Brook trout conservation within the context of climate change

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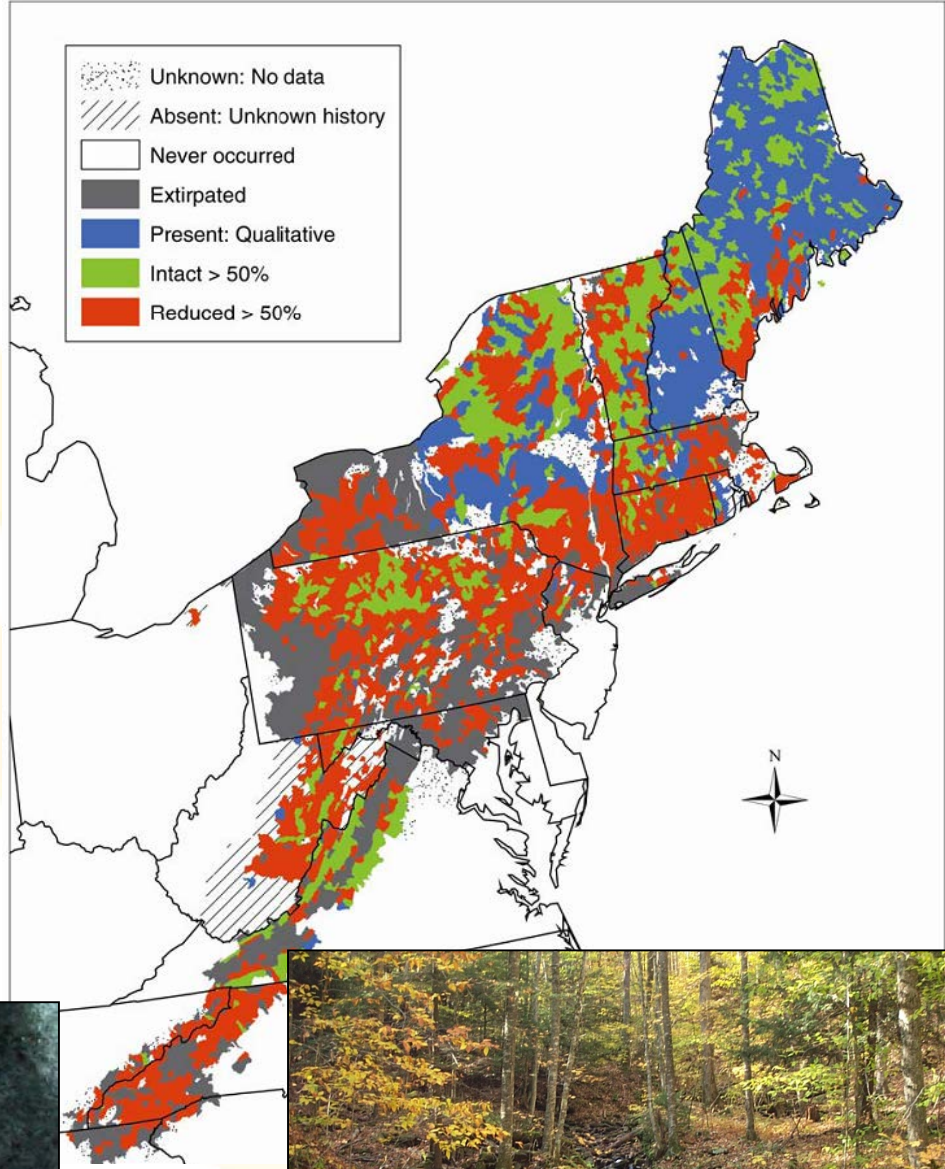
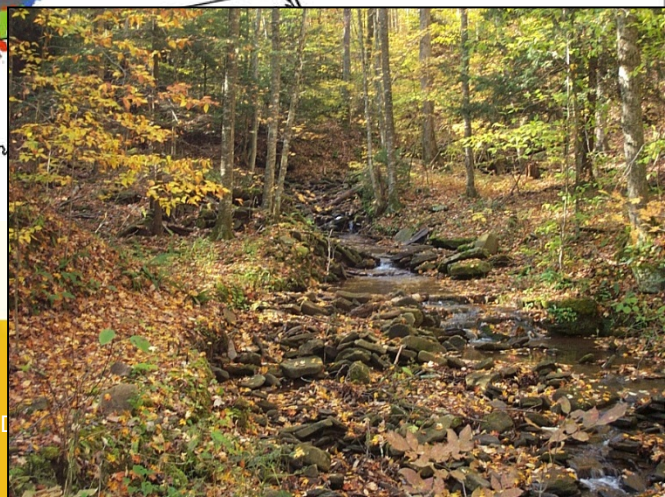
The Problem

- Extirpated or highly reduced in over 50% of their native range.
- Exist as isolated, relict populations throughout much of the mid-Atlantic.
- Acidification, harvest, barriers, sedimentation, exotic species, **warming**

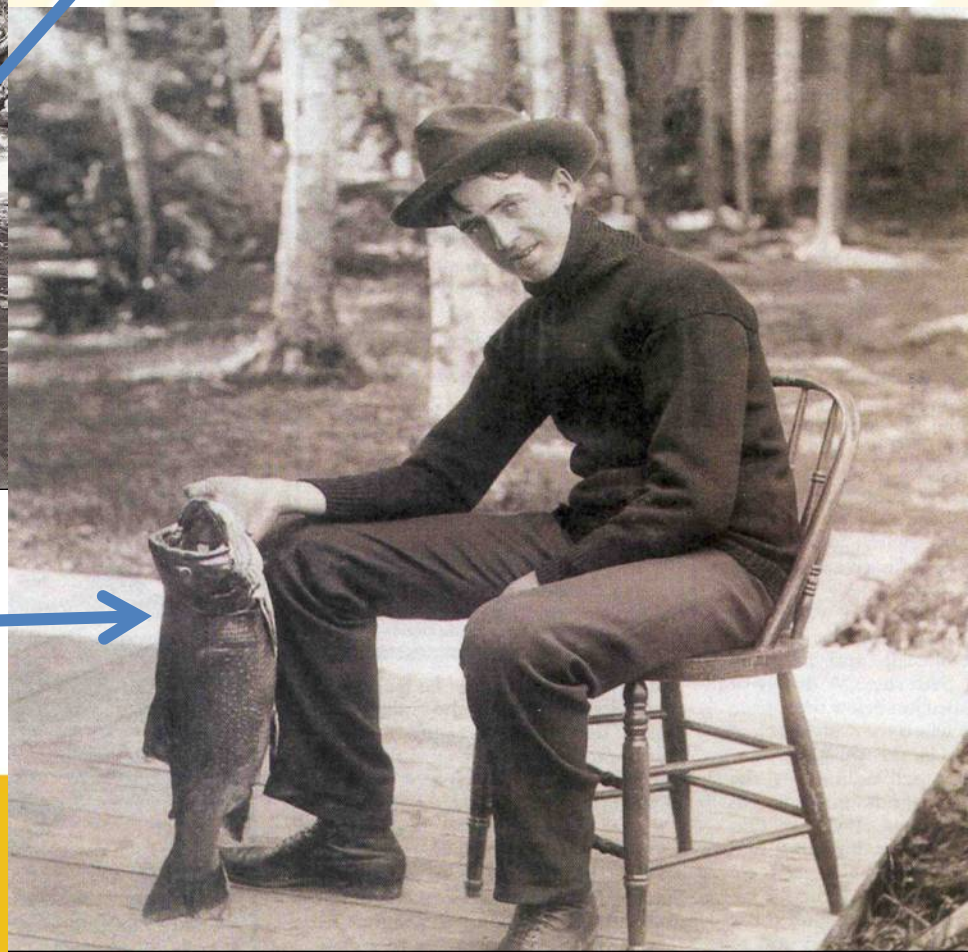




Shavers Fork near Cheat Bridge, WV – 1927 - WV Magazine

Big Rivers

Big Fish

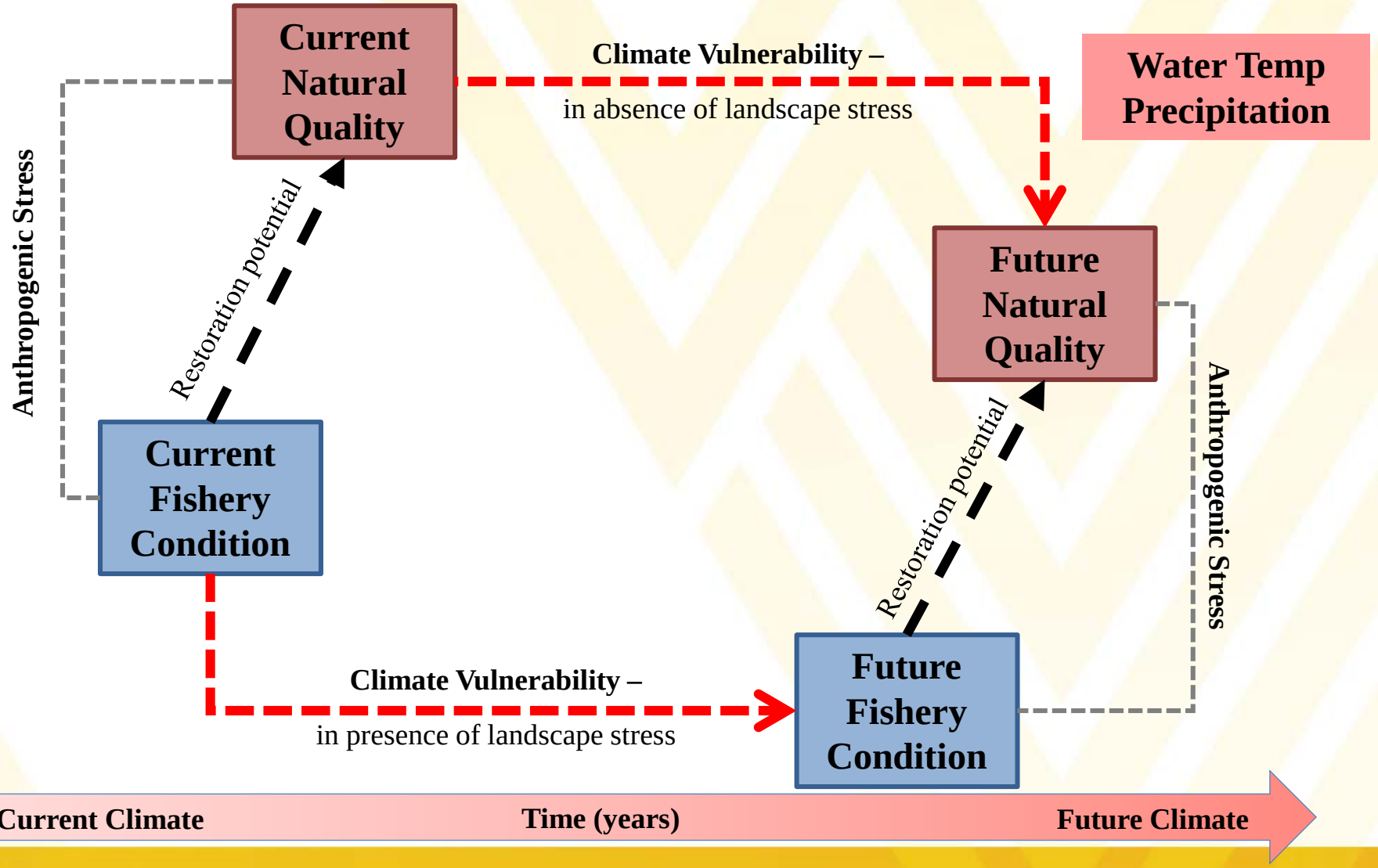


Brook trout from Blackwater River, WV – circa 1900-1920

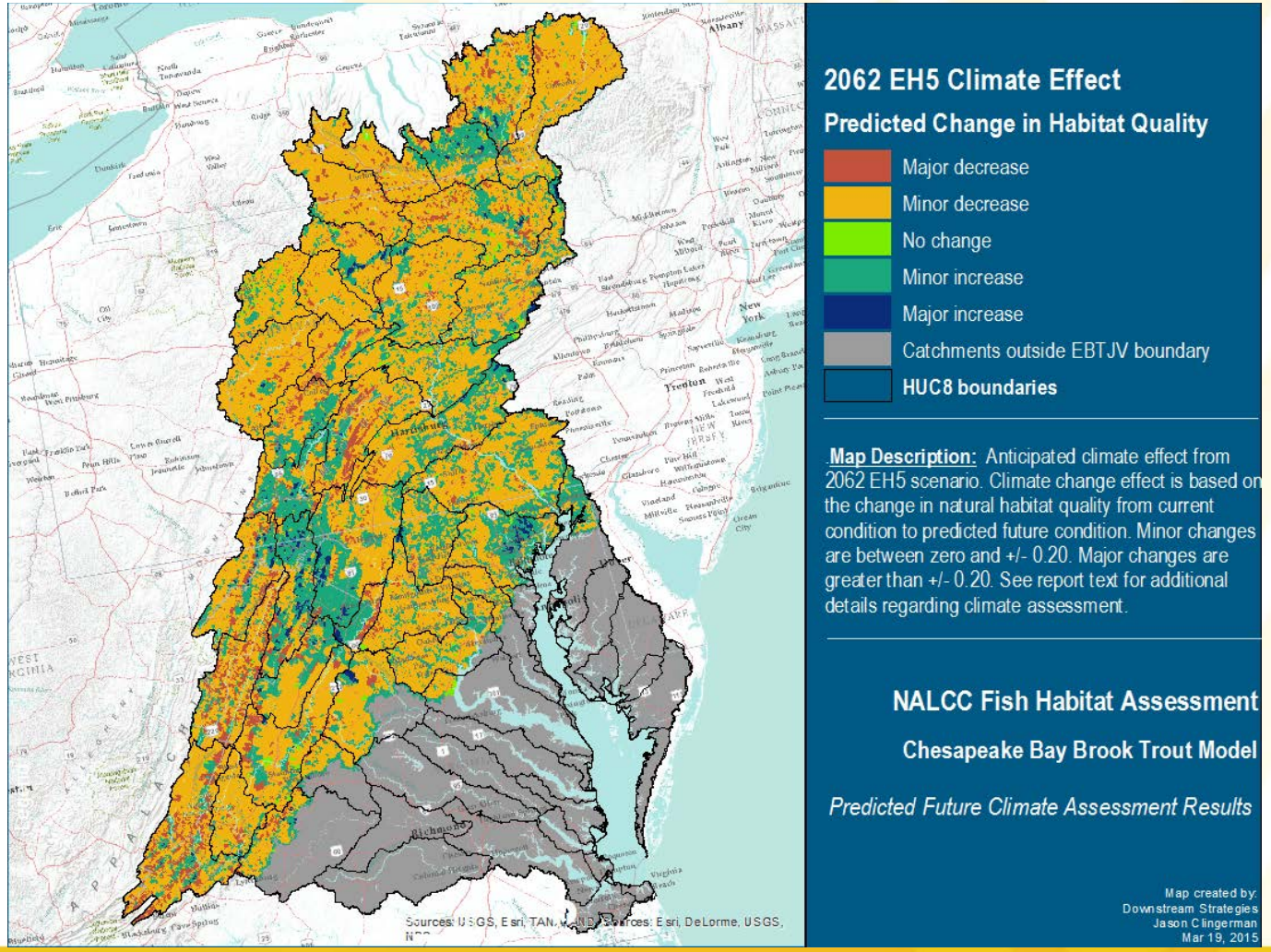
Research Questions

- How vulnerable are central Appalachian watersheds and brook trout populations to climate change?
- What are the mechanisms by which brook trout populations are impacted by climate change?
- What is the potential for protecting and/or restoring large, mobile brook trout to central Appalachian rivers?

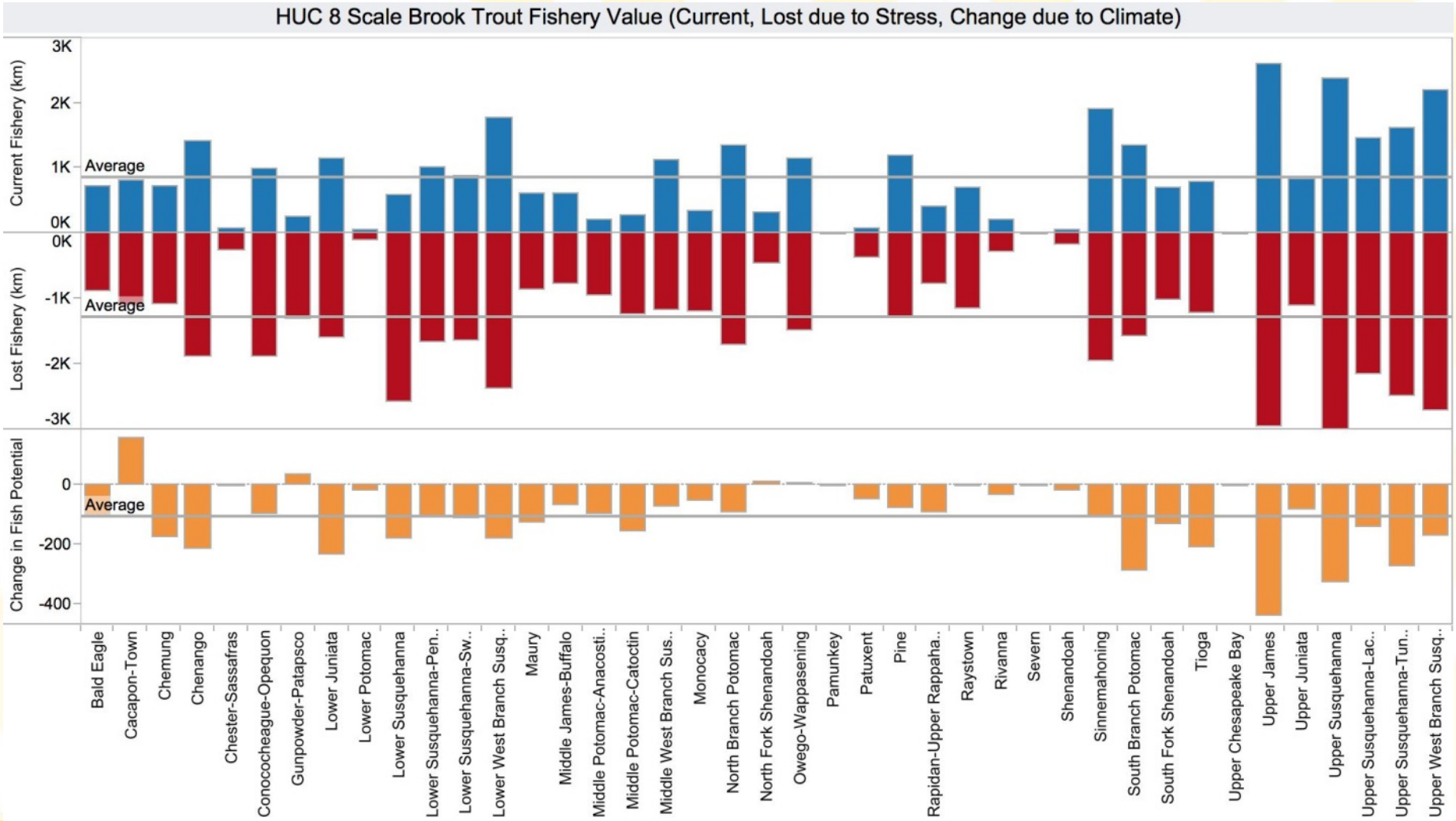
Climate vulnerability



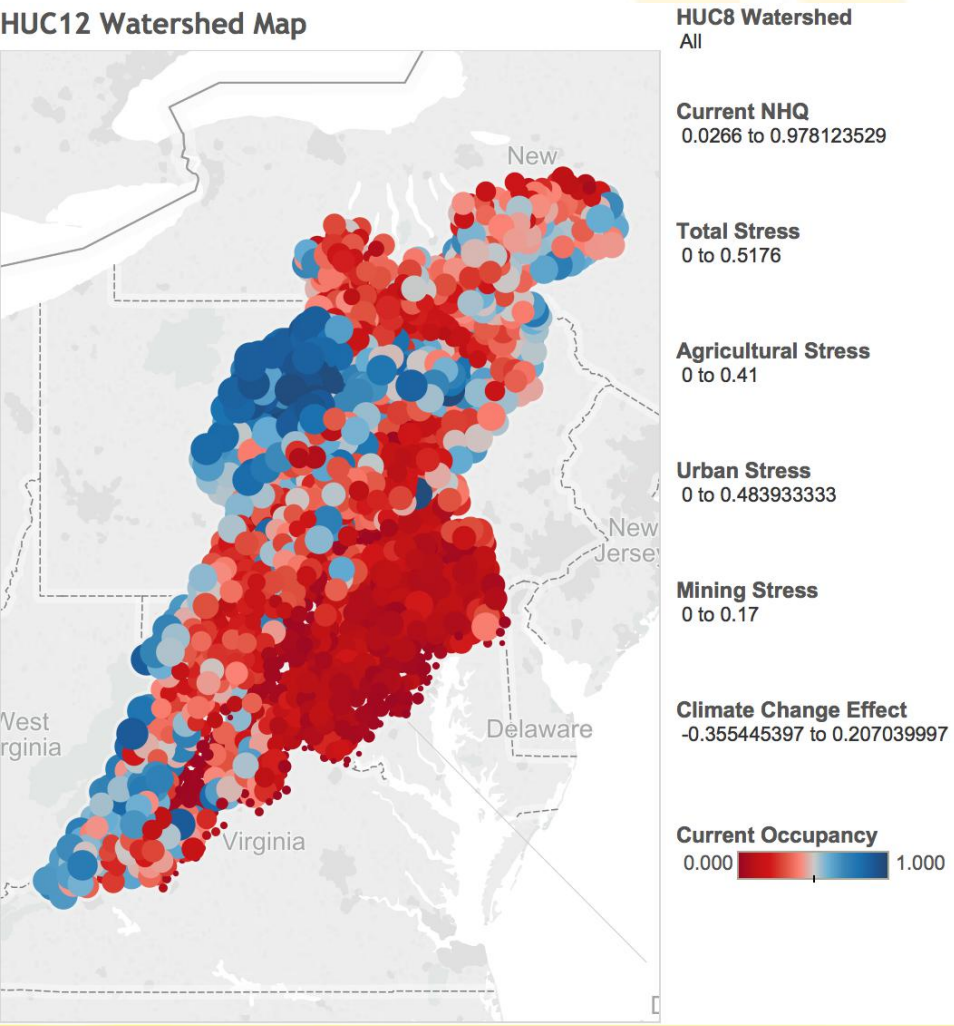
Climate vulnerability – Chesapeake Bay



Climate vulnerability – HUC8 scale



Climate vulnerability – HUC12 scale



HUC8 Watershed
All

Current NHQ
0.0266 to 0.978123529

Total Stress
0 to 0.5176

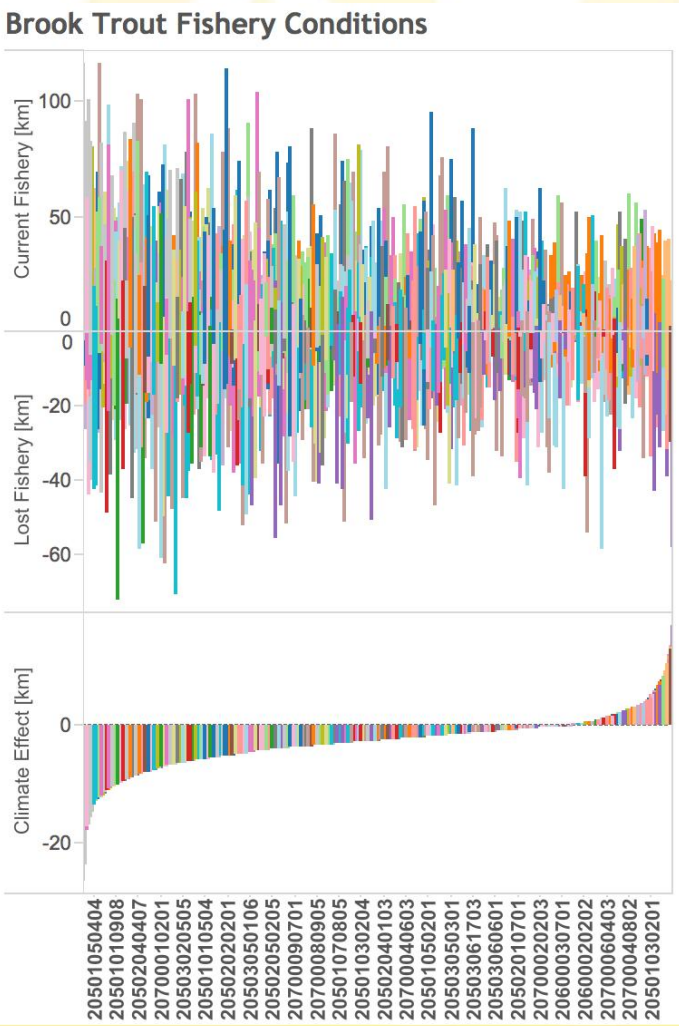
Agricultural Stress
0 to 0.41

Urban Stress
0 to 0.483933333

Mining Stress
0 to 0.17

Climate Change Effect
-0.355445397 to 0.207039997

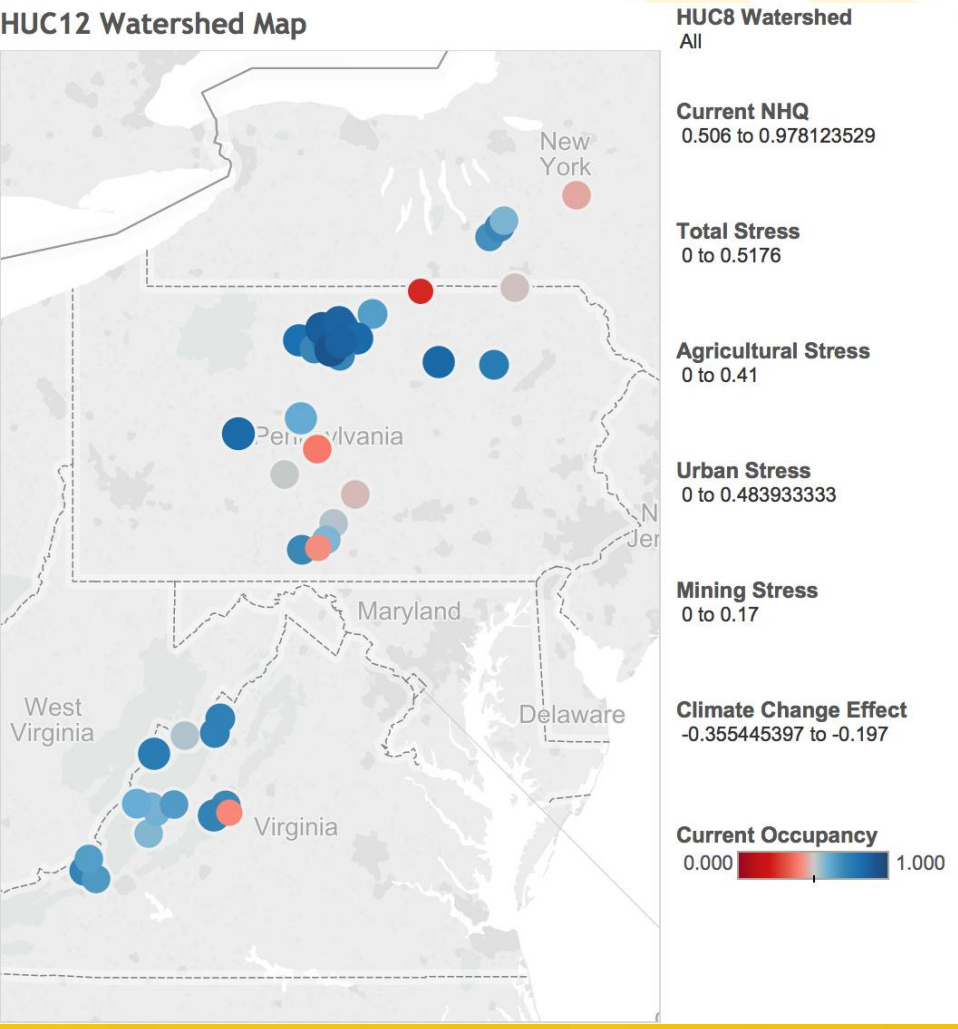
Current Occupancy
0.000 — 1.000

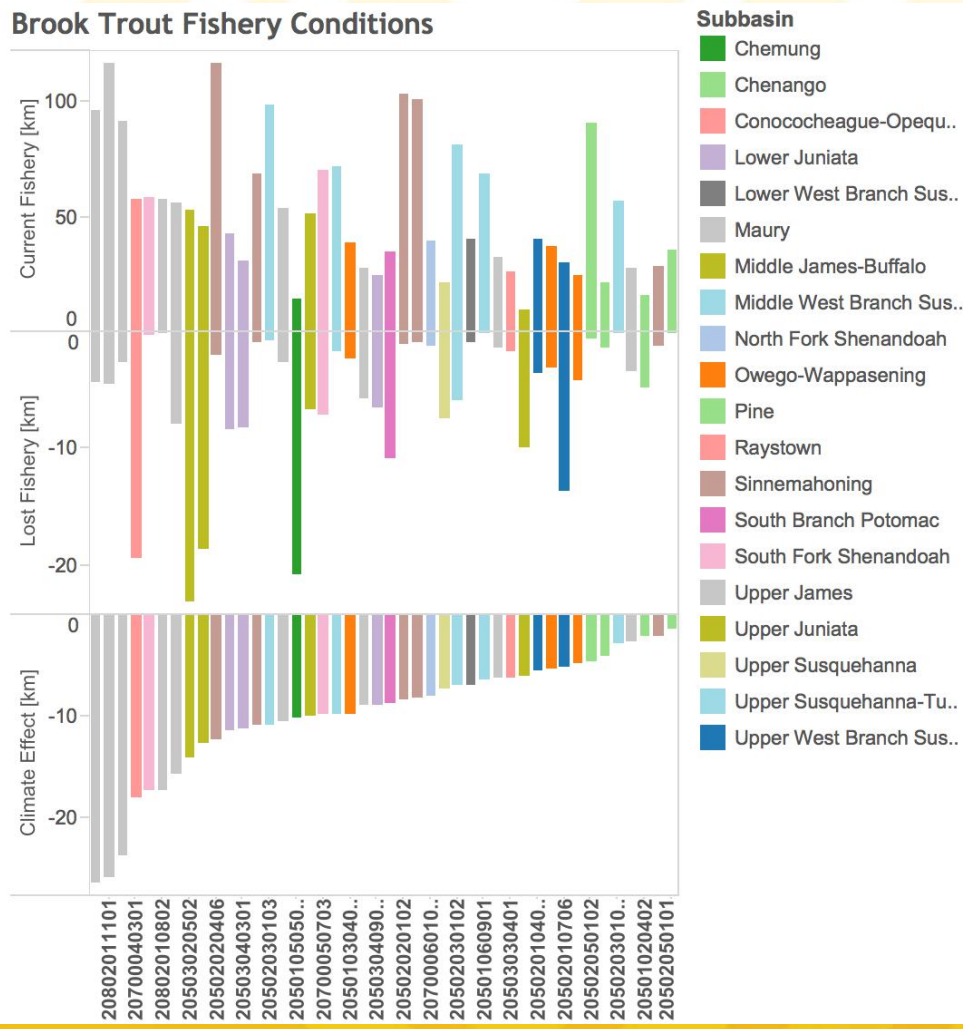


Subbasin

- Bald Eagle
- Cacapon-Town
- Chemung
- Chenango
- Chester-Sassafras
- Conococheague-Opequ..
- Gunpowder-Patapsco
- Lower Juniata
- Lower Potomac
- Lower Susquehanna
- Lower Susquehanna-Pe..
- Lower Susquehanna-Sw..
- Lower West Branch Sus..
- Maury
- Middle James-Buffalo
- Middle Potomac-Anacos..
- Middle Potomac-Catoctin
- Middle West Branch Sus..
- Monocacy
- North Branch Potomac
- North Fork Shenandoah
- Owego-Wappasening
- Pamunkey
- Patuxent
- Pine
- Rapidan-Upper Rappah..
- Raystown

Climate vulnerability – HUC12 scale





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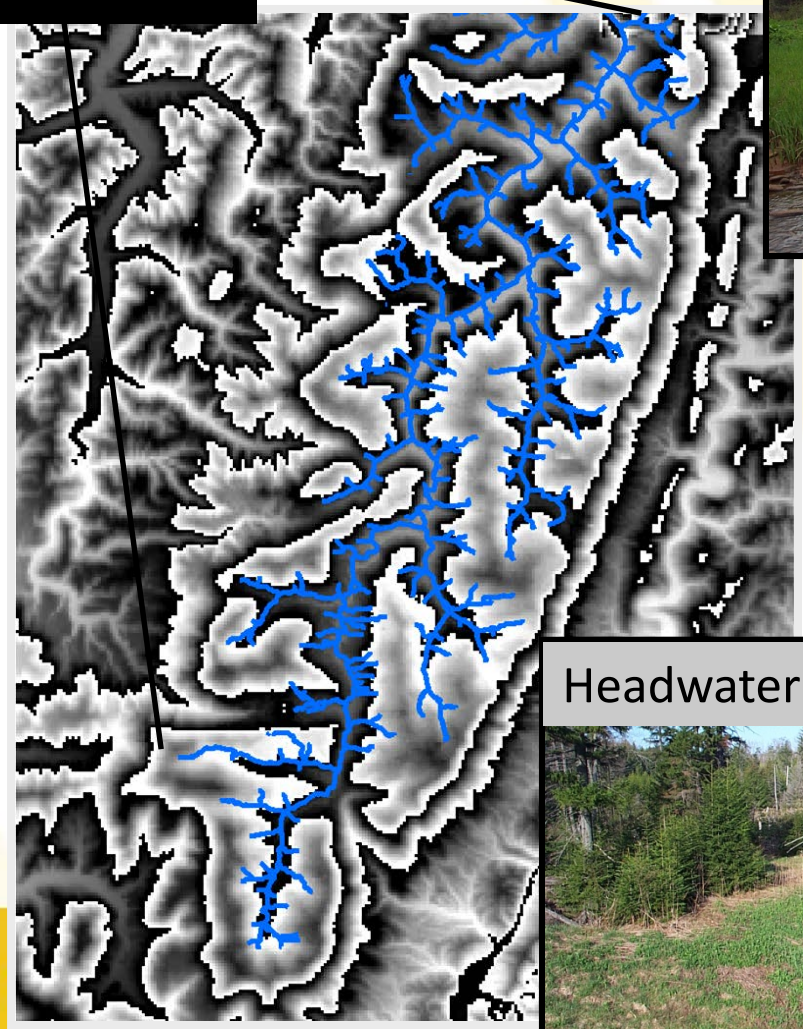
Upper Shavers Fork



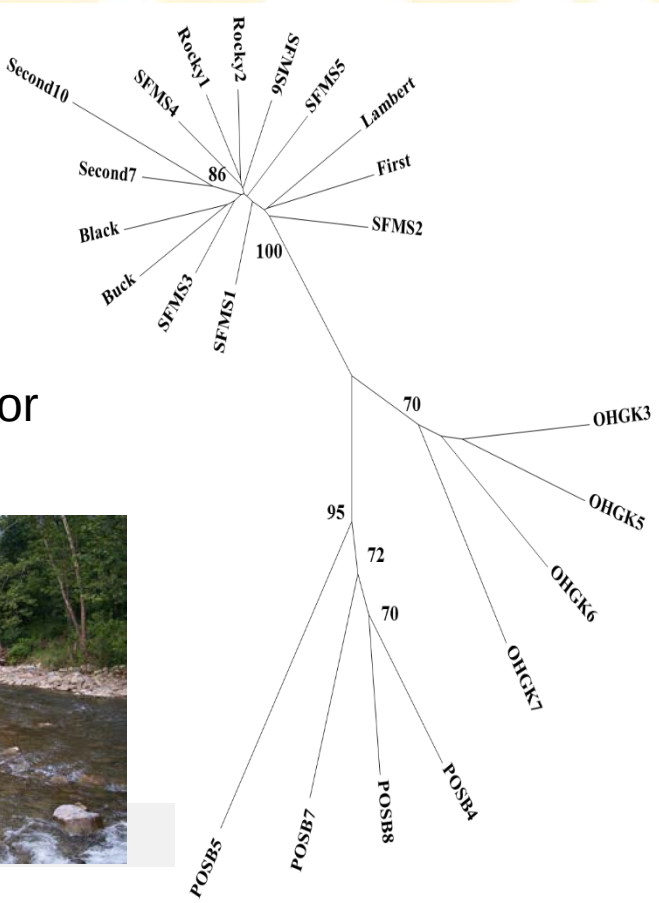
Mainstem

Larger Tributaries

Headwater Tributaries

Sub-population fragmentation

Shavers Fork
Highly permeable corridor

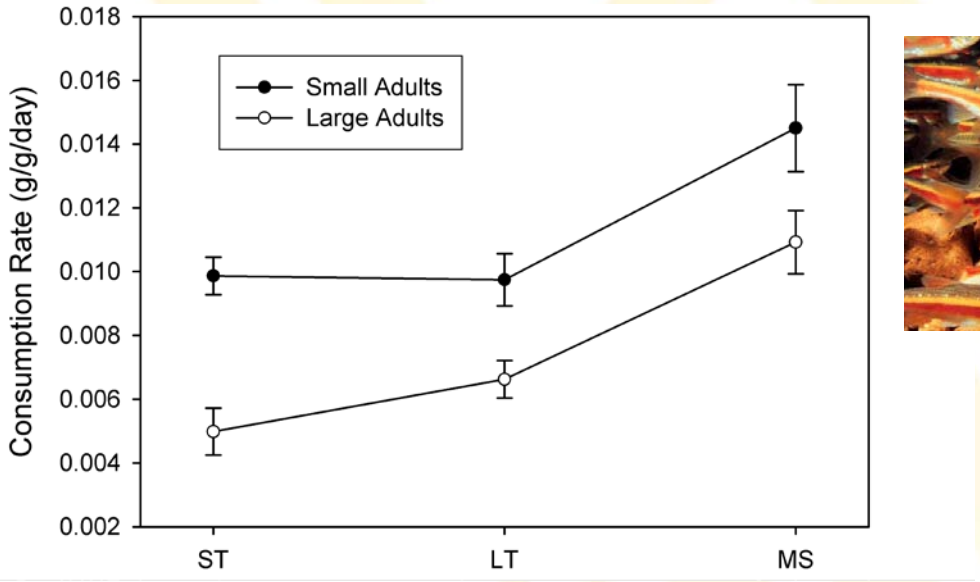


Greenbrier
Moderate corridor

North Fork
Dispersal barrier

Aunins, Petty, King, Schilz and Mazik. 2015. River main stem thermal regimes influence population structuring within an Appalachian brook trout population. *Conservation Genetics*.

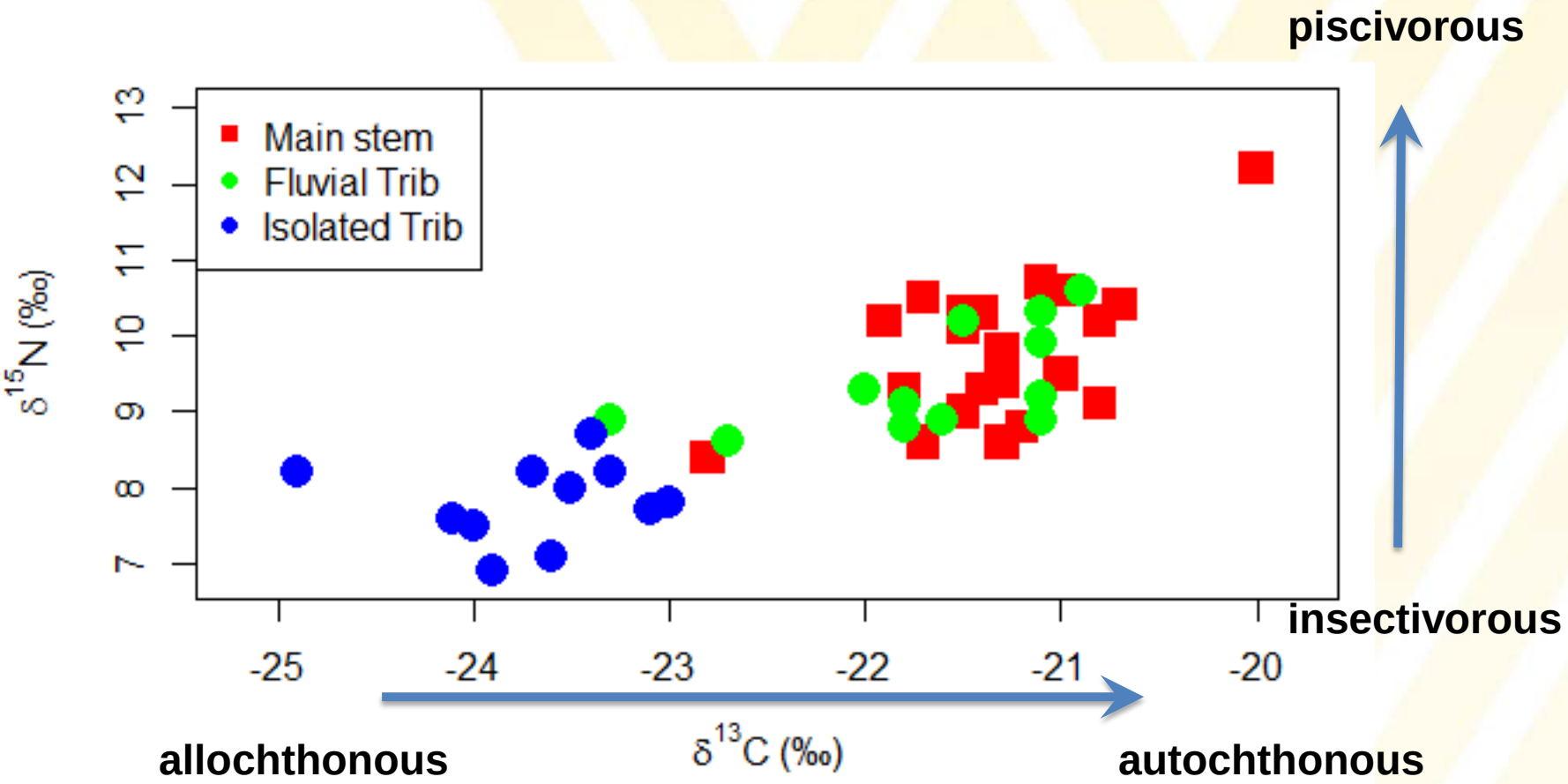
Supplemental foraging habitat



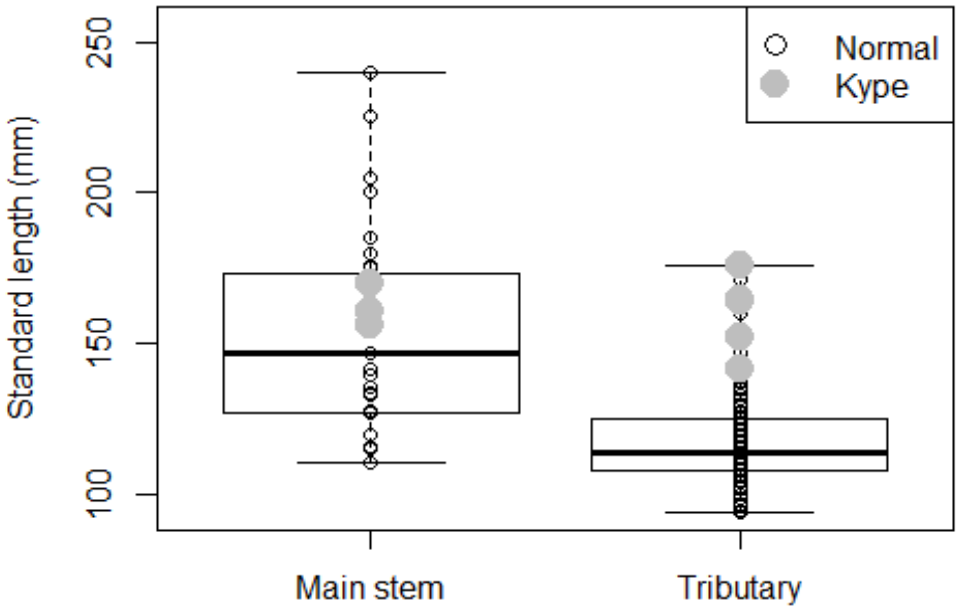
Cold
Low productivity
1-2 fish species

Warm
High productivity
15+ fish species

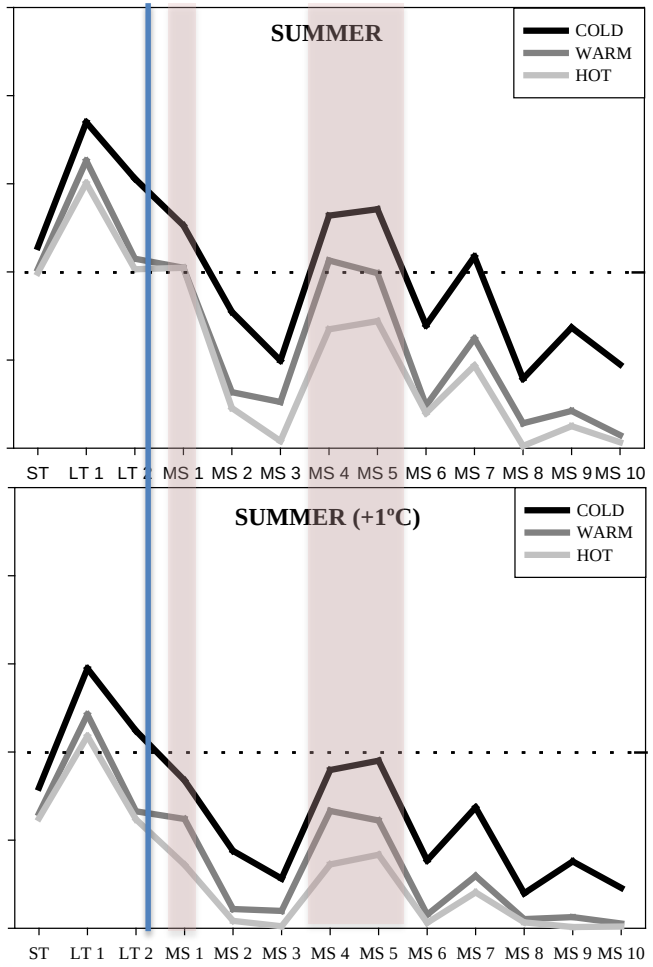
Supplemental foraging habitat



Supplemental foraging habitat



Climate change vulnerability



Current growth potential

Future growth potential
+ 1C in water temperature

Huntsman, B., J. T. Petty, and K. Hartman. Unpublished ms. *CJFAS*.

Climate change vulnerability

With warming of main stem habitats, headwater populations become isolated from one another and isolated from productive food sources.

- *Incr. vulnerability of extinction*
- *Reduced overall productivity*

Current growth potential

Future growth potential
+ 1C in water temperature

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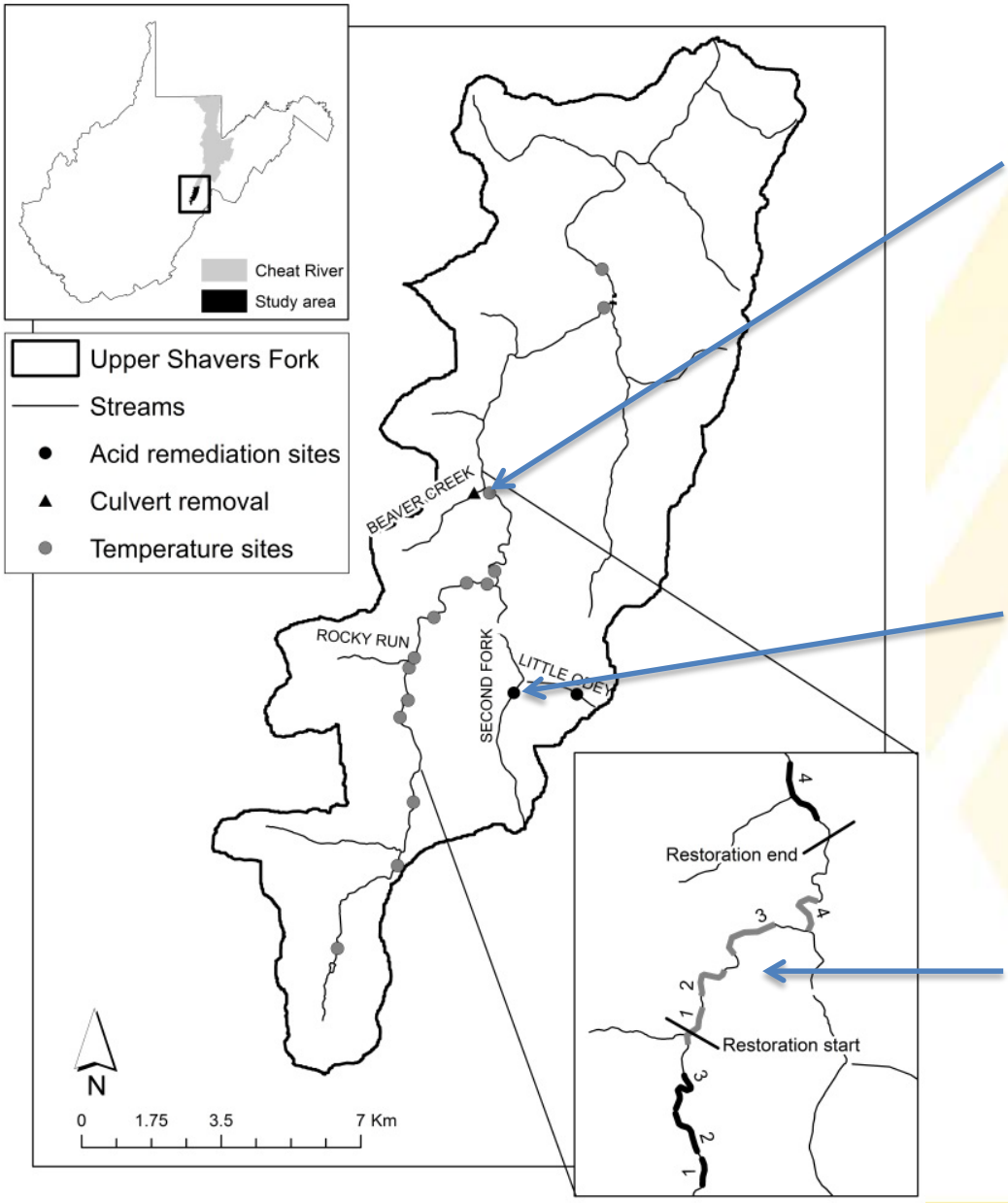
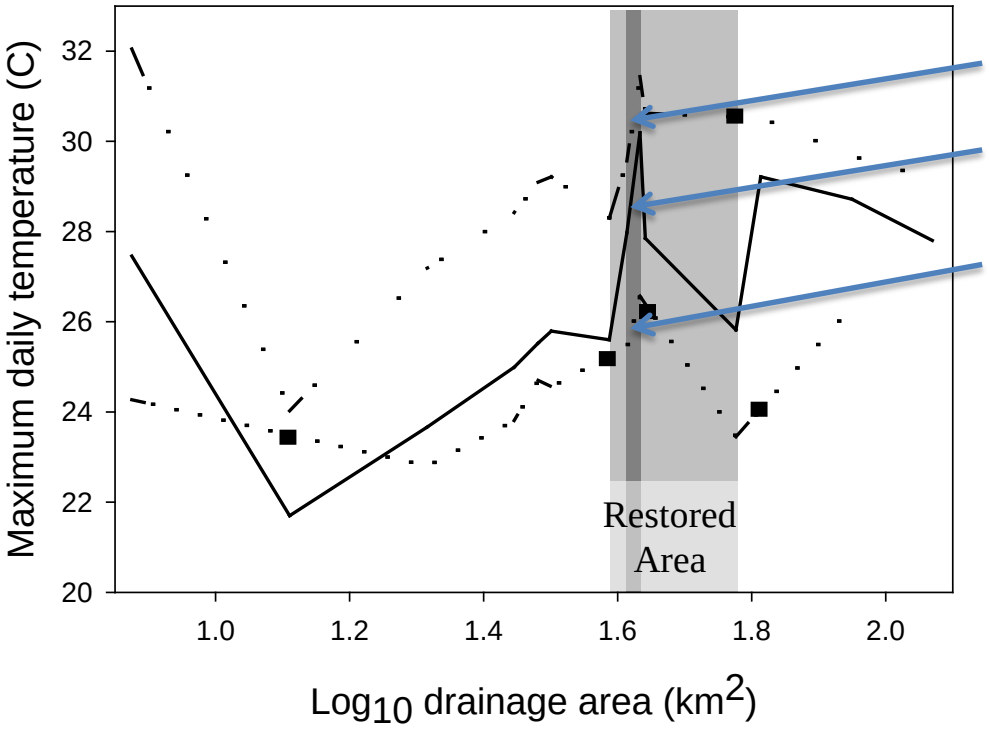
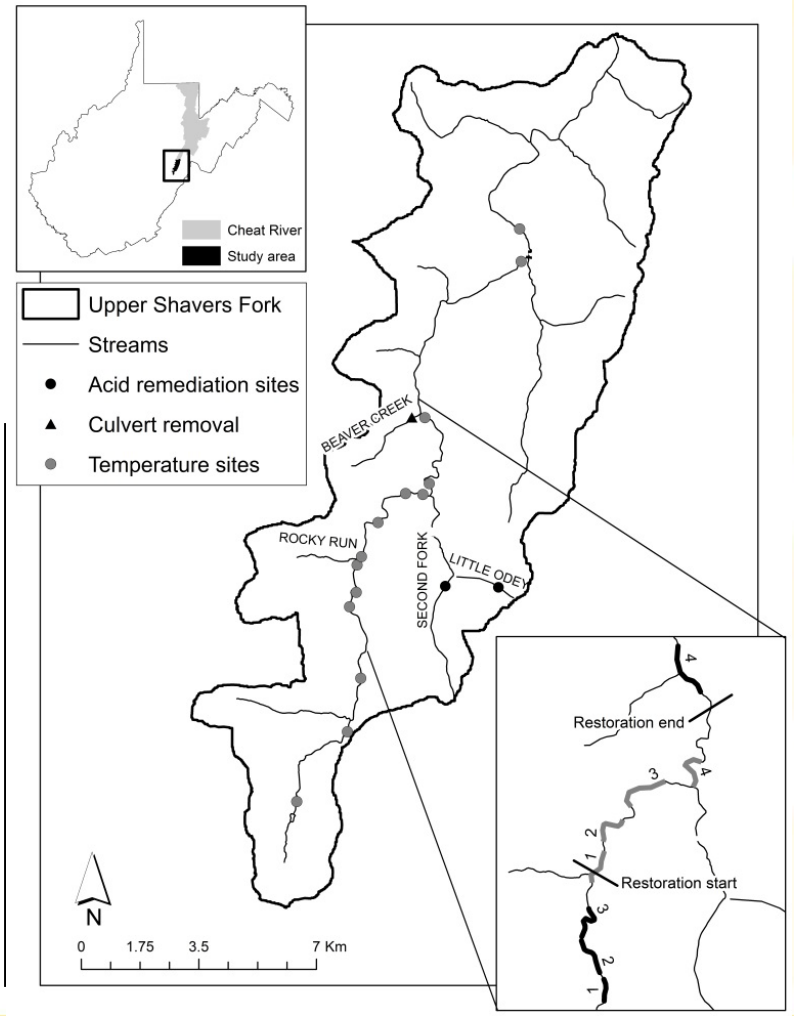
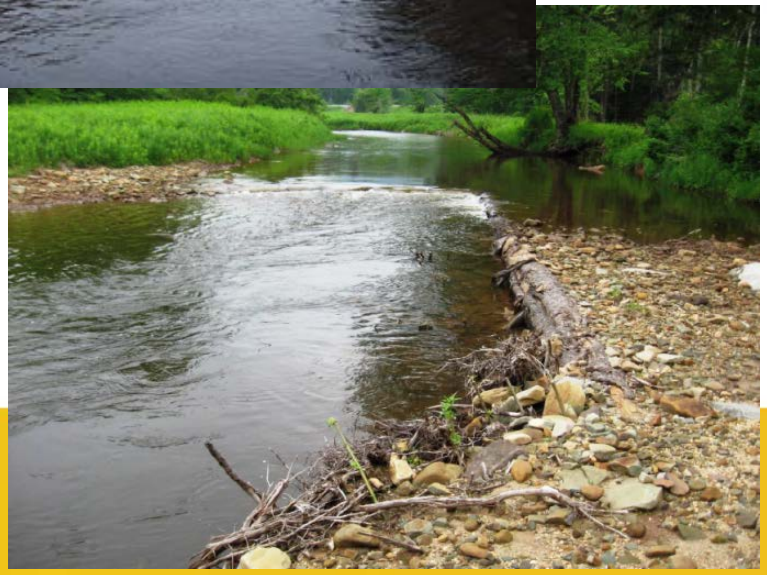
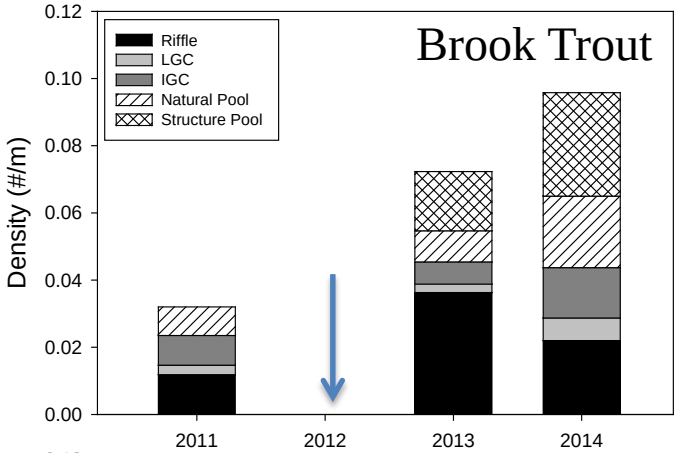

Cheat River
Study area
Upper Shavers Fork
Streams
Acid remediation sites
Culvert removal
Temperature sites
BEAVER CREEK
ROCKY RUN
SECOND FORK
LITTLE COEY
N
0
1.75
3.5
7 Km
Restoration end
Restoration start
4
3
2
1

Mainstem Restoration



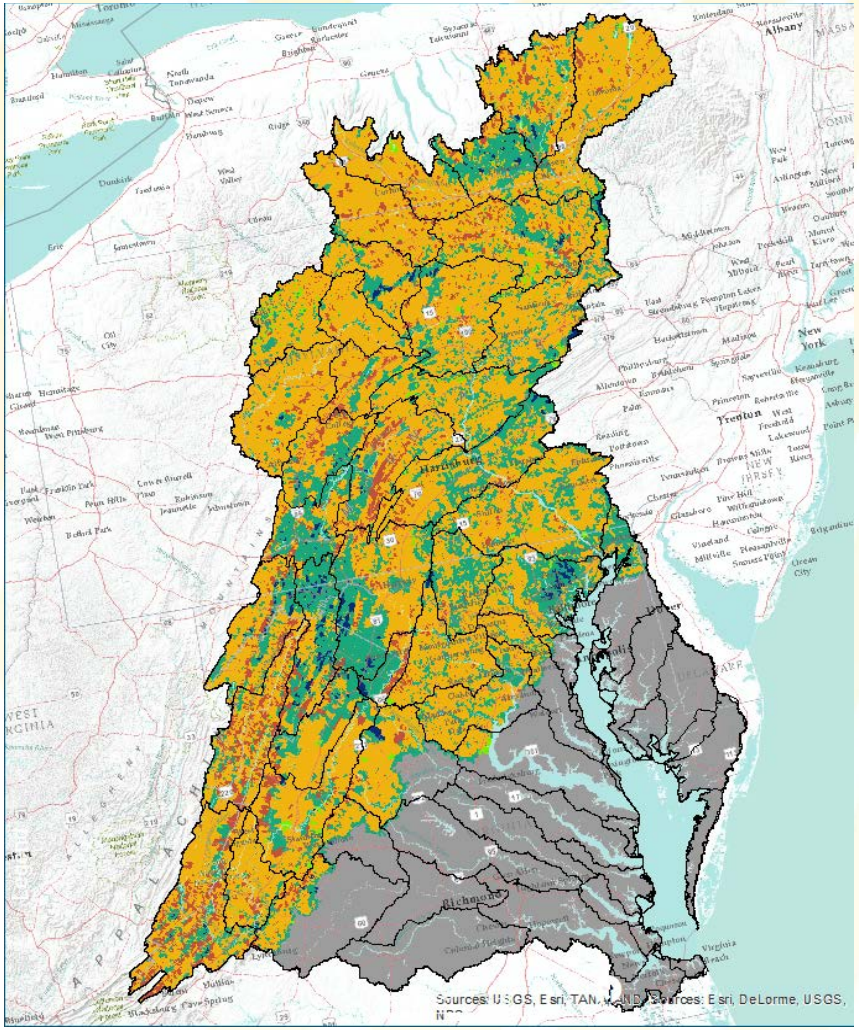





Brook Trout
Riffle
LGC
IGC
Natural Pool
Structure Pool
Density (#/m)
0.12
0.10
0.08
0.06
0.04
0.02
0.00
2011
2012
2013
2014

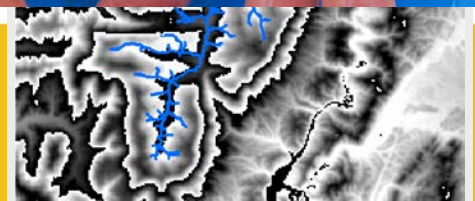
Conclusions

- Strong spatial variability in the vulnerability of brook trout populations to climate change.



Conclusions

- Mechanisms of climate change impacts to brook trout:
  - Direct loss of populations from larger rivers
  - Fragmentation of sub-populations
  - Loss of large bodied individuals dependent of main stem food



Conclusions

- Successful restoration of brook trout within the context of a changing climate will require that we:
    - Integrate actions that will benefit juvenile recruitment, dispersal, and growth

Appalachian Main stem Initiative

- Identify large river main stems with potential to serve as foraging habitat and dispersal corridors for brook trout.
- Restore and protect these habitats as part of the broader brook trout conservation effort.