Watershed Characteristics and Landscape Factors Influencing Vulnerability and Resilience to Rising Water Temperatures

Renee Thompson, USGS

Discussion Questions

How is this element distinct from other elements?

How can concepts of conservation of vital lands and healthy watersheds be woven into this framework?

HEALTHY WATERSHEDS GOAL

Goal: Sustain state-identified healthy waters and watersheds recognized for their high quality and/or high ecological value

Outcome: 100 percent of state-identified healthy waters and watersheds remain healthy.

HEALTHY WATERSHEDS VISION

Sustain watershed health where it is ***high, exceptional and/or outstanding…***

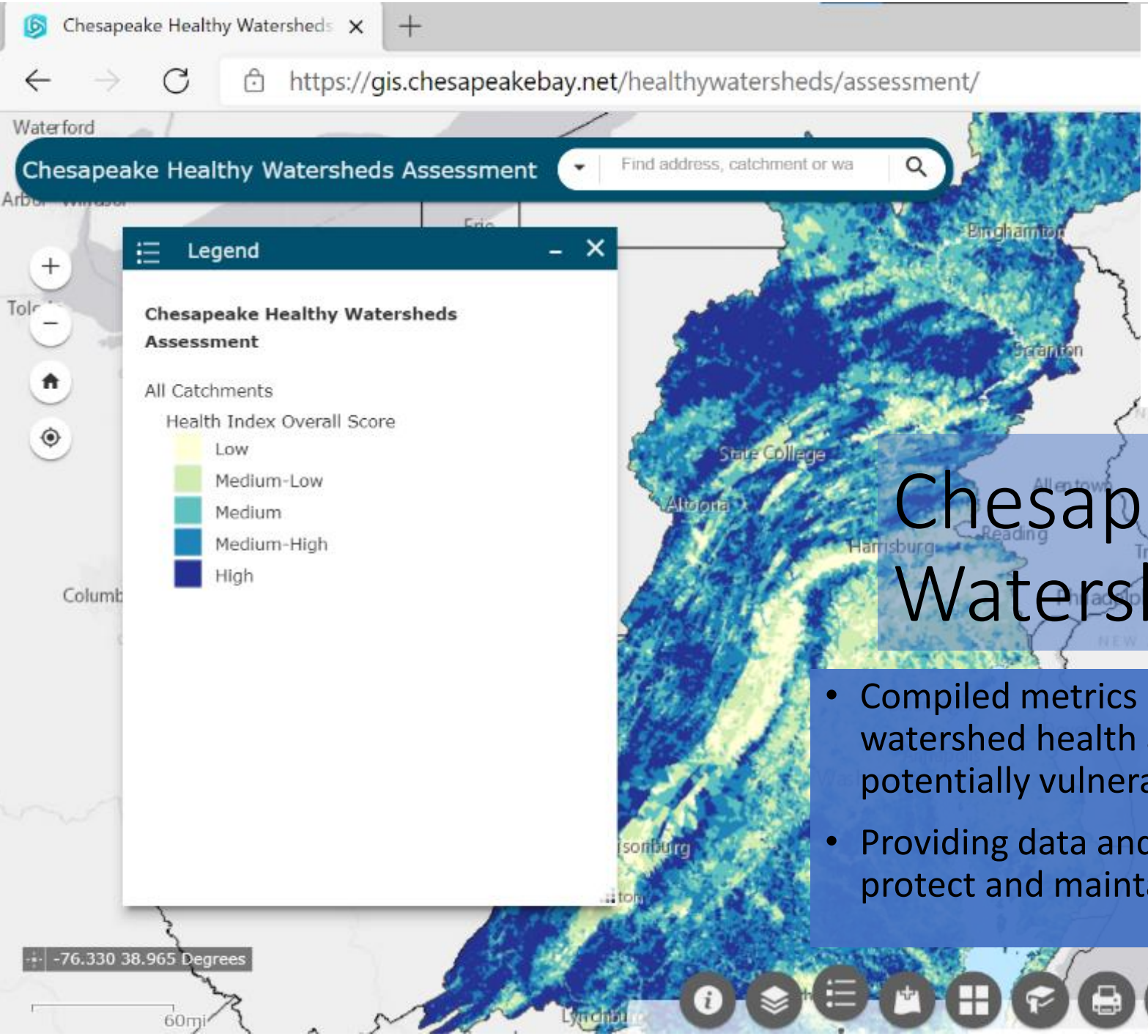
to ***increase the number of healthy watersheds*** in the future…

Provide the forum for mutual shared learning…

Develop information resources…

Promote the science…
And

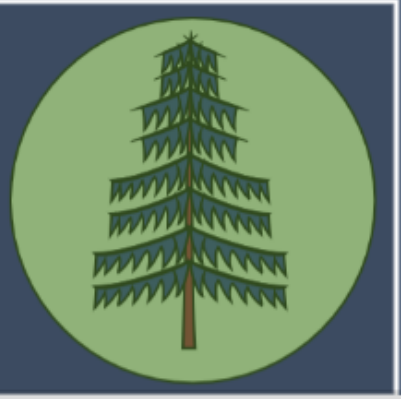
Coordination, Integration and Collaboration.



Chesapeake Healthy Watersheds Assessment

- Compiled metrics characterizing multiple aspects of watershed health and landscape stressors to inform potentially vulnerable and/or resilient catchments.
- Providing data and information to support strategies to protect and maintain healthy watersheds.

Landscape Condition



Habitat

Metrics Included

- % Natural Land Cover (Ws)*
- **% Forest in Riparian Zone (Ws)**
- Population Density (Ws)
- **Housing Unit Density (Ws)**
- Mining Density (Ws) ?
- **Historic Forest Loss (Ws)**
- **% Managed Turf Grass in Hydrologically Connected Zone (Ws)***

Biological Condition

Hydrology

Non-coal and coal mining density, MD MDE
Active and Abandoned Mines, Chesapeake Conservancy, Conservation Innovation Center

Bold: New metrics developed for this assessment
Asterisk*: Customized using Chesapeake Bay high-resolution land use/cover data 2013/14
Regular: Original EPA Preliminary Healthy Watersheds Assessment Metrics

Landscape Condition

Habitat

% of stream miles in catchment that are entrenched (entr. Ratio <1.4)
% of stream miles in the catchment that are slightly to not entrenched (entr. Ratio >2.2)

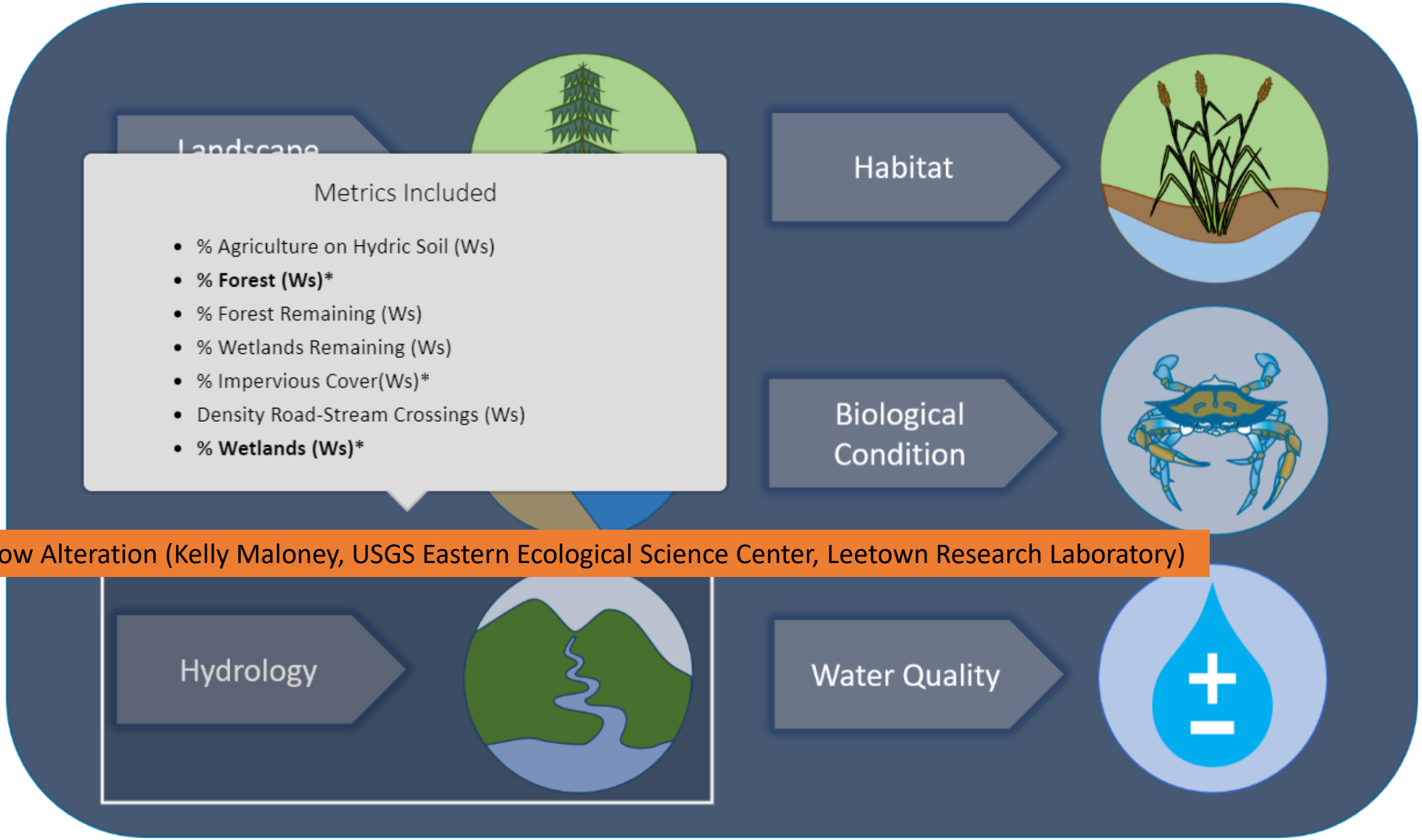
Geomorphology

Biological Condition

Water Quality

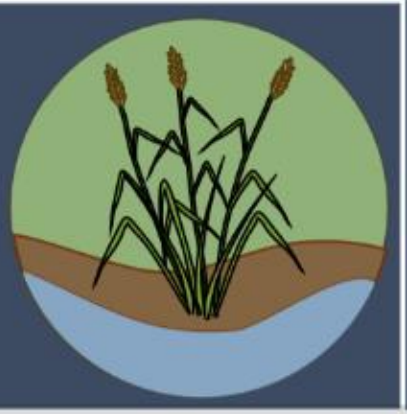
Metrics Included

- Dam Density (Ws)
- Road Density in Riparian Zone (Ws)
- % Impervious in Riparian Zone (Ws)*
- % Vulnerable Geology (Ws)


Landscape
Metrics Included
% Agriculture on Hydric Soil (Ws)
% Forest (Ws)*
% Forest Remaining (Ws)
% Wetlands Remaining (Ws)
% Impervious Cover(Ws)*
Density Road-Stream Crossings (Ws)
% Wetlands (Ws)*
Habitat
Biological Condition
Hydrology
Water Quality
Flow Alteration (Kelly Maloney, USGS Eastern Ecological Science Center, Leetown Research Laboratory)

Landscape Condition

Habitat



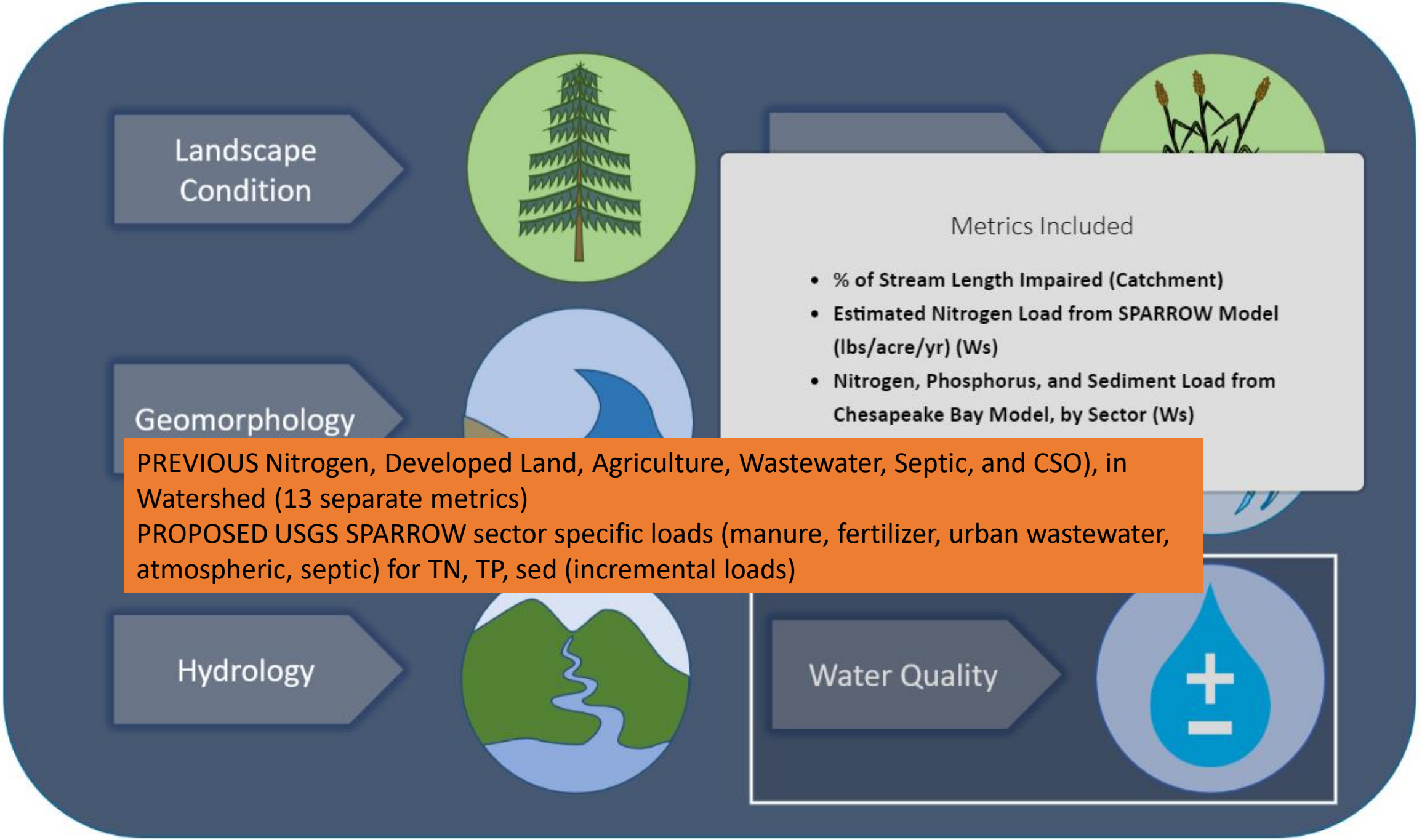
Geomorphology

Hydrology

Metrics Included

- **% Natural Connectivity (Catchment)**
- Fish Habitat Condition Index: Local (Catchment)

Forest Habitat (Forest interior), P. Claggett USGS CBP
MBSS Stronghold Watersheds, MD DNR
BioNet (wildlife and rare species), MD iMAP
MBSS Physical Habitat Indicator, TBD incomplete data


Landscape Condition
Geomorphology
Hydrology
Water Quality
Metrics Included
% of Stream Length Impaired (Catchment)
Estimated Nitrogen Load from SPARROW Model (lbs/acre/yr) (Ws)
Nitrogen, Phosphorus, and Sediment Load from Chesapeake Bay Model, by Sector (Ws)
PREVIOUS Nitrogen, Developed Land, Agriculture, Wastewater, Septic, and CSO), in Watershed (13 separate metrics)
PROPOSED USGS SPARROW sector specific loads (manure, fertilizer, urban wastewater, atmospheric, septic) for TN, TP, sed (incremental loads)

Land Use Change

Water Use

Wildfire

Metrics Included

- **% Increase in Development (Catchment)**
- **Recent Forest Loss (Ws)**
- **% Protected Lands (Ws)**

Climate Change Vulnerability Index, Natureserve

- **Change in Probability of Brook Trout Occurence with 6°C Temperature Change (Catchment)**
- **NALCC Climate Stress Indicator (Catchment)**

Maryland Fire Priority Areas, MD DNR Forest Service

Metrics Included

- **% Wildland Urban Interface (Ws)**

Bol
Reg

Metrics

MD HWA: Examples of New or Maryland-Specific Candidate Overlays

- Forest Health – MD DNR Forest Health Map, I. Allen, A. Harriston-Strang)
- % Vulnerable Geology in Watershed – USGS, E. Trentacoste, CBP
- Forest Conversion –P. Claggett USGS, CBO
- Agricultural Conversion - P. Claggett USGS, CBO
- Age of Development of Impervious – CBP TBD
- Marsh Migration Zones – MD DNR wetland adaptation areas overlay

Watershed Classification

Healthy ⟷ **Unhealthy**

Stream Condition (Response)

- **Biological condition, as measured by fish and benthic Indices of Biotic Integrity (Maryland Biological Stream Survey)**

Risk Factors

(informed by CHWA and CBP Land Data team)

- Population Density
- Impervious Cover (%)
- Tree Cover (%)
- Hydric Soils (%)
- Road x stream crossing density
- Probability of land conversion

Diagnostic Measures

(informed by USGS Science and geospatial contract work)

- Stream flow
- Stream temperature
- Stream incision/floodplain connectivity
- Aquatic community composition
- Toxics
- Nutrients
- Sediment

Statistical approach (example)

- Stepwise regression – exploratory analysis for CHWA

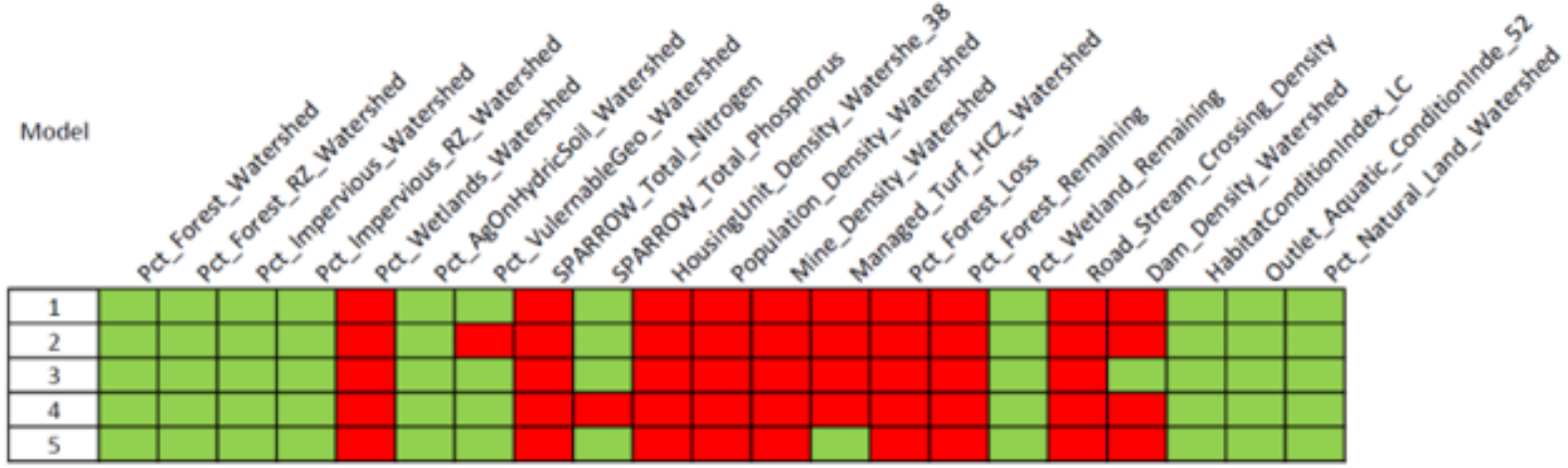


Figure 28: Exploratory analyses: best five model runs showing metrics selected by stepwise linear model. Green box indicates metric provided significant contribution when added to model; red indicates not significant

Source: Roth et al. 2020. Chesapeake Healthy Watersheds Assessment: Assessing the Health and Vulnerability of Healthy Watersheds within the Chesapeake Bay Watershed

Ancillary Data

- County Land Use
- Abandoned Mine Lands
- Landfills
- Roads

Land Cover Data

- Impervious surfaces
- Tree canopy
- Low vegetation
- Water

Land Use Data

- Impervious-Roads
- Forests
- Turf Grass
- Cropland

USGS

CBP Full Land Use/Cover Classification (61 classes, final version)

1. Water (10)

- 1.1 Lentic
  - 1.1.1 Estuary (tidal)
  - 1.1.2 Lakes & Ponds
- 1.2 Lotic
  - 1.2.1 Streams
    - 1.2.1.1 Open Channel
    - 1.2.1.2 Tree Canopy over Channel
    - 1.2.1.3 Culverted/ Buried Channel
  - 1.2.2.Ditches
    - 1.2.2.1 Open Ditch
    - 1.2.2.2 Tree Canopy over Ditch
    - 1.2.2.3 Culverted/ Buried Ditch

2. Developed (12)

- 2.1 Impervious
  - 2.1.1 Roads
  - 2.1.2 Structures
  - 2.1.3 Other Impervious (Parking lots, driveways)
  - 2.1.4 Tree Canopy (TC) over Impervious
    - 2.1.4.1 TC over Roads
    - 2.1.4.2 TC over Structures
    - 2.1.4.3 TC over Other Impervious
- 2.2 Pervious
  - 2.2.1 Turf Grass
  - 2.2.2 Bare Developed
  - 2.2.3 Suspended Succession (rights-of-way)
    - 2.2.3.1 Barren
    - 2.2.3.2 Herbaceous
    - 2.2.3.3 Scrub-shrub
  - 2.2.4 Tree Canopy over Turf Grass

3. Forest (7)

- 3.1 Forest (>= 1 acre, 240-ft width)
- 3.2 Tree Canopy in Agriculture
- 3.3 Harvested Forest (<= 3 years)
  - 3.3.1 Barren
  - 3.3.2 Herbaceous
- 3.4 Natural Succession (> 3 years)
  - 3.4.1 Barren
  - 3.4.2 Herbaceous
  - 3.4.3 Scrub-shrub

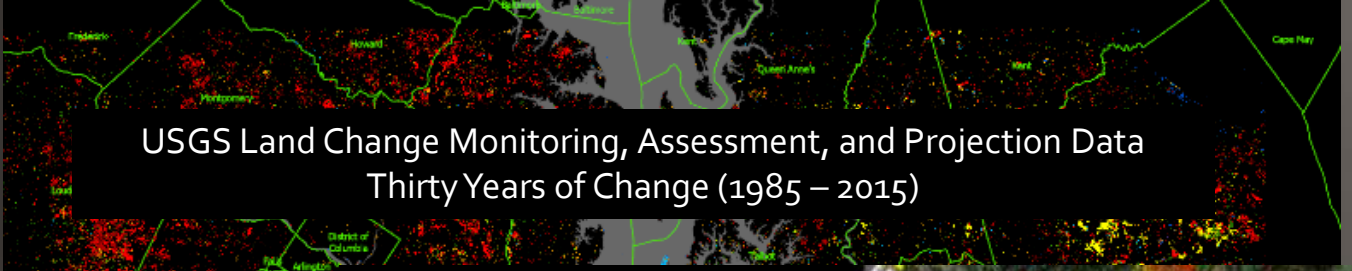
4. Production (16)

- 4.1 Agriculture
  - 4.1.1 Cropland
    - 4.1.1.1 Barren
    - 4.1.1.2 Herbaceous
  - 4.1.2 Pasture
    - 4.1.2.1 Barren
    - 4.1.2.2 Herbaceous
  - 4.1.3 Orchard/vineyard
    - 4.1.3.1 Barren
    - 4.1.3.2 Herbaceous
    - 4.1.3.3 Scrub-shrub
  - 4.1.4 Animal Operations (TBD)
    - 4.1.4.1 Impervious
    - 4.1.4.2 Barren
    - 4.1.4.3 Herbaceous
- 4.2 Solar fields
  - 4.2.1 Impervious
  - 4.2.2 Pervious
    - 4.2.2.1 Barren
    - 4.2.2.2 Herbaceous
    - 4.2.2.3 Scrub-shrub
- 4.3 Extractive (active mines)
  - 4.3.1 Barren
  - 4.3.2 Impervious

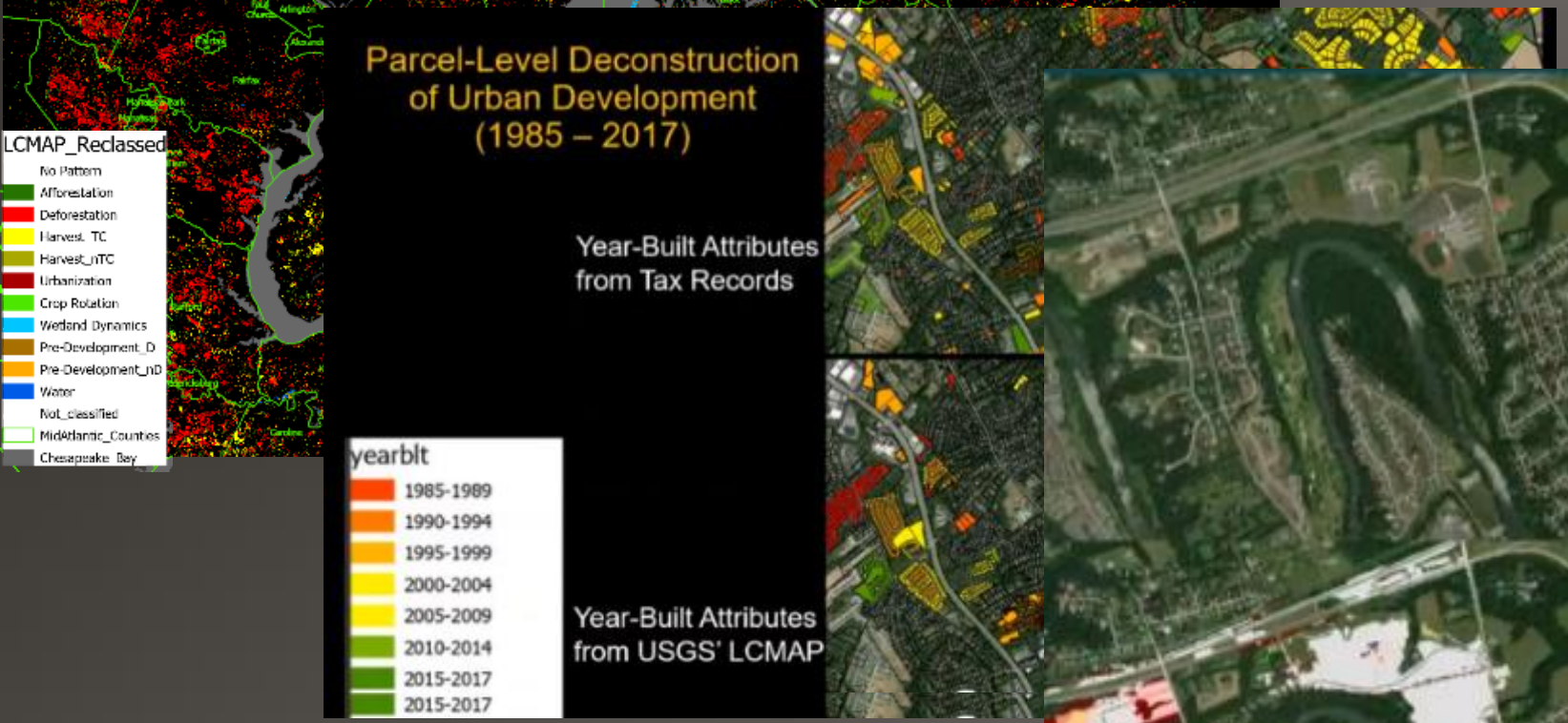
5. Wetlands and Water Margins (16)

- 5.1 Tidal
  - 5.1.1 Barren
  - 5.1.2 Herbaceous
  - 5.1.3 Scrub-shrub
  - 5.1.4 Tree Canopy
  - 5.1.5 Forest
- 5.2 Riverine (Non-tidal)
  - 5.2.1. Barren
  - 5.2.2 Herbaceous
  - 5.2.3 Scrub-shrub
  - 5.2.4 Tree Canopy
  - 5.2.5 Forest
- 5.3 Terrene/Isolated (Non-tidal)
  - 5.3.1 Barren
  - 5.3.2 Herbaceous
  - 5.3.3 Scrub-shrub
  - 5.3.4 Tree Canopy
  - 5.3.5 Forest
- 5.4 Bare shore

Increasing knowledge at a scale that is locally relevant



USGS Land Change Monitoring, Assessment, and Projection Data
Thirty Years of Change (1985 – 2015)



Rates of conversion:

- Farmland
- Forest
- Wetland
- Impervious Cover

Slides courtesy of Peter Claggett, USGS CBP

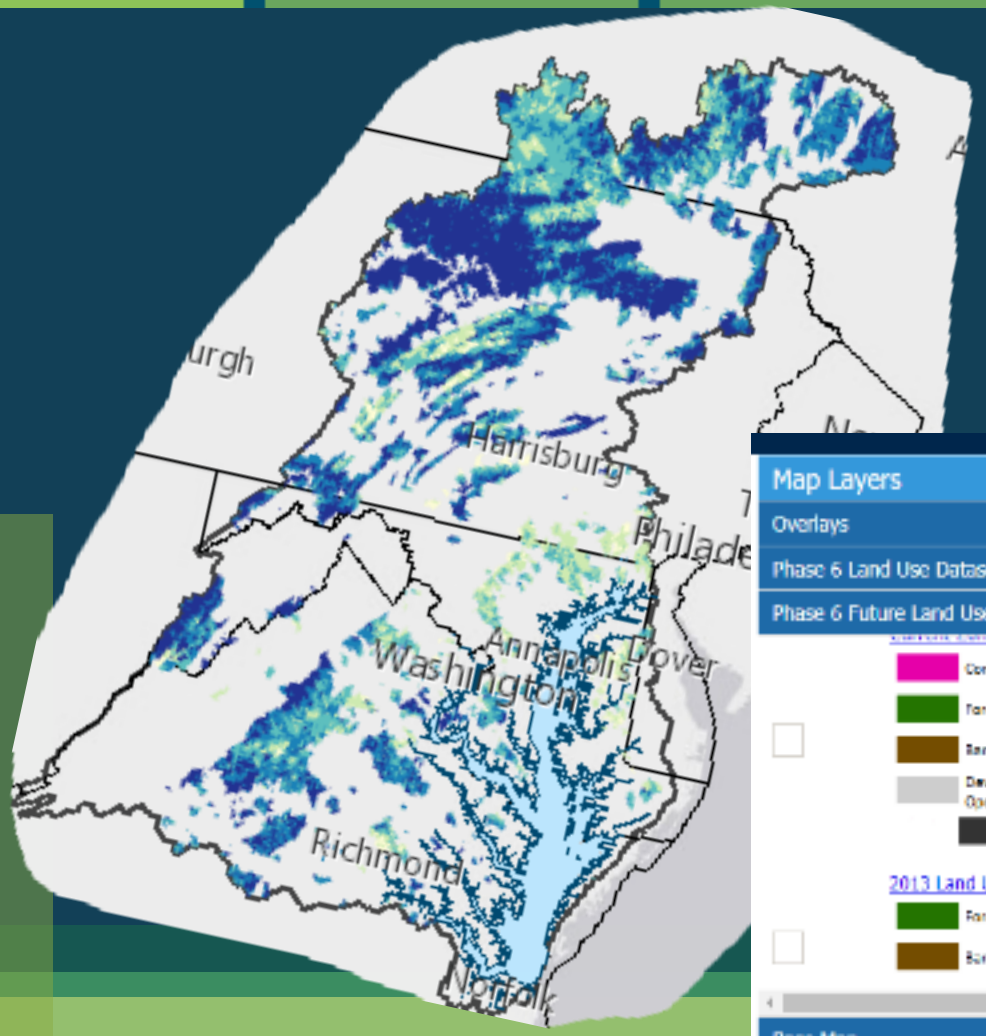
Chesapeake Bay Environmental Justice and Equity Dashboard (DRAFT)

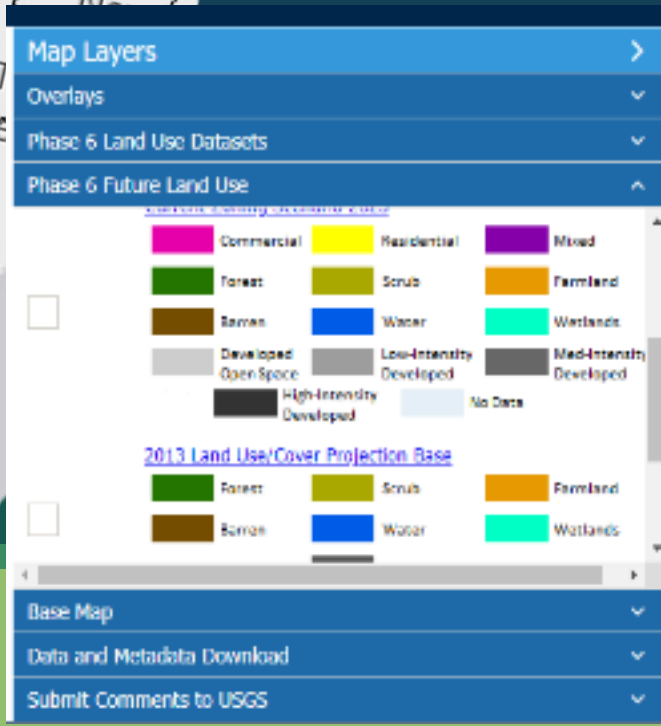
Overview | Demographic Indicators | Cross-Outcome Applications | Current Initiatives | Acknowledgements

.."Evaluate policy options, incentives and planning tools that could assist in continually improving capacity.."

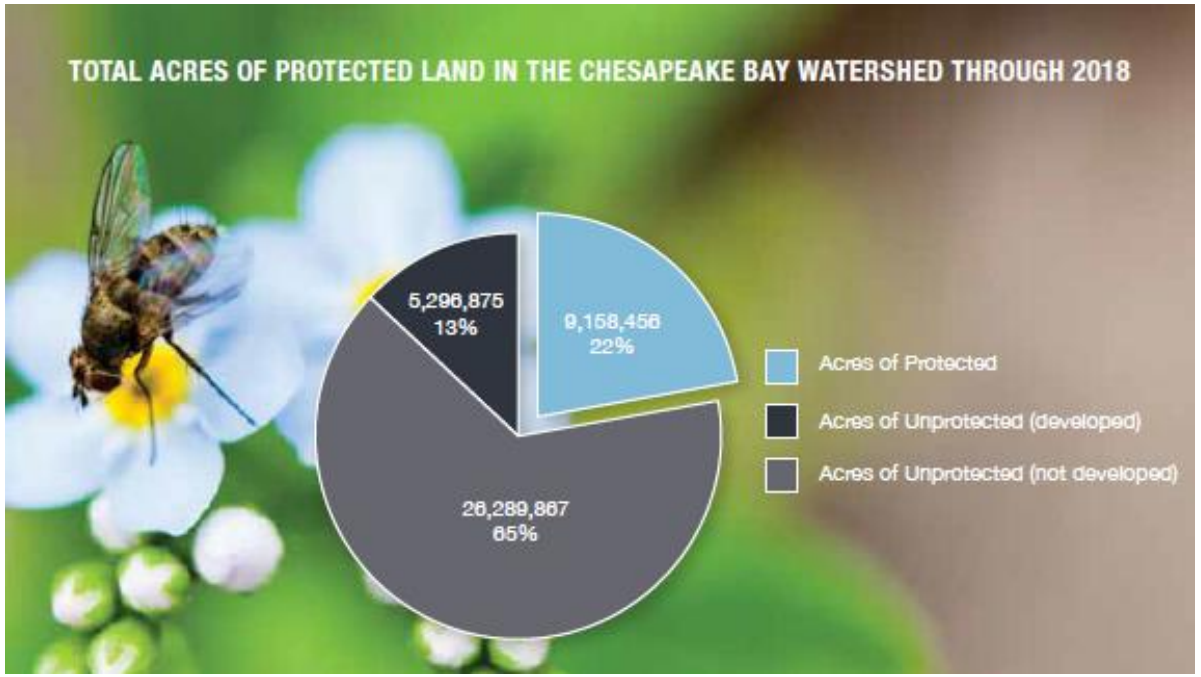
Data and Tools

- Hi-res land cover
- Phase 6 Land Use Viewer
- Data Dashboard
- Chesapeake Healthy Watersheds Assessment
- Environmental Justice and Equity Dashboard

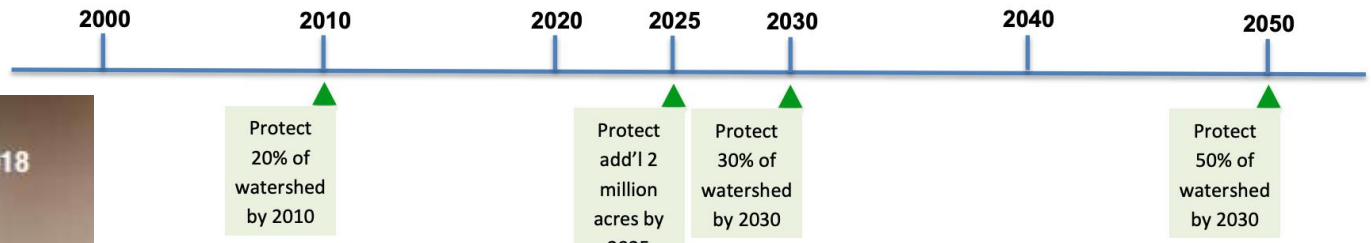




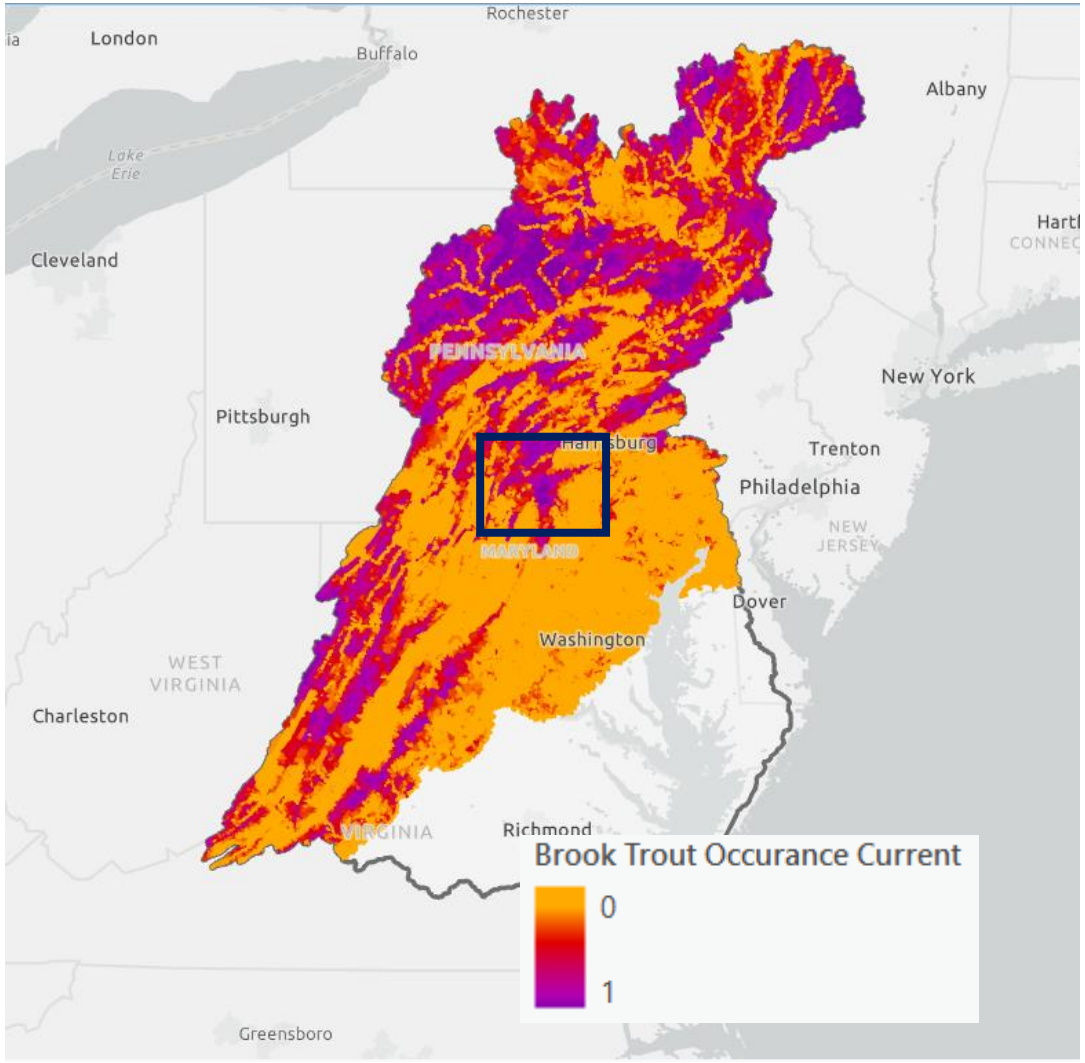
→ Protect an additional 2 million acres of land throughout the watershed—currently identified as high-conservation priorities at the federal, state, or local level—including 225,000 acres of wetlands and 695,000 acres of forestland of highest value for maintaining water quality.

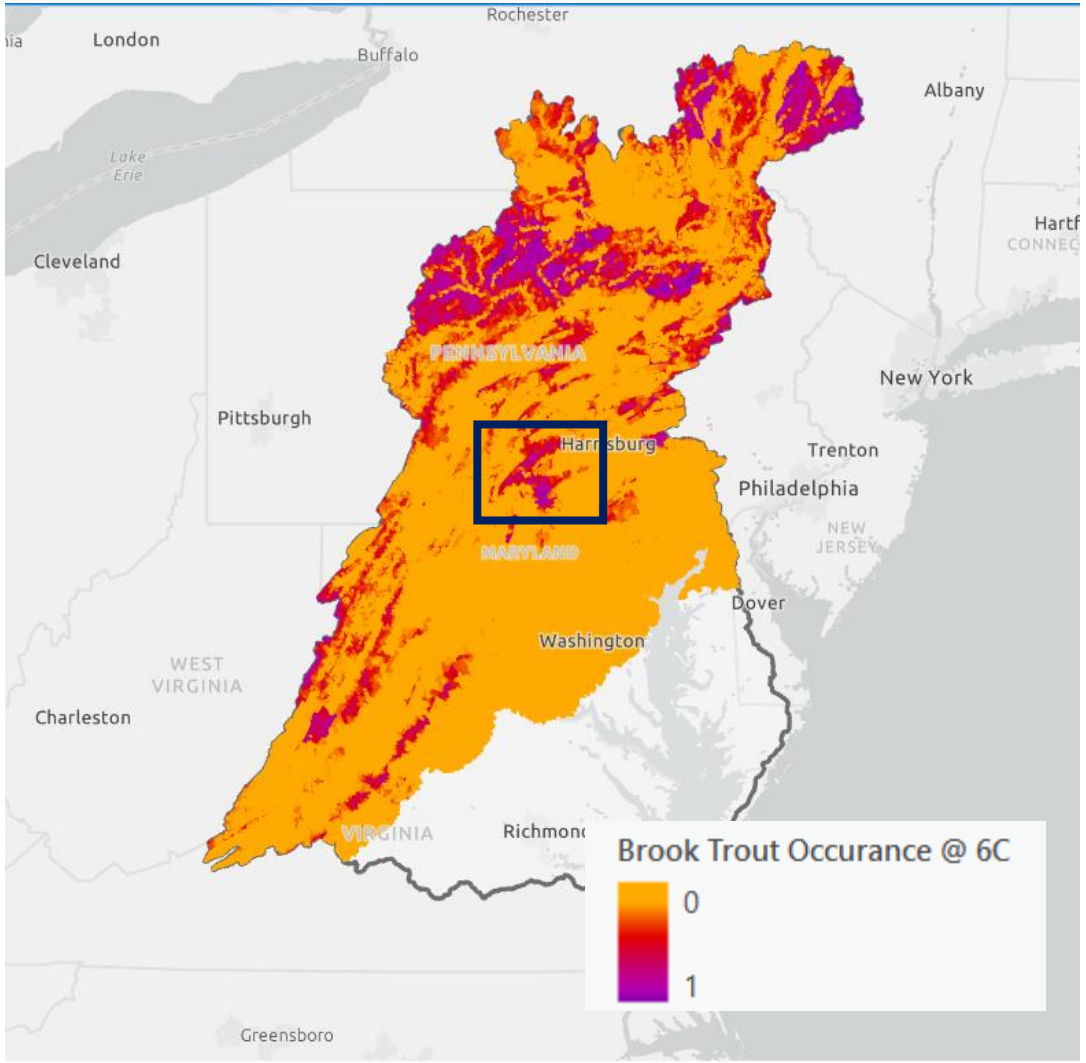


Land Protection Outcomes



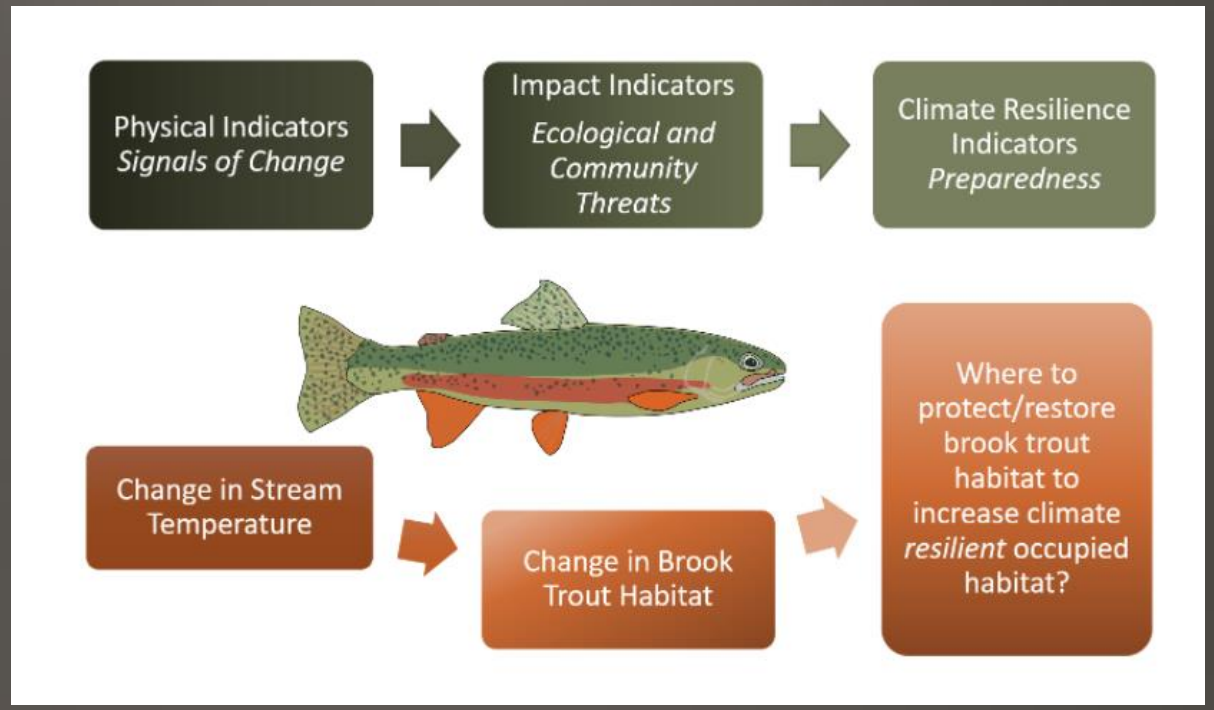
Current Brook trout vs.
Brook trout 6 deg C. increase





Discussion Questions

How is this element distinct from other elements?



How can concepts of conservation of vital lands and healthy watersheds be woven into this framework?

Acknowledgements:

Water is our most precious and interconnected natural resource. It sustains all ecosystems, communities, and economies from local watersheds to the seas. It's vital to sustaining our health, safety, and the environments in which we live and work. Simply put, water is life.

- Alexandra Cousteau

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