Northwest **Power** and **Conservation** Council

May 9, 2017

MEMORANDUM

TO: **Fish and Wildlife Committee members**

FROM: **Leslie Bach**

SUBJECT: **Climate velocity effects on cold-water habitat: An impetus for new conservation tools and databases**

BACKGROUND:

Presenter: Daniel Isaak, U.S. Forest Service

Summary: At the April meeting staff presented an overview of ongoing work on cold-water habitats; examples of cold-water projects and studies at different scales; tools and methods to identify and map these habitats; and relationships to fish use. Committee members indicated a strong interest in recent work on rates of warming of regional rivers and streams and the implications for cold-water species. Dan Isaak is leading some of that research, and will provide an overview of his current work and the state of the science.

Relevance: Actions related to cold-water habitat are identified in numerous locations in the 2014 Fish and Wildlife Program. Protecting and restoring habitat is a key sub-strategy in the Ecosystem Function section of the Program (page 41). An important aspect of this is ensuring that the habitats that are restored and protected are providing the appropriate thermal regimes for fish and other aquatic life. Under the Climate-Change sub-strategy, the general measures call for the action agencies to “evaluate the effectiveness and feasibility of possible actions to mitigate effects of

851 S.W. Sixth Avenue, Suite 1100
Portland, Oregon 97204-1348
www.nwcouncil.org

Steve Crow
Executive Director

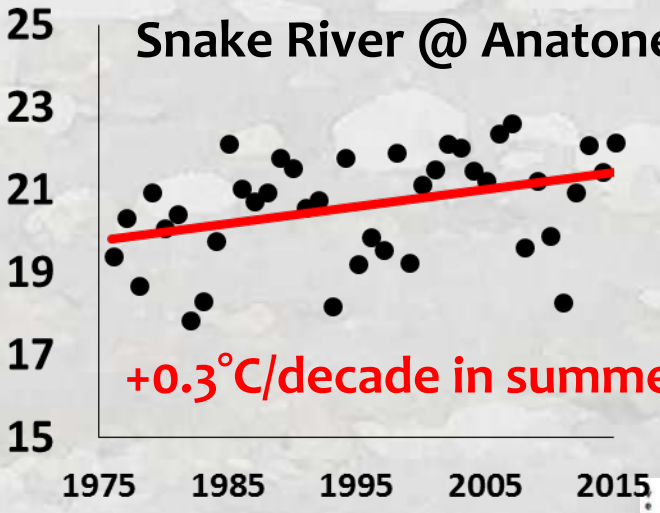
503-222-5161
800-452-5161
Fax: 503-820-2370

climate change…other actions to create or protect cool water refugia in mainstem reaches or reservoirs" (page 58).

Background: Components of this topic have been addressed at previous Council meetings over the past several years

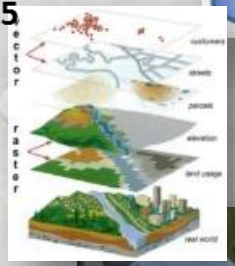
More Info: March 2017 presentation by Council staff

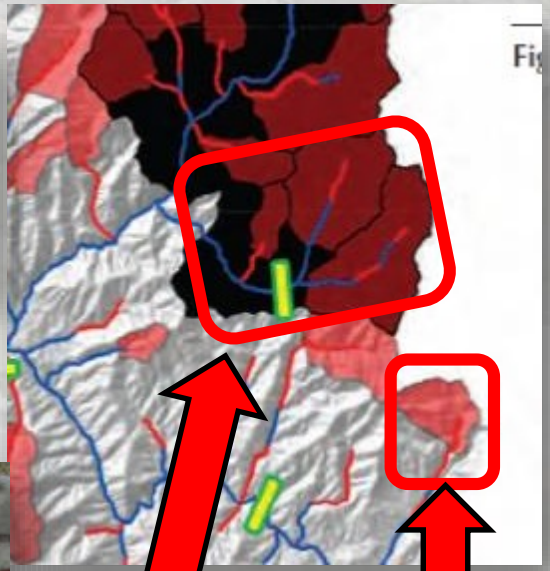
Climate Velocity and Warming Effects on Cold-Water Habitat: An impetus for new strategic conservation tools and databases



Dan Isaak

Forest Service Research

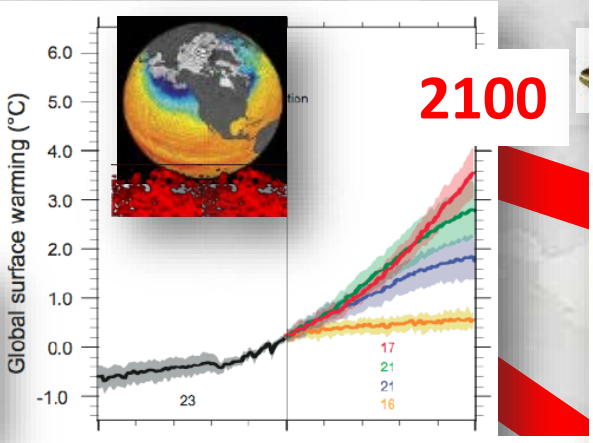




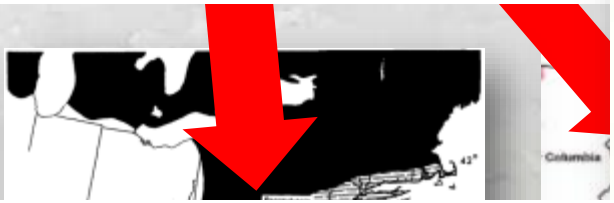
I'm going to invest here

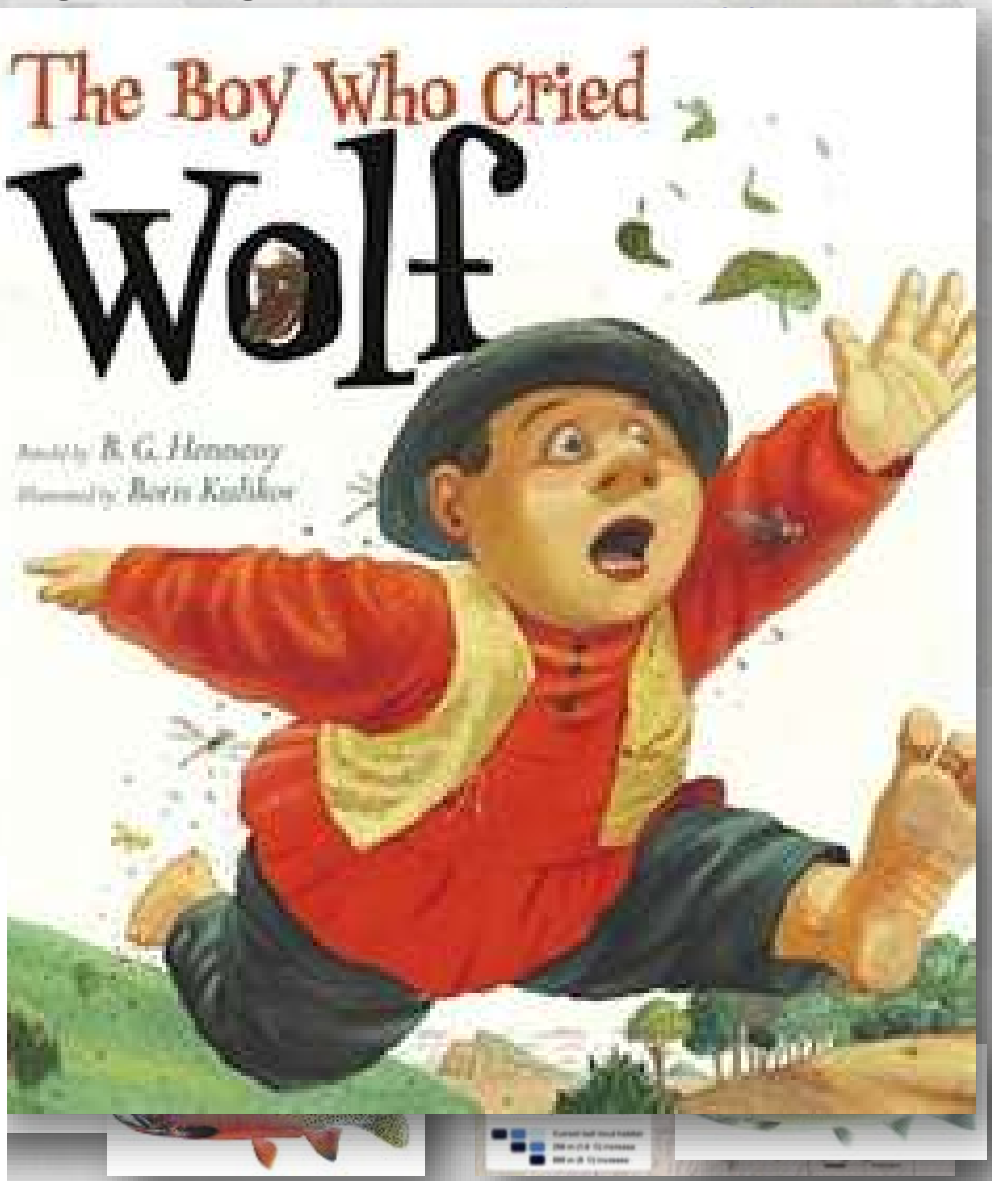
… not here

Obviously, the Cold-Water Fish World Will End in Immolation…



Declines predicted: 20%-100%

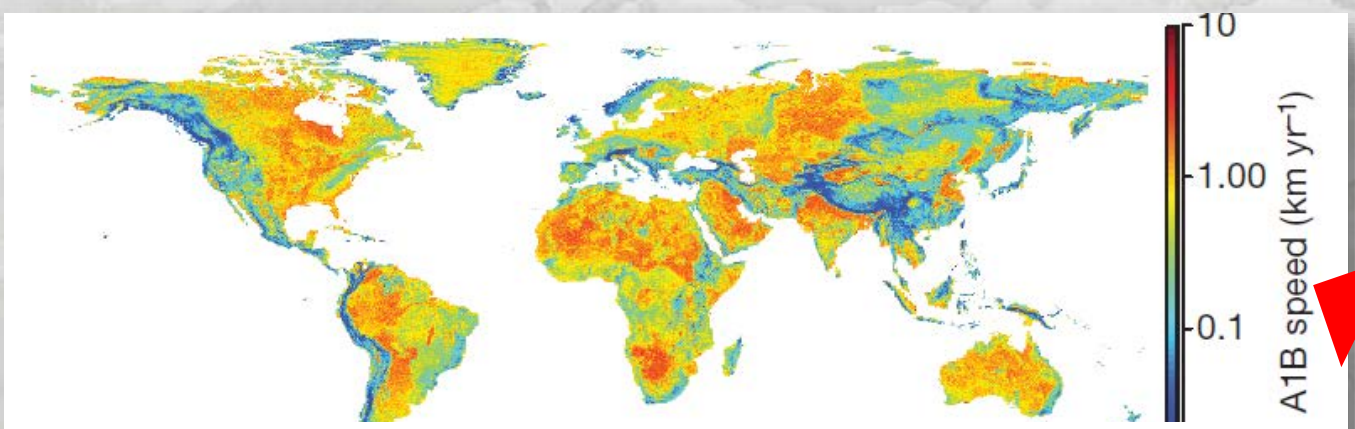




But: We've been predicting doom for almost 30 years

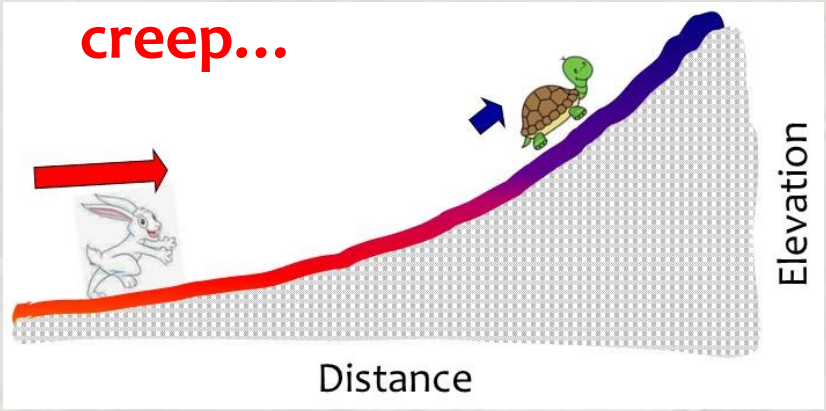
Climate "Velocity" is What's Biologically Relevant

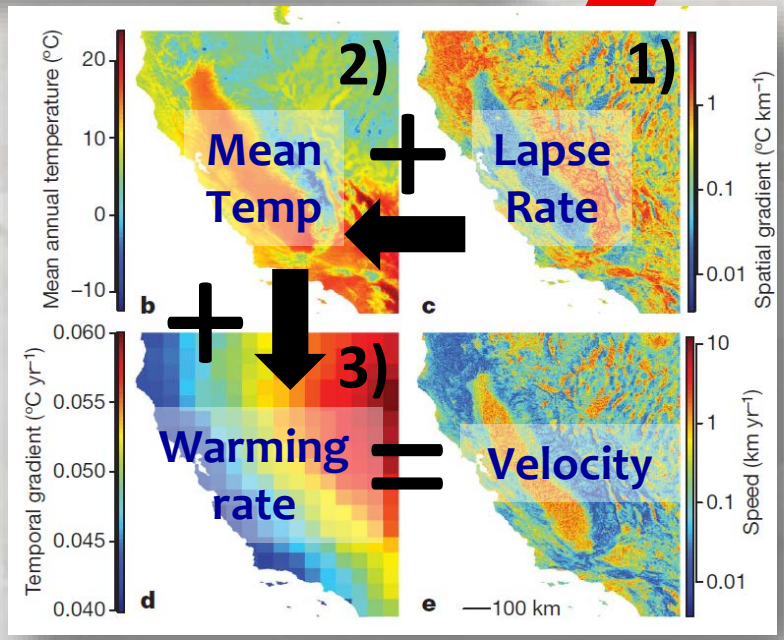
Rate at Which Isotherms & Thermal Niches Shift



Velocity varies 100x for same warming rate

If it's steep, it slows the creep…

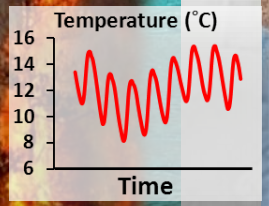




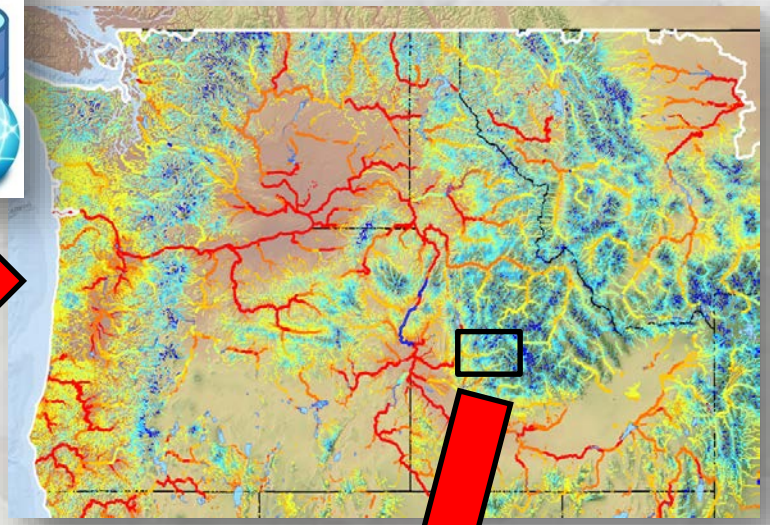
Loarie et al. 2009. The Velocity of Climate Change. *Nature* **462**:1052-1055.

Calculating Velocity for Streams Required Temperature Data & Accurate Scenarios

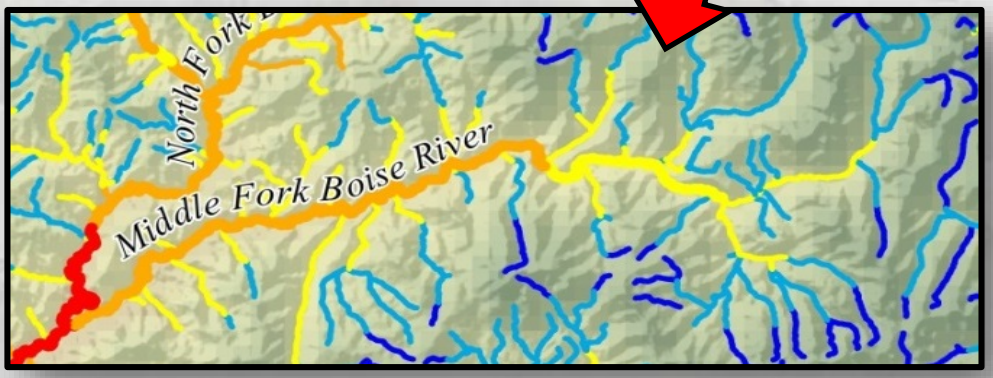
Organize Data → NorWeST Stream Temp → High-resolution Climate Scenarios



DATABASE



>220,000,000 hourly records
>22,700 unique stream sites



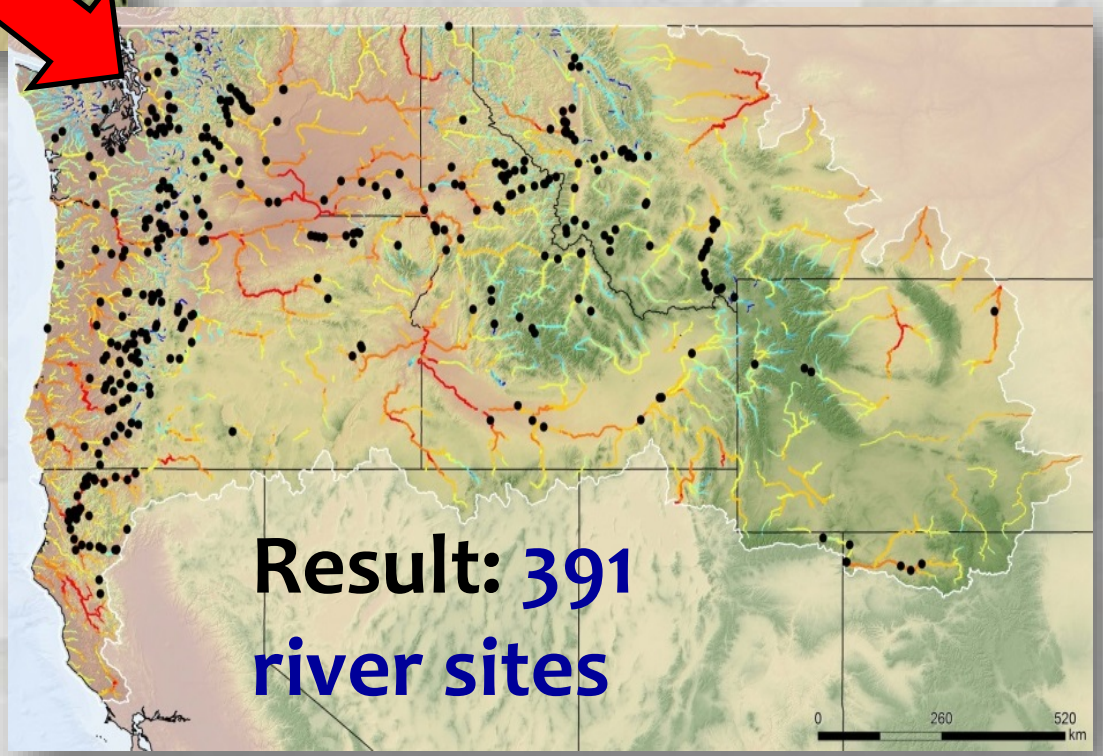
Needed to Know Warming Rates of Salmon & Trout Rivers in the PNW…

Database query:

1) How many sites have >10 years of monitoring?

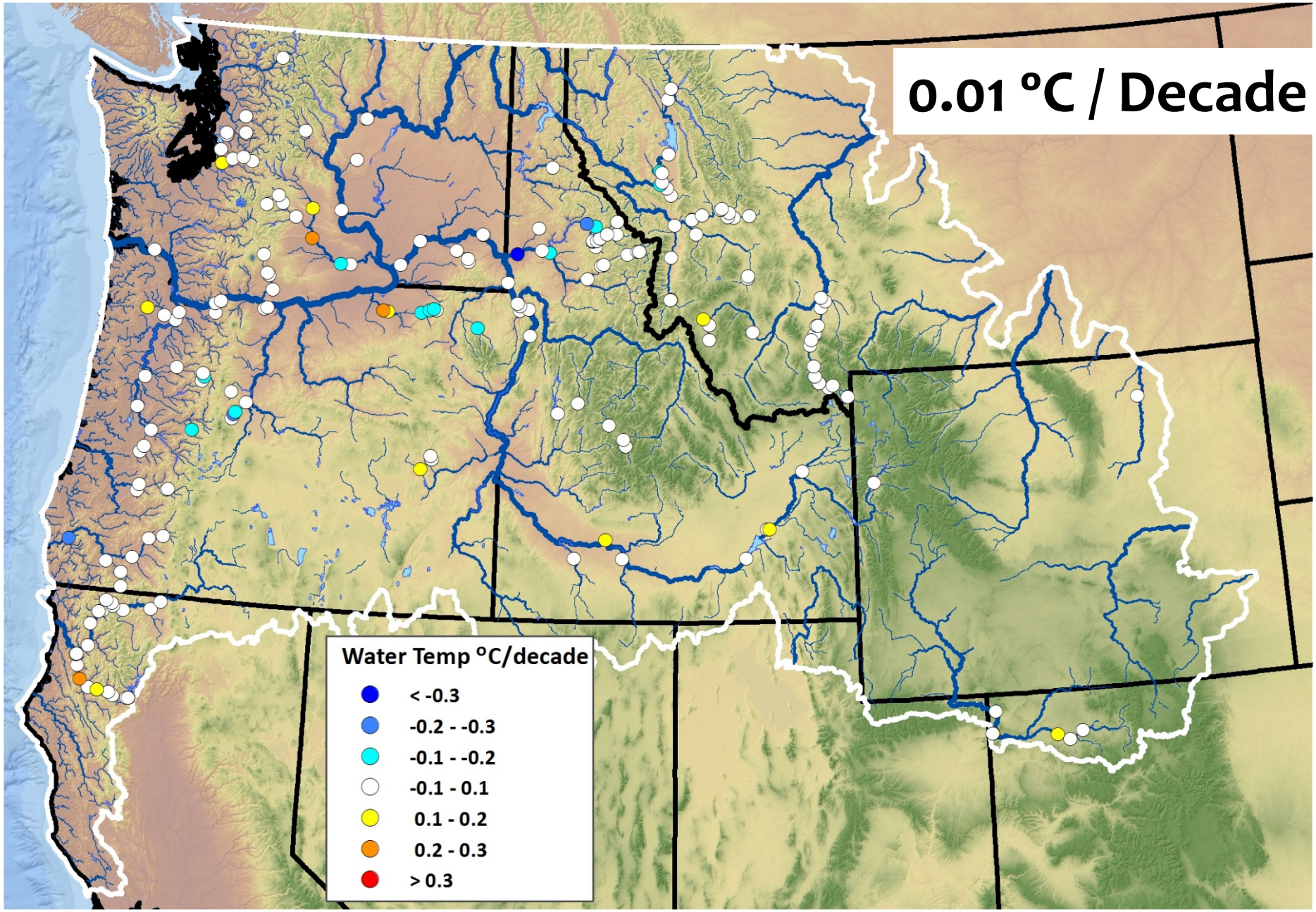
2) How many sites occur on rivers with >100 cfs flow?

NorWeST Stream Temp

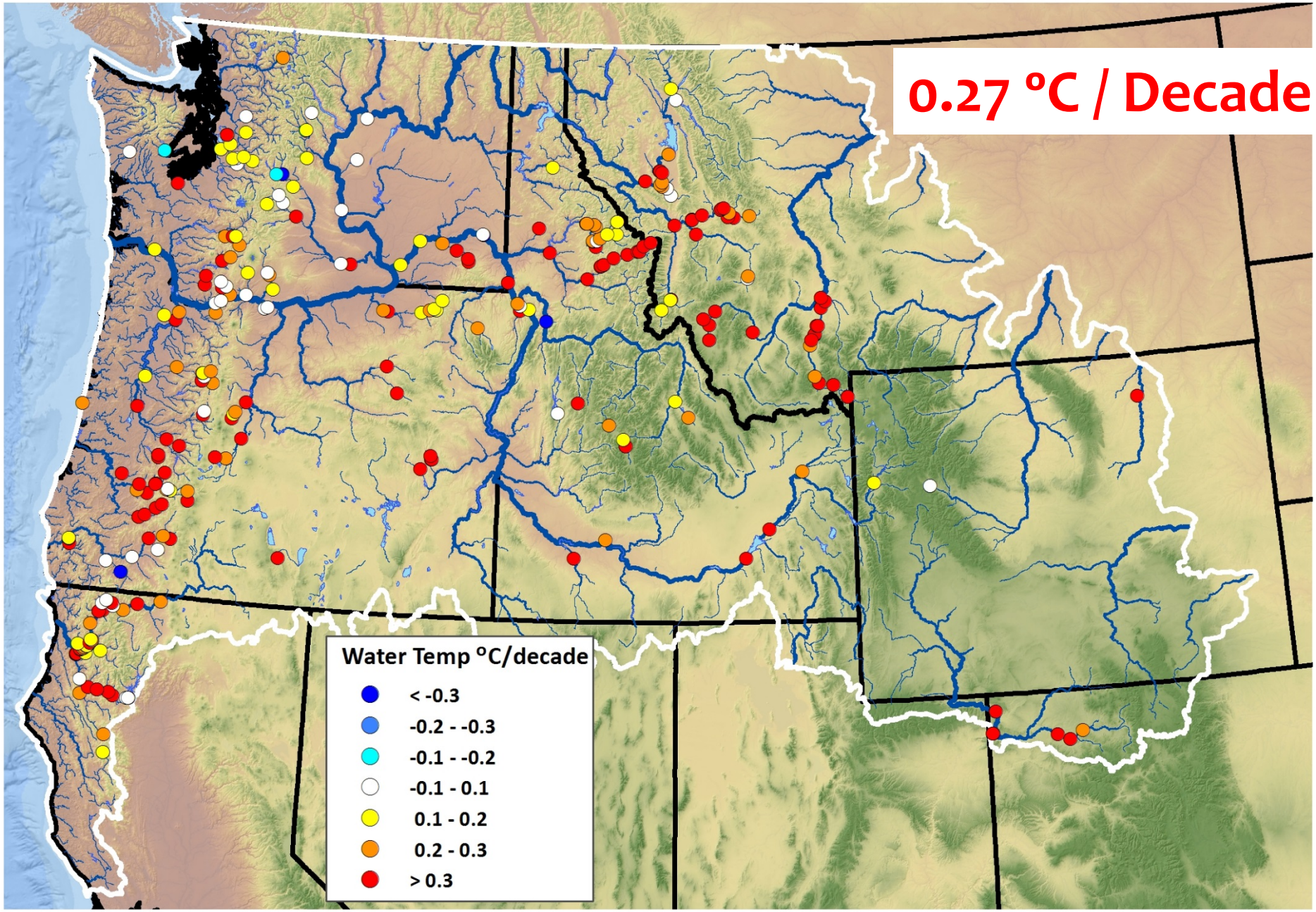


Result: 391 river sites

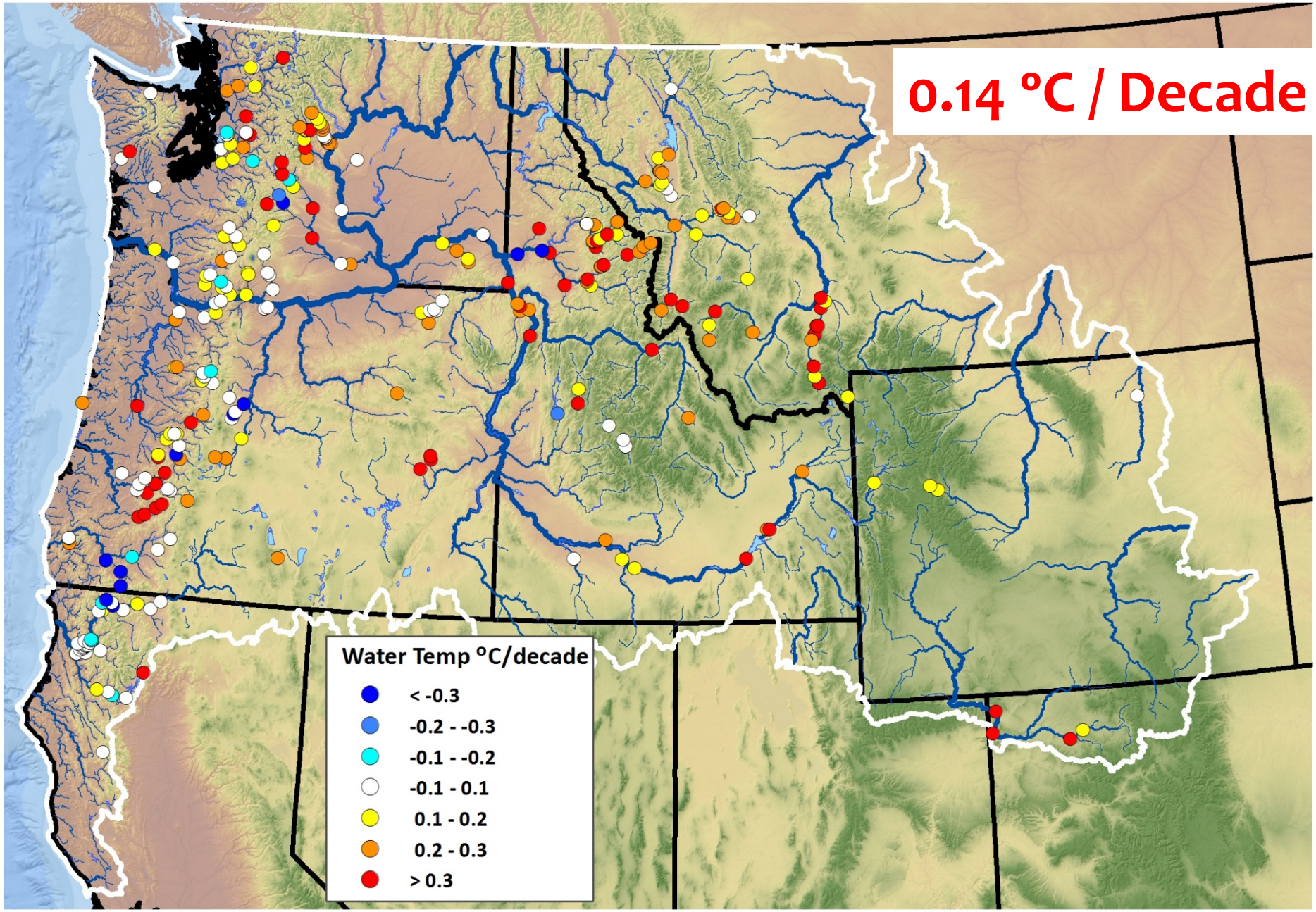
40 Year (1976–2015) Monthly River Temperature Trend - June



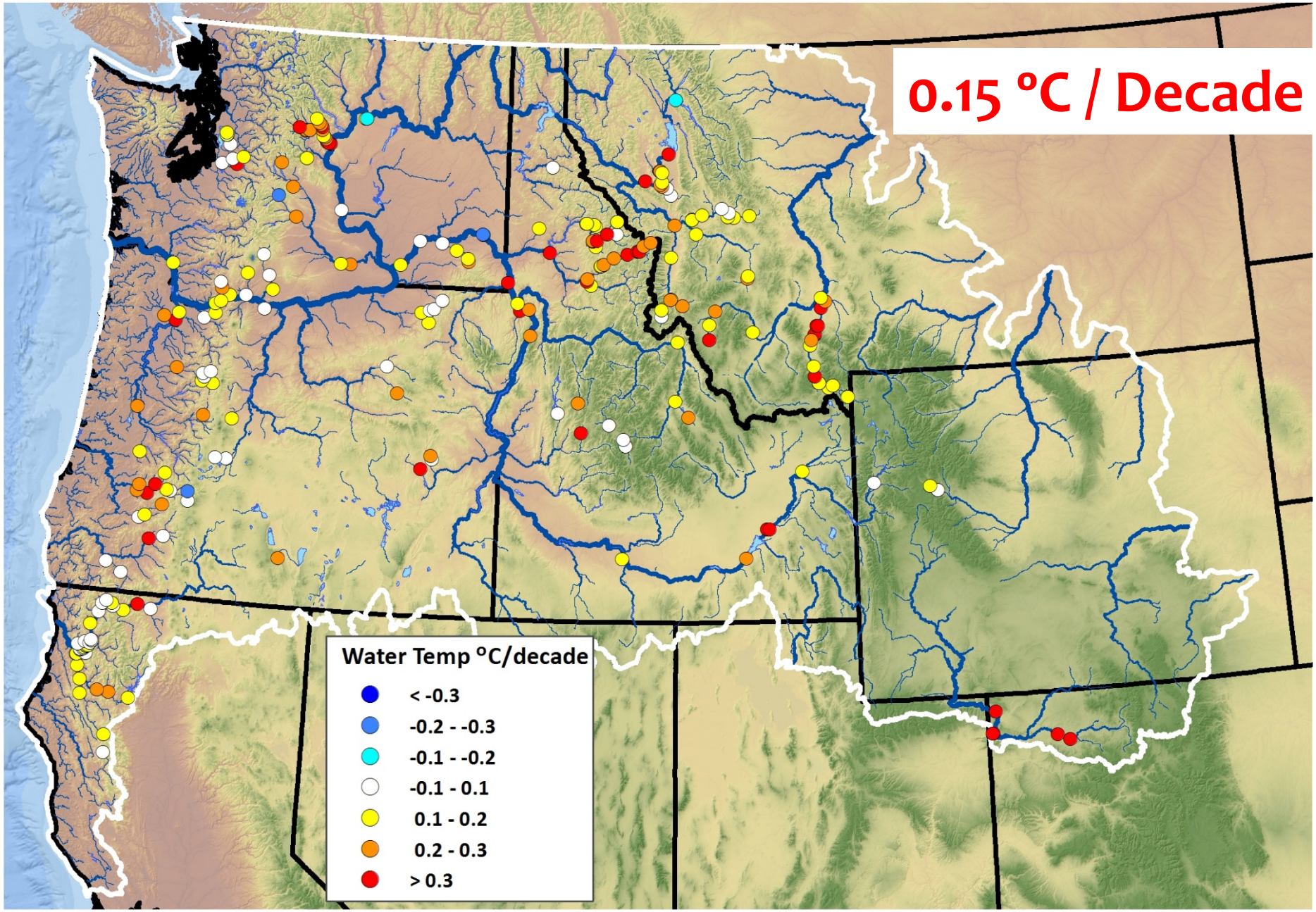
40 Year (1976–2015) Monthly River Temperature Trend - July



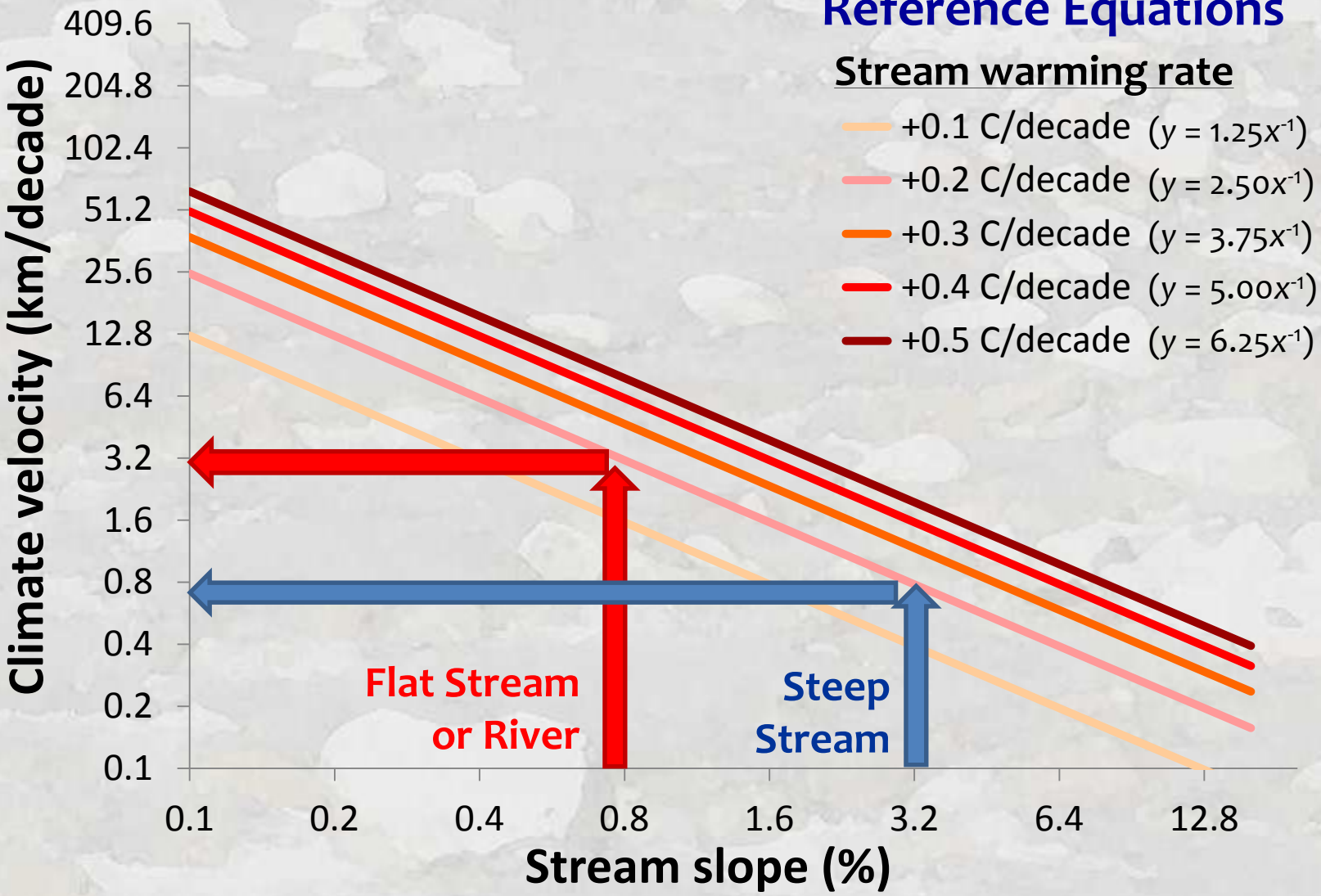
40 Year (1976–2015) Monthly River Temperature Trend - August



40 Year (1976–2015) Monthly River Temperature Trend - September

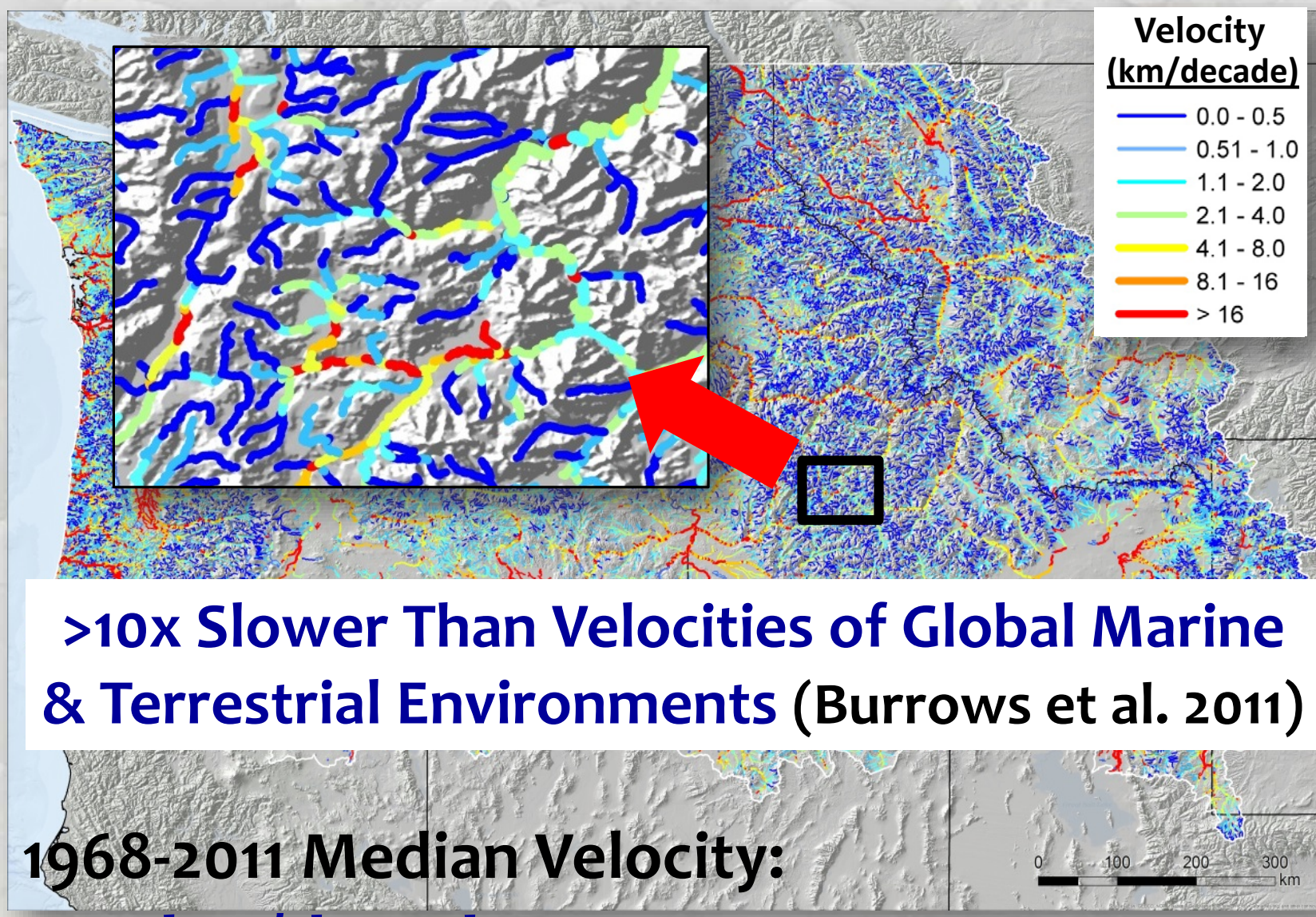


Convert Warming Rate to Velocity



Isaak & Rieman. 2013. *Global Change Biology* **19**:742-751.

Climate Velocity Map for Regional Network

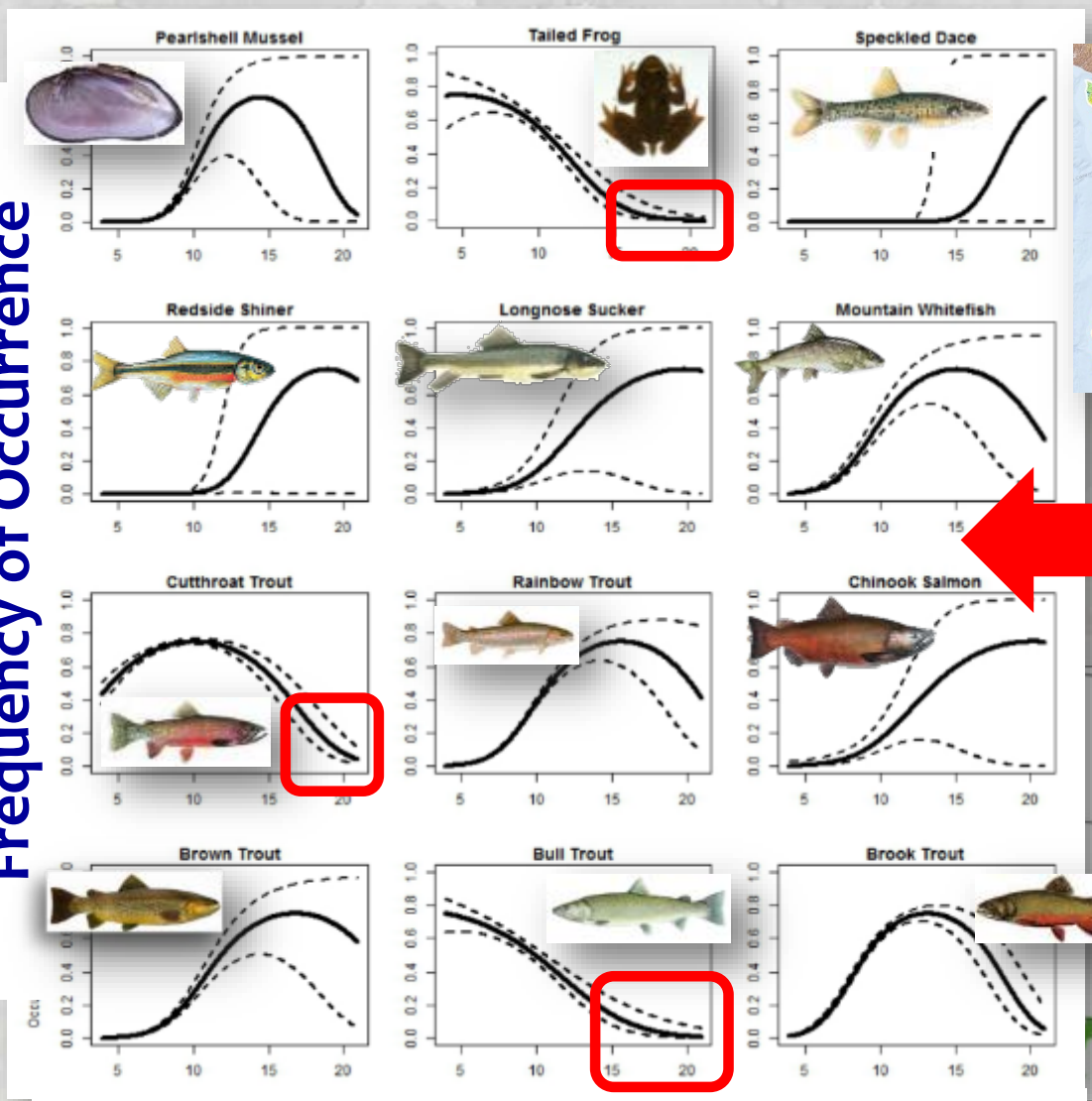


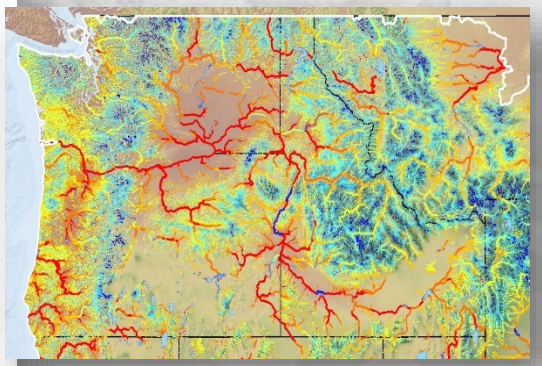
>10x Slower Than Velocities of Global Marine & Terrestrial Environments (Burrows et al. 2011)

1968-2011 Median Velocity:

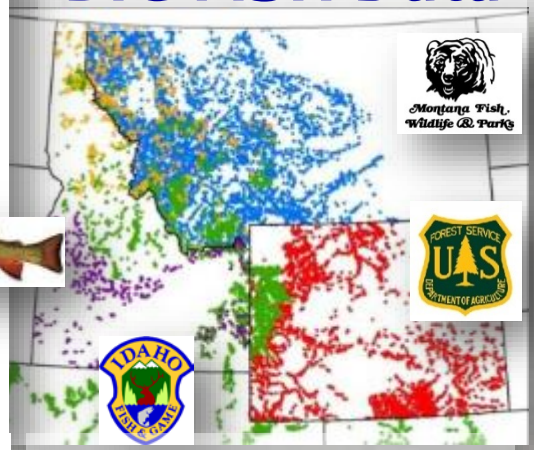
1.07 km/decade

Species Vulnerable at Edge of Thermal Niche





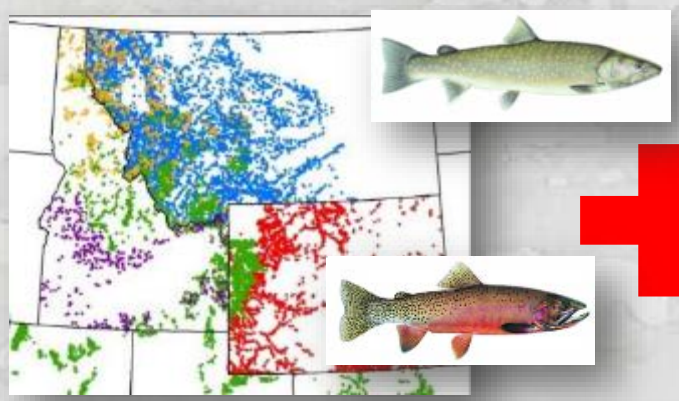
BIG FISH Data

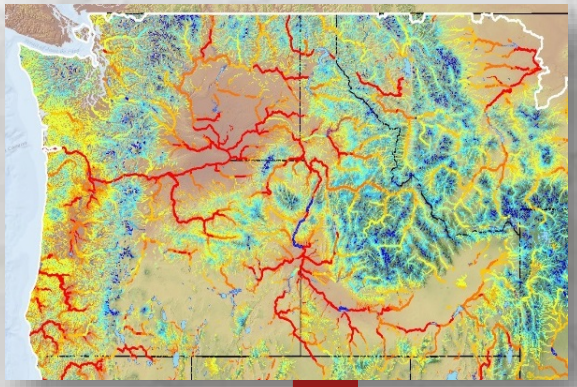


>13,000 surveys

Isaak et al. 2017. Big biology meets microclimatology. *Ecol. Apps.* doi:10.1002/eap.1501

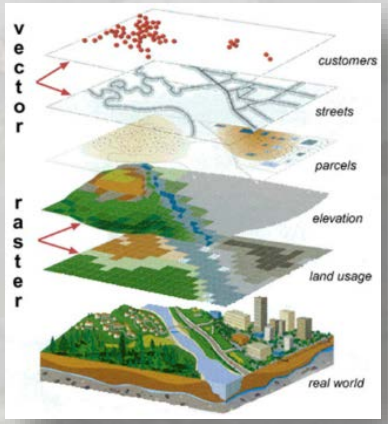
Fish Distribution Models Predict Where Thermal Constraints Occur

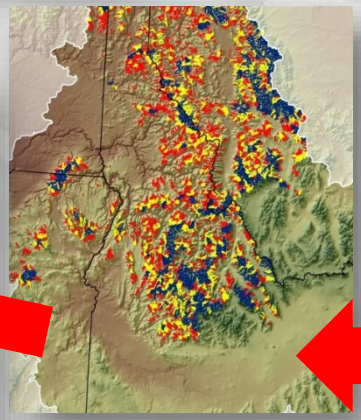




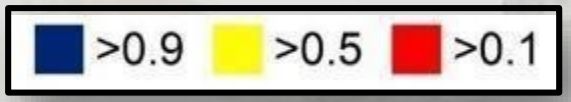
Climate Shield

Predictive Spatial Models in GIS





Occurrence probability maps

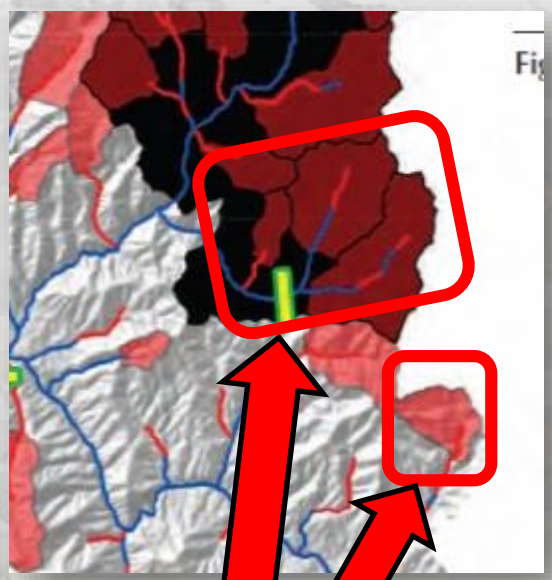


Isaak et al. 2015. The cold-water climate shield: Delineating refugia for preserving native trout through the 21st Century. *Global Change Biology* **21:** 2540-2553

Climatic Context for Where to Invest

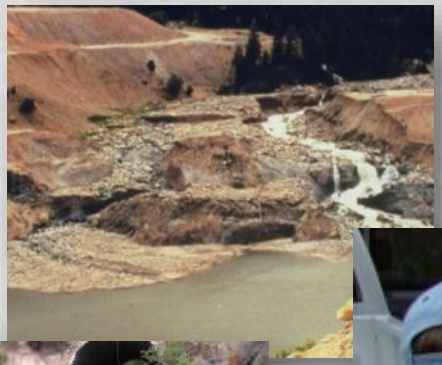
Many Options Once we Know "Where"

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



I'm going to invest here…

…not here



eDNA Databases will Improve Accuracy

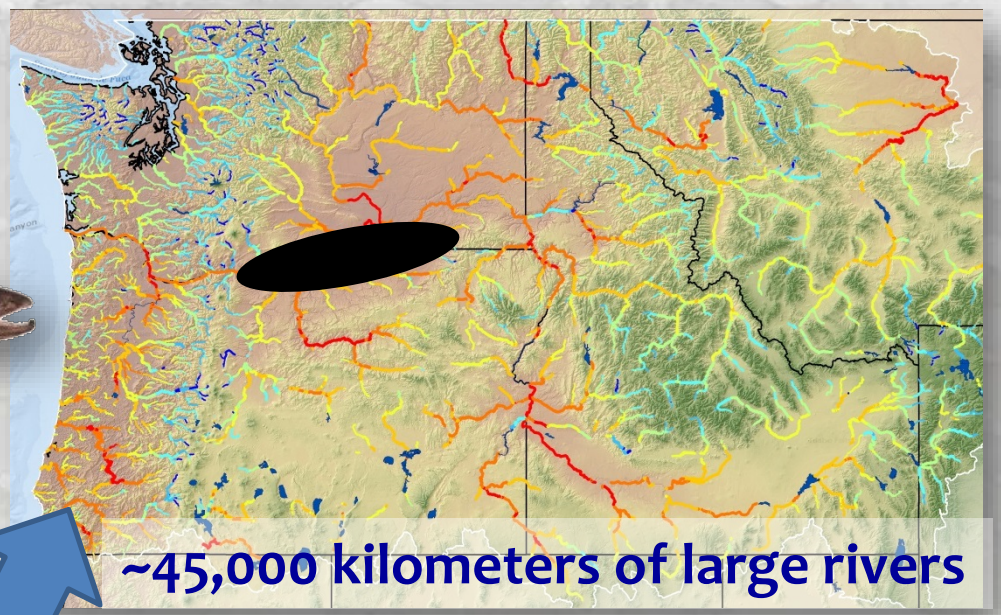
Website: Rangewide eDNA Bull Trout Project

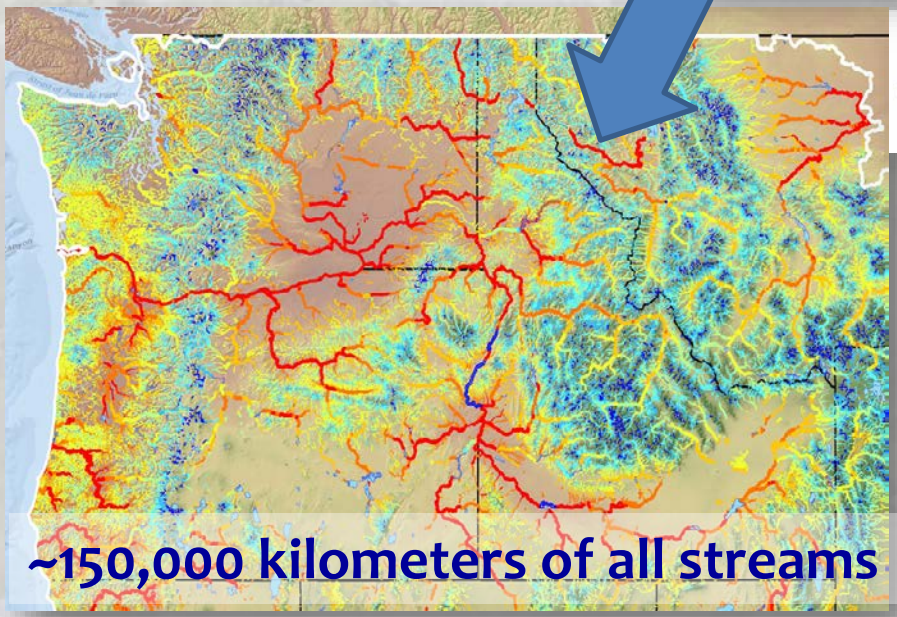
All Species: eDNAtlas Database Project

National Genomics Center for Wildlife & Fish Conservation

NATIONAL FISH AND WILDLIFE FOUNDATION NFWF

Big Fish in Rivers are a Bigger Challenge

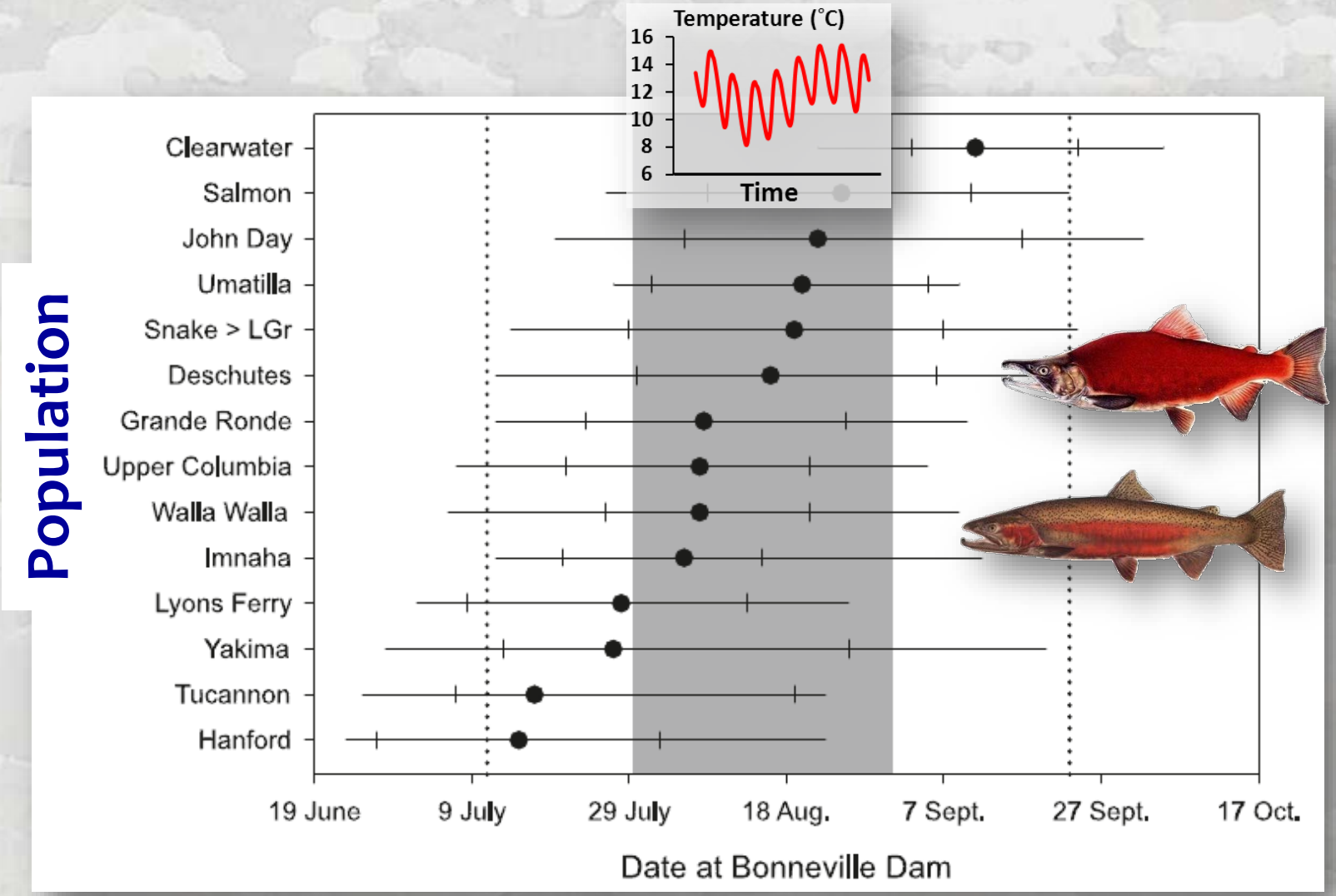




Headwater species:

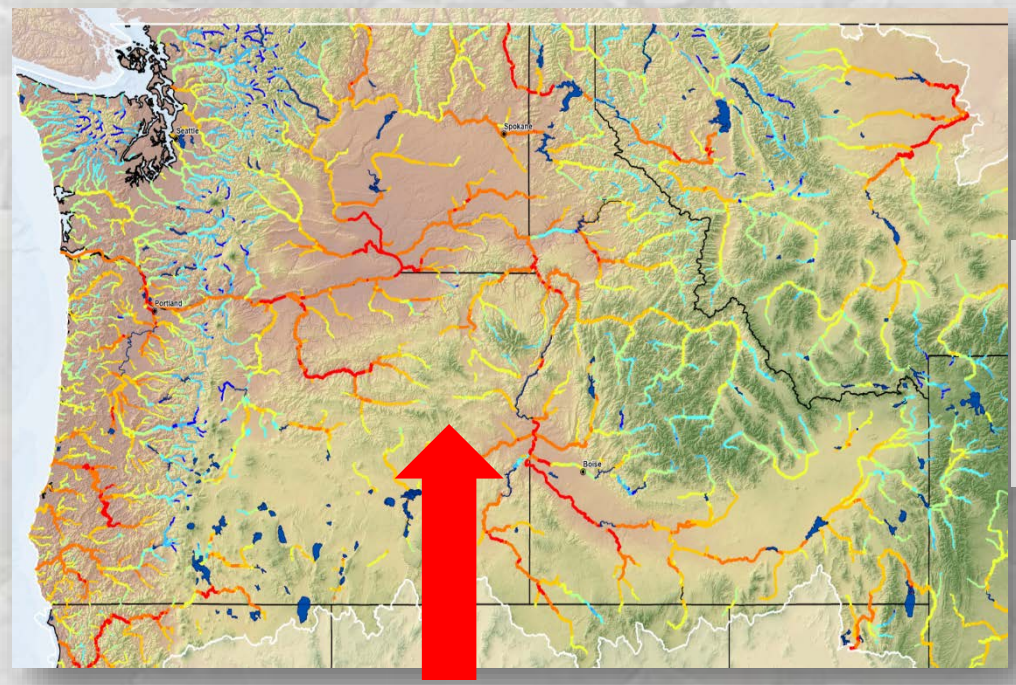
- Slow climate velocities
- Non-anadromous
- Life cycle encompasses small areas
- Many populations

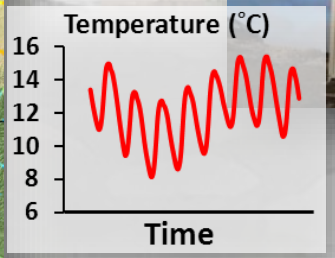
Need Accurate Temperature Information Within Years Because Migration Timing is Key



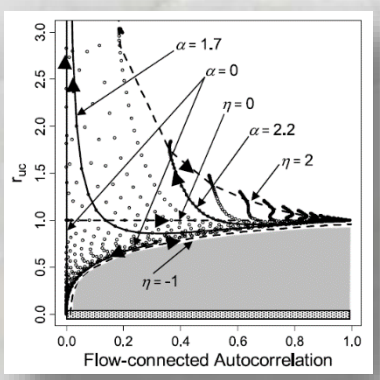
Keefer et al. 2009

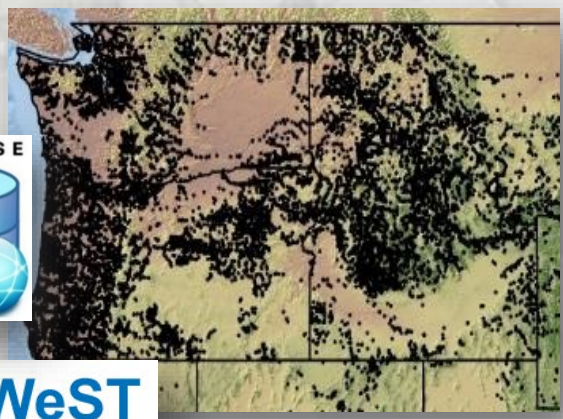
A Real-Time "Weather System" for All Rivers ~30,000 river kilometers in CRB





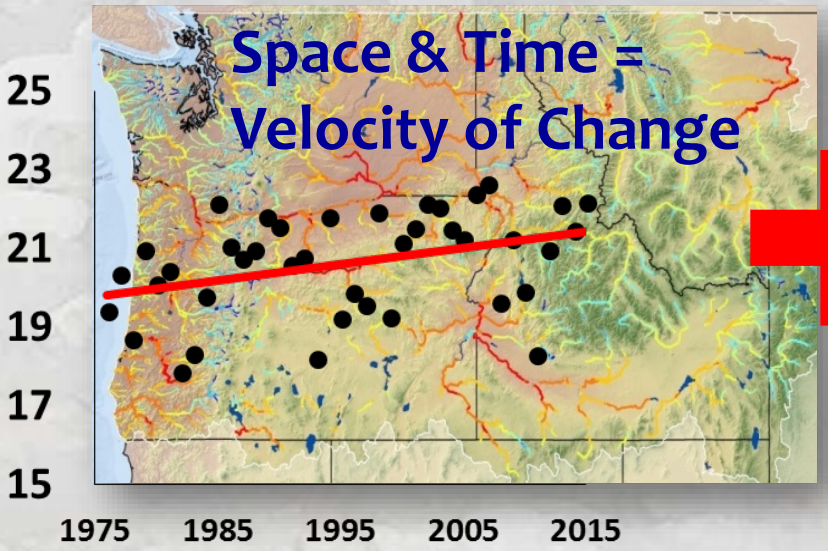
Space-time network models (new statistical theory & big computers required)

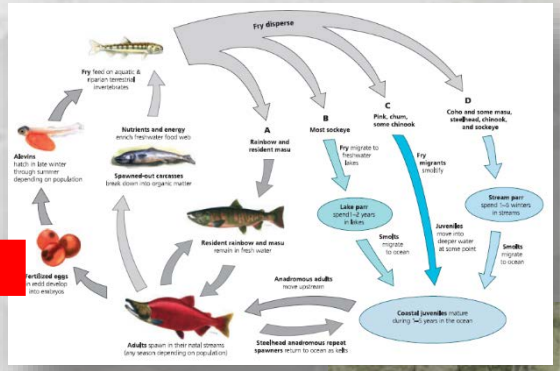


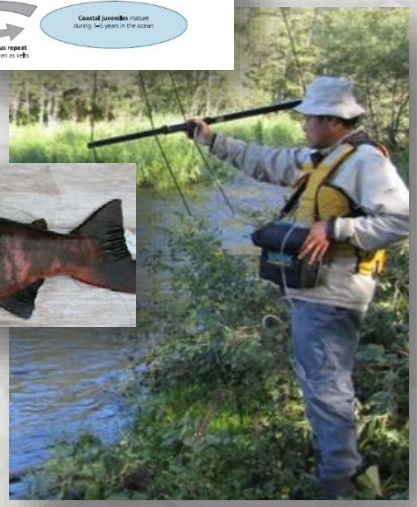


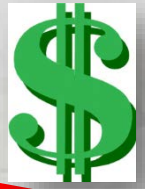
NorWeST Stream Temp

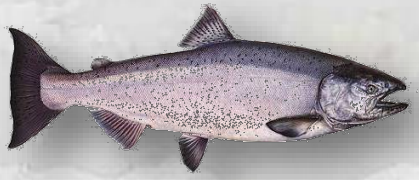
River Weather Forecasts Create Synergies with Bioenergetics Models & Biotelemetry



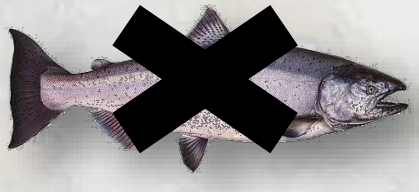








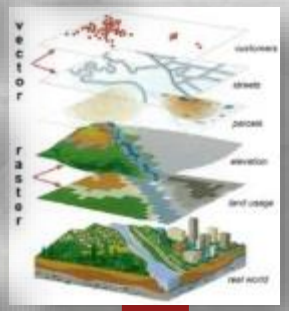
Yes



NO

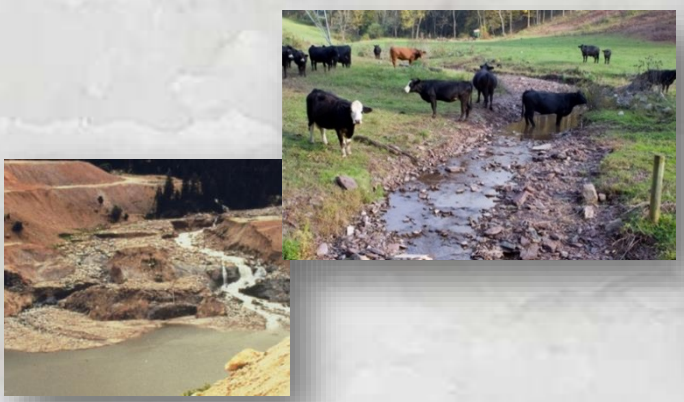
Information system for spatially explicit investment planning…

Better Databases, Models, & Information Useful for Addressing Many Challenges…



Urbanization & Population Growth

Habitat restoration



Climate Change