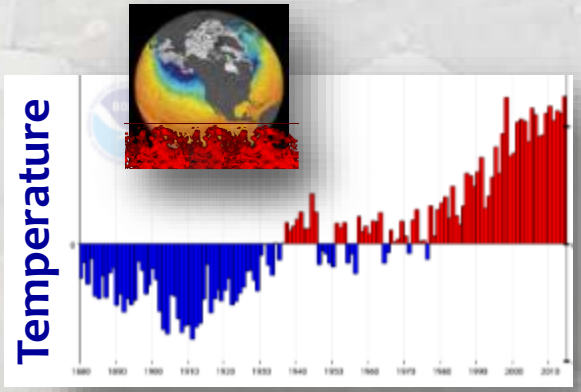
This Century's Bull Trout Forecast: Partly Sunny With Scattered Rain Showers

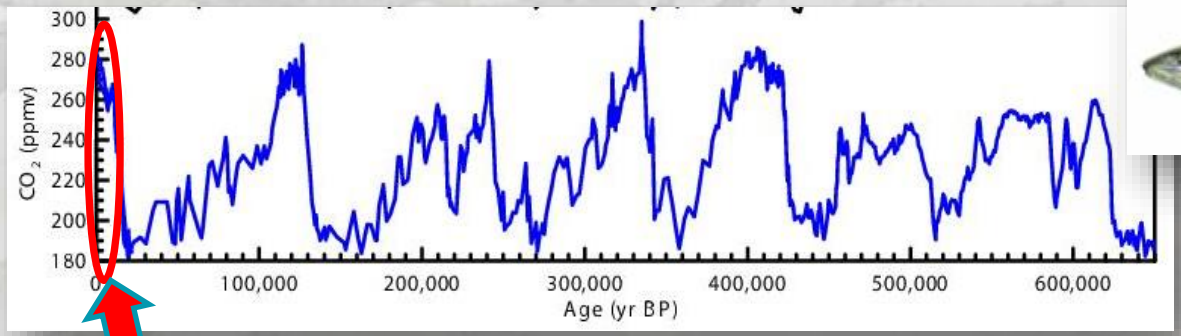
Dan Isaak and Mike Young
U.S. Forest Service, Rocky Mountain Research Station

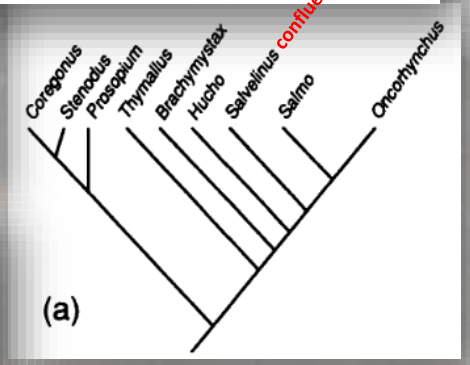


Before

After

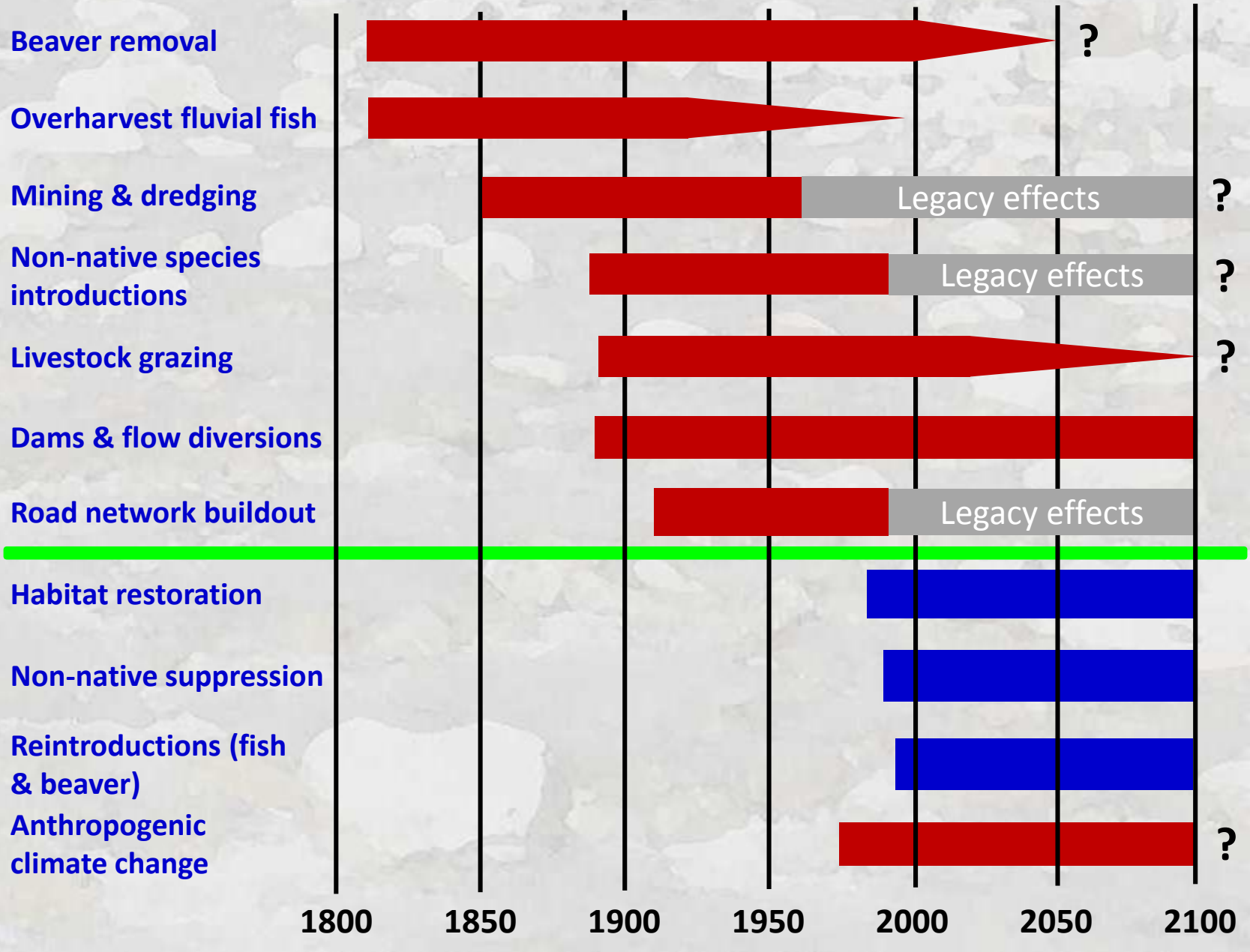
Much Has Transpired in the Bull Trout World Over Millions of Years…





Human Civilization

Novel Twists Last 200 Years…

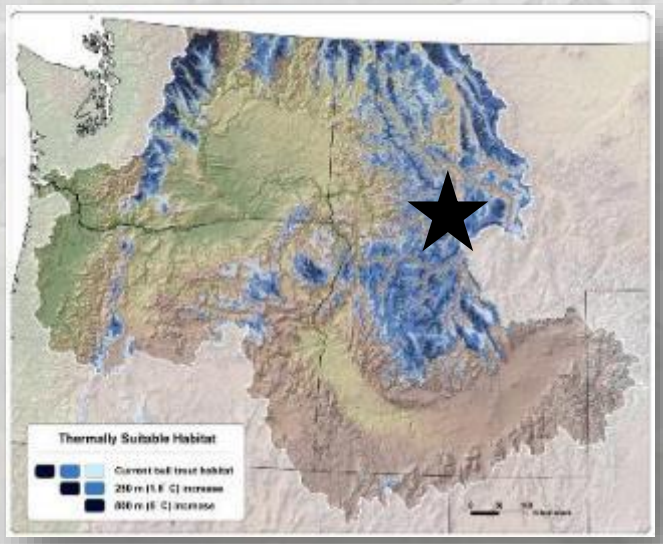


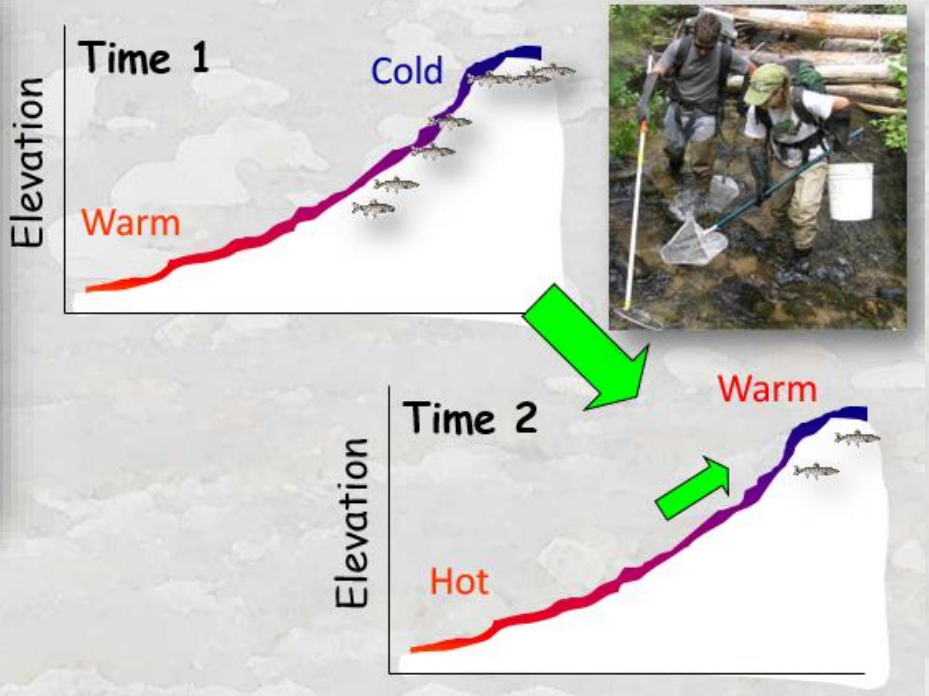
1st-Generation Bull Trout Climate Model Predicts Large Habitat Reductions from Warming

+1.6°C AirT = 40% habitat loss
+5.0°C AirT = 92% habitat loss

Rieman et al. 2007. Anticipated climate warming effects on bull trout habitats and populations across the Interior Columbia Basin. *TAFS* **136**:1552-1565

Subsequent Resurvey Studies Confirm Distributions are Contracting into Headwaters





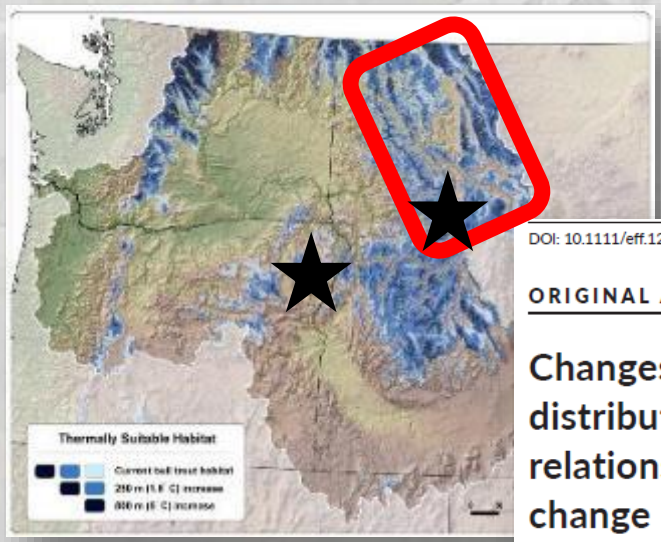
OPEN ACCESS Freely available online

PLOS ONE

Evidence of Climate-Induced Range Contractions in Bull Trout *Salvelinus confluentus* in a Rocky Mountain Watershed, U.S.A.

Lisa A. Eby[1], Olga Helmy[1], Lisa M. Holsinger[2], Michael K. Young[3]*

Subsequent Resurvey Studies Confirm Distributions are Contracting into Headwaters



DOI: 10.1111/eff.12386

ORIGINAL ARTICLE

WILEY Ecology of FRESHWATER FISH

Changes in native bull trout and non-native brook trout distributions in the upper Powder River basin after 20 years, relationships to water temperature and implications of climate change

Philip J. Howell

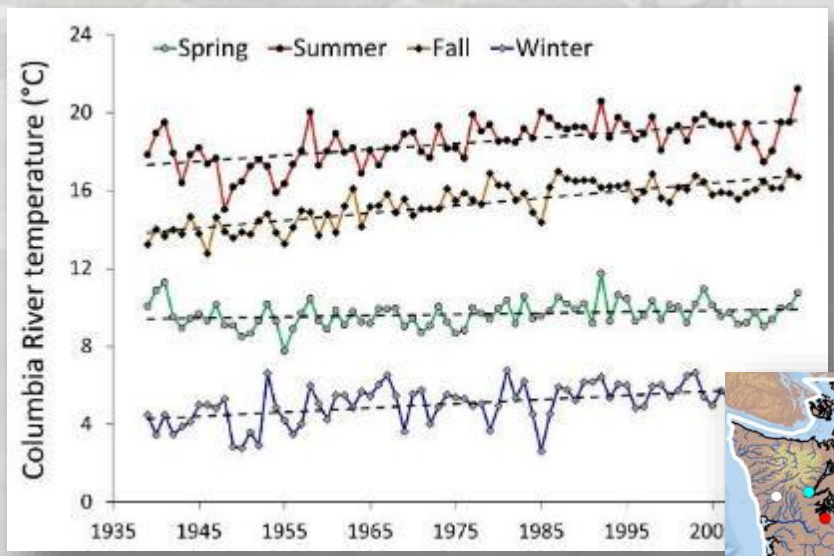
NRC Research Press

ARTICLE

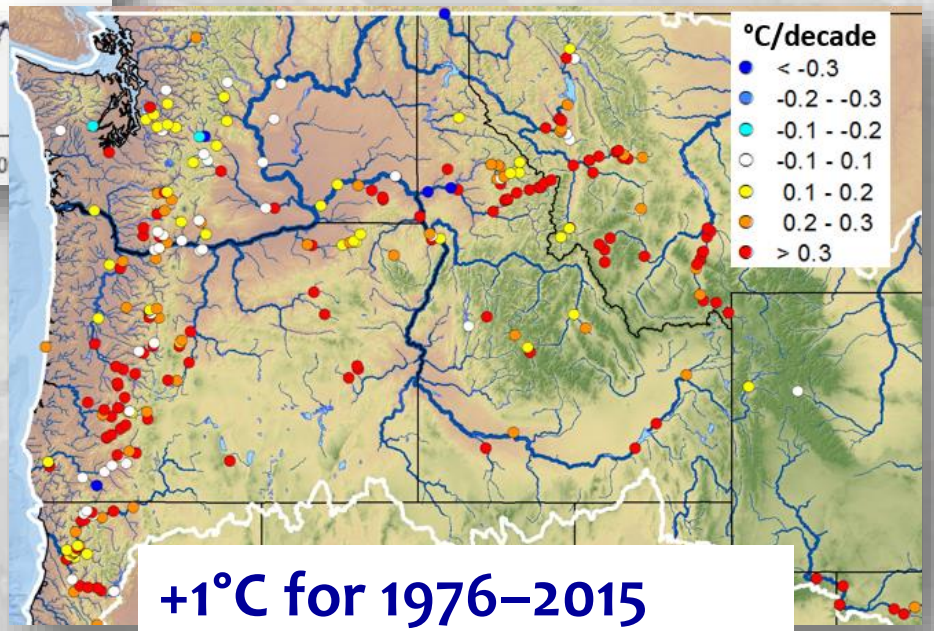
Are brown trout replacing or displacing bull trout populations in a changing climate?

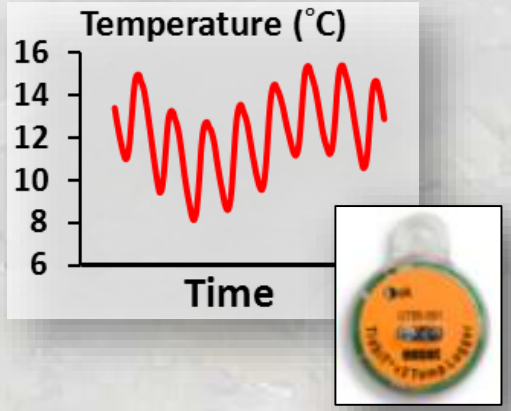
Robert Al-Chokhachy, David Schmetterling, Chris Clancy, Pat Saffel, Ryan Kovach, Leslie Nyce, Brad Liermann, Wade Fredenberg, and Ron Pierce

Expected Because Rivers & Streams are Getting Warmer…



Bonneville Dam Temperature Record

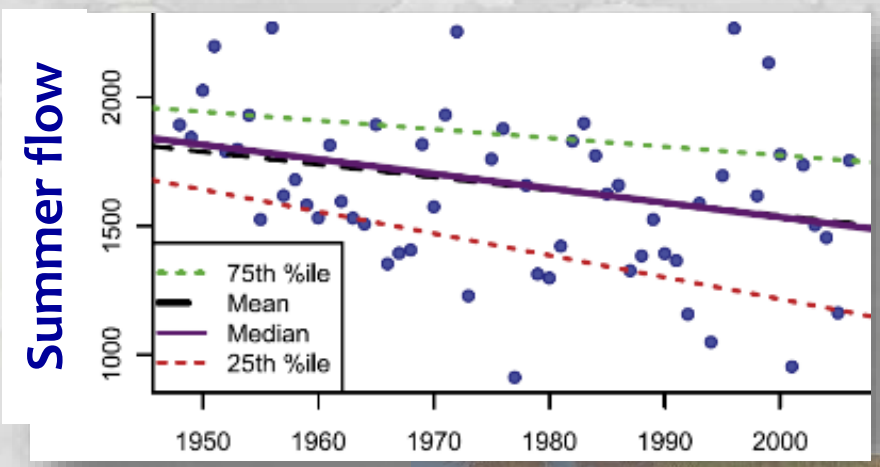


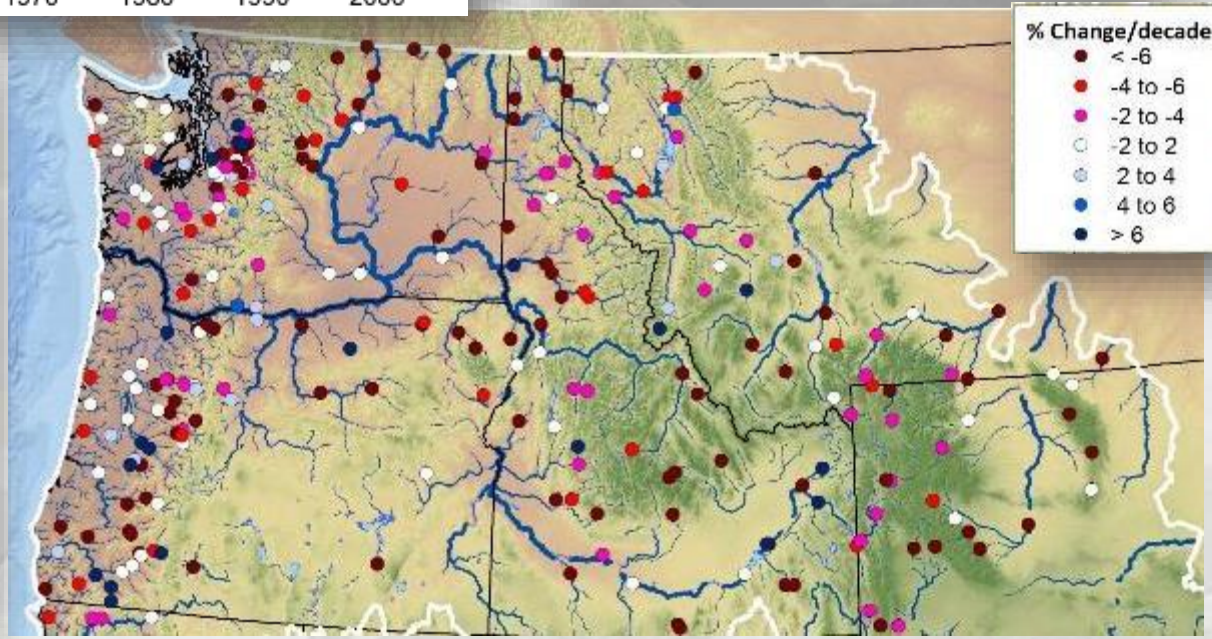


+1°C for 1976–2015 Summer & fall months

Isaak et al. 2018. Global warming of salmon and trout rivers in the Northwestern U.S. Road to ruin or path through purgatory? *Transactions of the American Fisheries Society* **147**:566-587.

Summer Flows are Decreasing (1950–2015)

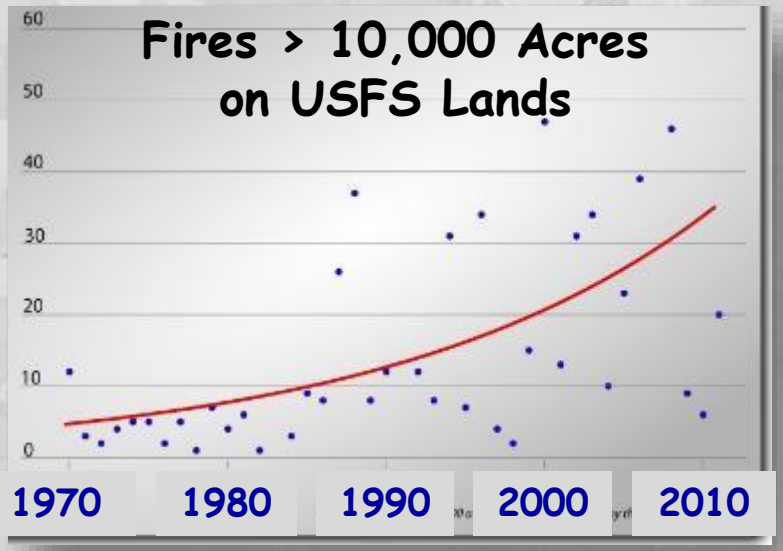


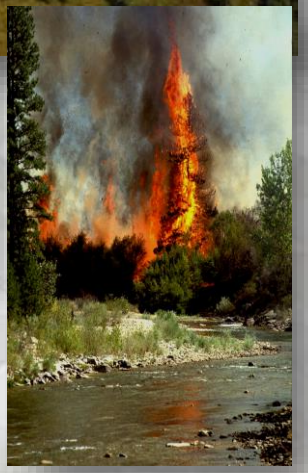


Luce and Holden 2009. Declining annual streamflow distributions in the PNW, 1948-2006. *Geophysical Research Letters* **36**: L16401.

Luce et al. 2013. The missing mountain water. *Science* **342**: 1360-1364.

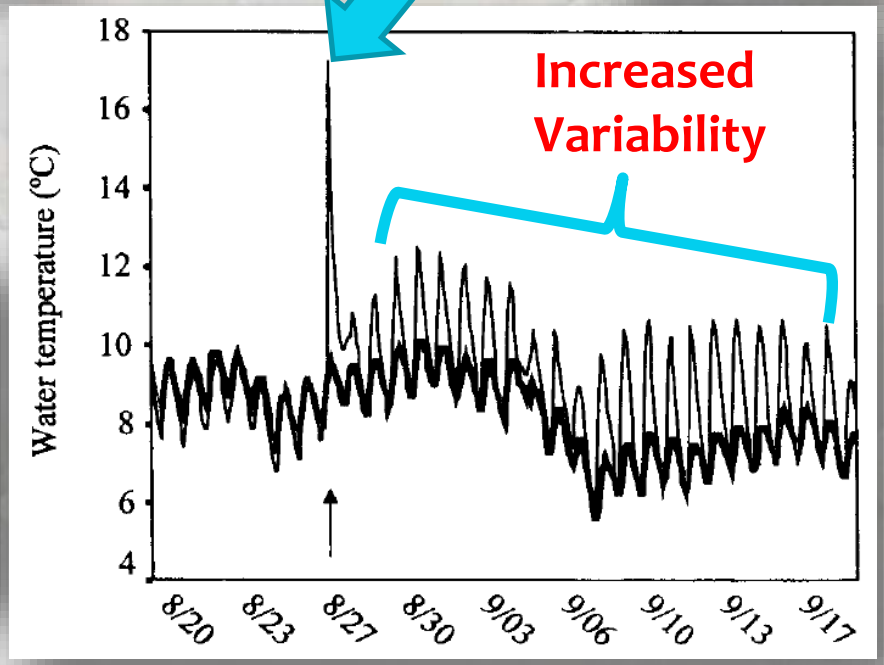
& Wildfires are Increasing



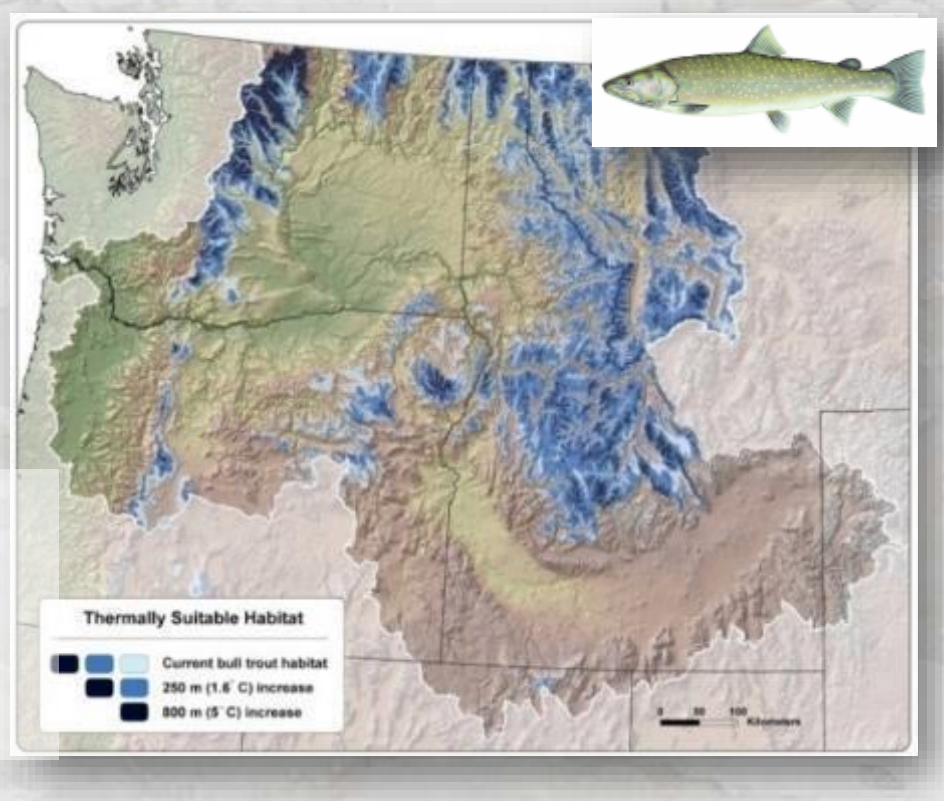


Fire

Exacerbates temperature gains & short-term disturbances

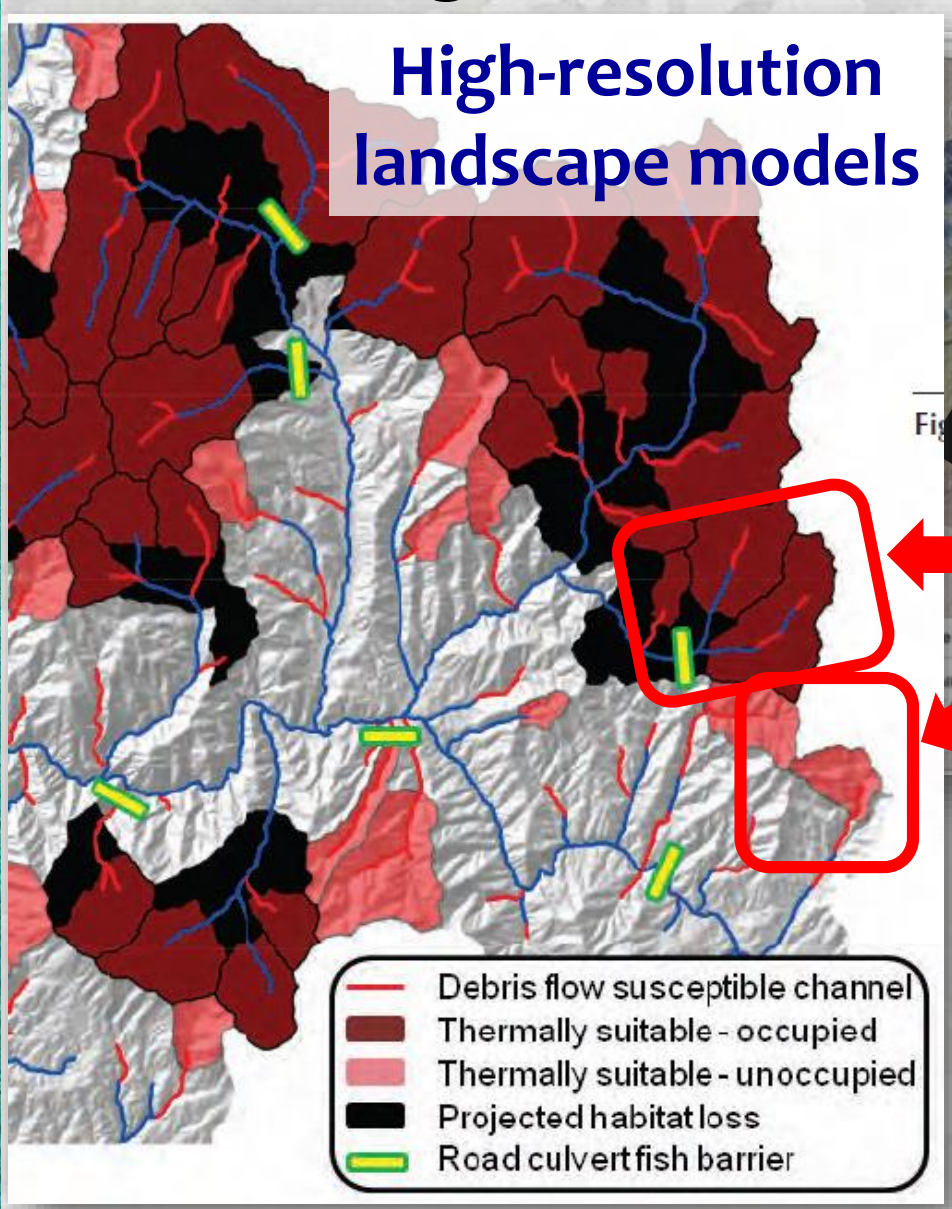


Which Streams May Serve as Climate Refugia? Precision Forecasts Needed



Models based on air temperature are coarse

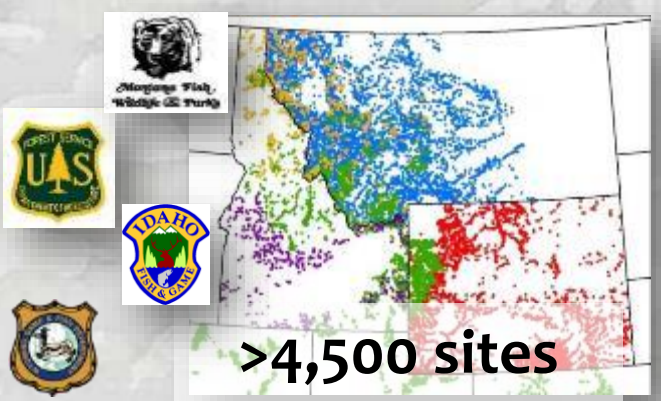
Which Streams May Serve as Climate Refugia? Precision Forecasts Needed



2nd-Generation Bull Trout Climate Model

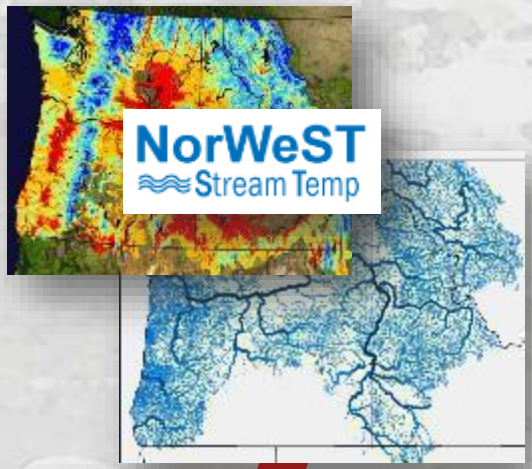
Climate Shield

BIG FISH DATA



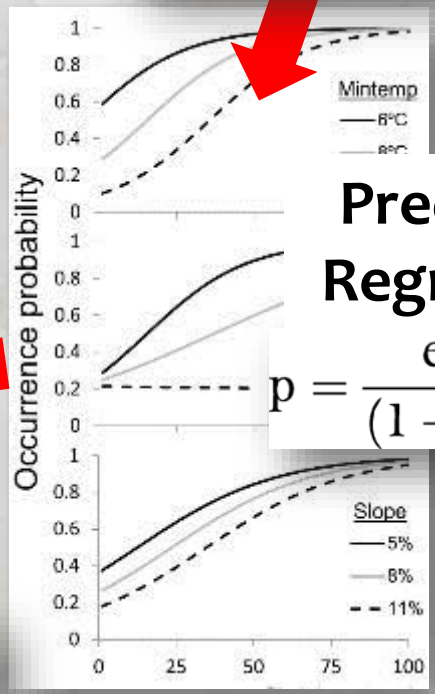
>4,500 sites

>500 streams



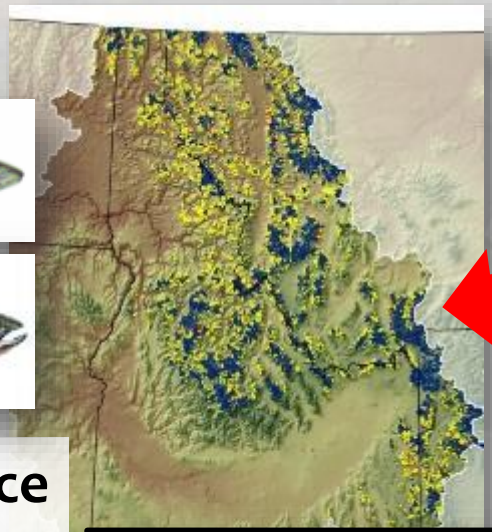
Variables

- Summer temp
- Patch size
- Gradient
- % Brook trout



Predictive Logistic Regression Models

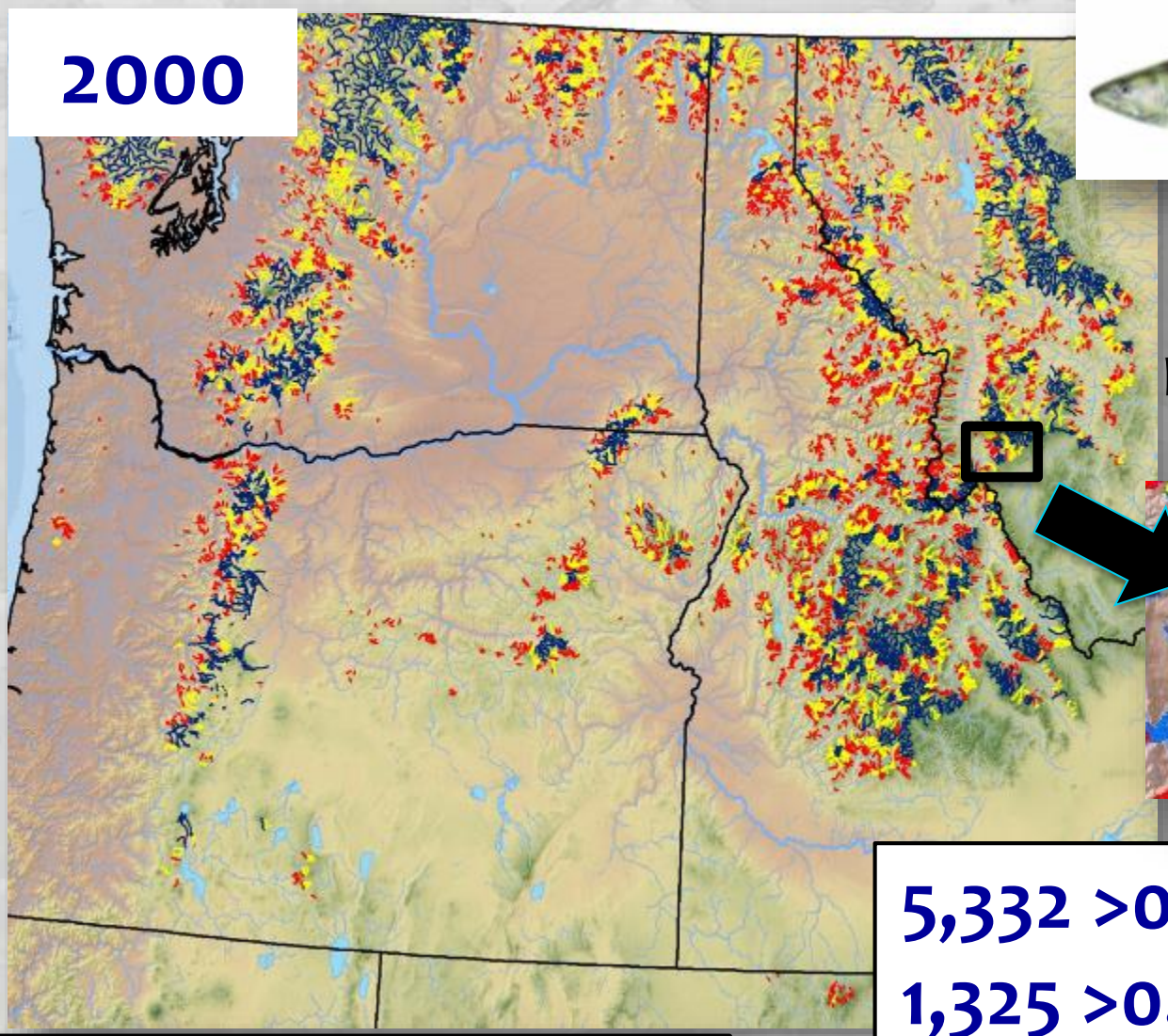
$$p = \frac{\exp(a + bx \ldots ny)}{(1 + \exp[a + bx \ldots ny])}$$



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 Population Occurrence Probability

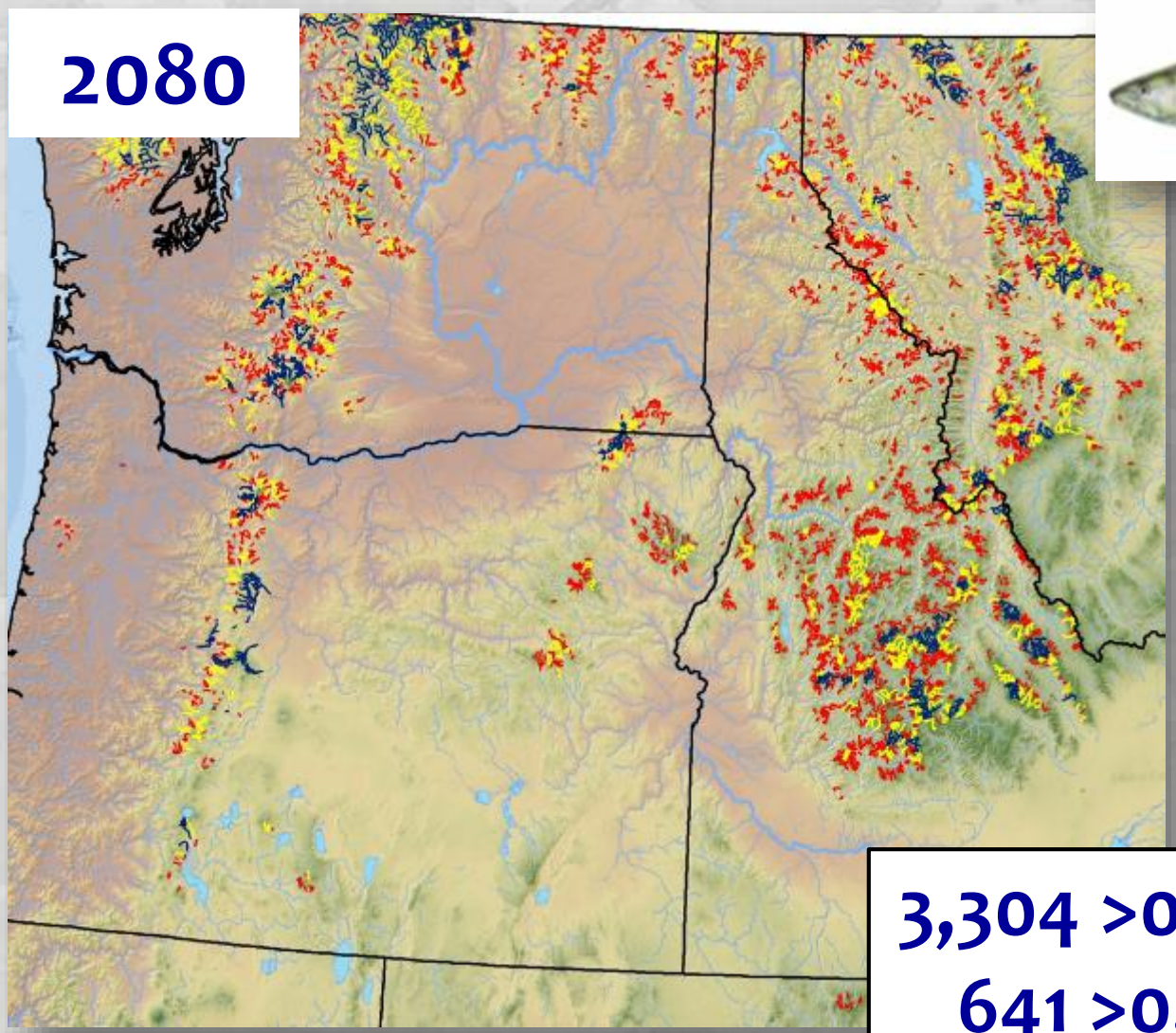


Stream population scale predictions

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

Bull Trout Population Occurrence Probability

2080

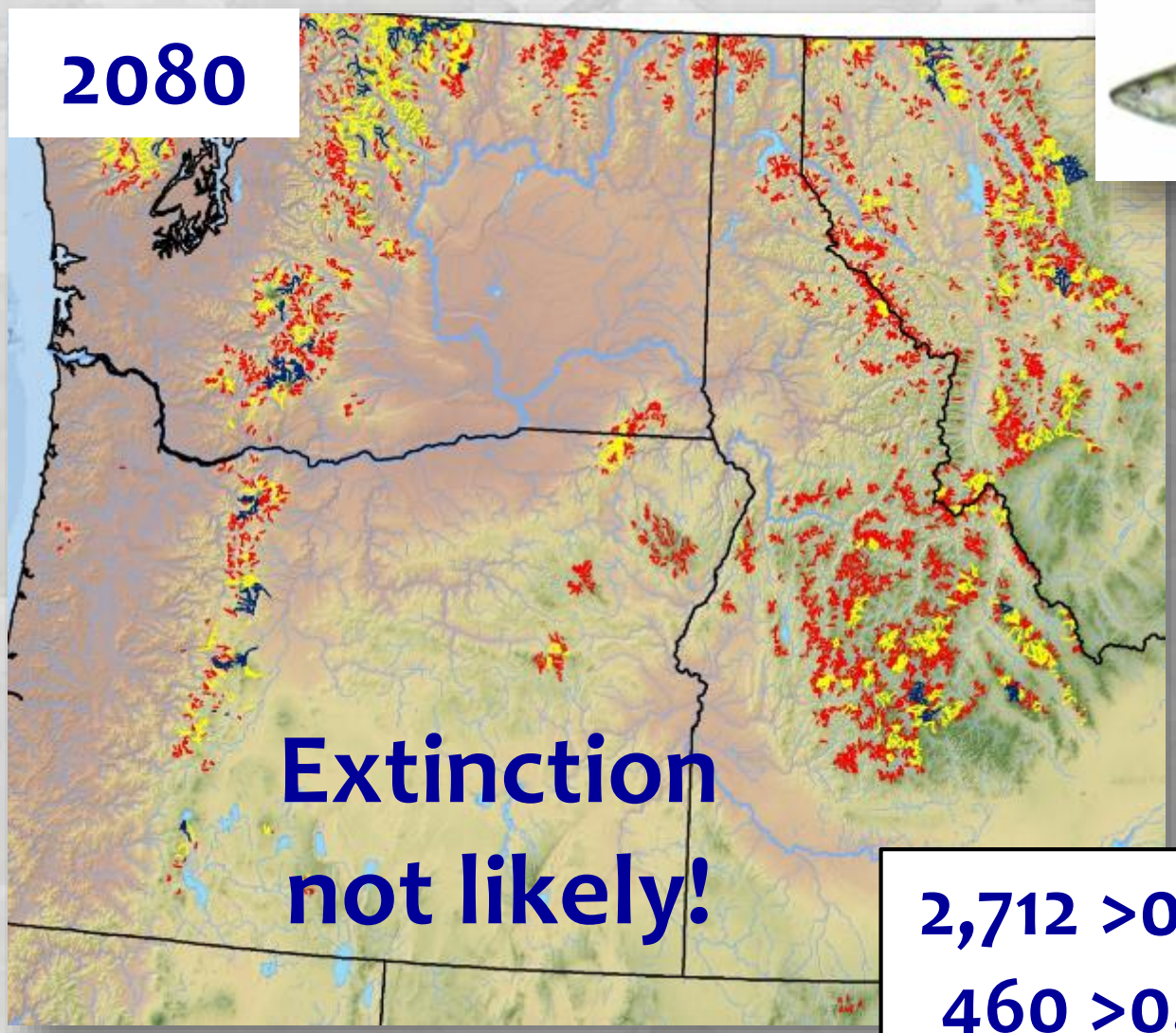


>0.9 >0.5 >0.1

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

Bull Trout Population Occurrence Probability

2080



&

everywhere

Extinction not likely!

>0.9 >0.5 >0.1

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

Local Reversals of Negative Effects

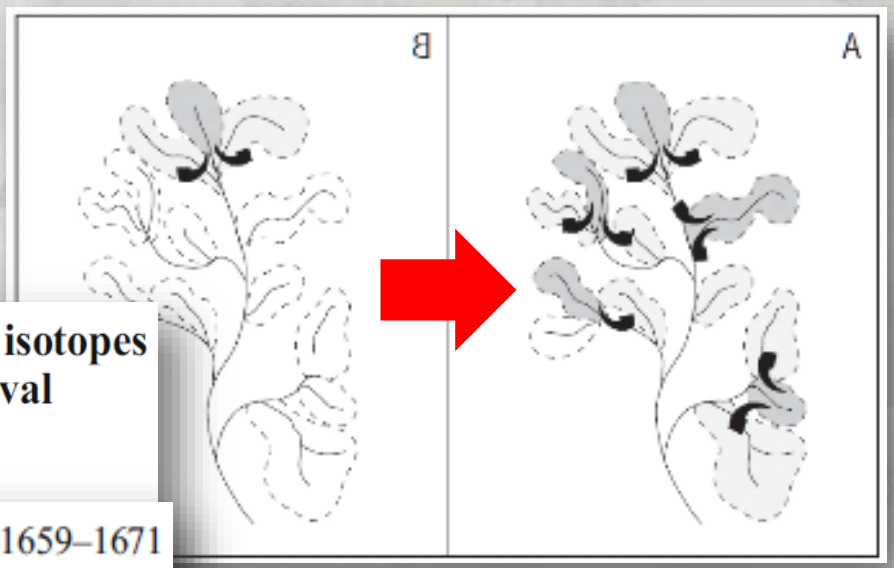
Habitat quality & connectivity improvements

Technical Guide for Field Practitioners: Understanding and Monitoring Aquatic Organism Passage at Road-Stream Crossings

Nicholas Heredia
Brett Roper
Nathaniel Gillespie
Craig Roghair

Forest National Stream & Technical Report

Before → **After**



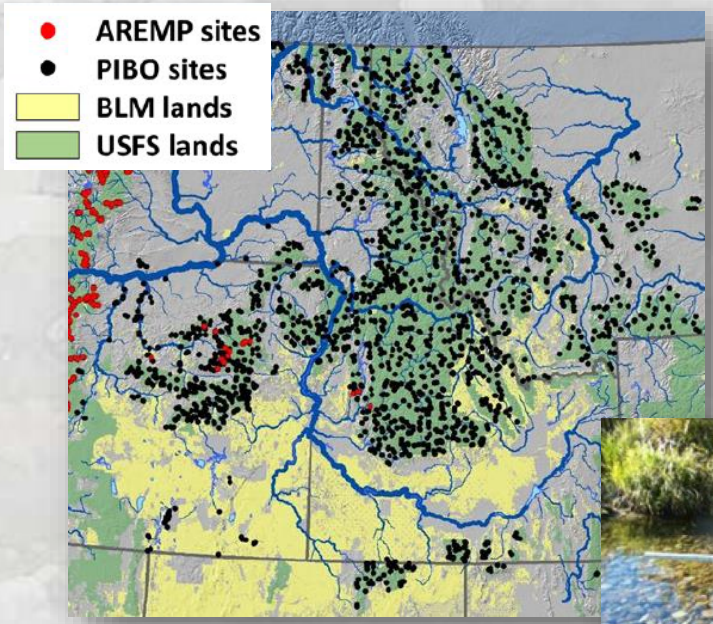
Re-awakening dormant life history variation: stable isotopes indicate anadromy in bull trout following dam removal on the Elwha River, Washington

Thomas P. Quinn · Morgan H. Bond · Samuel J. Brenkman · Rebecca Paradis · Roger J. Peters

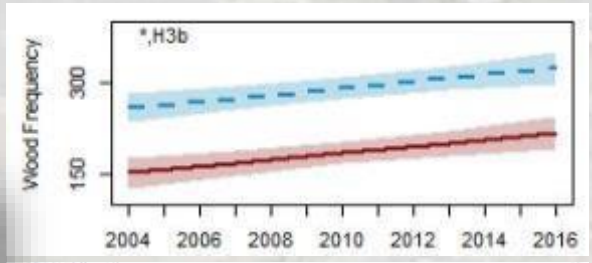
Environ Biol Fish (2017) 100:1659–1671
DOI 10.1007/s10641-017-0676-0

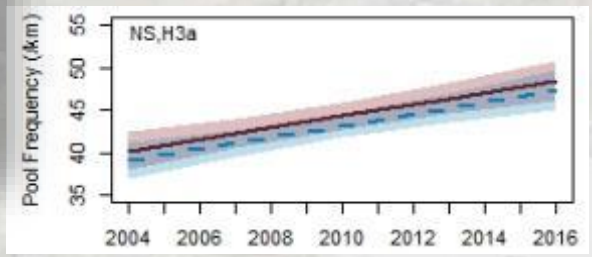
Local Reversals of Negative Effects

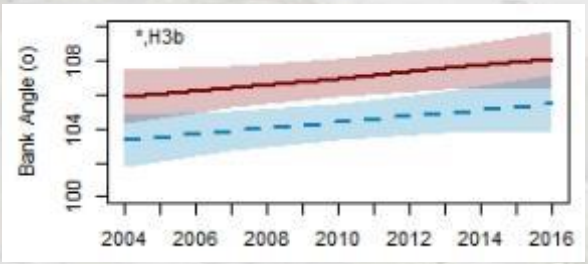
Habitat quality & connectivity improvements



- PIBO monitoring program 2004–2016
- Random sample of 1,250 sites in FS/BLM streams
- Trends: 1) more LWD, 2) more pools, 3) better banks







Roper et al., In review. Did changes in western federal land management policies improve salmonid habitat in streams on public lands within the Interior Columbia River Basin? *Environmental Management*

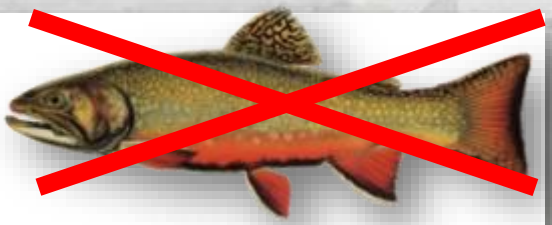
Local Reversals of Negative Effects

Eradication & suppression of brook trout

North American Journal of Fisheries Management 33:117–129, 2013

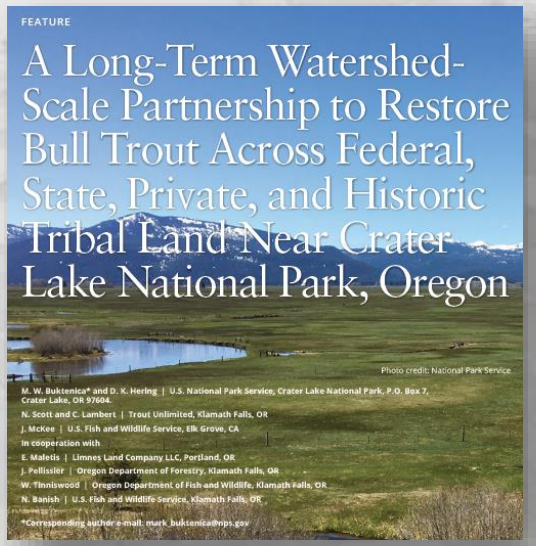
ISSN: 0275-5947 print / 1548-8675 online
DOI: 10.1080/02755947.2012.747452

ARTICLE



Eradication of Nonnative Brook Trout with Electrofishing and Antimycin-A and the Response of a Remnant Bull Trout Population

Mark W. Buktenica,* David K. Hering, and Scott F. Girdner
U.S. National Park Service, Crater Lake National Park, Post Office Box 7, Crater Lake, Oregon 97604, USA



Costs could drop in the future

Survival and Reproductive Success of Hatchery YY Male Brook Trout Stocked in Idaho Streams

Patrick A. Kennedy,* Kevin A. Meyer, and Daniel J. Schill
Idaho Department of Fish and Game, 1414 East Locust Lane, Nampa, Idaho 83686, USA

Matthew R. Campbell and N
Idaho Department of Fish and Ga

Simulated Effects of YY-Male Stocking and Manual Suppression for Eradicating Nonnative Brook Trout Populations

Daniel J. Schill* and Kevin A. Meyer
Idaho Department of Fish and Game, 1414 East Locust Lane, Nampa, Idaho 83686, USA

Michael J. Hansen
U.S. Geological Survey, Great Lakes Science Center, Hammond Bay Biological Station, 11188 Millersburg, Michigan 49759, USA

GMO

Local Reversals of Negative Effects

Reintroductions to historical habitats

Fish & Wildlife | Water | *Ecotrope*

Bull Trout Are Back In The Clackamas

Ecotrope Feb. 1, 2012 1:39 a.m. | Updated: July 10, 2018 1:28 p.m.

OREGON Fish & Wildlife

U.S. FISH & WILDLIFE SERVICE

A bull trout reintroduction in Oregon proves what's possible

The ambitious effort brings a threatened predator back to the Clackama watershed.

Case histories & institutional knowledge are increasing

Vol. 34: 191–209, 2017
https://doi.org/10.3354/esr00849

ENDANGERED SPECIES RESEARCH
Endang Species Res

Published September 5

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REVIEW

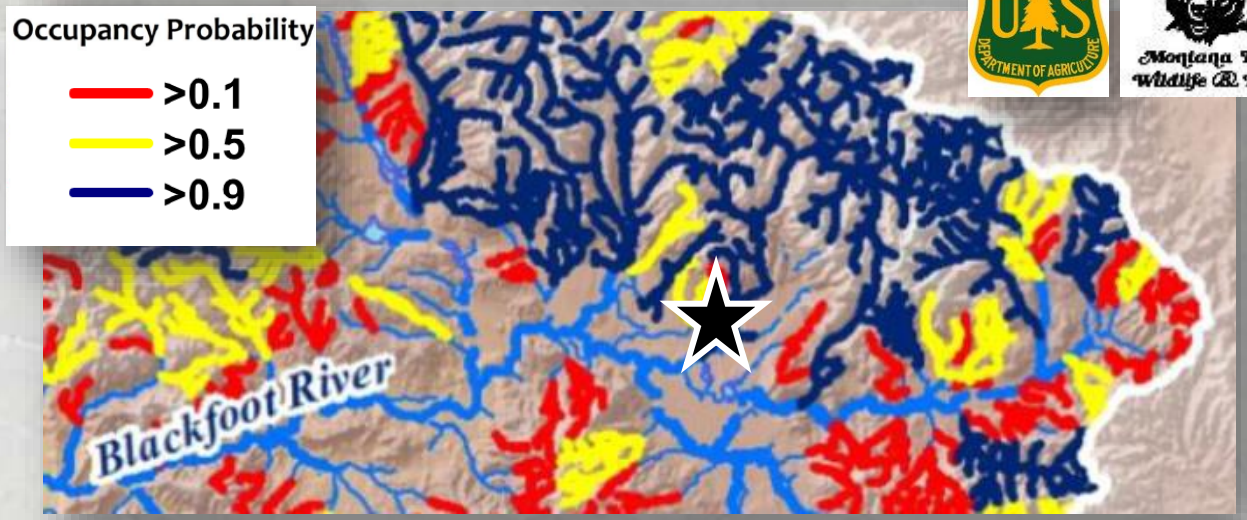
Translocation and reintroduction of native fishes: a review of bull trout *Salvelinus confluentus* with applications for future reintroductions

Molly F. Hayes, Nolan P. Banish*

U.S. Fish and Wildlife Service, Klamath Falls Fish and Wildlife Office, Klamath Falls, OR 97601, USA

Local Reversals of Negative Effects

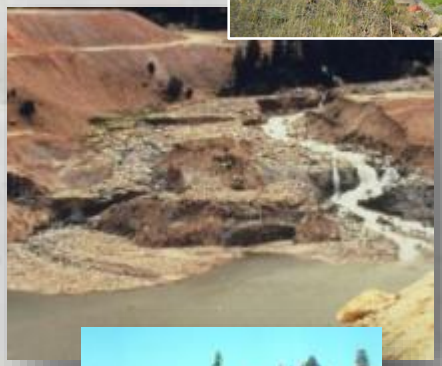
Assisted migration into long-term climate refugia



Climate Shield

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

Investing Strategically is Key



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

Where to do them?

How to maximize bang for the

Investment Precision Improved by Better Distribution Information…

Rangewide eDNA Bull Trout Project (Website)

Many Resources

Supporting Science

Protocols

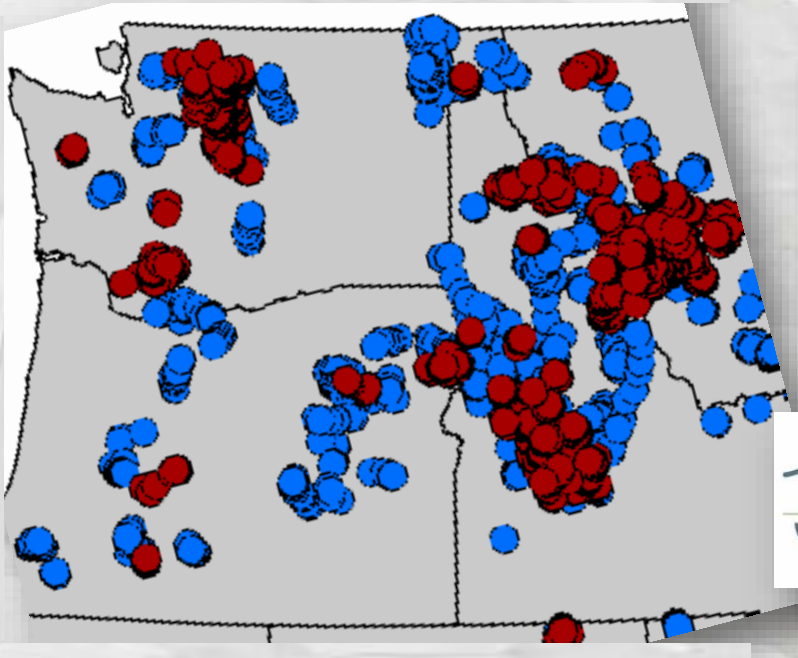
Sampling maps

ArcGIS Online

Results

Progress to date…

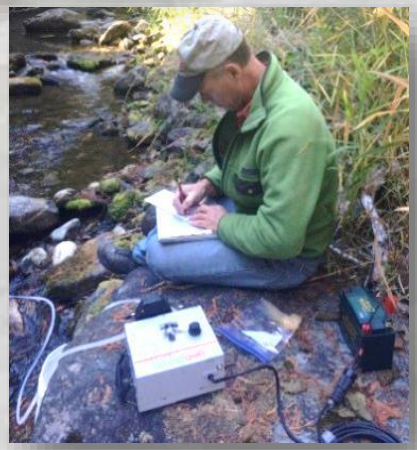
2015–2018 : ~7,000 sites sampled



Funded by

Great Northern Landscape Conservation Cooperative

Forest Service U.S. Department of Agriculture



Crowd-sourced data collections by many partner agencies

Idaho Fish & Game

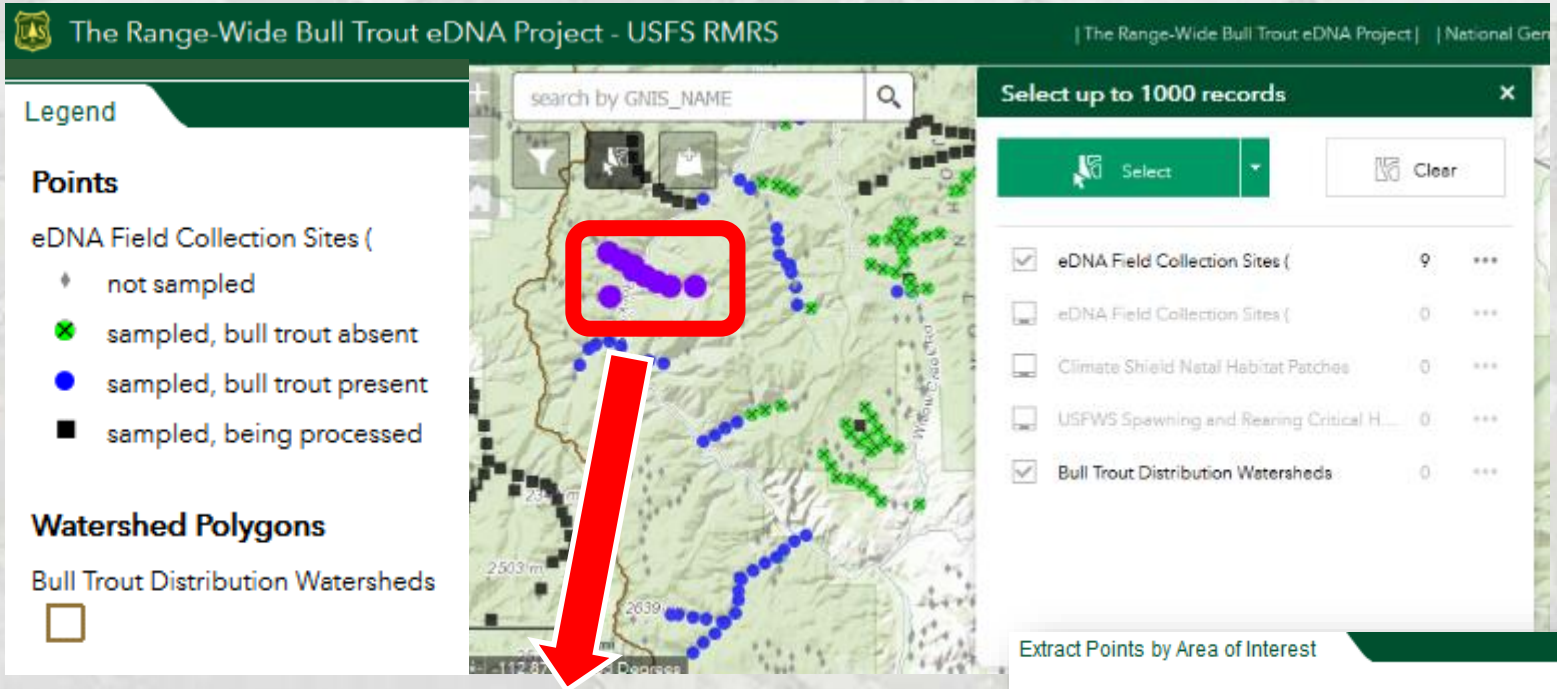
Trout Unlimited

U.S. Fish & Wildlife Service

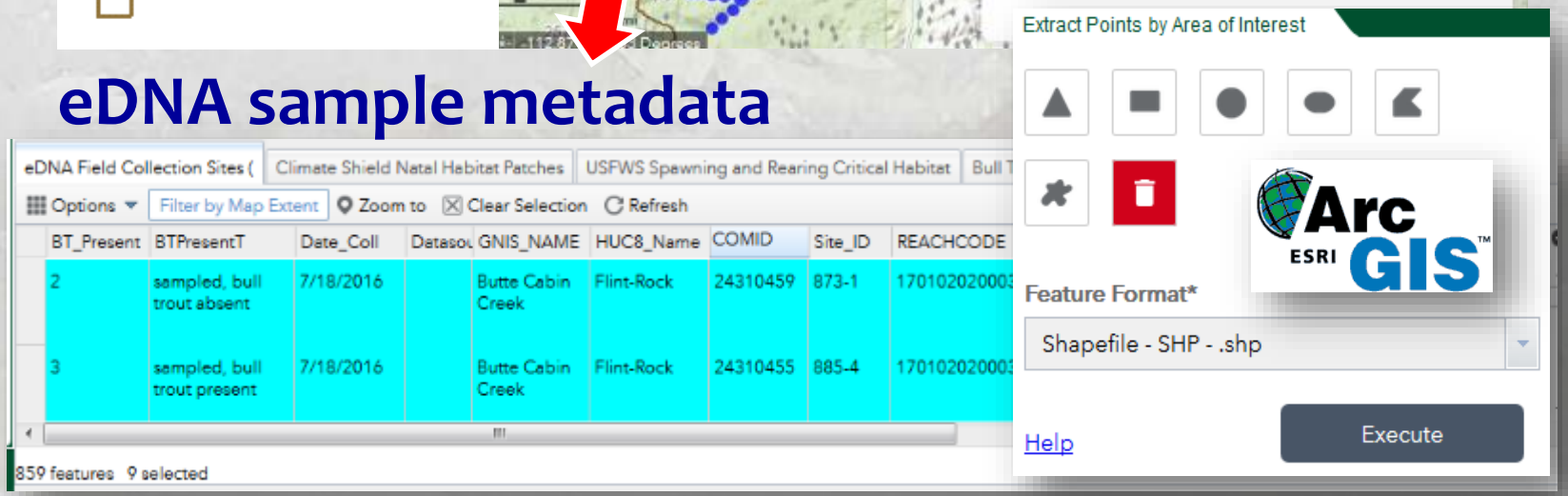
Montana Fish, Wildlife & Parks

Oregon Fish & Wildlife

Dynamic Webportal Delivers Data in User-Friendly Digital Formats w/Metadata

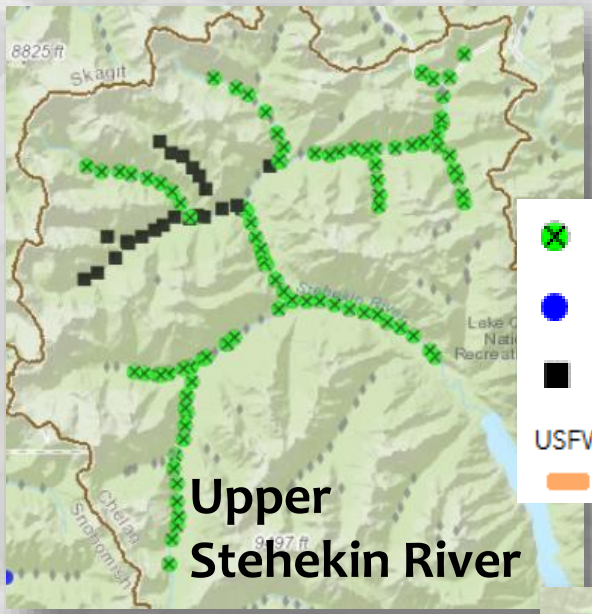


eDNA sample metadata



eDNA Information Has Resulted in…

Confirmed absences



sampled, bull trout absent

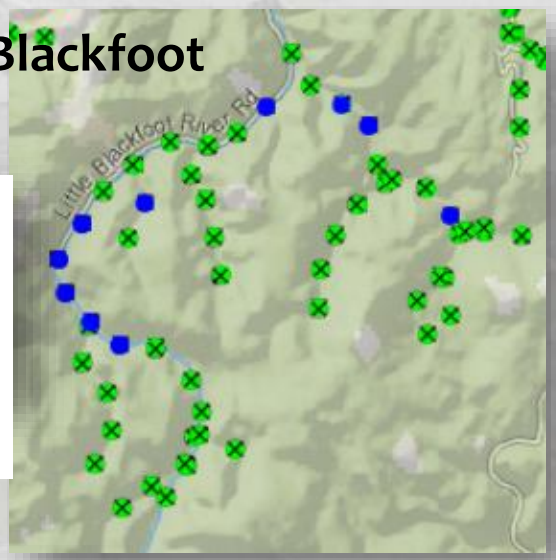
sampled, bull trout present

sampled, being processed

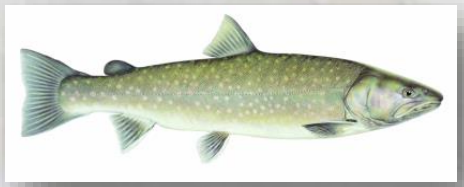
USFWS Spawning and Rearing Critical Habitat

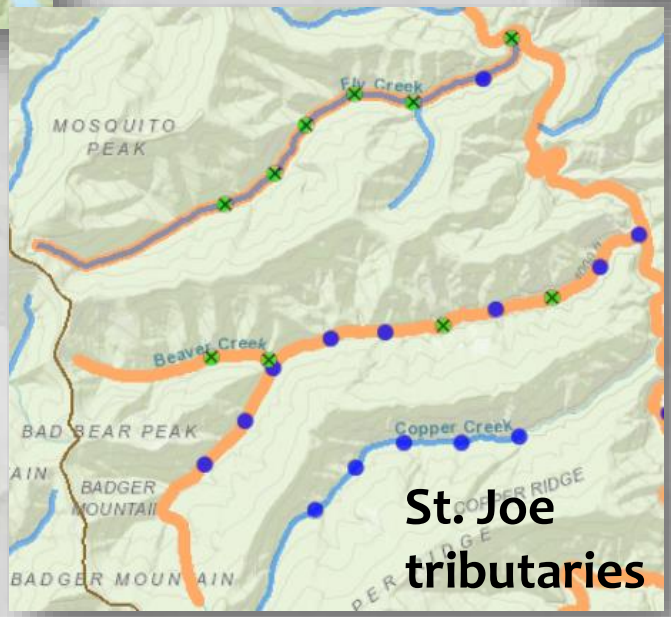
Discovery of new populations

Little Blackfoot River



Refinements of critical habitat?





eDNA Trend Assessments from Repeat Samples

2006-2007 e-fishing surveys

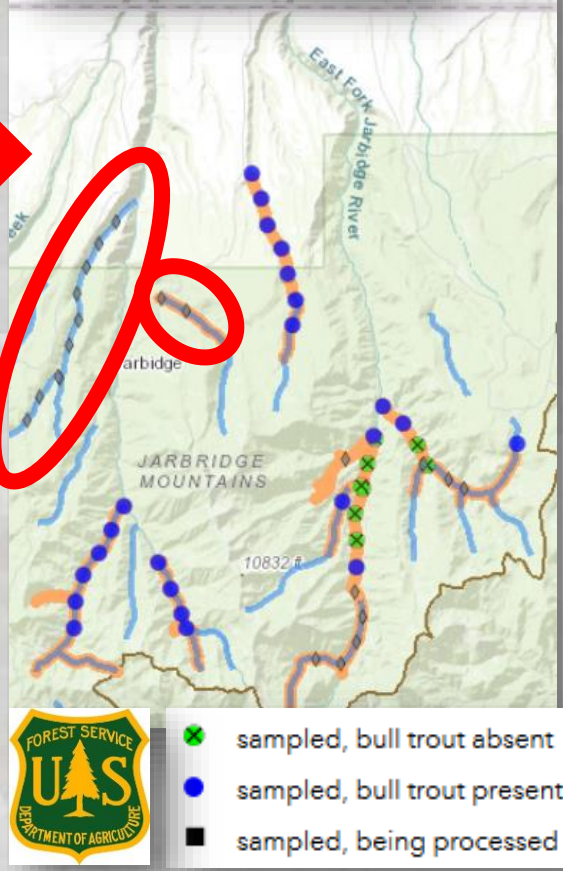
USGS
science for a changing world

Prepared in cooperation with the U.S. Fish and Wildlife Service

Distribution and Movement of Bull Trout in the Upper Jarbidge River Watershed, Nevada

Allen et al. 2010

2016 eDNA surveys

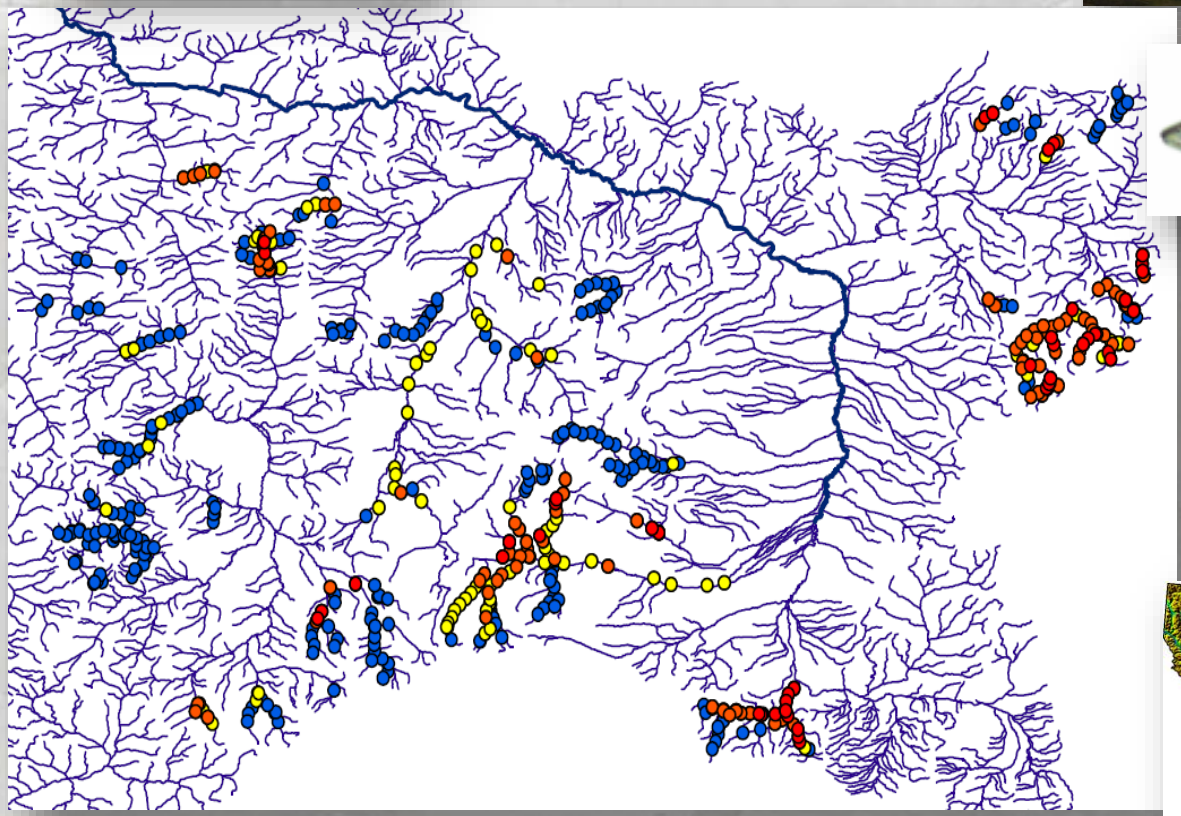


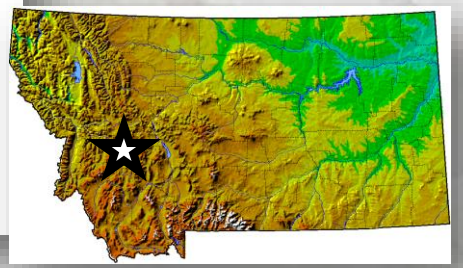
FOREST SERVICE
U S
DEPARTMENT OF AGRICULTURE

3rd-Generation Bull Trout Distribution Model:

High resolution with species interactions

100% 50% 0%





Wilcox et al. In Review. Fine-scale environmental DNA sampling reveals climate mediated interactions between native and invasive trout species. *Ecosphere*

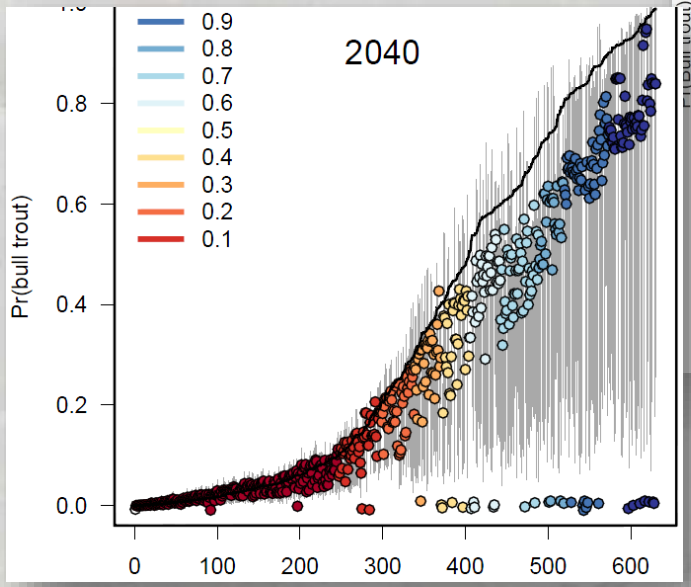
3rd-Generation Bull Trout Distribution Model:

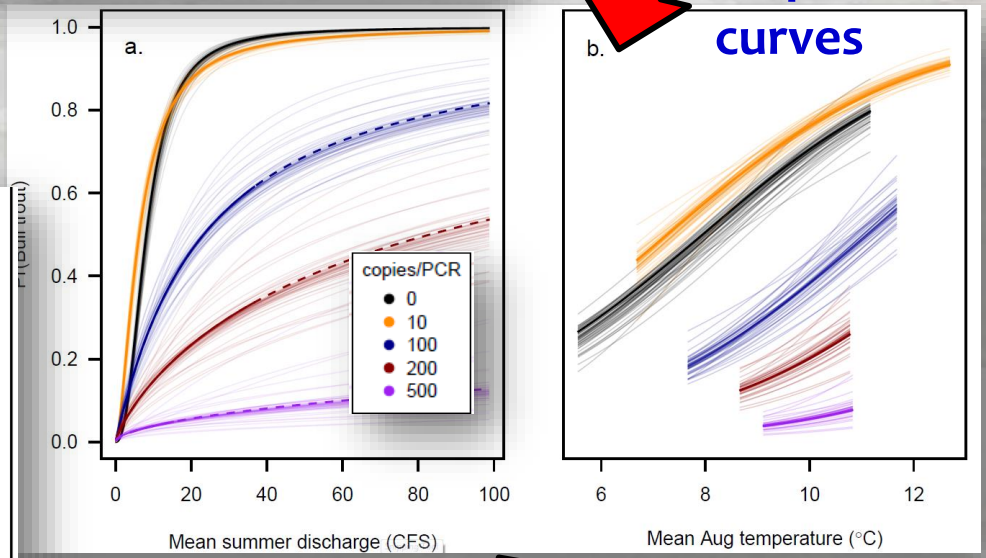
High accuracy at reach scale

	AIC	ΔAIC	AUC	Acc.
FLOW + TEMP + BRK + BRK2 + BRK*FLOW	464.0		0.964	0.897
FLOW + TEMP + BRK + BRK²	465.2	1.2	0.968	0.898
FLOW + TEMP + SLOPE + BRK + BRK² + BRK*FLOW	465.2	1.2	0.965	0.898
FLOW + TEMP + BRK + BRK2 + BRK*TEMP + BRK*FLOW	465.6	1.6	0.964	0.900
FLOW + TEMP + BRK + BRK2 + BRK*TEMP	466.5	2.5	0.967	0.900
FLOW + TEMP + SLOPE + BRK + BRK² + BRK*TEMP + BRK*FLOW	467.0	3.0	0.965	0.900
FLOW + TEMP + SLOPE + BRK + BRK²	467.1	3.1	0.968	0.898

Model response curves

Predict reaches where bull trout are vulnerable to climate & brook trout





Wilcox et al. In Review. Fine-scale environmental DNA sampling reveals climate mediated interactions between native and invasive trout species. *Ecosphere*

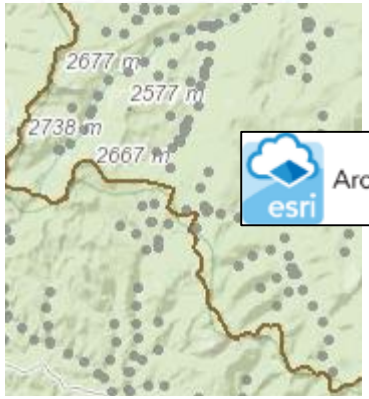
Aquatic eDNAtlas Project Website:

https://www.fs.fed.us/rm/boise/AWAE/projects/the-aquatic-eDNAtlas-project.html

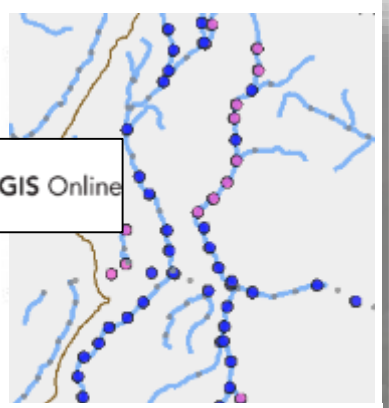
Subpage Resources

Supporting Science

FAQ & Protocol



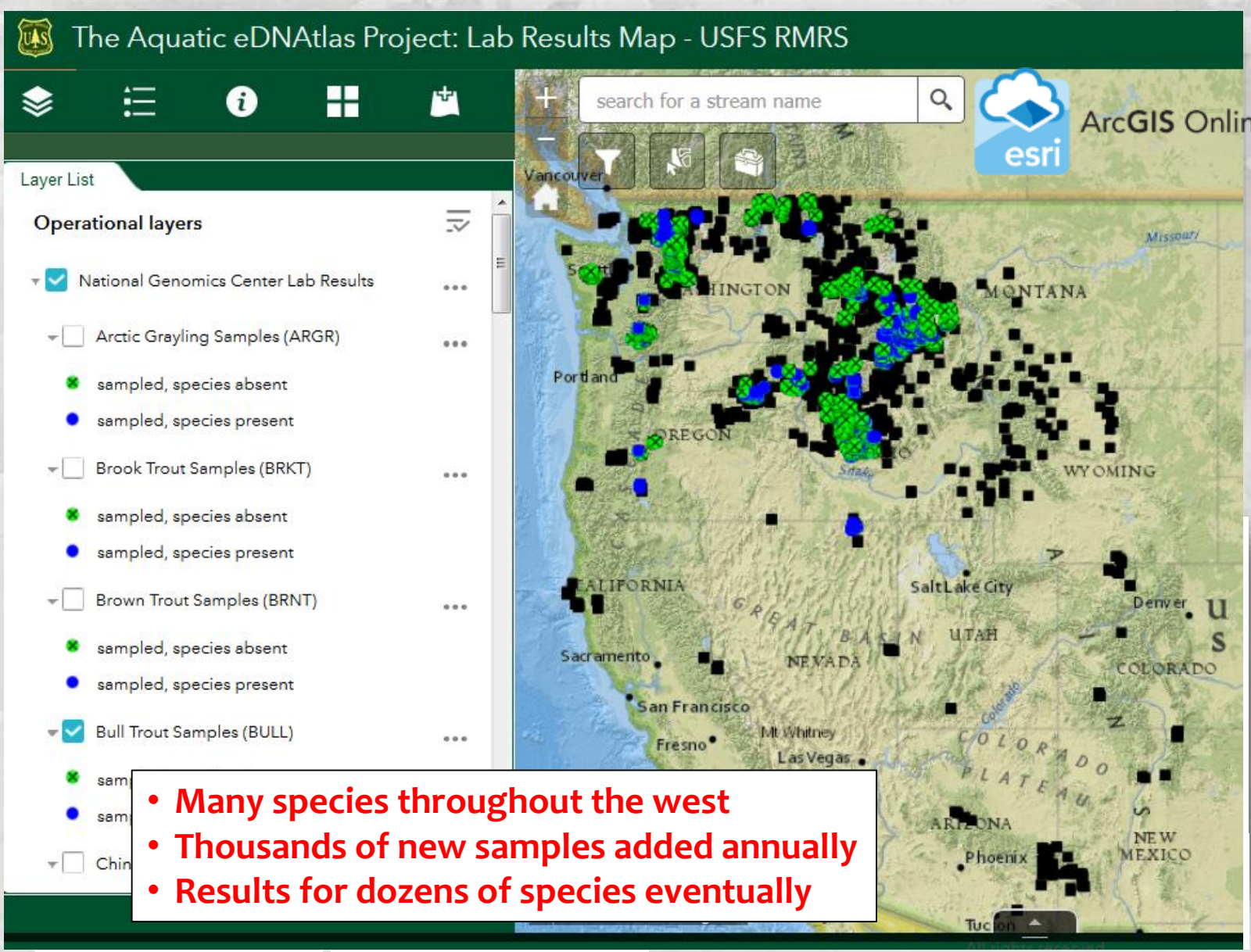
Field sampling site grid



eDNAtlas Results

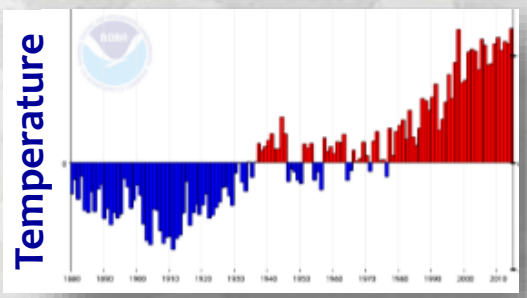
Aquatic eDNAtlas Project Website:

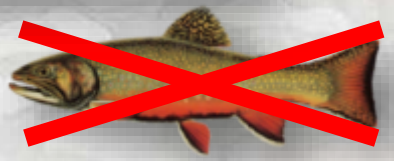
https://www.fs.fed.us/rm/boise/AWAE/projects/the-aquatic-eDNAtlas-project.html



- Many species throughout the west
- Thousands of new samples added annually
- Results for dozens of species eventually

Many Different Factors Weigh Into this Century's Partly Cloudy Bull Trout Forecast

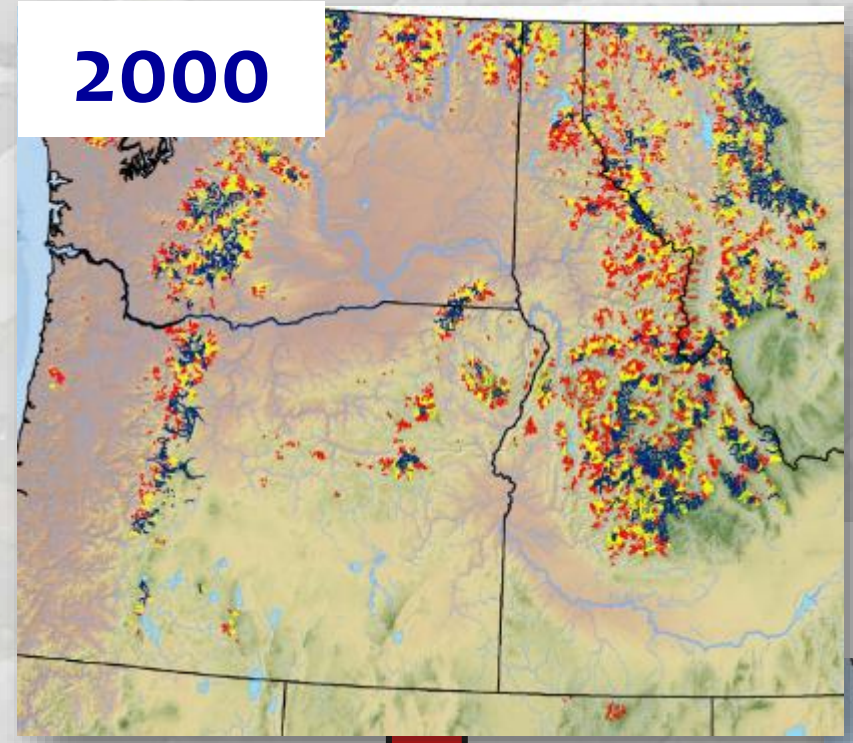




Before → After

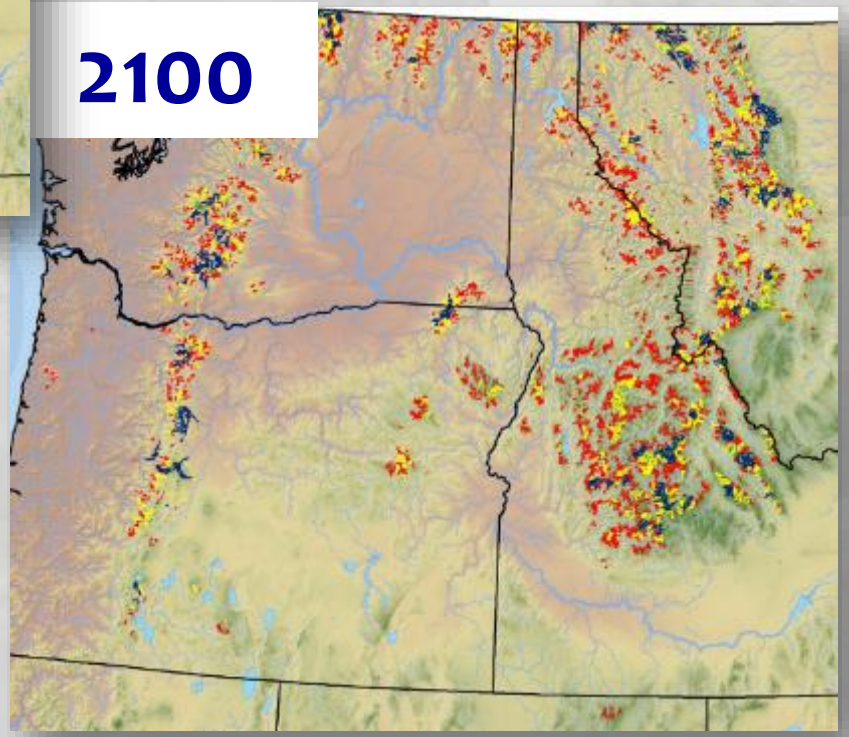
Regional Risk for Bull Trout Species is Low

2000



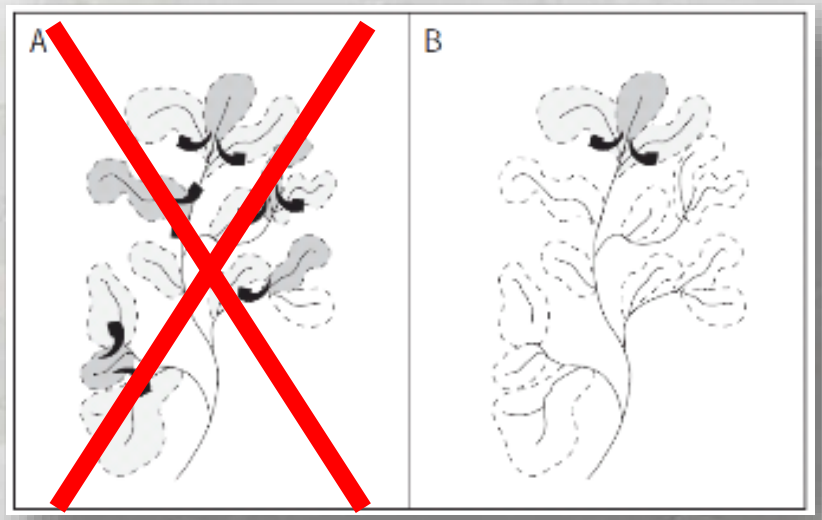
Many populations likely to persist

2100



High Risks for Some Individual Populations (e.g., Jarbidge populations)

Small, isolated, and alone…



Local Risks High for Some Individual Populations (e.g., Jarbidge populations)

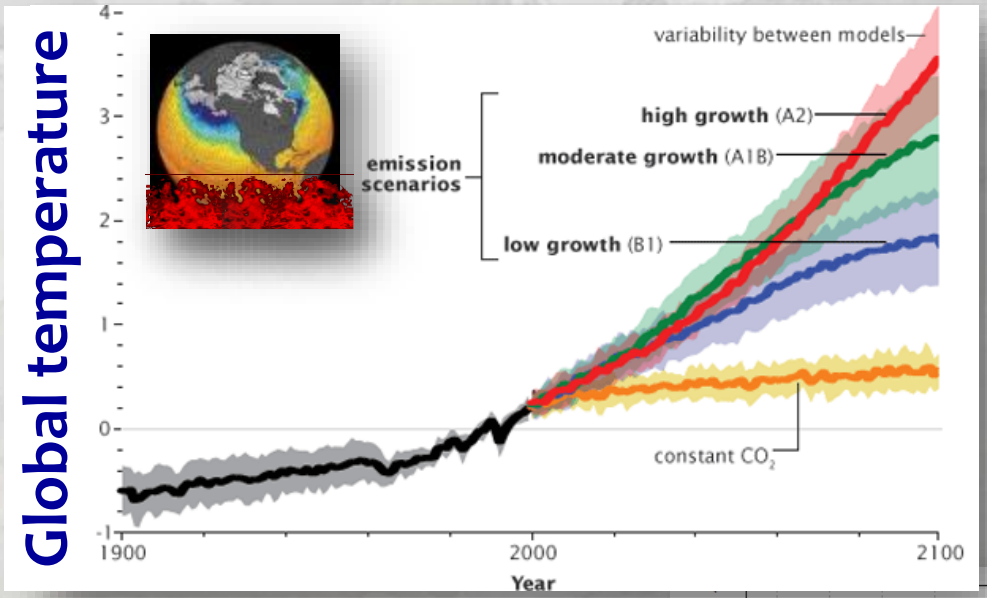
Mitigate risks by:

1) Keeping brook trout out (eDNA monitoring program for early detection)

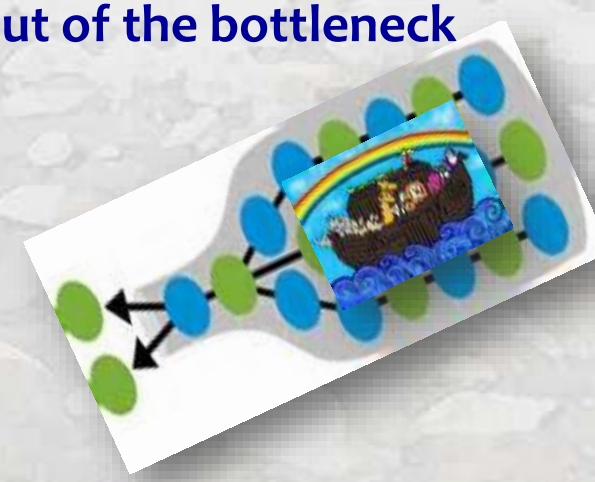
2) Proactively reduce wildfire risks (controlled burns to decrease fuel contiguity)

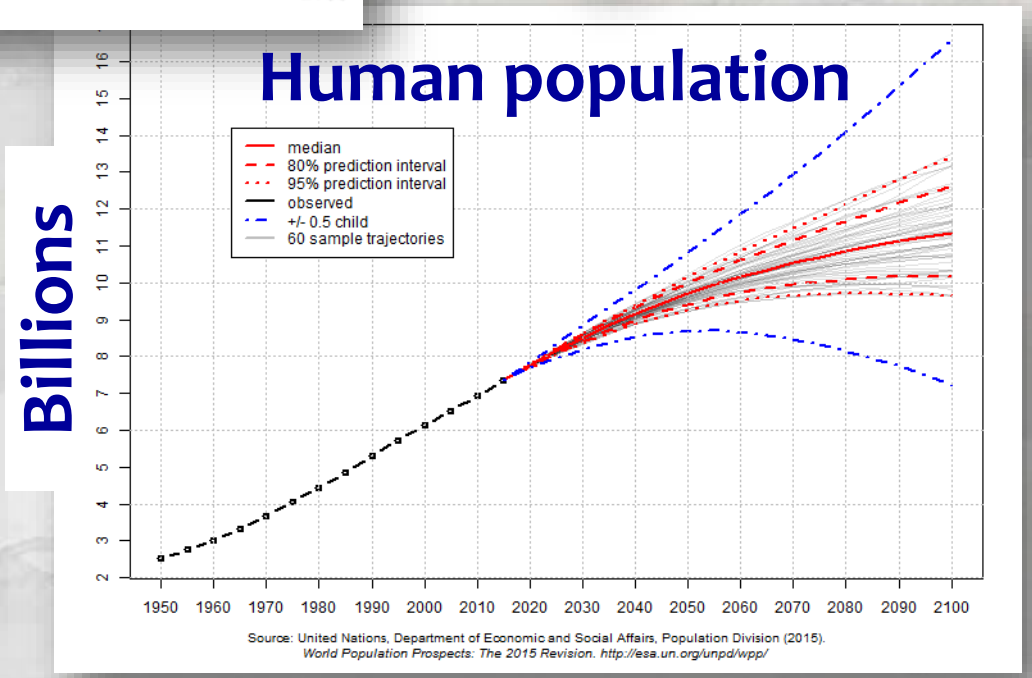
3) Enhancing habitat quality (grazing, stream shade, LWD)

Hang on For an Interesting 21st Century



Something will come out of the bottleneck






The End