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Chesapeake Bay Program
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Healthy Watersheds Assessments for Chesapeake and Maryland Watersheds

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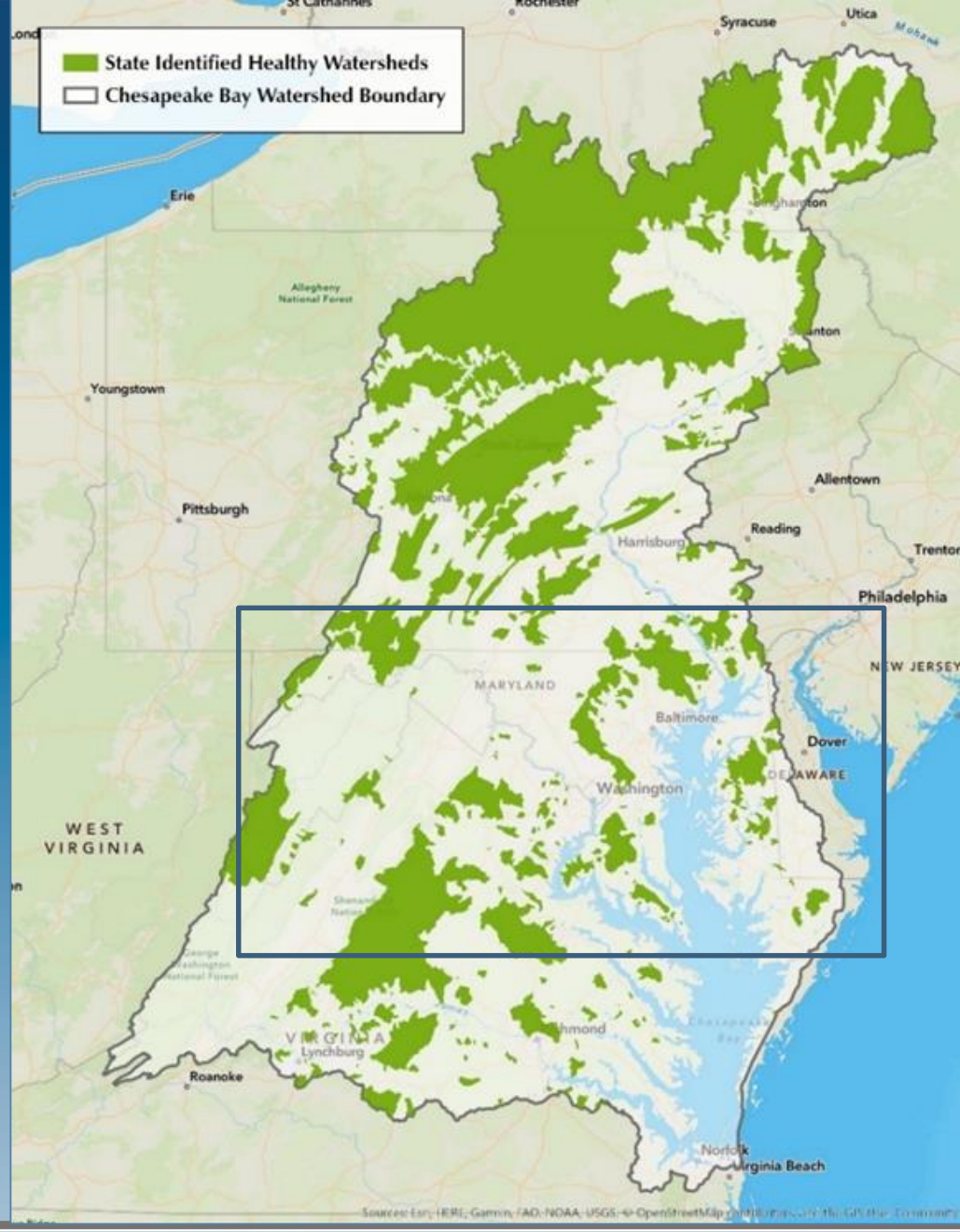
Tetra Tech

July 13, 2021

FOREVER MARYLAND



Healthy Watersheds, Healthy Streams

EPA defines a healthy watershed as one in which natural land cover supports:

- Dynamic hydrologic and geomorphic processes within their natural range of variation,
- Habitat of sufficient size and connectivity to support native aquatic and riparian species, and
- Physical and chemical water quality conditions able to support healthy biological communities.

Source: EPA, Healthy Watersheds Protection

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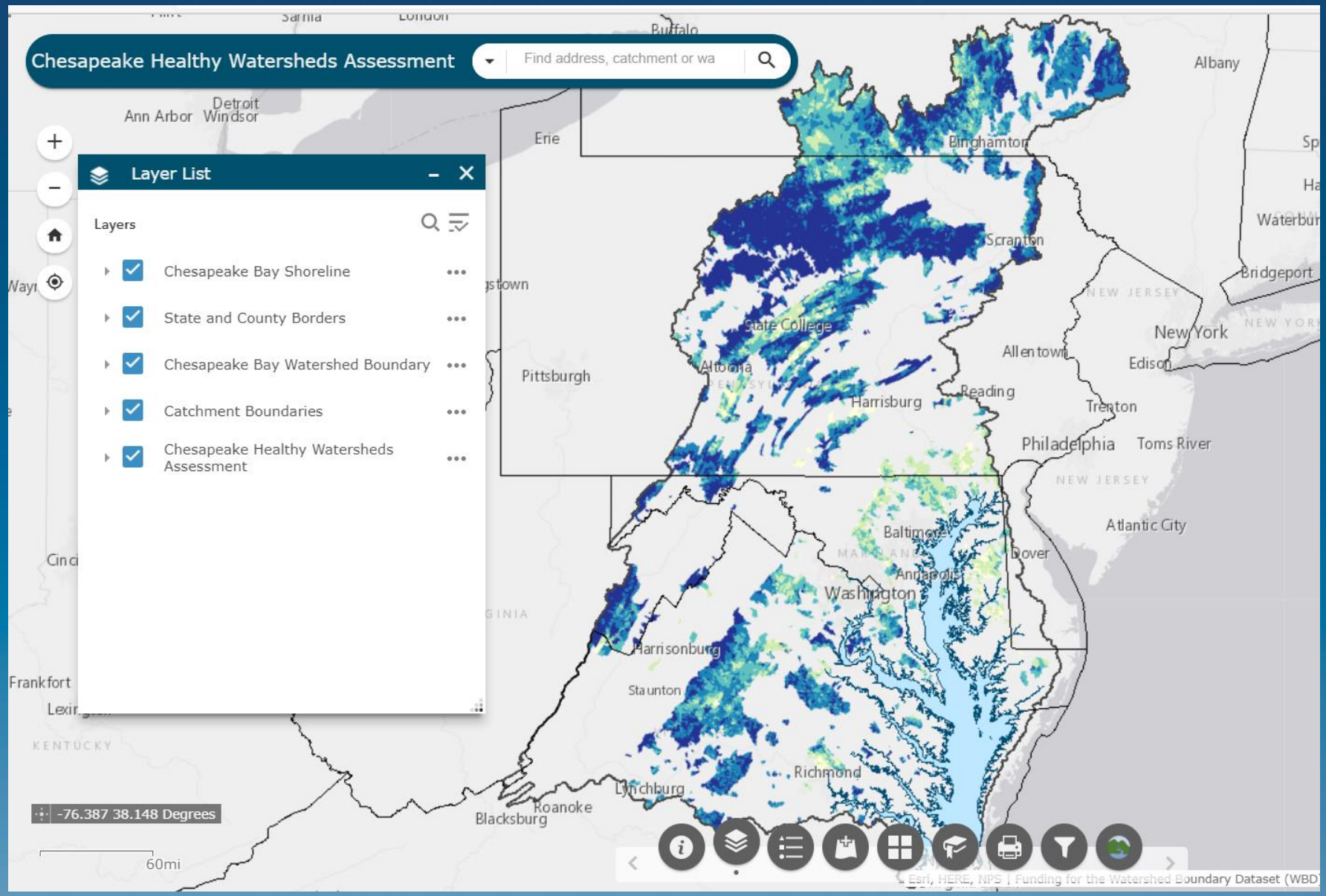
Chesapeake Healthy Watersheds Assessment



https://gis.chesapeakebay.net/healthywatersheds/assessment/

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Chesapeake Healthy Watersheds Assessment

Condition Metrics

Landscape Condition

Subindex score:

Metric values

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

Hydrology

Subindex score:

Metric values

- % Agriculture on Hydric Soil (Ws)
- **% Forest (Ws)***
- % Forest Remaining (Ws)
- % Wetlands Remaining (Ws)
- % Imperviousness Cover (Ws)*
- Road Stream Crossing Density (Ws)
- **% Wetlands (Ws)***

Habitat

Subindex Score:

Metric values

- National Fish Habitat Partnership (NFHP) Habitat Condition Index (Catchment)
- **% Natural Connectivity (Catchment)**
  - **Habitat Condition Index – Local**
  - **Habitat Condition Index – Network**
  - **Habitat Condition Index – Cumulative**

Geomorphology

Subindex Score:

Metric values

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

Water Quality

Subindex score:

Metric values

- **% 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)**

Biological Condition

Subindex score:

Metric values

- **Outlet Aquatic Condition Score (Catchment)**

https://gis.chesapeakebay.net/healthywatersheds/imagemaps/healthindex.html

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Chesapeake Healthy Watersheds Assessment

Vulnerability Metrics

Land Use Change

Metric values

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

Wildfire

Metric value

- % Wildland Urban Interface (Ws)

Water Use

Metric values

- Agricultural Water Use (Catchment)
- Domestic Water Use (Catchment)
- Industrial Water Use (Catchment)

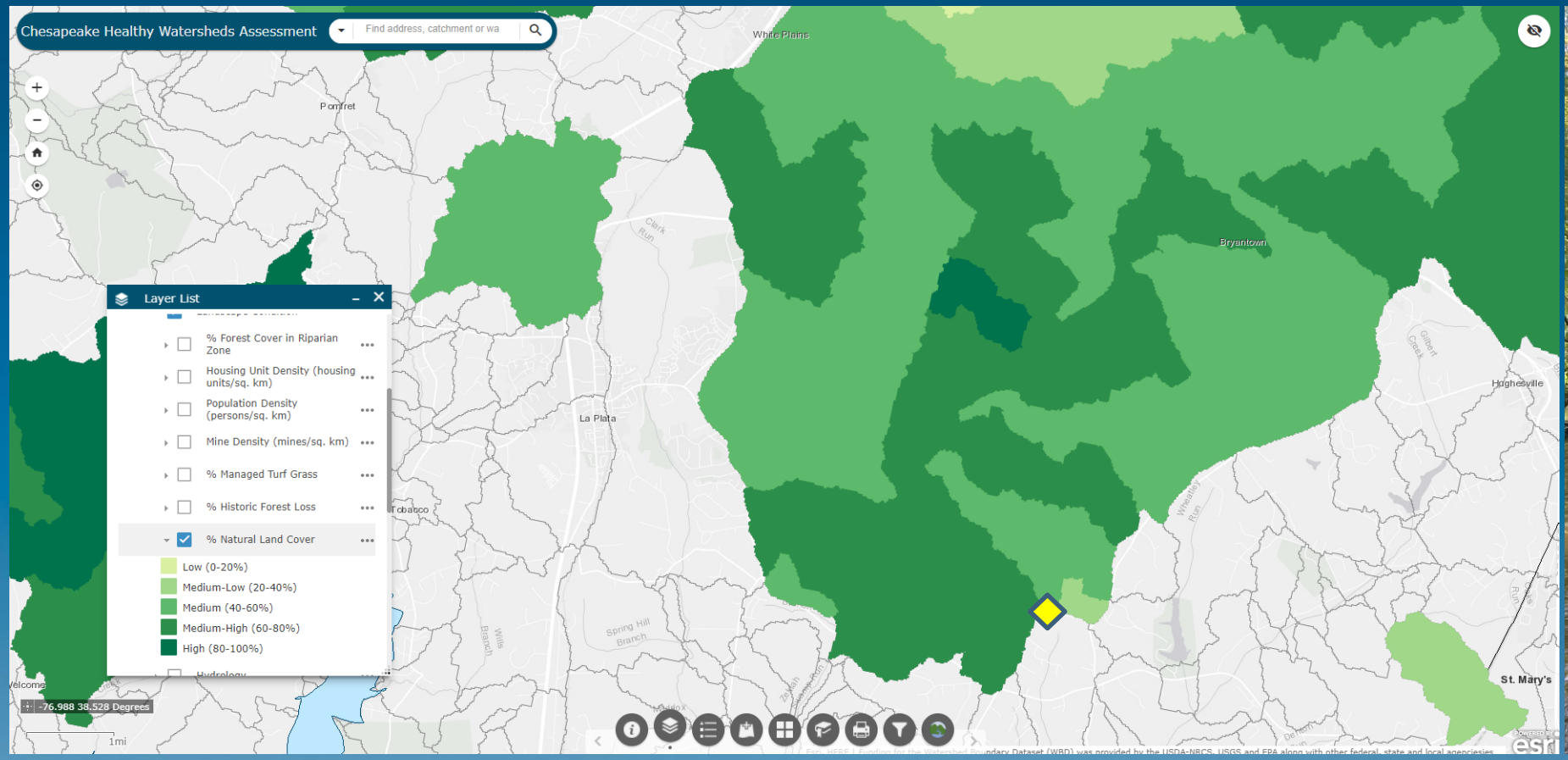
Climate Change

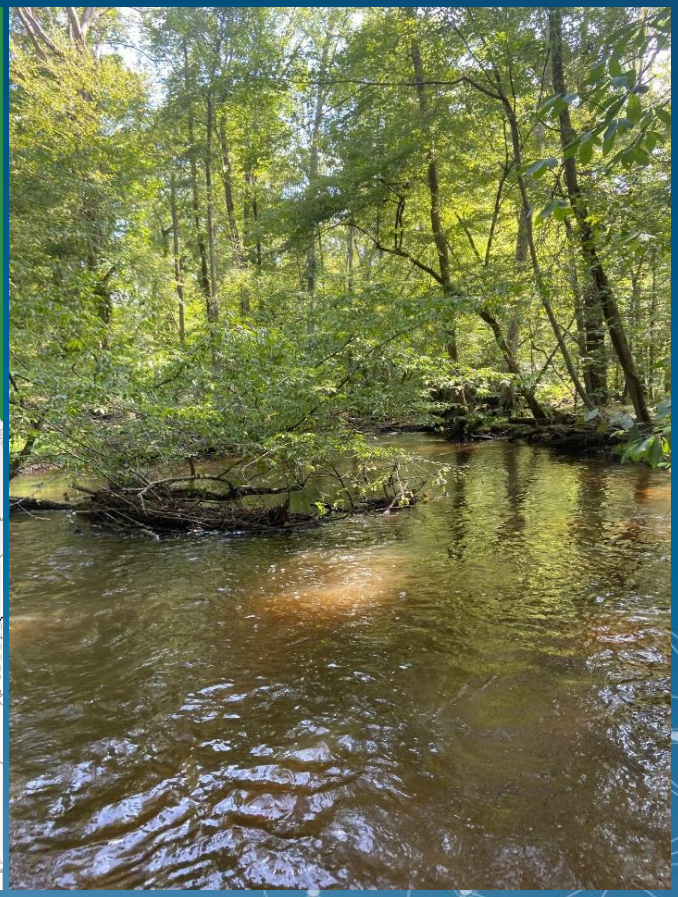
Metric values

- Brook Trout Occurrence – current (Catchment)
- Change in Probability of Brook Trout Occurrence with 6 C Temperature change (Catchment)
- NALCC Climate Stress Indicator (Catchment)

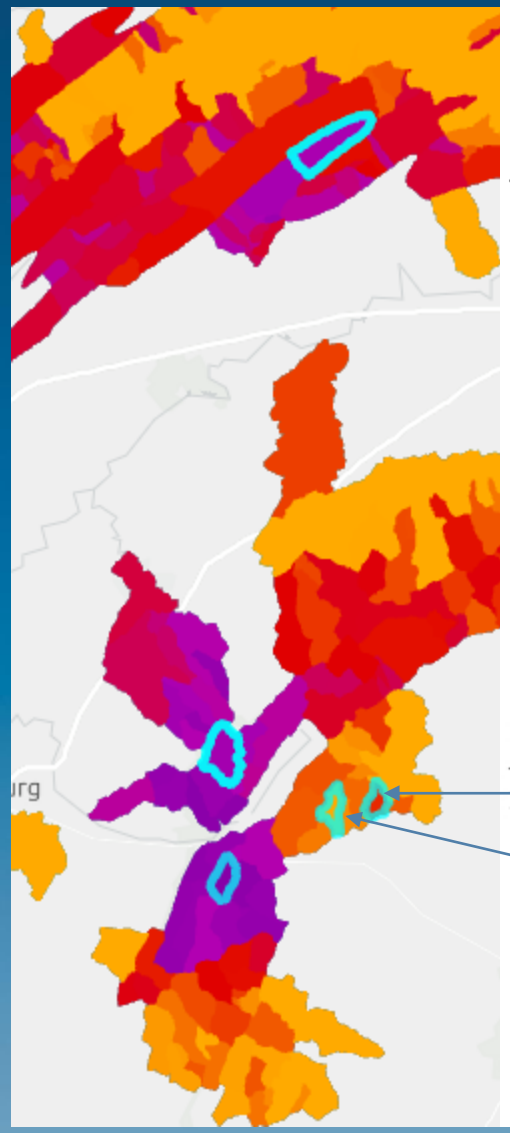
https://gis.chesapeakebay.net/healthywatersheds/imagemaps/vulnerabilityindex.html

Example: Zekiah Swamp

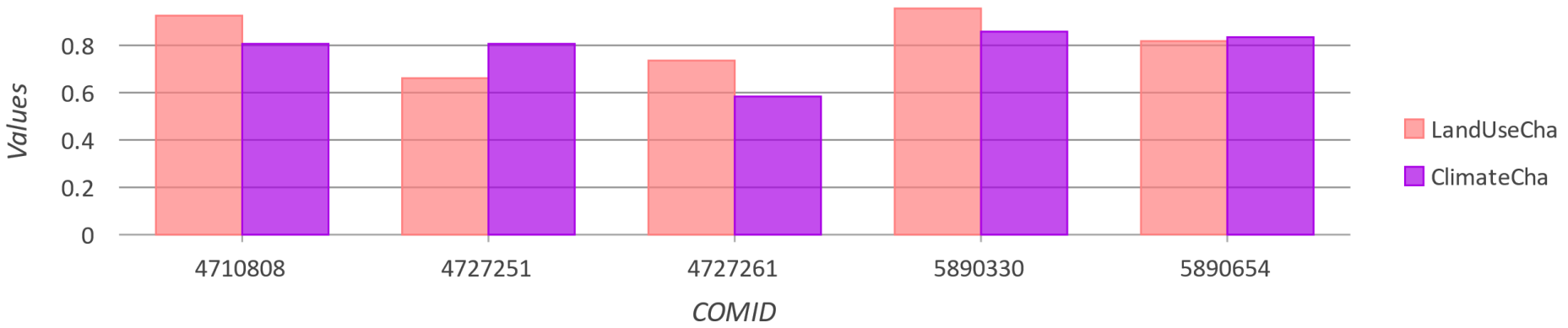




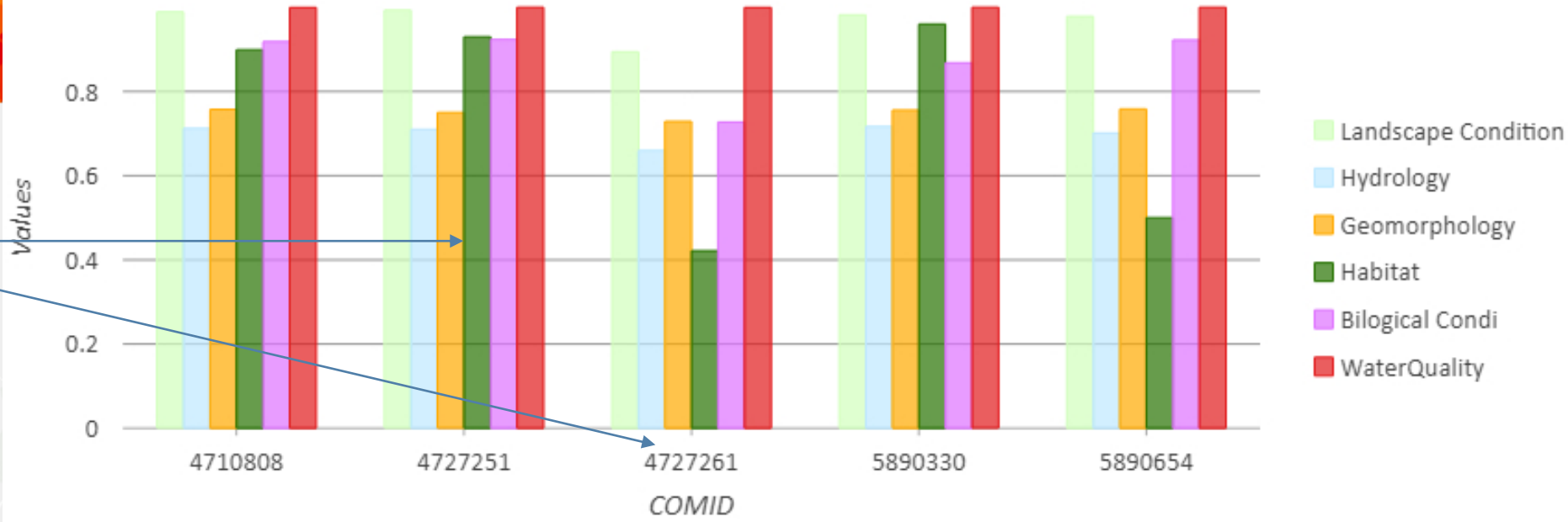
CHWA Metric: % Natural Land Cover

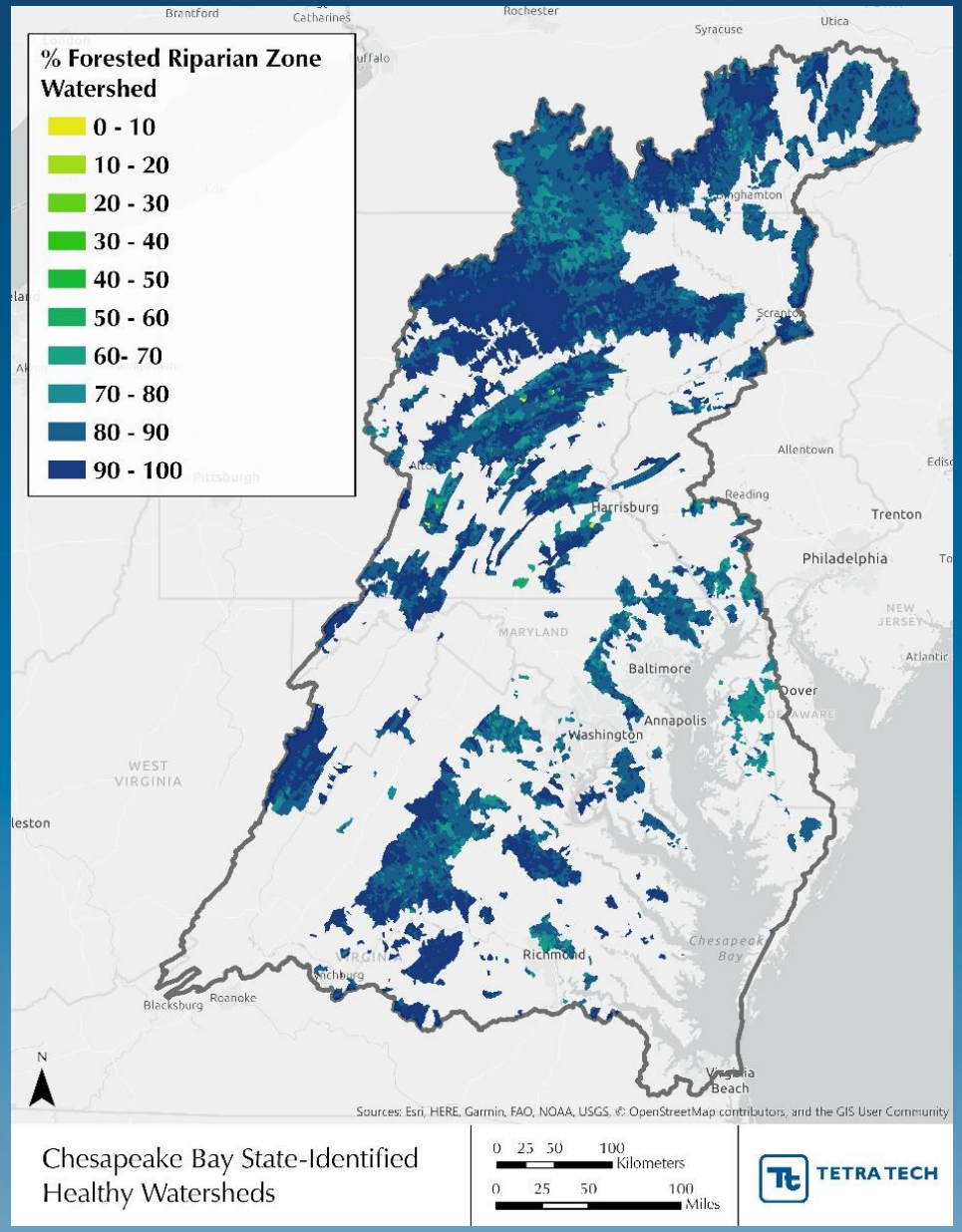


Vulnerability Sub-Indices



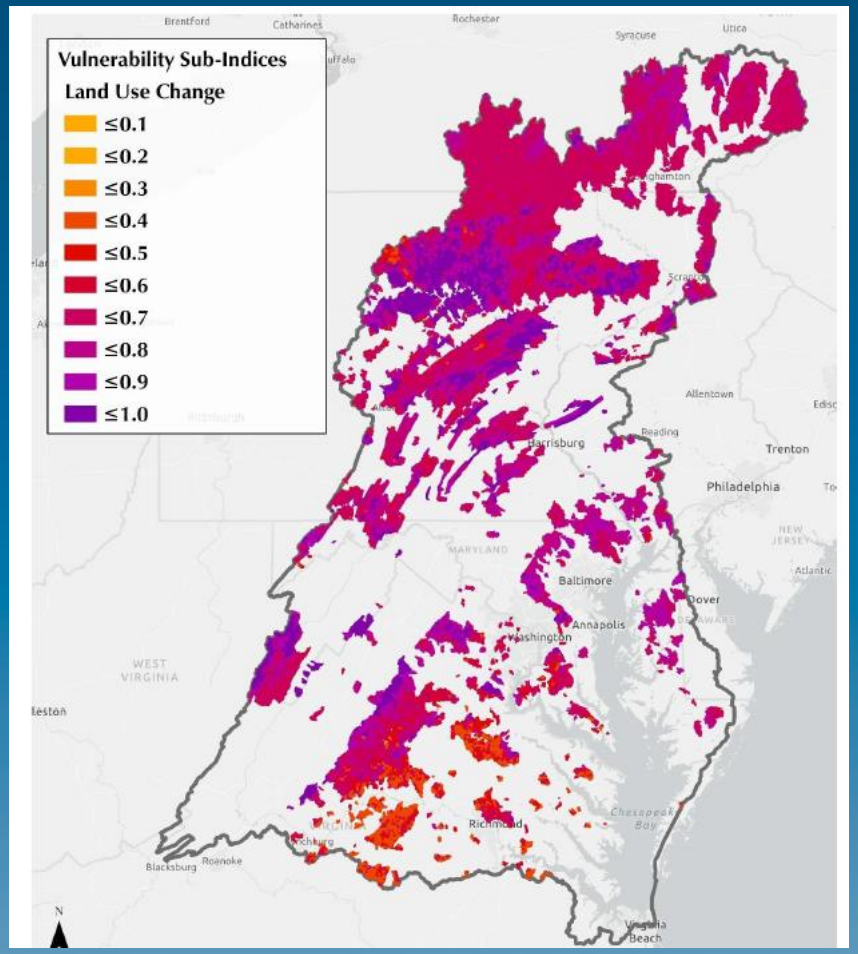
Watershed Health Sub-Indices

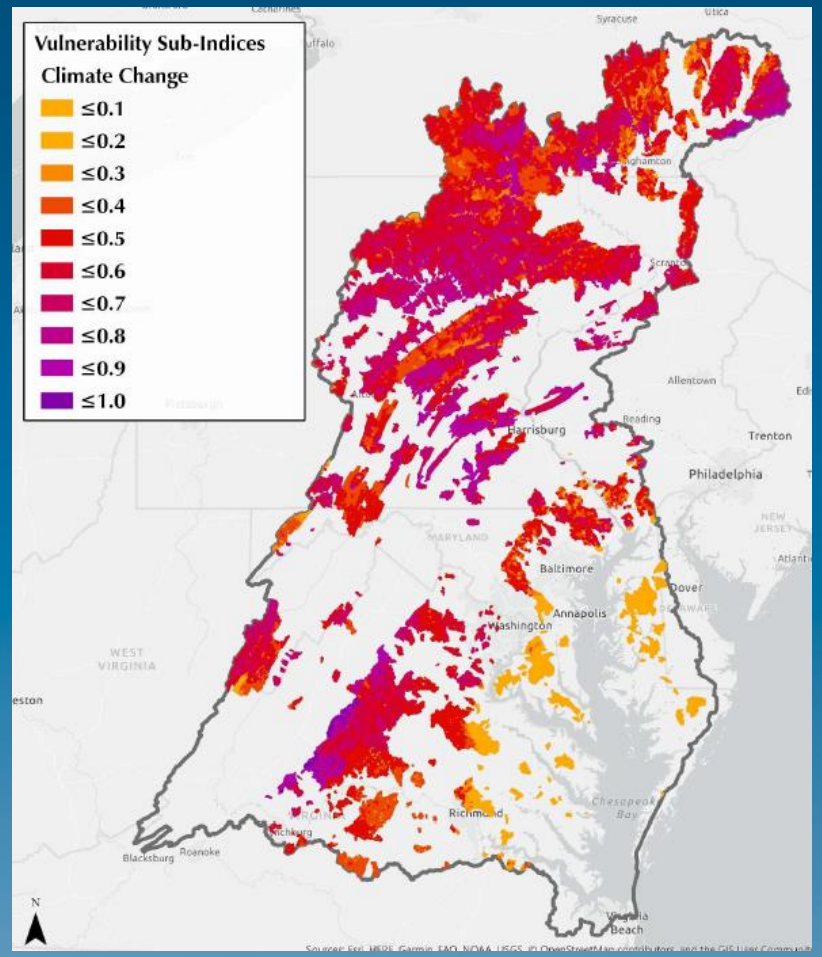




Example Landscape Condition Metric:

Percent Forest in Riparian Zone





LAND USE CHANGE AND CLIMATE CHANGE

VULNERABILITY METRICS

Chesapeake Bay State-Identified Healthy Watersheds

0 25 50 100 Kilometers

0 25 50 100 Miles

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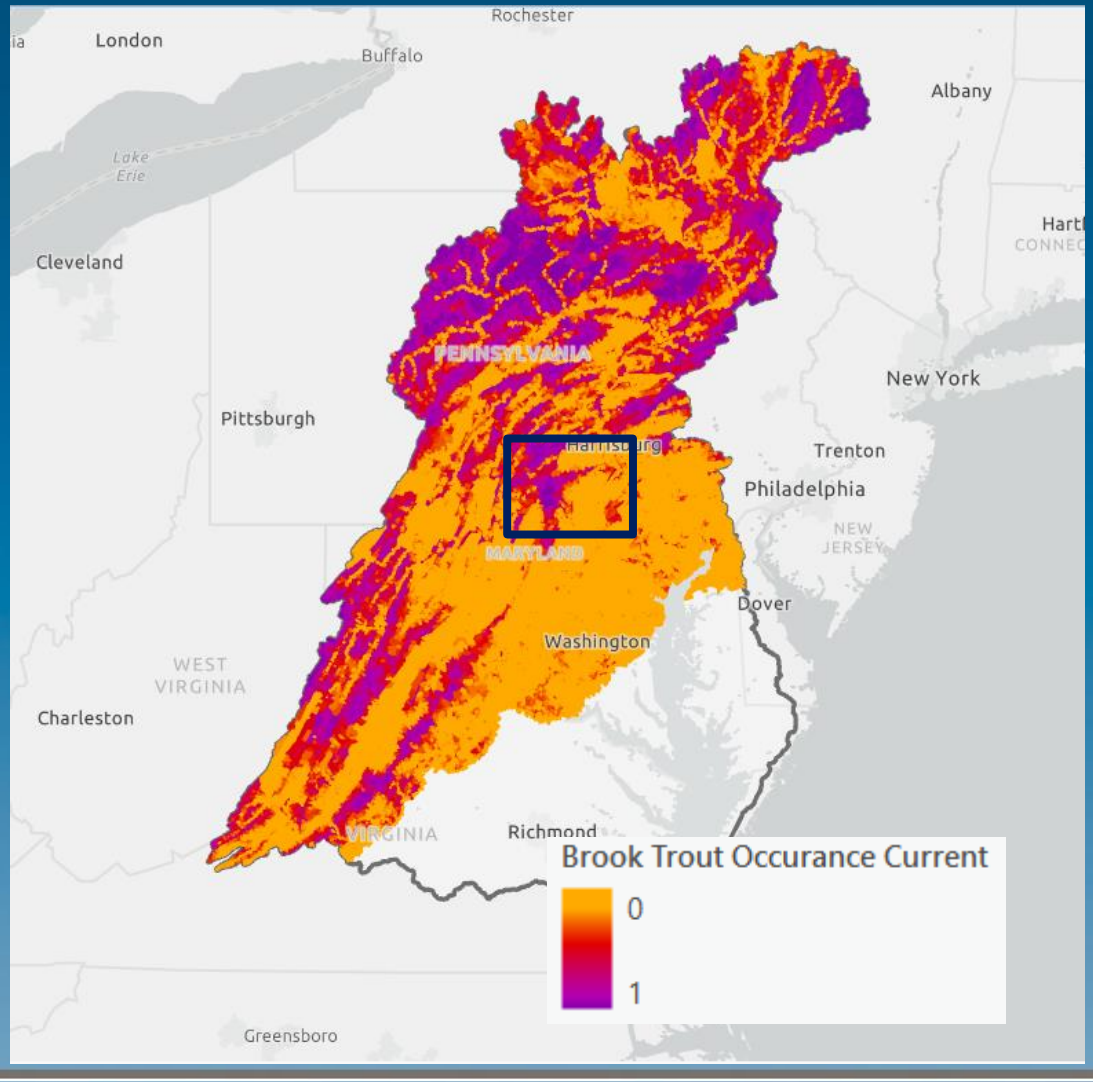
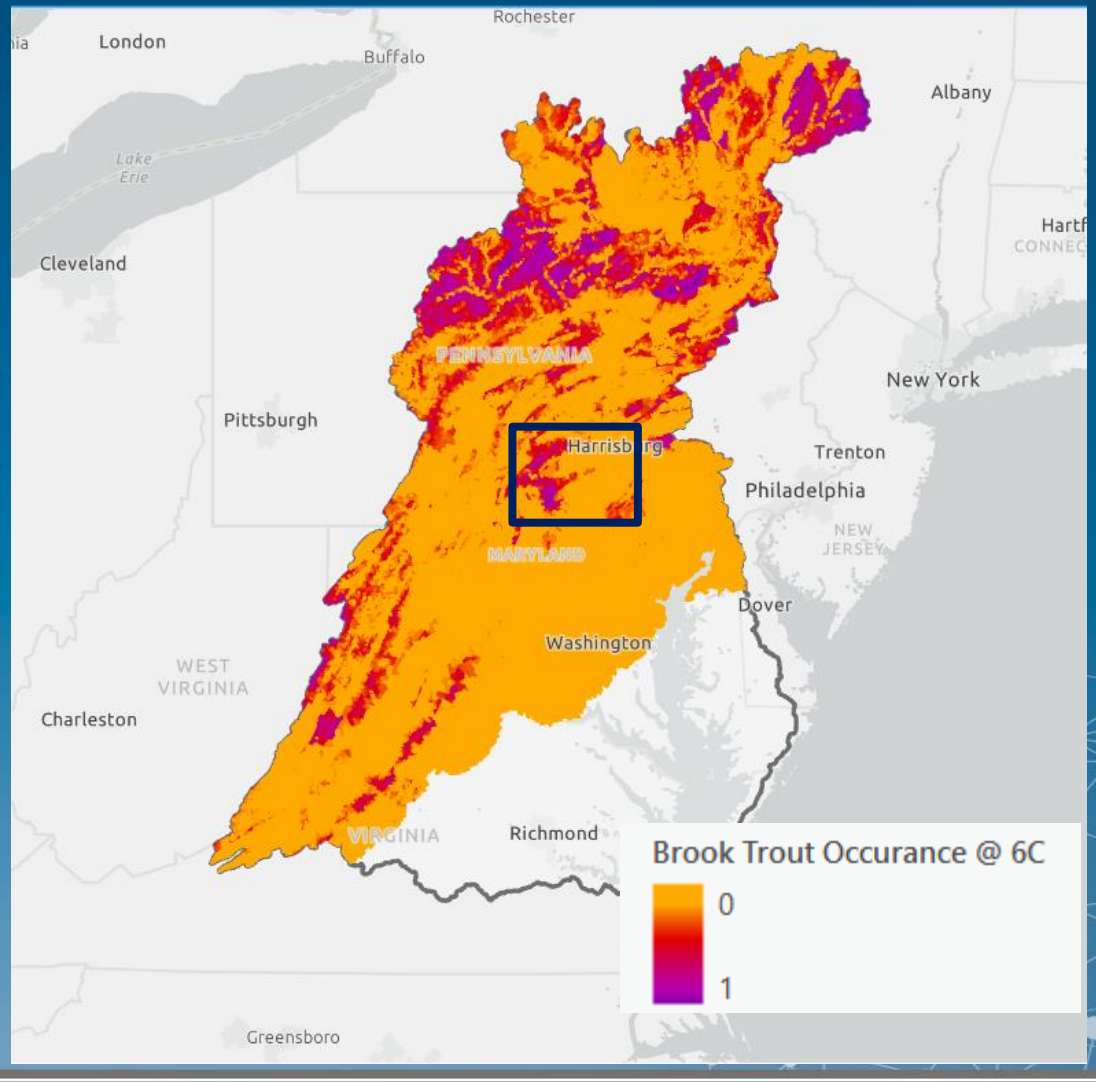
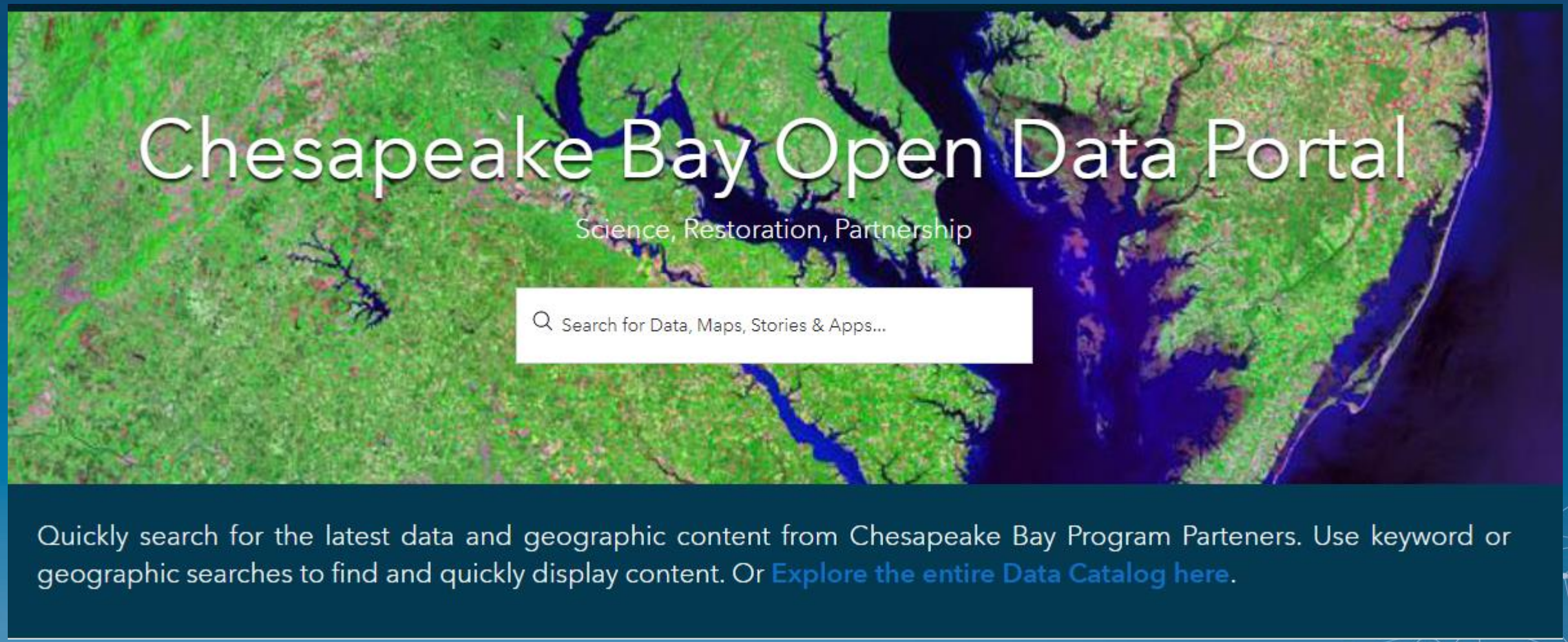
Current Brook Trout vs Brook Trout 6 degree C increase







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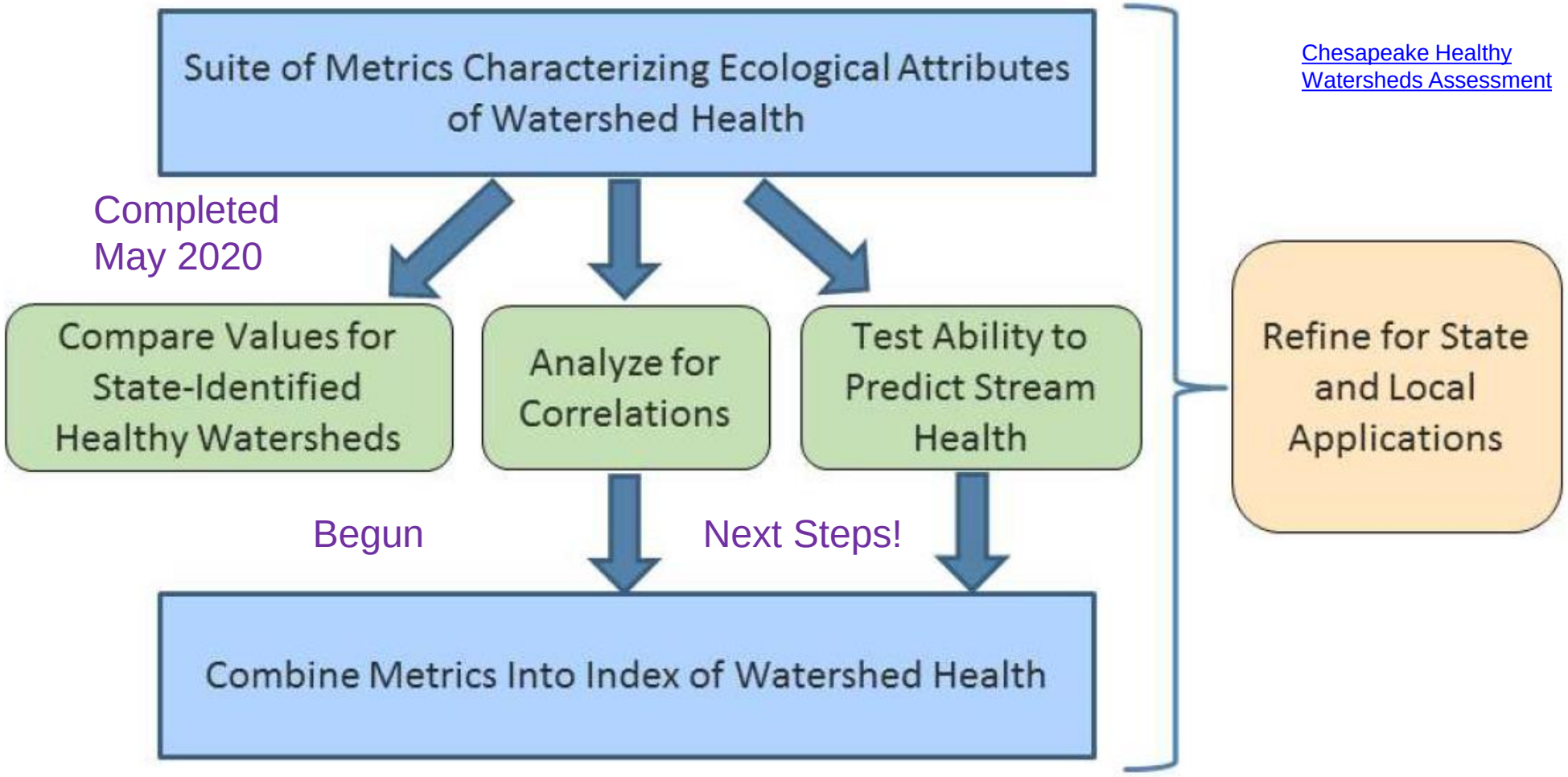

[Chesapeake Healthy Watersheds Assessment]

Figure 10: Exploration and refinement of metrics of watershed health. While initial analyses have been completed, additional investigations and refinement are proposed as future steps for the CHWA.

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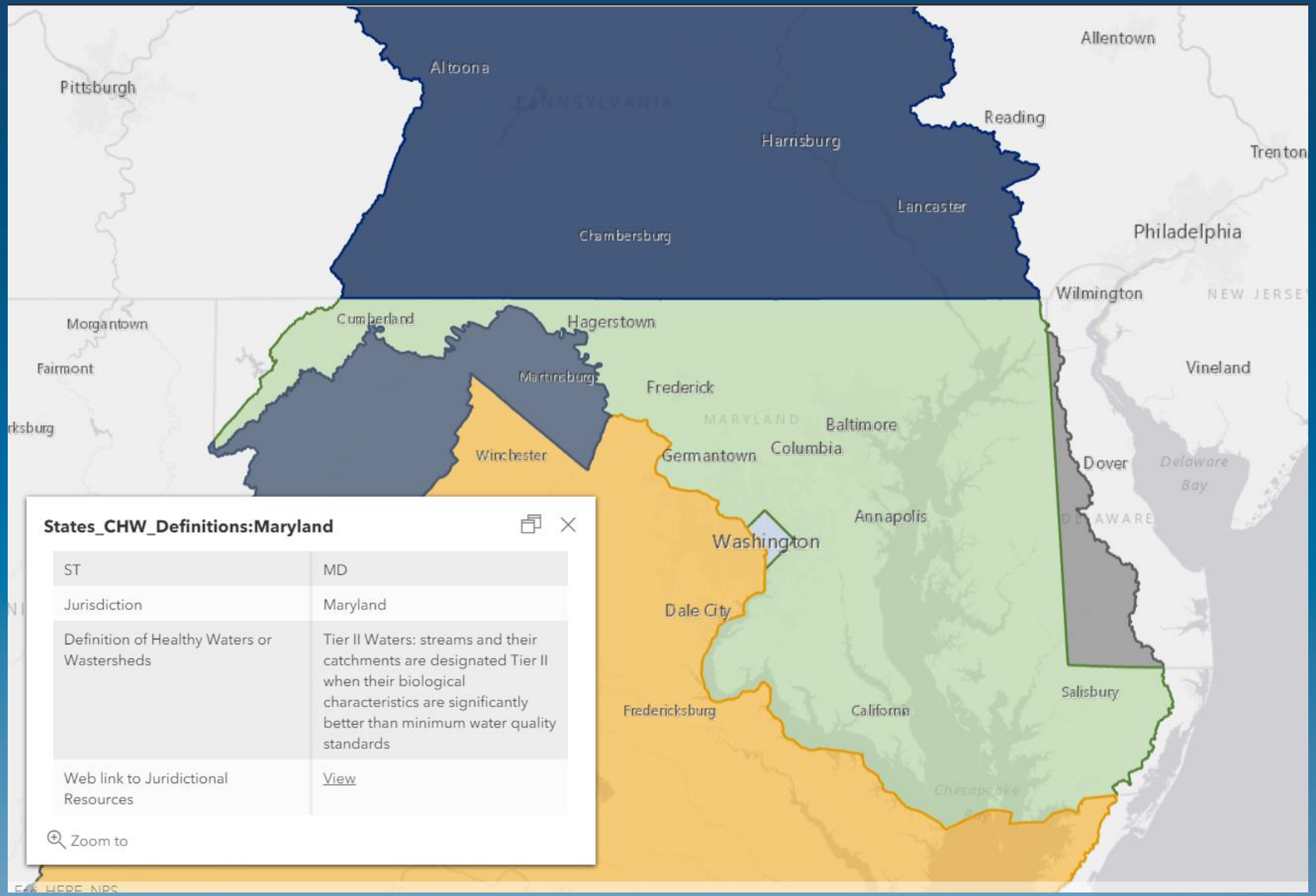
Maryland Healthy Watersheds Assessment



Implementation of Chesapeake Healthy Watersheds Assessment in Maryland's Tier II watersheds. (GIT Funding 2020-21)

Refine and customize (CHWA) for application in Maryland.

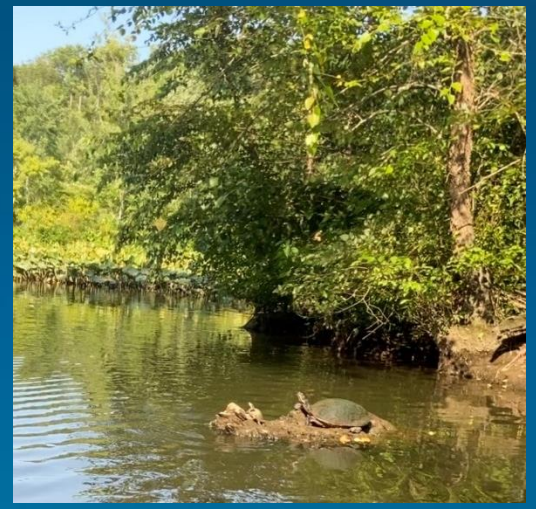
High quality streams in Maryland are classed as Tier II waters. Maryland uses an Index of Biotic Integrity (IBI) based on data from the Maryland Biological Stream Survey.

To develop indicators of stream and watershed health that are useful in Maryland, the CHWA metrics need to be statistically related to IBI scores and other diagnostic measures of stream health.

Because other jurisdictions also characterize healthy watersheds by the health of streams, the process for updating and applying more refined state-level data can be replicated in those states.

Purpose of Maryland HWA

- Refine and customize the CHWA for application in Maryland
- Evaluate statistical relationships between landscape indicators and on-the-ground (*or better yet…in-the-stream!*) diagnostic measures of stream condition
- Develop approach that can be replicated in other jurisdictions using state, local, or regional data
- Provide Maryland with new tool to manage their heathy watersheds



Applying the HWA in Maryland

Providing data to support management decision-making, particularly for maintaining the health of watersheds

- Assess current watershed condition
- Track condition over time
- Provide early warning signs – vulnerability to degradation
- Identify resiliency – ability to sustain good watershed health in spite of stressors

Process for Developing the MD HWA

Process for Developing the MD HWA

- Scientifically-based review of factors influencing MD streams
- Select candidate metrics
- Identify MD-specific data sources
- Review statistical approaches

Coordination with Core Team, Project Advisory Team, and GIT

Process for Developing the MD HWA

Create Strategy for MD HWA Development → Develop Metrics → Assess Statistical Relationships → Provide Documentation, Data, and Tools for Sharing

- Scientifically-based review of factors influencing MD streams
- Select candidate metrics
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- Review statistical approaches

- Gather source data
- Develop code (R, Python)
- Calculate and test metrics

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Develop Metrics

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Assess Statistical Relationships

- Evaluate predictive ability of landscape factors, related to measures of stream health

Provide Documentation, Data, and Tools for Sharing

Coordination with Core Team, Project Advisory Team, and GIT

Process for Developing the MD HWA

- Scientifically-based review of factors influencing MD streams
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- Gather source data
- Develop code (R, Python)
- Calculate and test metrics

- Evaluate predictive ability of landscape factors, related to measures of stream health

- Report
- Geodatabase
- Manual
- Video tutorial
- iMAP integration

Coordination with Core Team, Project Advisory Team, and GIT

Example Influencers of Watershed Health

Potential Vulnerability Metrics

Watershed Health

- Water quality – nutrient and sediment loads
- Impervious surface
- Riparian buffers
- Habitat condition
- Streambank erosion
- Flow alteration
- Landscape surrogates (e.g., urban, forest, wetland, turf)

Vulnerability

- Land use change: urbanization, forest loss
- Climate change: biological impacts
- Climate change: resilient lands, wetland adaptation areas
- Wildfire risk

Proposed New Metrics for MD HWA and Beyond

Active and Abandoned Mines, Chesapeake Conservancy, Conservation Innovation Center	Streambank Erosion, Streambank Change, and Sediment Flux (USGS Florence Bascom Geoscience Center)	Extent of Stream Miles that are Entrenched (USGS Floodplain and Channel Evaluation Tool)	Forest Interior Habitat (Peter Claggett, USGS CBP)
MBSS Stronghold Watersheds, MD DNR	Maryland Biodiversity Conservation Network (BioNet), MD Natural Heritage Program	MBSS Physical Habitat Indicator, MD DNR	Flow Alteration (Kelly Maloney, USGS Eastern Ecological Science Center, Leetown Research Laboratory)
Conductivity (Rosemary Fanelli, USGS South Atlantic Water Science Center)	Stream Impairments, Maryland Integrated Report, MDE	USGS SPARROW sector specific loads (manure, fertilizer, urban wastewater, atmospheric, septic) for TN, TP, Sediment	Maryland Fire Priority Areas, MD DNR Forest Service

Management applications of the Chesapeake and Maryland HWAs include:

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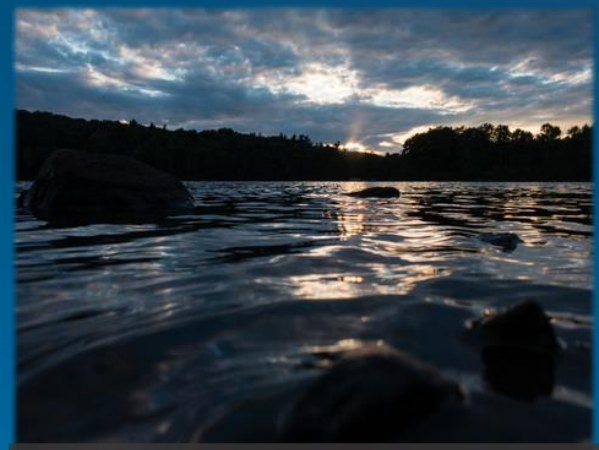
Coordination with CBP's Fish Habitat Assessments

Source water protection (drinking water)

Engagement with local governments to inform land use decisions



Assessing landscape factors affecting fish habitat in non-tidal and tidal watersheds

Identifying areas of brook trout populations susceptible to climate shifts

Examining/quantifying stressors affecting stream health (not just in healthy watersheds)

Supporting land trusts and other organizations managing protected lands

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