Climate change, bull trout and the Malheur

Joe Benjamin and Jason Dunham
The threatened bull trout

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

- Fire history
- Disturbance
- Nonnative fish
- Human footprint
- Flow regime
- Thermal regime
- Stream length in a patch
- Patch connectivity
- Migratory connectivity
- Hydrologic alteration
- Fragmentation
Step 3. Model persistence (presence)

- Fire history
- Disturbance
- Nonnative fish
- Human footprint

Flow regime

Hydrologic alteration

Fragmentation

Stream length in a patch

Thermal regime

Patch connectivity

Migratory connectivity
Explanation - temperature

- Temperature *doubly* important
  - Need large cold patches ($<13^\circ C$)
  - AND very cold water within patches ($<10^\circ C$)
Explanation – patch size

- Larger population size
- Less vulnerable to disturbance

<10°C

Patch size (km stream)
Explanation – Winter floods

• More likely affects survival of recently emerged juveniles in winter
• Flows not high enough to produce substantial scouring of reds
• 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.
Klamath River, Oregon
Benjamin et al. 2016
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?

Invasive hybridization in a threatened species is accelerated by climate change

Clint C. Muhlfeld¹,²*, Ryan P. Kovach², Leslie A. Jones¹,³, Robert Al-Chokhachy⁴, Matthew C. Boyer⁵, Robb F. Leary⁶, Winsor H. Lowe³, Gordon Luikart² and Fred W. Allendorf³
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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
Barriers
Translocation
BK suppression
Improve migratory conditions

Preliminary data – not for circulation!
Groundwater & riparian vegetation may buffer water temperatures

Baxter & McPhail 1999

Base flow index

Stream temperature trend (°C per decade)

% of riparian vegetation (100m buffer)

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
Rangewide Climate Vulnerability Assessment for Threatened Bull Trout

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
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

Cold patches in headwaters
Spawning and early rearing
Migratory destinations
Feeding

All fish illustrations courtesy of Joe Tomelleri
Step 2. Patch attribution: local human influences

Human influences

THE HUMAN FOOTPRINT IN THE WEST: A LARGE-SCALE ANALYSIS OF ANTHROPOGENIC IMPACTS
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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 identified areas affected by human activity using a digital spatial data model based on the ecological effect area, the zone influenced by features beyond their physical presence, by combining seven input models: three models quantified topdown anthropogenic influences of sympathetic predictors (crown predictors, domestic dog and cat presence risk), and four models quantified bottom-up anthropogenic influences on habitat (erosion of exotic plants, human-induced fire, energy extraction, and anthropogenic wildfire fragmentation). Using independent bird population data, we found bird abundance of four sympatric 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 relative to terrestrial (ecoregions) and aquatic systems (major rivers and lakes), regional management and conservation units, physical environments, and temporal changes in human actions. The physical effect area of anthropogenic features covered 3% of the western United States with agricultural land 5%, being most prominent. High-impact human footprint areas fall 1.8% overlapped highly productive low-employment private lands. The 1.5% of the western United States comprised 3% of U.S. lands under human footprint analysis. Human footprint extent was within 3% of riverine corridor habitat. Areas within 3% of rivers were more affected by the human footprint compared to lakes. Percentages of human population growth was higher in low intensity human footprint areas. The disproportionate 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 conservation 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 land and land use response to human disturbance and gradient.
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