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Forest and Rangeland Ecosystem Science Center

# Climate change, bull trout and the Malheur

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U.S. Geological Survey

# The threatened bull trout

- Coldwater specialist
- Highly fragmented
- Often found in disturbed environments
- Climate change may exacerbate threats

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# Climate change, streams, and bull trout

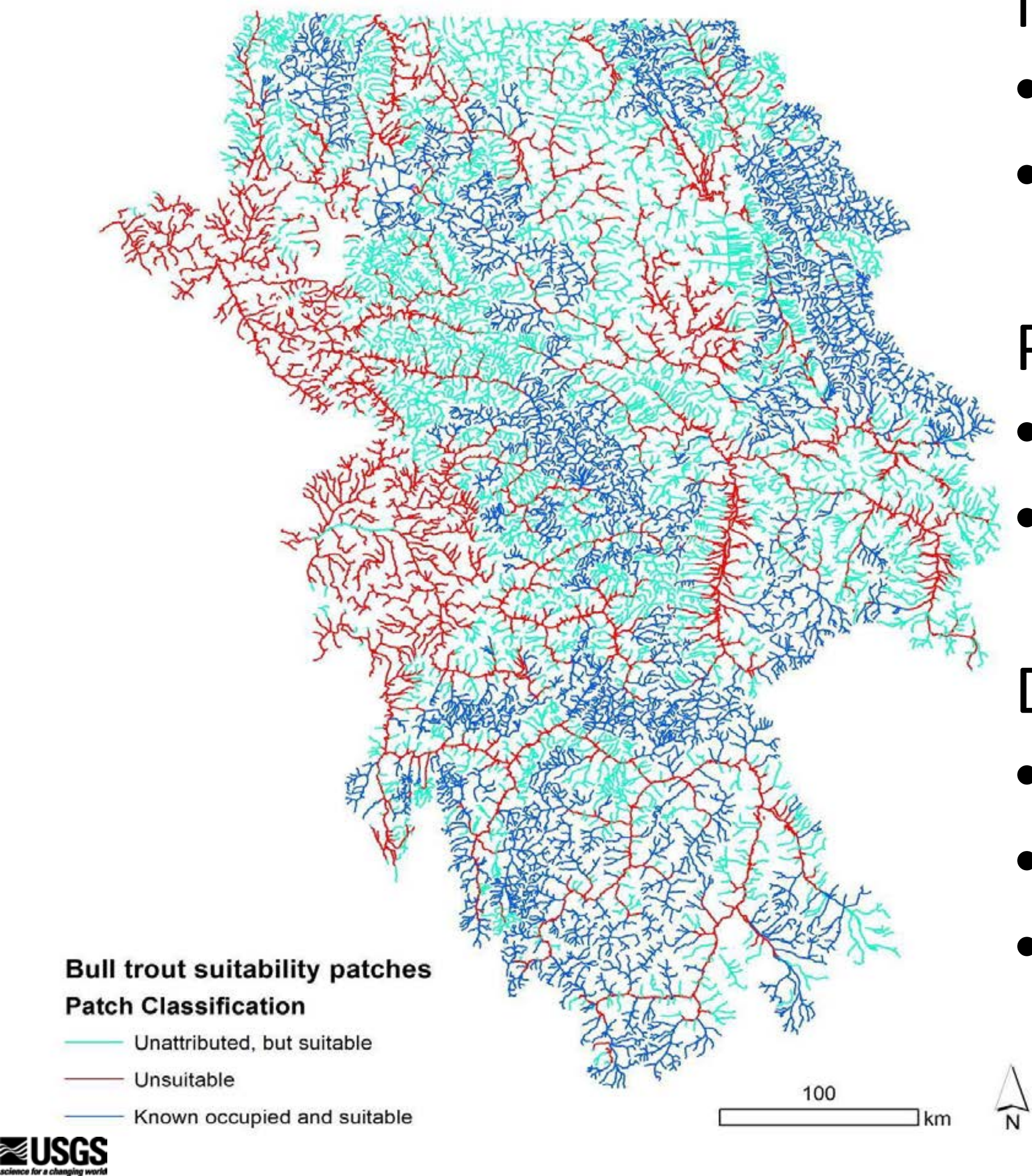
- **Warming water**
  → Habitat fragmentation
  → Physiological stress
  → Nonnative invasion
- **Less snow** → Lower summer flows
  → More winter floods
- **More fire**
  → More channel disturbance

# The BTVA in 4 steps

1. **Map suitable habitat** “patches” across the species’ range in the conterminous US.
2. **Attribute patches and migratory habitats** with information on local and climate related threats
3. **Model persistence (≈presence)**
4. **Apply** results

# Network temperature models (Isaak, Peterson, et al.)

http://nrmsc.usgs.gov/gnlcc/str_tempDB




NorWeST model prediction

- <13$^{o}$C mean August
- 1km intervals

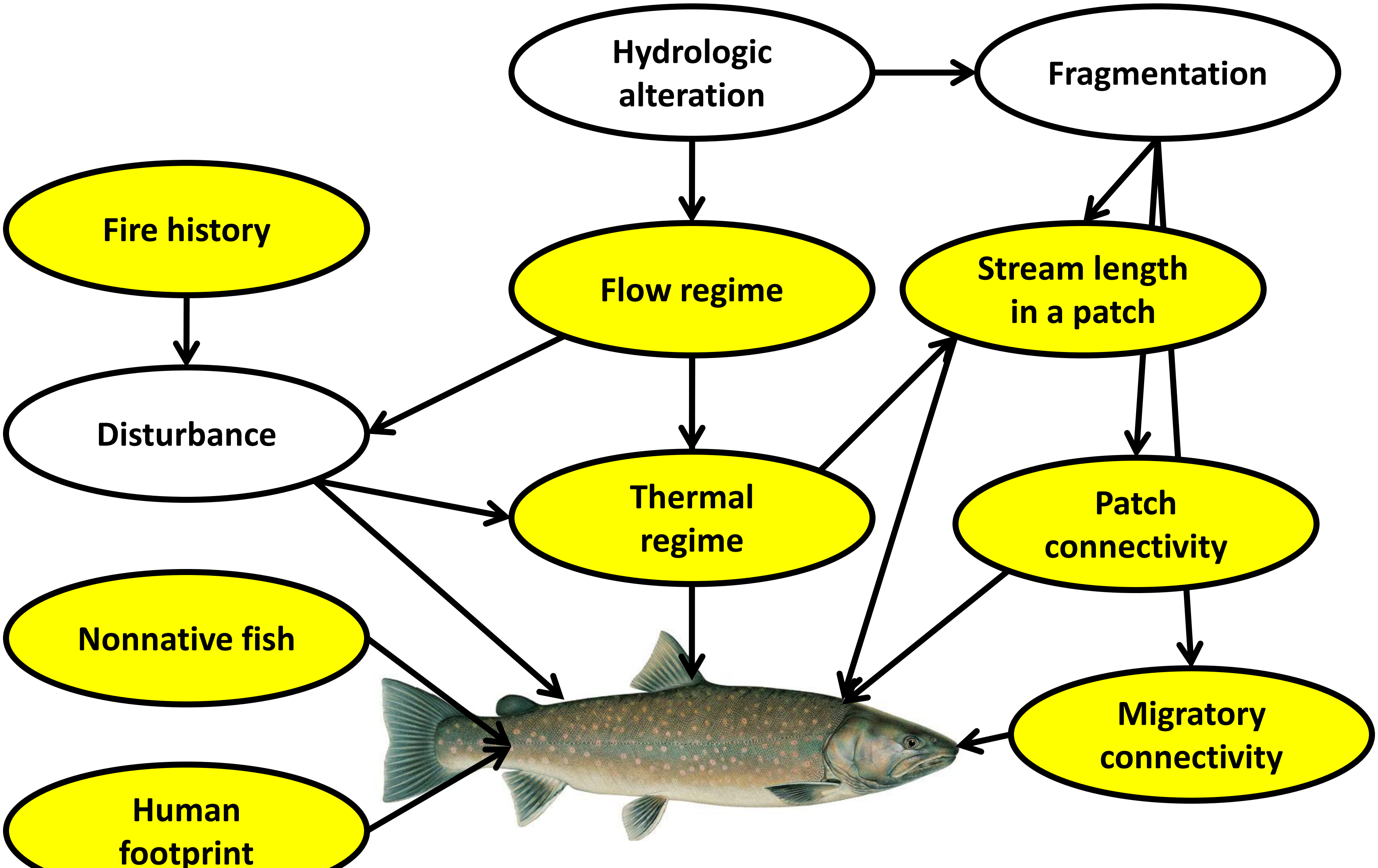
Patches split by

- Distance
- Large dams

Does not include

- Local natural barriers
- Small human barriers
- Other types of resistance

# Step 2. Patch attribution

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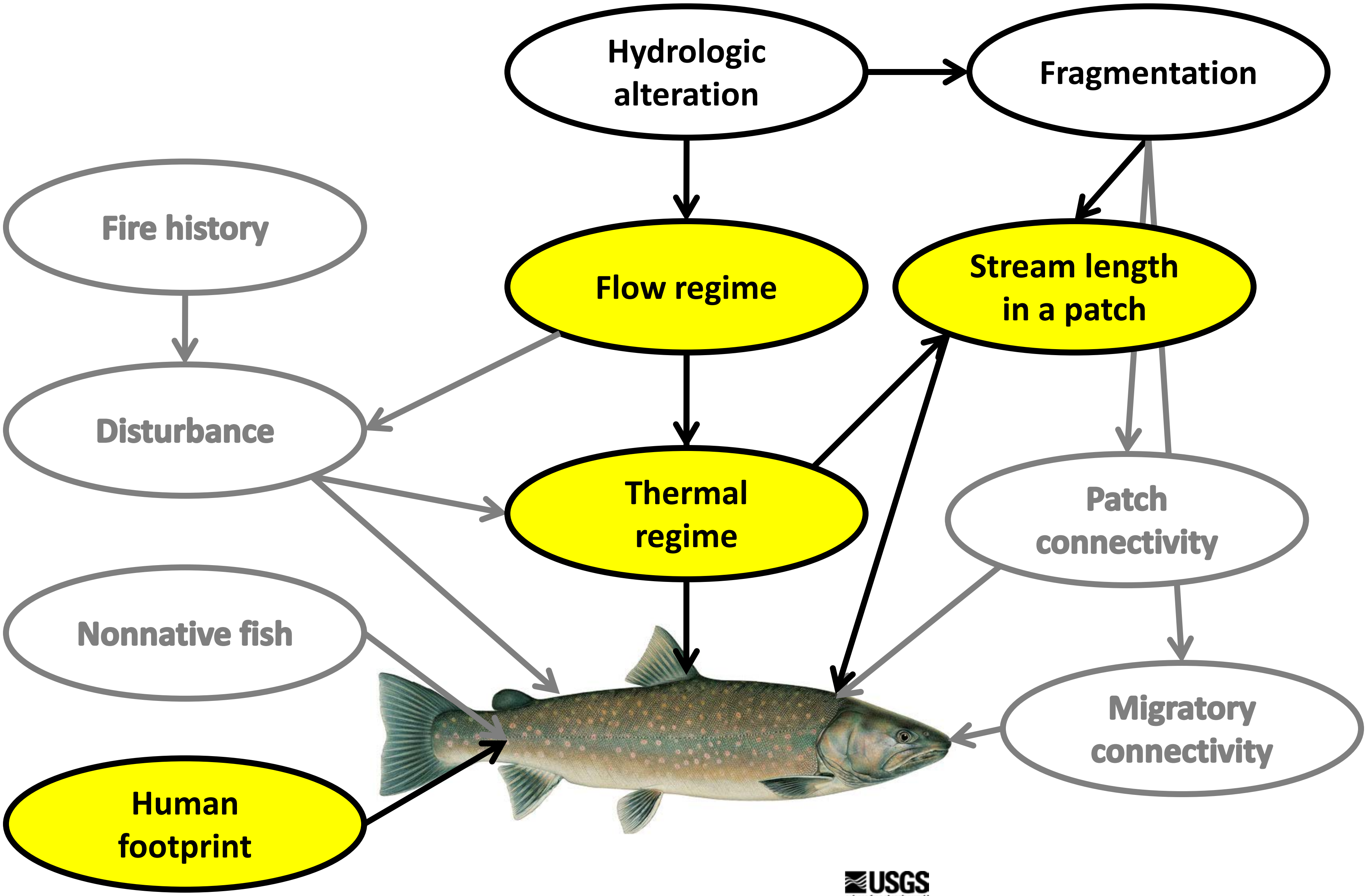
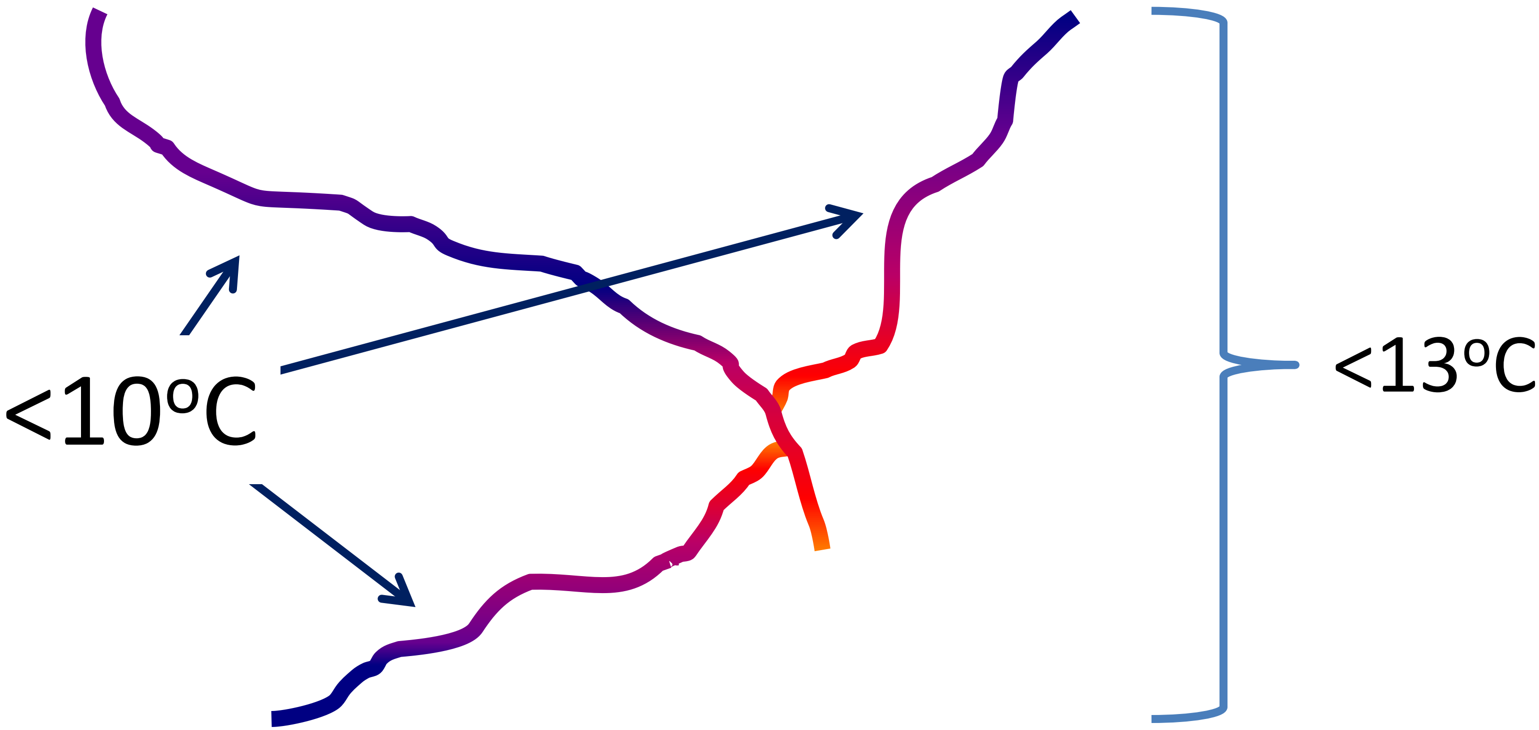
# Step 3. Model persistence (presence)



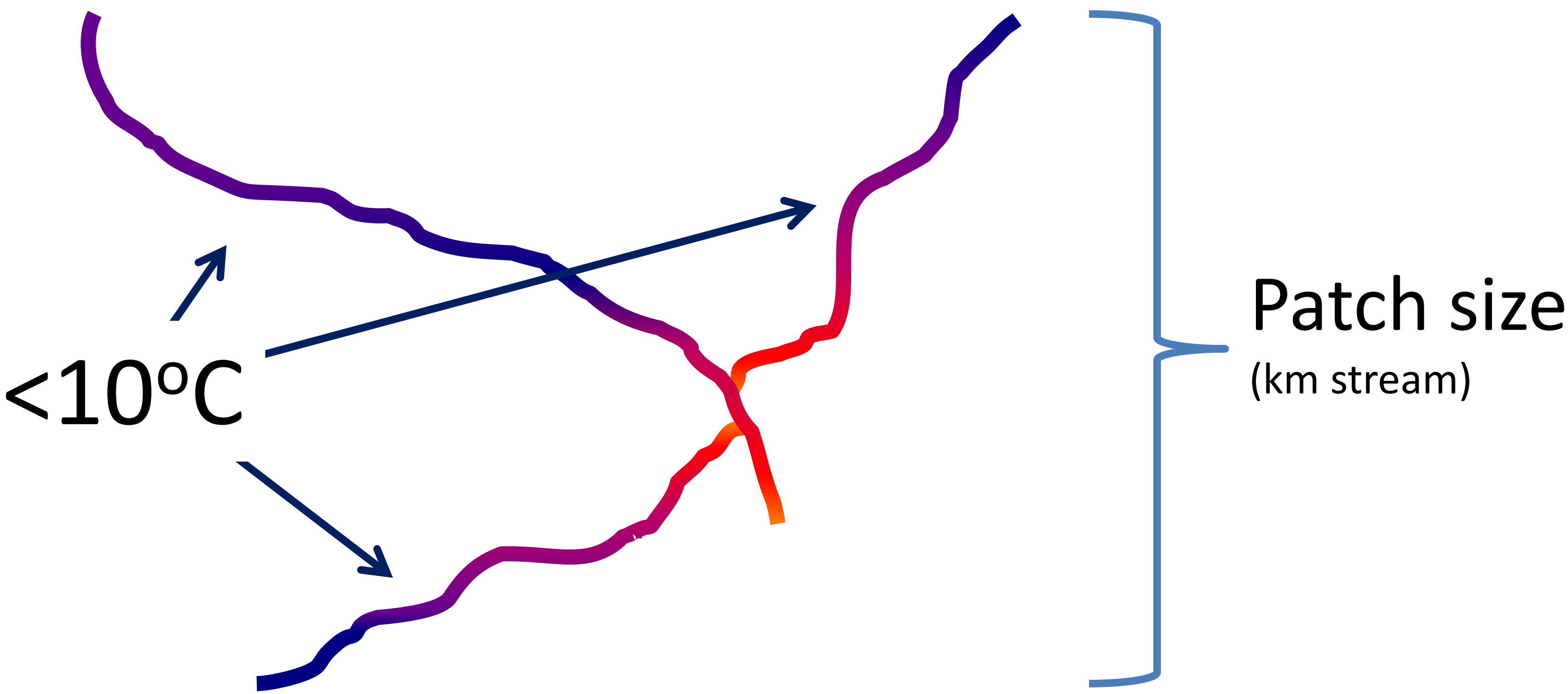
# Explanation - temperature

- Temperature *doubly* important
  - Need large cold patches (<13$^{o}$C)
  - AND very cold water within patches (<10$^{o}$C)



# Explanation – patch size

- Larger population size
- Less vulnerable to disturbance



# Explanation – Winter floods

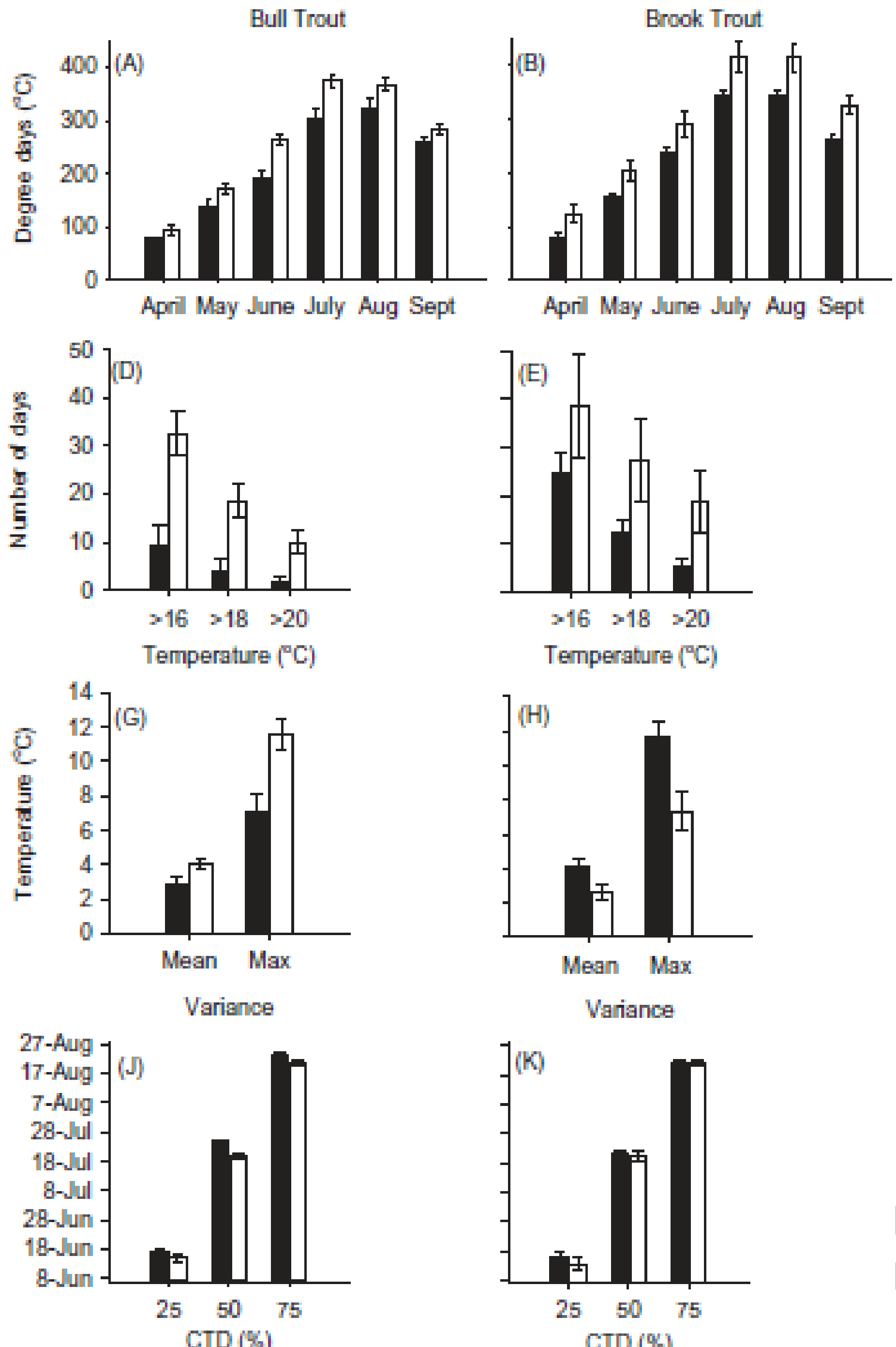
- More likely affects survival of recently emerged juveniles in winter
- Flows not high enough to produce substantial scouring of redds
- Will become more important as we lose snow and ice

# Explanation – Human Footprint

- Bigger footprint = less likely for bull trout
- Catch-all indicator of human influences
  - Local effects we didn't account for
    - Stocking of nonnative brook or brown trout
    - Angling
    - Small barriers not in ACOE database
    - Various local factors that we don't have good wall-to-wall data on
    - NEED data on these factors!

# What’s not in the BTVA

- Learn about “the little things…” **local threats**
  - **Presence of nonnatives**
  - Small barriers & diversions
  - Localized disturbances
  - Characteristics of lentic water bodies
  - Groundwater
  - Etc.




absent
present

Klamath River, Oregon
Benjamin et al. 2016

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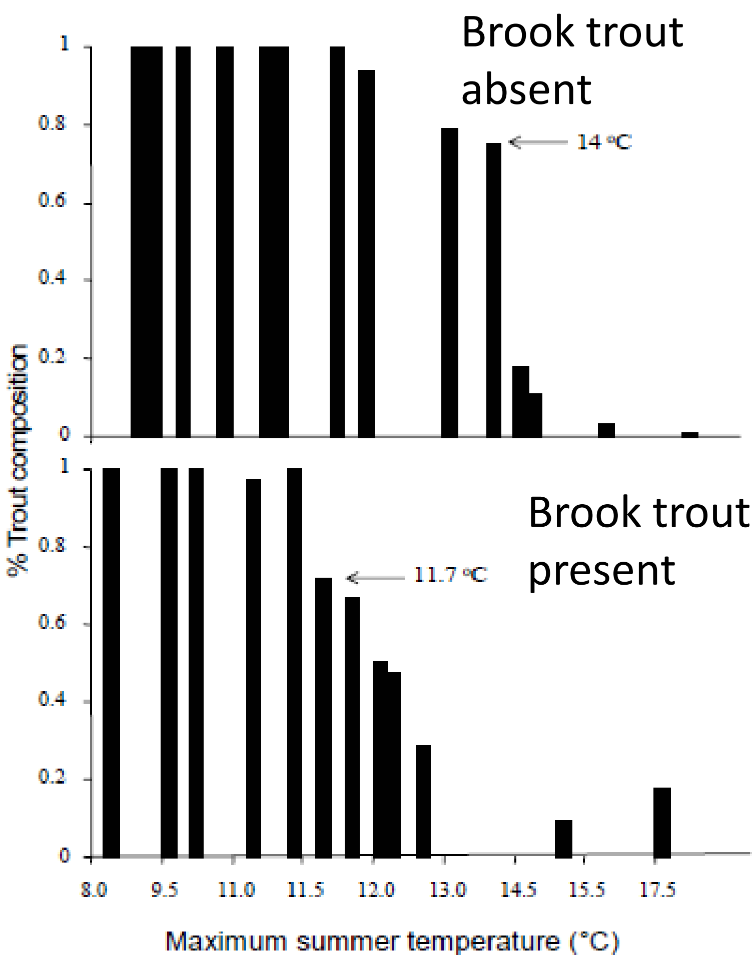
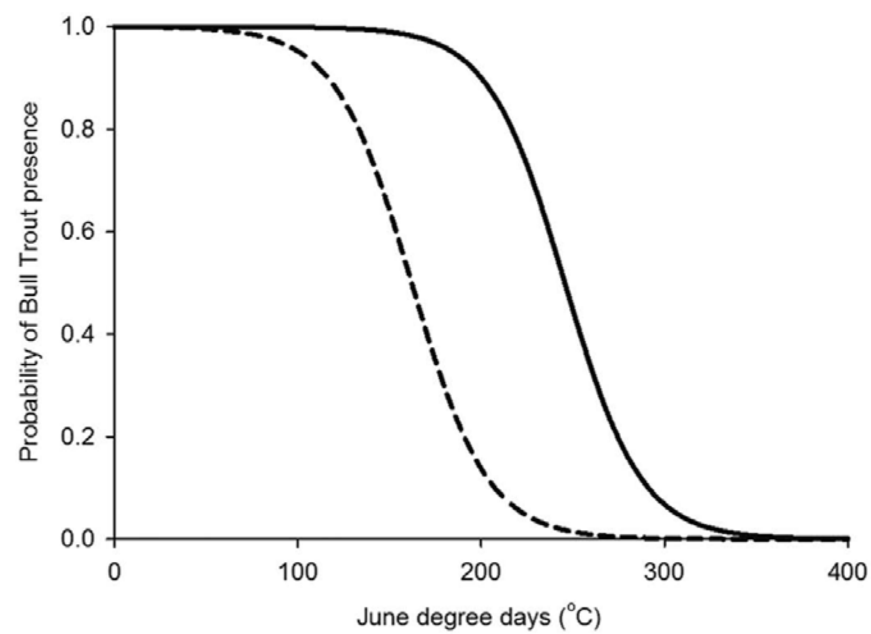
# Bull trout *do* occupy warmer reaches when brook trout are absent




Salmon River, Idaho
Benjamin 2006




Klamath River, Oregon
Benjamin et al. 2016

# Is hybridization a concern?

LETTERS
PUBLISHED ONLINE: 25 MAY 2014 | DOI: 10.1038/NCLIMATE2252

nature climate change

## Invasive hybridization in a threatened species is accelerated by climate change

Clint C. Muhlfeld[1,2*], Ryan P. Kovach[2], Leslie A. Jones[1,3], Robert Al-Chokhachy[4], Matthew C. Boyer[5], Robb F. Leary[6], Winsor H. Lowe[3], Gordon Luikart[2] and Fred W. Allendorf[3]

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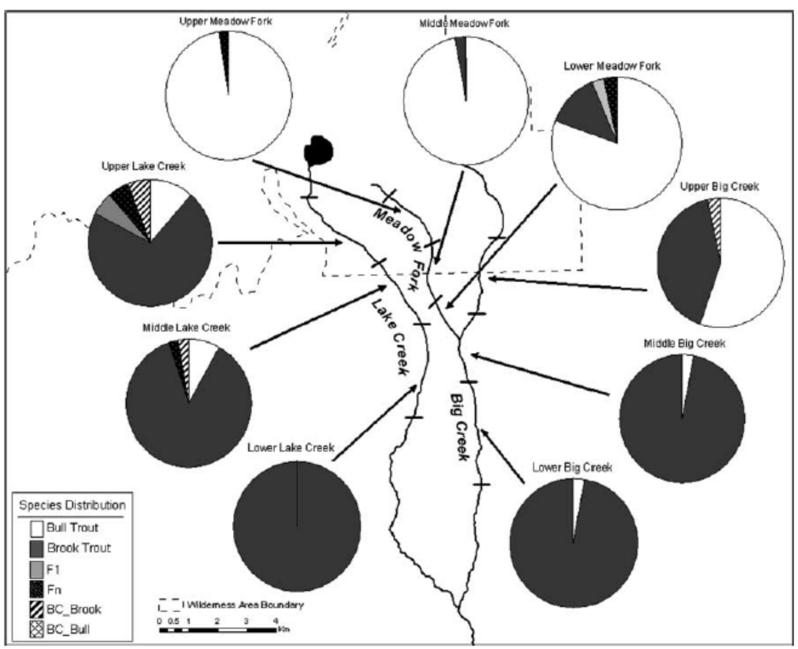
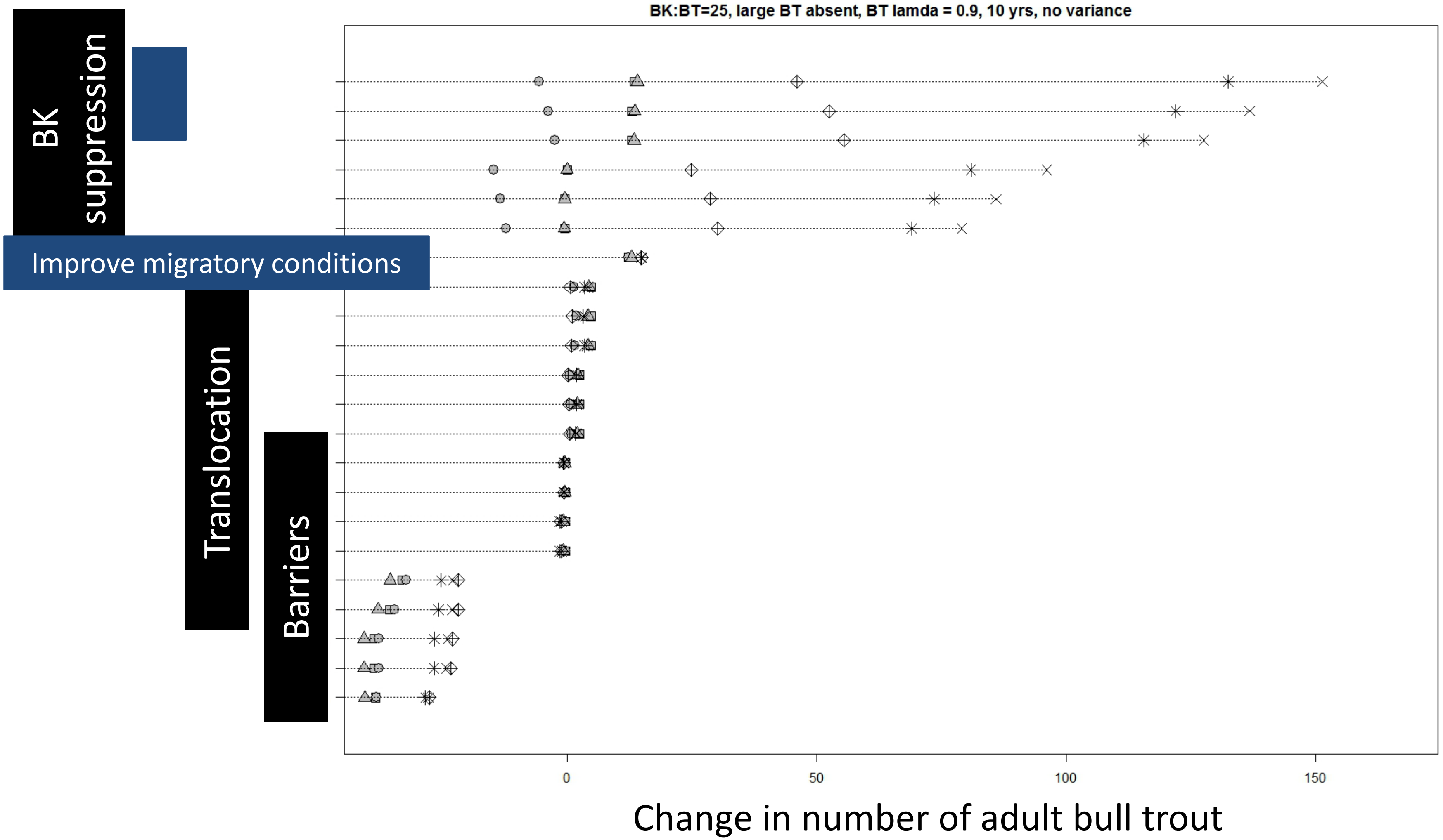



Conserv Genet
DOI 10.1007/s10592-009-9937-6
RESEARCH ARTICLE

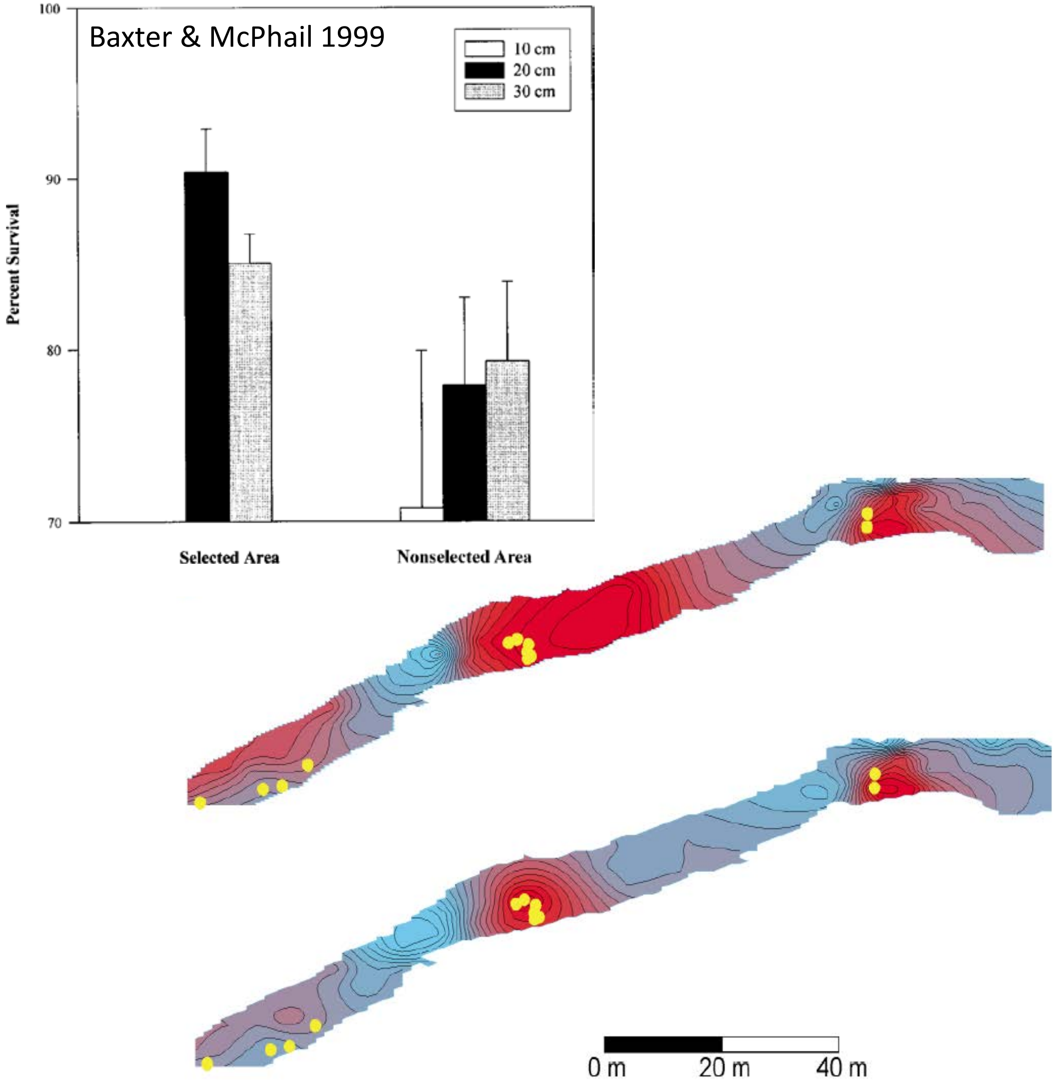
## Spatial patterns of hybridization between bull trout, *Salvelinus confluentus*, and brook trout, *Salvelinus fontinalis* in an Oregon stream network

Patrick W. DeHaan · Lawrence T. Schwabe · William R. Ardren

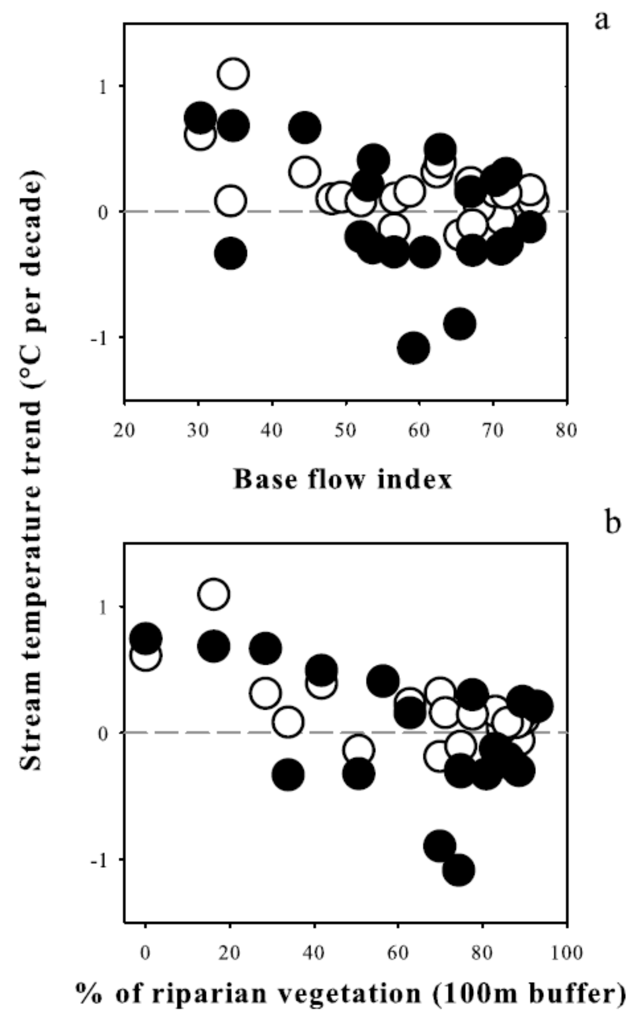



Preliminary data – not for circulation!

# Groundwater & riparian vegetation may buffer water temperatures




Baxter & Hauer 2000




Arismendi et al. 2012

# Bottom lines

- Streams are warming, but not too fast
- Threats greater when we cut off options for fish to be resilient – more fragmented
- Climate change may constrain resilience
- Manage to support natural resilience

# https://nccwsc.usgs.gov/

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## Rangewide Climate Vulnerability Assessment for Threatened Bull Trout

### Project Information

Search Projects

**Affiliation:** Northwest CSC

**Principal Investigator(s):**

Jason B Dunham (*U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center*)

**Cooperator(s)/Partner(s):**

Stephen Zylstra (*U.S. Fish and Wildlife Service*)
Daniel Isaak (*U.S. Forest Service, Rocky Mountain Research Station*)
Seth Wenger (*University of Georgia*)

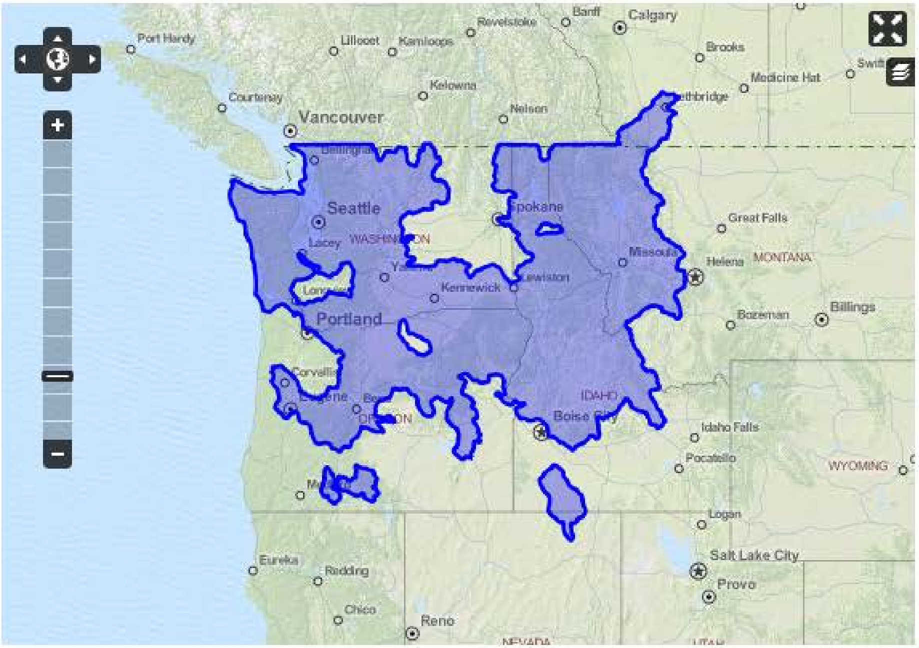
**Start Date:** 2011

**End Date:** 2014

**Project Status:** Completed

**Tags:** climate change, vulnerability, vulnerability assessment, bull trout, Northwest, Oregon, Washington, Idaho, Montana, CSC, Northwest CSC, 2011

**Fiscal Year:** FY 2011 Projects




### Summary

# Partners

**U.S. Fish and Wildlife Service**

Science Applications

U.S. Forest Service

**Dan Isaak, RMRS**

**U.S. Geological Survey**

NW CSC

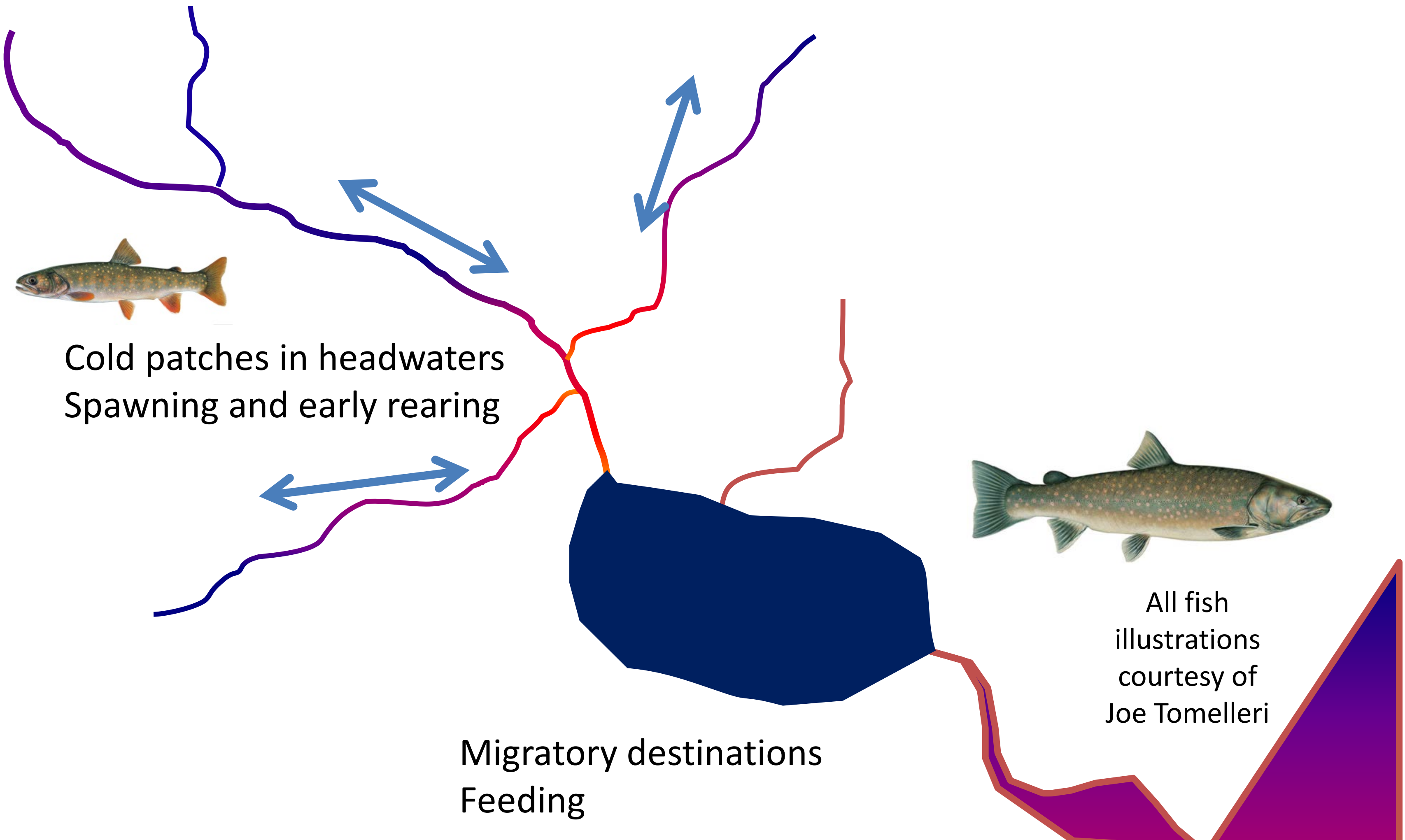
NW Region

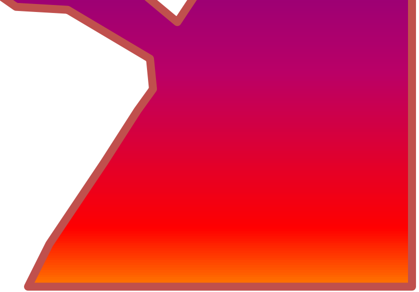
**FRESC – Dave Hockman-Wert, Nate Chelgren, Mike Heck**

Trout Unlimited - UGA

**Seth Wenger**

# Step 2. Patch attribution: connectivity



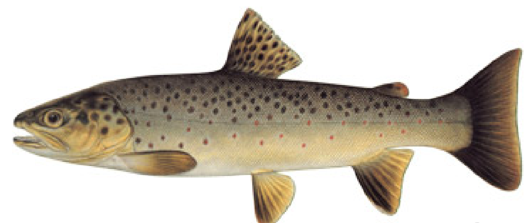



- Connectivity to lakes and reservoirs
- Connectivity among patches

# Step 2. Patch attribution: local human influences

## **Human influences**

Nonnative trout presence



???

Human footprint

*Ecological Applications*, 18(5), 2008, pp. 1119–1139


THE HUMAN FOOTPRINT IN THE WEST:
A LARGE-SCALE ANALYSIS OF ANTHROPOGENIC IMPACTS

MATTHIAS LEU,[1] STEVEN E. HANSER, AND STEVEN T. KNICK

*U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center, Snake River Field Station, 970 Lusk Street, Boise Idaho 83706 USA*

*Abstract.* Anthropogenic features such as urbanization, roads, and power lines, are increasing in western United States landscapes in response to rapidly growing human populations. However, their spatial effects have not been evaluated. Our goal was to model the human footprint across the western United States. We first delineated the actual area occupied by anthropogenic features, the physical effect area. Next, we developed the human footprint model based on the ecological effect area, the zone influenced by features beyond their physical presence, by combining seven input models: three models quantified top-down anthropogenic influences of synanthropic predators (avian predators, domestic dog and cat presence risk), and four models quantified bottom-up anthropogenic influences on habitat (invasion of exotic plants, human-caused fires, energy extraction, and anthropogenic wildland fragmentation). Using independent bird population data, we found bird abundance of four synanthropic species to correlate positively with human footprint intensity and negatively for three of the six species influenced by habitat fragmentation. We then evaluated the extent of the human footprint in relation to terrestrial (ecoregions) and aquatic systems (major rivers and lakes), regional management and conservation status, physical environment, and temporal changes in human actions. The physical effect area of anthropogenic features covered 13% of the western United States with agricultural land (9.8%) being most dominant. High-intensity human footprint areas (class 8–10) overlapped highly productive low-elevation private landholdings and covered 7% of the western United States compared to 48% for low-intensity areas (class 1–3), which were confined to low-productivity high-elevation federal landholdings. Areas within 1 km of rivers were more affected by the human footprint compared to lakes. Percentage human population growth was higher in low-intensity human footprint areas. The disproportional regional effects of the human footprint on landscapes in the western United States create a challenge to management of ecosystems and wildlife populations. Using footprint models, managers can plan land use actions, develop restoration scenarios, and identify areas of high conservation value at local landscapes within a regional context. Moreover, human footprint models serve as a tool to stratify landscapes for studies investigating floral and faunal response to human disturbance intensity gradients.

*Key words: abiotic interaction; anthropogenic disturbance; ecological human footprint; human footprint; human population growth; landscape management; land stewardship; physical human footprint; western United States.*

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# Step 2. Patch attribution: climate influences

**Really cold water**

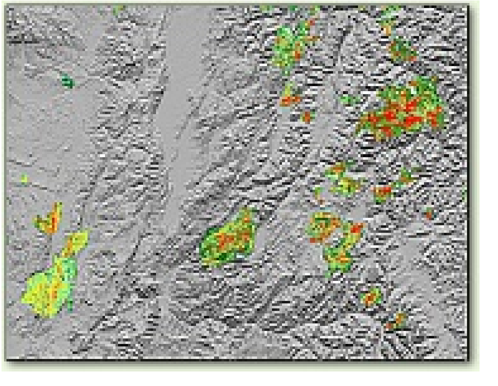
- % patch length <10C (NorWEST August mean)

**No winter floods**

- % patch length with W95 <2 events[1]

**Low chance of wildfire**

- % patch AREA with severe fire in last 20yr (MTBS)



[1]from VIC see Wenger et al. 2010, WRR; 2011, CJFAS