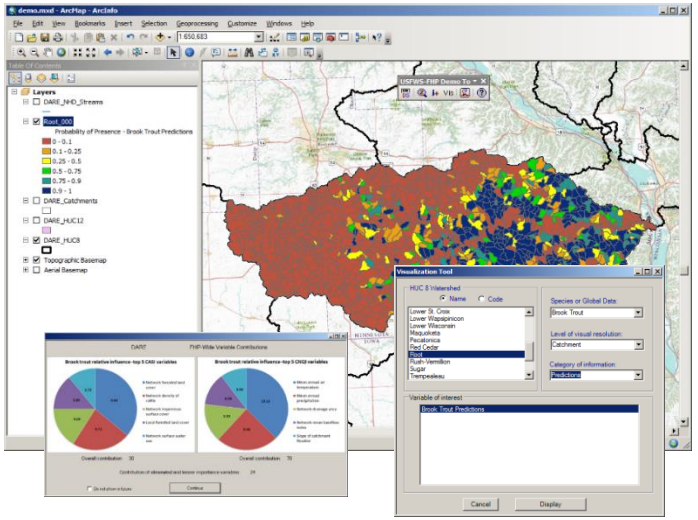
A view of stream habitats in the Chesapeake Bay from the eyes of Brook Trout

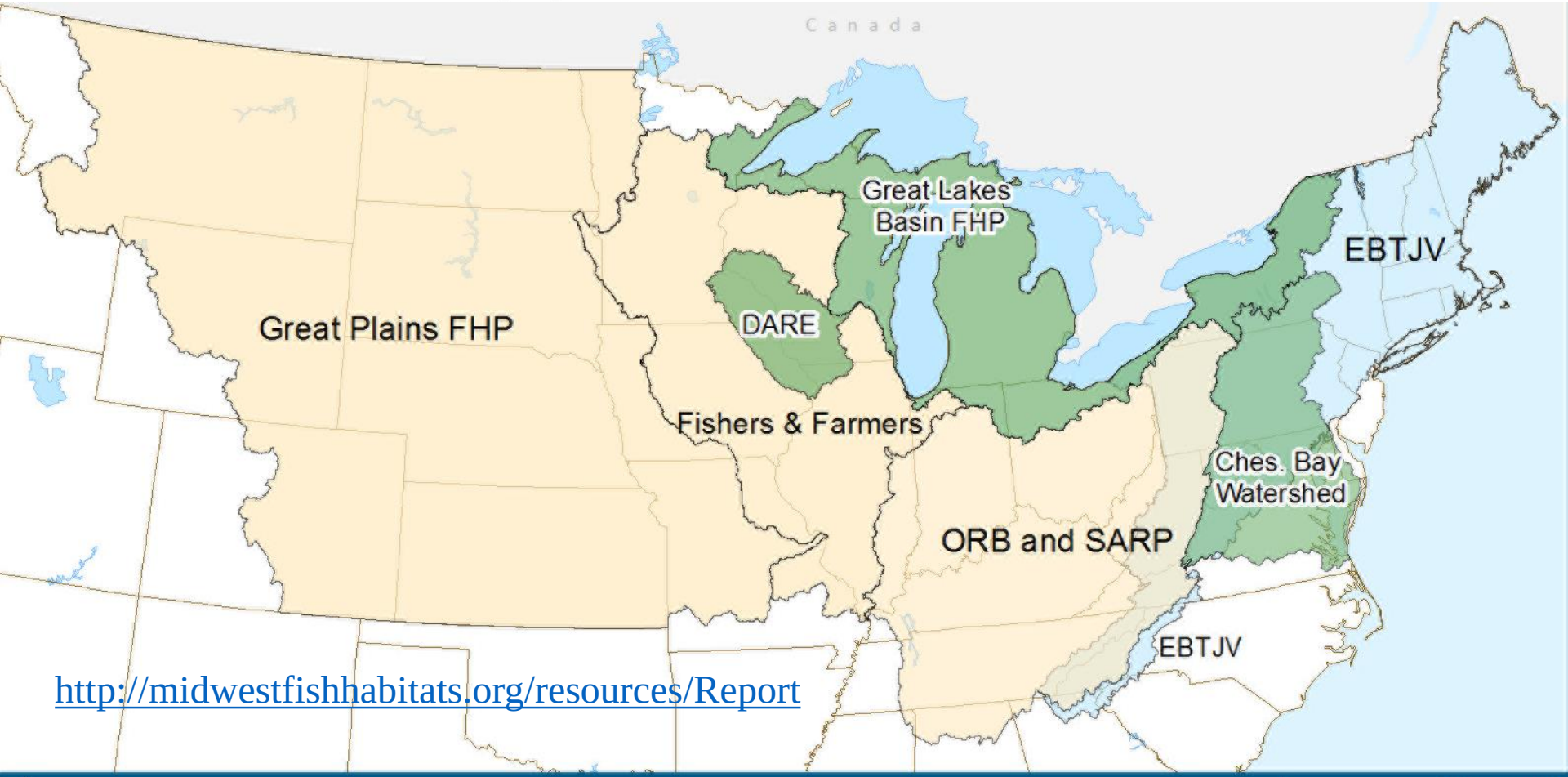


Jason Clingerman
Fritz Boettner

Todd Petty
Michael Strager

Chesapeake Bay Program – STAR – 12/4/14

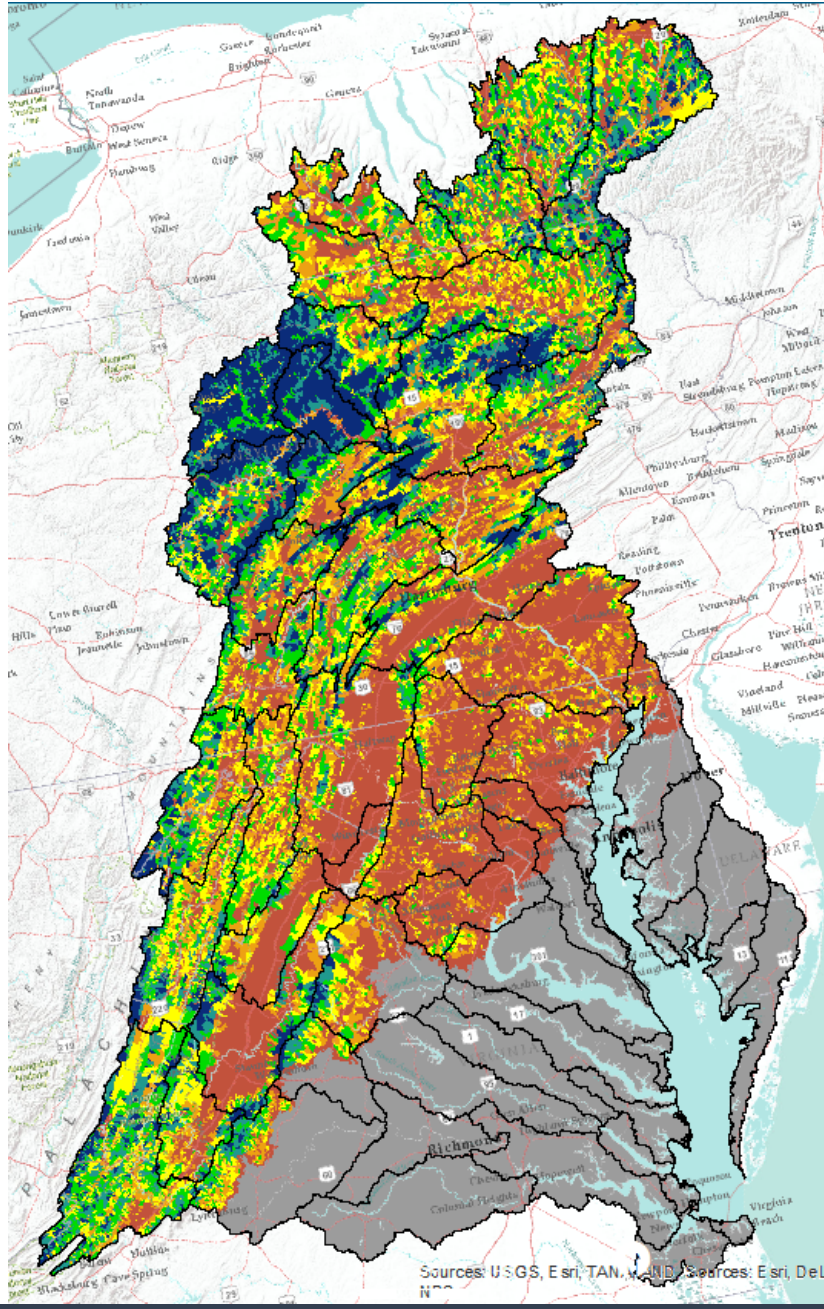
Scale of Application



http://midwestfishhabitats.org/resources/Report

Objectives

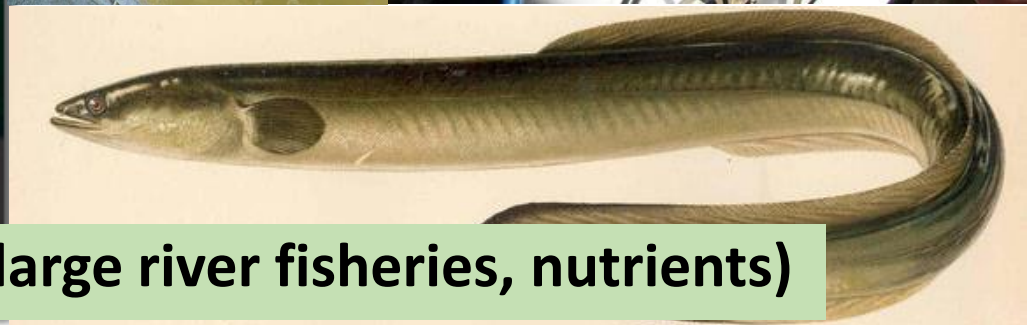
Web-based analytical system that makes use of big data and machine learning statistics to facilitate conservation decisions for the Chesapeake Bay watershed.



Current predicted likelihood of brook trout occurrence within the Chesapeake Bay watershed. Mapped at the 1:100K stream segment scale.

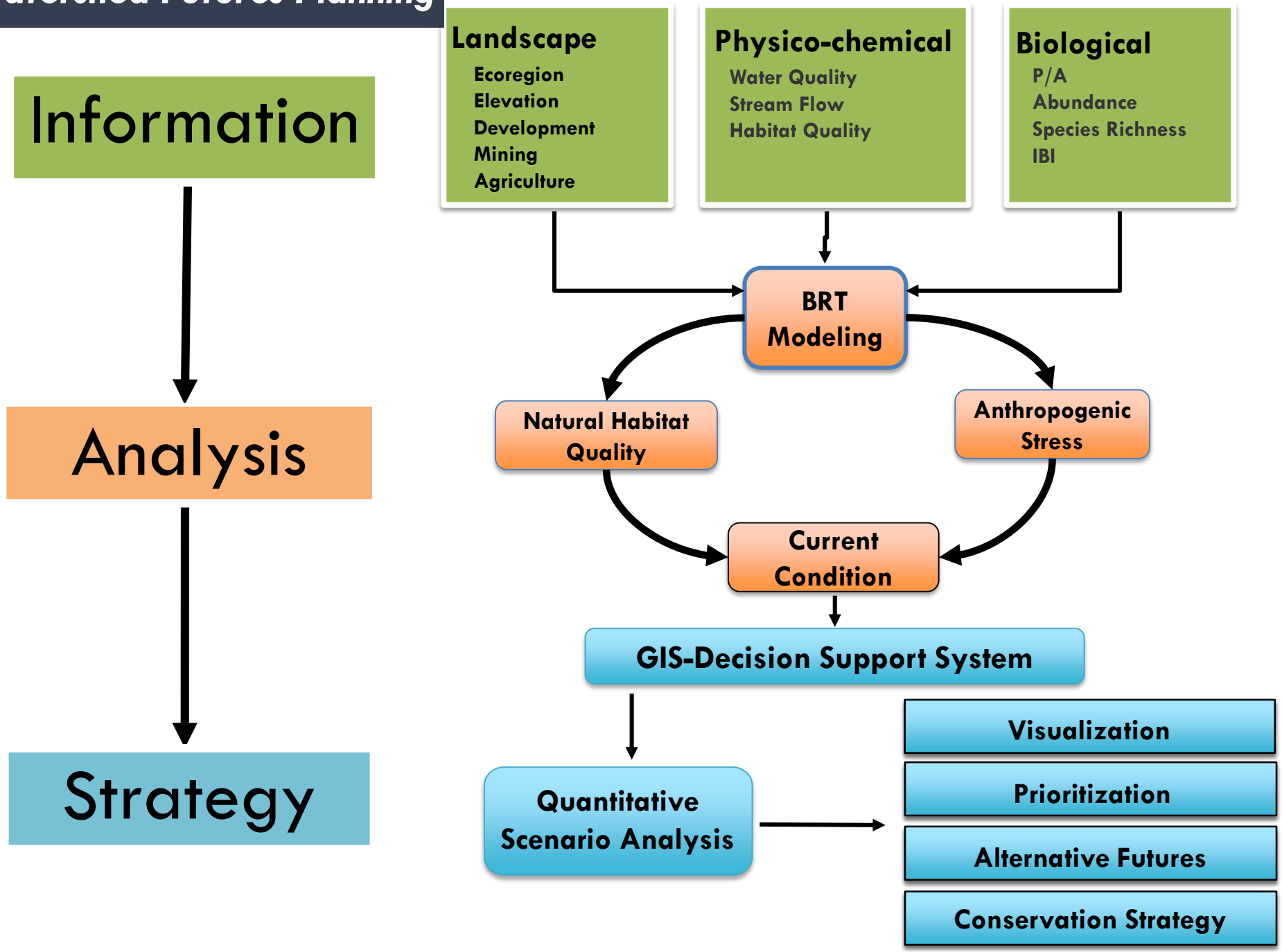
Local benefits (**brook trout habitat quality)**

Headwater Restoration

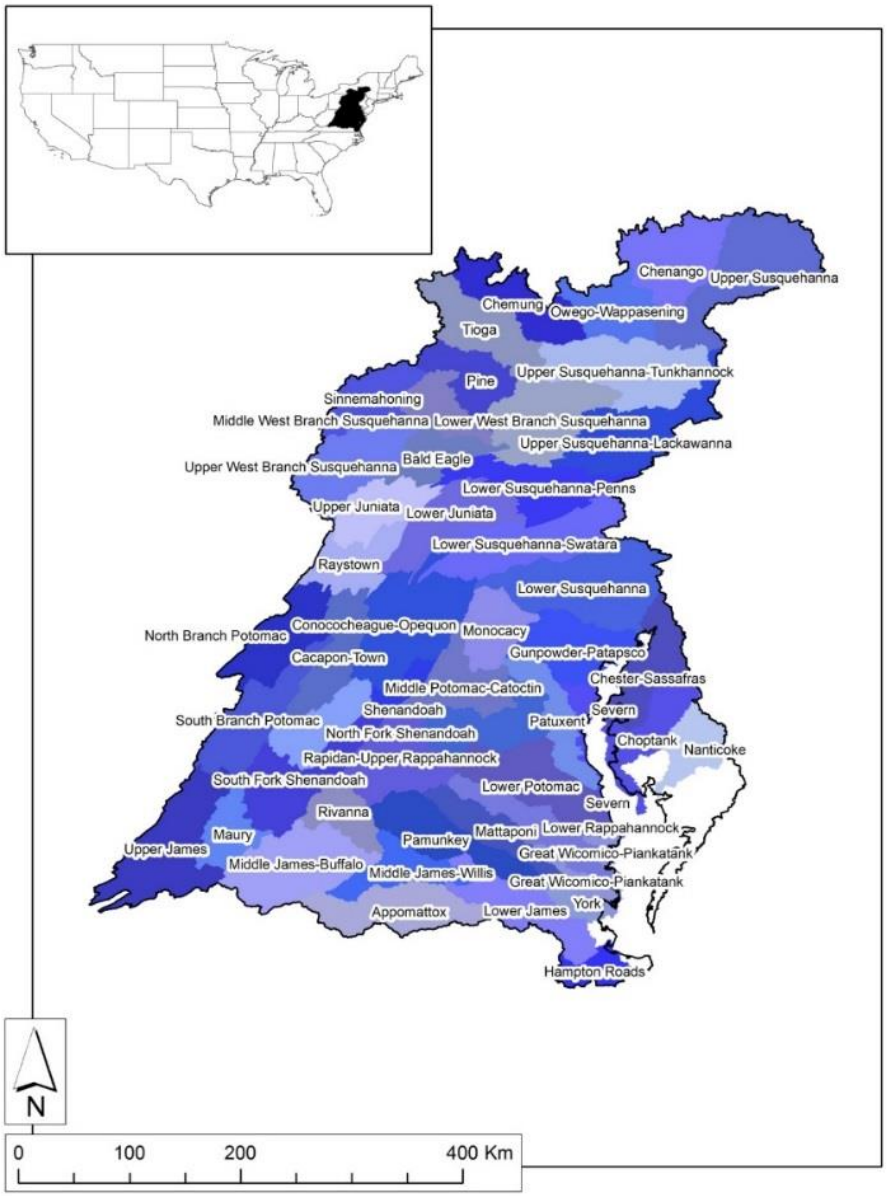


Downstream benefits (**large river fisheries, nutrients)**

Watershed Futures Planning



Land cover / Land use



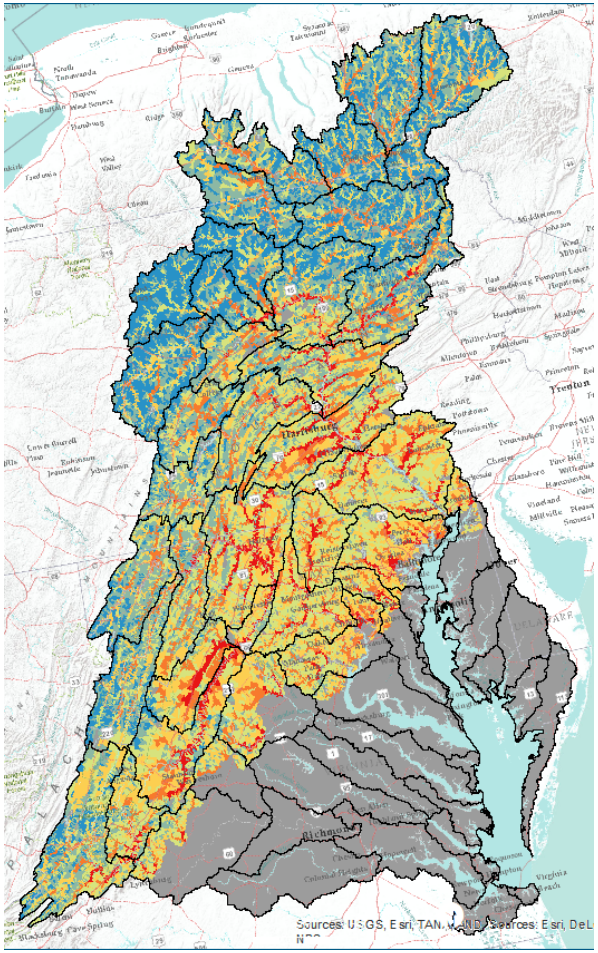
40+ HUC 8 watersheds
160+ HUC 12 subwatersheds
64,000+ stream segments

15-20 Land cover / land use data sets

- Forest
- Agriculture
- Urban
- Impervious
- NPDES permits
- Super Fund Sites
- Water withdrawal
- Mining
- Geology
- Precipitation
- EcoRegion

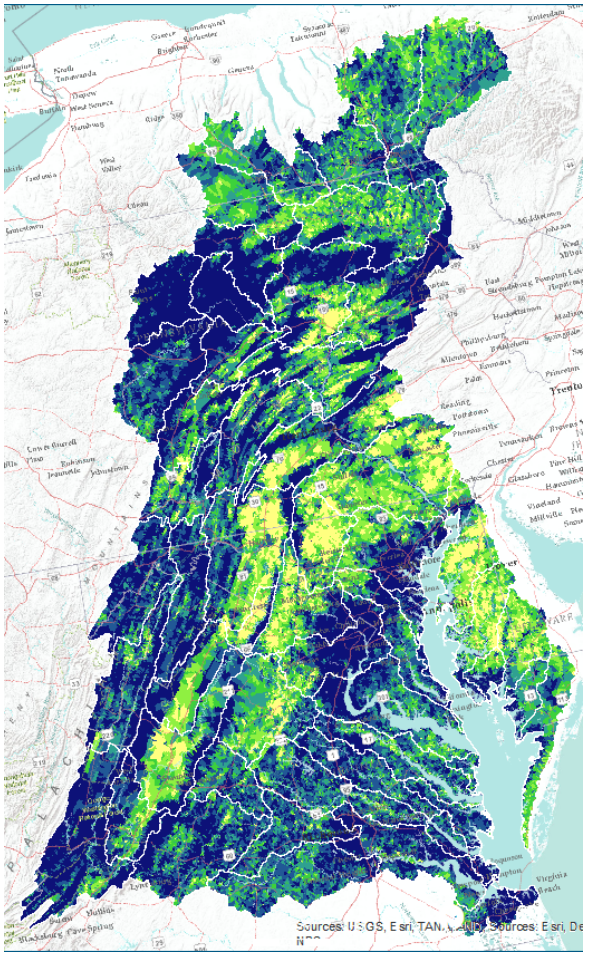
Land cover / Land use

Natural Habitat



Water Temp
Precipitation
Slope

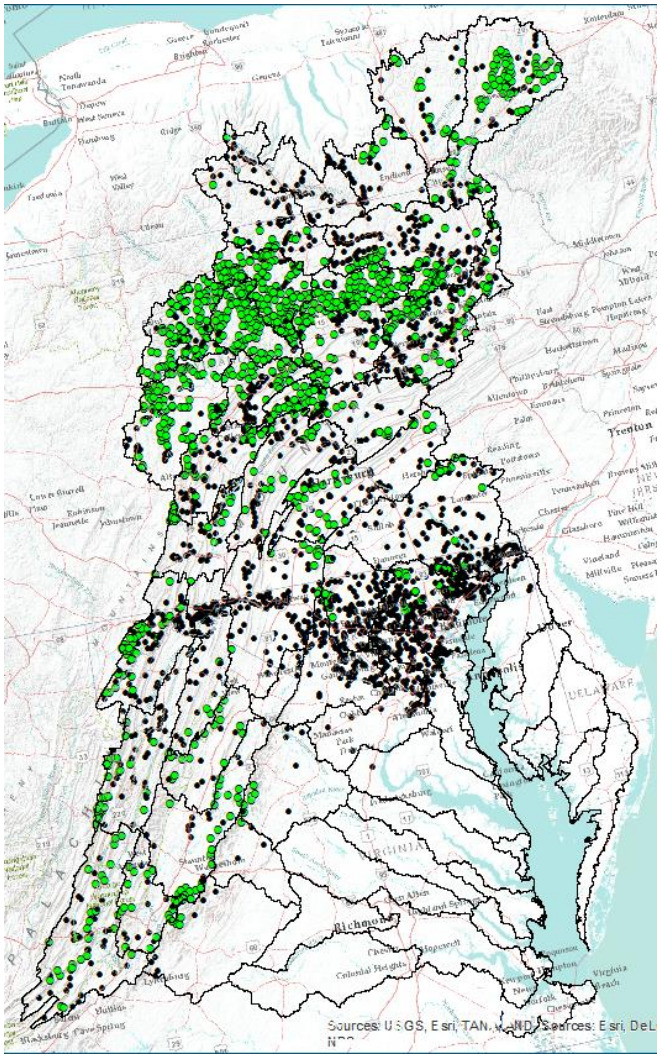
Stressors



Agriculture
Urbanization
Mining

In-stream / Biological Response

Brook trout



- 5 states
- 2,949 sample sites
- Dates – within past 10 years
- Multi-species abundance data
- Electrofishing

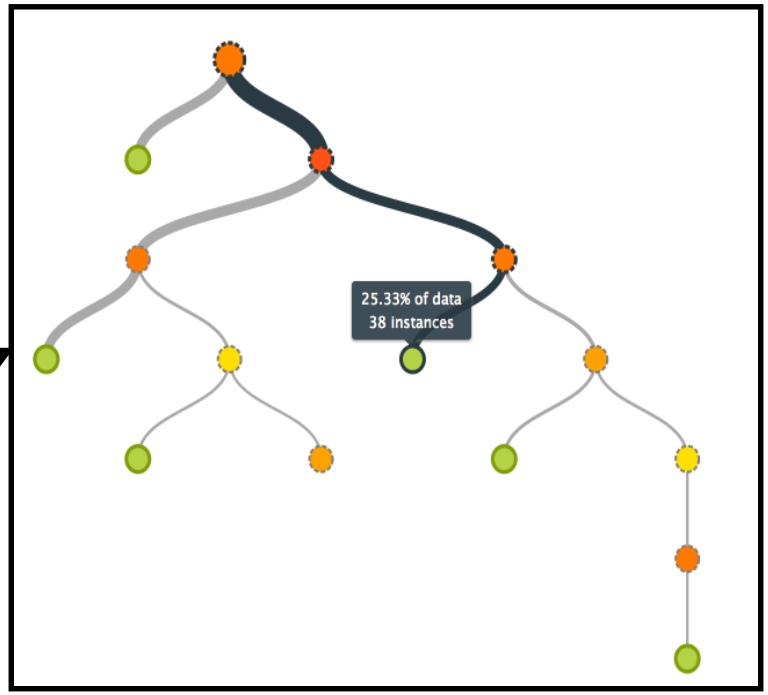
Brook Trout Present

Brook Trout Absent

Modeling approach

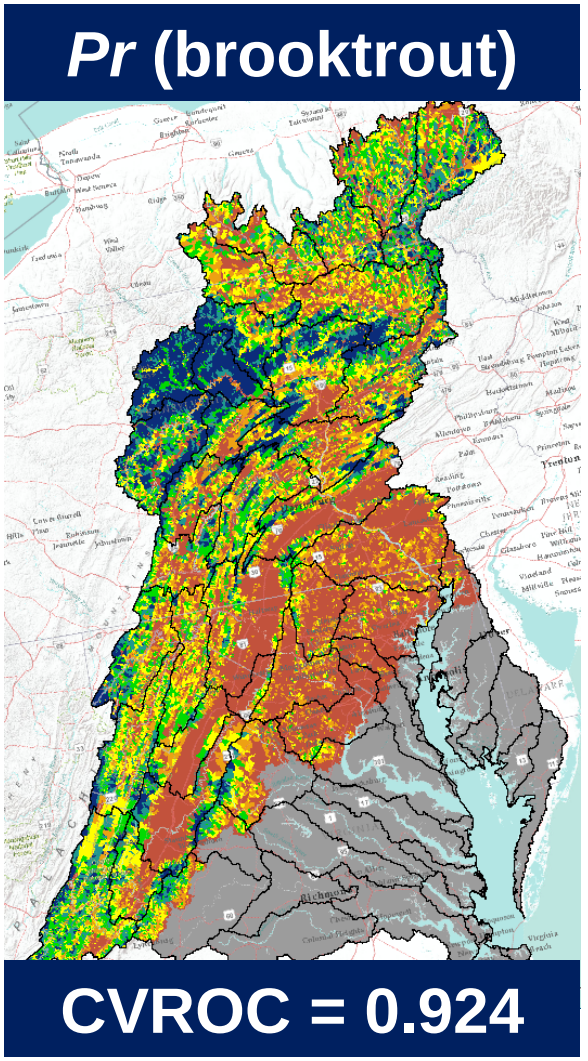
- Predict fish occurrence or abundance at segment scale
- *Pr(*occurrence) = *fn* (natural habitat, stressors)
- **Boosted Regression Trees** (Elith et al. 2009)
- Machine Learning Statistics
- Powerful and Efficient
- CART on steroids

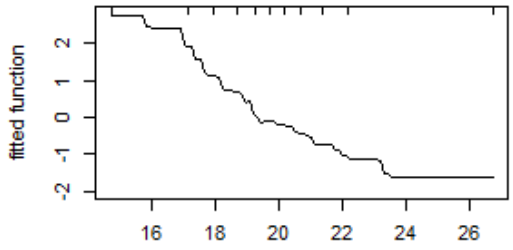
10,000s of decision trees constructed and averaged



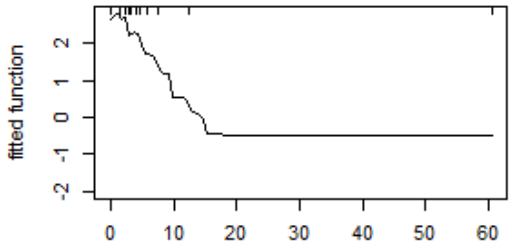
Model results –
factors that affect brook trout

	Variable description	% Effect
Natural Quality	Average July water temperature	42.7
	Network % impervious cover	21.6
	Network % agricultural cover	9.7
Stress	Segment slope	7.5
	Annual precipitation	6.6
	Local percent acidic geology	2.5
	Network percent mining cover	2.3

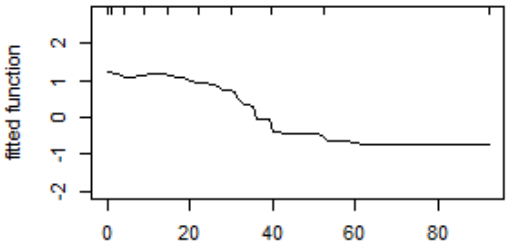




Water Temp (43%)



% Impervious (22%)



% Agriculture (10%)

Model results – habitat conditions

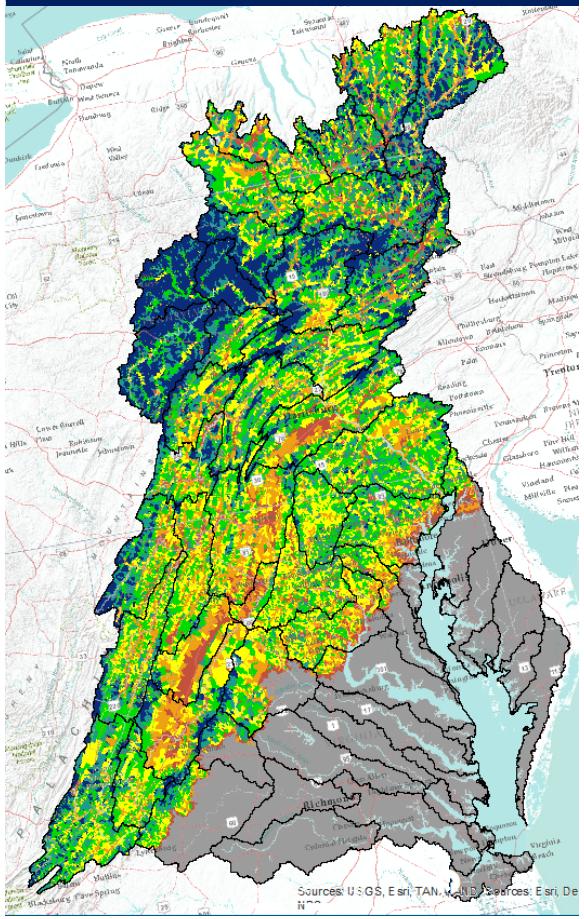
NHQI – Historic Condition

Expected occurrence of brook trout in the absence of stress given natural habitat features.

- **Water temperature**
- **Slope**
- **Precipitation**

Model results – habitat conditions

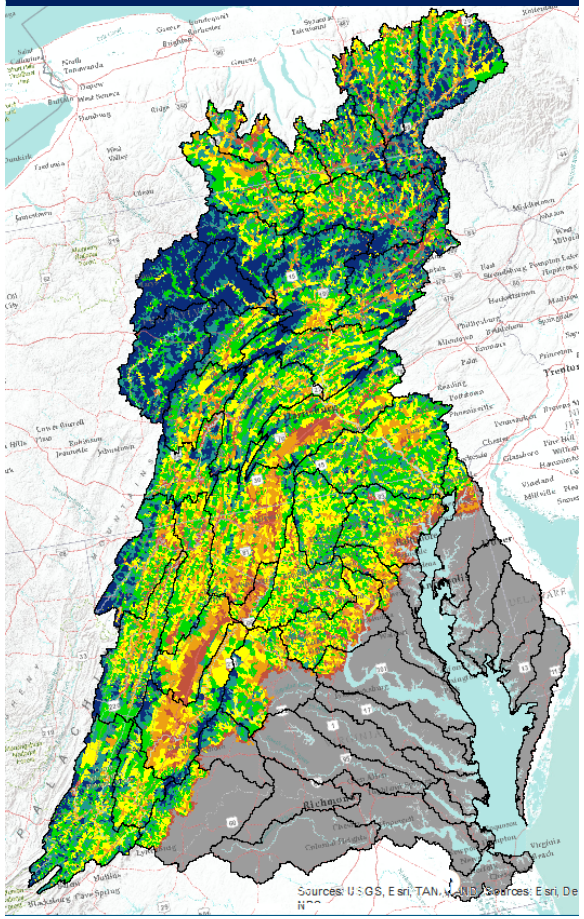
NHQI – Historic Condition



- **Water temperature**
- **Slope**
- **Precipitation**

Model results – habitat conditions

NHQI – Historic Condition



- **Water temperature**
- **Slope**
- **Precipitation**

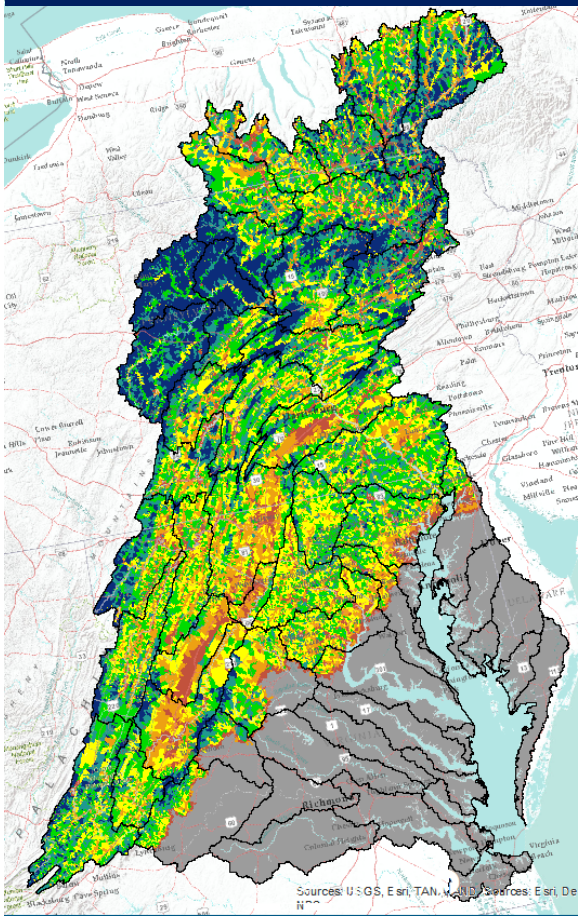
_Pr_ (brooktrout) – Current Condition

Expected occurrence of brook given natural habitat features and current levels of stress.

- **Natural habitat quality**
- **Anthropogenic stress**

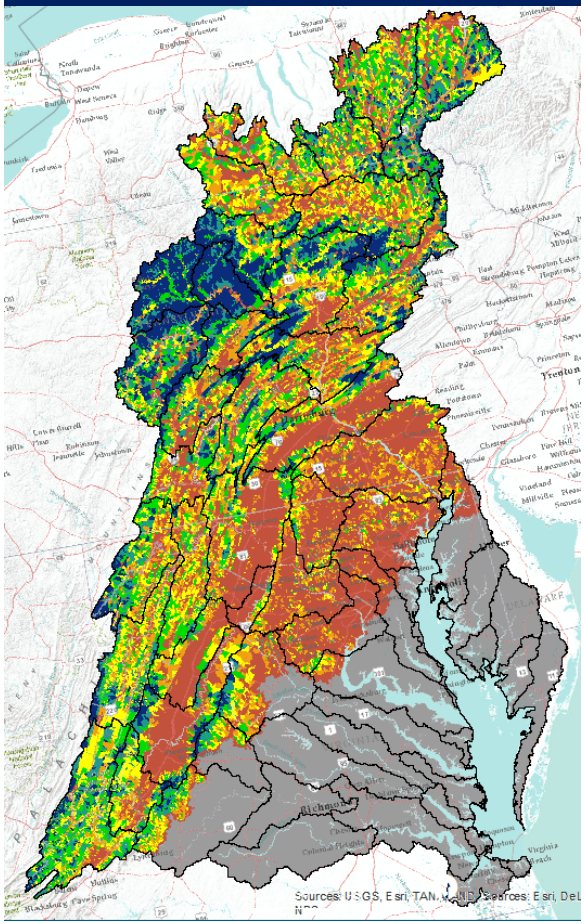
Model results – habitat conditions

NHQI – Historic Condition



- Water temperature
- Slope
- Precipitation

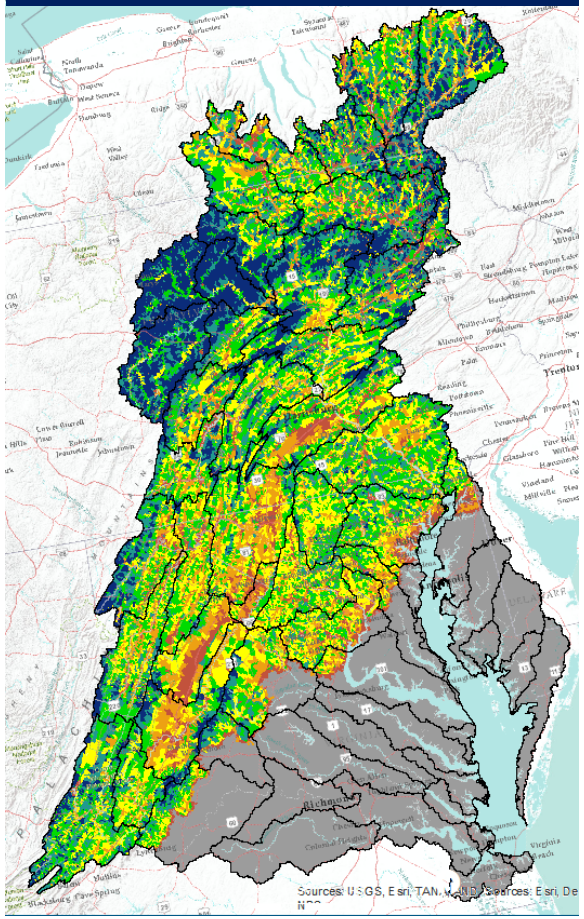
Pr (occurrence) – Current Condition



- Natural habitat quality
- Anthropogenic stress

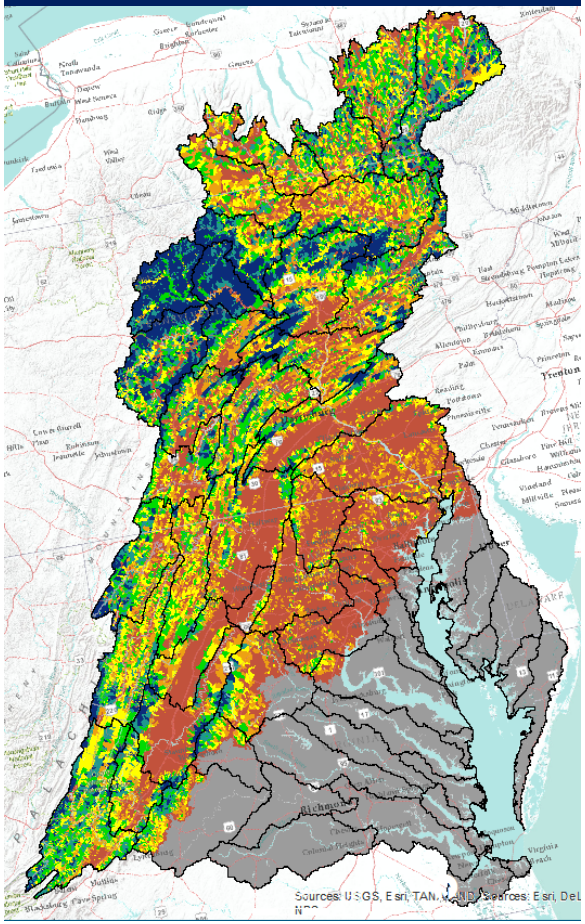
Model results – habitat conditions

NHQI – Historic Condition



- Water temperature
- Slope
- Precipitation

Pr (brooktrout) – Current Condition



- Natural habitat quality
- Anthropogenic stress

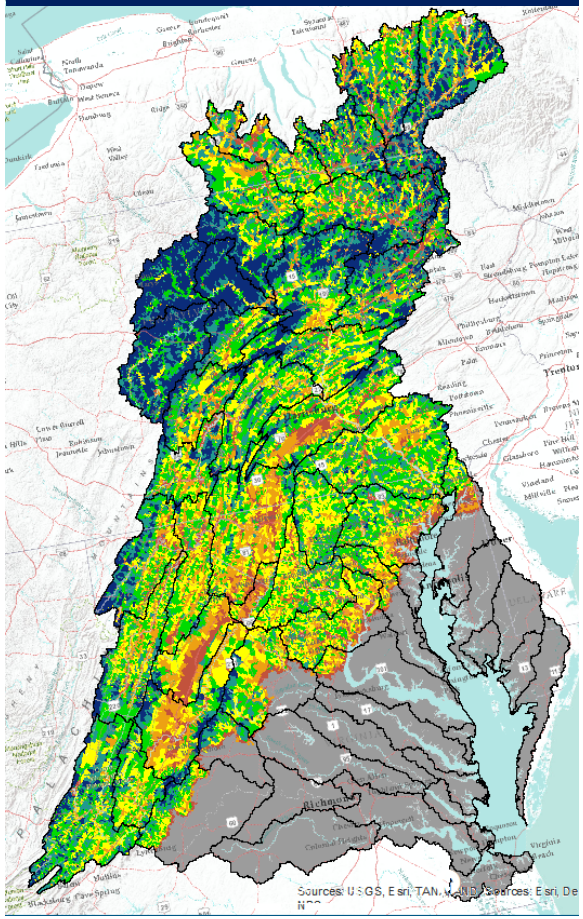
CASI – Lost Function

Change in brook trout distributions that can be attributed to stress.

- Impervious surface
- Agriculture
- Mining

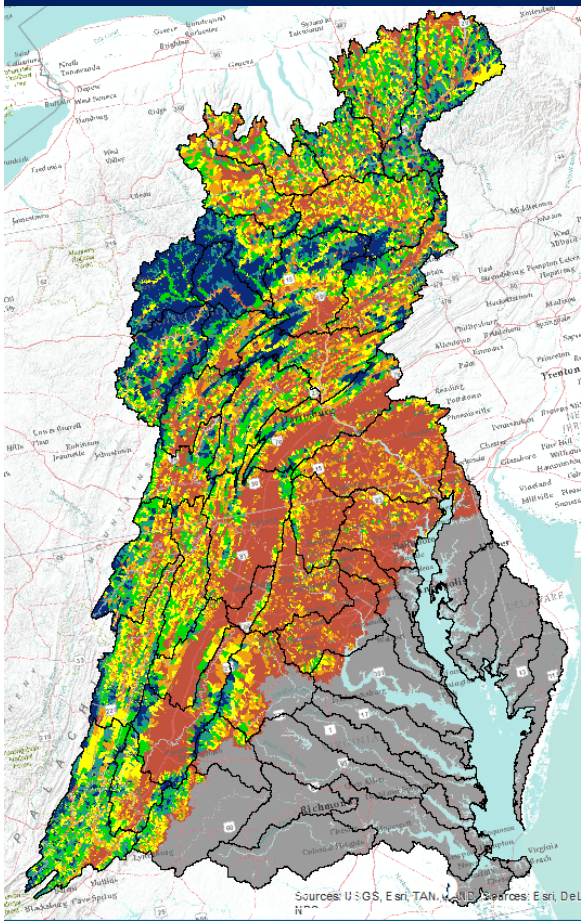
Model results – habitat conditions

NHQI – Historic Condition



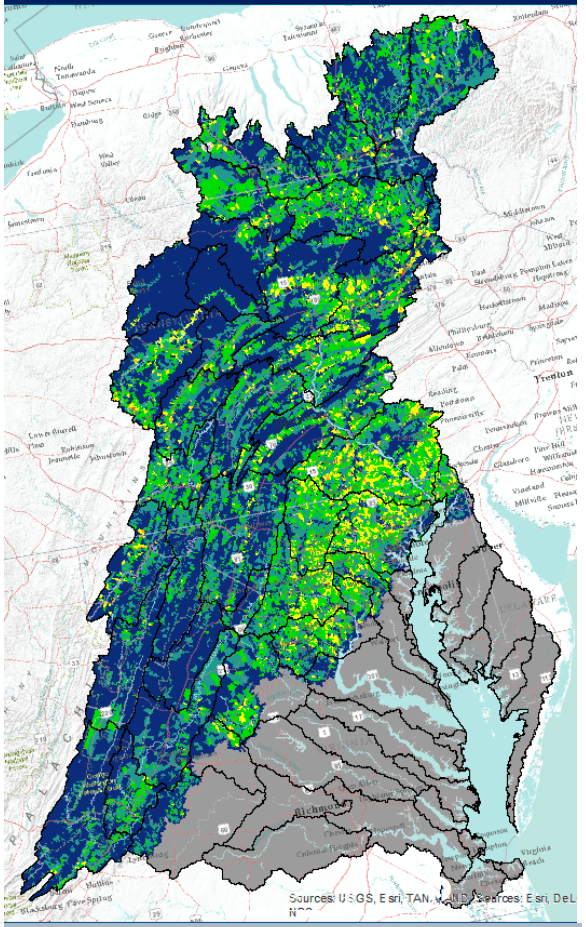
- Water temperature
- Slope
- Precipitation

Pr (brooktrout) – Current Condition



- Natural habitat quality
- Anthropogenic stress

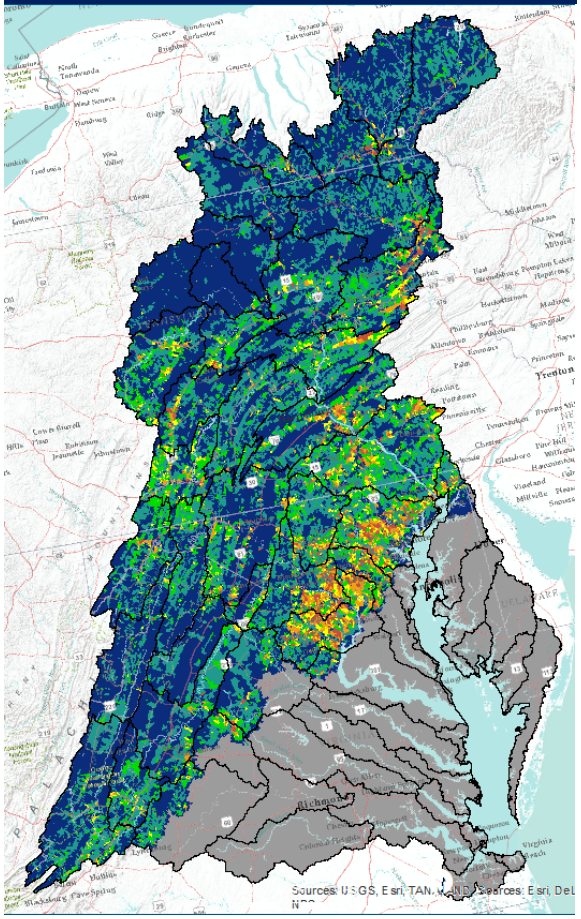
CASI – Lost Function



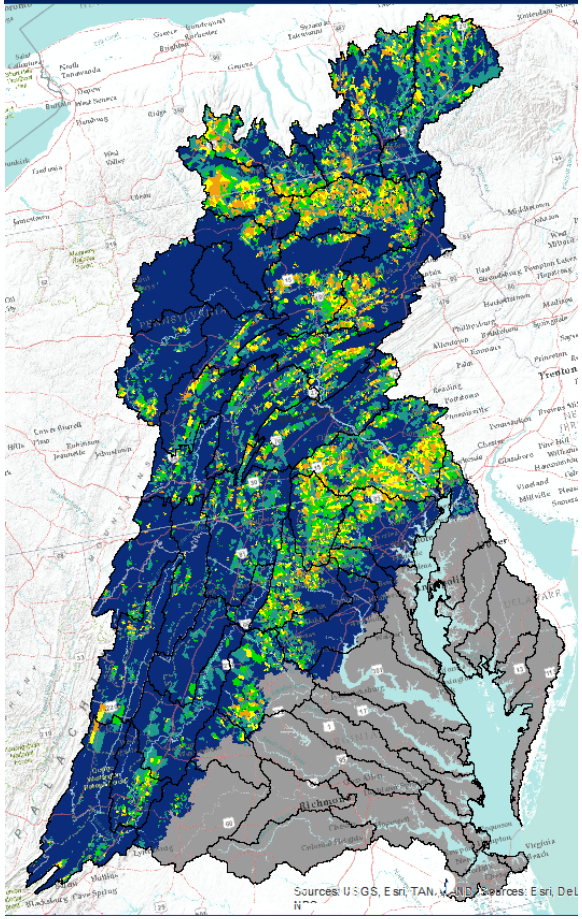
- Impervious surface
- Agriculture
- Mining

Model results – stressors

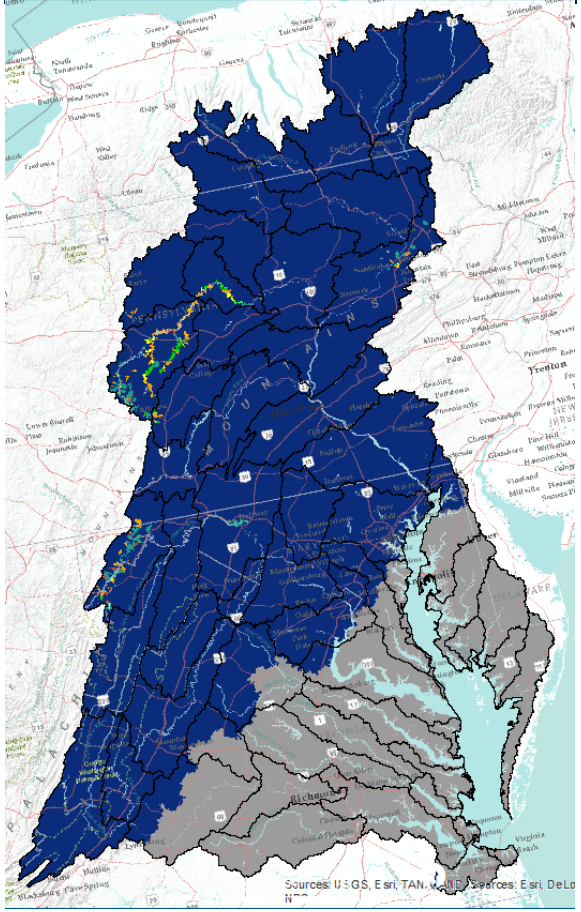
Impervious Surface



Agriculture



Mining



Web-Based Decision Support Tool

Visualization Tool

Visualize and access data sets and model outcomes at multiple spatial scales (segment and aggregated to HUC12 and HUC8).

Ranking Tool

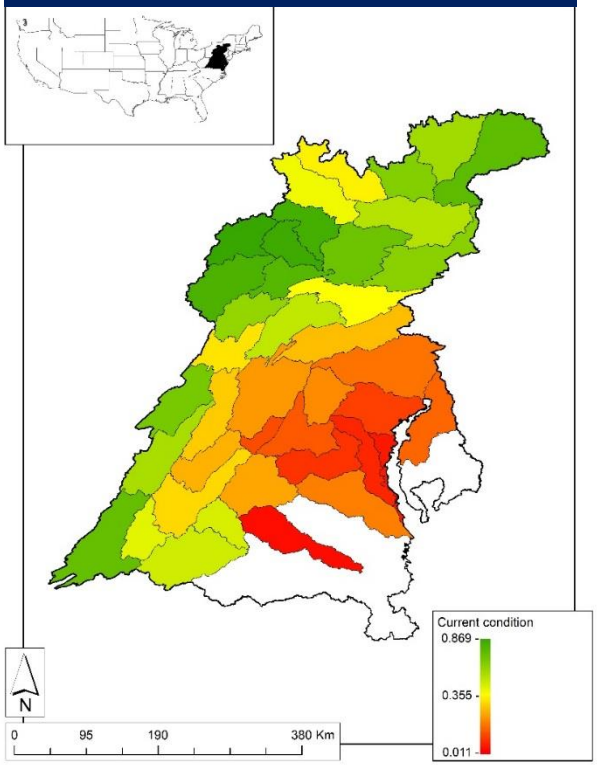
Identify restoration and protection priorities at segment, HUC12 and HUC8 scales based on user defined criteria.

Futuring Tool

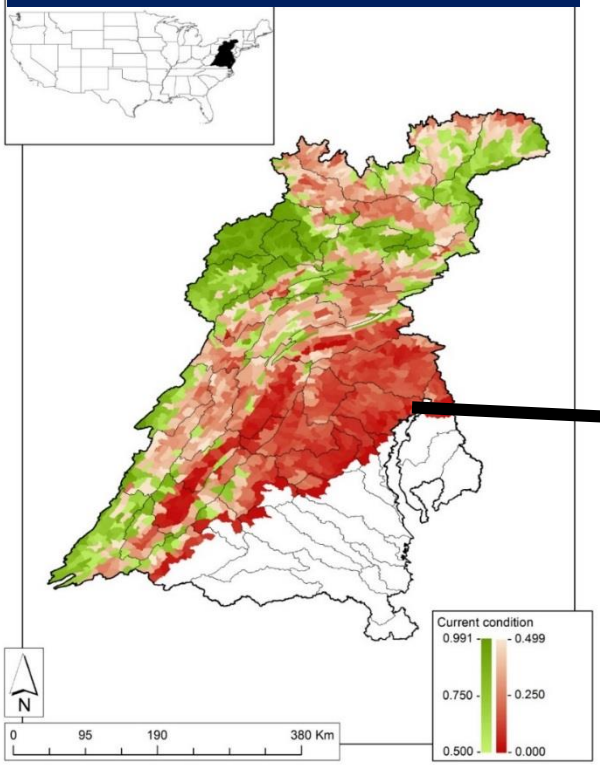
Run spatially-explicit, user defined alternative future scenario analyses. Landscape updating, climate scenarios, and BRT modeling.

Hierarchical visualization

8-Digit HUC "regions"

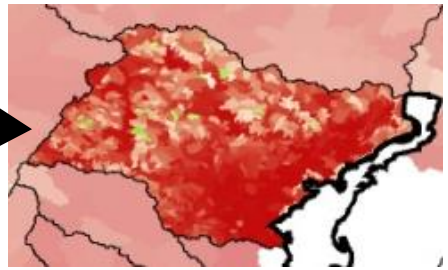


12-Digit HUC "neighborhoods"



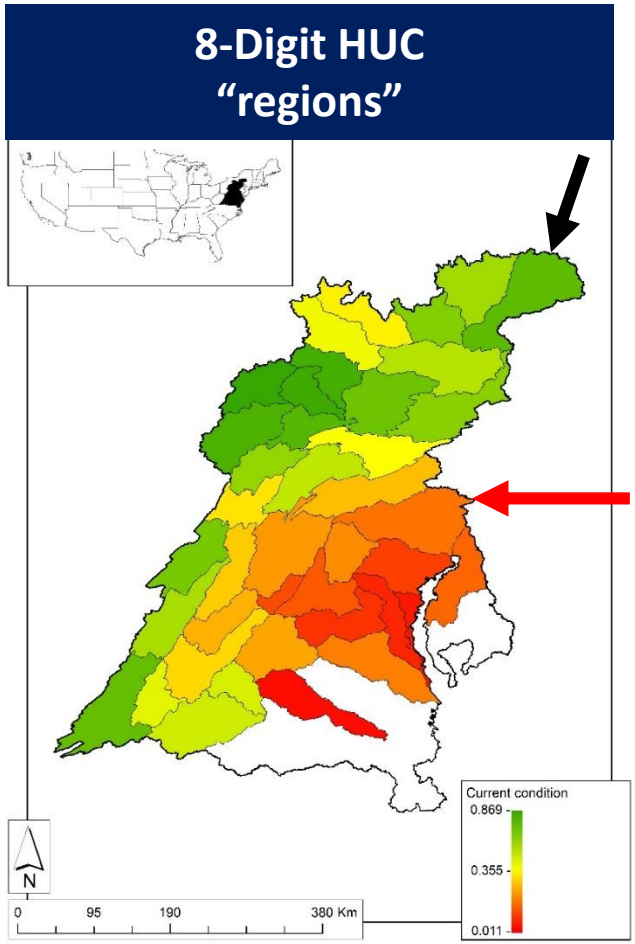
SLW "houses"

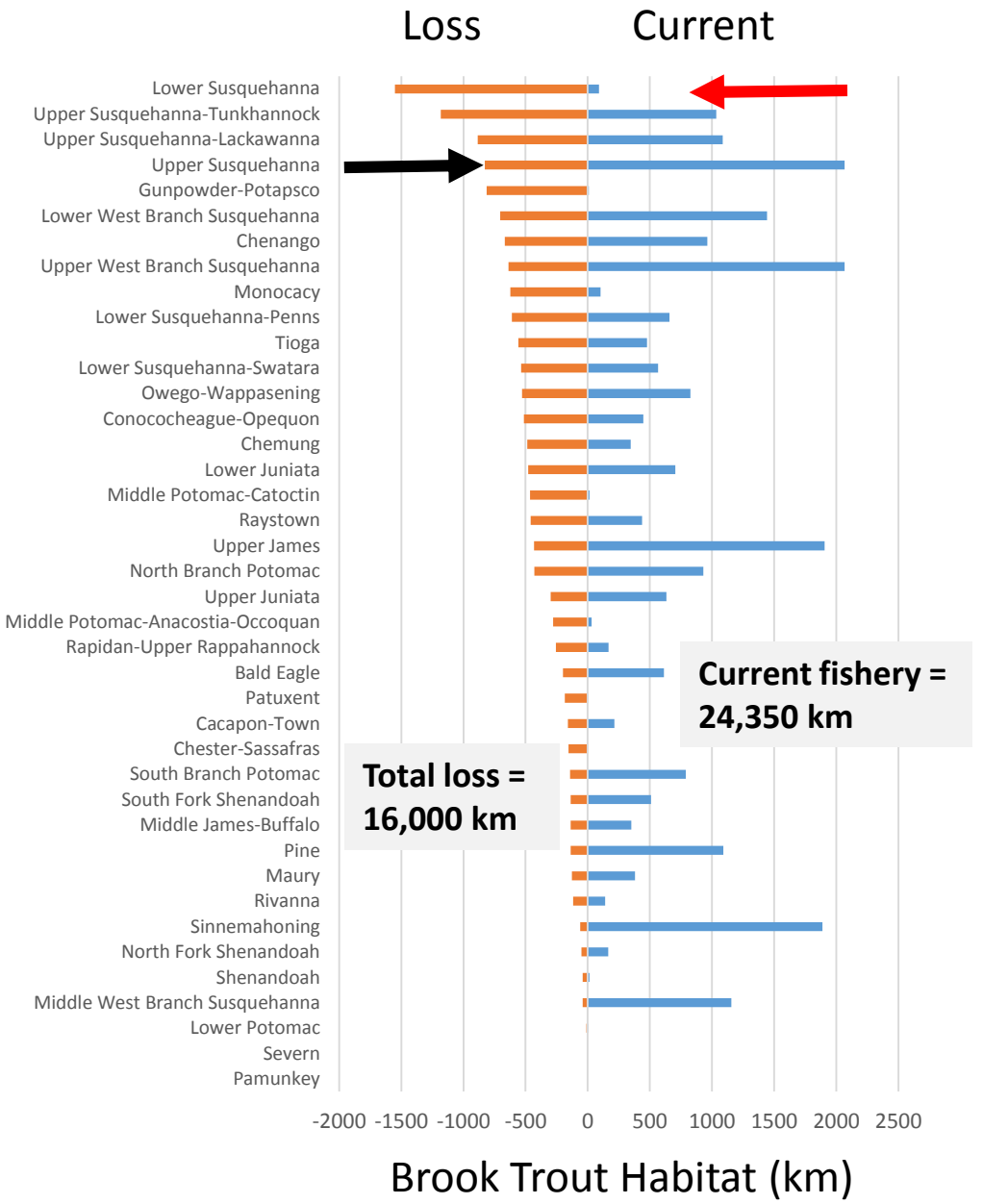
Gunpowder - Potapsco



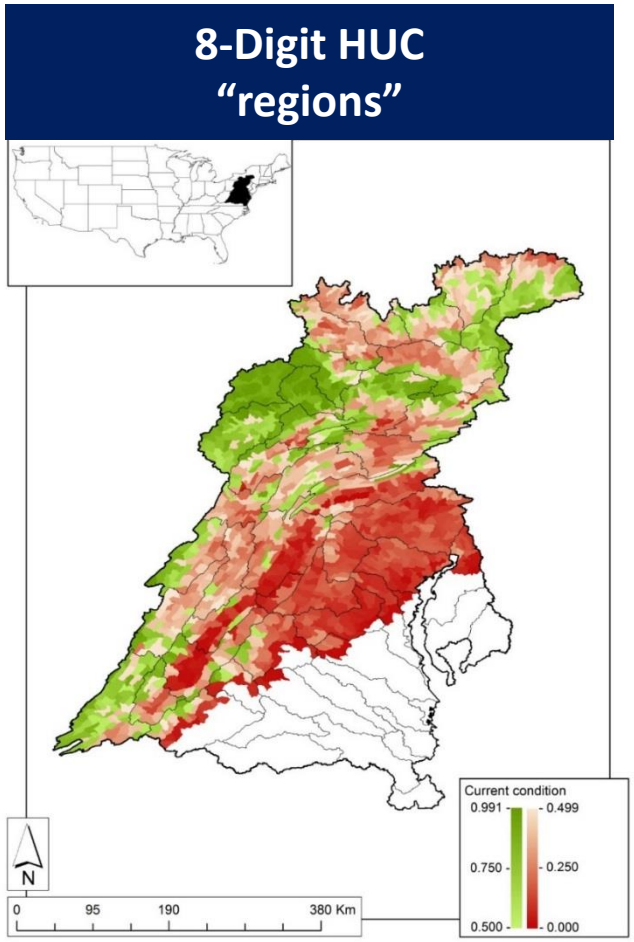
Merovich and Petty. 2013. Hierarchical classification of stream condition: a house-neighborhood framework for establishing conservation priorities. *Freshwater Science* 32:874-891.

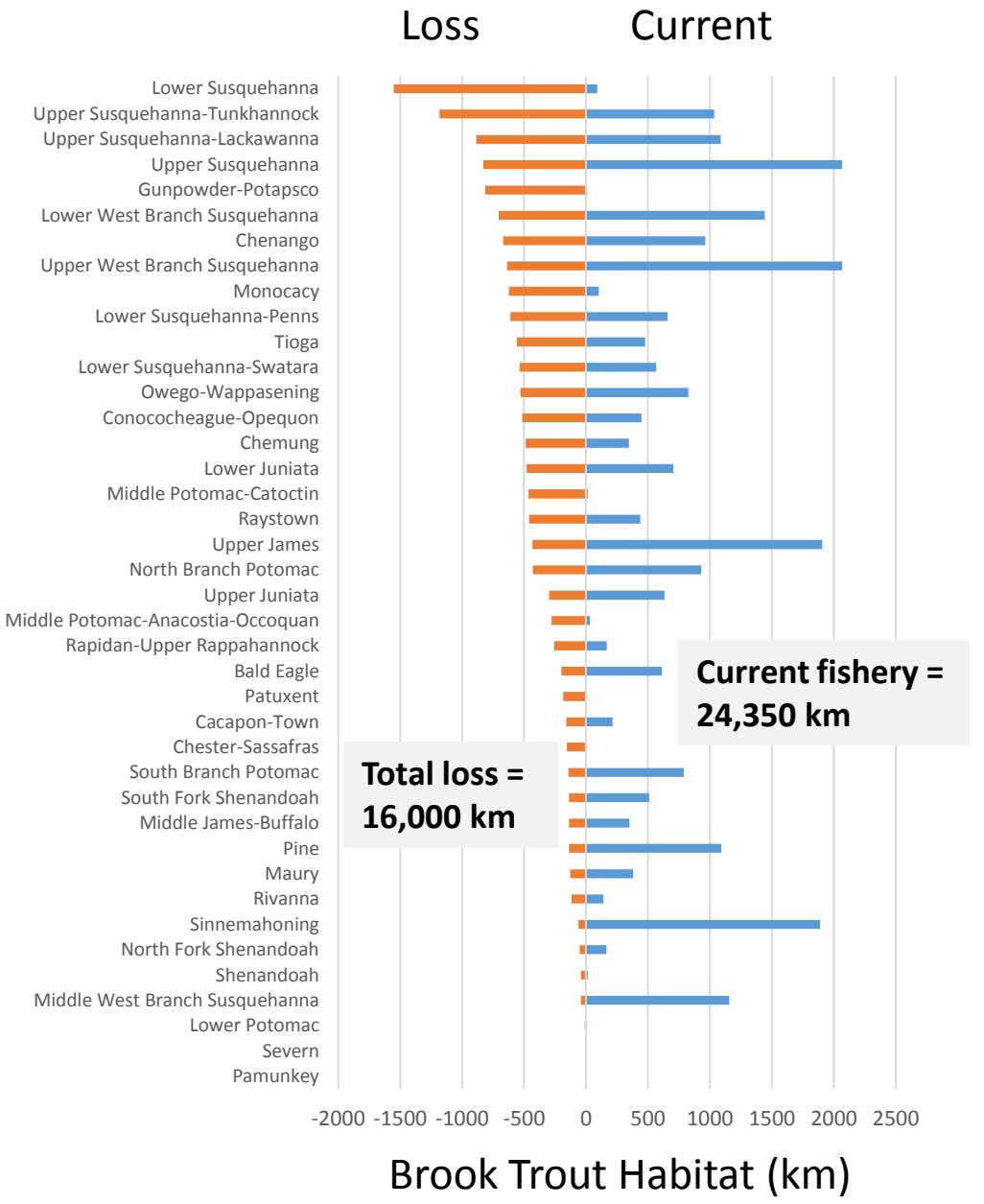
Hierarchical visualization



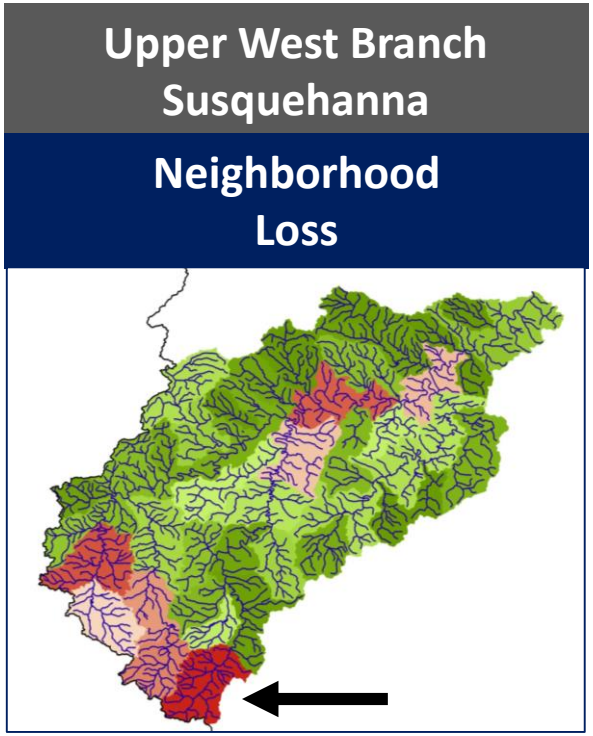


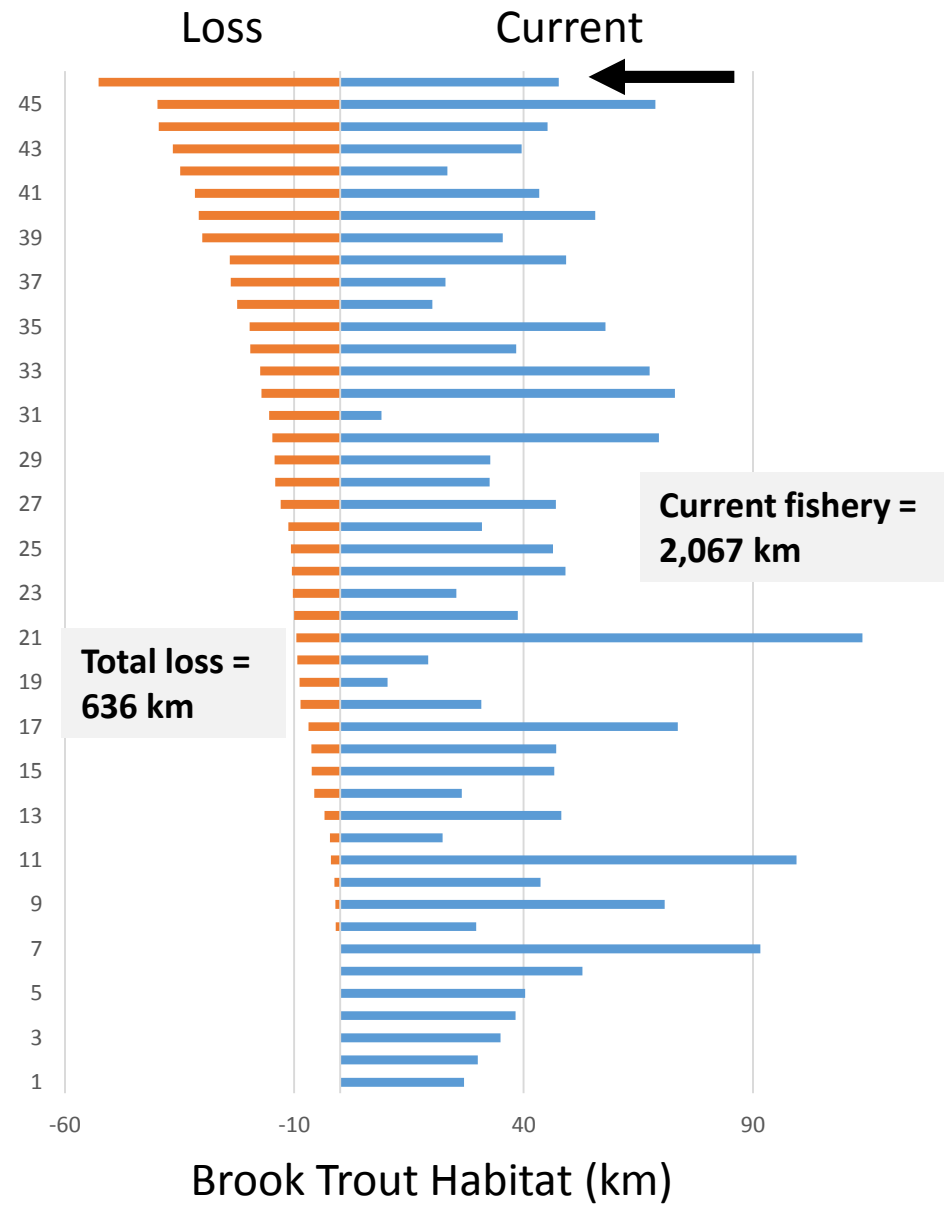
Hierarchical visualization





Hierarchical visualization

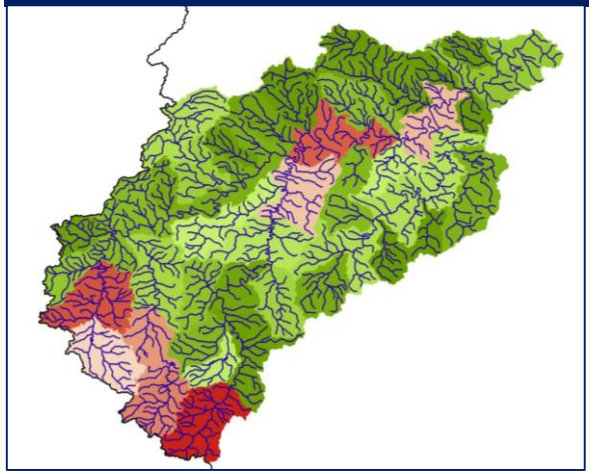




Hierarchical visualization

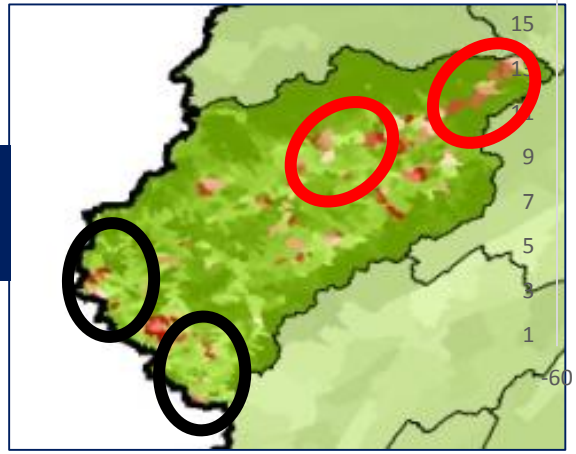
Upper West Branch Susquehanna

Neighborhood Loss

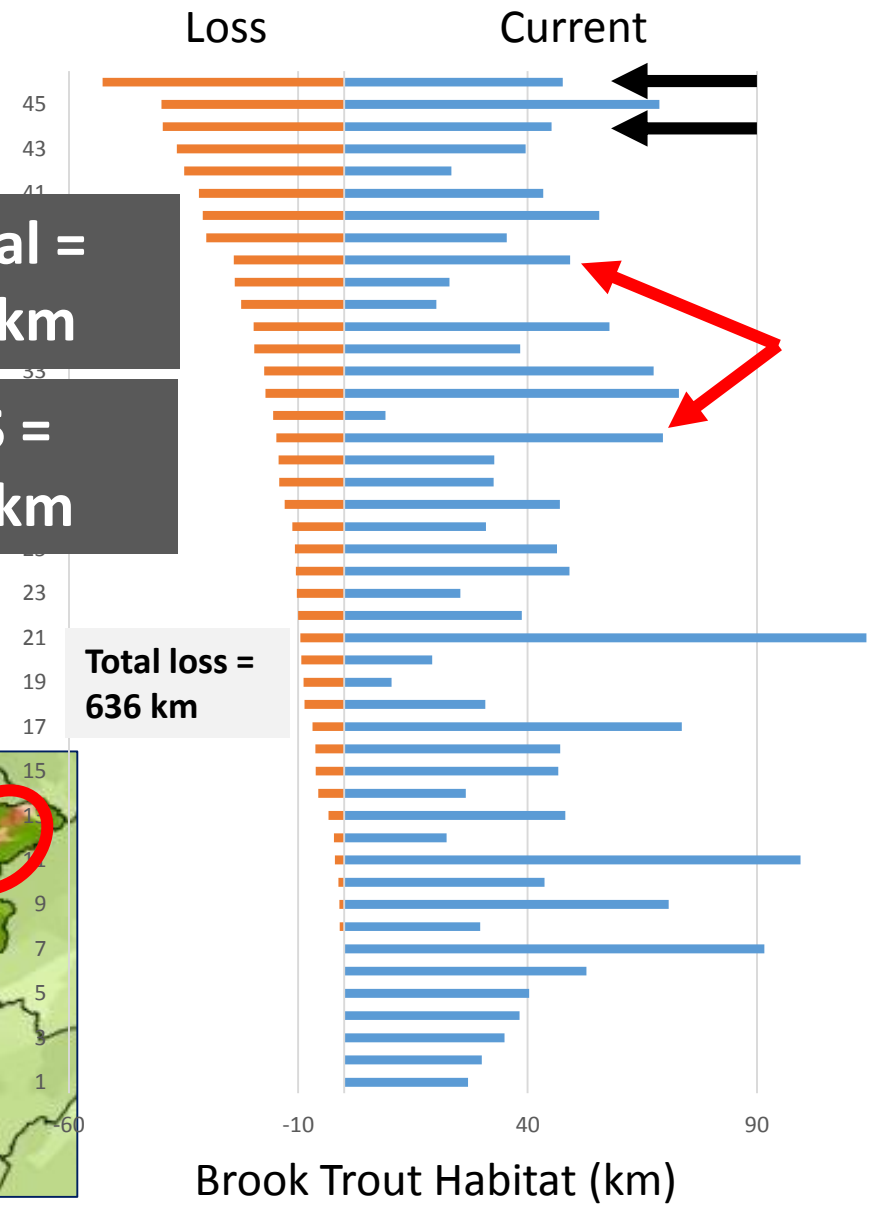


Local = 90 km

DS = 50 km



SLWs "houses"

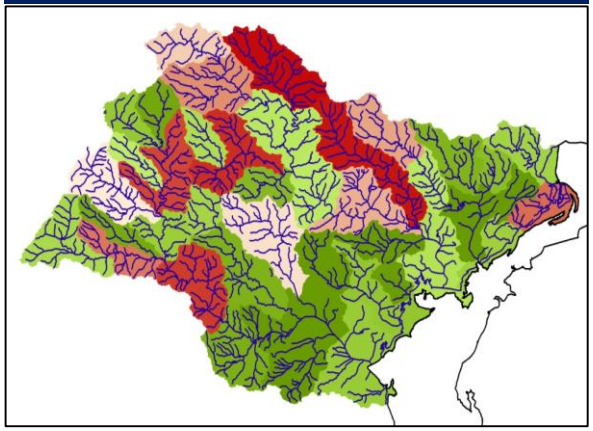


Total loss = 636 km

Hierarchical visualization

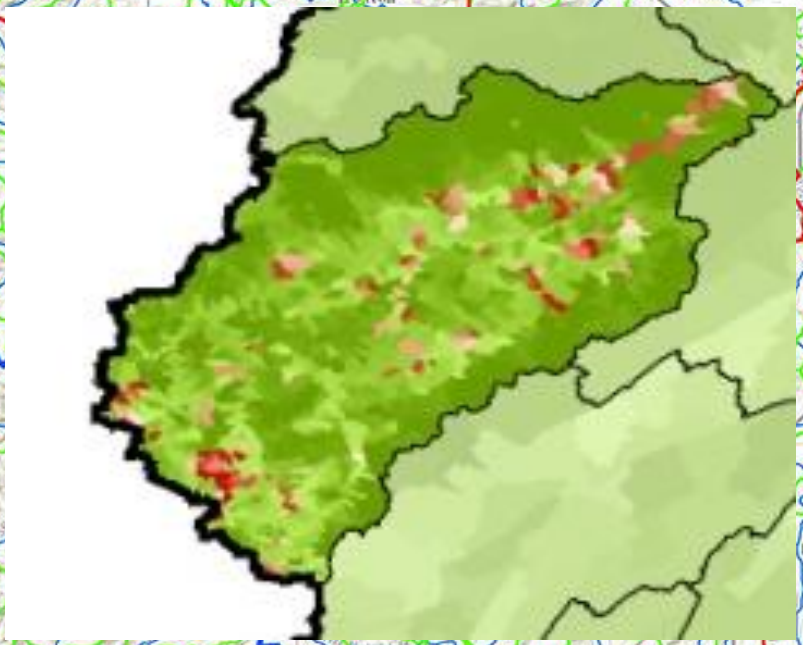
Gunpowder - Potapsco

Neighborhood Loss



SLWs "houses"

Ranking Tool



Select point on map

Watershed selected:

Baraboo - 03070005

Choose Variables of Interest

	0 Importance 100 Inverse	
X	Mining Stress	☐
X	Imper ous Stress	☐
X	Ag Stress	☐
X	Exotic Species	☑
X	Dispersal Barrier	☑
X	EBTJV patch	☐
X	SPAR W phosphorus	☐
X	SPARROW nitrogen	☐
X	Climate Resilience	☐
X	Public wnership	☐

Run Model

34.476596, -83.050272

2km

1mi

Futuring Tool

Landscape | SocioEconomic | **Brook Trout** | Brown Trout | Cottus | Longnose | Smallmouth

CASI Metrics | CNQI Metrics | Scores | Predictions

% Mining Cover

% Impervious Cover

% Agricultural Cover

Future Climate ?!?

Done

Select point on map

Watershed selected:

Gunpowder

Choose model:

Brook Trout

Choose catchments:

13652548
13654068
13651256

Select

Flash

Remove

Choose Variables of Interest

0 Percentage 100

X % impervious

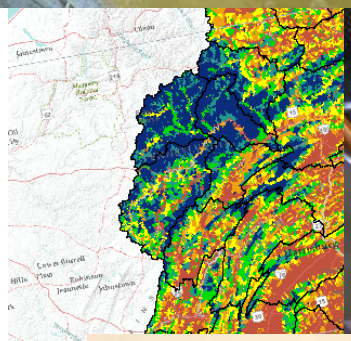
X % agriculture

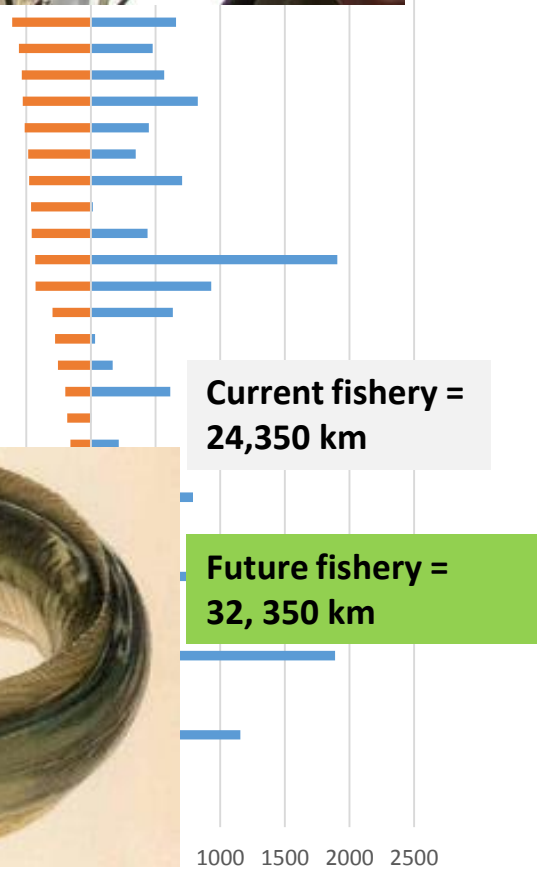
X % mining

Enter scenario name

Run Model

Let’s go




Current fishery =
24,350 km
Future fishery =
32, 350 km
1000
1500
2000
2500
Brook Trout Habitat (km)