6. Incorporating uncertainty

Scenario Narratives

High Population

Scenario 2: Development occurring along roadways with increased parcelization, increasing forest loss and fragmentation

Scenario 1: Development is focused around urban centers, agriculture is maintained or increased, resulting in a flourishing job market

Reactive Planning

Scenario 2

Scenario 1

Strategic Planning

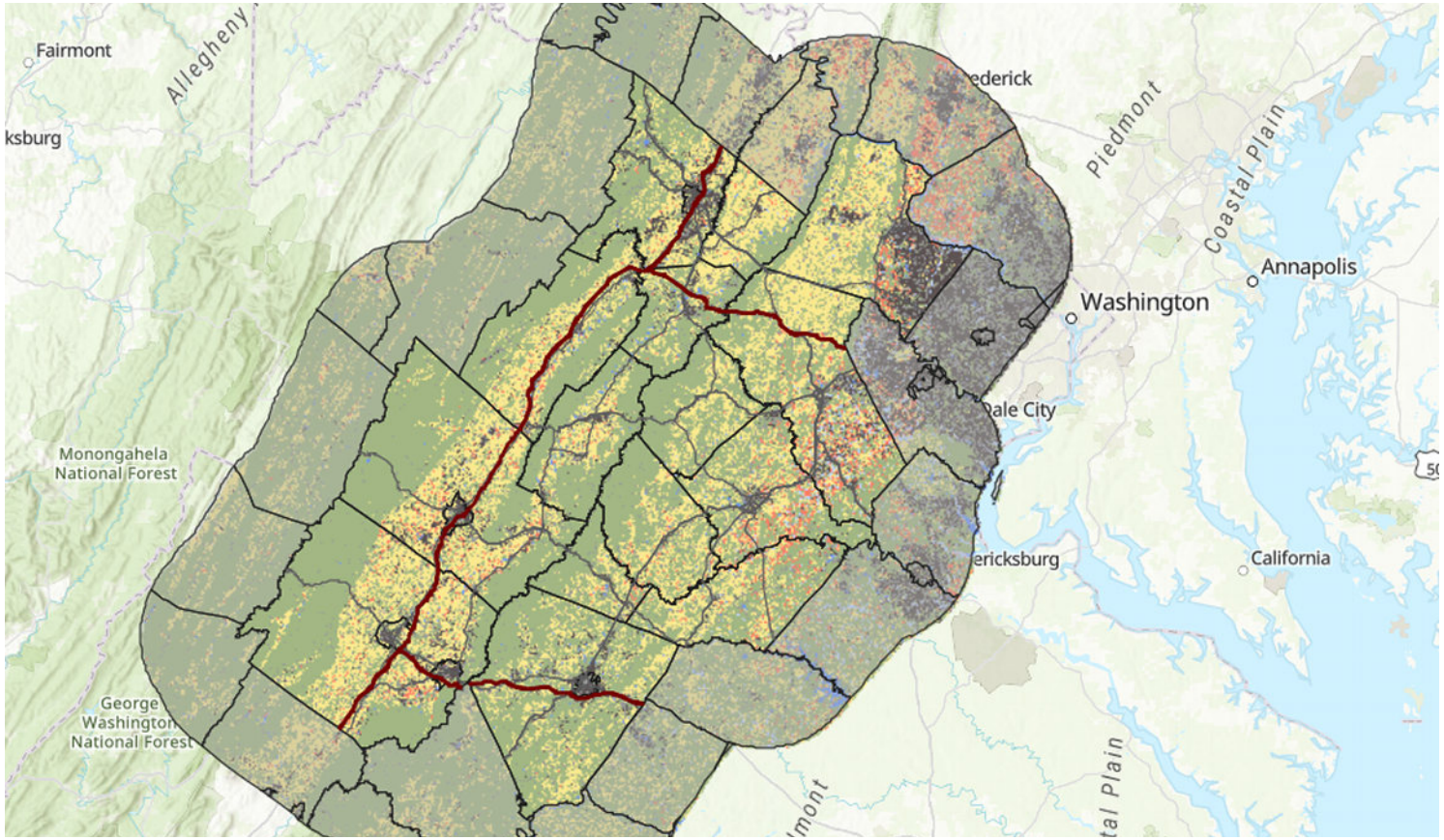
Scenario 3

Scenario 4

Scenario 3: The region's resources (good soils, productive forests, and water) are extracted to support other high population areas, like D.C. Industrial scale resource extraction overruns traditional agriculture in the region

Scenario 4: Movement of younger generations from rural areas, reducing need for new infrastructure. Though, strategic planning preserves open space, forests, and family farms

Low Population



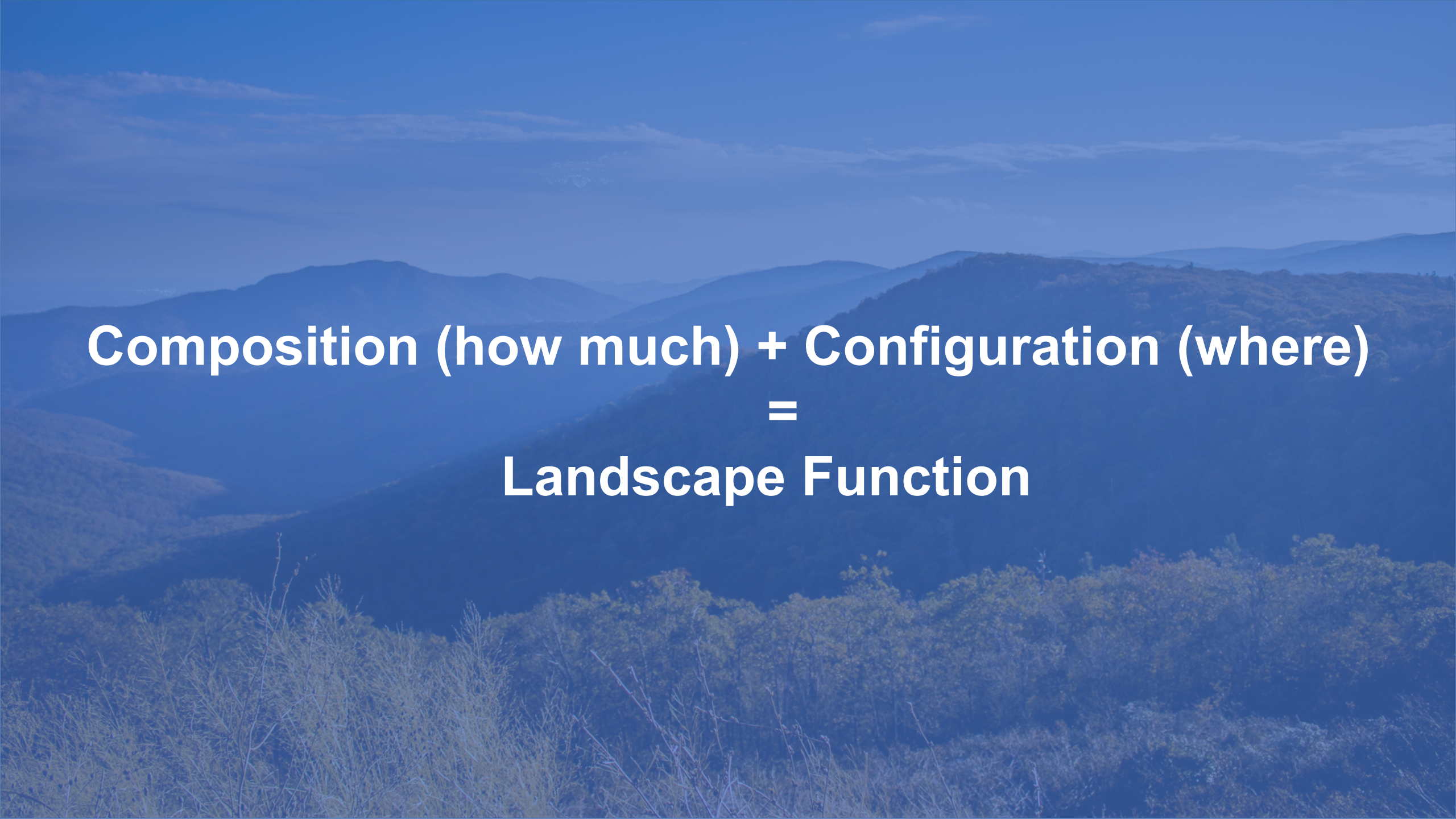
Translate Scenarios into Model Projections of the Future (2011-2061)

Compare two Scenarios for
High Population:

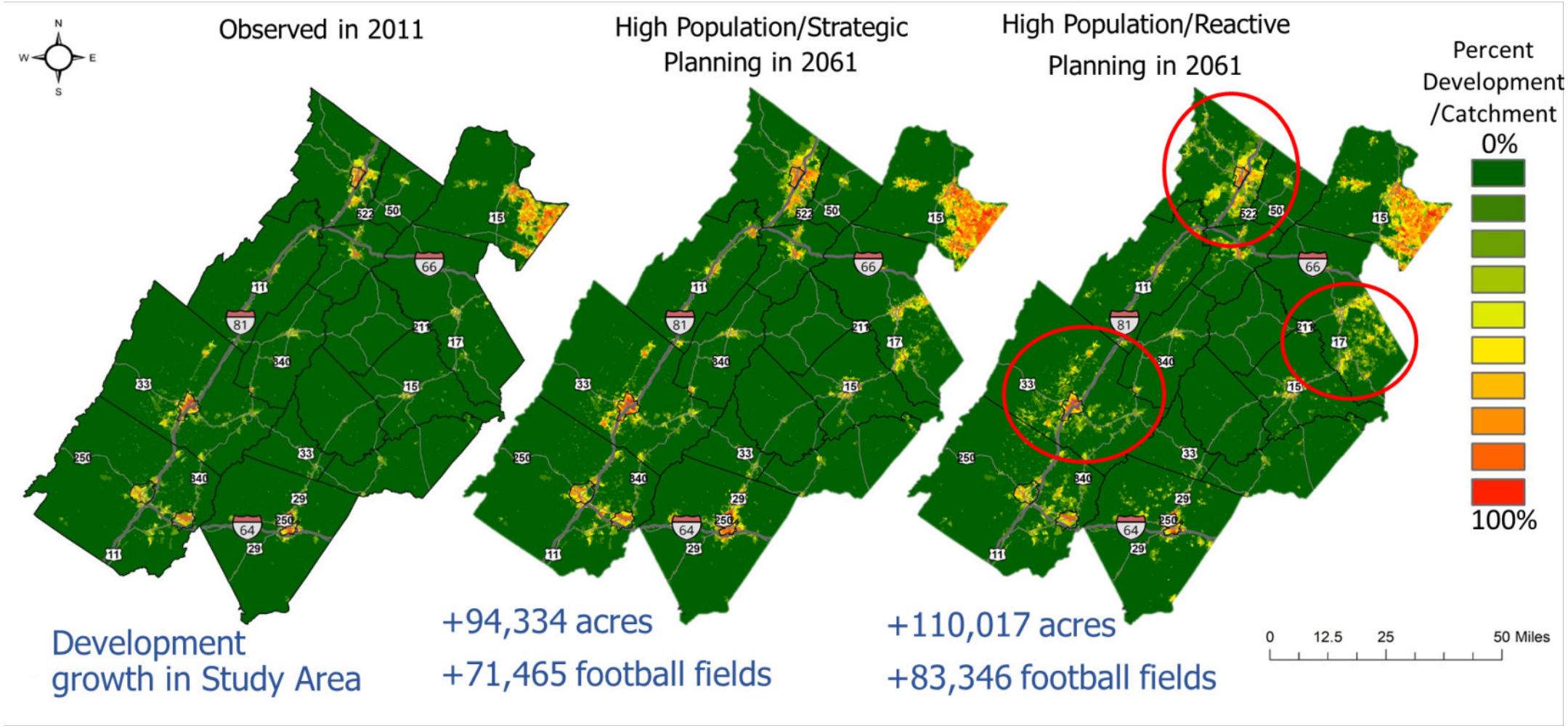
a) Reactive Planning
b) Strategic Planning




Evaluate Impacts


Composition (how much) + Configuration (where)
=
Landscape Function

Scenario Landscapes



Change in Development in Stream Catchments

Water Quality

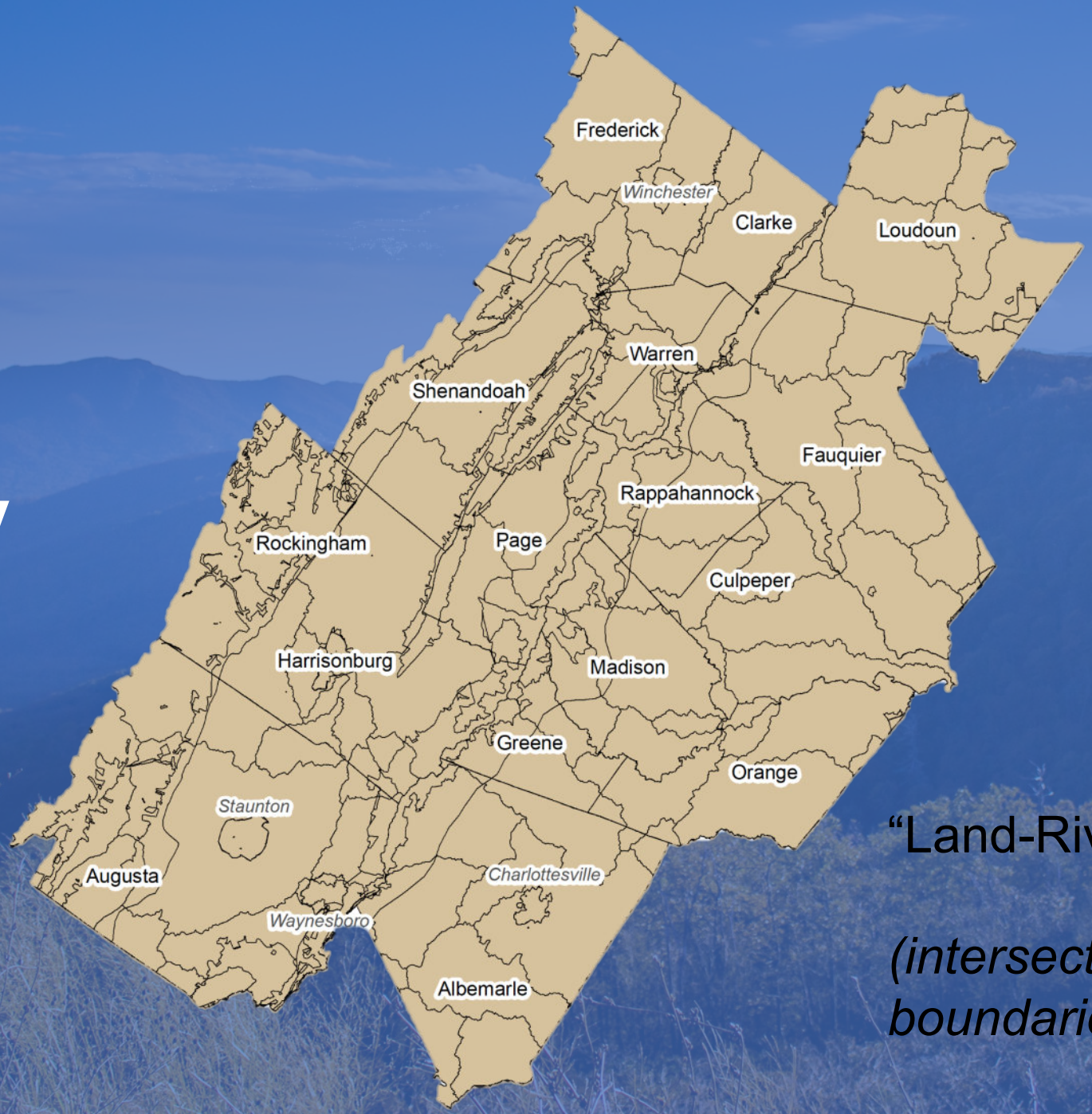
Chesapeake Bay TMDL Fact Sheet

Map of the Chesapeake Bay Watershed. The watershed encompasses six states and the District of Columbia.

Driving Actions to Clean Local Waters and the Chesapeake Bay

Load reduction requirements:
20% reduction sediment
25% reduction N
24% reduction P

Water Quality



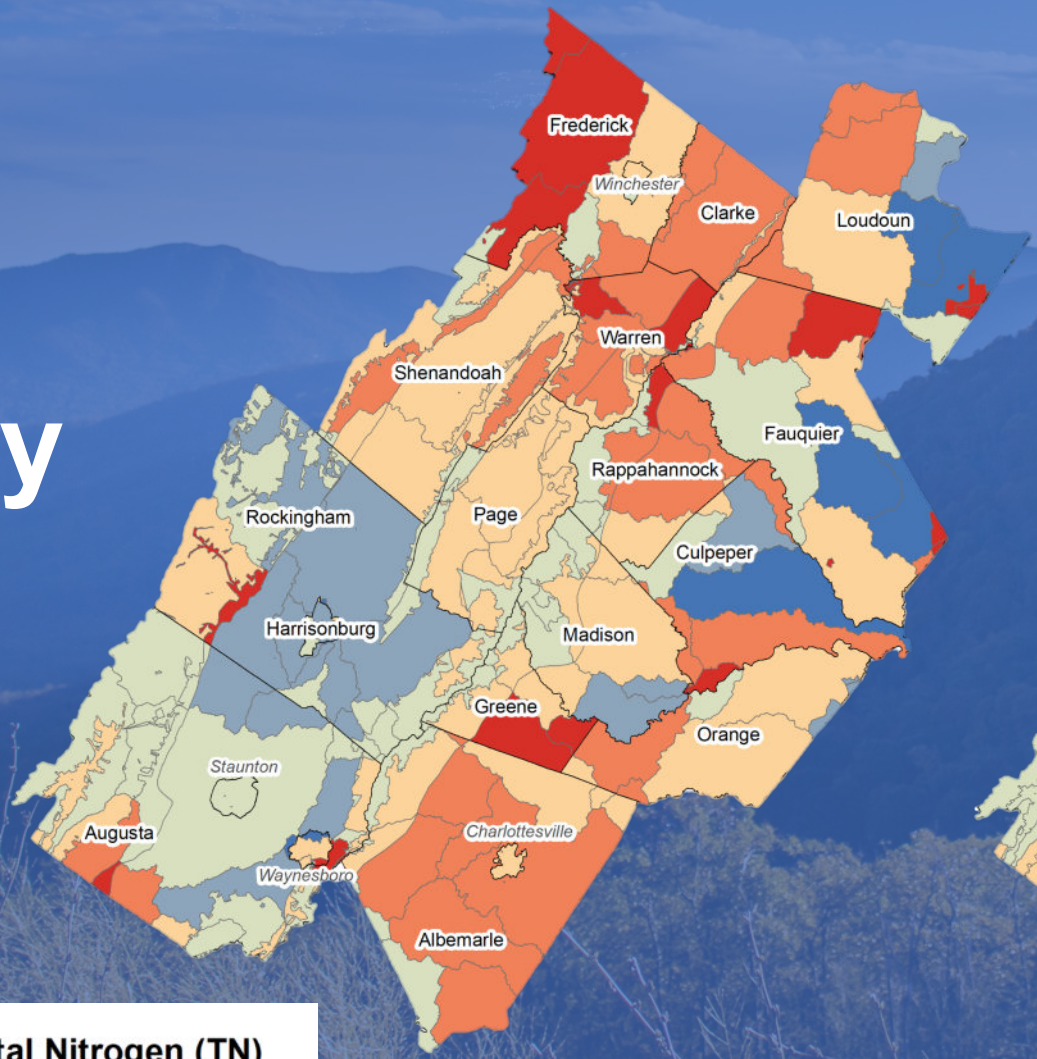
"Land-River segments"

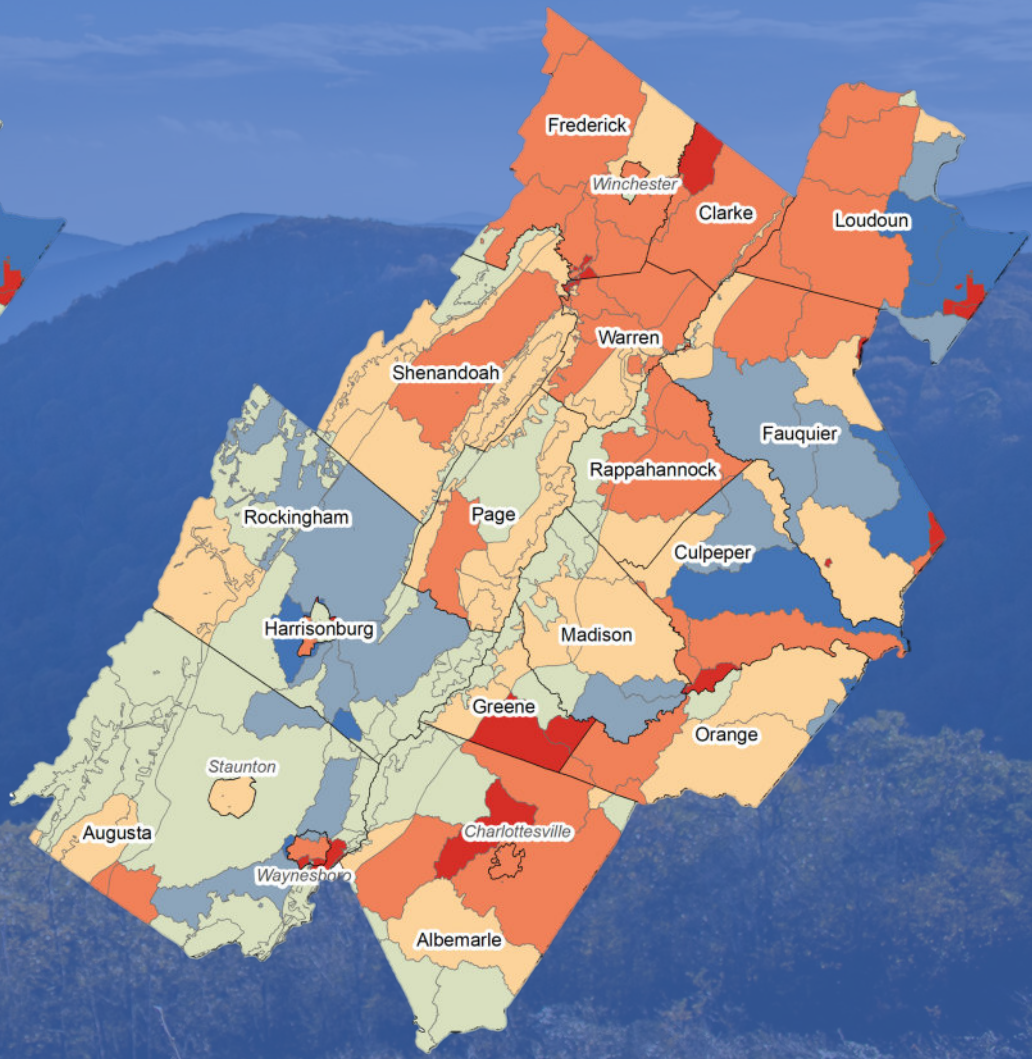
(intersection of county boundaries and watersheds)

Water Quality

LOW Political will

HIGH Political will





Percentage Change of Total Nitrogen (TN)

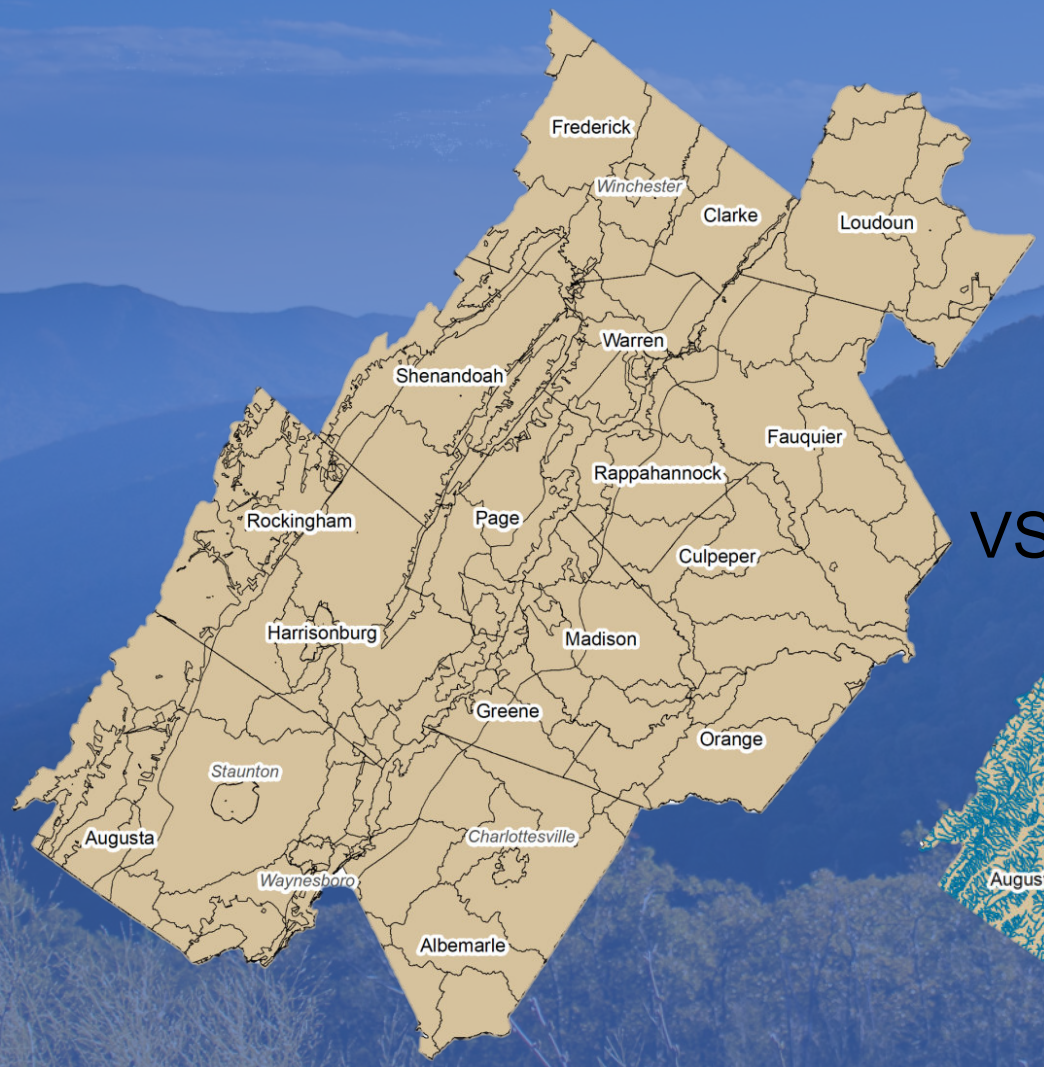
< -5%	-1% to 0%	1% to 5%
-5% to -1%	0% to 1%	> 5%

VIRGINIA TECH

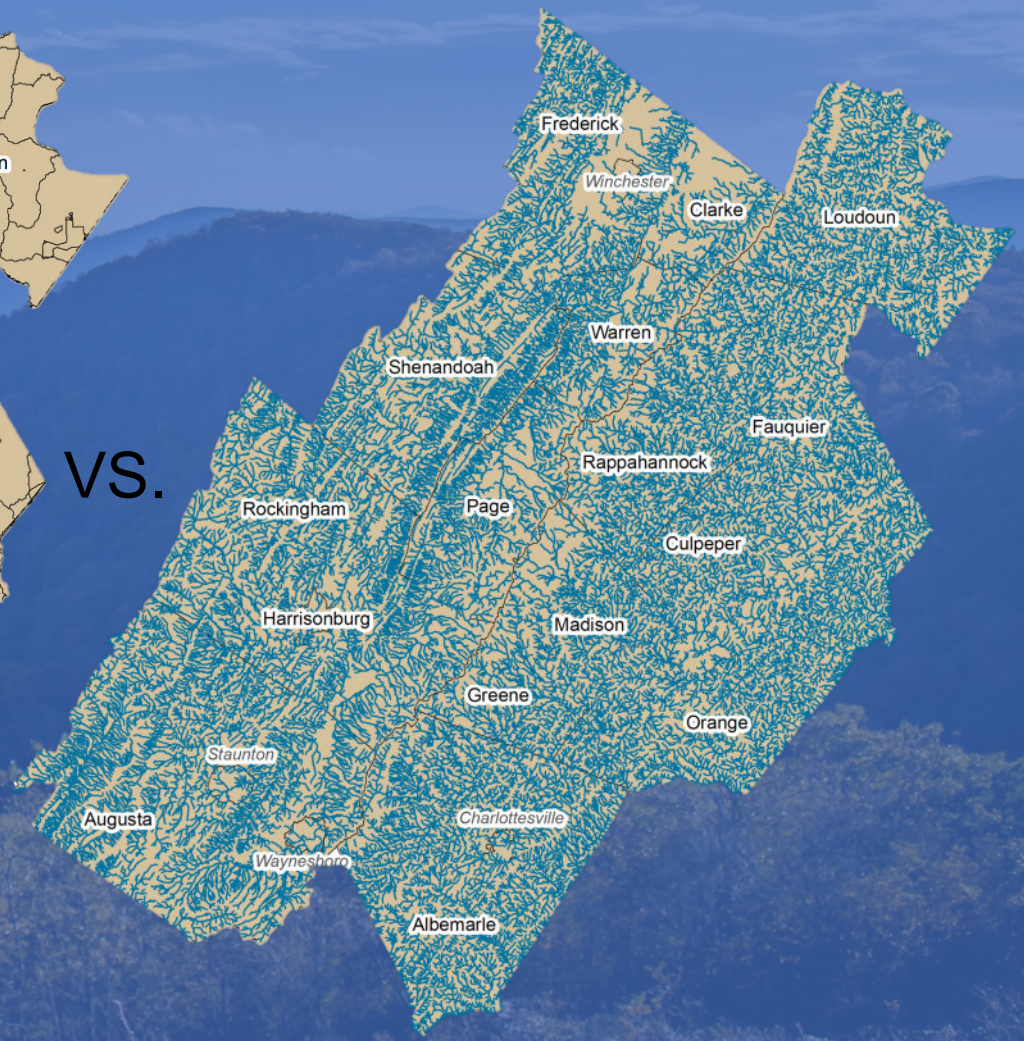
Water Quality

Land use planning is more important to water quality than population growth

Water Quality



VS.



Floodplain deposition & bank erosion rates

USGS

Why care about sediment?

- Sediment characteristics

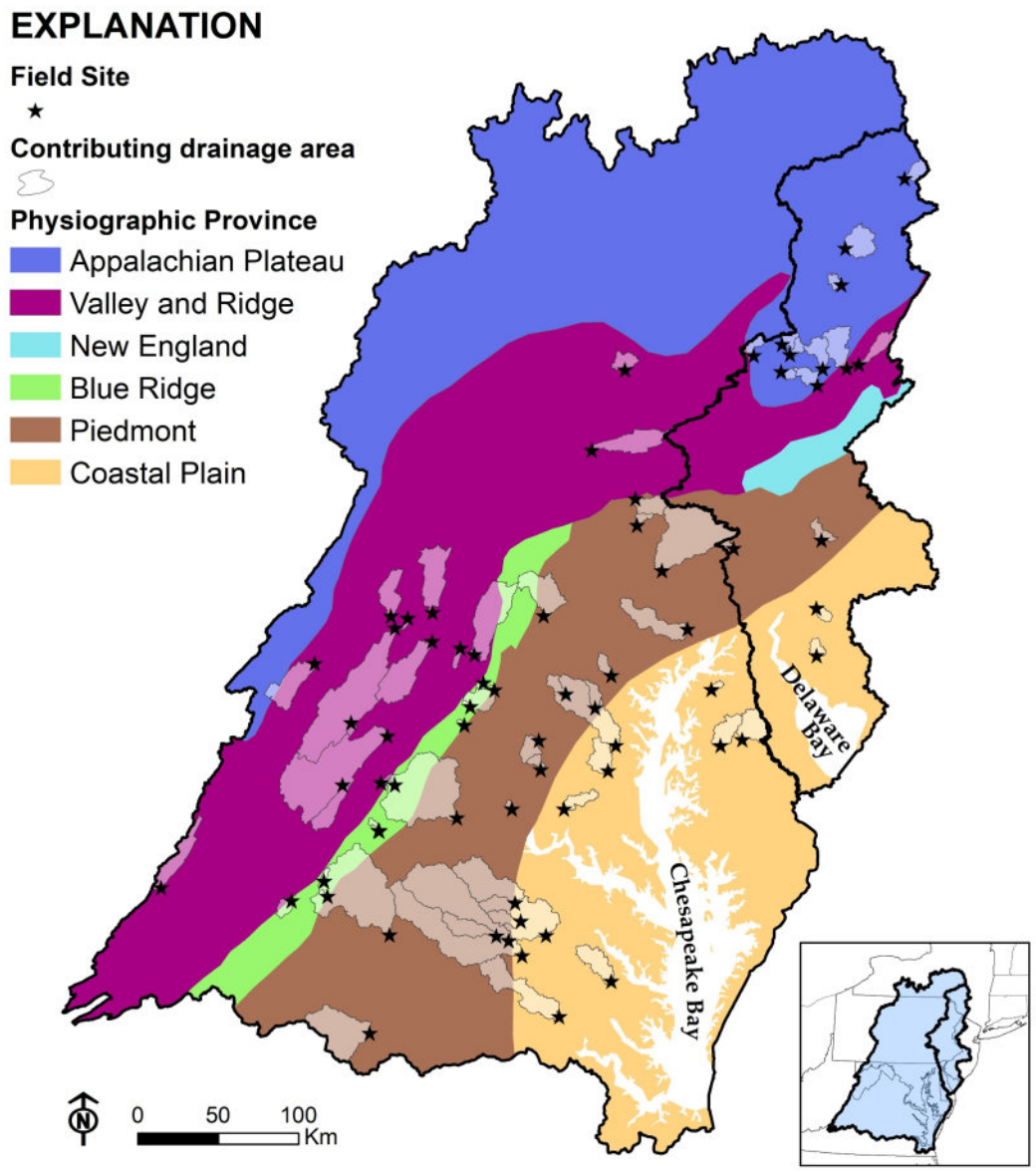
- Impacts on biota
  - Tidal and nontidal
  - Grain size matters
  - Multiple mechanisms

- Associated contaminants
  - Phosphorus and nitrogen
  - Other chemicals

USGS Chesapeake and Delaware Floodplain Network: network design

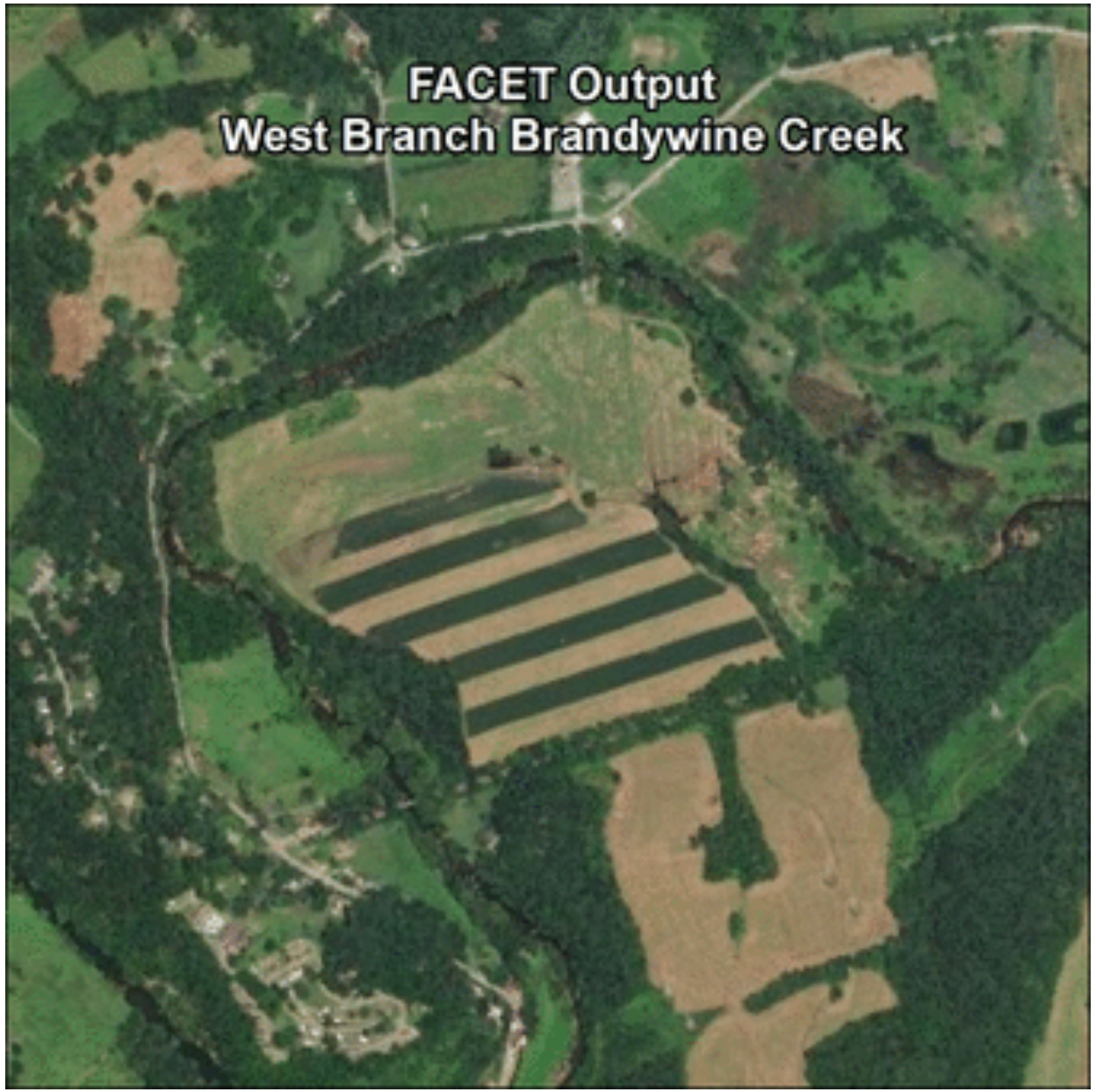
Long-term streambank and floodplain characteristics and sediment and associated nutrient loss/gain were measured at 68 reaches across U.S. Mid-Atlantic

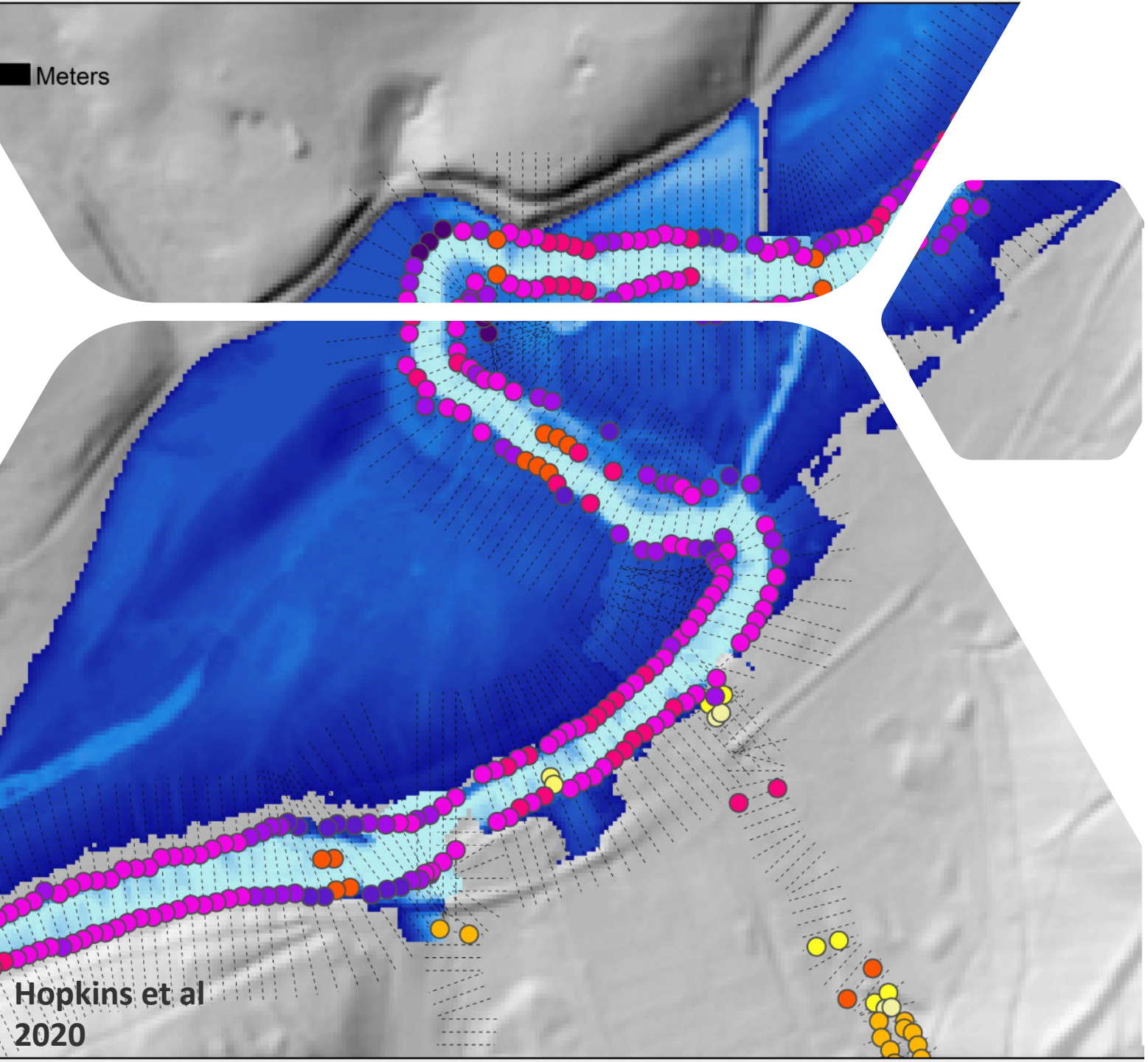
These sites are representative of regional variability in watershed drainage area, geology, topography, soils, hydrology, and land use



Floodplain and Channel Evaluation Toolkit (FACET)

Lamont et al. 2019

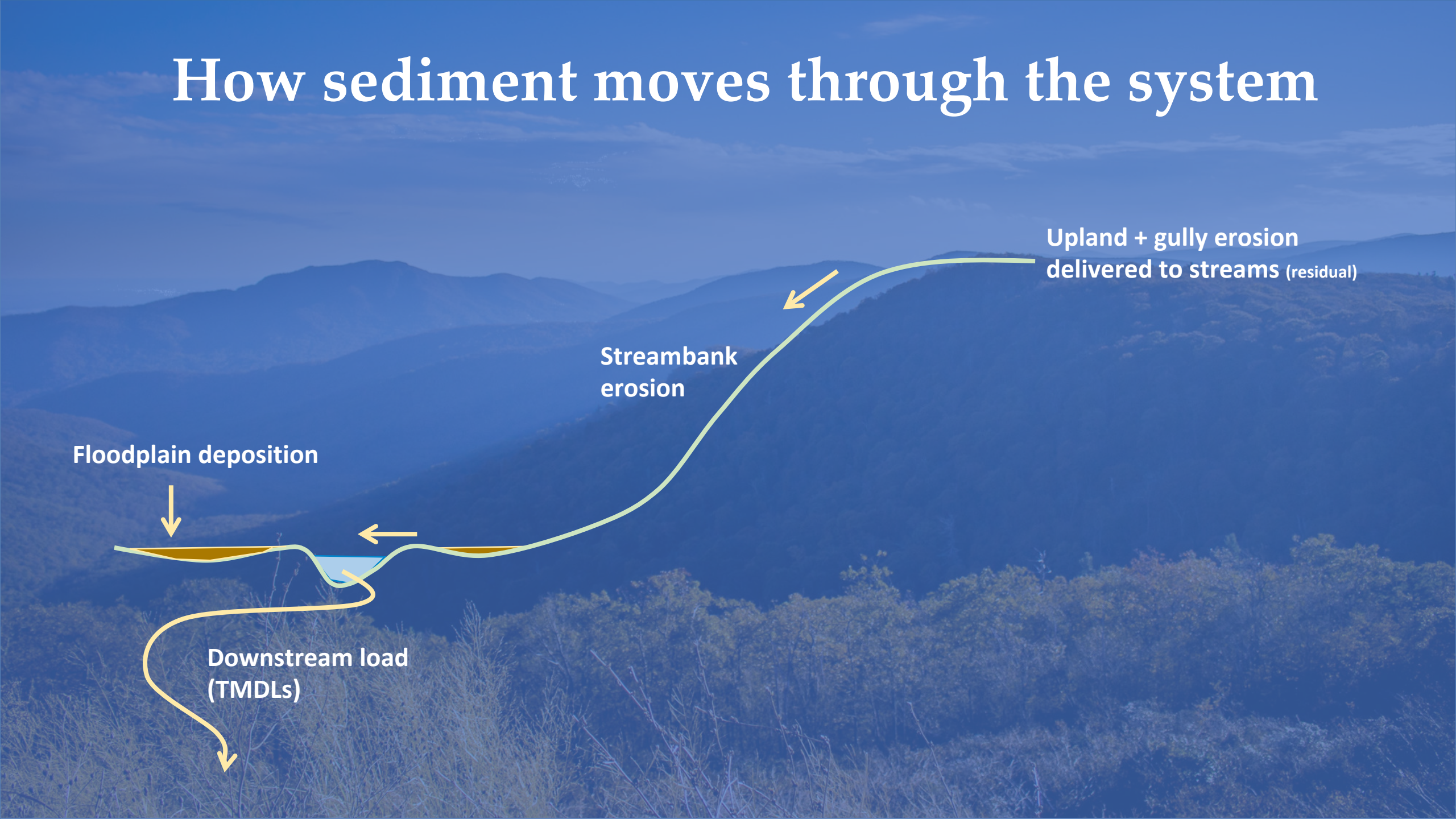




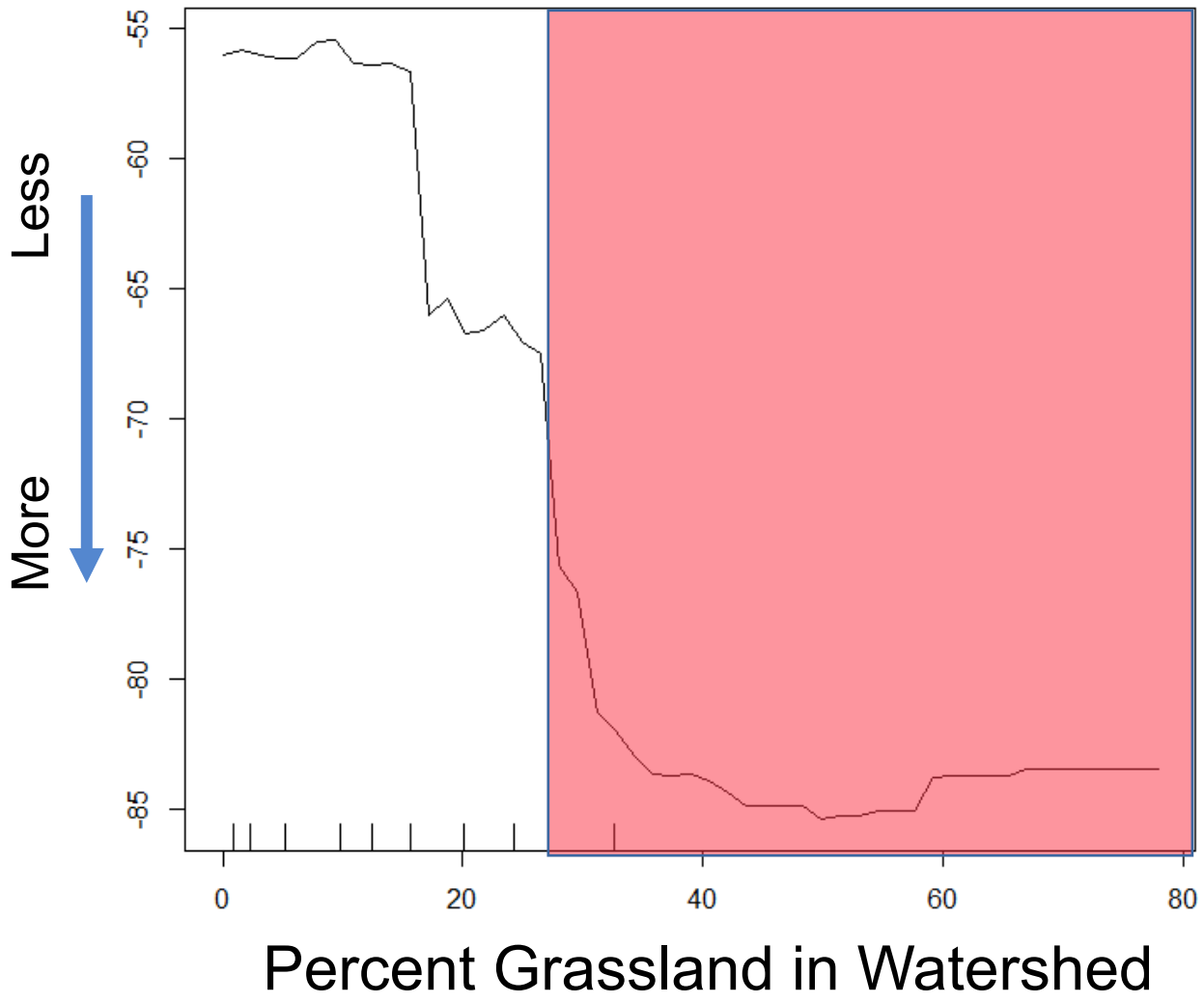
Geomorphometry for Streams and Floodplains in the Chesapeake and Delaware Watersheds

- Every watershed with LIDAR
- GIS: shapefiles and rasters of the stream network, cross sections, streambank point locations, floodplain extent, height above nearest drainage (HAND)
- Tables: reach-scale summaries of bank height, channel width, floodplain width, and a suite of other metrics

How sediment moves through the system



Bank sediment flux (kg/m/yr)



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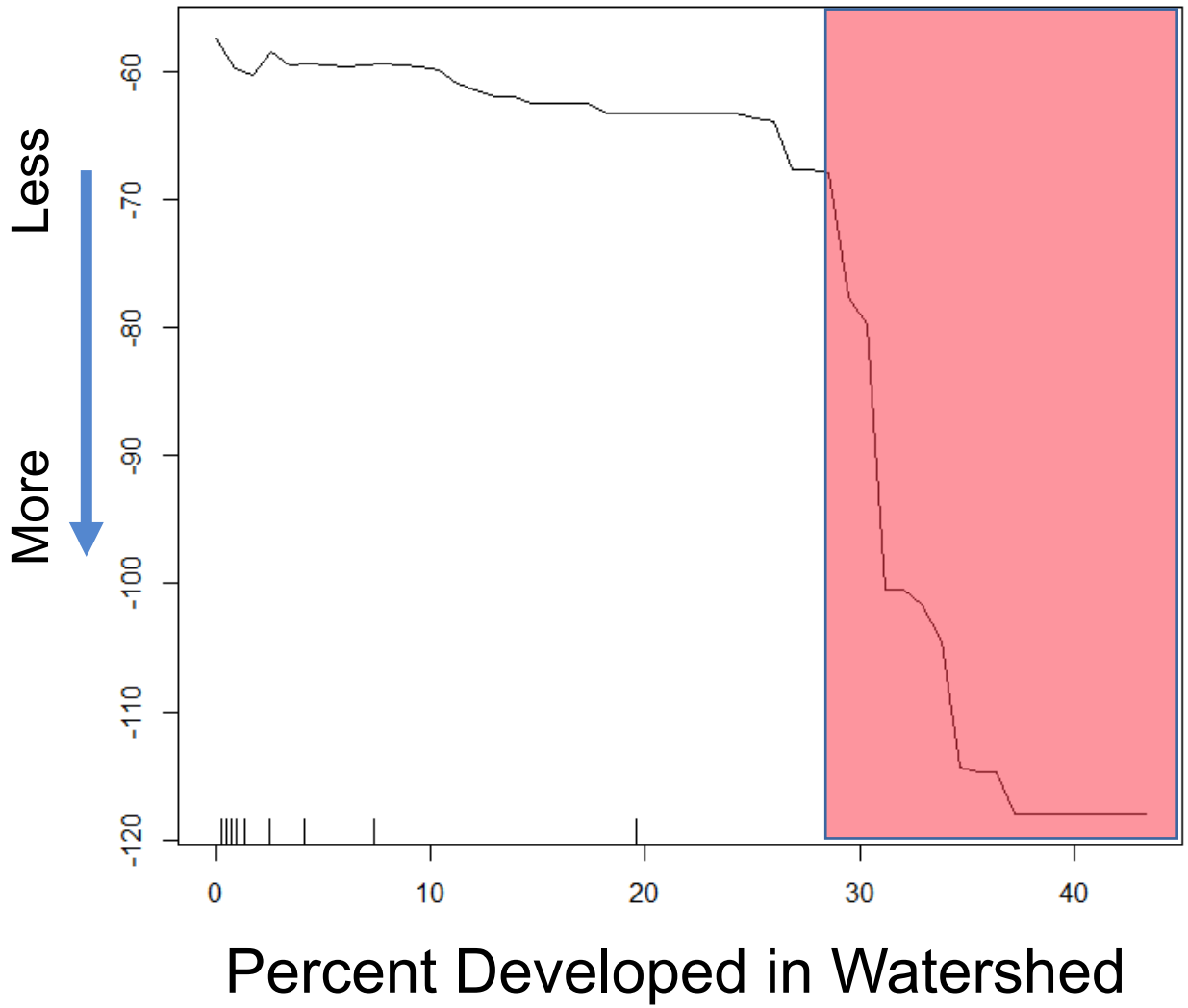
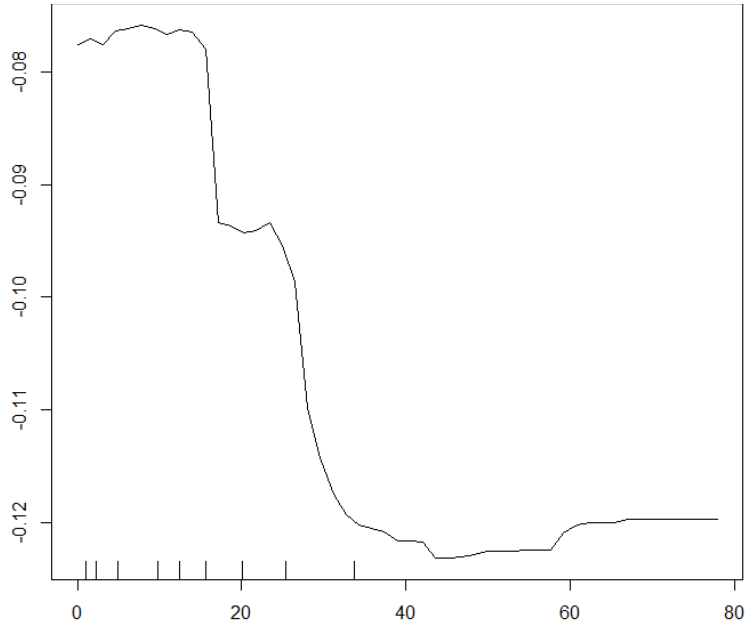


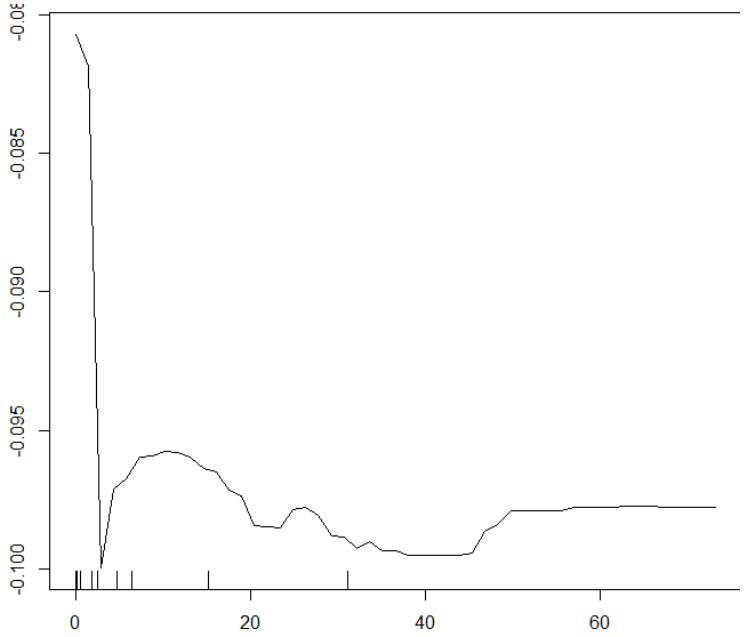
Bank sediment N flux (kg/m/yr)

Less

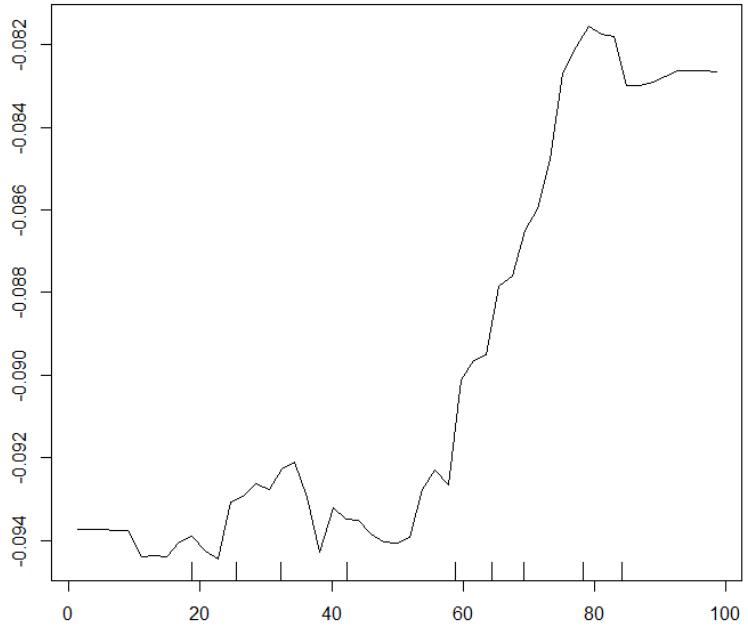
More



% Developed



% Row Crop



% Forest

** Identify tradeoffs w/r to land use types and their impacts within watersheds

Scenario Narratives

High Population

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Reactive Planning

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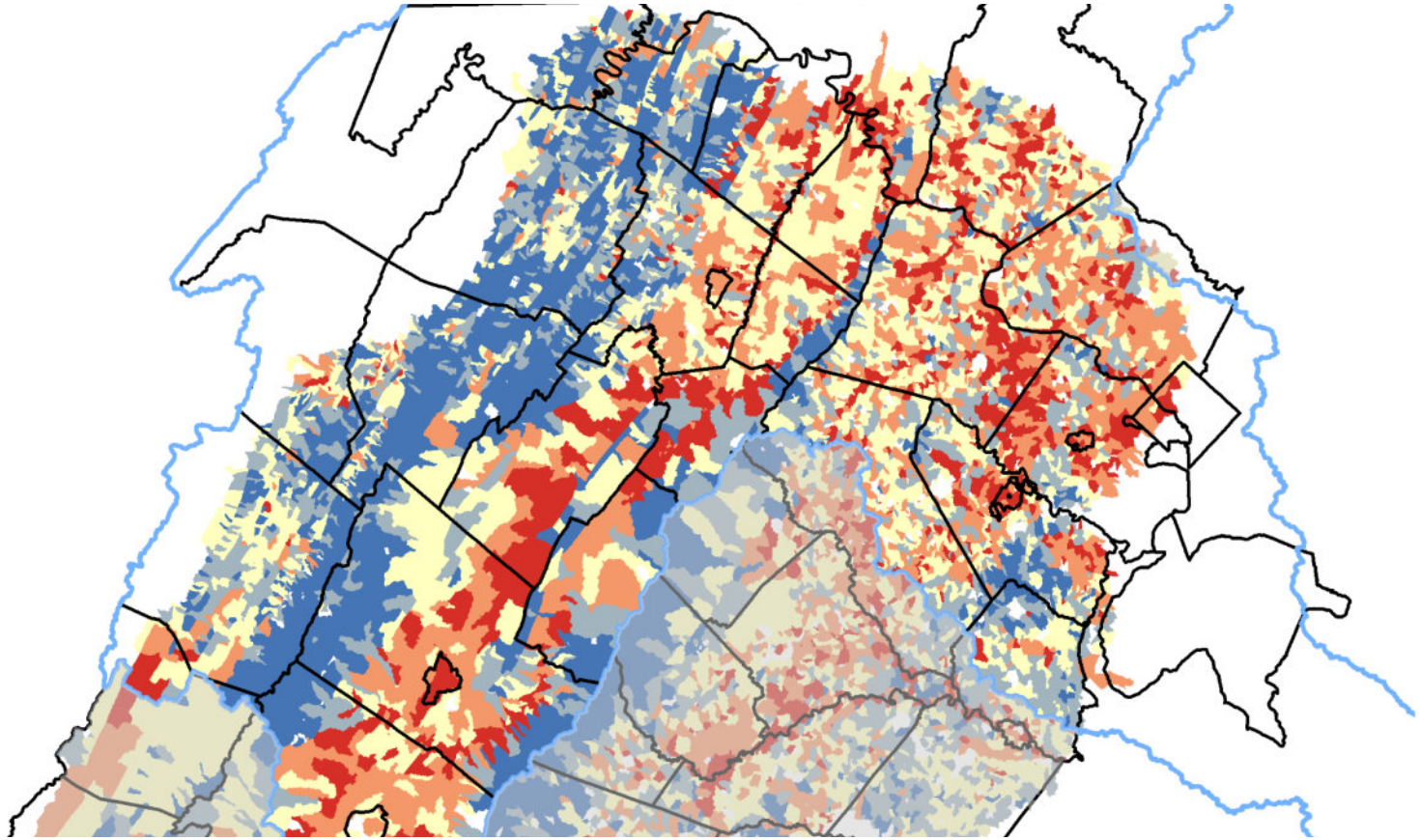

2011/ “Current”

Horizontal Stream Bank Erosion (cm/yr)

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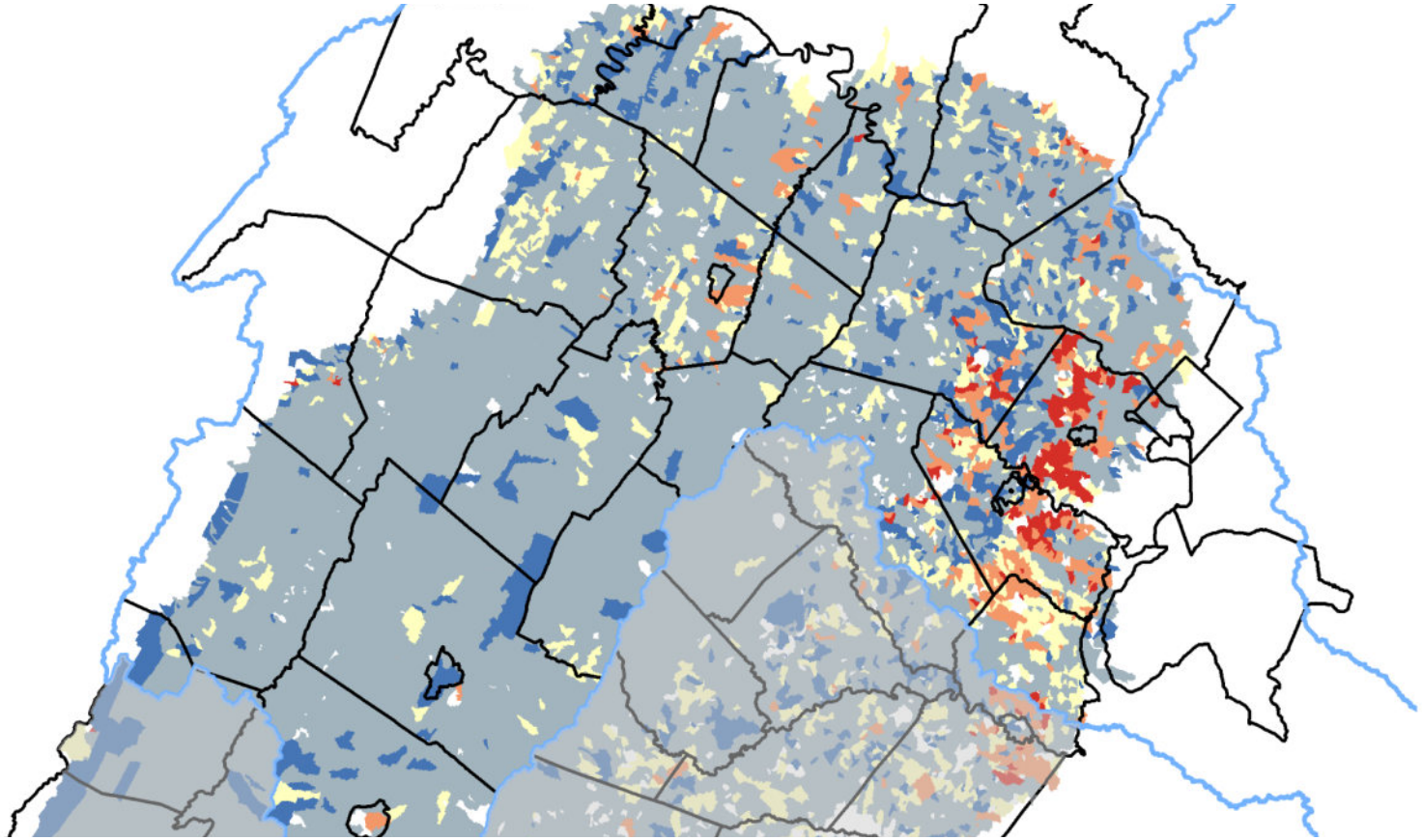

High Population/ Strategic

CHANGE
2011-2061

Horizontal
Stream Bank
Erosion (cm/yr)

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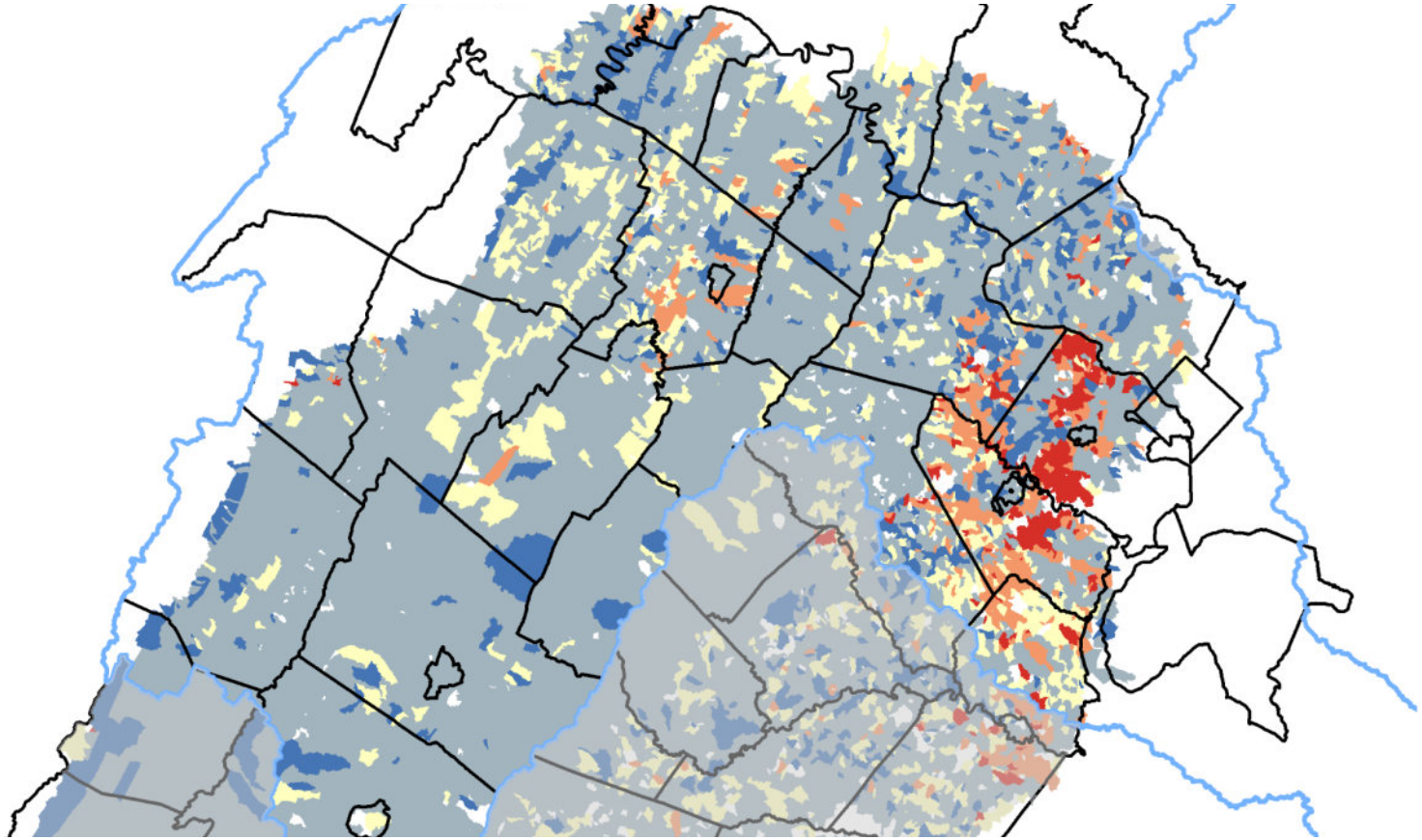
LANDSCAPES
INITIATIVE



High Population/ Reactive

CHANGE
2011-2061

Horizontal
Stream Bank
Erosion (cm/yr)

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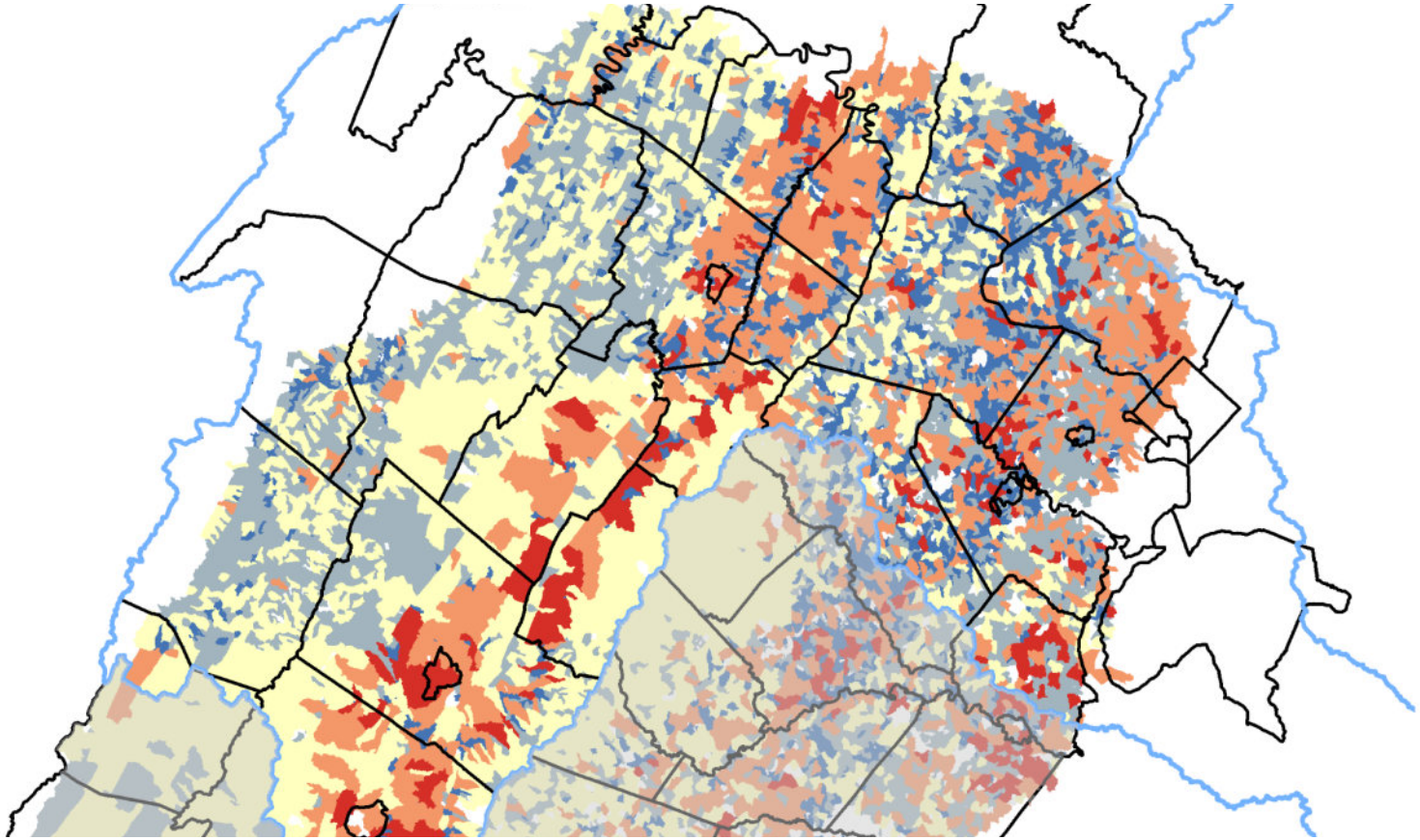
LANDSCAPES
INITIATIVE



2011/ “Current”

Stream Bank Nitrogen Flux

(kg-N/m/yr)

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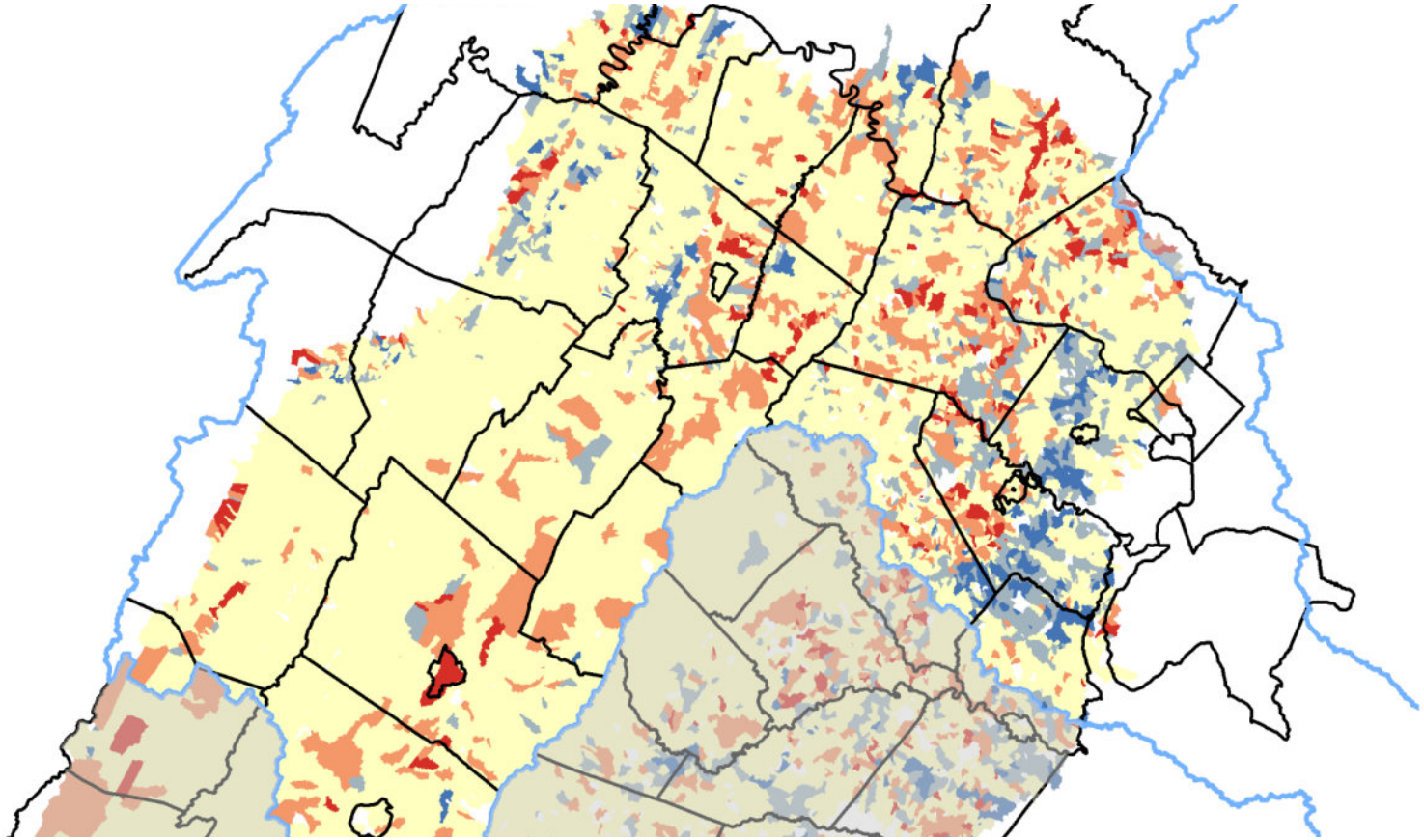
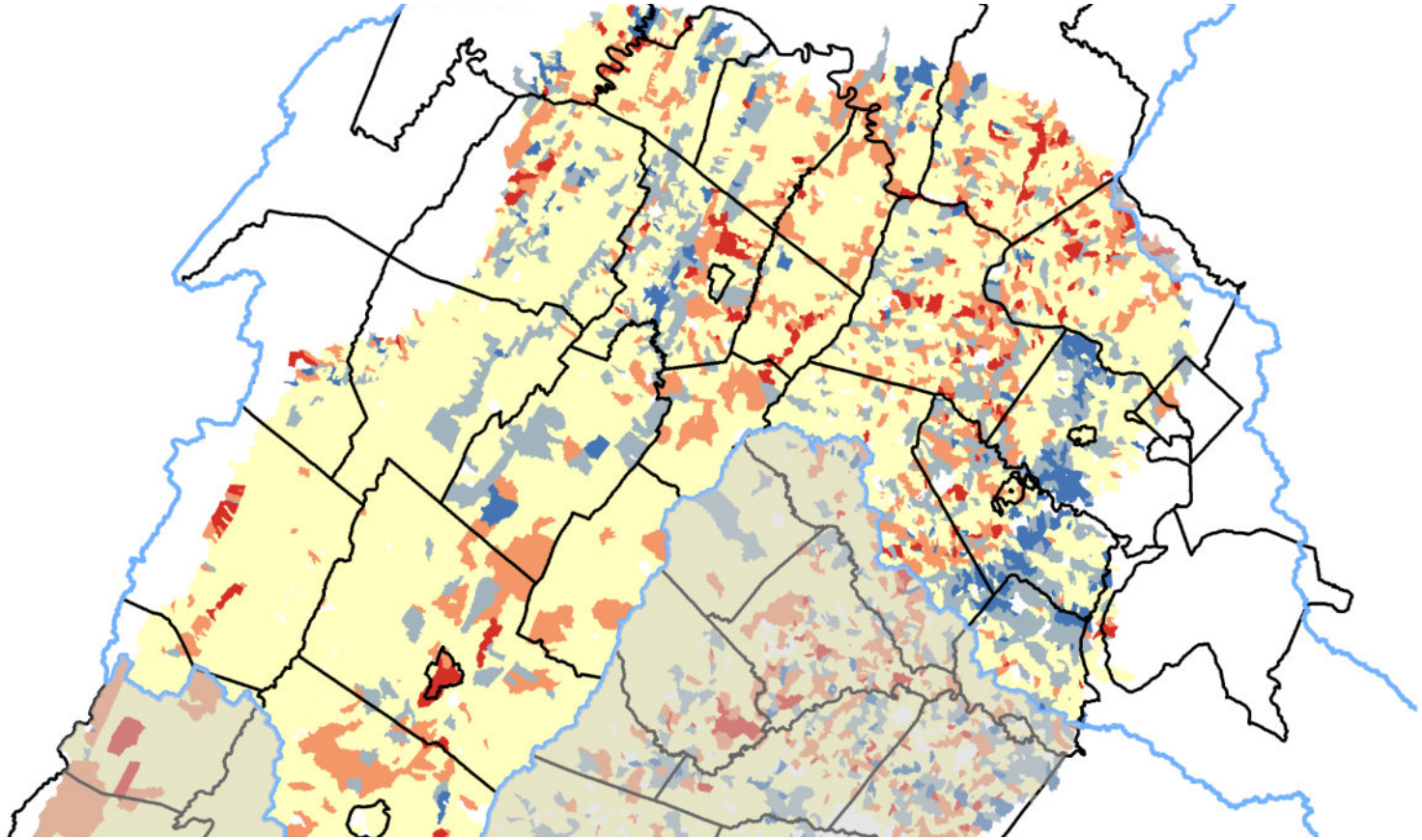


High Population/ Strategic

CHANGE
2011-2061

Stream Bank
Nitrogen Flux
(kg-N/m/yr)

CHANGING
LANDSCAPES
INITIATIVE



High Population/ Reactive

CHANGE
2011-2061

Stream Bank Nitrogen Flux
(kg-N/m/yr)

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COMMUNICATING OUR RESULTS FOR PUBLIC SUPPORT

Current

CHANGING LANDSCAPES INITIATIVE

COMMUNICATING OUR RESULTS FOR PUBLIC SUPPORT

Reactive

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COMMUNICATING OUR RESULTS FOR PUBLIC SUPPORT

Strategic

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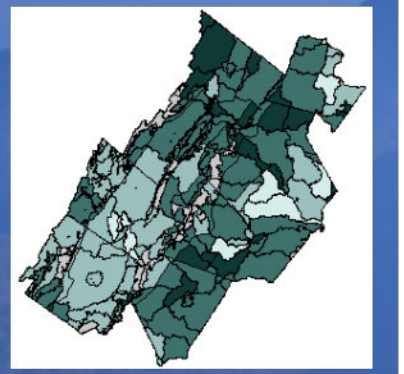
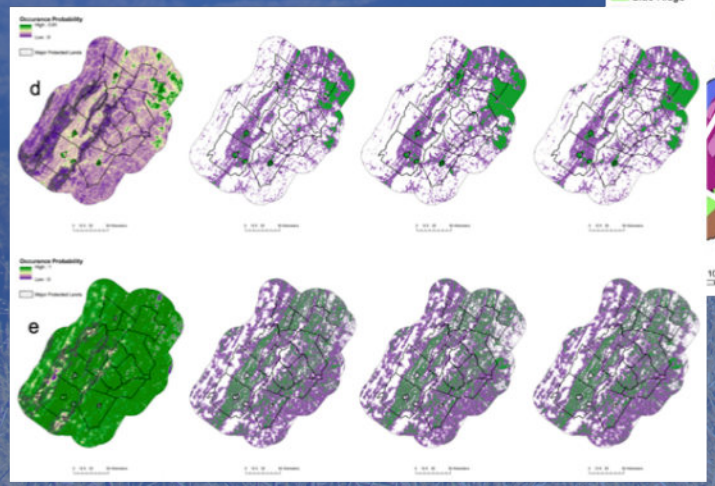
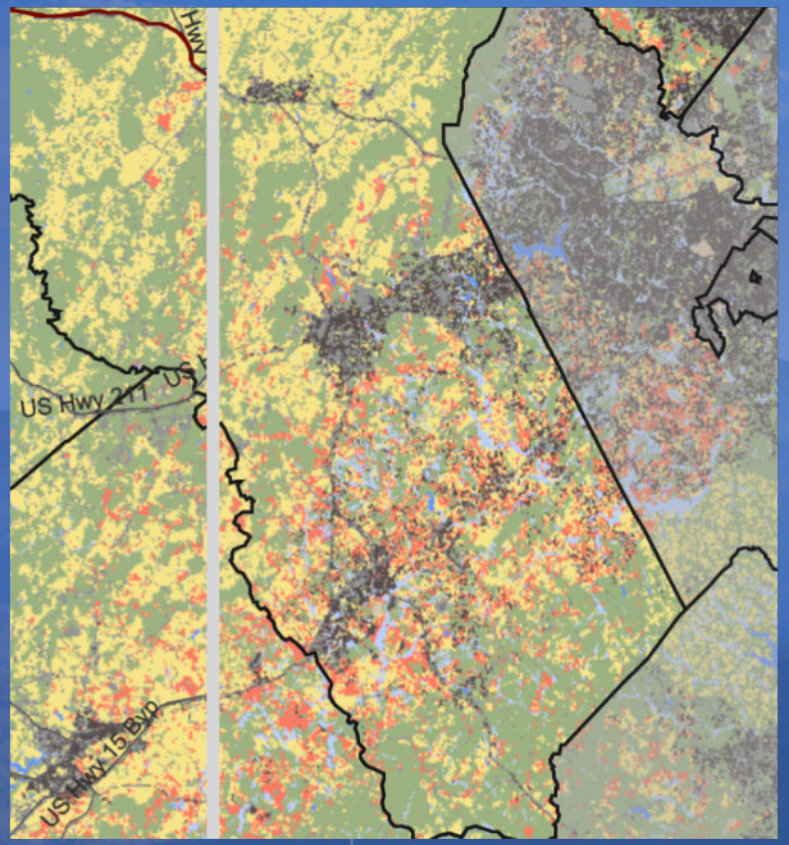
Tether maps and data



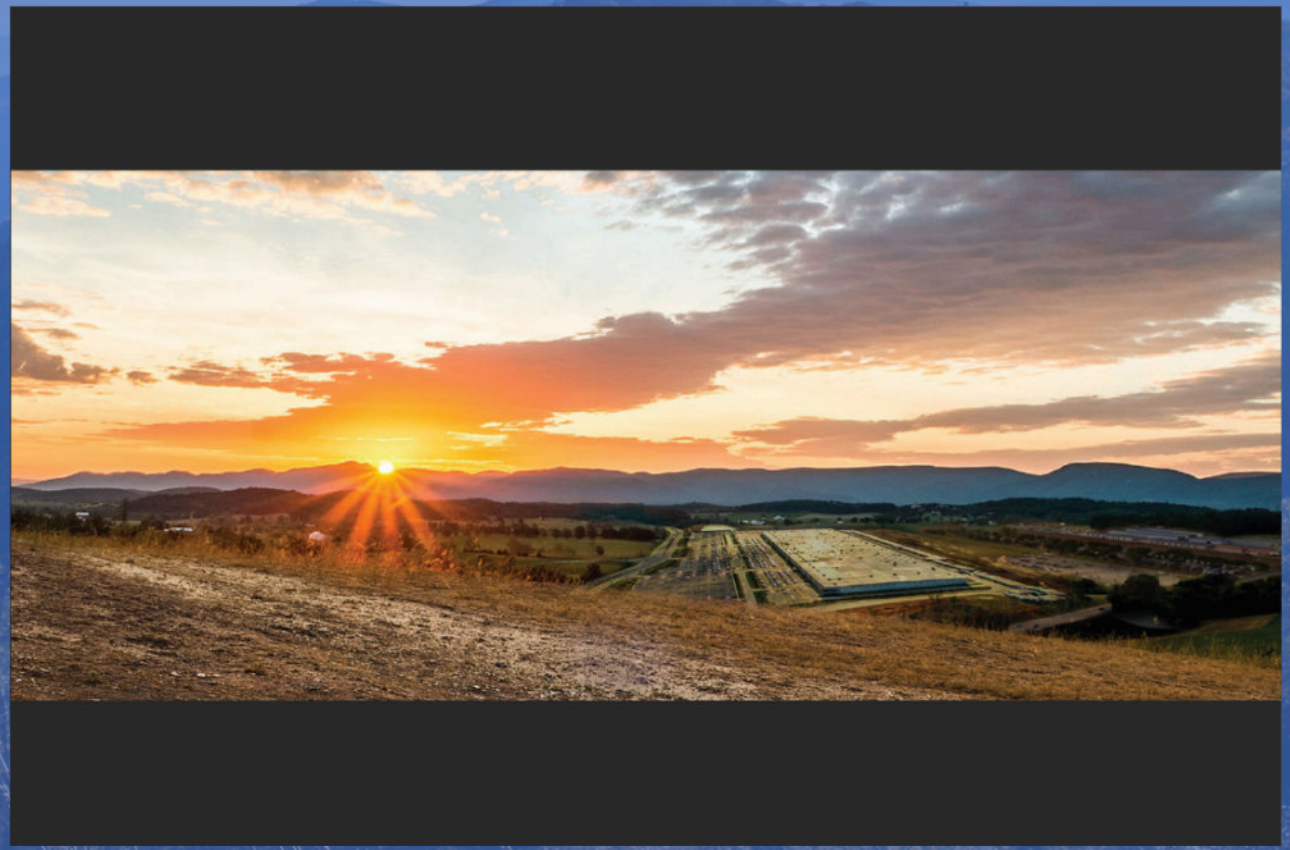


To a plausible, relatable story about the future

High population, high political will



With real projections of what that future could look like



Our Value

- Objective data
- Assess impact of policy on water resources
- Provide information to aid prioritization of efforts
- Provide information for long-term strategic water management plans

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Our Value

- Encourage and support cross-county collaboration
- Vehicle for discussion about shared resources i.e. water
- Determine how local comprehensive plans fit into the "big picture"
- Help evaluate tradeoffs between different land uses in particular locations
- Scenarios projections as a tool for outreach

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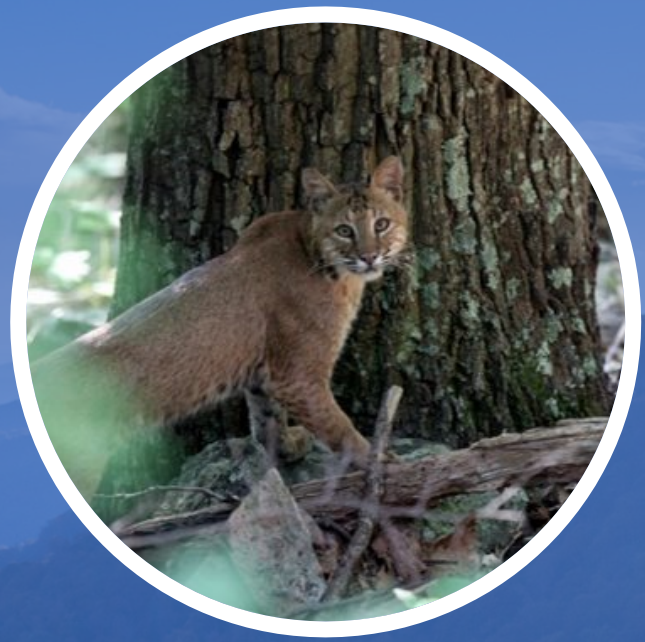
Additional Ecosystem Services

FURMAN UNIVERSITY



… Underpinned by biodiversity


ALLIANCE
FOR THE SHENANDOAH VALLEY
Conserving our Land, Water,
and Way of Life
Piedmont
Environmental
Council

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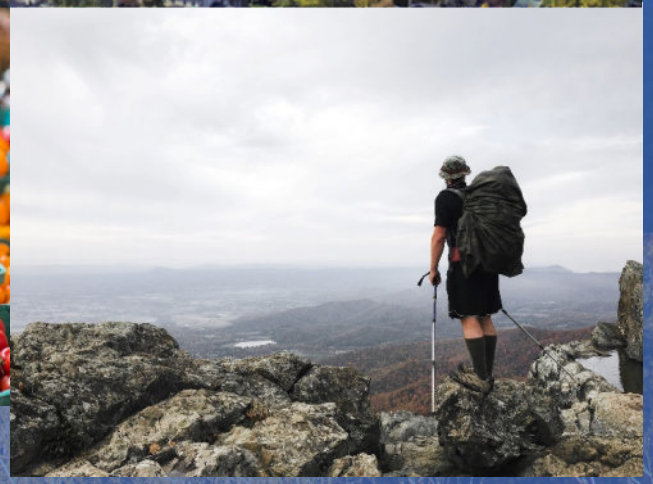
END

Scenario: As Told by Community Leaders



High Population
High Political Will

- Development focused around urban centers
- Strong economies and local identities
- Concentrated infrastructure & rejuvenated forests

2060

Scenario: As Told by Community Leaders

2060

High Population
Low Political Will

- Development occurring along roadways
- Land becomes expensive and fragmented
- Ecological resilience, water quality, recreation & forest are reduced

Scenario: As Told by Community Leaders

Low Population
Low Political Will

- Resource extraction
- Absentee landownership
- Lower demand to conserve natural resources

2060

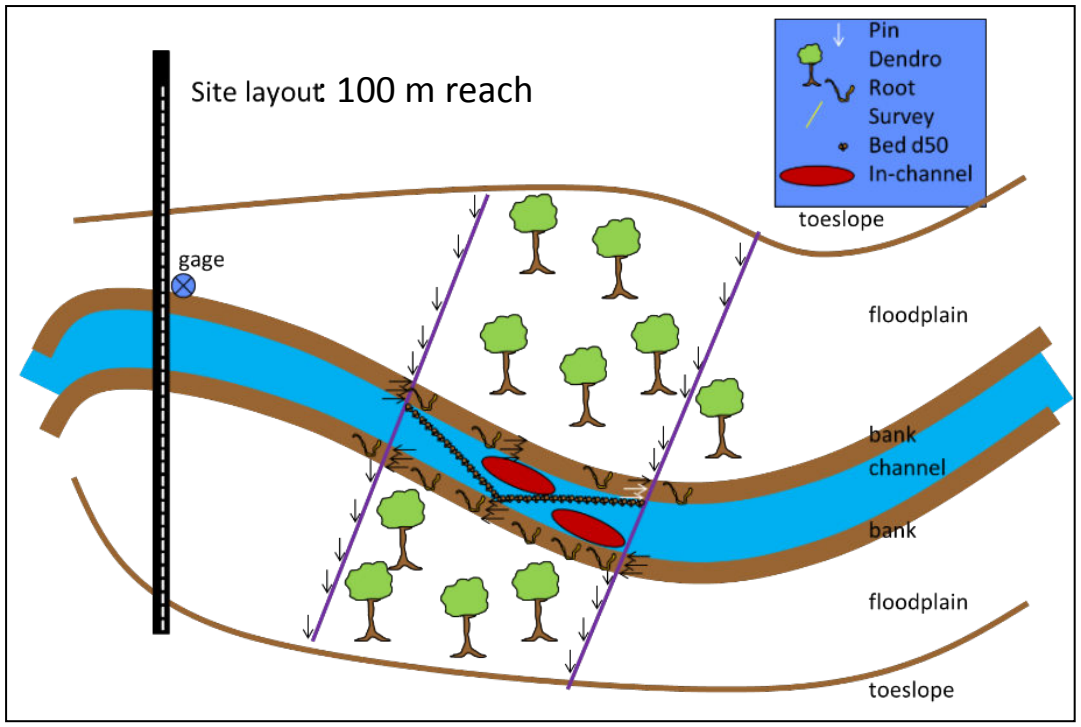
Scenario: As Told by Community Leaders

Low Population
High Political Will

- Younger generations move towards urban areas
- Strategic planning preserves open space and forest
- Region can provide water, outdoor recreation, ag products

2060

Chesapeake and Delaware Floodplain Network: measurements at 68 reaches



Stream valley x-section surveying:
136 x-sections

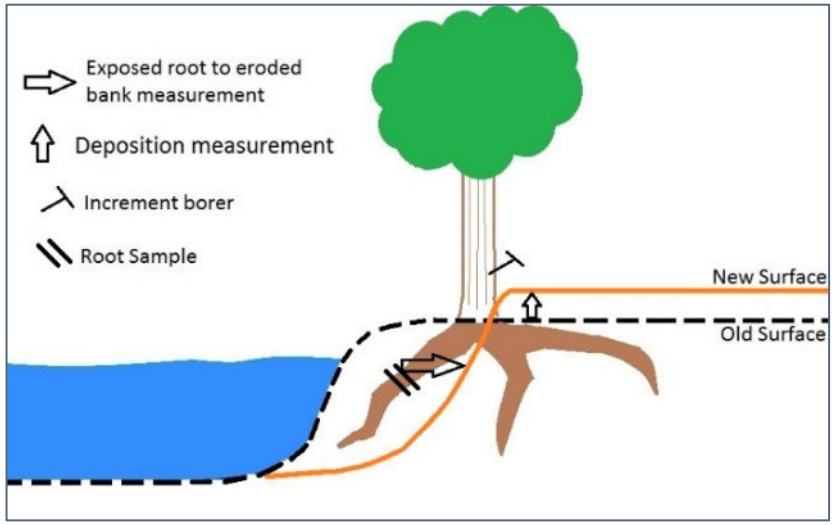
Floodplain tree coring:
667 floodplain tree cores

Bank root:
457 bank root samples

Floodplain sed coring (5 cm deep):
376 floodplain samples

Bank sed coring (5 cm deep):
541 bank samples

Dendrogeomorphic fluxes



Root analysis to determine years since exposure

Geomorphic measurements:
Active (~2 yr) floodplain width
Bank height
Channel width
Lateral and vertical change (cm/yr)
% eroding bank
Adjusted lateral erosion (cm/yr)

Sediment characteristics:
Bulk density (g/cm3)
Bulk density <2 mm (g/cm3)
Bulk density <1 mm (g/cm3)
% organic
% mineral
% carbonate
Total OC (%)
Total N (%)
Total P (%)
Total Ca (mg/g)
Total Na (mg/g)
Total Mg (mg/g)
Total K (mg/g)
Total Al (mg/g)
Total Fe (mg/g)
Total Ti (mg/g)
Particle size: mean (um)
Particle size: d50 (um)
Particle size: %<63 um

USGS Chesapeake and Delaware Floodplain Network: best predictors of flux

Random Forest importance of predictors: best models

Streambank erosion flux (kg-sed m^{-1} yr^{-1})
% Var explained: 30.4

Term	%IncMSE
Log_BASIN_AREA	23
NLCD11_22_23_24	11
NLCD11_71_81	8
WB5100_ANN	7
NLCD11_82	6
NLCD11_90_95	5
NLCD11_31	5
NLCD11_41_42_43_52	2
NLCD11_21	2
KFACT	NIM
NO200AVE	NIM
BFI	NIM
TWI	NIM
IEOF	NIM
OLSON_S	NIM
OLSON_FE	NIM
NDAMS2013	NIM

(log) **Floodplain flux** (kg-sed m^{-1} yr^{-1})
% Var explained: 25.9

Term	%IncMSE
NLCD11_22_23_24	12.2
Log_BASIN_AREA	10.8
Floodplain width	10.3
NLCD11_21	8.3
TWI	8.0
WB5100_ANN	7.9
NLCD11_82	6.7
CW/FW	6.5
NLCD11_41_42_43_52	5.4
NDAMS2013	5.3
OLSON_FE	5.3
NLCD11_90_95	4.4
NLCD11_31	3.5
NLCD11_71_81	3.3
KFACT	NIM
NO200AVE	NIM
BFI	NIM
IEOF	NIM
OLSON_S	NIM
Slope	NIM
Sinuosity	NIM
Bank height	NIM
Channel width	NIM
Bank angle	NIM
CW/BH	NIM
FW/BH	NIM

Streambed fine sediment cover (%)
% Var explained: 58.3

Term	%IncMSE
TWI	18
OLSON_FE	16
NLCD11_90_95	11
NLCD11_82	10
NLCD11_41_42_43_52	7
NLCD11_71_81	7
NLCD11_31	6
NLCD11_21	3
NLCD11_22_23_24	0
Log_BASIN_AREA	NIM
KFACT	NIM
NO200AVE	NIM
BFI	NIM
WB5100_ANN	NIM
IEOF	NIM
OLSON_S	NIM
NDAMS2013	NIM

Bank sediment flux (kg/m/yr)

Less

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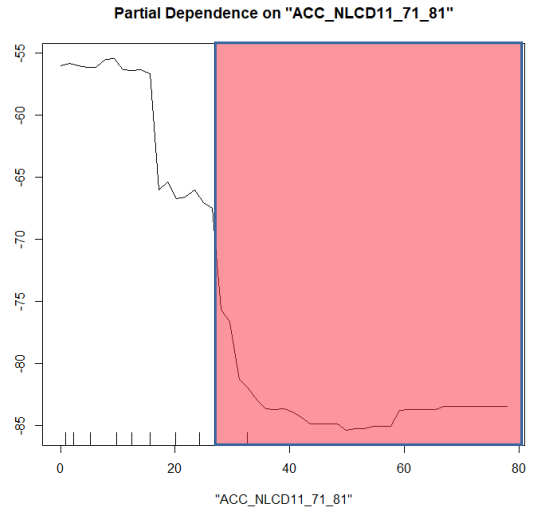
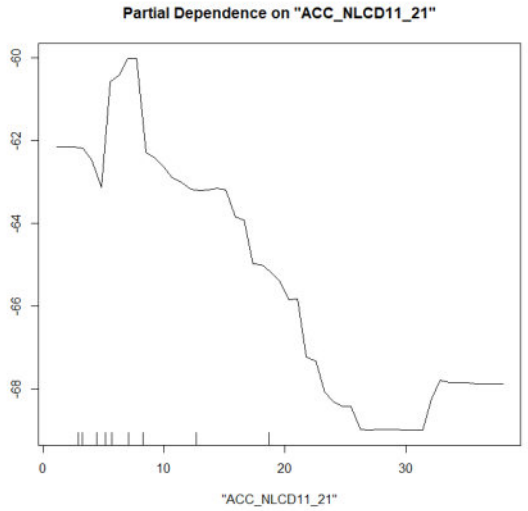
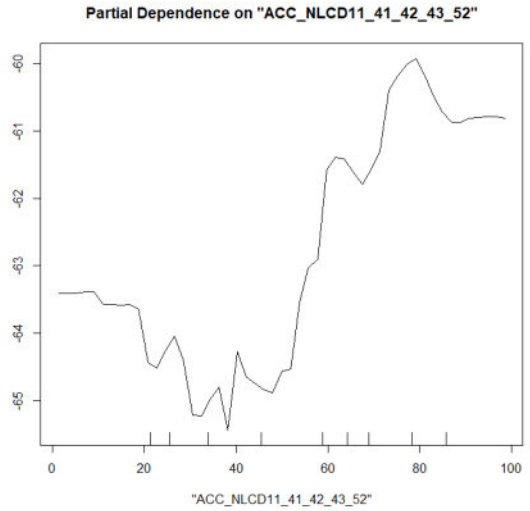
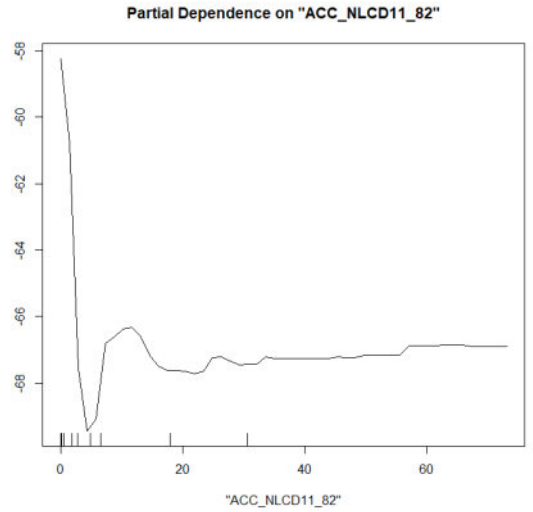
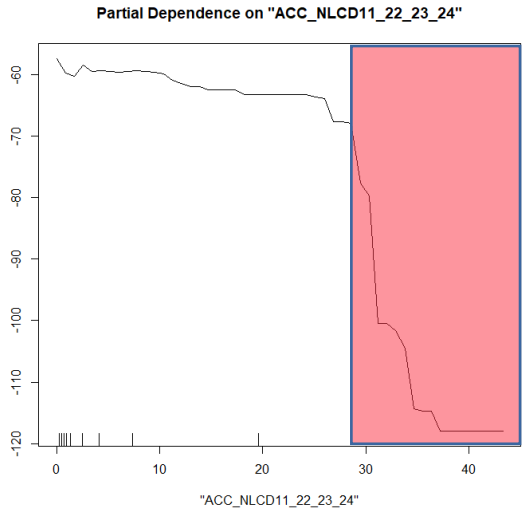
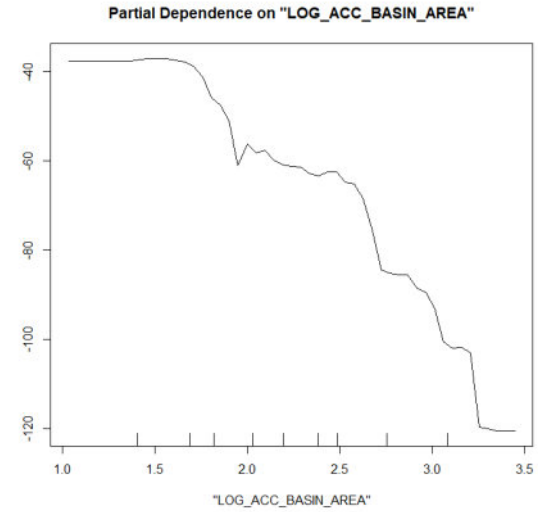




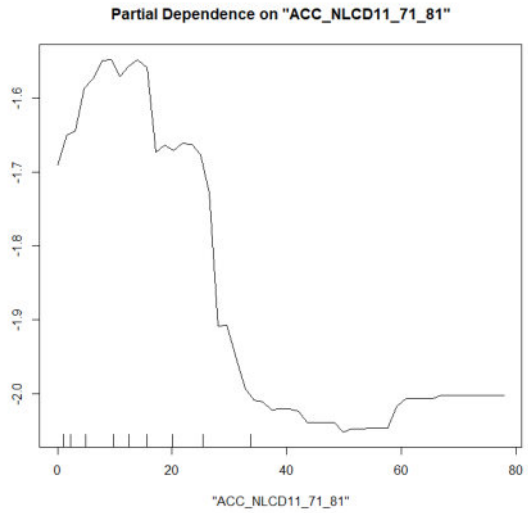


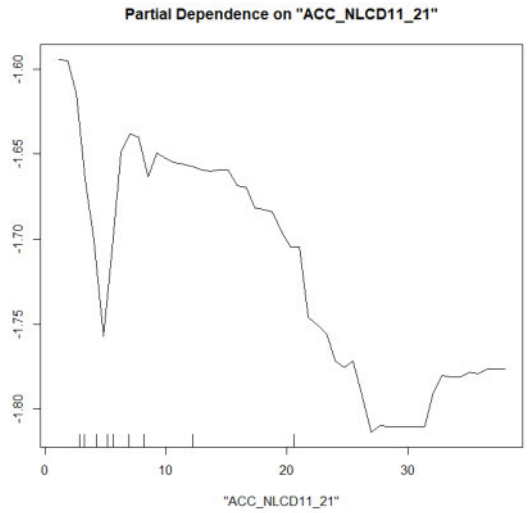


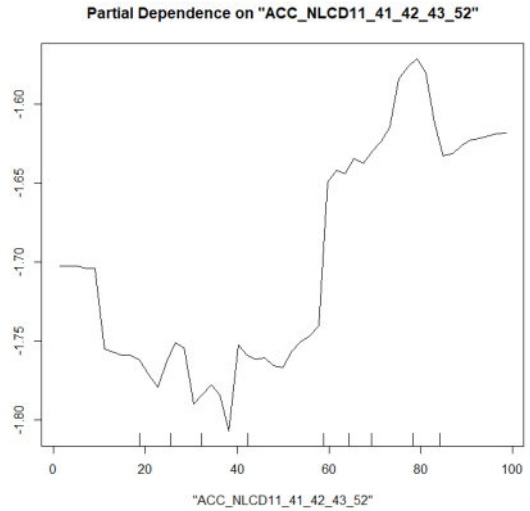


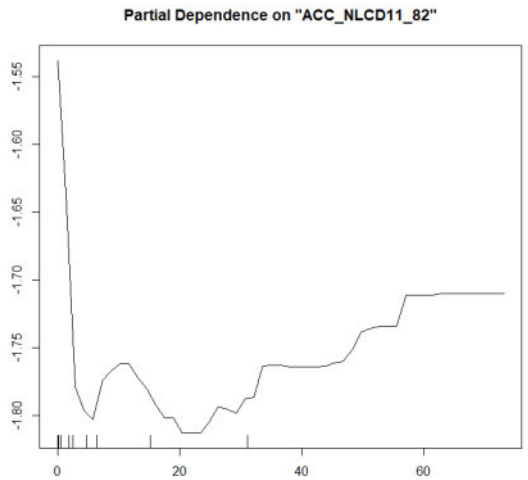


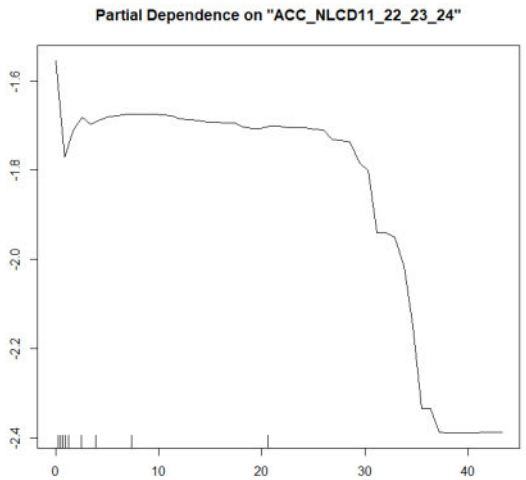
Bank lateral erosion (cm/yr)



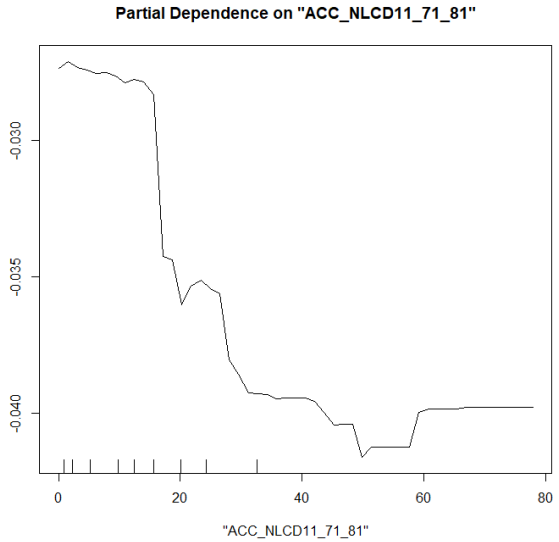


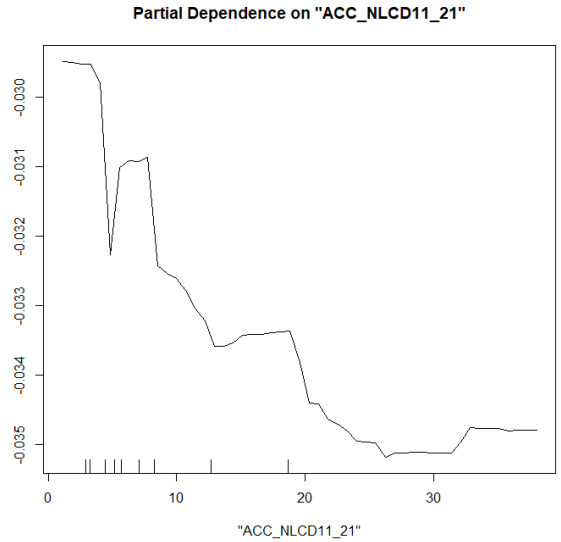


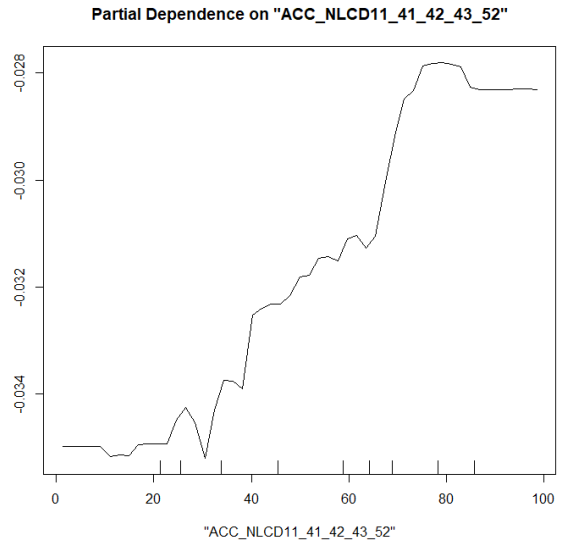


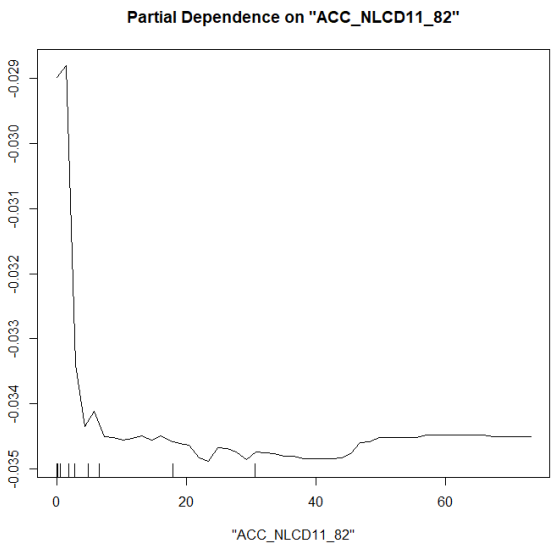


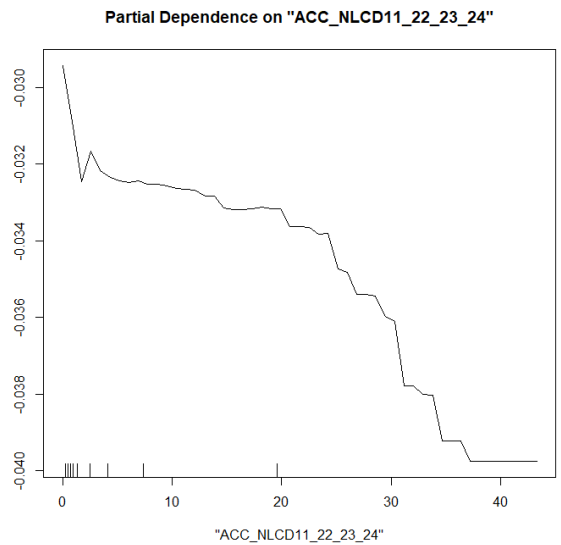
Bank sediment-P flux (kg-P/m/yr)











[log10] Floodplain sediment flux (kg/m/yr)

More

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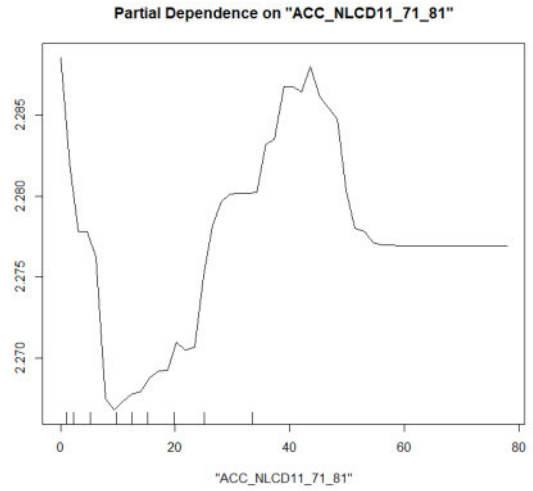

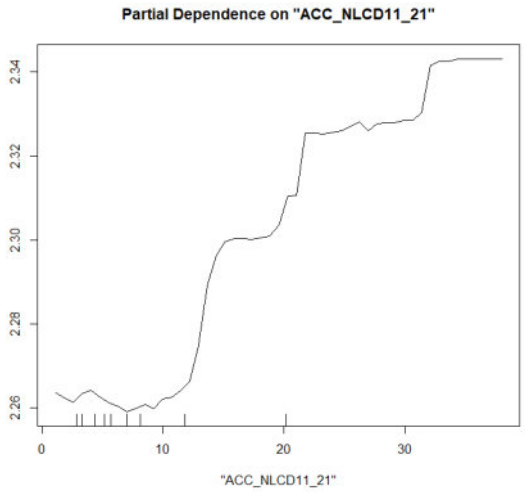

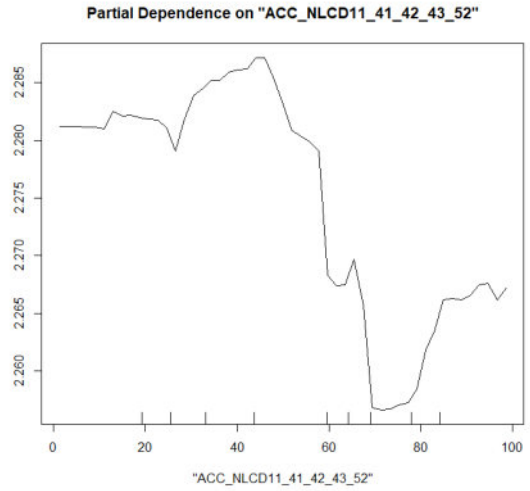

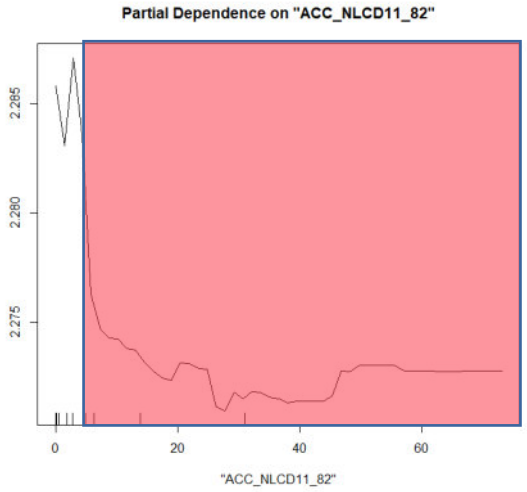

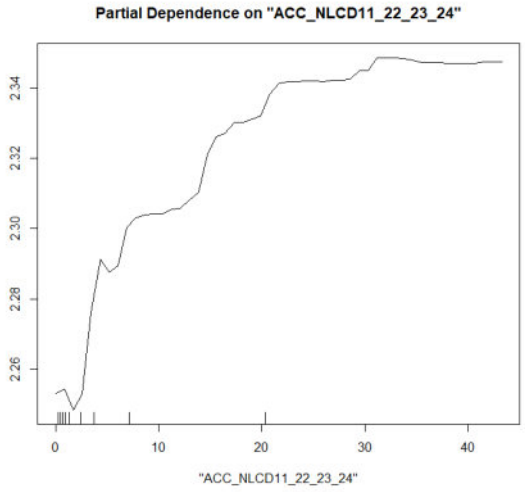

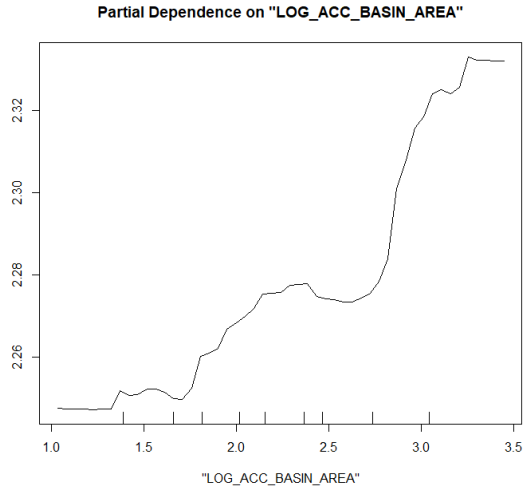

Bank sediment-N flux (kg-N/m/yr)