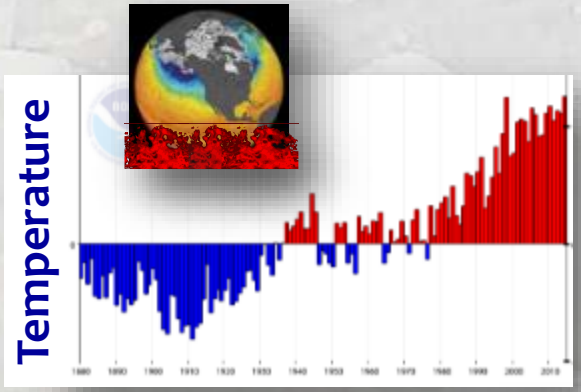
This Century's Bull Trout Forecast: Partly Sunny With Scattered Rain Showers

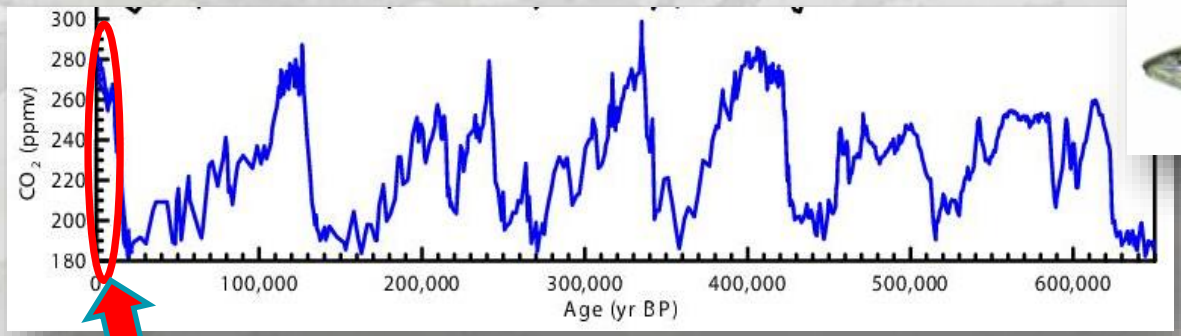
Dan Isaak and Mike Young
U.S. Forest Service, Rocky Mountain Research Station

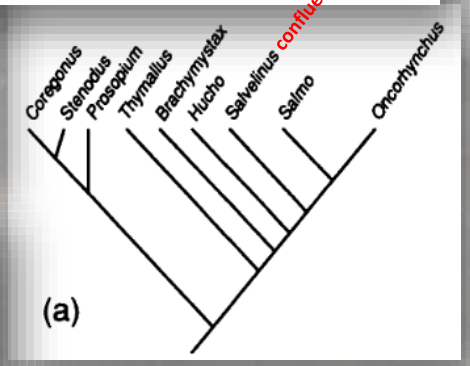


Before

After

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

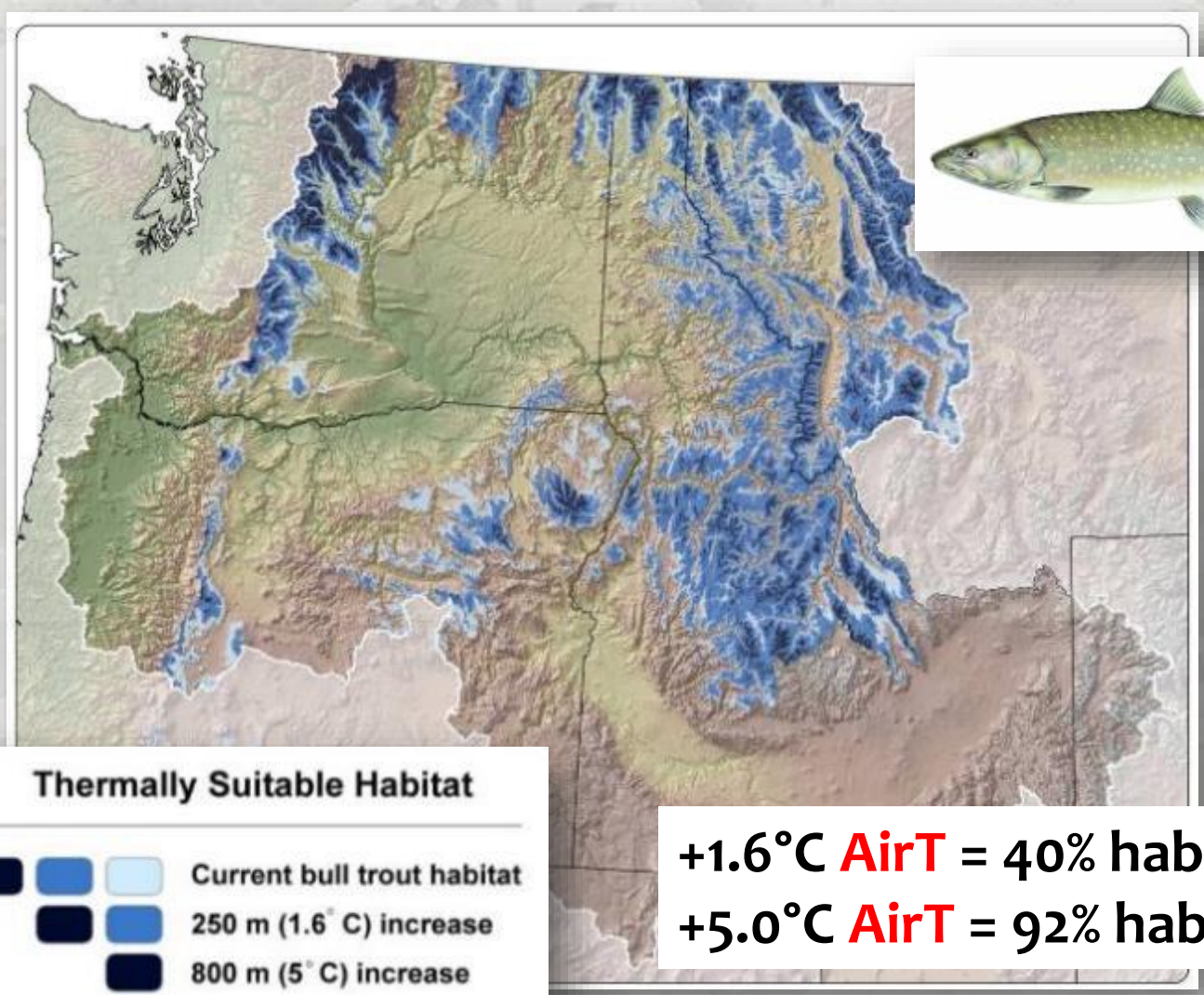




Human Civilization

Novel Twists Last 200 Years…

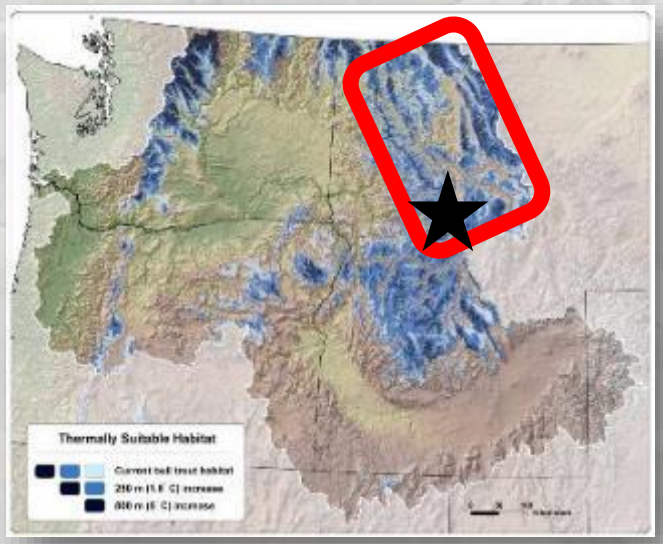
1st-Generation Bull Trout Distribution Model Predicts Large Habitat Reductions from Warming

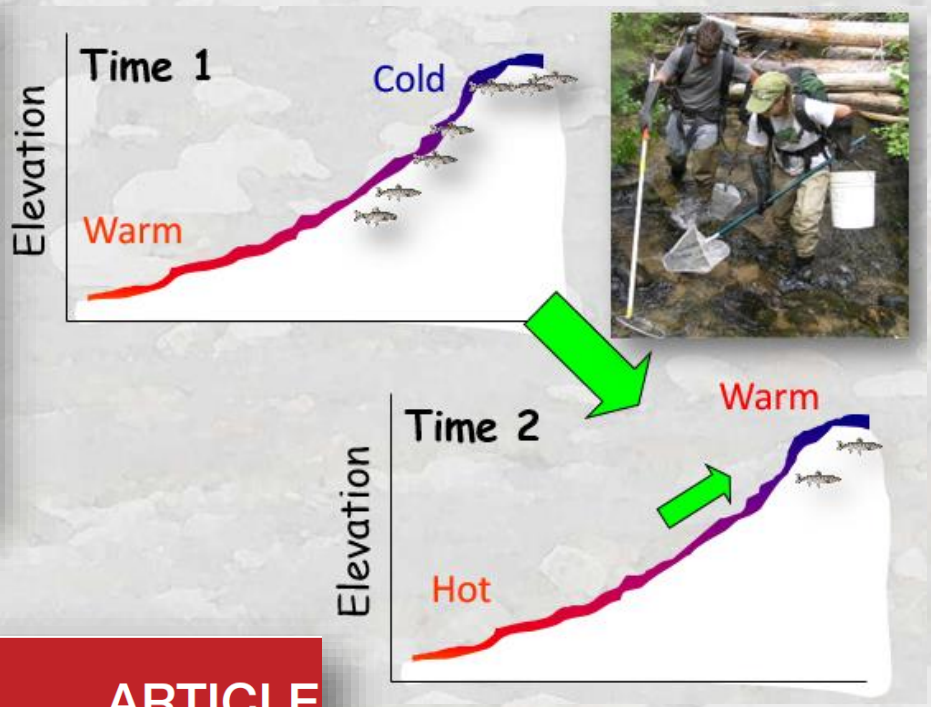


+1.6°C AirT = 40% habitat loss
+5.0°C AirT = 92% habitat loss

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

Some Research Suggests Distributions are Contracting into Headwaters





NRC Research Press

ARTICLE

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

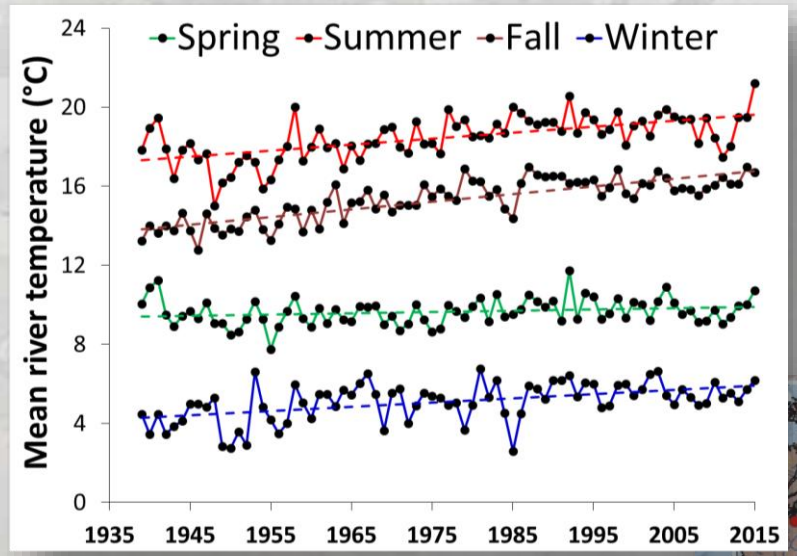
Robert Al-Chokhachy, David Schmetterling, Chris Clancy, Pat Saffel, Ryan Kovach, Leslie Nyce, Brad Liermann, Wade Fredenberg, and Ron Pierce

PLOS ONE

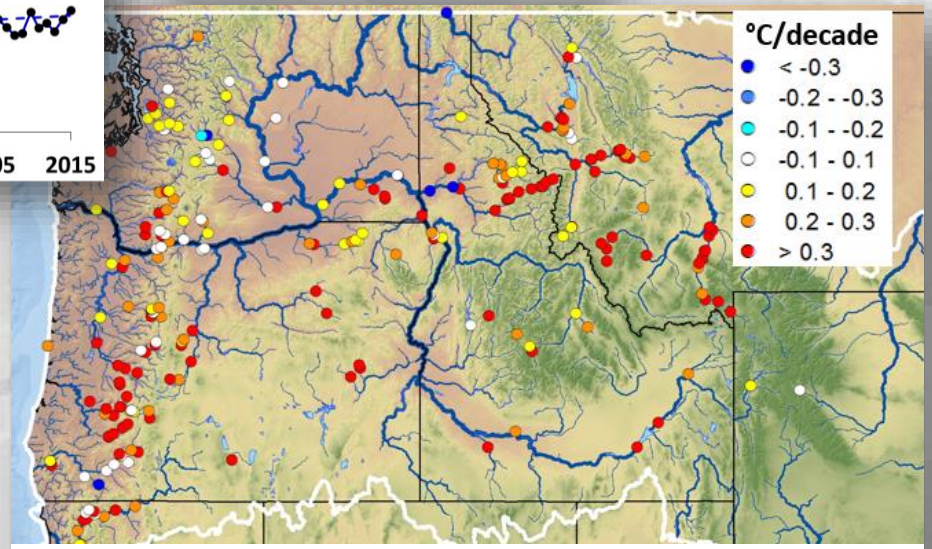
Evidence of Climate-Induced Range Contractions in Bull Trout *Salvelinus confluentus* in a Rocky Mountain Watershed, U.S.A.

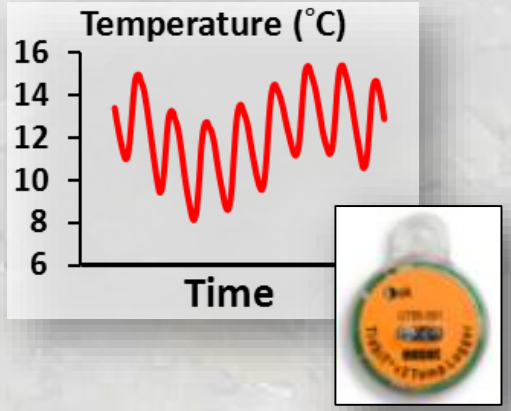
Lisa A. Eby[1], Olga Helmy[1], Lisa M. Holsinger[2], Michael K. Young[3]*

Expected Because Rivers & Streams are Getting Warmer…



Bonneville Dam Temperature Record

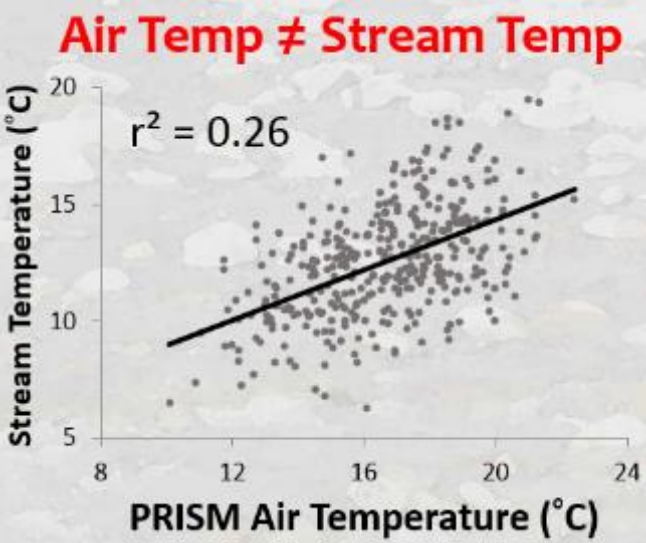


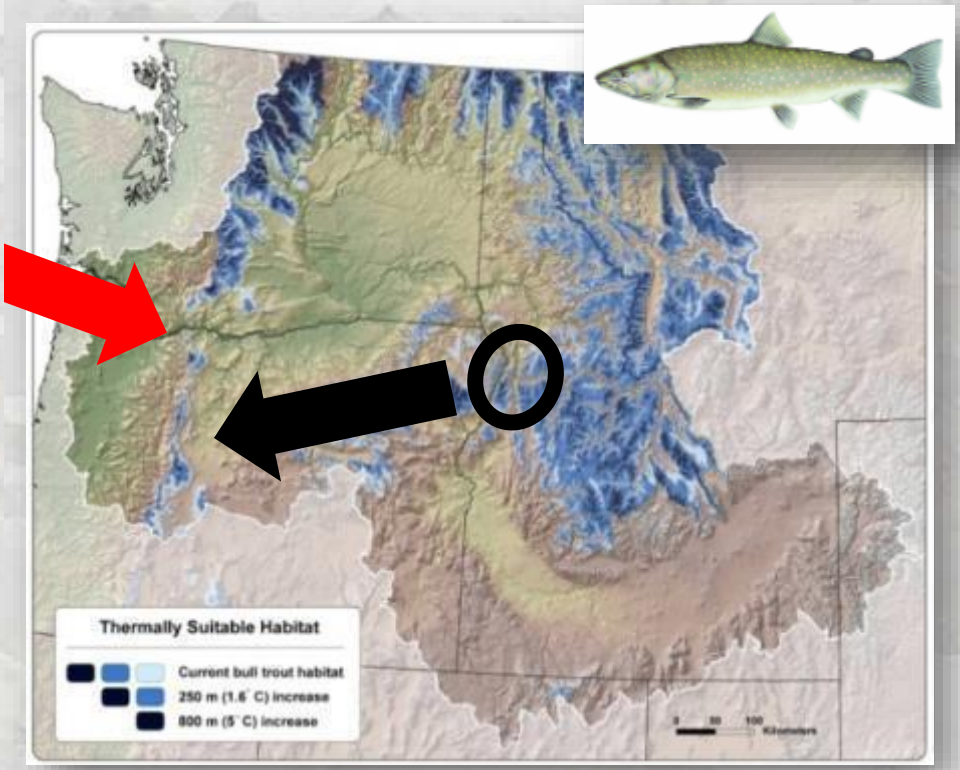


+0.5–1.0°C during 1976–2015 summer & early fall months

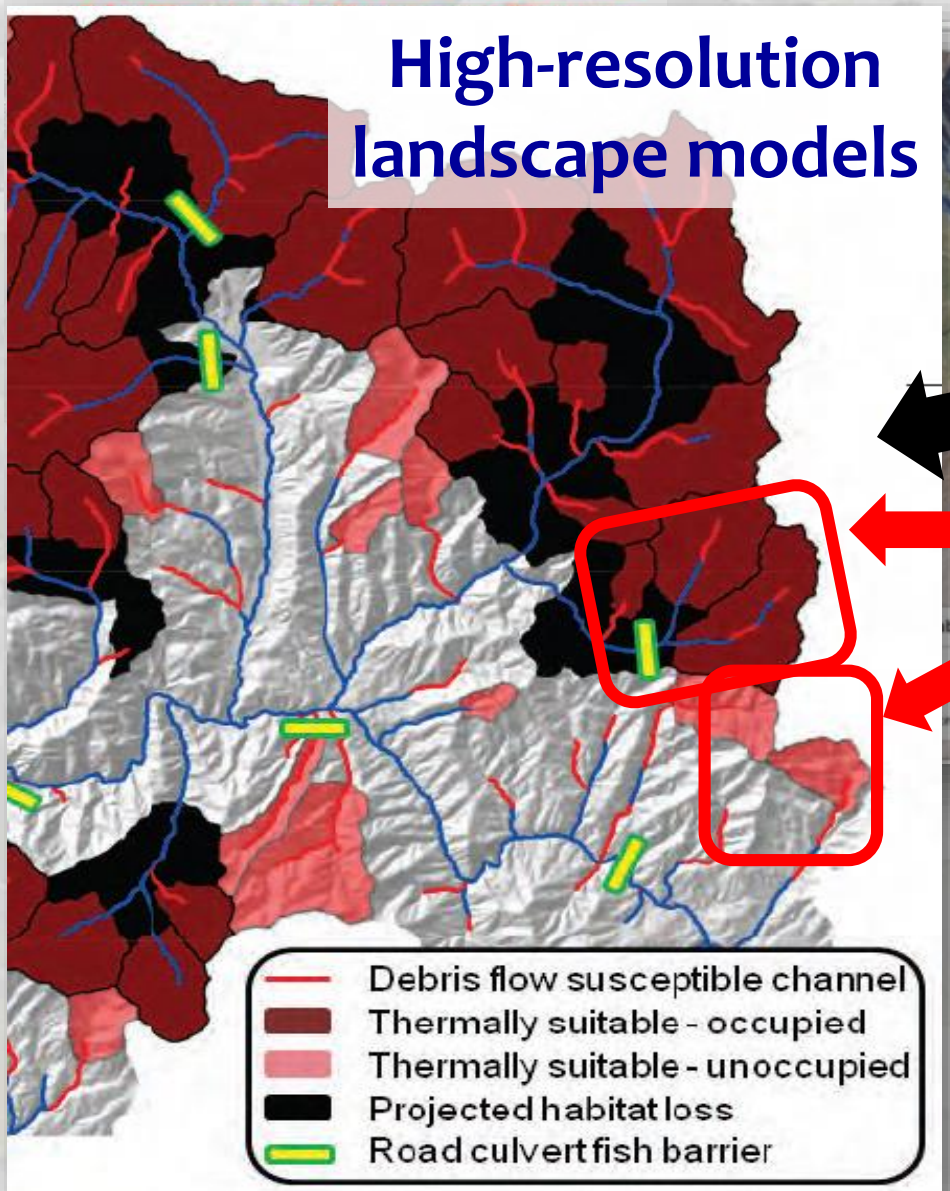
Isaak et al. 2018. Global warming of salmon and trout rivers in the Northwestern U.S. Road to ruin or path through purgatory? *Transactions of the American Fisheries Society* **147**:566-587.

Which Streams May Serve as Climate Refugia? Precision Forecasts Needed





Which Streams May Serve as Climate Refugia? Precision Forecasts Needed



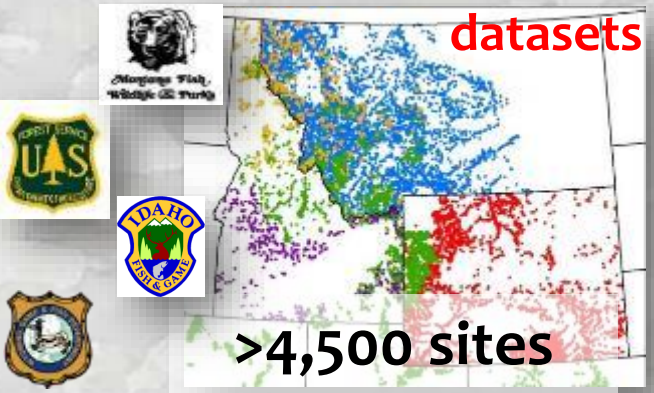
I'm going to invest here…

…instead of here

2nd-Generation Bull Trout Distribution Model

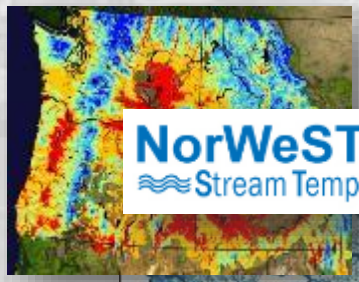
Climate Shield

Large species occurrence datasets



>4,500 sites

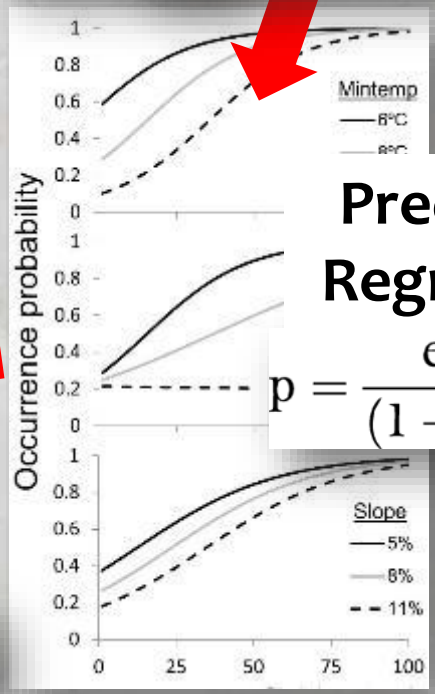
>500 streams



NHDPlus

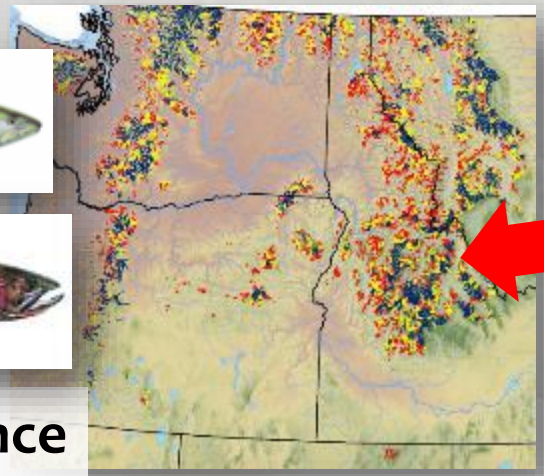
Better stream covariates

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



Predictive Logistic Regression Models

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



>0.9 >0.5 >0.1

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

2nd-Generation Bull Trout Distribution Model

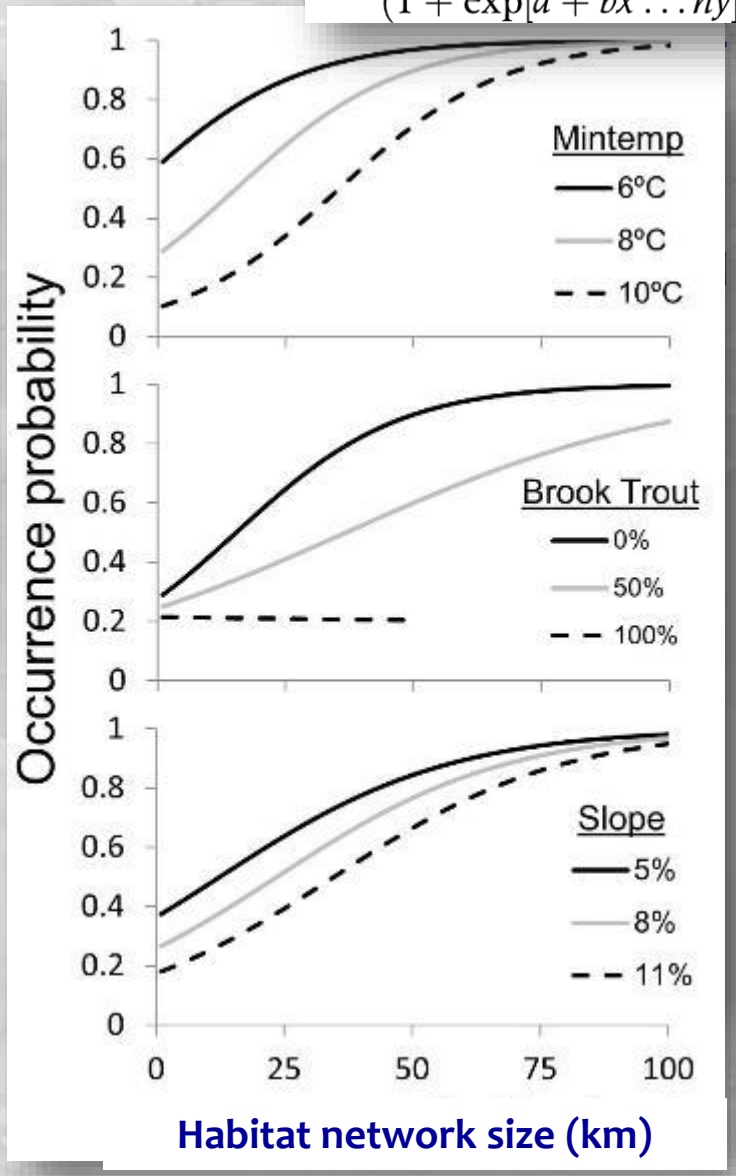
$$p = \frac{\exp(a + bx \ldots ny)}{(1 + \exp[a + bx \ldots ny])}$$

Model selection

Model	p	ΔAIC_c
Size, MinTemp, Slope, BKT, Size*BKT	**6**	**0.0**
Size, MinTemp, Slope, BKT, Size*BKT, Slope*BKT	7	0.5
Size, MinTemp, Slope, BKT	5	7.8
Size, MinTemp, BKT	4	18.2
Size, MeanTemp, BKT	4	25.7
Size, MinTemp, Slope	4	29.7
Size, MinTemp	3	31.2
Size, BKT	3	49.7

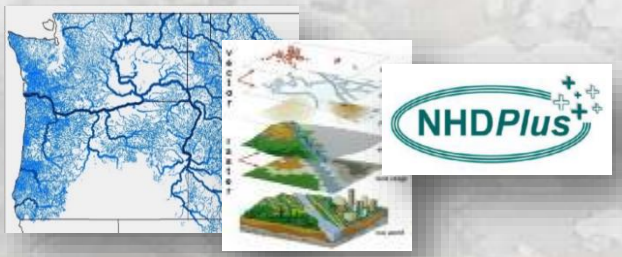
Best model accuracy: 78% (i.e., population occupancy correctly predicted for 400 of 512 streams)

Response curves

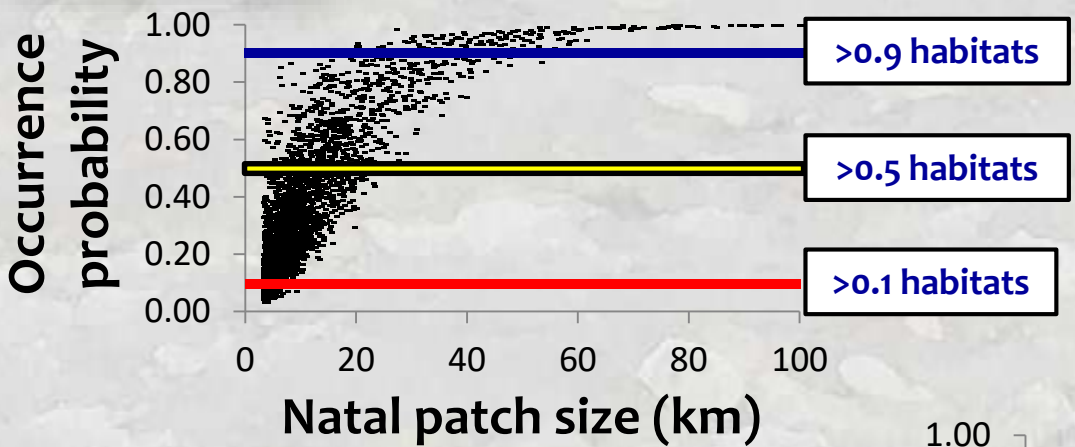


Model Used to Predict Potential Habitat Universe & Occurrence Probabilities

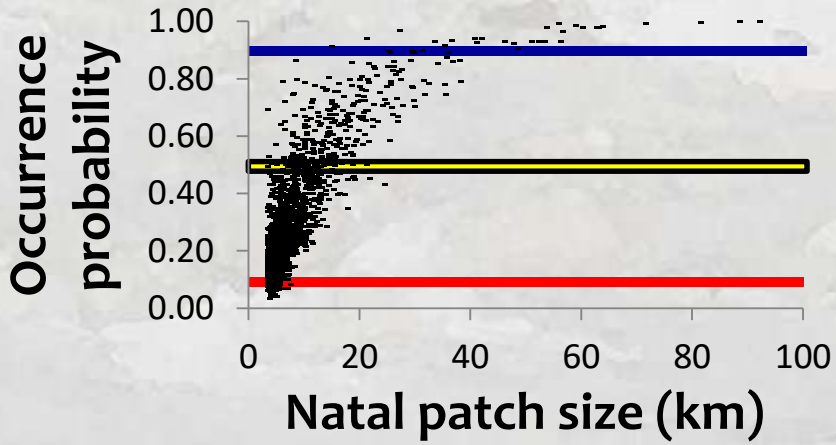
$$p = \frac{\exp(a + bx \ldots ny)}{(1 + \exp[a + bx \ldots ny])}$$



2000's: *N* = 5,300 habitats

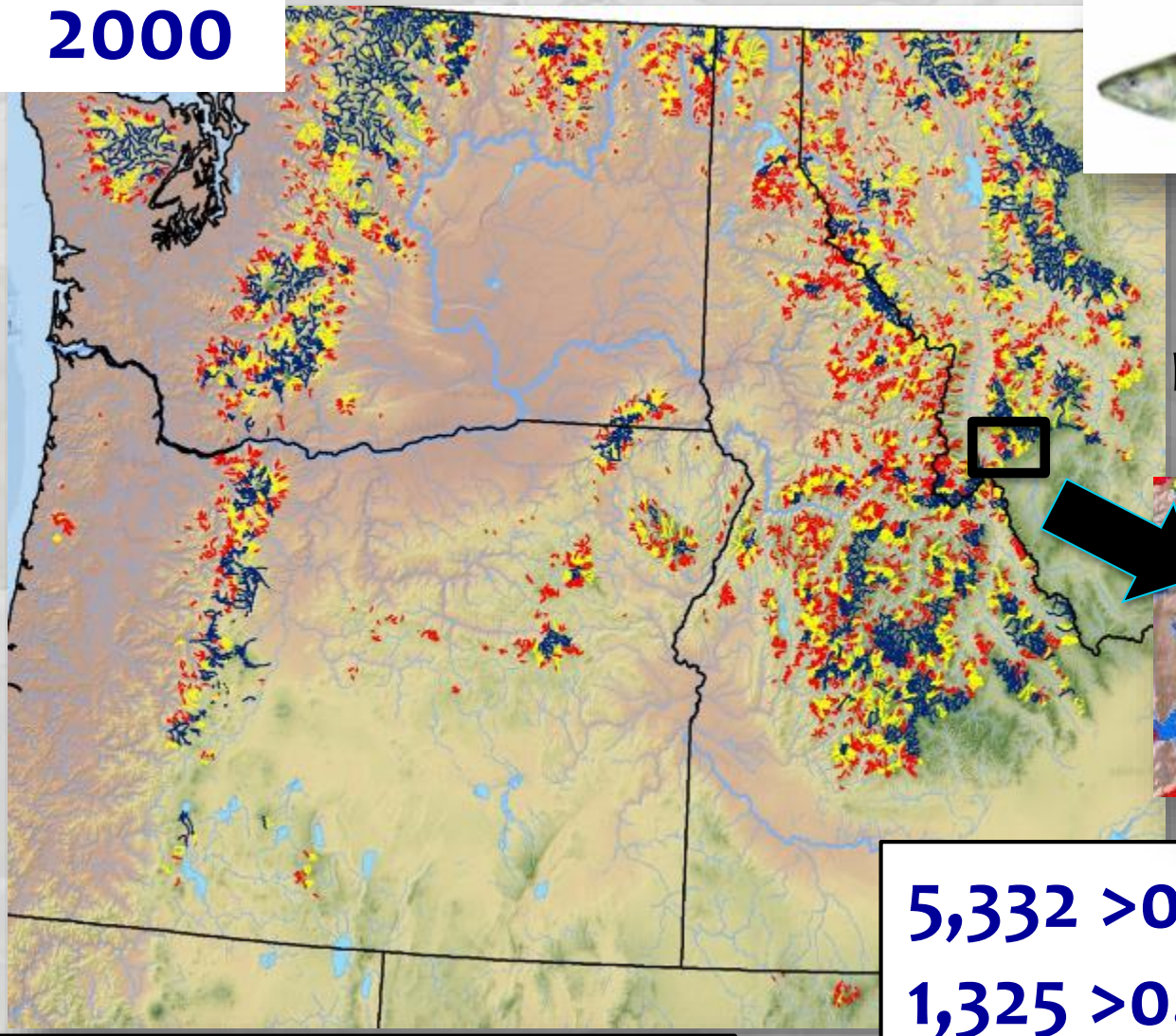


2080's: *N* = 3,300 habitats



Bull Trout Population Occurrence Probability

2000

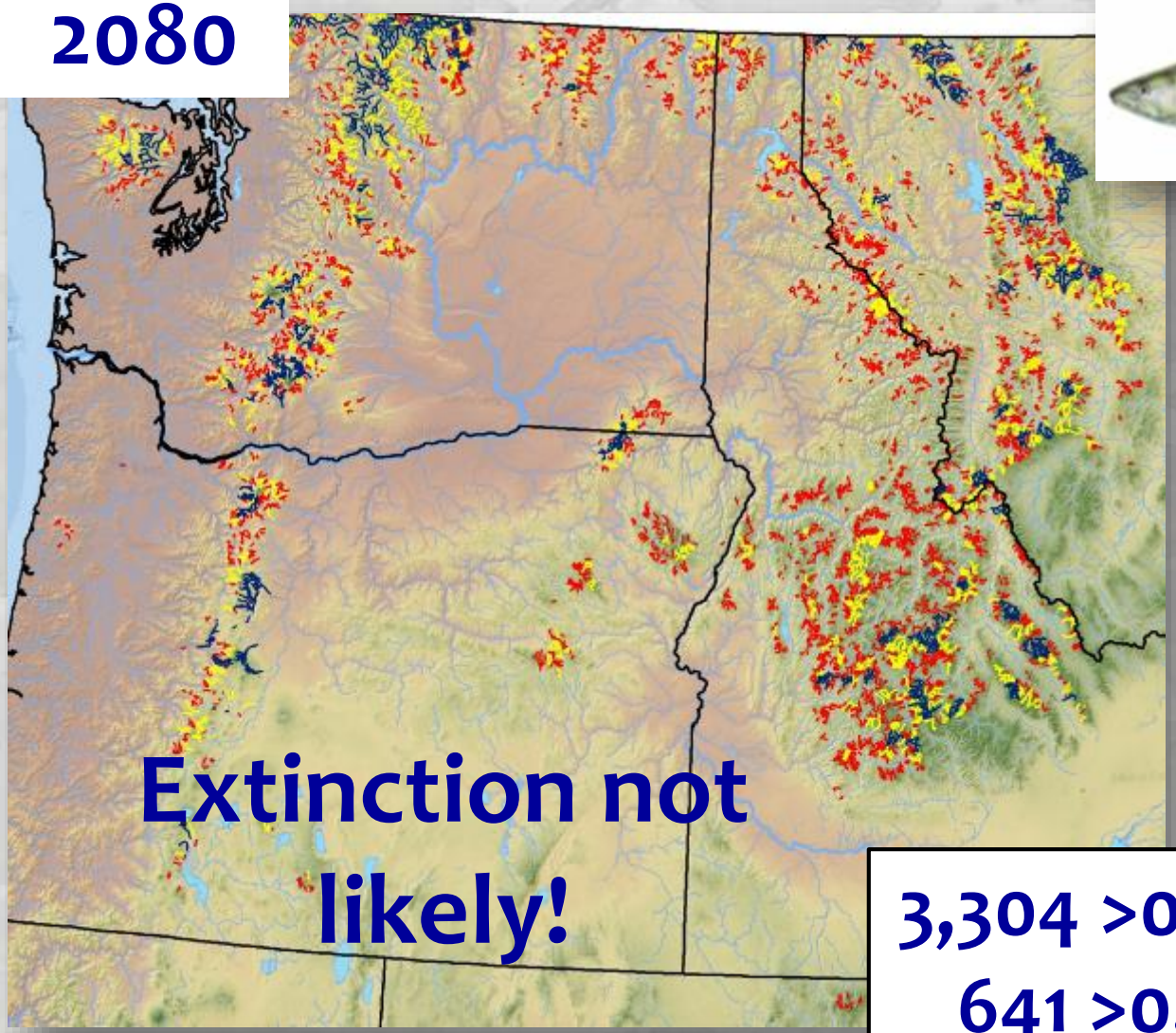


Stream population scale predictions

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

Bull Trout Population Occurrence Probability

2080

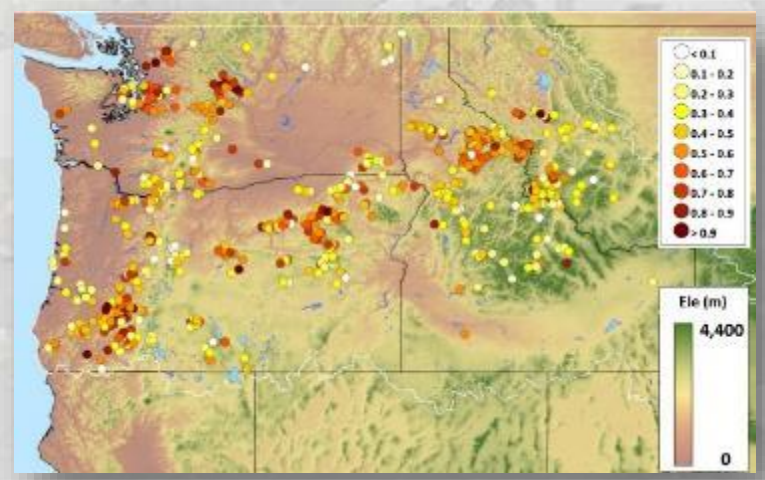


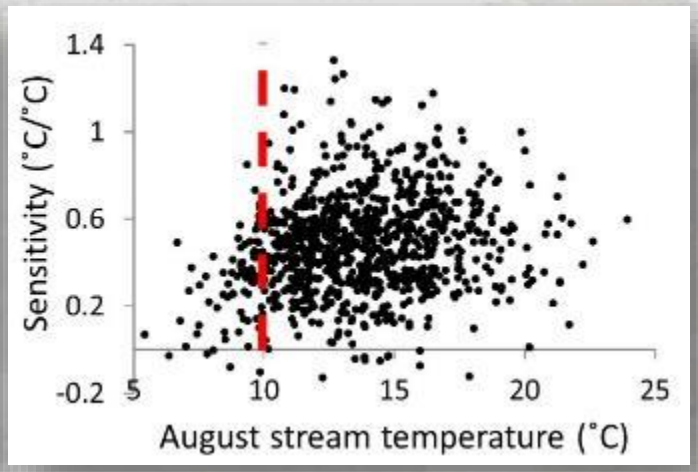
+5°C air scenario = 40% habitat loss. Not earlier 92% estimate

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

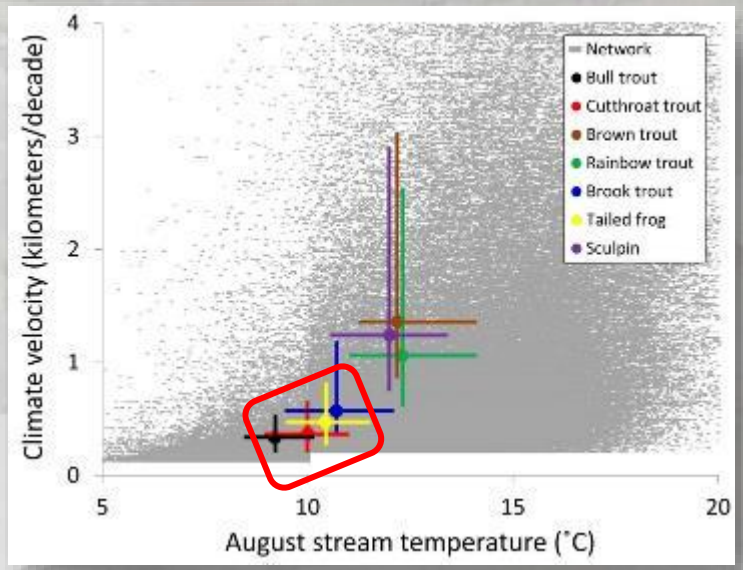
Why the Discrepancy?

1. Cold bull trout streams are weakly responsive to climate variability



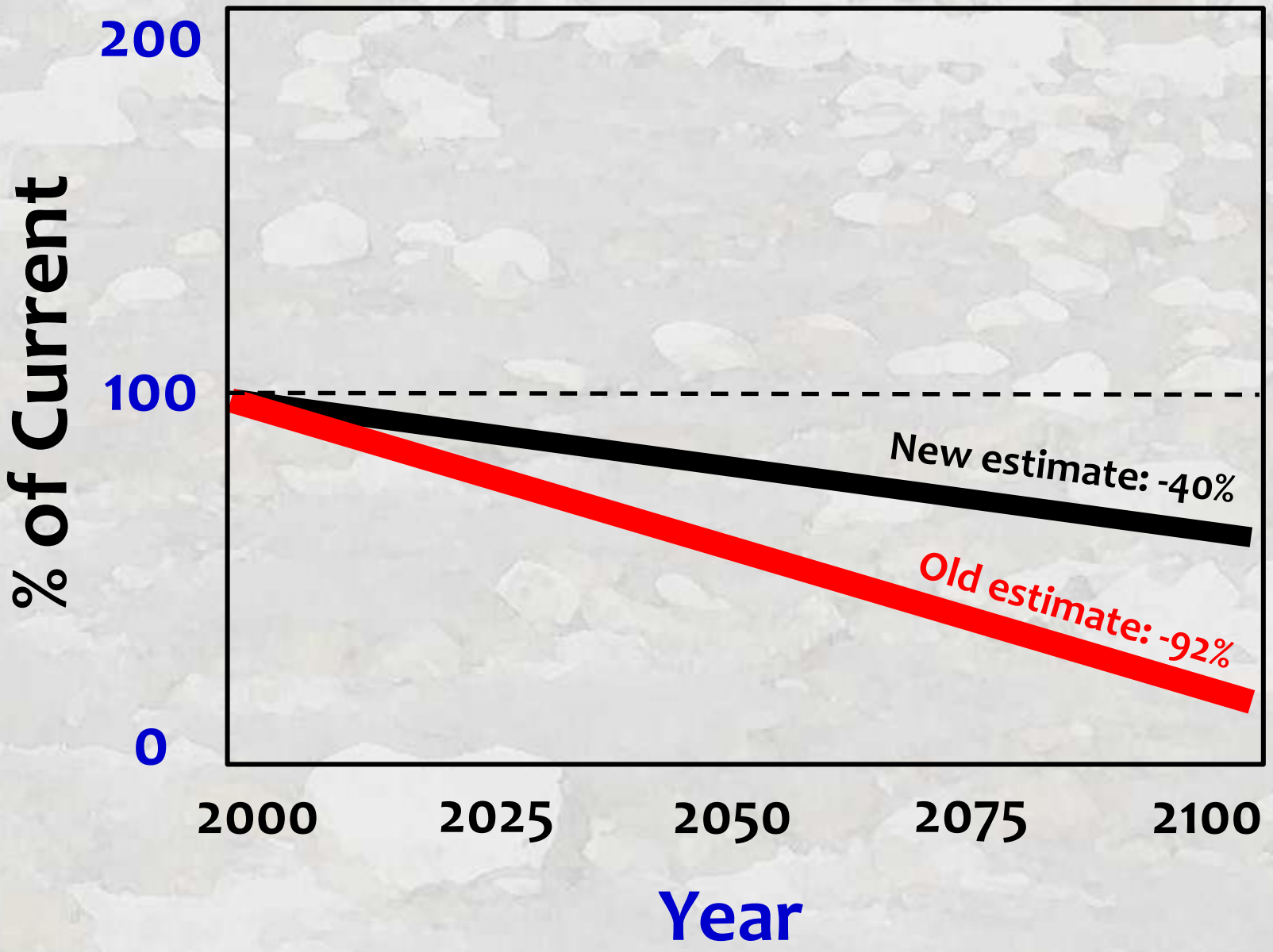


2. Slow climate velocities (0.3 to 0.5 km/decade) due to steep spatial temperature gradients & small warming rates

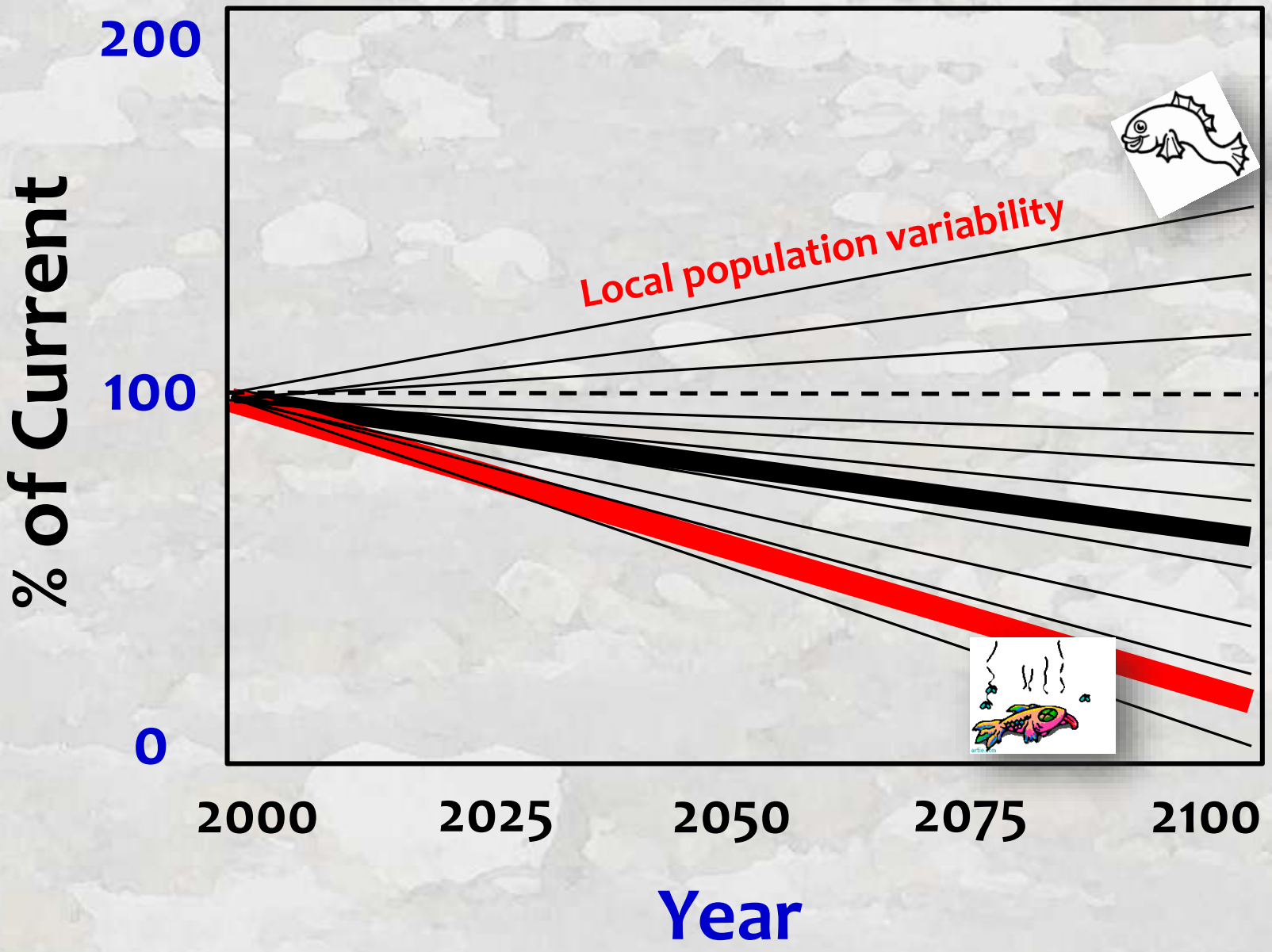


Isaak et al. 2016. Slow climate velocities of mountain streams portend their role as climate refugia for cold-water biodiversity. *Proceedings of the National Academy of Sciences* **113**:4374-4380.

21st Century Regional Bull Trout Trend



21st Century Regional Bull Trout Trend



Local Reversals of Regional Decline

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

OPEN ACCESS

REVIEW

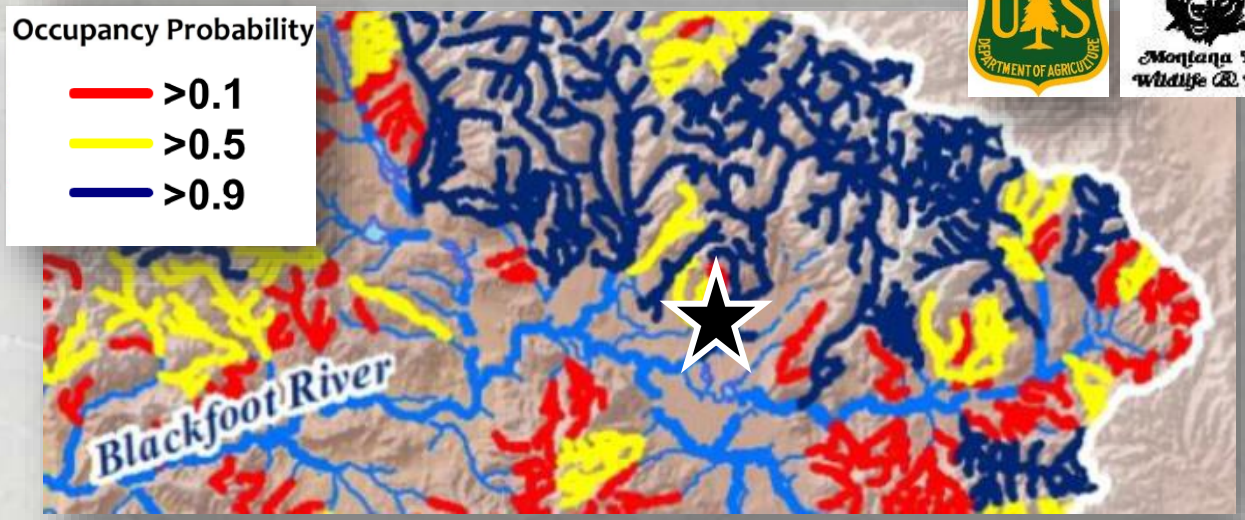
Translocation and reintroduction of native fishes: a review of bull trout *Salvelinus confluentus* with applications for future reintroductions

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 Regional Declines

Assisted migration into climate refugia above geologic barriers



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

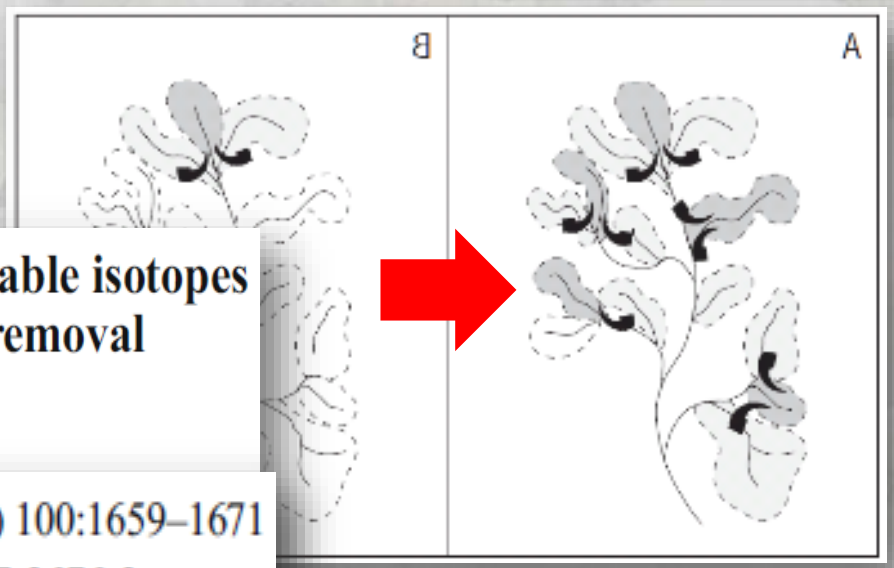
Local Reversals of Regional Declines

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

Before → **After**



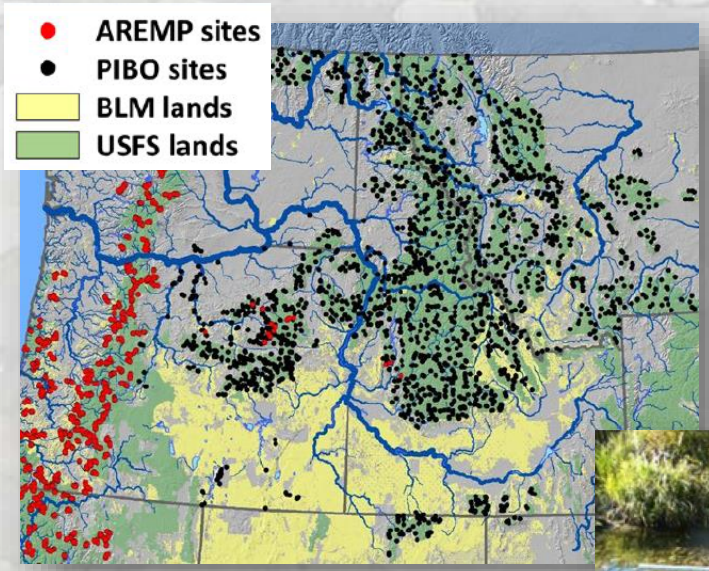
Re-awakening dormant life history variation: stable isotopes indicate anadromy in bull trout following dam removal on the Elwha River, Washington

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

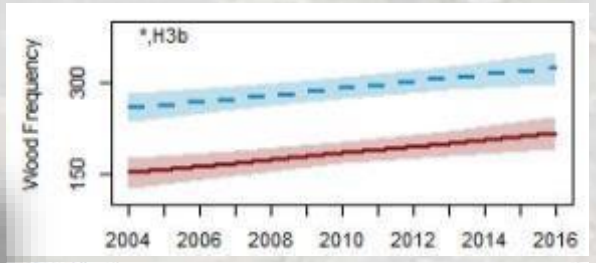
Environ Biol Fish (2017) 100:1659–1671
DOI 10.1007/s10641-017-0676-0

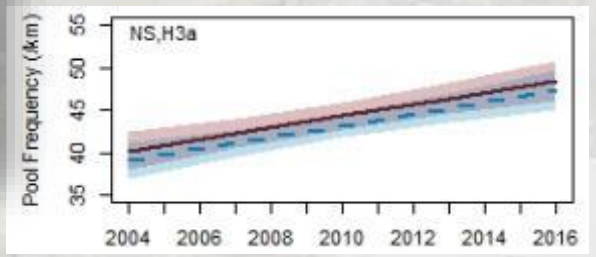
Local Reversals of Regional Declines

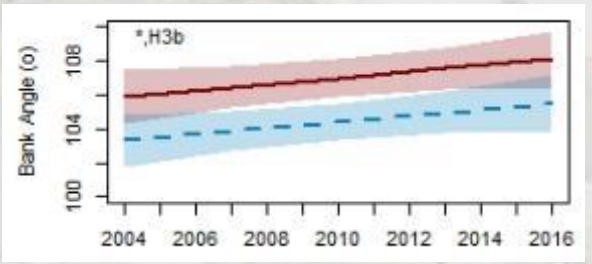
Habitat quality on public lands is improving



- 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. 2019. Did changes in western federal land management policies improve salmonid habitat in streams on public lands within the Interior Columbia River Basin? *Environmental Management* **191**:574.

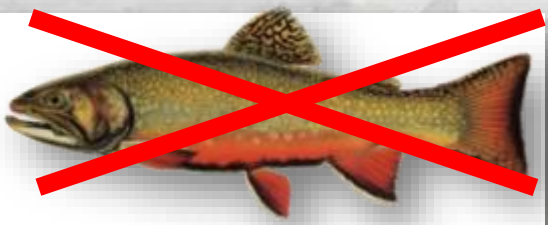
Local Reversals of Regional Declines

Eradication & suppression of brook trout

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

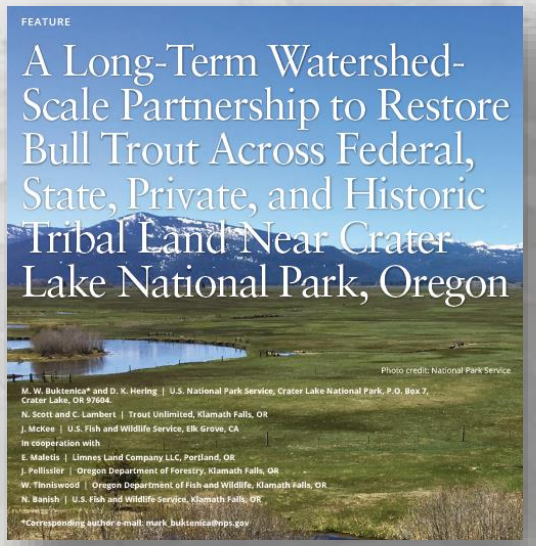
ISSN: 0275-5947 print / 1548-8675 online
DOI: 10.1080/02755947.2012.747452

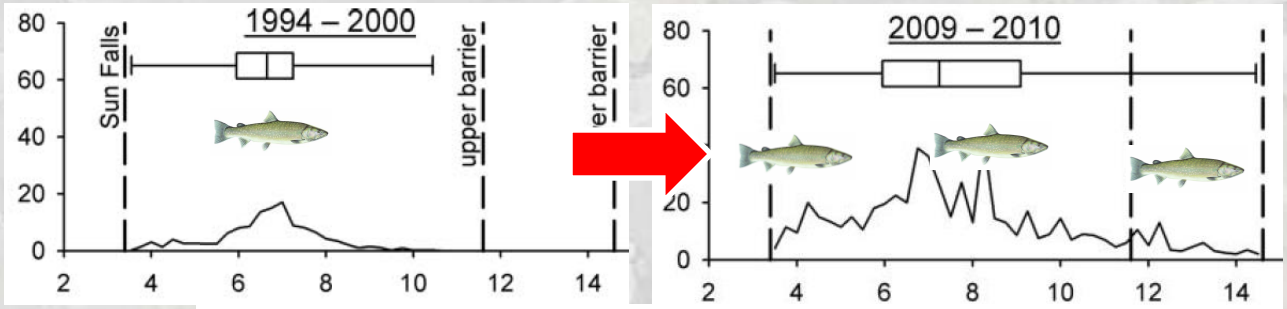
ARTICLE



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





Distance from headwaters (km)

Local Reversals of Regional Declines

Eradication & suppression of brook trout

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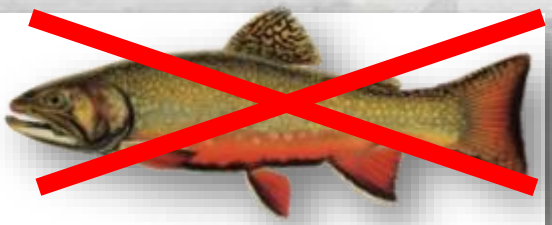

Eradication of Nonnative Brook Trout with Electrofishing and Antimycin-A and the Response of a Remnant Bull Trout Population

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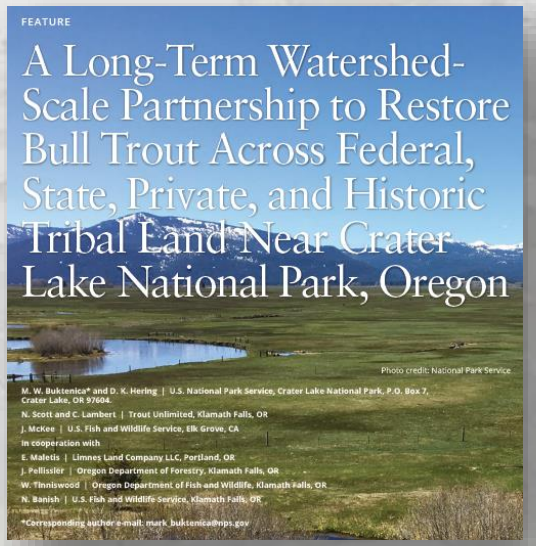
U.S. National Park Service, Crater Lake National Park, Post Office Box 7, Crater Lake, Oregon 97604, USA



Costs could drop in the future

GMO

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

Matthew R. Camp
Idaho Department of

2 4

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, 1118 Millersburg, Michigan 49759, USA

Understanding What Does/Doesn't Work

- 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

Precise Inventory & Monitoring

Website: Rangewide eDNA Bull Trout Project

Subpages

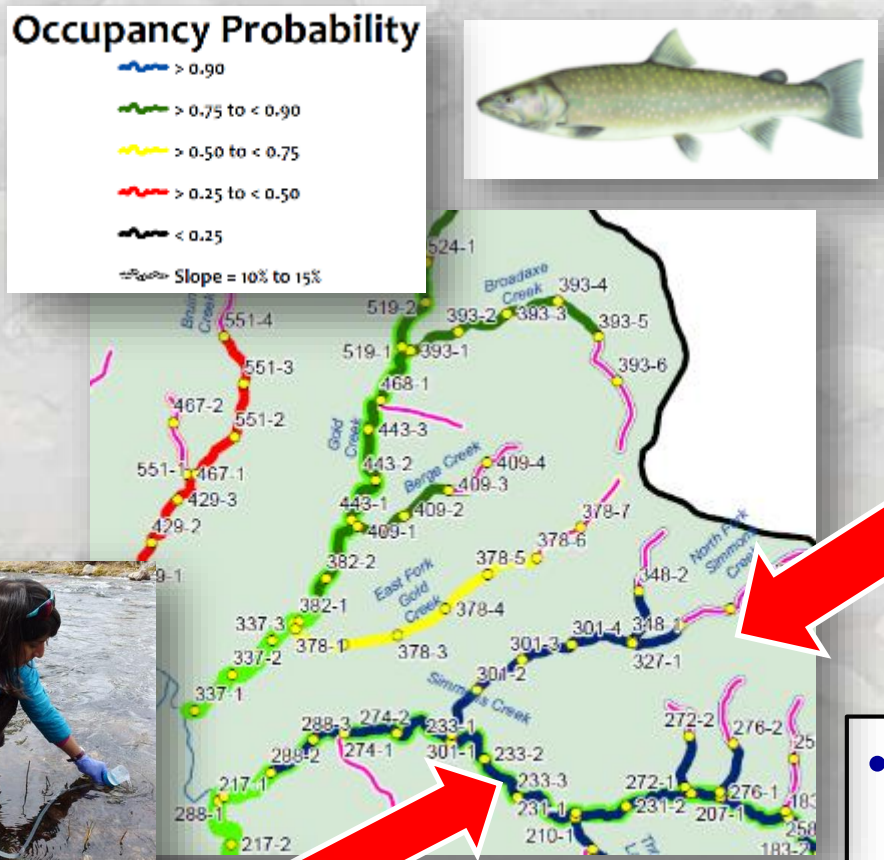
Supporting Science

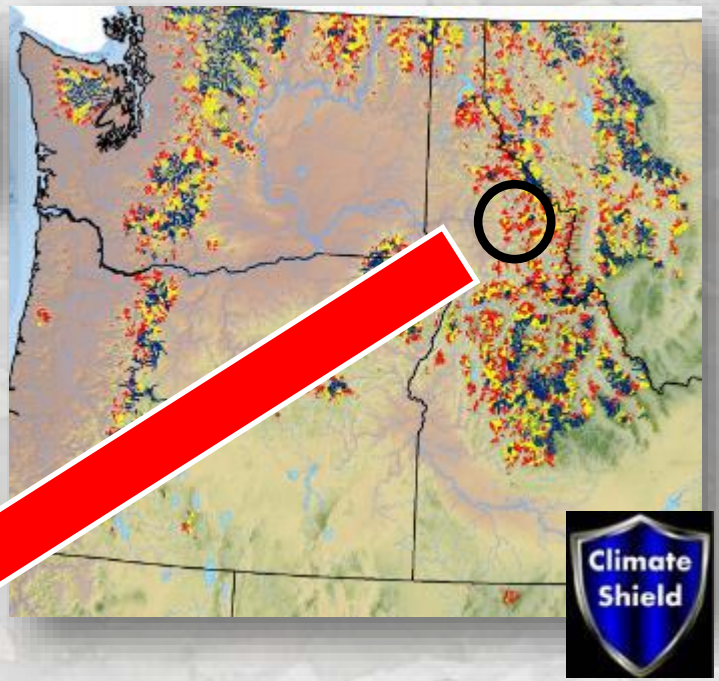
Protocols

Sampling maps

Results

Climate Shield Potential Habitat Maps Guide Efficient eDNA Sampling Inventories





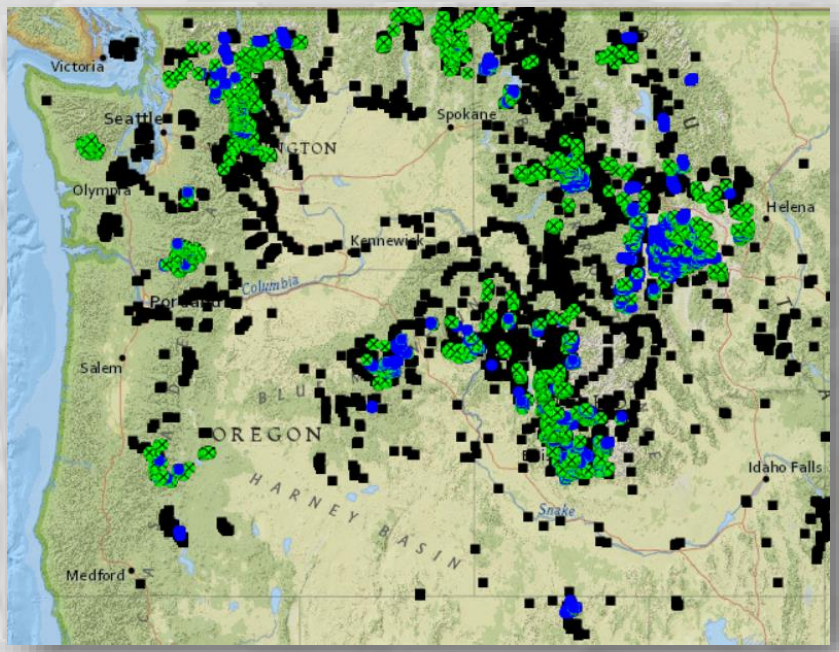
Does this stream support a population?

Are trends apparent?

- There are ~5,332 potential bull trout habitats
- New samples targeted to reduce uncertainties

Progress to date…

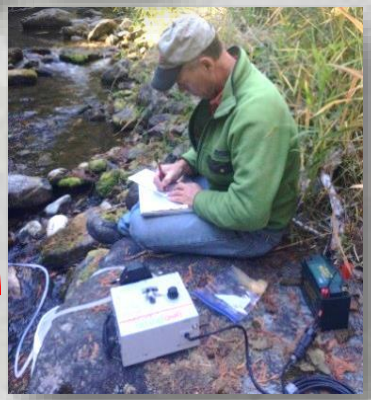
2015–2019 : ~7,000 sites sampled



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

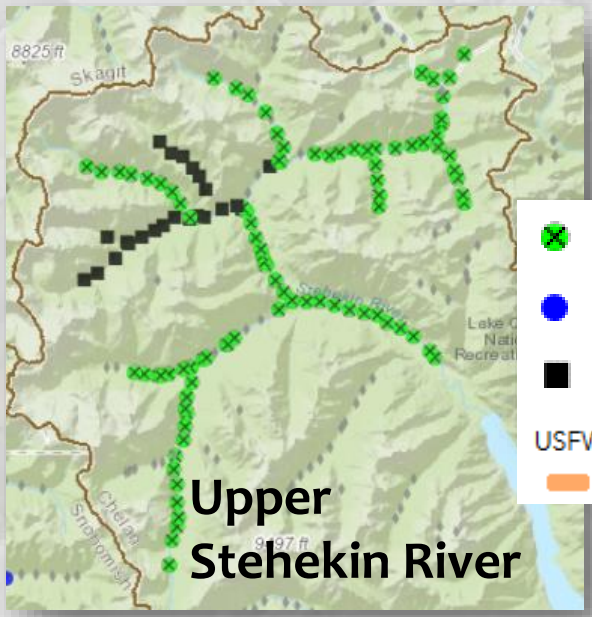
Montana Fish, Wildlife & Parks

OREGON Fish & Wildlife

IDAHO POWER An IDACORP Company

Climate Shield Habitat Maps + Rapid eDNA Surveys Have Helped…

Confirm absences



sampled, bull trout absent

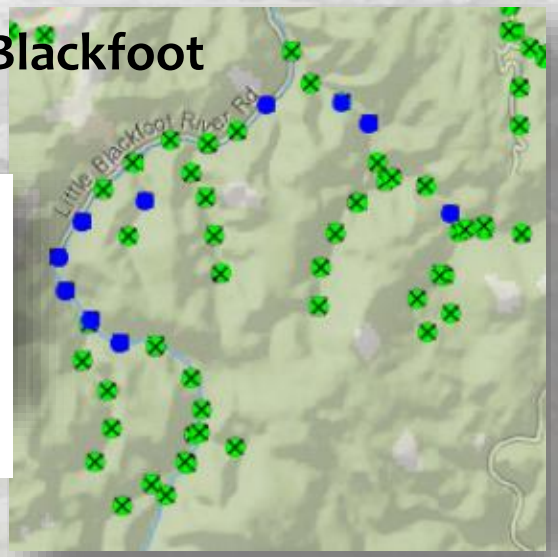
sampled, bull trout present

sampled, being processed

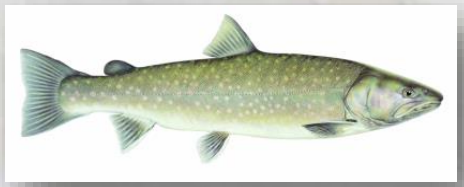
USFWS Spawning and Rearing Critical Habitat

Discover new populations

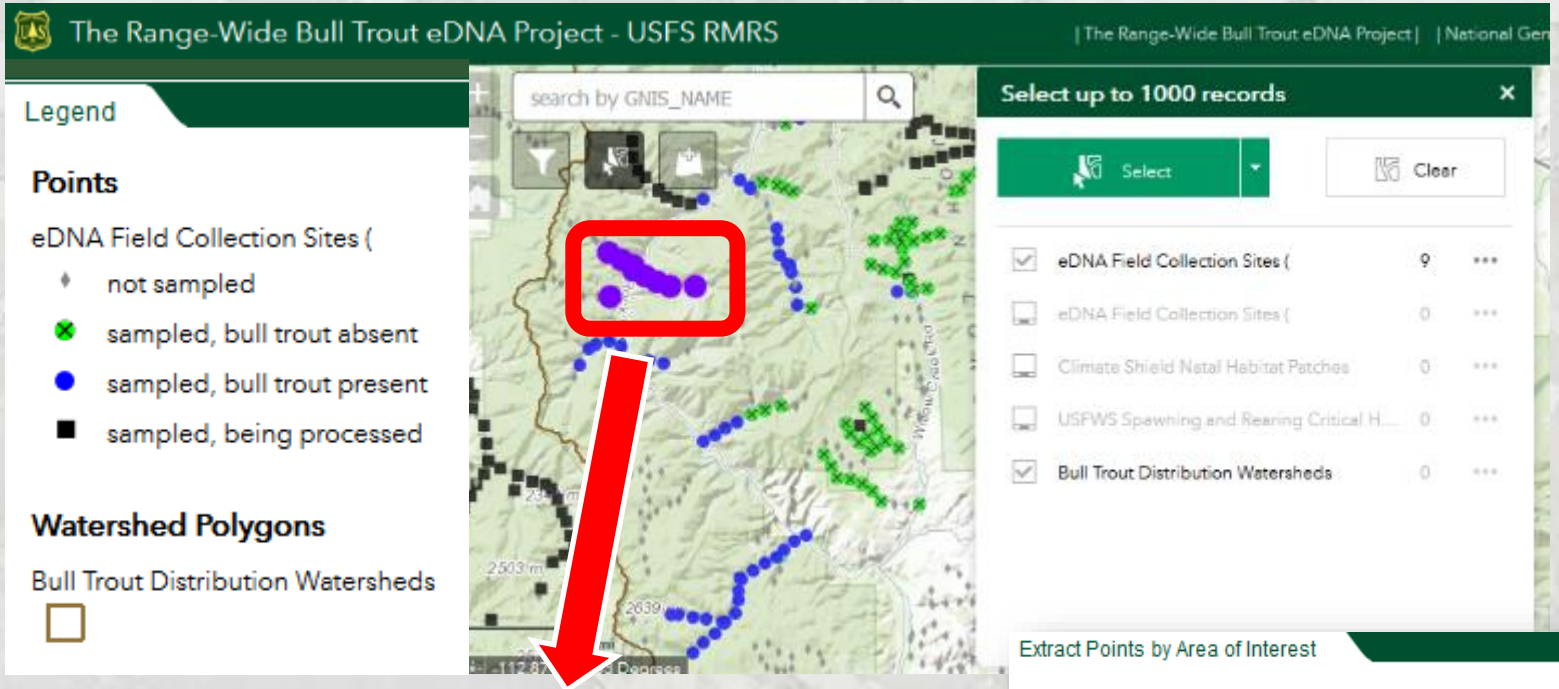
Little Blackfoot River



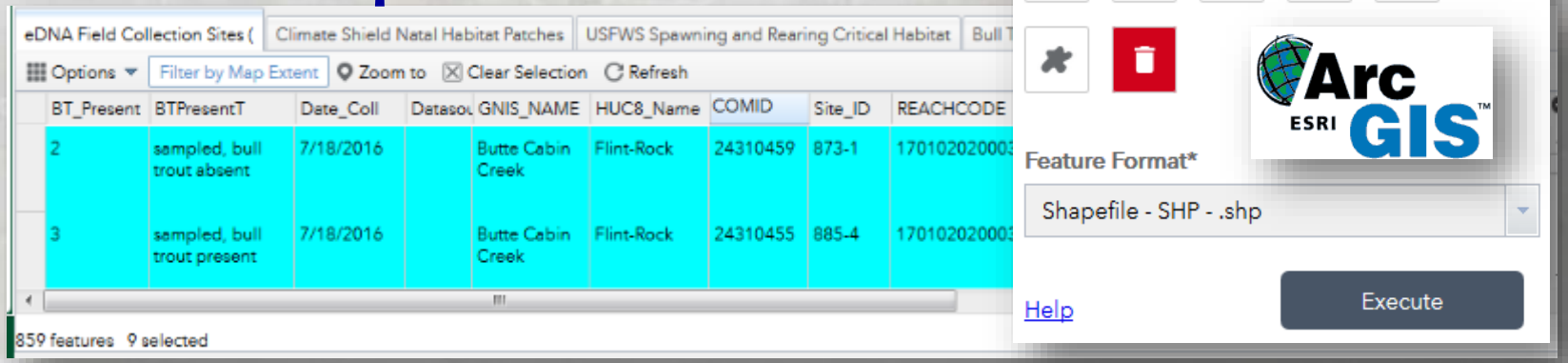
Refine critical habitat?



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



eDNA sample metadata



Powerful Status & Trend Assessments

2006-2007 e-fishing surveys

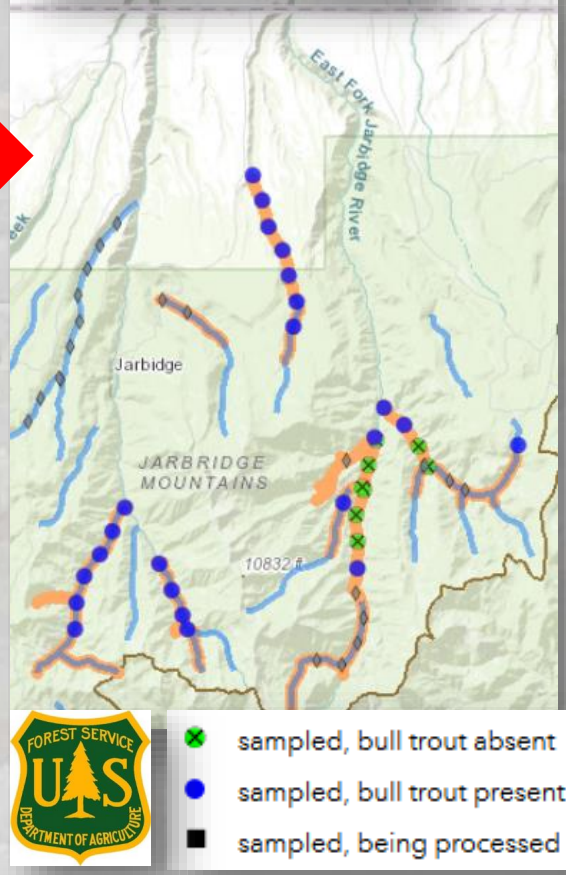
USGS
science for a changing world

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

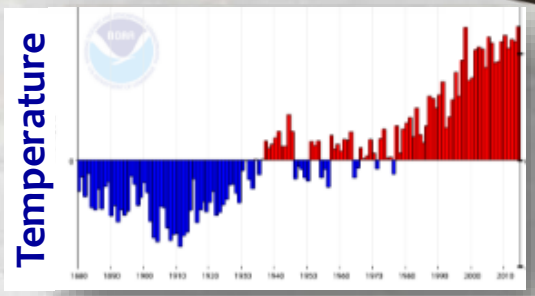
Distribution and Movement of Bull Trout in the Upper Jarbidge River Watershed, Nevada

Allen et al. 2010

2016 eDNA surveys

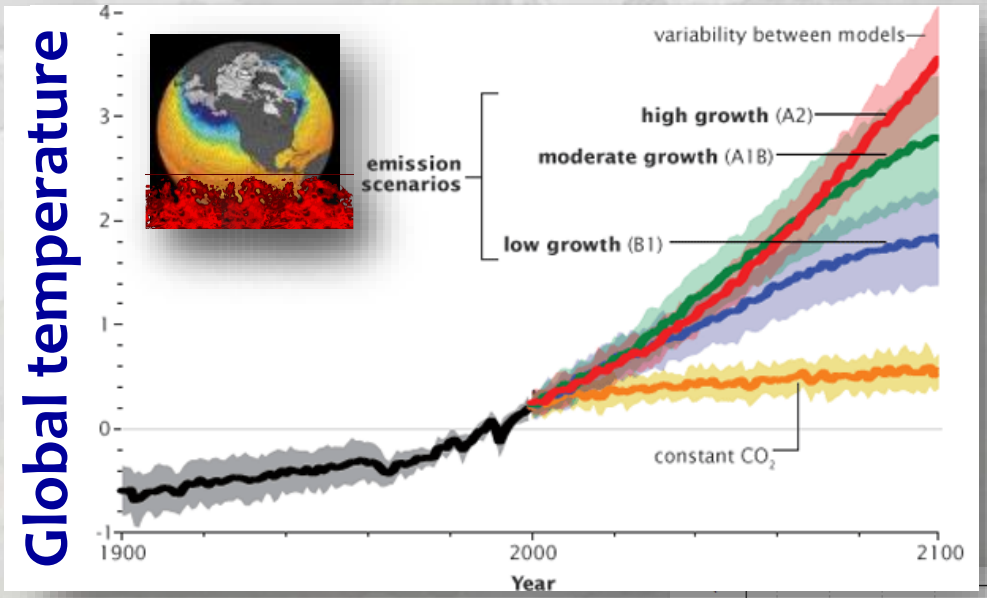


Many Different Factors Weigh Into this Century's Partly Cloudy Bull Trout Forecast

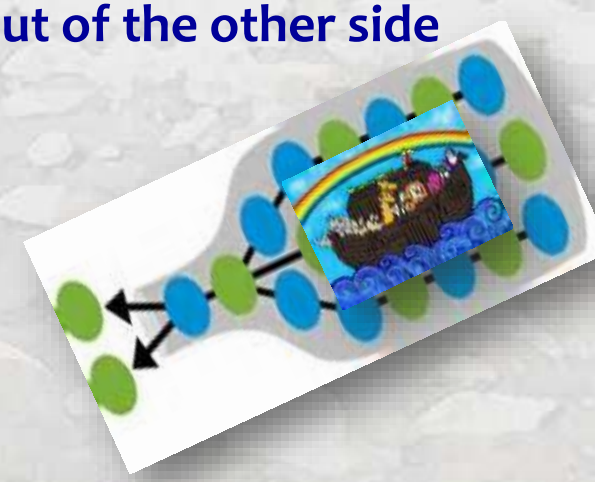


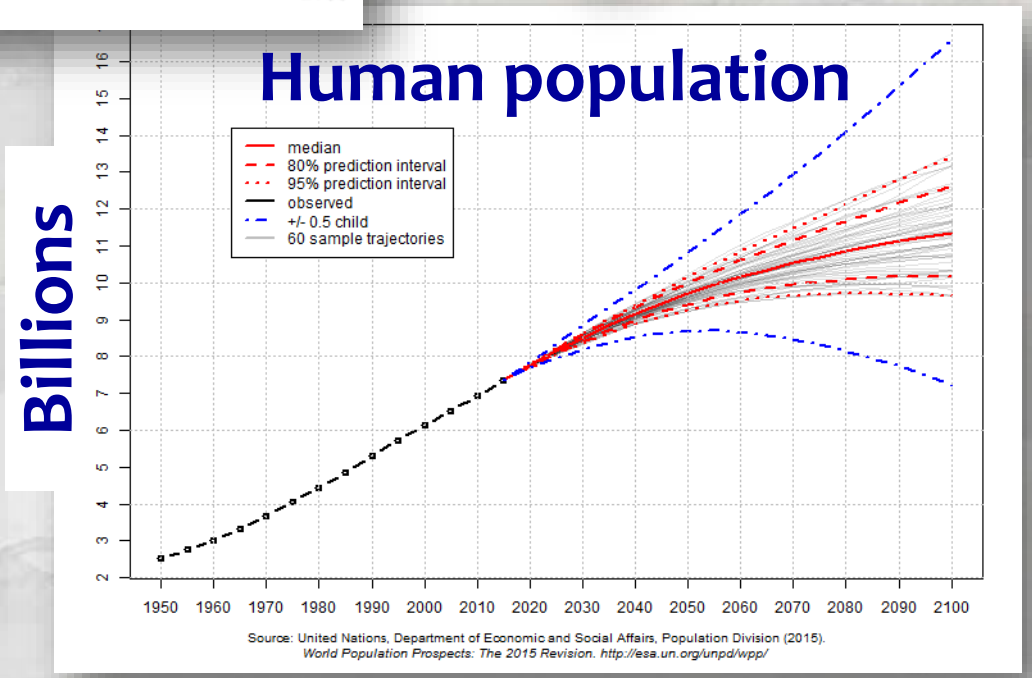
Before → After

21st Century is a BottleNeck to Survive

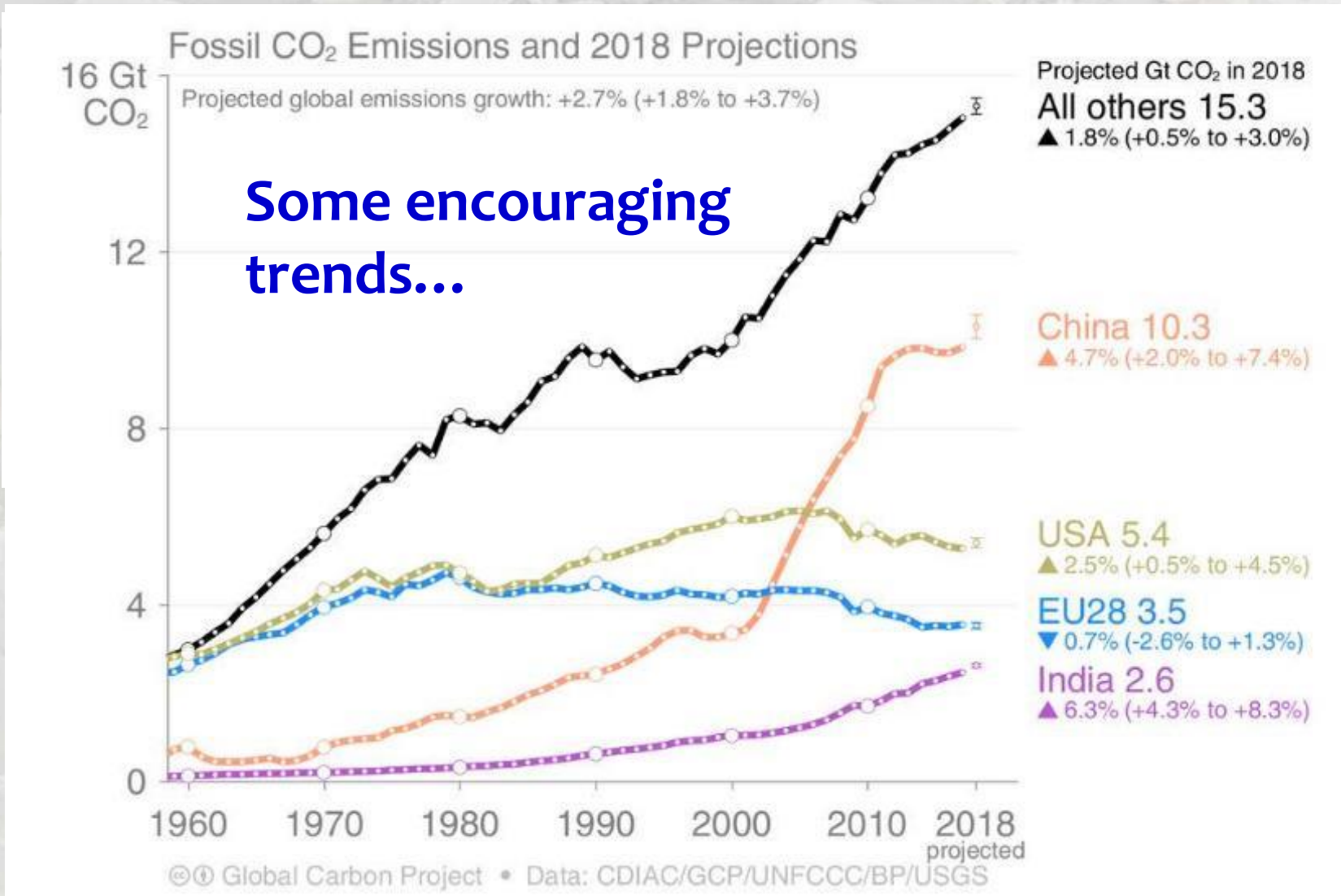


Something will come out of the other side

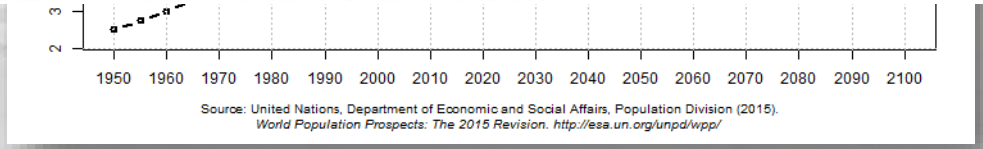




21st Century is a BottleNeck to Survive



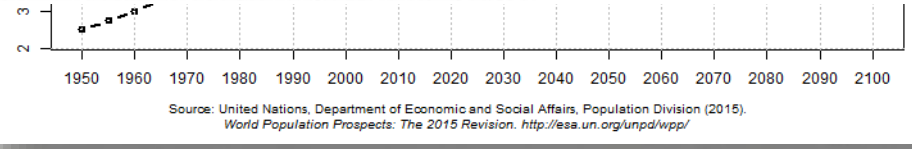
Some encouraging trends…



21st Century is a BottleNeck to Survive

$0.02 / kwh installed

+$0.01 kwh with battery storage




The End