# Fisheries: Responding to Drought and Water Challenges

## Coldwater Fisheries and Climate Adaptation Case Studies in the Eastern and Western United States

AUDIO CONNECTION

**1. Phone:** mute your computer speakers and call 1-877-369-5243; access code: 0436649#

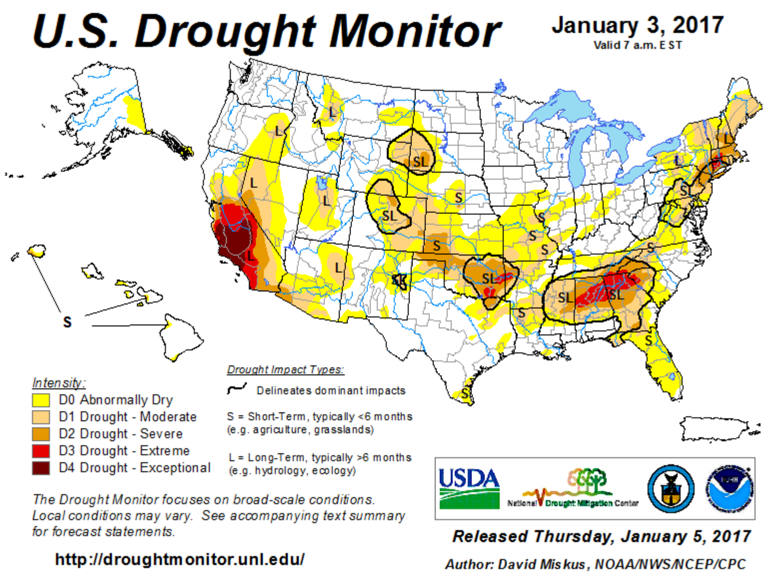
OR

**2. Audio through the computer:** Make sure your computer speakers are on and listen with speakers or headphones.

**Note:** Phone audio will allow you to both listen and speak up with questions. If you listen through the computer, you will not be able to speak up with questions, but will be able to type questions into the Q&A pod which will be answered by the appropriate speaker.

# How much water will we have?

- Rising global temperatures
- Changing precipitation patterns
- Increasing natural disturbance
- Increasing water use and demand


U.S. Drought Monitor
January 3, 2017
Valid 7 a.m. EST
Intensity:
D0 Abnormally Dry
D1 Drought - Moderate
D2 Drought - Severe
D3 Drought - Extreme
D4 Drought - Exceptional
Drought Impact Types:
Delineates dominant impacts
S = Short-Term, typically <6 months (e.g. agriculture, grasslands)
L = Long-Term, typically >6 months (e.g. hydrology, ecology)
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.
http://droughtmonitor.unl.edu/
USDA
National Drought Mitigation Center
Released Thursday, January 5, 2017
Author: David Miskus, NOAA/NWS/NCEP/CPC

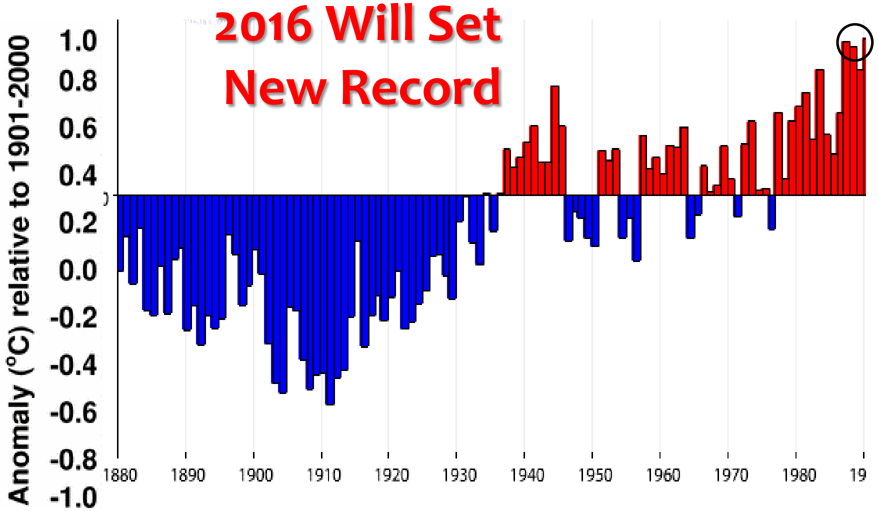
# Whither Coldwater Fishes In A Warming World?

## *Using The Climate Shield For Strategic Detection & Protection*

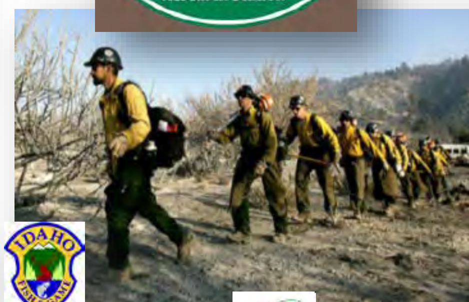
## (Western U.S. examples)

**Dan Isaak** - *Research Scientist, US Forest Service*
**Scott Spaulding** - *Fish Program Manager, Northern Region*
**Mike Young** - *Research Fisheries Biologist, Rocky Mt. Research Station*

# Whither Coldwater Fishes In A Warming World? Using The Climate Shield For Strategic Detection & Protection (Western U.S. examples)



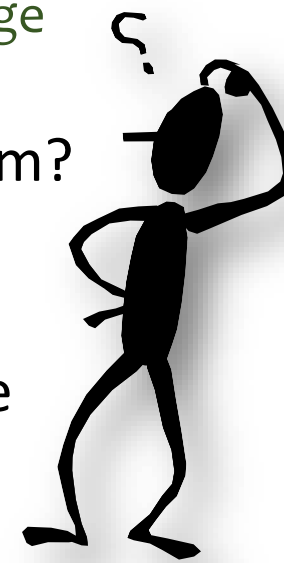

Climate Shield



# Many Things Can be Done to Improve Habitat & Population Resilience

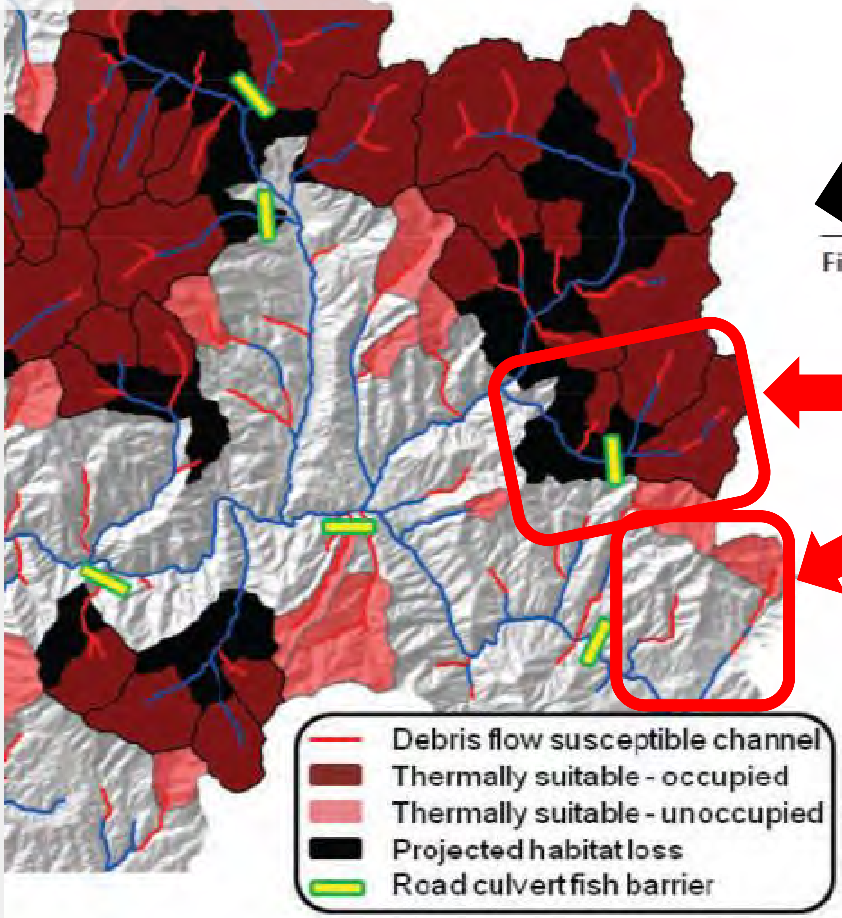

- Maintaining/restoring flow
- Maintaining/restoring riparian
- Restoring channel form/function
- Prescribed burns limit wildfire risks
- Non-native species control
- Improve/impede fish passage

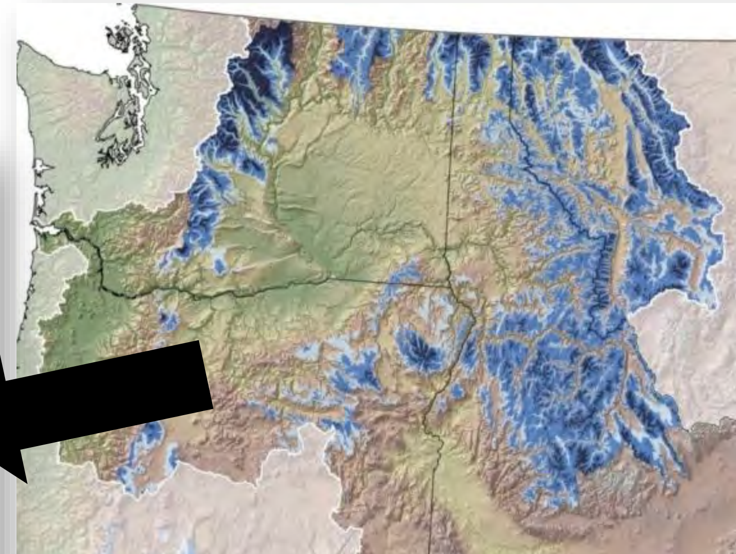
1. Where to do them?
2. Is there a grand strategy?
3. How to maximize the bang for the buck?



# 1st Generation Stream Climate Models Were Too Coarse

**High-resolution models needed**



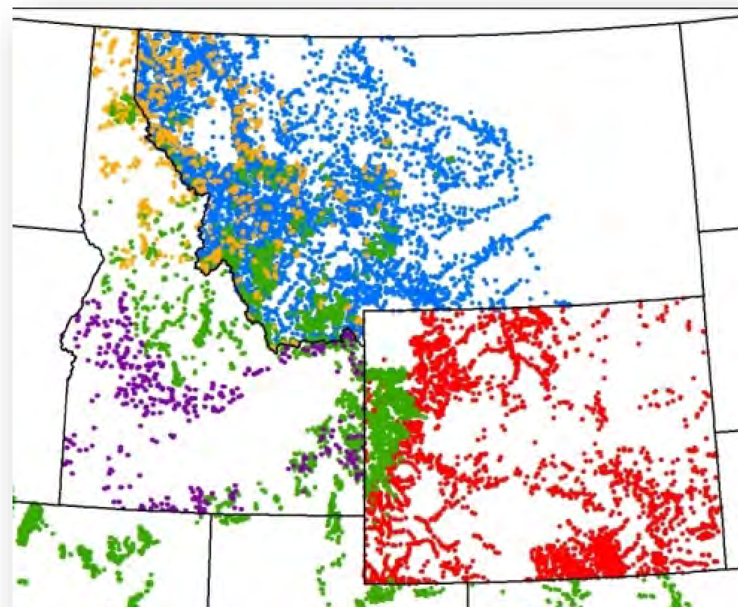
**I'm going to invest here…**

**…instead of here**

# We were Swimming in Un-usable Data

**>20,000 stream temperature sites**

**>13,000 fish sample sites**



# Grants Funded a SECRET WEAPON

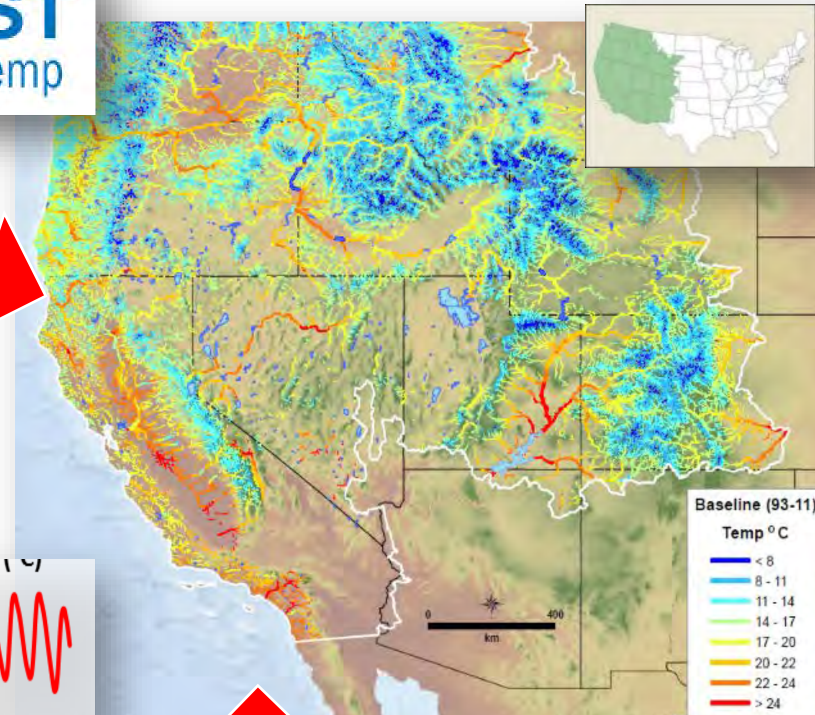
a.k.a. A Database Team

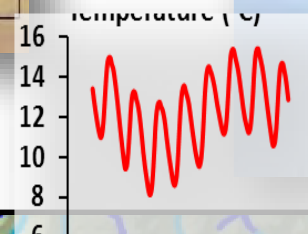
# Messy Data → Database → Precise Climate Scenarios

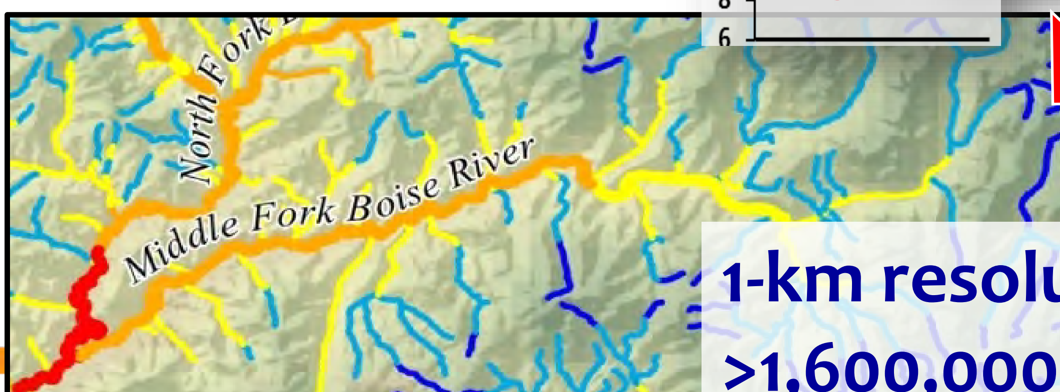
NorWeST Stream Temp

>200,000,000 hourly records

>20,000 unique stream sites



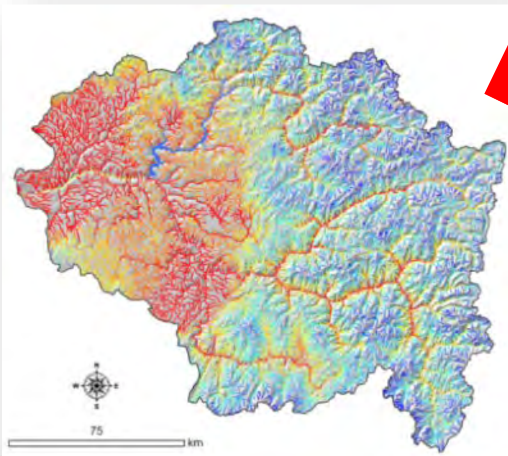

**101 National Forests**

**1-km resolution**

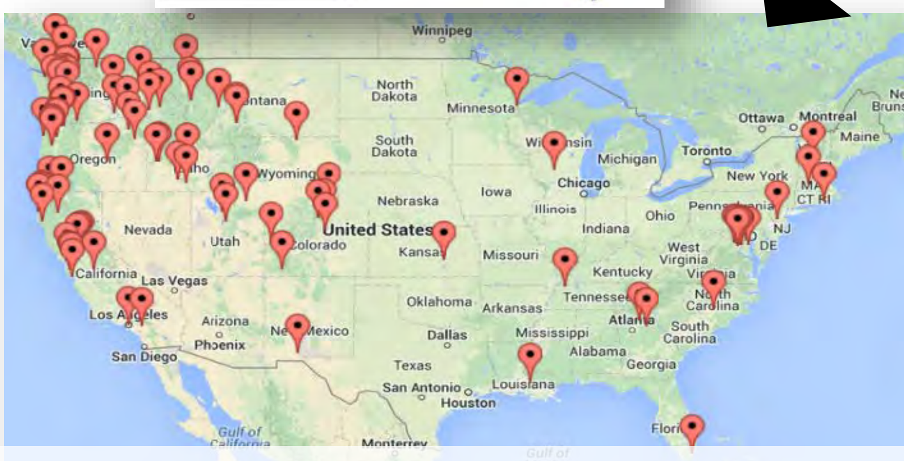
**>1,600,000 stream kilometers**

# Custom Website Distributes Data Products in User-Friendly Digital Formats

**1) GIS shapefiles of stream temperature scenarios**




**Google "NorWeST temperature"**

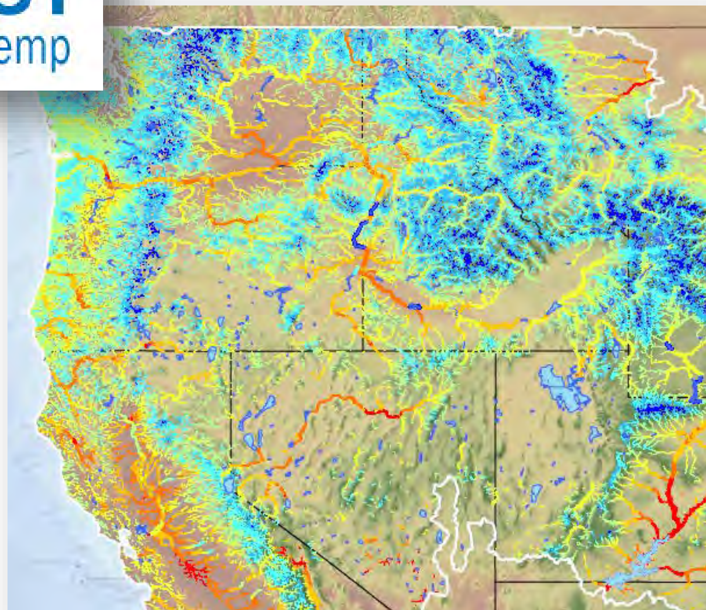




**40-50 visits/day; 12,000 visits/year**

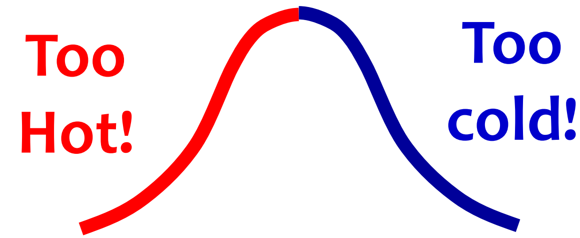
**2) Temperature data**

# Temperature Applications

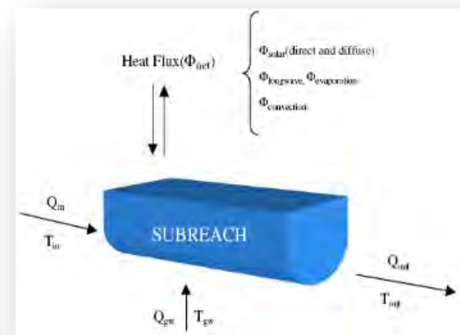
NorWeST Stream Temp

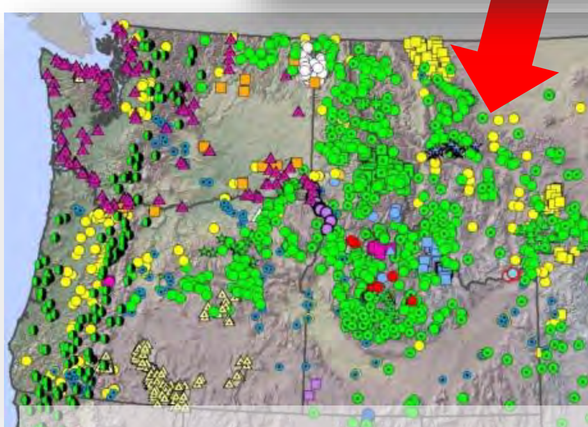


Regulatory temperature standards

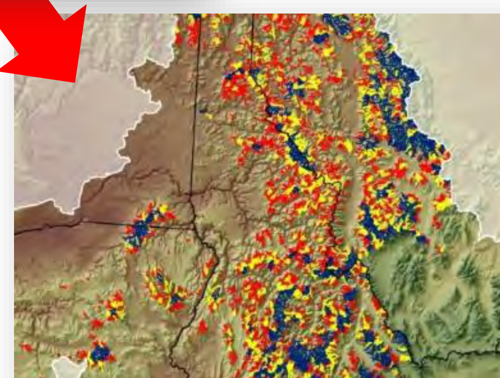



Data access accelerates temperature R&D



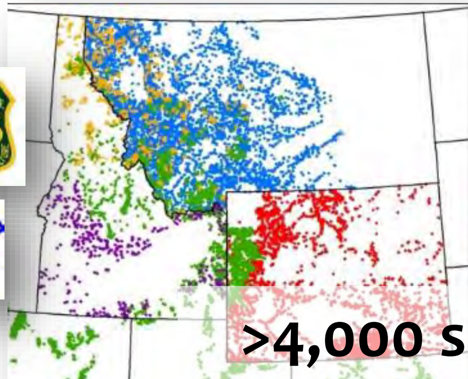
Coordinated Interagency monitoring



Species distribution models & climate assessments

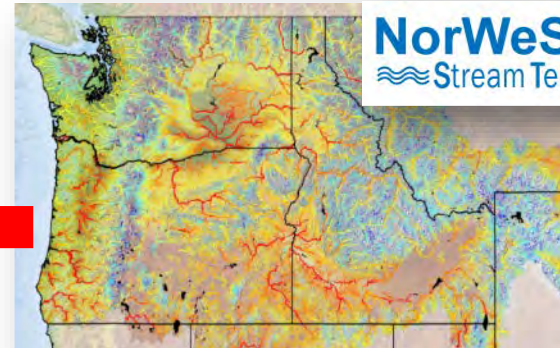
# Precise Species Distribution Models to Highlight Climate Refugia

**BIG FISH DATA**

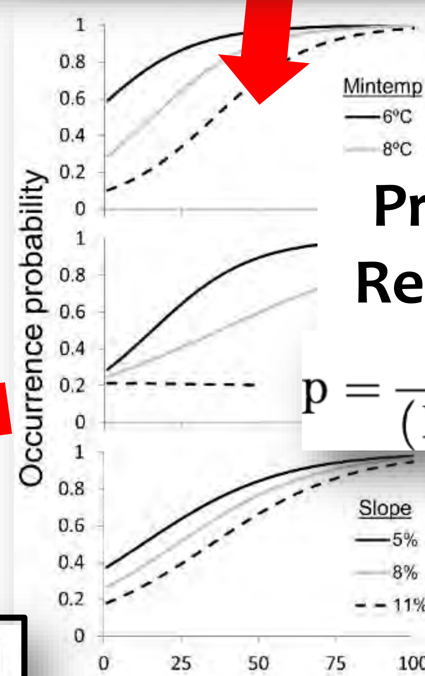


>4,000 sites

>500 streams



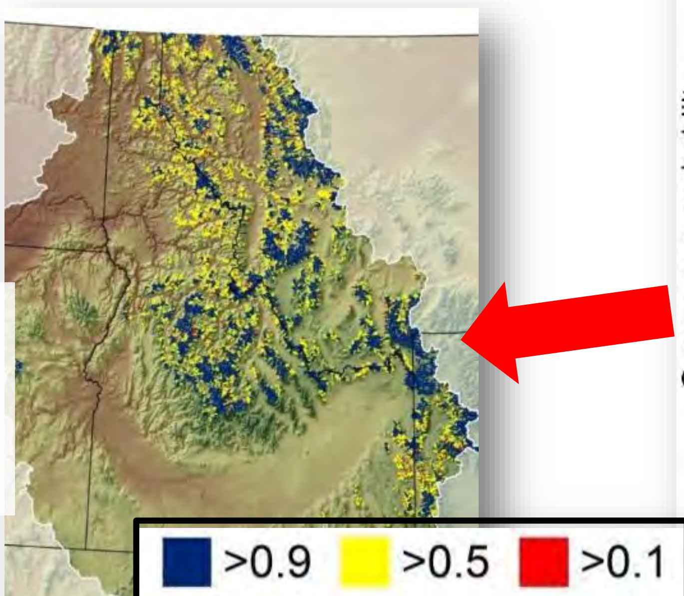

Climate Shield




**Predictive Logistic Regression Models**

$$p = \frac{\exp(a + bx \ldots ny)}{(1 + \exp[a + bx \ldots ny])}$$

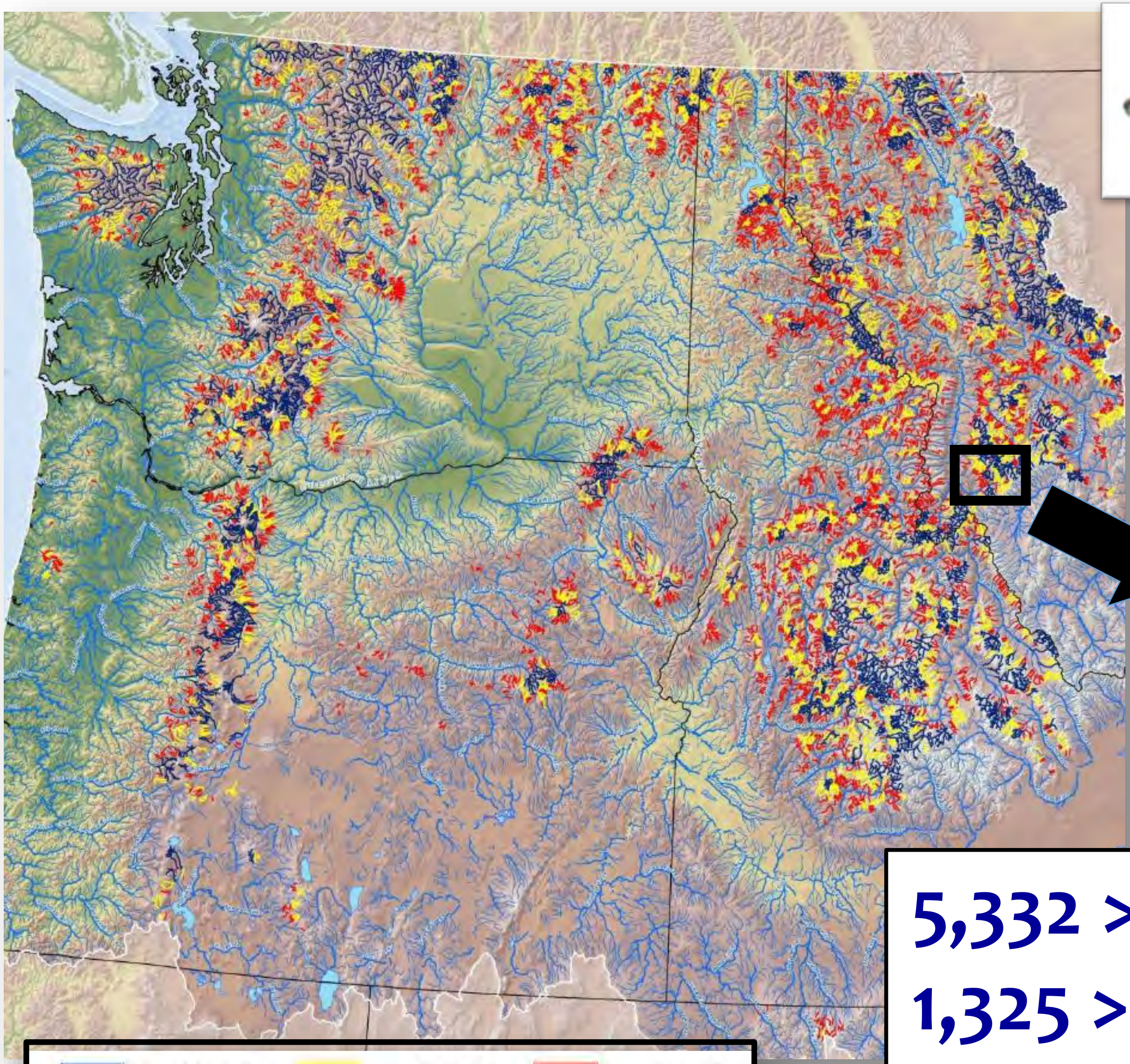
**Occurrence probability maps**



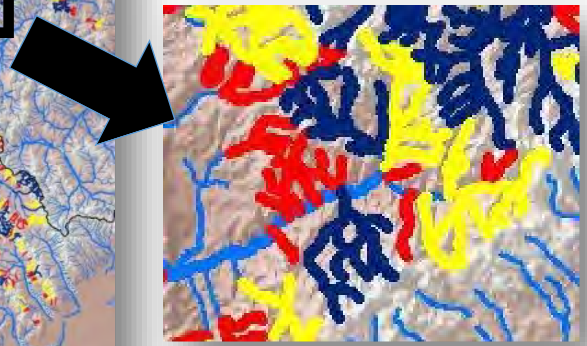

Isaak et al. 2015. The cold-water climate shield: Delineating refugia for preserving native trout through the 21st Century. *Global Change Biology* **21:** 2540-2553

# Bull Trout Probability Map

**1980s**



**Stream population scale predictions**

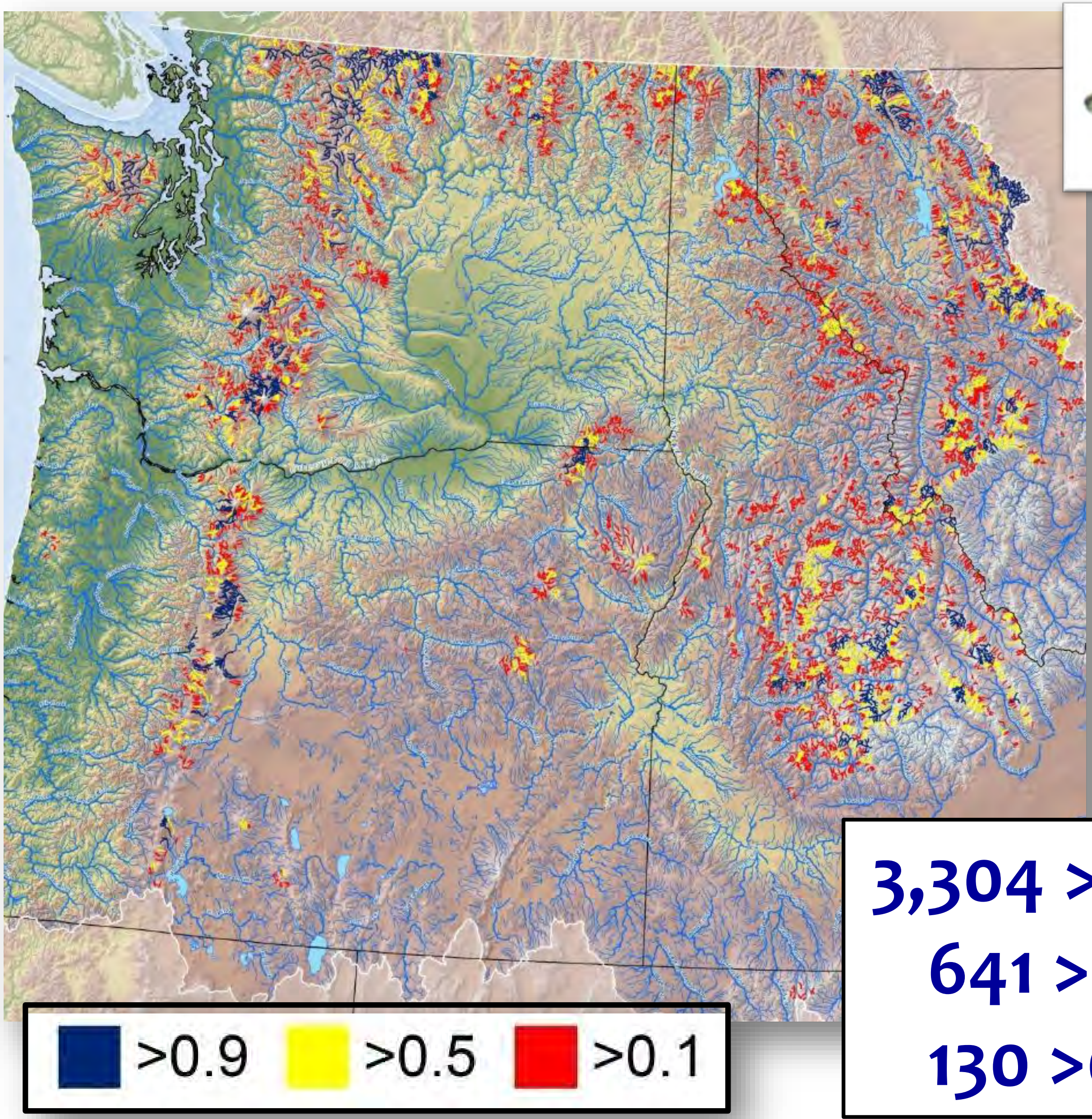


>0.9 >0.5 >0.1

**5,332 >0.1 habitats**
**1,325 >0.5 habitats**
**348 >0.9 habitats**

# Bull Trout Probability Map

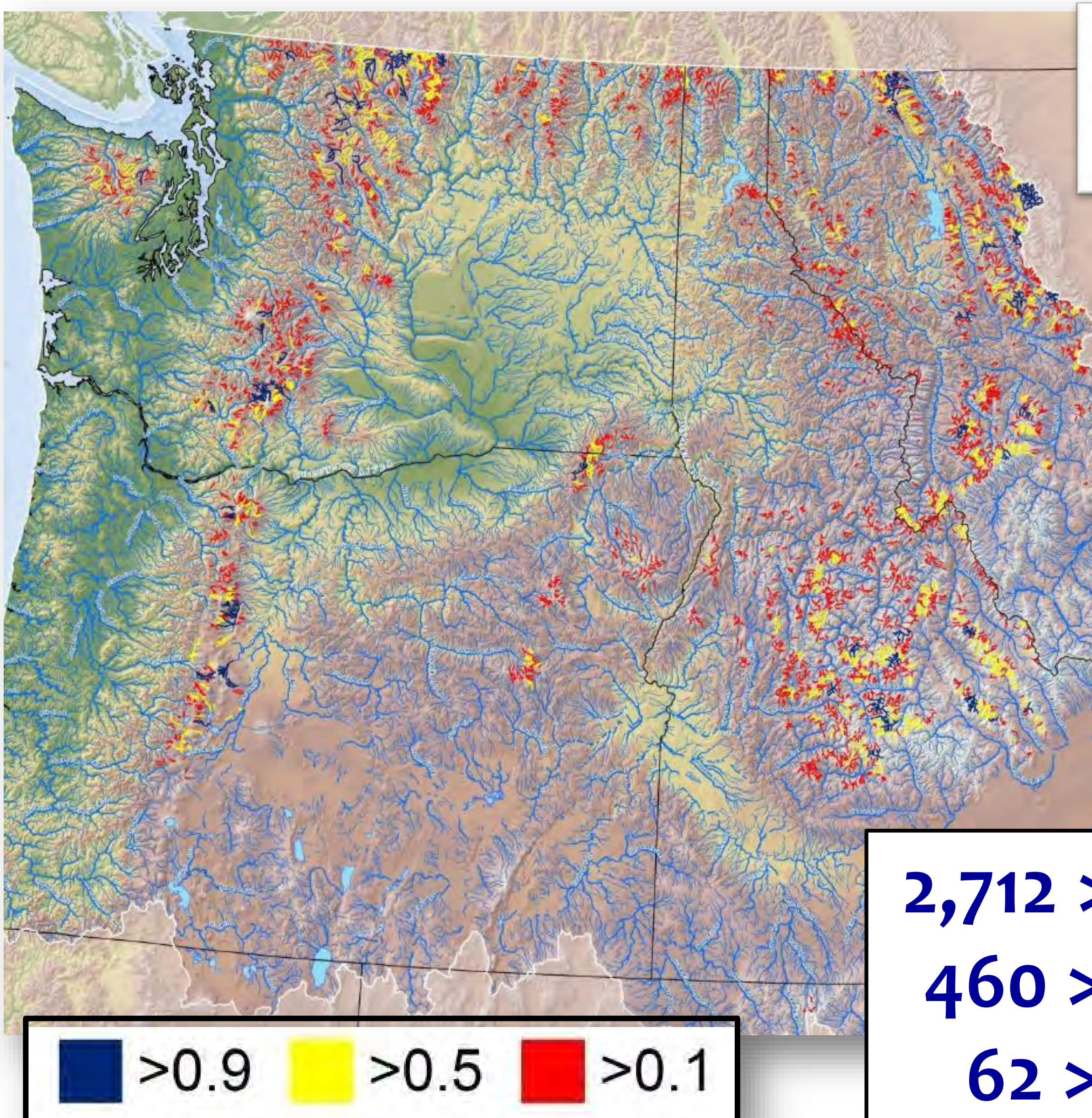
**2040s**




**3,304 >0.1 habitats**
**641 >0.5 habitats**
**130 >0.9 habitats**

# Bull Trout Probability Map

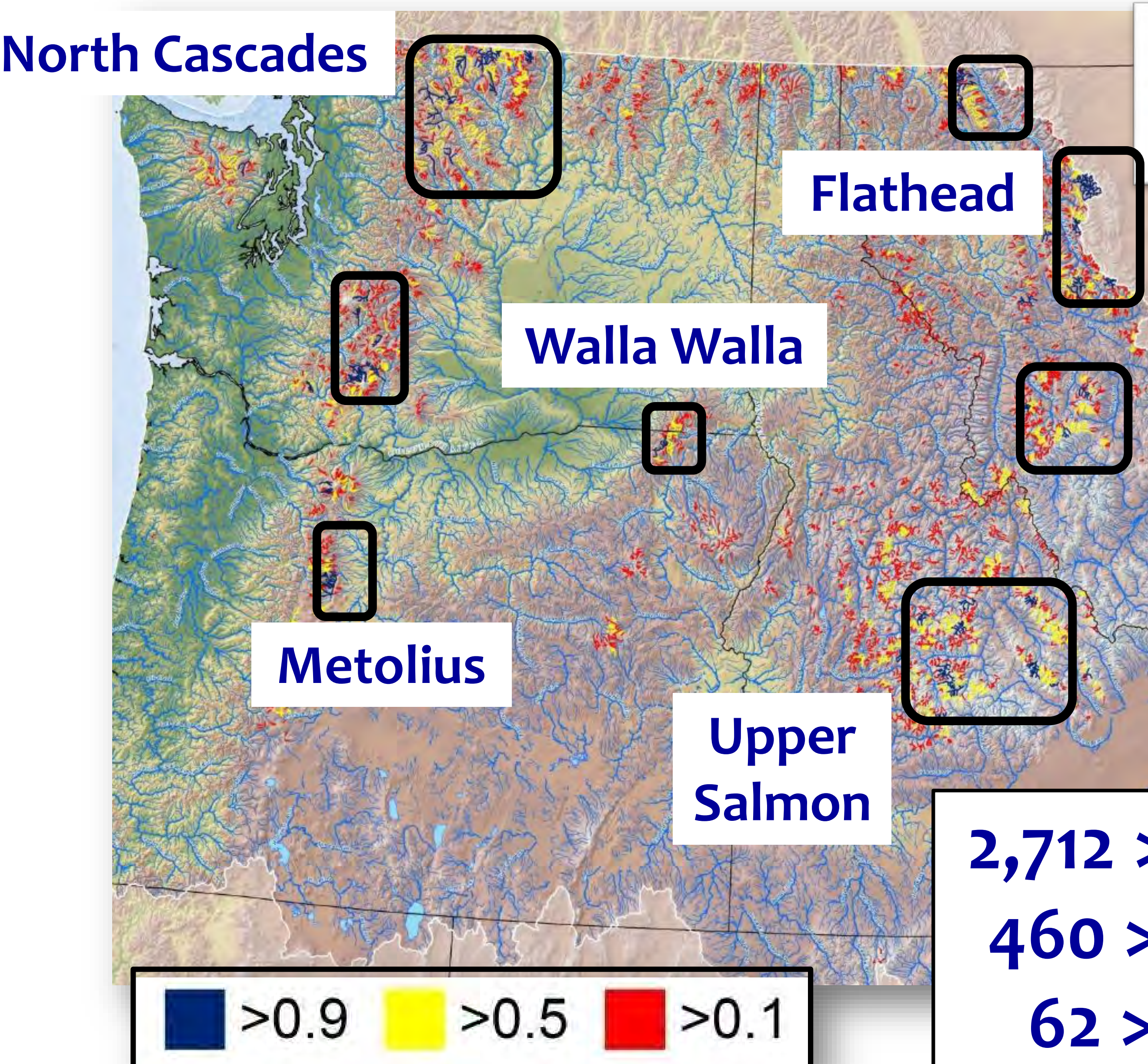
**2080s**




**2,712 >0.1 habitats**
**460 >0.5 habitats**
**62 >0.9 habitats**

# Bull Trout Probability Map

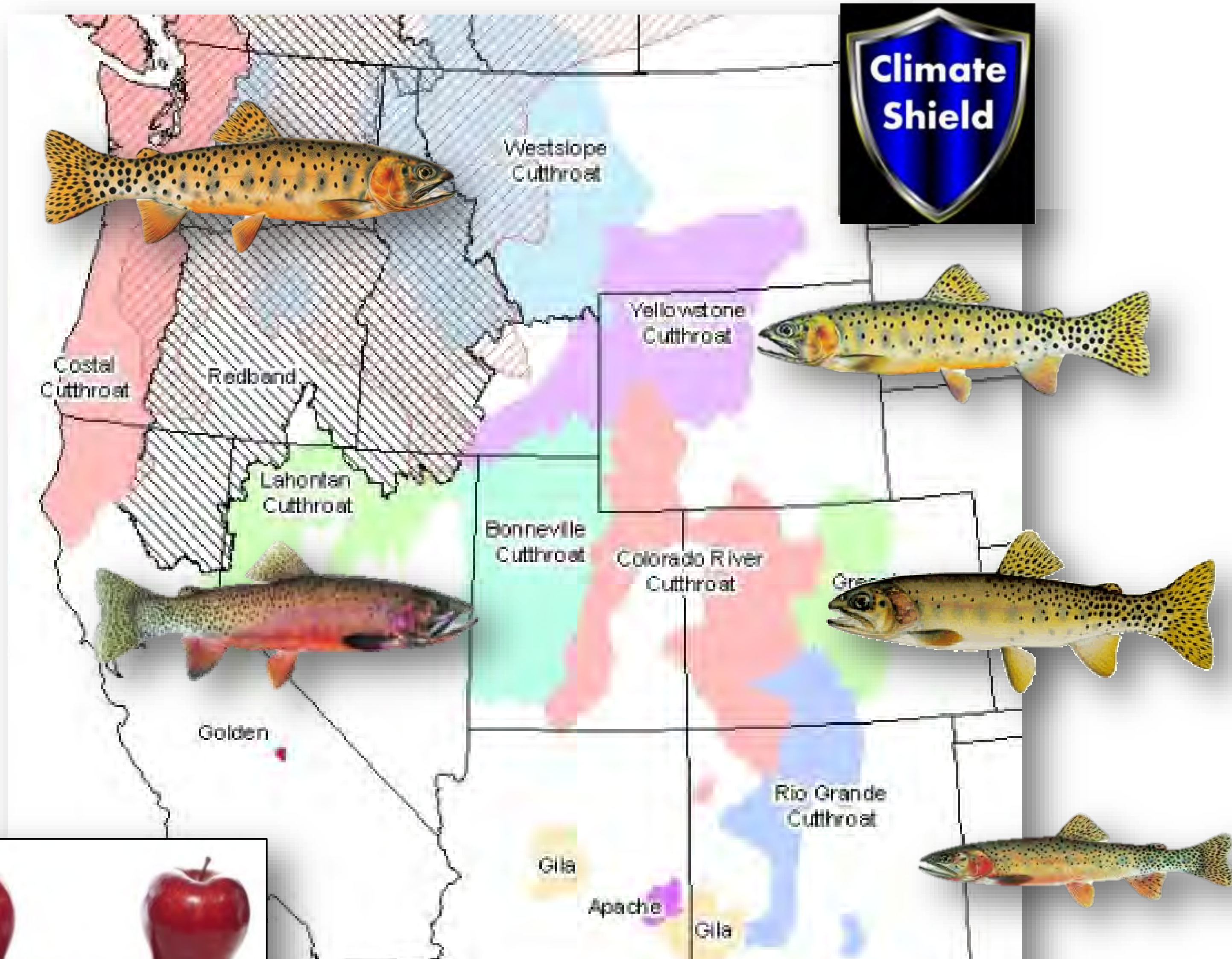
**2080s**

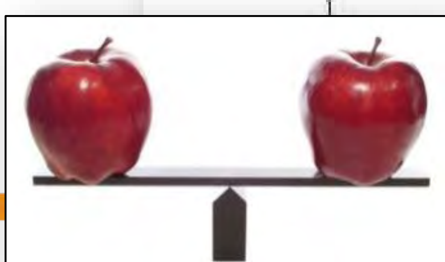



**Extreme scenario!**
**+5°C**

2,712 >0.1 habitats
460 >0.5 habitats
62 >0.9 habitats

# All Cutthroat Trout Streams Too



**Consistent for all Rocky Mountain Streams**

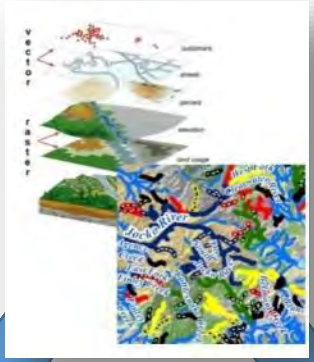
# Website Provides Information in User-Friendly Digital Formats

Climate Shield

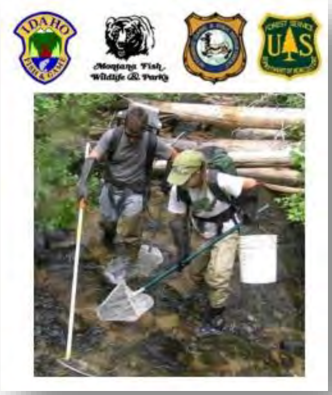
## Google "Climate shield trout"

Presentations & Publications

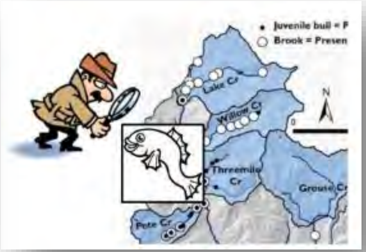

Digital Maps & ArcGIS Shapefiles



Fish Data Sources



Distribution Monitoring



## File formats:

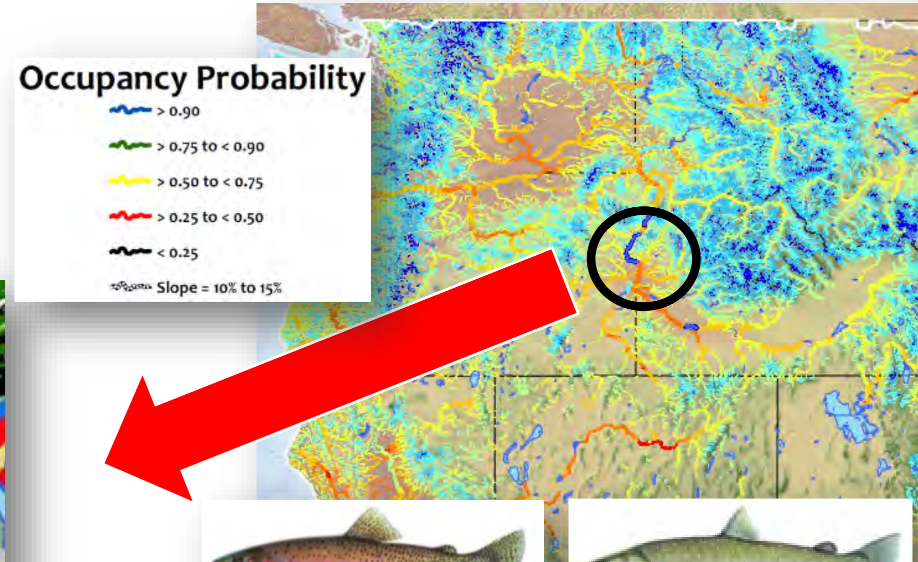
- ArcGIS files
- pdf files

## 15 Scenarios:

- 3 climate periods
- 5 Brook invasion levels

# Precise Information Across Broad Scales

**Empowers local decision makers & facilitates agency planning**





**Highest priority conservation investment!**

# Aquatic Management Issues

- ESA and species conservation
- Roads, grazing, mining, veg management
- Fragmented landscapes (FS and all lands)
- Hybridization and competition
- Climate Change
- Limited Resources

# Northern Region
# Forest Service Investment Strategy

- Region-wide issues and science application need
- RMRS partnership and proposals
- FS Northern Region Investment Management (RIM) Board
- Must be funding synergies (e.g., Great Northern LCC)
- **Published work is expectation**

# Essential Products

**(CC: temp, flow and spp distribution; eDNA, genetic baselines and hybridization)**


Isaak, D.J., Wenger, S.J., Peterson, E.E., Ver Hoef, J.M., Hostetler, S.W.; Luce, C.H., Dunham, J.B.; Kershner, J.L.; Roper, B.B., Nagel, D.E., Chandler, G.L., Wollrab, S.P., Parkes, S.L., Horan, D.L. 2016. NorWeST modeled summer stream temperature scenarios for the western U.S. Fort Collins, CO: Forest Service Research Data Archive. https://doi.org/10.2737/RDS-2016-0033.

Wenger, S.J., C.H. Luce, A.F. Hamlet, D.J. Isaak and H.M. Neville. 2010. Macroscale hydrologic modelling of ecologically relevant flow metrics. Water Resources Research, Vol. 46, W09513, doi:10.1029/2009WR008839

Isaak, D., M. Young, D. Nagel, D. Horan, and M. Groce. 2015. The cold-water climate shield: Delineating refugia for preserving salmonid fishes through the 21st Century. Global Change Biology. 21:2540-2553.

McKelvey, K. S., Young, M. K., Wilcox, T. M., Bingham, D. M., Pilgrim, K. L. and Schwartz, M. K. (2016). Patterns of hybridization among cutthroat trout and rainbow trout in northern Rocky Mountain streams. Ecol Evol, 6: 688–706. doi:10.1002/ece3.1887

Young M.K., Isaak D.J., McKelvey K.S., Wilcox T.M., Bingham D.M, Pilgrim K.L. (2016). Climate, Demography, and Zoogeography Predict Introgression Thresholds in Salmonid Hybrid Zones in Rocky Mountain Streams. PLoS ONE 11 (11): e0163563. doi:10.1371/journal.pone.0163563

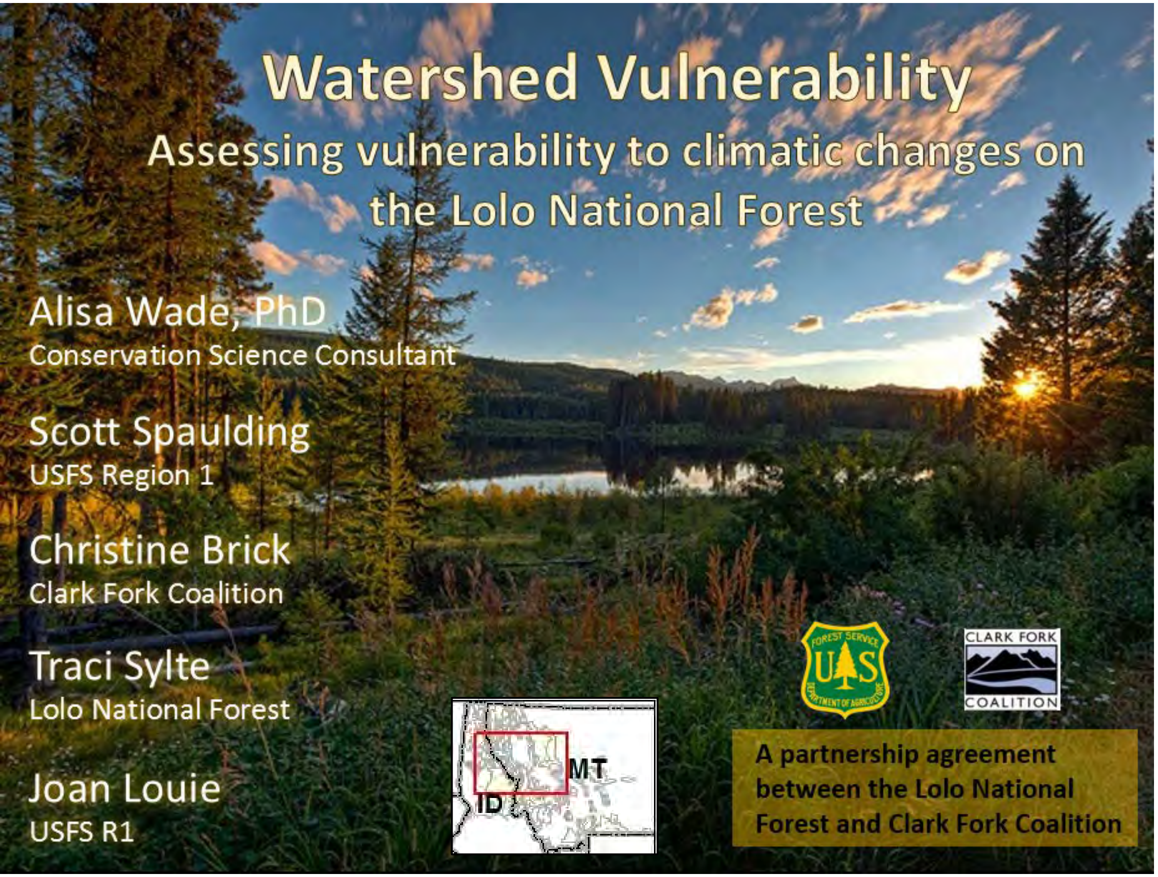
McKelvey, K.S.; Young, M.K.; Knotek, E.L.; Wilcox, T.M.; Carim, K.J.; Padgett, T.M.; Schwartz, M. Sampling large geographic areas for rare species using eDNA: A preliminary study of bull trout *Salvelinus confluentus* occupancy in western Montana. K. 2016. Journal of Fish Biology. 88: 1215–1222. doi:10.1111/jfb.12863.

Peterson, D. P.; Wenger, S.J.; Rieman, B.E.; Isaak, D.J. 2013. Linking climate change and fish conservation efforts using spatially explicit decision support tools. Fisheries. 38(3): 112-127 + 58 pages of appendices.

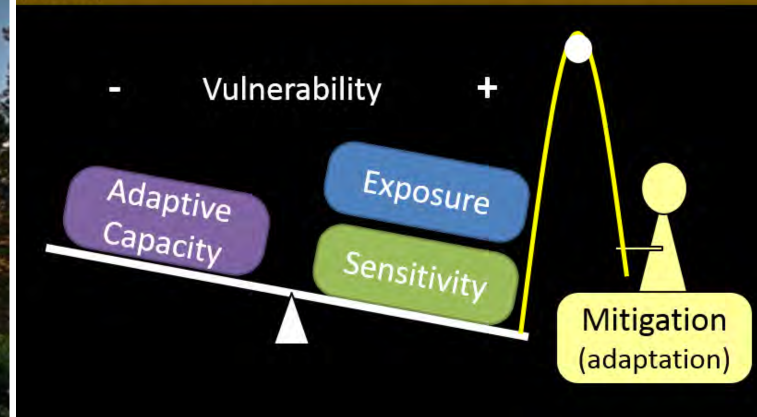
Peterson, D. P.; Rieman, B.E.; Young, M.K., Brammer J.A. 2013. Modeling predicts that redd trampling by cattle may contribute to population declines of native trout. Ecological Application, 20(4):954-966.

# Examples

- CC and Watershed Vulnerability Assessment, Lolo National Forest
- Wilderness, Fish Management and Bull trout occupancy models
- eDNA and management applications




Vulnerability ~ f(Exposure, Sensitivity, Adaptive Capacity)
(IPCC 2007)




## Vulnerability Assessment Goals

- Understand magnitude of potential climatic changes on LNF
- Conceptualize relative vulnerability of forest resources that may be affected
- Help managers prioritize actions for improving or maintaining resiliency

# Our Approach

**LNF & USFS R1 chose 3 resource areas for vulnerability assessment:**

1. Aquatics
   - Bull trout
   - Pearlshell mussel
2. Water Supply
3. Infrastructure
   - Recreation sites
   - Trails
   - Forest-jurisdiction roads


Resource Area:

# Bull Trout Conceptual Model

## Exposure

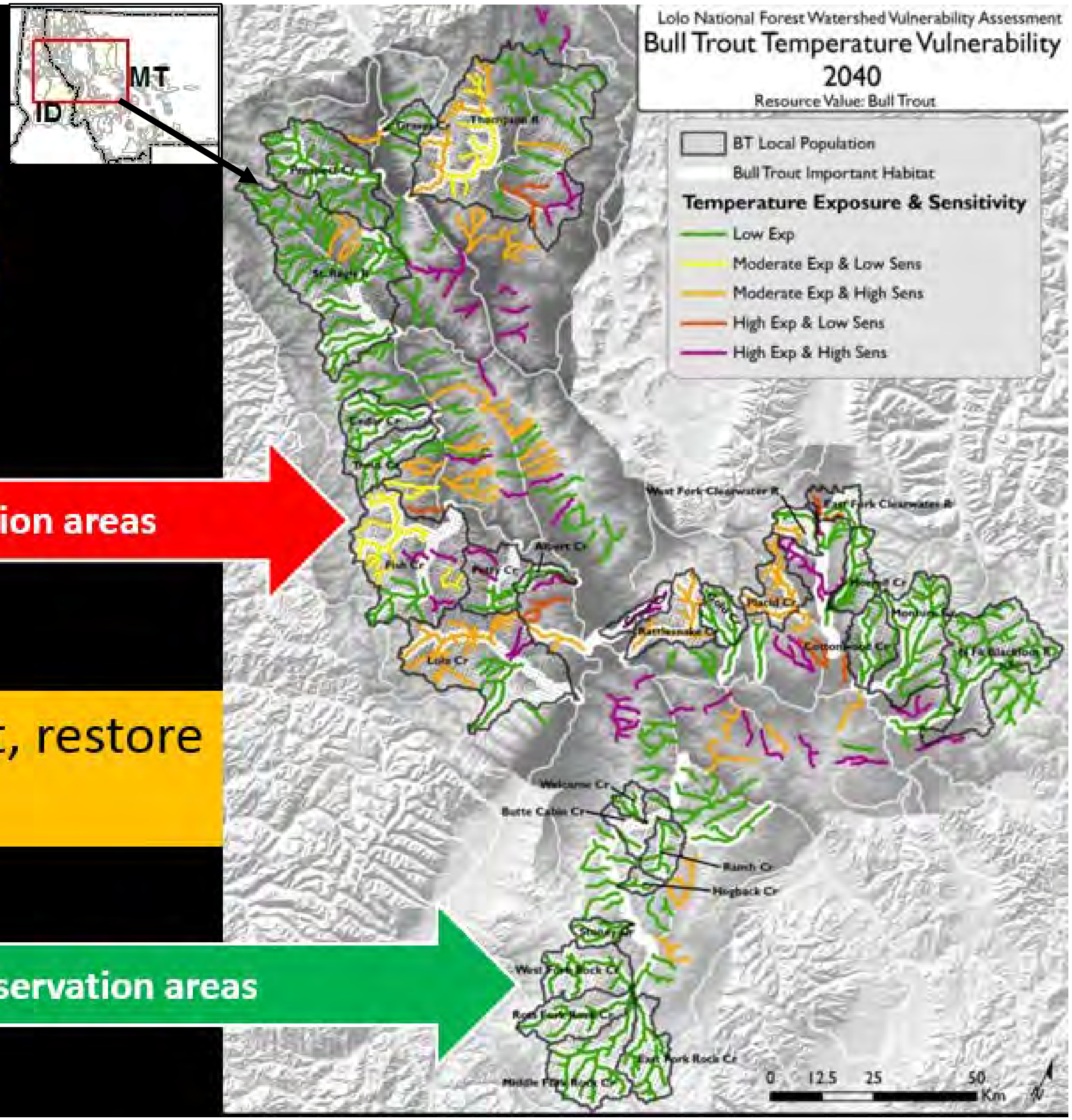
- Reduced thermally suitable habitat
- Winter flood scour
- Reduced summer flow

## Sensitivity

- Low population size/viability
- Presence of Brook trout
- Low stream connectivity
- Increased sediment
  - Road crossings, roads near streams
- Low channel complexity
  - Riparian cover, roads near streams, grazing
- Water diversions
- Low stream-floodplain connection

Resource Area:

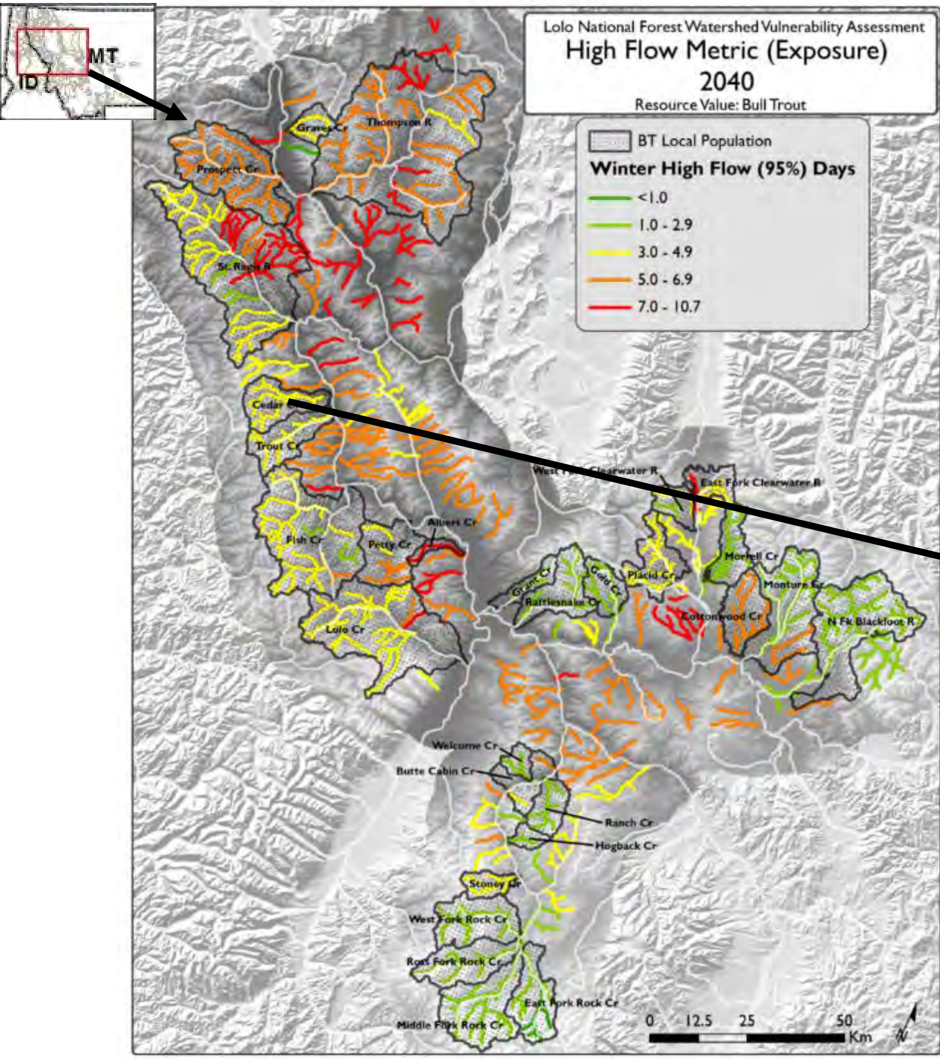
# Bull Trout: Temperature Vulnerability




**Priority restoration areas**

"Protect the best, restore the rest"

**Priority conservation areas**




# Cedar Creek Habitat Restoration and Road Relocation

Northern Region | Lolo National Forest | Superior Ranger District

| | |
|---|---|
| State- Montana | Congressional District- 1 |
| FY2015 Accomplishment | |
| Partners- Trout Unlimited | Forest Service Contribution- $365,000 |
| Target Species- Bull trout & Westslope cutthroat trout | Partner Contribution- $90,600 |

2015 Accomplishments

- Realign 1 mile of stream adjacent road to reduce impacts on the stream and regain historic floodplain.
- Construct 111 large woody debris (LWD) jams in a 2 mile reach to provide overwintering habitat, substrate sorting for spawning bull and westslope cutthroat trout, and rehabilitate the stream towards more natural ranges of structure and function.

Cedar Creek is an important bull trout and westslope cutthroat fishery in the Clark Fork River basin. Historically Cedar Creek had a railroad and was placer mined with substantive riparian logging and road building in the narrow valley bottom. The stream is over-straightened with localized incision and lacks habitat complexity and floodplain connectivity. More work is needed to address other road segments and impacts to sediment loads, LWD, shade, and natural channel meander processes.

Existing Road & Impacted Stream

New Subgrade (left) for Road to be Relocated

Wood Jam Installations

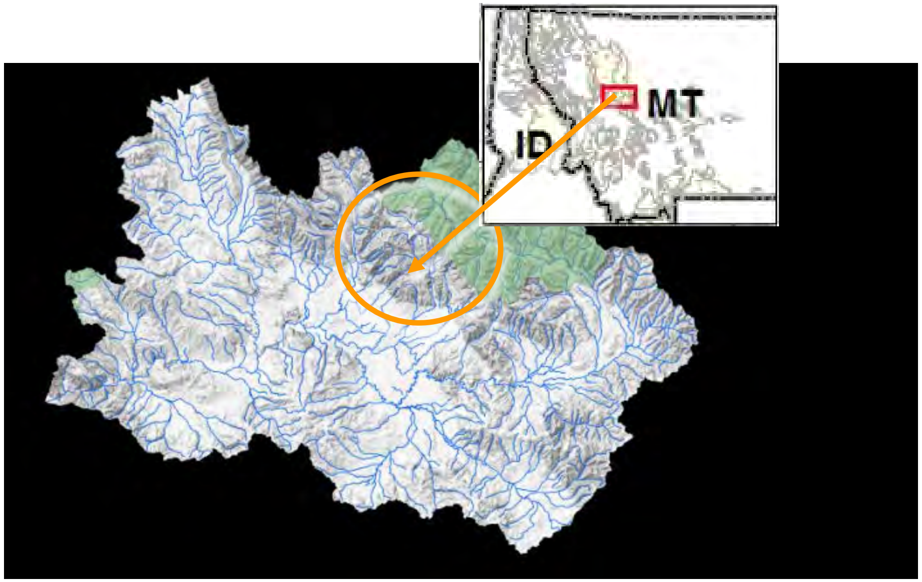
(designed and installed to meet site specific morphologic, habitat, & integrity criteria)

Project location and objectives tie in with *Western Montana Bull Trout Conservation Strategy* by concentrating on those streams that are the most important to ESA listed fish, and focusing on the degraded habitat metrics that have the greatest potential to improve bull trout at the subpopulation level. USFWS consultation was through Section 10(a)(1)(A) Recovery Permit intended to foster the recovery of listed species.

Project Contact: Jon Hanson 406-822-3919 jrhanson@fs.fed.us

# Bull trout "translocation" in the Scapegoat Wilderness?

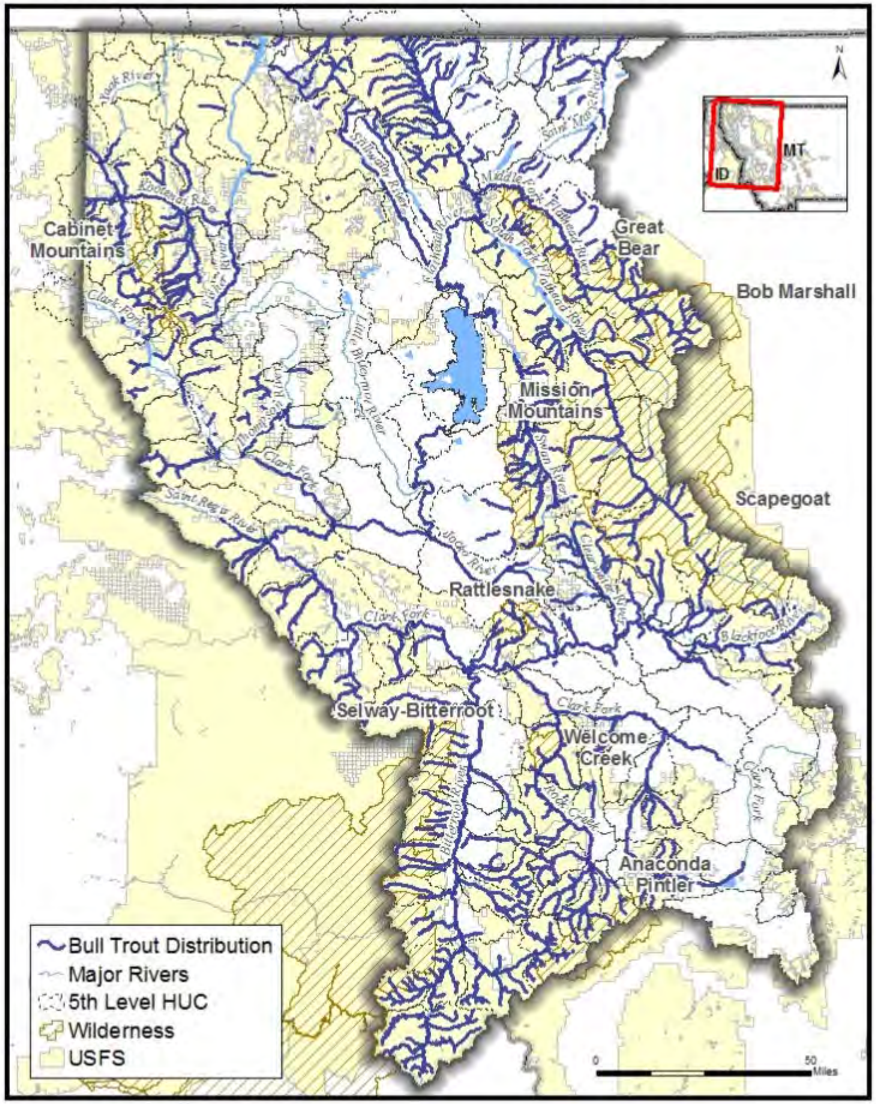
Upper North Fork of the Blackfoot River



# Questions Addressed

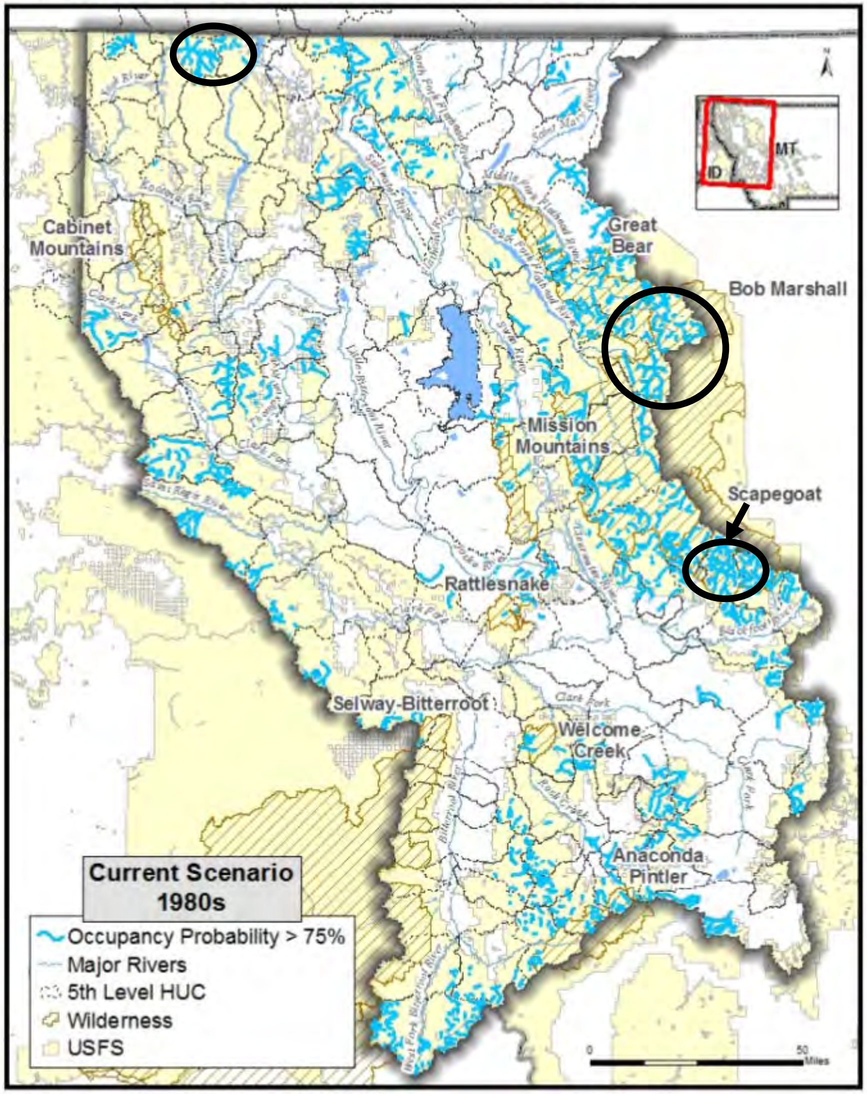
- Why here, why now?
- Where do opportunities lie: in and out of Wilderness
- How extensive is a “suitable unoccupied” network (to meet bull trout life history needs)?
- Why is “suitable unoccupied” not occupied?
- How is suitability expected to change with climate forcing over time?

Western Montana - Current Bull Trout Distribution




Western Montana - Potential Bull Trout Restoration Networks

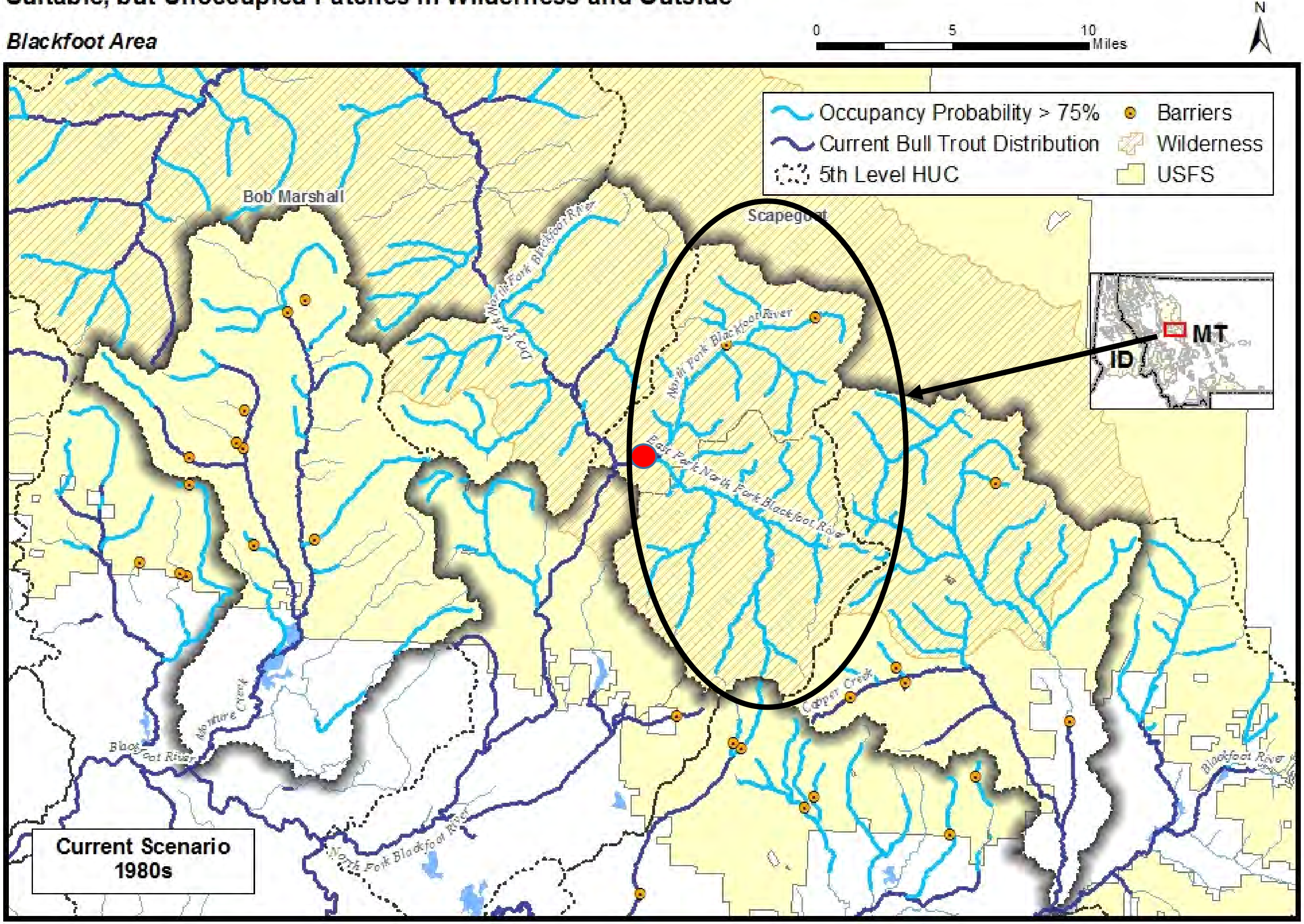
Suitable, but Unoccupied Patches in Wilderness and Outside



## Western Montana - Potential Bull Trout Restoration Networks

### Suitable, but Unoccupied Patches in Wilderness and Outside

*Blackfoot Area*



## Blackfoot River Sub-basin

| 5th code HUC | Miles currently occupied | unoccupied (current) | unoccupied (2040) | rcent Reduction (t1 to t2) | index (roads, plus grazing) |
|---|---|---|---|---|---|
| Keep Cool (Blackfoot) | | | | | |
| Non-W | 63 | 58.4 | 31.5 | 46% | High |
| Landers Fork (Blackfoot) | | | | | |
| Non-W | 26.5 | 10.3 | 3.8 | 63% | Low/Mod |
| W (Scapegoat) | 0 | 60.4 | 22 | 64% | Low |
| Headwaters (Blackfoot) | | | | | |
| Non-W | 19.2 | 25 | 0 | 100% | High |
| Nevada Creek (Blackfoot) | | | | | |
| Non-W | 29 | 27.6 | 14.3 | 48% | High |
| NFK Blackfoot (Dry Fork) | | | | | |
| Non-W | 8 | 7.3 | 7.3 | 0% | Low |
| W (Scapegoat) | 0 | 34.4 | 26.6 | 23% | Low |
| NFK Blackfoot (Upper) | | | | | |
| W (Scapegoat) | 3.5 | 82.2 | 62 | 25% | Low |
| NFK Blackfoot (Lower) | | | | | |
| Non-W | 42.9 | 15.1 | 0 | 100% | High |
| Monture (Blackfoot) | | | | | |
| Non-W | 42.1 | 42.2 | 38.6 | 9% | Low/mod |
| Cottonwood (Blackfoot) | | | | | |
| Non-W | 73.4 | 23.1 | 0 | 100% | High |
| Clearwater River | | | | | |
| Non-W | 100.3 | 20.5 | 4.2 | 80% | High |
| Placid | | | | | |
| Non-W | 12.5 | 14.6 | 0 | 100% | High |
| Gold Creek | | | | | |
| Non-W | 40.5 | 3.9 | 0 | 100% | High |
| W (Rattlesnake) | 0 | 2.9 | 0 | 100% | Low |

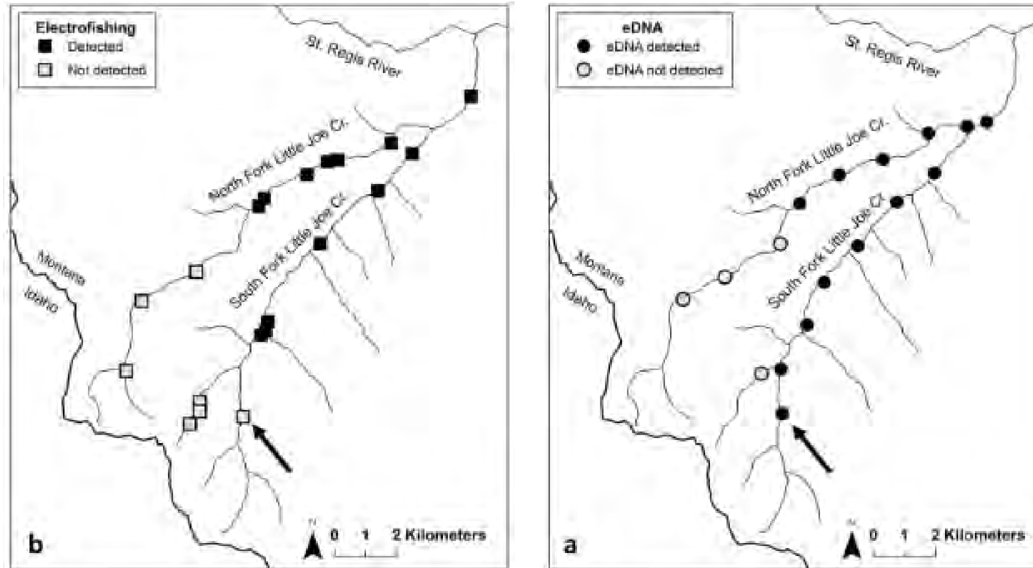
Low current occupancy, nearly 80 miles suitable projected to persist in the W in 2040

Non W opportunity?

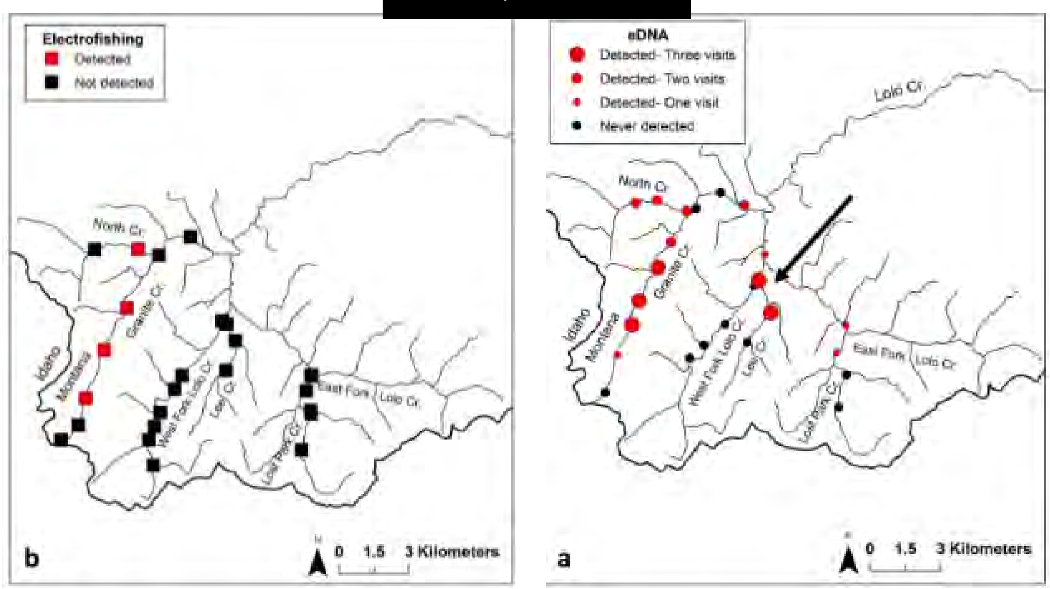
# Using eDNA sampling to detect bull trout

- Threatened under ESA
- Dictates land & water management & planning
- Widespread - rare
- Difficult to detect
- Juveniles constrained by water temperature
- = ideal candidate for eDNA sampling

- Test: Montana 2014
- Confirmed known habitats
- Discovered new ones




McKelvey et al. 2016



# Questions & Answers

- **By phone:** **Dial #2 to enter the queue.**
- **On your computer:** **Type your question into the Q & A pod on the left side of your screen.**

# Adapting to Climate Change in Northeastern Freshwater Ecosystems: Science and Science Needs

**Keith H. Nislow**

**USDA Forest Service Northern Research Station**

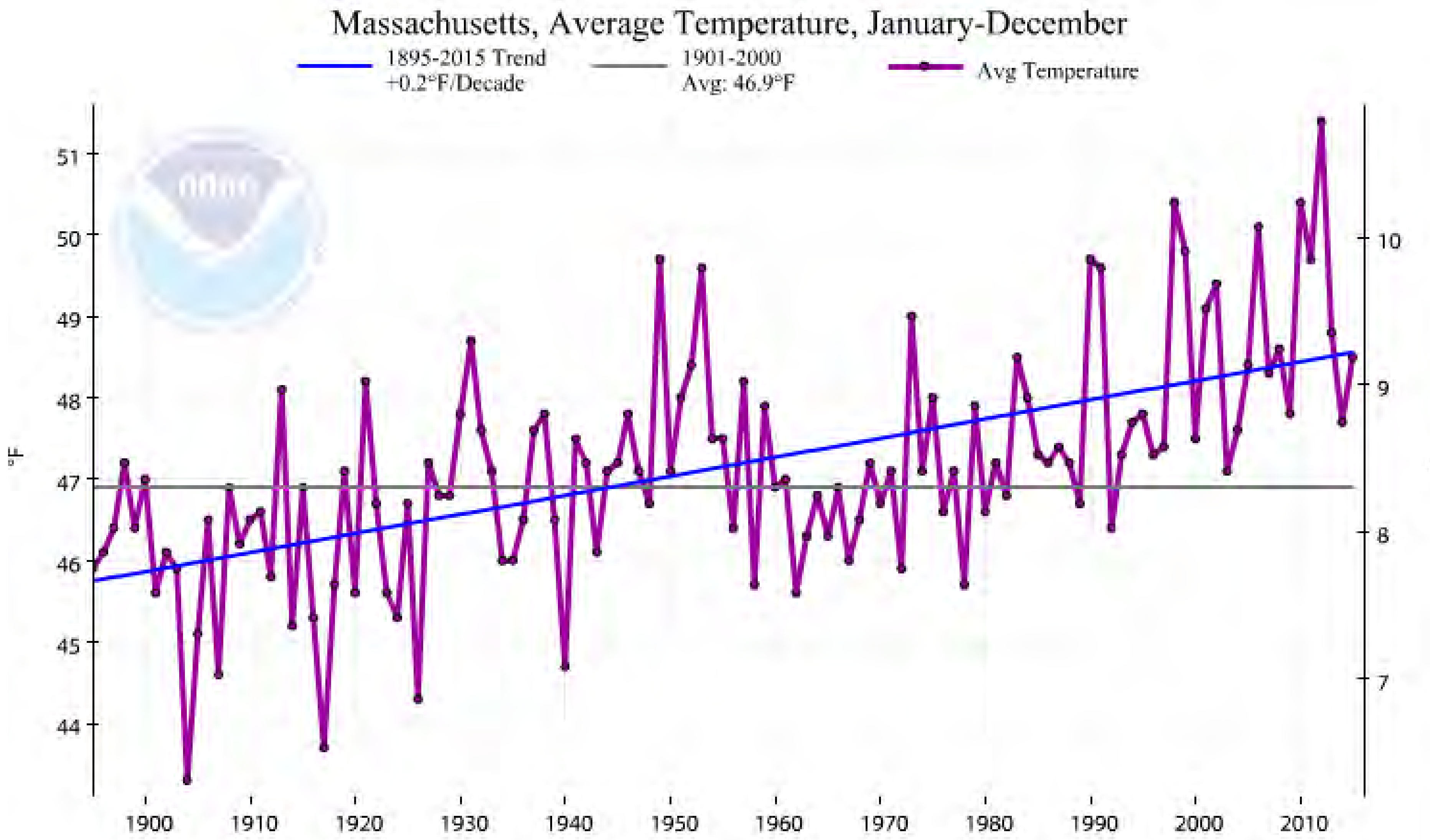
Eastern Brook Trout
JOINT VENTURE

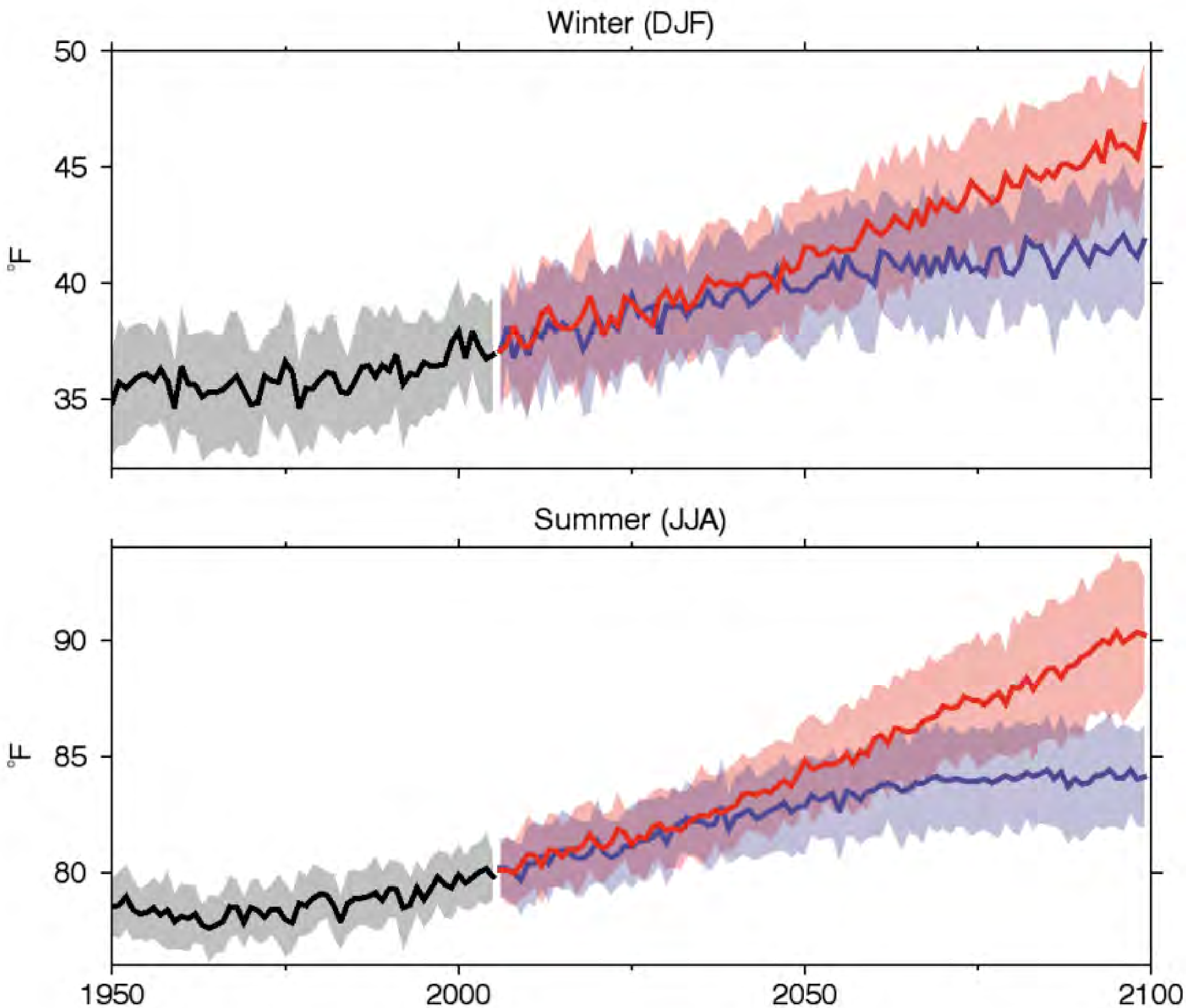

EXPLANATION

Landscape Conservation Cooperatives in the Northeast CSC region

- 1. Appalachian
- 10. North Atlantic
- 14. South Atlantic
- 4. Eastern Tallgrass Prairie and Big Rivers
- 9. Gulf Coastal Plains and Ozarks
- 13. Plains and Prairie Potholes
- 16. Upper Midwest and Great Lakes

Approximate boundary of Climate Science Center (CSC)


Massachusetts, Average Temperature, January-December
1895-2015 Trend
+0.2°F/Decade
1901-2000
Avg: 46.9°F
Avg Temperature
°F
°C
51
50
49
48
47
46
45
44
10
9
8
7
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010



Winter (DJF)
50
45
40
35
°F
Summer (JJA)
90
85
80
°F
1950
2000
2050
2100

# Climate Change and Forest Service Research in the East

- Understand mechanisms to improve science support
- Consider changes in the frequency and magnitude of extreme events
- Incorporate multiple dimensions of adaptation
- Provide data platforms and decision support tools

## Ben Letcher

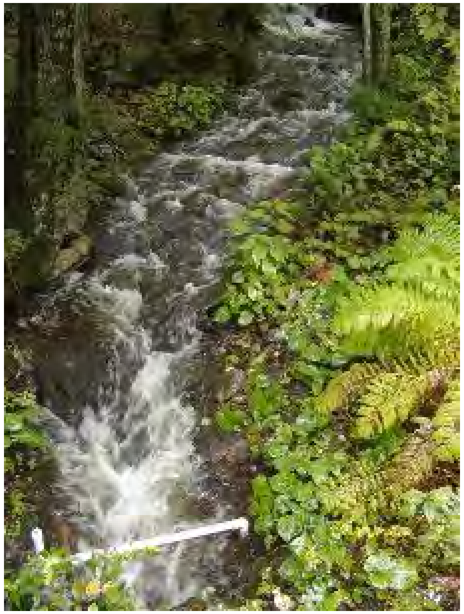
Yoichiro Kanno, Ron Bassar, Evan Childress, Paul Schueller, Matt O'Donnell, Todd Dubreuil

## Jason Coombs

## Andrew Whiteley

Department of Natural Resources Conservation UMass, Amherst, MA, USA Conte Anadromous Fish Research Center, U.S. Geological Survey, Turners Falls, MA, USA





North Atlantic LCC

USGS science for a changing world

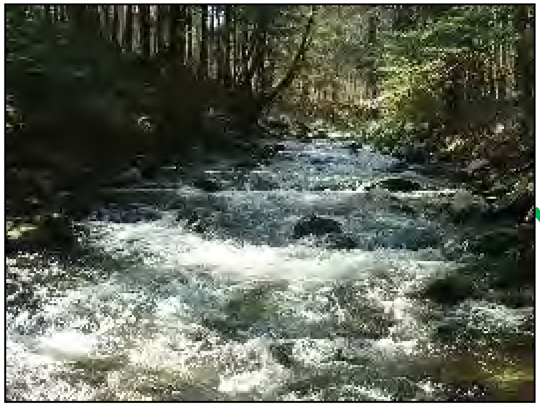
University of Massachusetts Amherst 1863

NECSC Northeast Climate Science Center

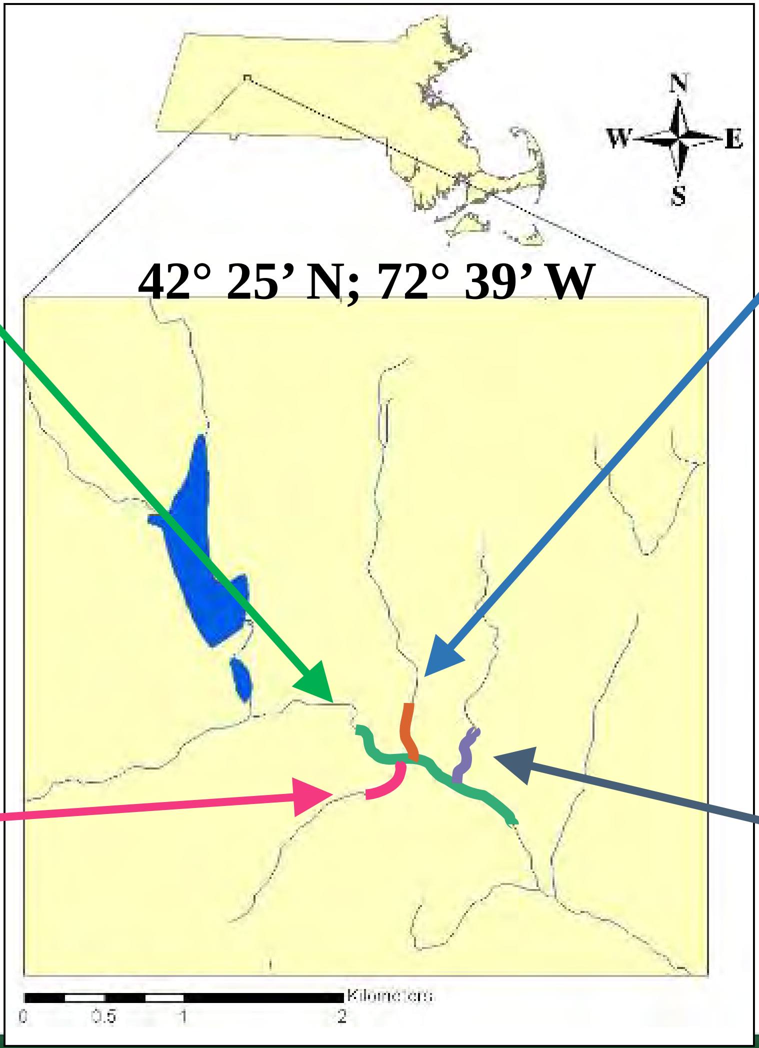
The Nature Conservancy Protecting nature. Preserving life.

# Understand mechanisms to improve science support

West Brook (WB)

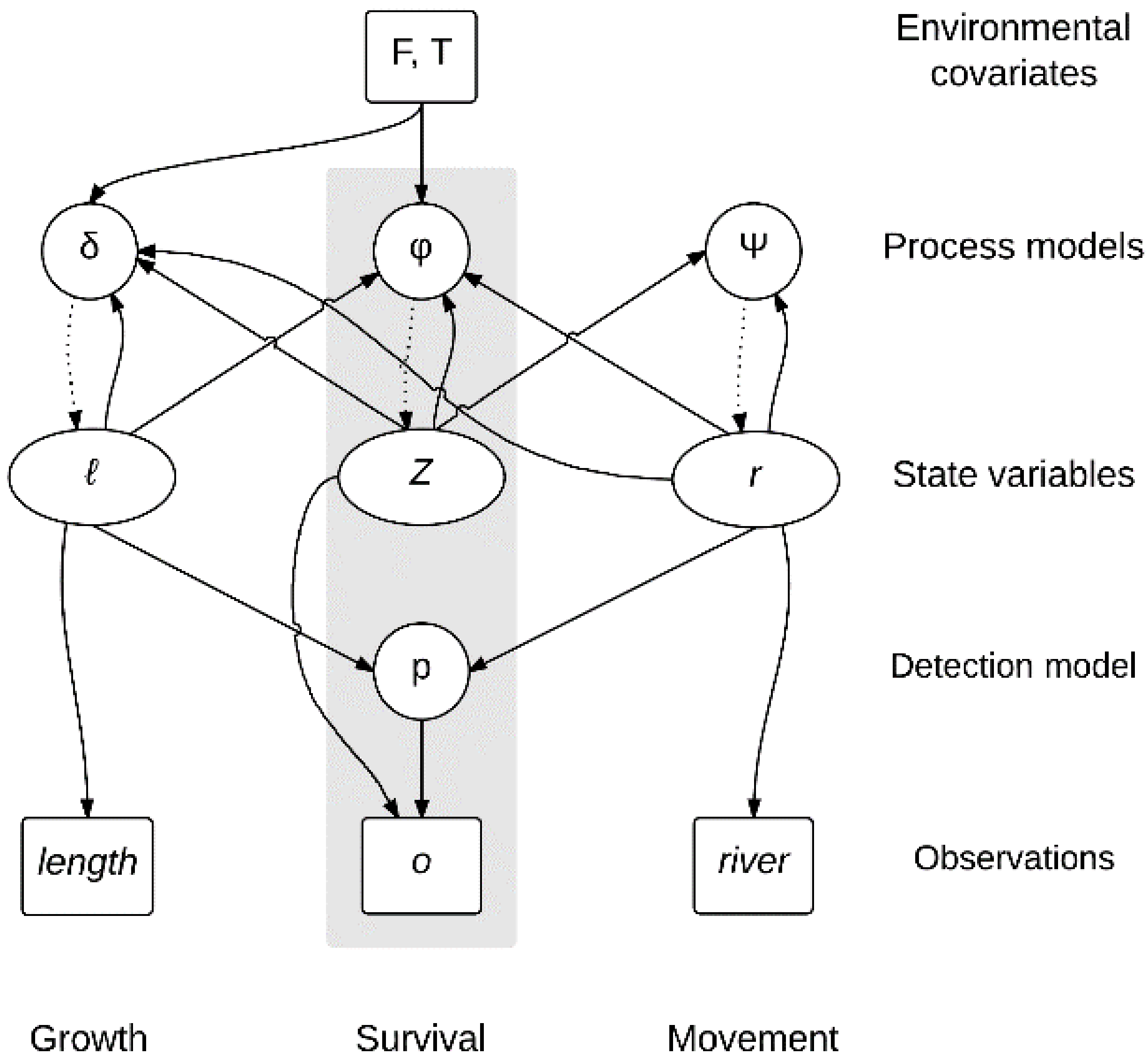


Isolated

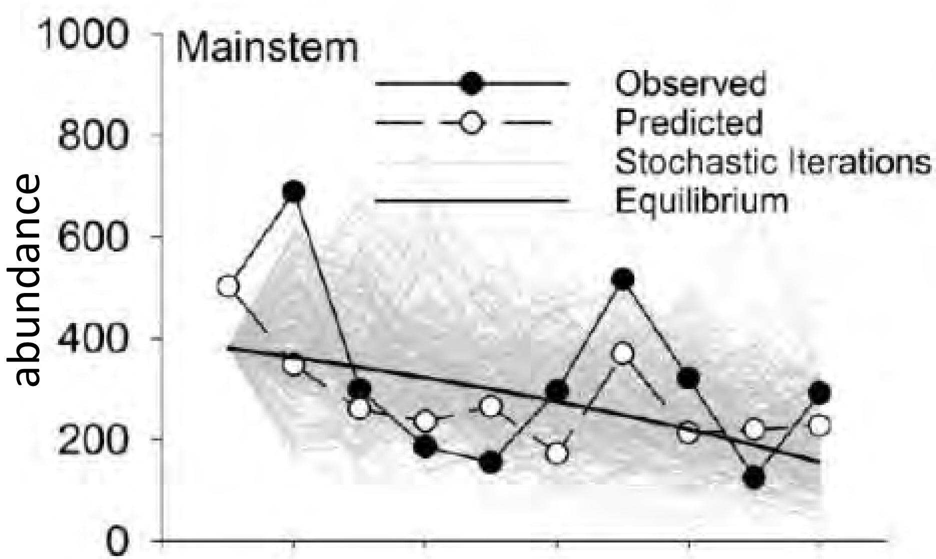


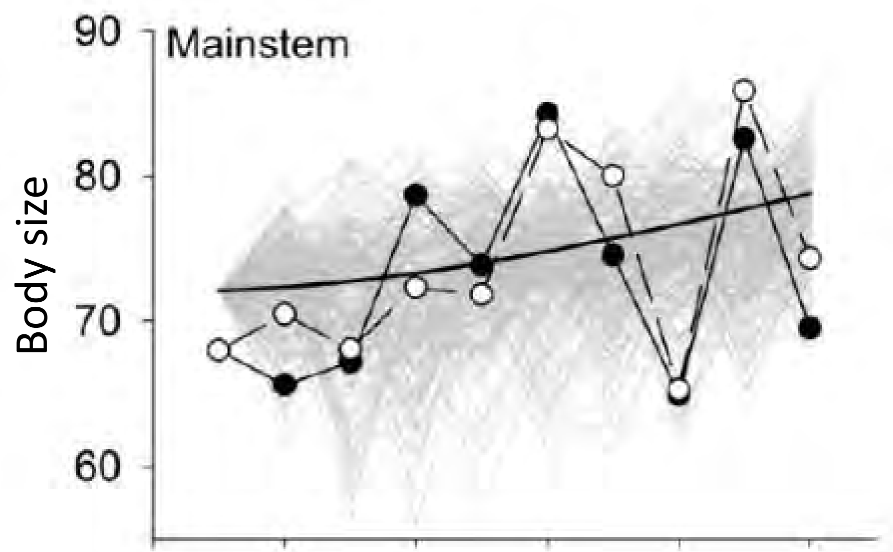

Open Large (OL)

Open Small (OS)

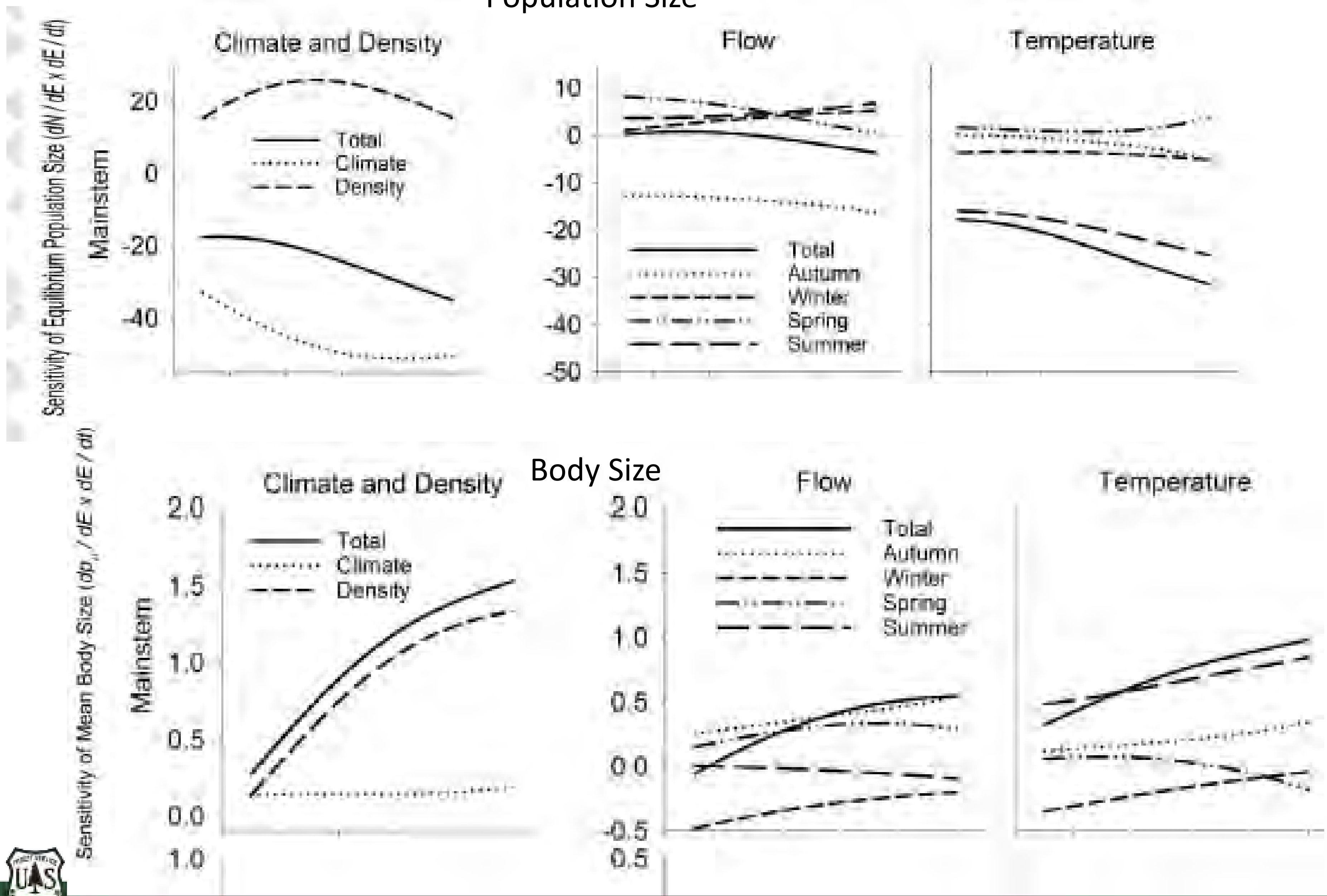

F, T
Environmental covariates
δ
φ
Ψ
Process models
ℓ
Z
r
State variables
p
Detection model
length
o
river
Observations
Growth
Survival
Movement

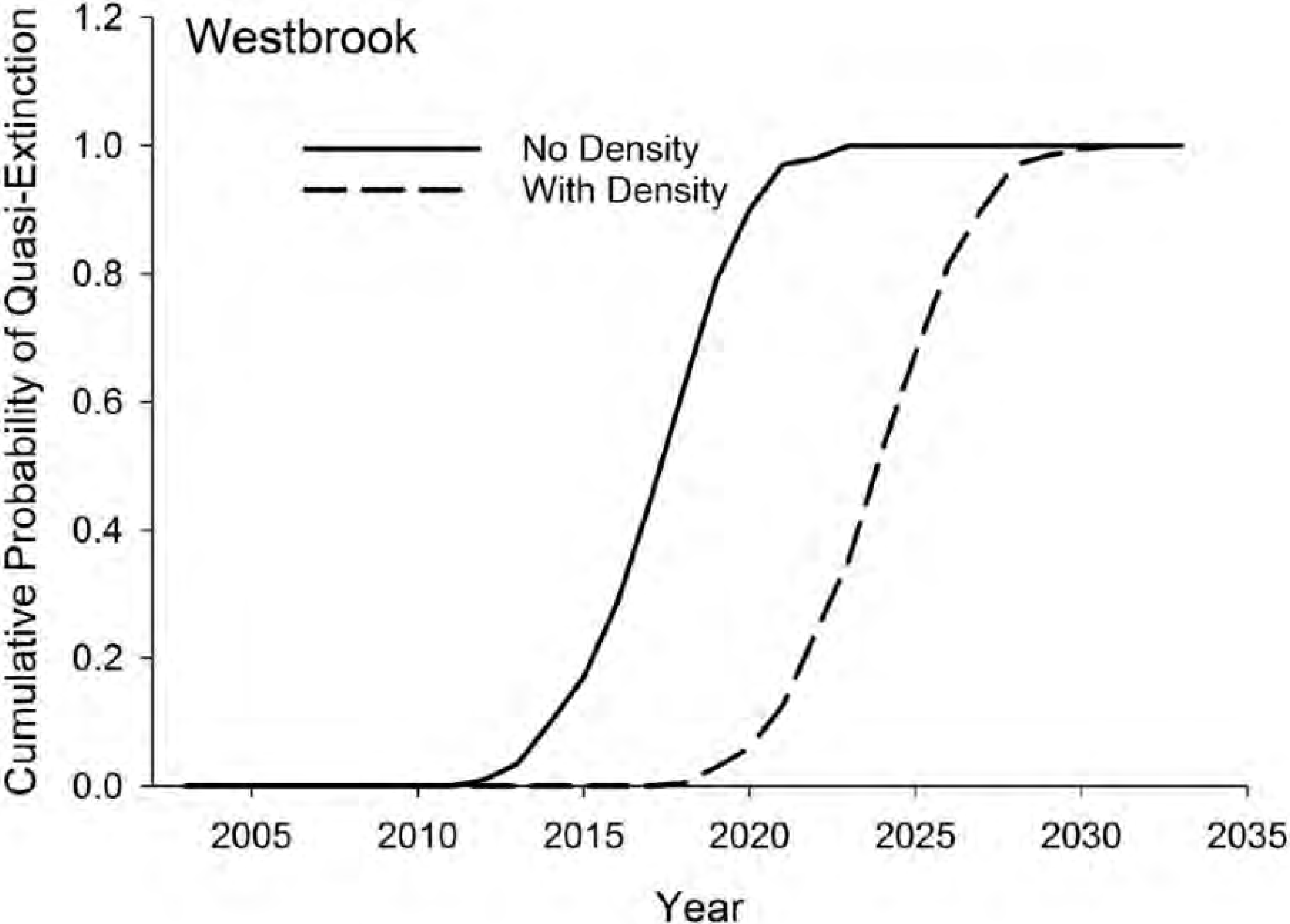
Bassar, R.D., Letcher, B.H., Nislow, K.H. and A.R. Whiteley 2015 *Journal of Animal Ecology*



# Population Size




Westbrook
No Density
With Density
Cumulative Probability of Quasi-Extinction
1.2
1.0
0.8
0.6
0.4
0.2
0.0
2005
2010
2015
2020
2025
2030
2035
Year

# Consider changes in the frequency and magnitude of extreme events

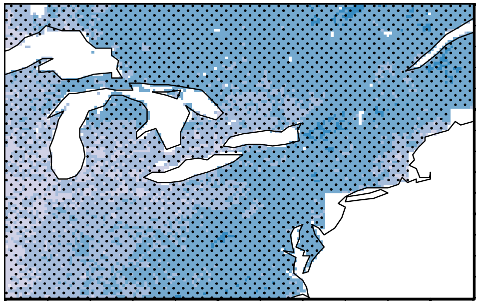
- Floods, droughts, heatwaves
- Influence and attention way out of proportion to their frequency

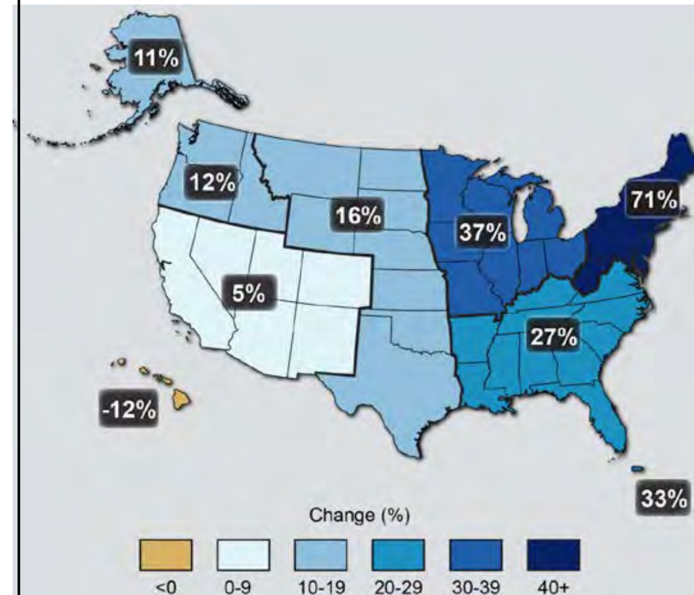
# The role of chronic and episodic disturbances on channel–hillslope coupling: the persistence and legacy of extreme floods

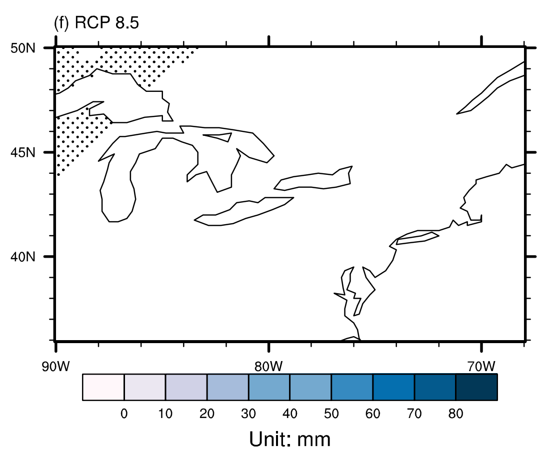
Evan Dethier,[1*] Francis J. Magilligan,[2] Carl E. Renshaw[1] and Keith H. Nislow[3]
[1] Department of Earth Sciences, Dartmouth College, New Hampshire USA, 03755
[2] Department of Geography, Dartmouth College, New Hampshire USA, 03755
[3] Northeastern Research Station, USDA Forest Service, Massachusetts USA, 01003-9285


Mapped and dated landslides pre- and post-Hurricane Irene

Estimated sediment and wood yields





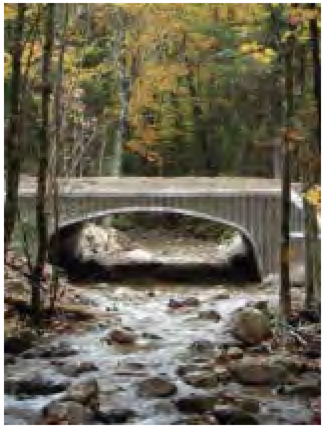




From Ning, L., E. E. Riddle, and R. Bradley, 2014: Projected changes in climate extremes over the northeastern United States. J. Climate (accepted pending revision)

# Incorporate Multiple Dimensions

- Floods
- Risks to Natural Resources and Human Infrastructure
- Options

\- Identify risks, improve infrastructure

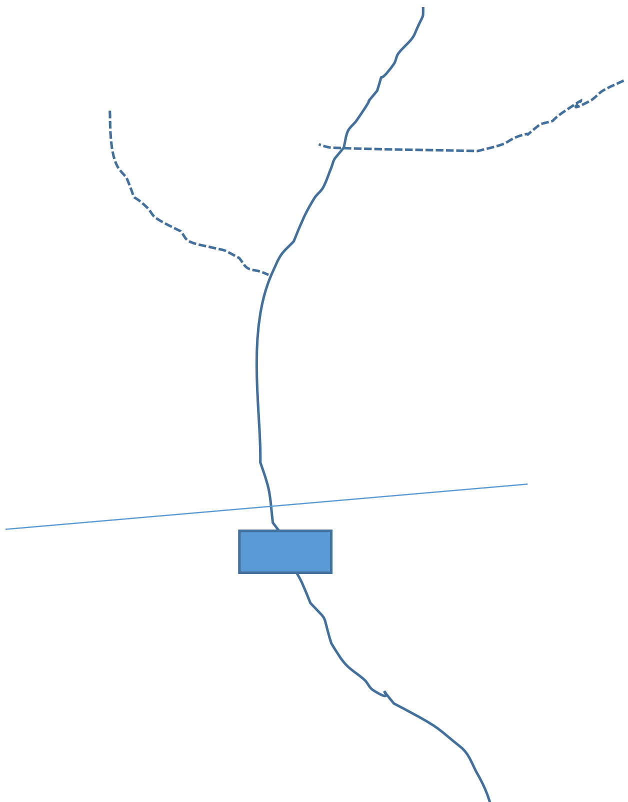


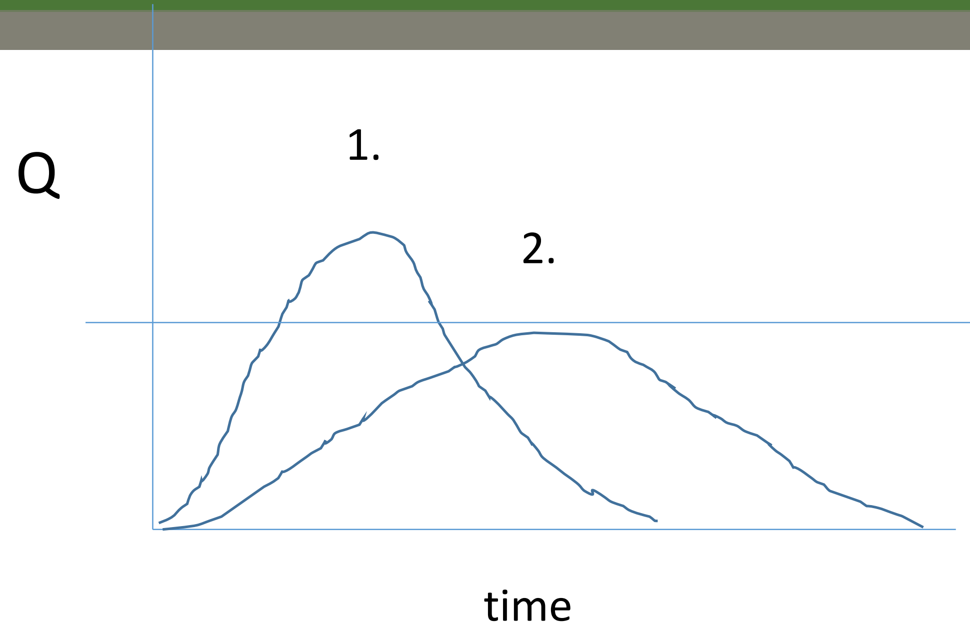
# Slow the Flow for Climate Resilience

Decreasing vulnerability of ecosystems and human infrastructure from the headwaters to the coasts

Project Goals:

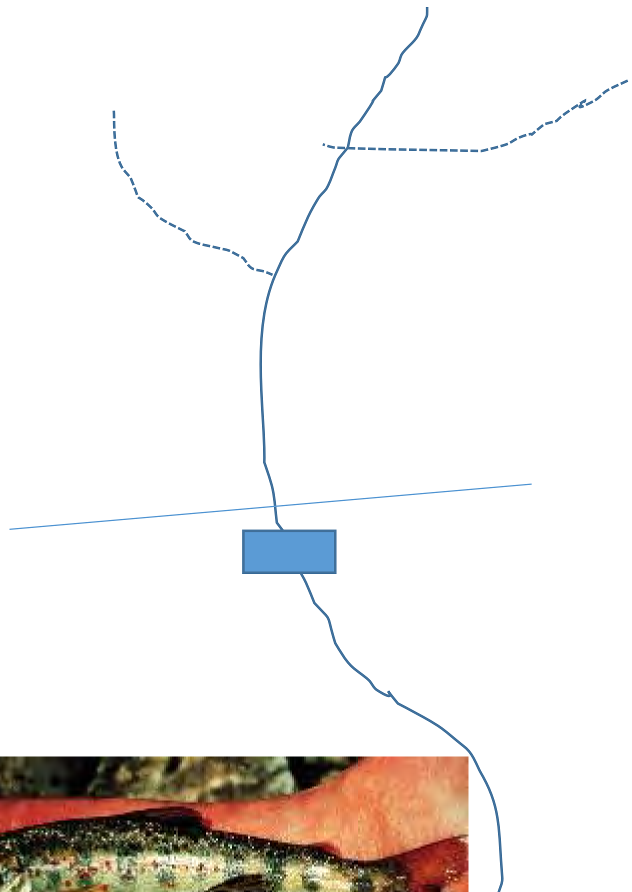
- Identify effective mechanisms
- Reveal mutual benefits (and potential conflicts)
- Determine scope for adaptation

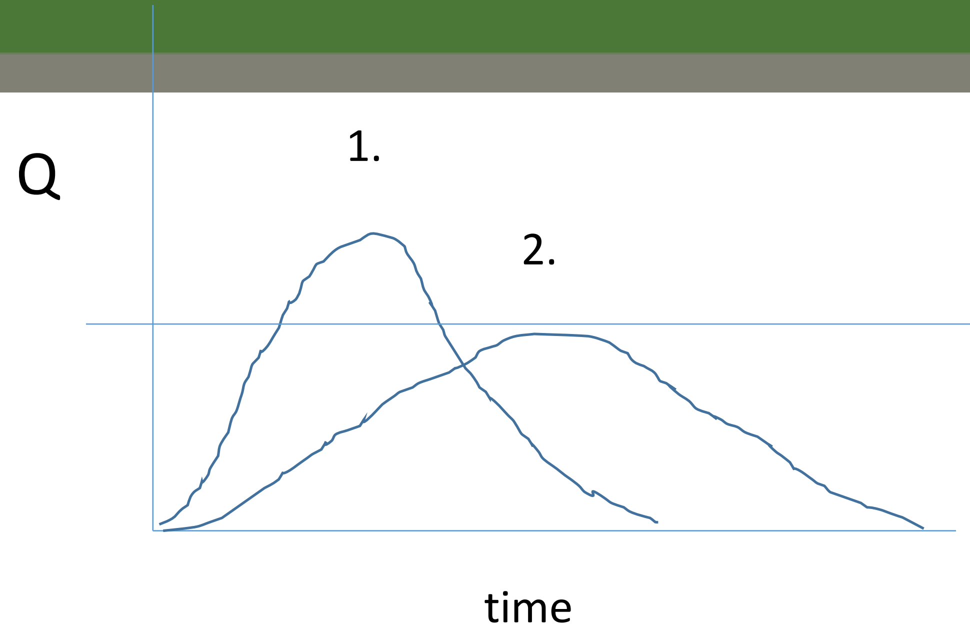





**What is the capacity for gains or losses of green infrastructure to move flood hydrographs from 1. to 2.?**

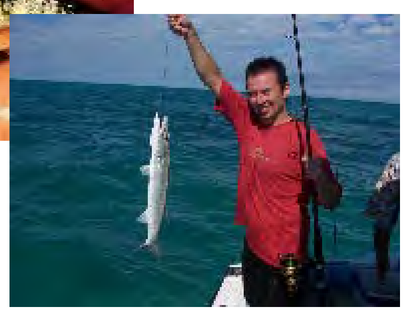
- Soil permeability (impervious surface conversion)
- Channel and bed roughness (habitat restoration)
- Flowpath length
- Floodplain storage






**How do these actions influence:**

- Conservation of critical habitat
- Population resilience of key species
- Ecosystem Services

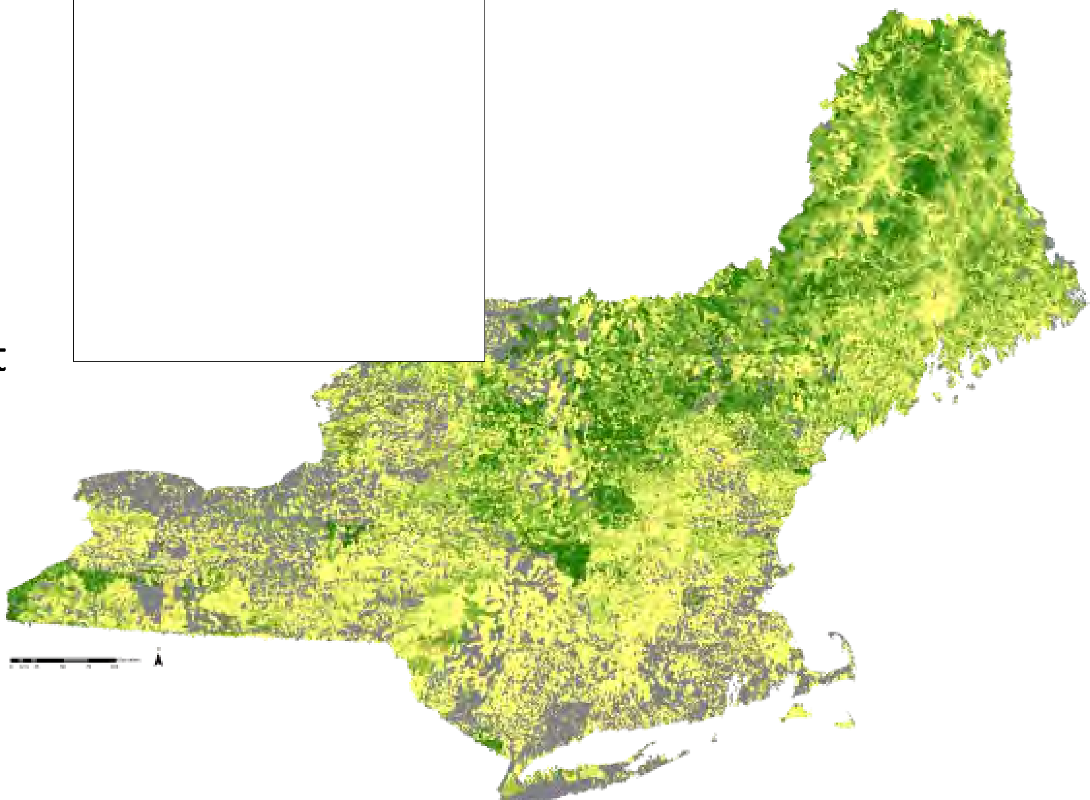


# Provide data platforms and decision support tools

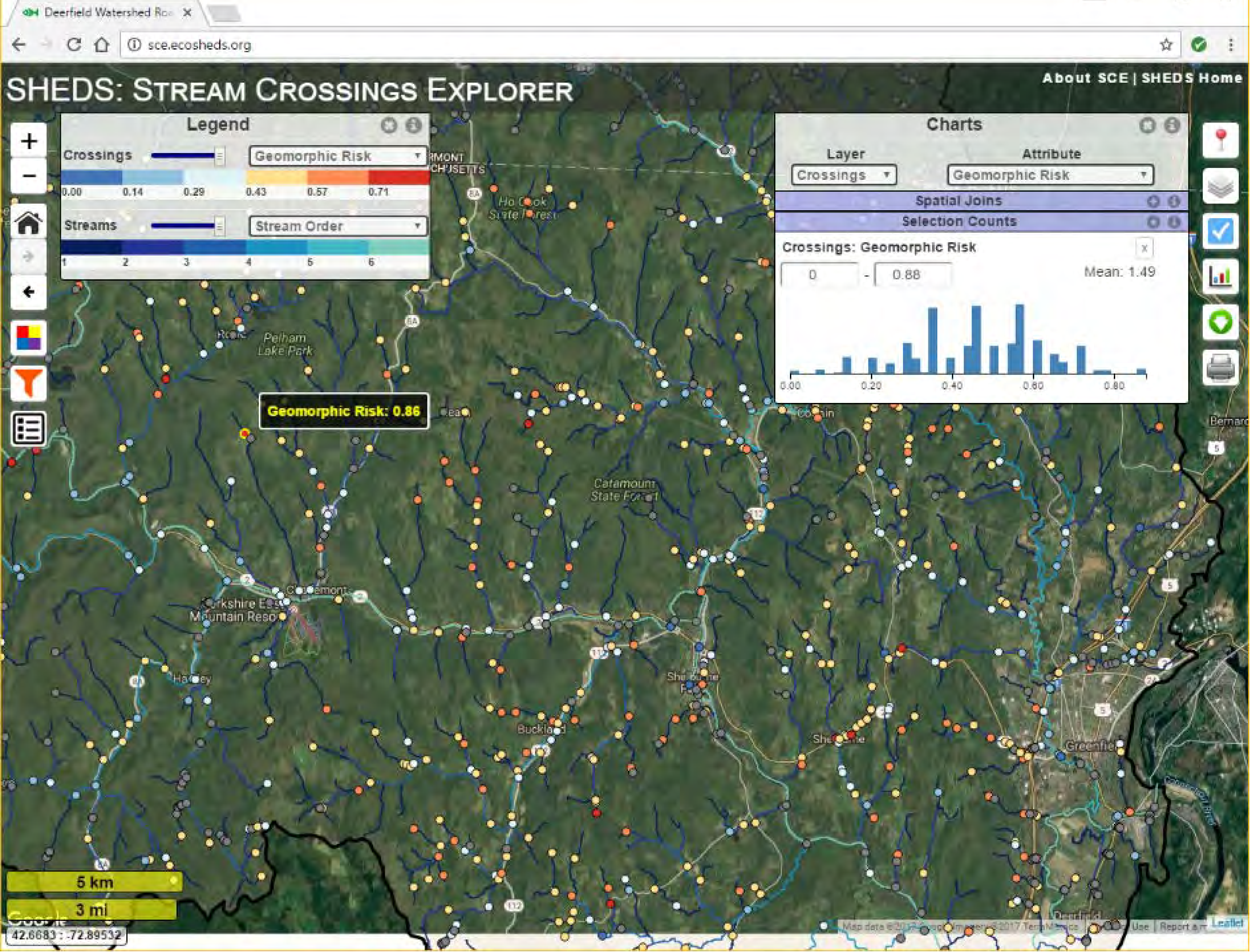
**Spatial Hydro-Ecological Decision System (SHEDS)**

**SHEDS** is a web application that seamlessly links hydro-ecological datasets, models, and decision support systems.
**SHEDS** provides tools for gaining insight, improving decision making, and supporting better management of hydro-ecological resources.

**Stream Temperature Database**
**Stream Temperature Model**
**Interactive Catchment Explorer**
**Eastern Brook Trout Joint Venture**
**Data & Tools**



http://ecosheds.org/home



Deerfield Watershed Ro
sce.ecosheds.org
SHEDS: Stream Crossings Explorer
About SCE | SHEDS Home
Legend
Crossings
Geomorphic Risk
0.00 0.14 0.29 0.43 0.57 0.71
Streams
Stream Order
1 2 3 4 5 6
Charts
Layer
Crossings
Attribute
Geomorphic Risk
Spatial Joins
Selection Counts
Crossings: Geomorphic Risk
0 - 0.88
Mean: 1.49
0.00 0.20 0.40 0.60 0.80
Geomorphic Risk: 0.86
Pelham Lake Park
Catamount State Forest
Buckland
Greenfield
5 km
3 mi
42.6683 : -72.89532
Leaflet

# Managing for Resilience across the Eastern Brook Trout Historic Range

**Nat Gillespie, USDA Forest Service, Washington, DC**

**Steve Perry, Eastern Brook Trout Joint Venture Coordinator**

**Keith Nislow, Northern Research Station, USFS**

**Mark Hudy, Science Team, EBTJV**

**Jason Coombs, University of Massachusetts**

**Doug Besler, North Carolina Department of Wildlife Resources**

**Amanda Coulton, USFS**

Eastern Brook Trout
JOINT VENTURE

# Outline

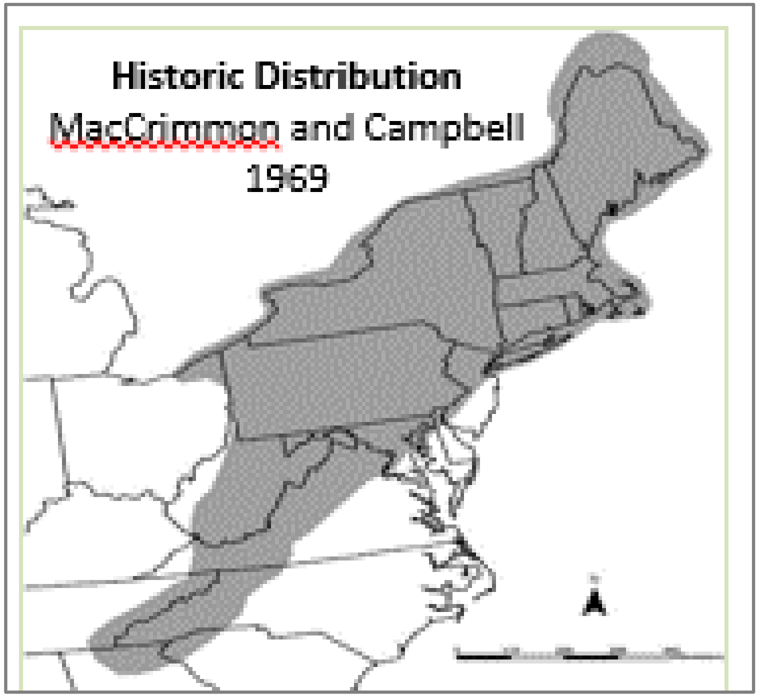
- Current Status of Eastern Brook Trout
- GIS Modeling, Patch Analysis, and Decision Support Tools
- Strategies for Resilience for Eastern Brook Trout
- Examples of Increasing Resilience for Eastern Brook Trout
- Economic and Social Components to Resilience

Credit: Eric Engbretson


Credit: Jim Herrig

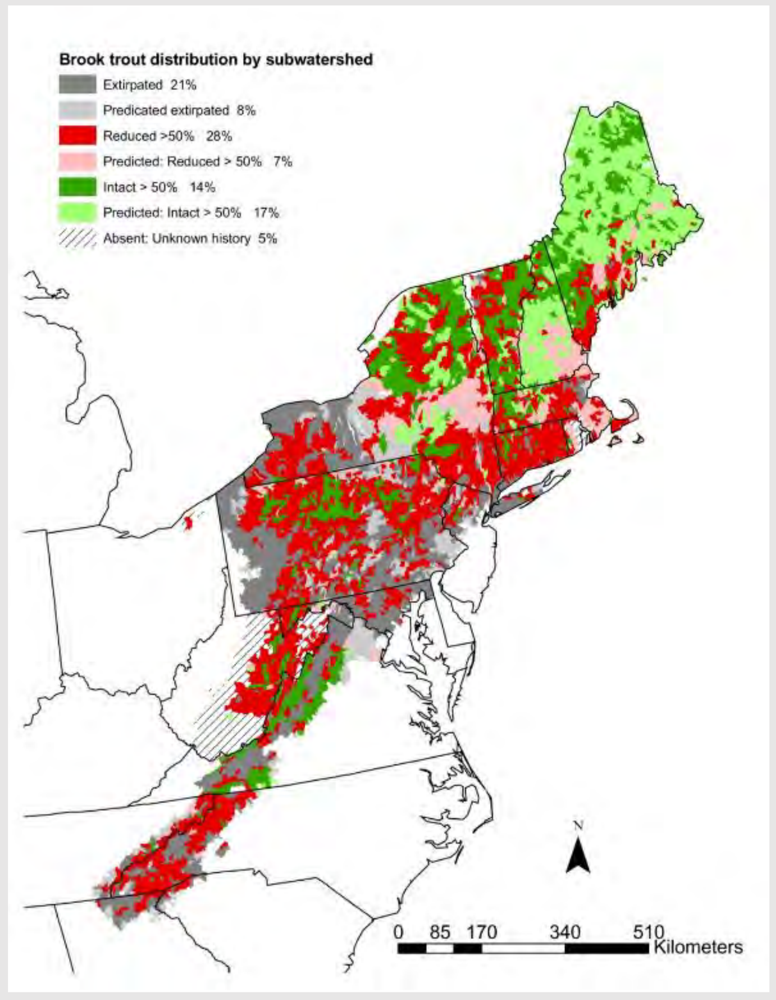
# Why Eastern Brook Trout?

"To ensure healthy, fishable wild Brook Trout populations throughout their historic eastern United States range."

# Eastern Brook Trout Joint Venture Subwatershed Analysis, 2006

- Assessment based on presence/absence
- Some threats listed by expert opinion
- GIS-based analysis of threats
- Provided some new and valuable information
- Valuable for data gaps and future assessments



# Three Broad Groups of Stressors

- Climate Change
- Land Use and Habitat Impacts
- Non-native

fish

# Past, Current and Future Stressors

- Legacy of industrial timber removal and conversion of habitat, then introduction of non-native fish
- Current stressors of high water temperatures, poor quality habitat, stream fragmentation, non-native fish
- Future impacts of increased drought, increased flooding, increased water demands and development, expansion of non-native species

Pisgah National Forest 1911

# Various Life History Characteristics






# EBTJV Prioritization – Subwatershed Scale, 2012

## Model Metrics

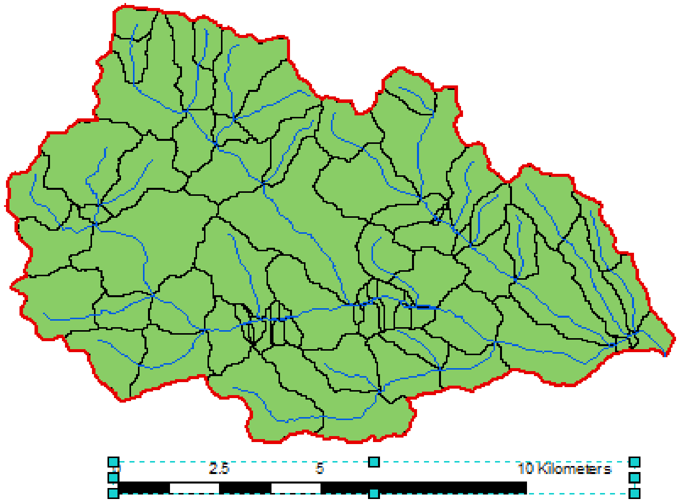
1. % Forest
2. Deposition kg/ha
3. % Agriculture
4. Road Density km/km$^2$
5. % Forest Riparian

Classification and Regression Tree (CART) model

Takes into account the estimated probabilities of neighboring subwatersheds to score high

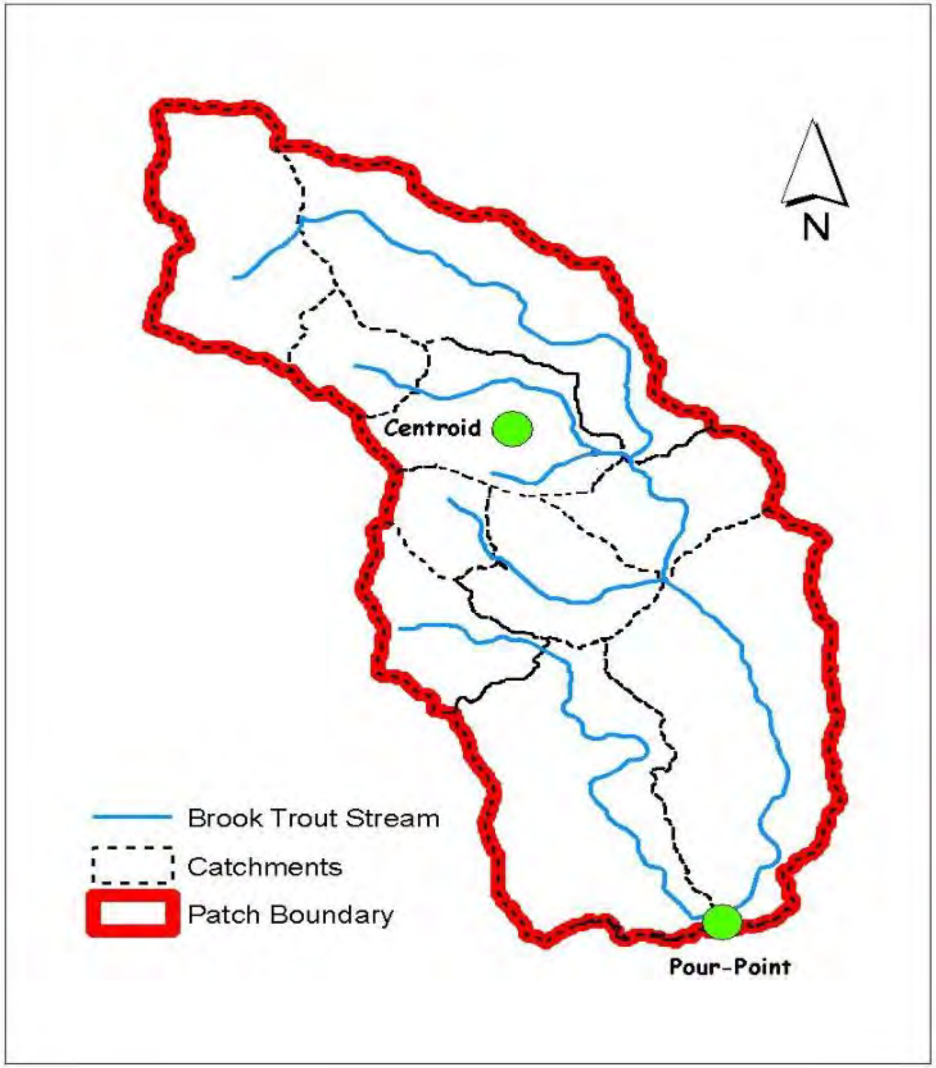
# Finer Scale Catchment Level Assessment, 2015

- Improved baseline of salmonid presence across range
- Fine Scale: 5 – 15 catchments per subwatershed
  - Classify catchments by presence at stream reach of brook, brown and rainbow trout
  - Improve ability to monitor species status & the impact of conservation and management actions



# Identification of Brook Trout "Patches"

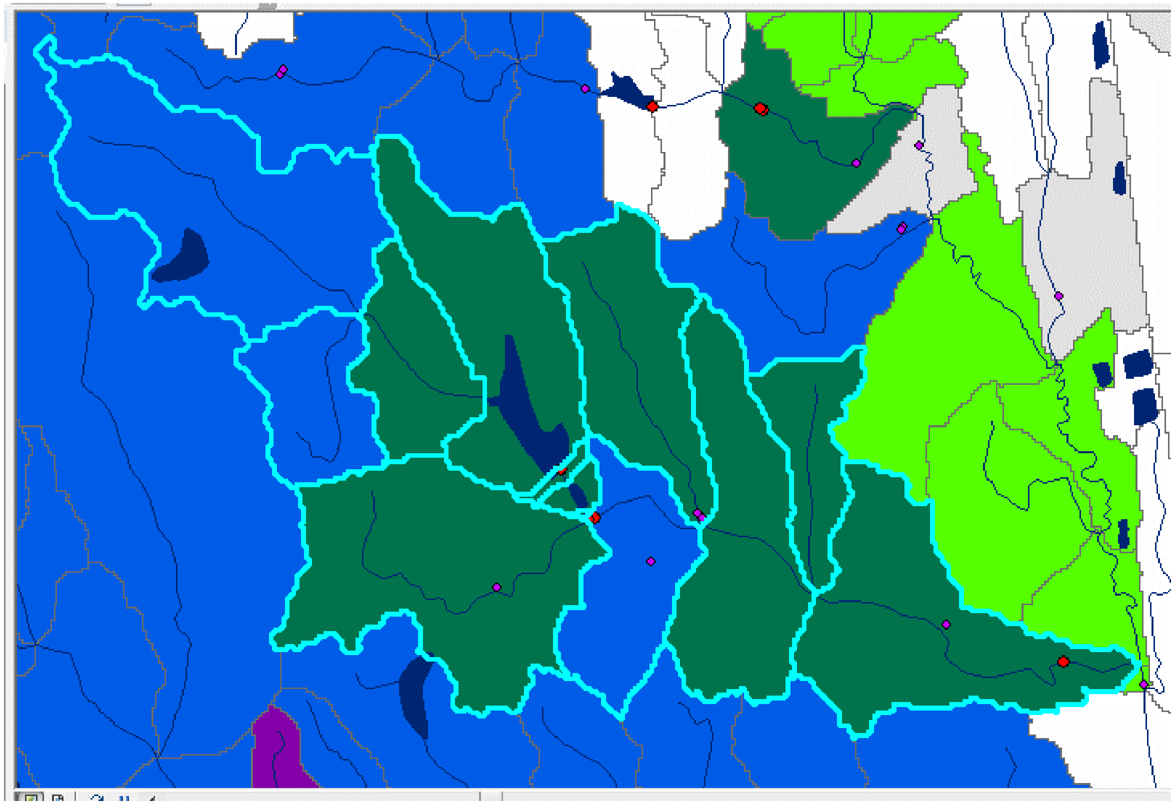
- "Patch"= a group of contiguous catchments occupied by wild brook trout.
- Patches not connected physically
  - Dams and culverts, warm water and poor water quality, non-native species
- Assumed to be genetically isolated populations



# Patch Analysis – Metapopulations

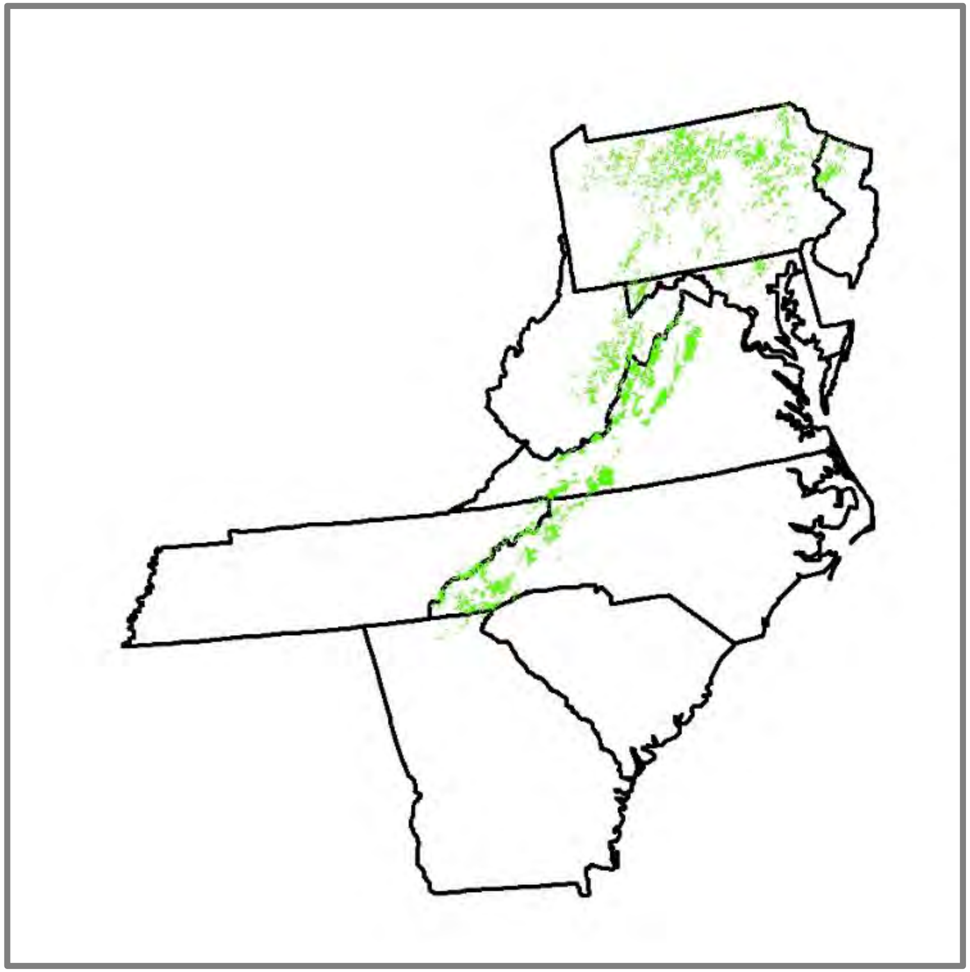
Classification Codes

- No salmonids
    - 0 WHITE
- Allopatric salmonids
    - 0.2 (brown trout) GREEN
    - 0.3 (rainbow trout) PINK
    - 1.1 (brook trout) BLUE
- Sympatric salmonids
    - 0.4 (brown & rainbow)
    - 1.2 (brook & brown)
    - 1.3 (brook & rainbow)
    - 1.4 (brook & brown, bow)



# Brook Trout Distribution: Catchments

From Pennsylvania South, 11% of 124,688 catchments occupied



"Brook trout have been extirpated from almost 90% of their historic catchments."

# Patch Numbers across Eastern Range

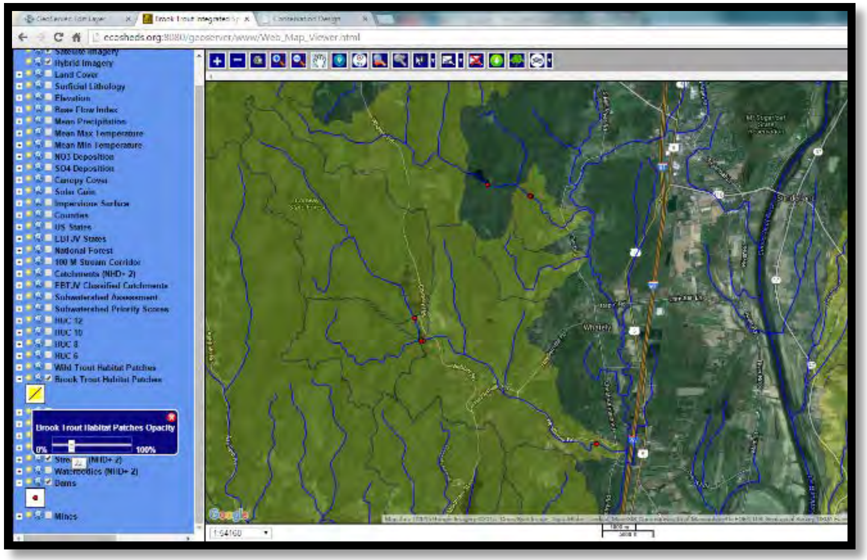
- 6,124 Brook Trout only patches across Eastern Range
- 78% of patches less than 350 hectares
- 3,879 Brook Trout patches also occupied by other trout
- A lot of questions:
  - What is the minimal viable patch size?
  - Conventional research says need minimum breeding population of 500+ adults?
  - What is the average size of patch with 500+ adults?
  - How will culvert data further reduce patch size?

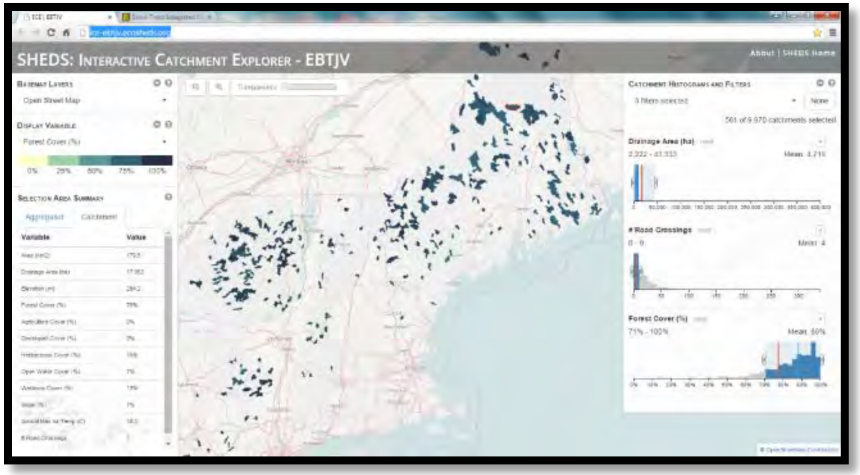
Monitoring Plan - 70 Patches within the Chesapeake Bay Watershed are monitored each year, with 25 Sentinel Sites monitored every year.

# Other Models and Decision Support Tools

Ecosheds.org

- Prioritization within patch
  - Use with riparian planting tool model
  - Add in any additional model data
- Interactive visualization of data
  - Use with interactive explorer
  - Plot histograms and compare scenarios given water temperature increases
- Building a culvert prioritization model for aquatic connectivity work



# Climate Change Variability Models

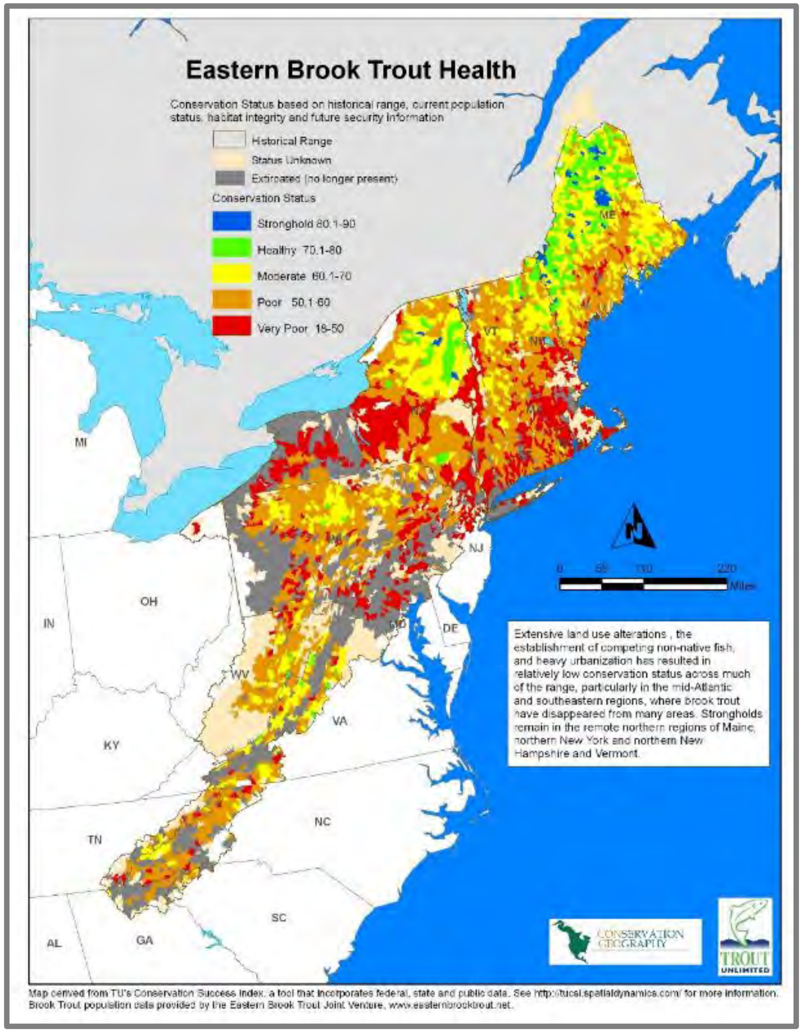
# Additional Analyses and Efforts

Chesapeake Bay Riparian Shading Tool

- Sensitivity and Vulnerability to climate change at the Patch Level
  - Solar Gain
  - Aspect
  - Elevation
  - Riparian Condition
  - % Groundwater (paired air/water thermographs)
- Potential for Persistence under Climate Change Stress
- Coordination with Appalachian LCC and Northeast Climate Science Center

# Trout Unlimited Conservation Portfolio

- Representation:
  - Geographic, life history and genetic diversity
- Resilience:
  - Having large enough populations and habitat to recover from stressors and rapid environmental change
- Redundancy:
  - Protecting enough populations so some can be lost without impact to the species



# Conservation Portfolio Approach

Concept: Diversity provides long-term viability in the face of disturbances and environmental variability

Balanced — Unbalanced

Retains historical genetic, life history, and geographic diversity

- Presence of large inter-connected populations
- Populations occupy a variety of habitats (streams, rivers, lakes)
- All life history forms present historically are represented
- Non-hybridized populations exist in all historically occupied sub-basins

Has lost historical diversity

- Small populations
- Minimal connectivity
- Small stream habitats
- No migratory populations
- Reduced geographic distribution

# EBJTV Strategic Priorities

1. Increase recreational fishing opportunities

2. Protect the "best of the best" habitat that supports existing, healthy wild brook trout populations.

3. Improve and reconnect adjacent habitats that have a high likelihood of supporting stable wild brook trout populations.

# EBJTV Strategic Priorities continued

4. Focus on critical wild brook trout spawning and early life history habitat in subwatersheds classified as Intact


5. Preserve genetic diversity of Eastern Brook Trout

6. Conserve unique Eastern Brook Trout life history strategies

# Climate Change Resilience Strategy

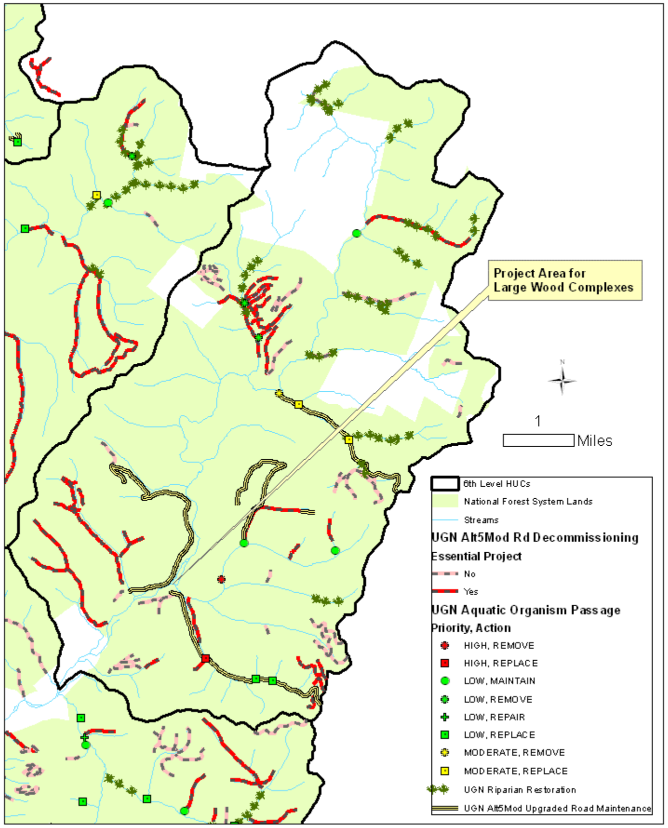
- Protect Brook trout strongholds by focusing on concentrations of watersheds assessed as “intact.”
- Protect and restore largest patches of brook trout.
- Restore resilience within larger brook trout patches by increasing aquatic connectivity, increasing habitat complexity, reducing non-native fish impacts.
- Identify most resilient habitat for collaborative restoration efforts and future conservation actions.
- Protect/expand unique patches with unique life history diversity.
- Expand the size of existing patches.

# Monongahela National Forest – watershed approach to improve water quality and aquatic habitat

- 3 Aquatic Organism Passage culverts in 2016 and up to 5 planned for 2017
- Decommissioned 22 miles of roads with 27 miles in 2017
- Improved 18 stream miles with large wood habitat
- Trout Unlimited partnership




UGN - Watershed Restoration Projects
Headwaters East Fork Greenbrier River HUC



# Green Mountain National Forest – flood damage recovery and aquatic habitat improvement


All Credit: Green Mountain NF

# Increasing habitat complexity and resilience

**<u>West Branch White River Project Accomplishments:</u>**
Restored fish habitat, channel sinuosity, & flood resiliency on public/private land on 3 miles of river.

**Forest Service Contribution:** $240,000
**Partner Contribution**: $530,000
**Total Project Costs:** $770,000

**<u>External Partners:</u>**
White River Partnership
Vermont Agency of Transportation
Trout Unlimited
NRCS
US Fish and Wildlife Service
Wing Farm


Credit: Green Mountain NF

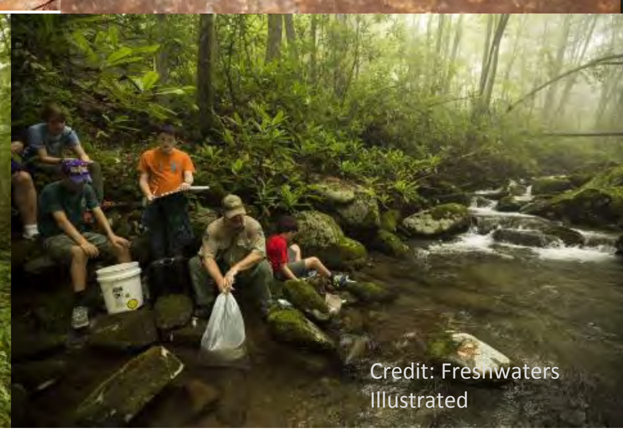
# Southern Appalachian Brook Trout– Non-native fish competition and aquatic connectivity

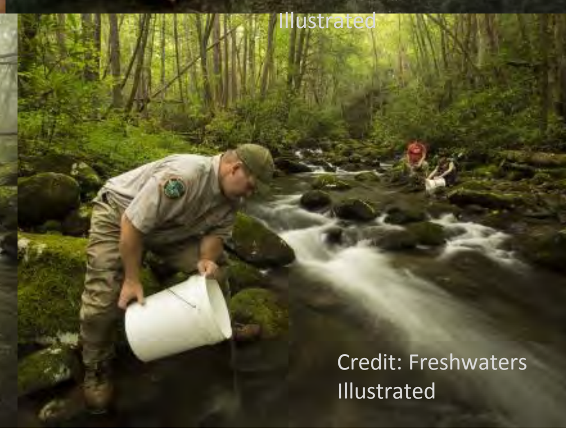

Credit: North Carolina WRC


Credit: North Carolina WRC


Credit: Freshwaters Illustrated


Credit: Freshwaters Illustrated


Credit: Freshwaters Illustrated


Credit: Freshwaters Illustrated

# Aquatic Connectivity – watershed scale

Trout Unlimited and North Carolina National Forest's partnership on Buck's Branch

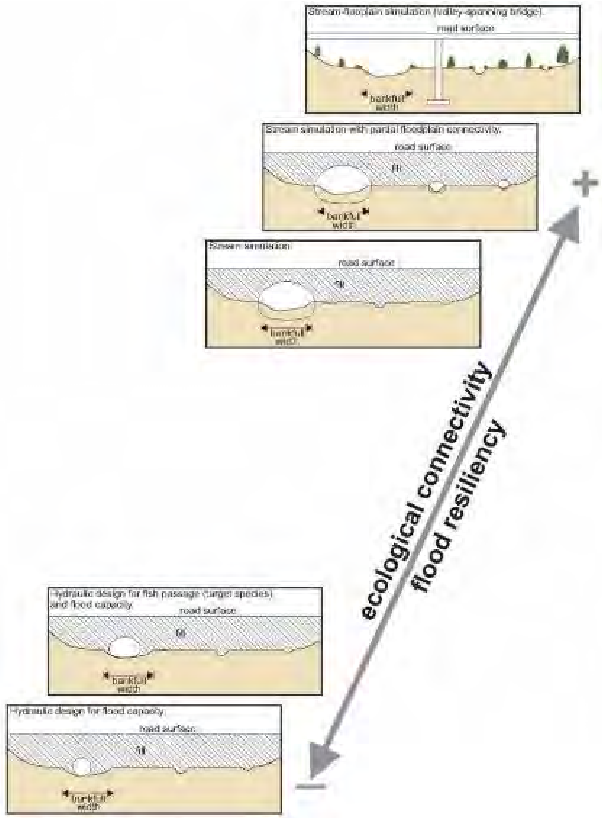
Credit: NC NFs

Credit: Trout Unlimited

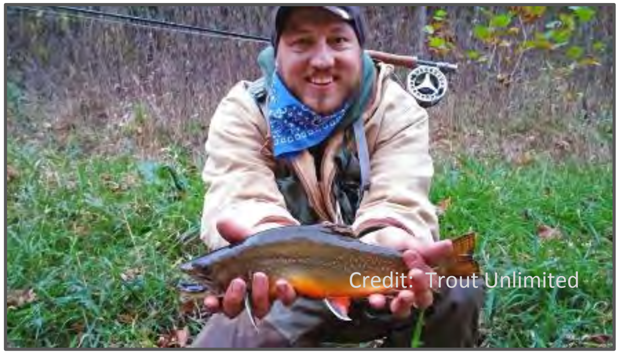
Credit: Trout Unlimited

Credit: Trout Unlimited

# Keys to Future Success – Multiple Benefits for Communities

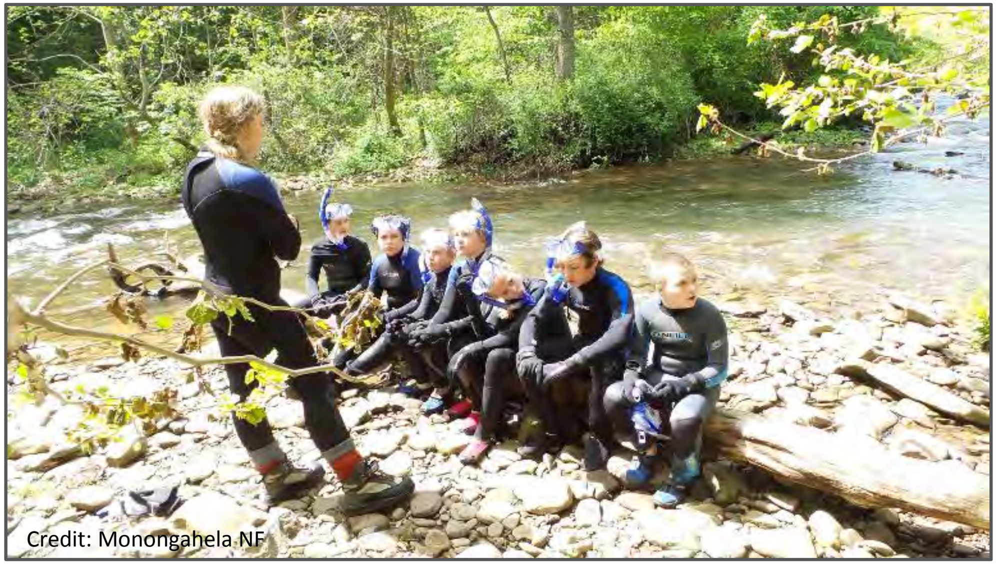





# Expand awareness and build on cultural importance

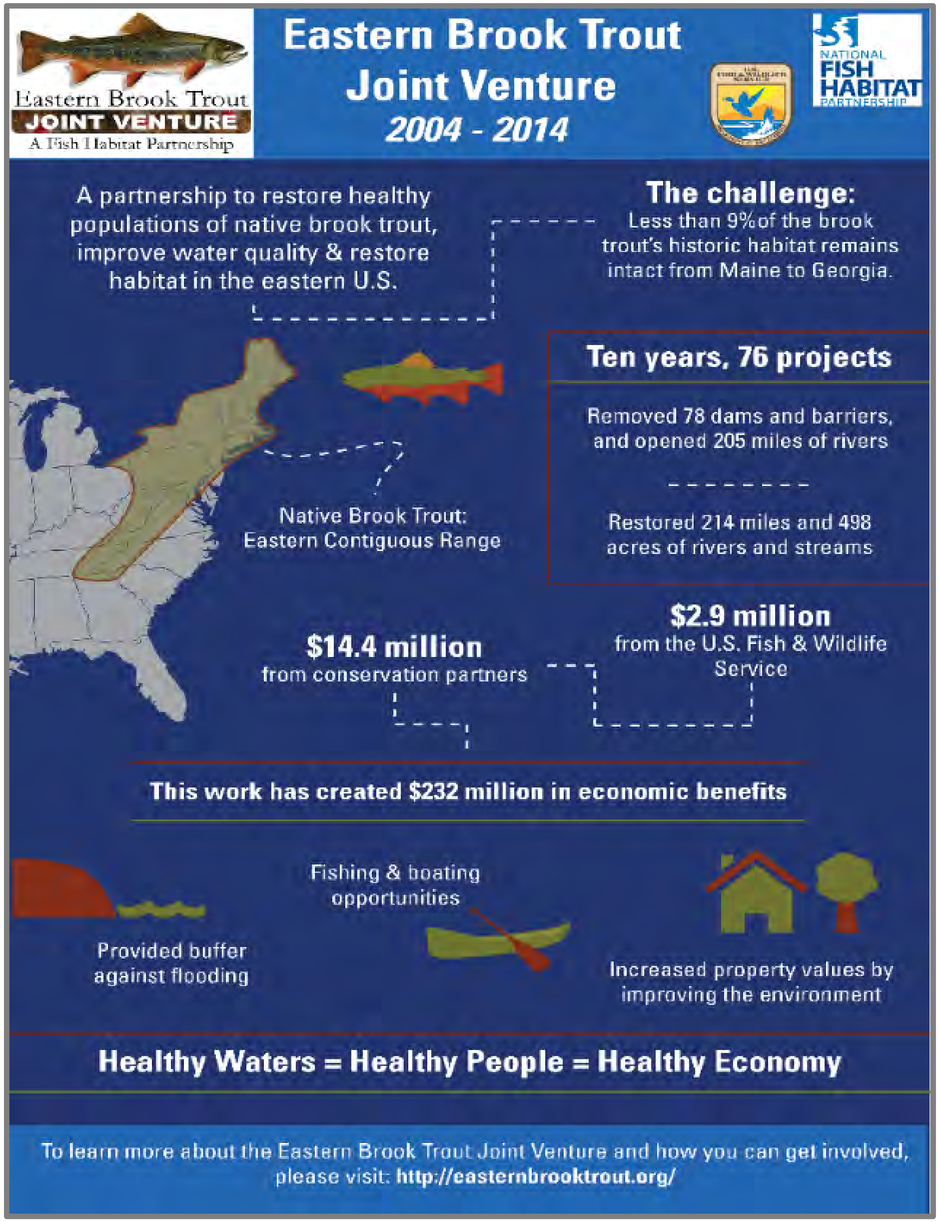
Credit: Freshwaters Illustrated



Credit: Monongahela NF


Credit: Freshwaters Illustrated

# Enlisting New Partners

# Questions & Answers

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- **On your computer:** **Type your question into the Q & A pod on the left side of your screen.**

# Thank you for attending today's webinar!

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http://www.forestrywebinars.net/webinars/fisheries-responding-to-drought-and-water-challenges