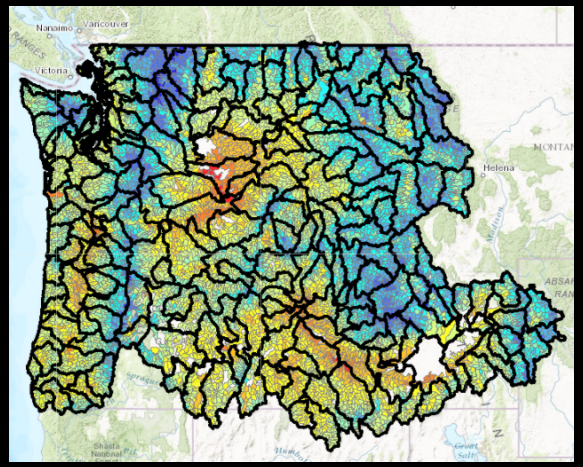
Projecting Effects of Climate Change on River Habitats and Salmonid Fishes:

Integrating Remote Sensing, Genomics, and Demography to Inform Conservation

Brian Hand, Diane Whited, Alisa Wade, Gordon Luikart (PI)

May 2017



UNIVERSITY OF MONTANA
Flathead Lake Biological Station

NASA

Urgent need for climate change vulnerability assessments (CCVAs)

Urgent Need

- Salmonids are "canaries of climate change"
- >300 M $ spent annually on salmonid conservation
- Prioritization of populations for mangement

Clean, Connected COLD Habitat

Spawning bull trout

Vulnerability to future climate depends on climate exposure, sensitivity & adaptive capacity.

Integrate as key elements of VULNERABILITY

Habitat (Remotely Sensed)

Genomics

Genetic diversity

Demographics

Abundance

Life History Diversity

Explosion of data

Exciting time for conservation

Exposure

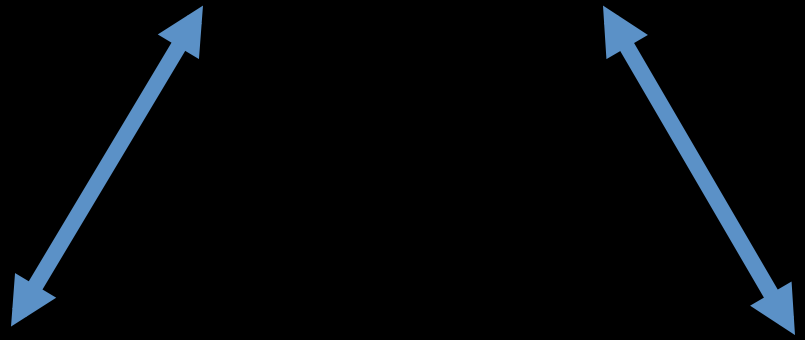
Sensitivity – physiological response

Adaptive Capacity – rapid response

An iterative and integrative project approach

Research and Collaboration

Collaborators in government, state, tribal and non-profit agencies



Best Practices and Outreach

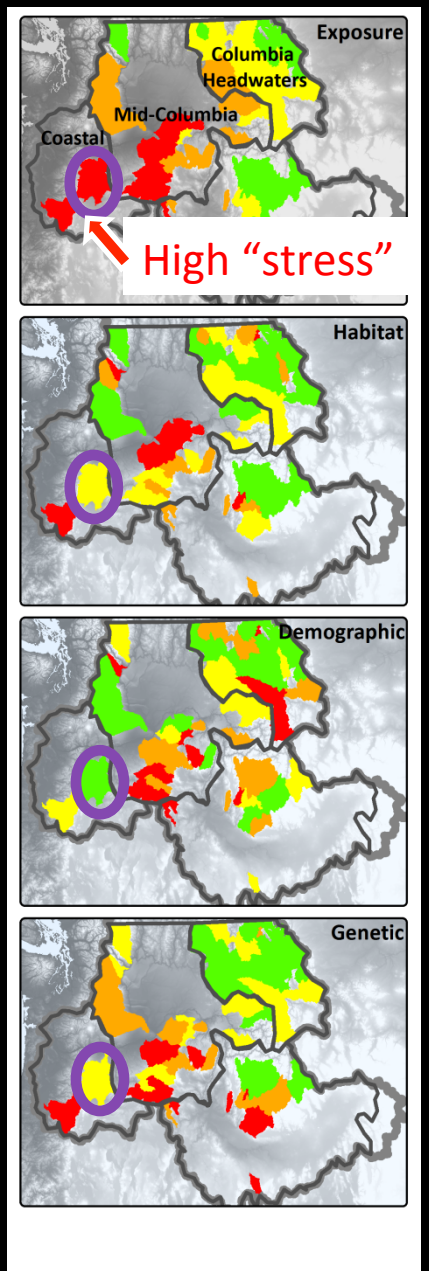
Development of best practices and use cases – partner (end-user) outreach

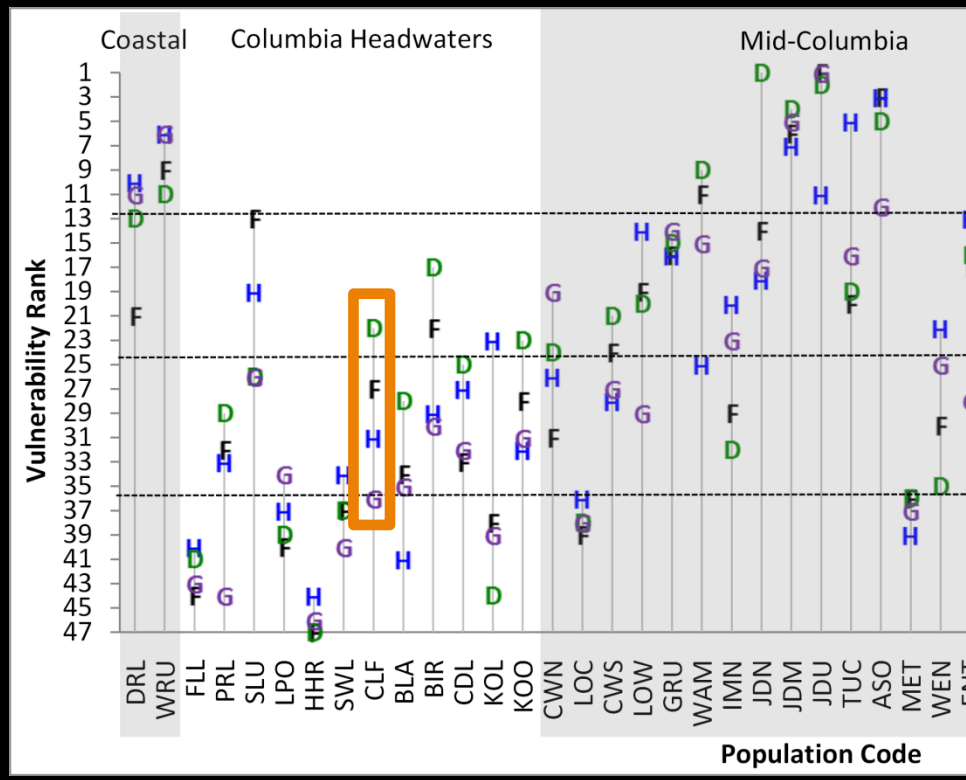
Tool Development

End-user driven feedback on needs for data hosting and software tool building

Research and Collaboration: How does habitat, demography, and genetics interact with climate across populations…

Wade et al. Conservation Biology 2016





A given population may have very different levels of "stress" depending on stressor type

A given population may be considered "relatively vulnerable" solely on the basis of the variables considered

Population responses of Chinook to environmental conditions and habitat quality/quantity

Nick Gayeski – Wild Fish Conservancy

Demographic (time series)

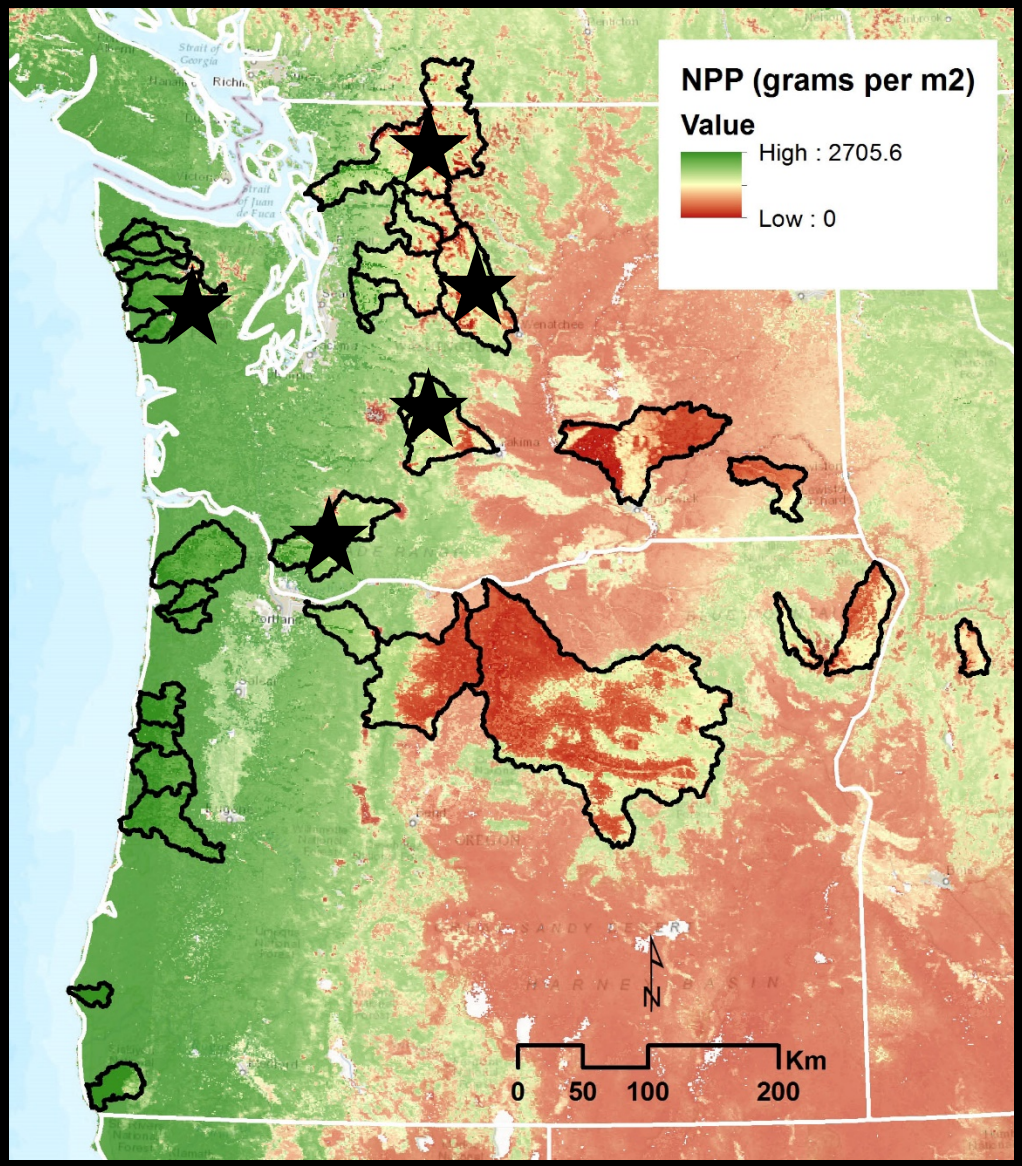
- Smolt-to-adult returns
- Total adult recruits
- Total adult spawners

Environmental variables

- NPP, human disturbance, temperature, floodplain area

Preliminary results

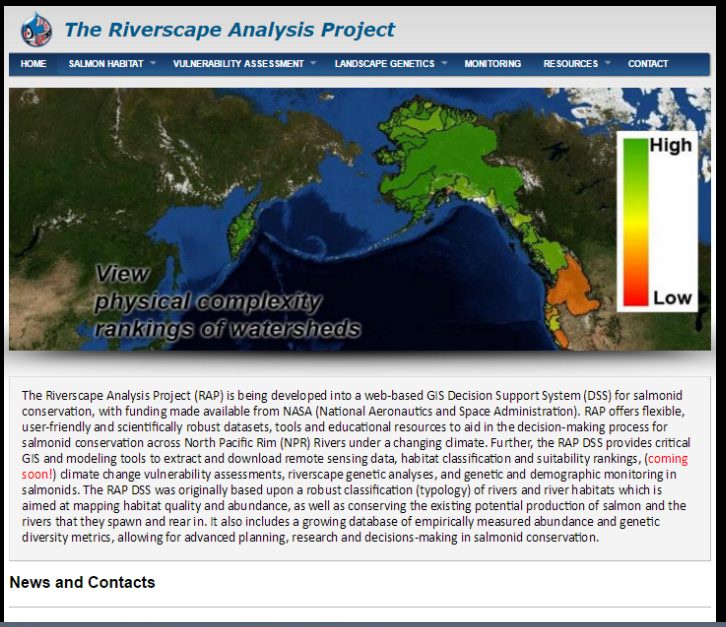
- R = 0.788-0.813 for temperature and flow (annual and summer hydrograph) variables correlated to the estimated annual # of spawners



Tool Development: An integrated platform for salmonid conservation

The Riverscape Analysis Project (RAP)

Web-based DSS for salmonid conservation



Data

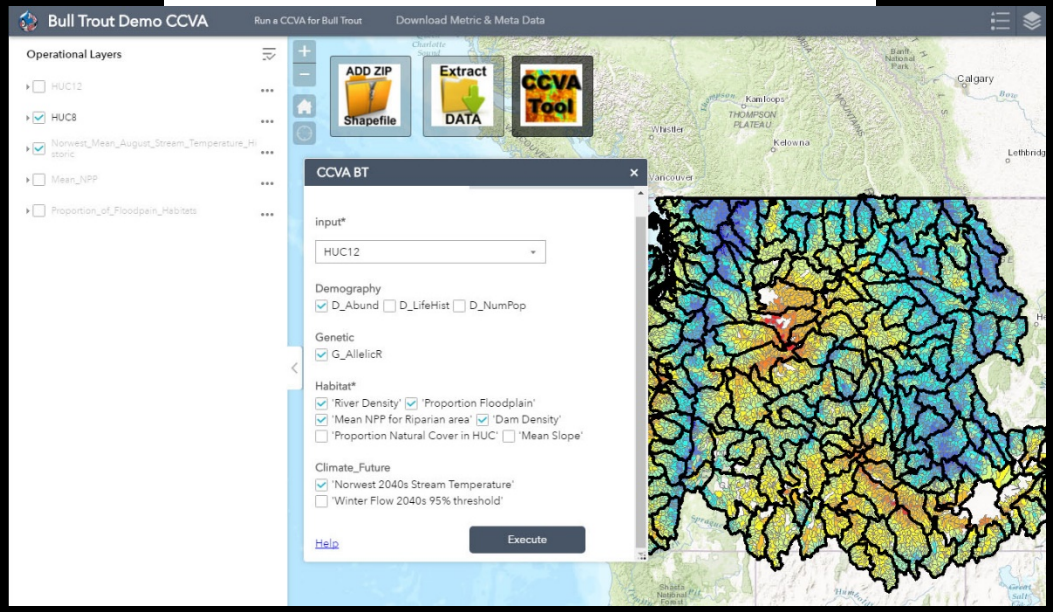
- Expanded access to remotely-sensed climate/habitat data
- Crowd-sourced genetic and demographic data

Tools

- CCVA tools
- Landscape genetic tools

Guidance & Examples

- Best practices
- Worked examples



Increased Data Access to salmonid/aquatic habitat characteristics

Climate Data	RS Mission/ Product
Freeze-Thaw Timing	**NASA SSM/I, AMSR-E**
Open Water	**NASA AMSR-E**
NorWeST Stream Temperature	**NASA Landsat TM** & NAIP
USFS Stream Flow	n/a
Future predictions Air Temperature, Precipitation, Runoff	**NASA NEX-DCP 30**

Habitat Quality Data	RS Mission/ Product
Drainage Density, Amount, and Sinuosity	**NASA SRTM** & NHDPlusv2
Productivity	**NPP**
Disturbance: NOAA CHAMP, Human Footprint, and NLCD 2011	**NASA GRUMP, GPWv3, DMSP, Landsat** (Landcover - % disturbance and % forested)
Channel and Valley Slope	**NASA SRTM**
Others: Glaciers, Dams, Elevation, Waterbodies	various

Answering the need for monitoring tools (and metrics) related to abundance and genomic diversity: AgeStrucNb

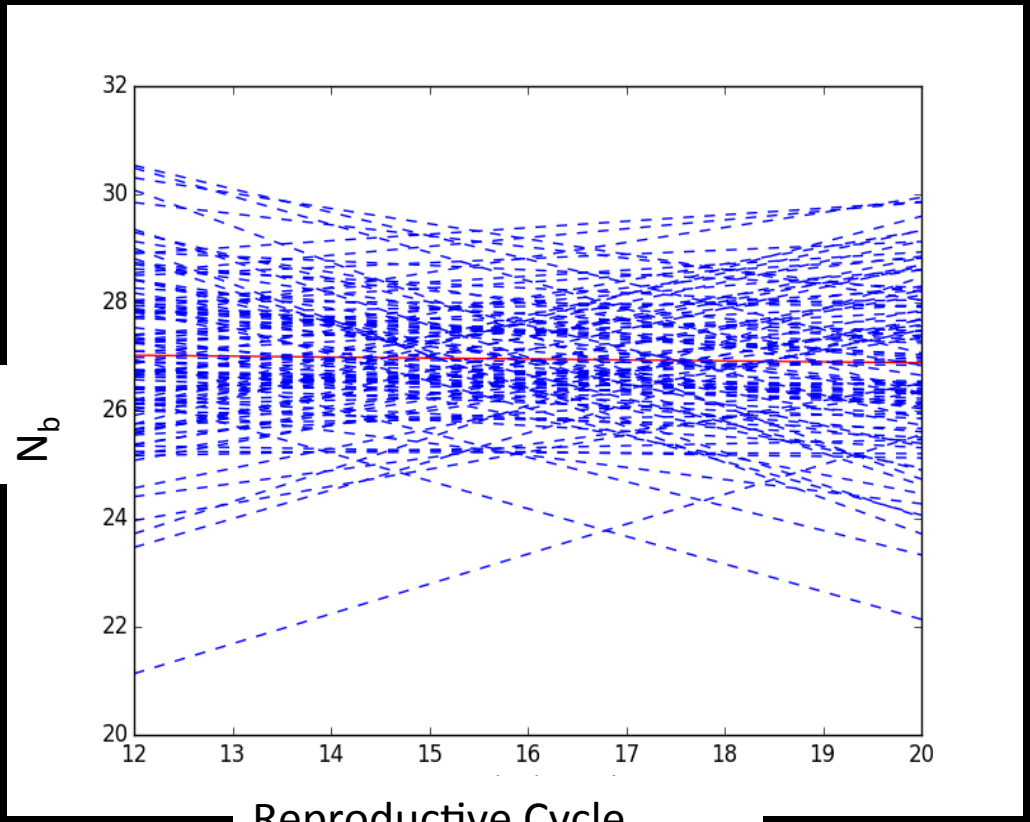
Hand et al. in prep

Nb (number of breeders) provides an annual measure of abundance and genomic diversity, and is driven by environmental factors

Program Features

- Simulate, estimate and visualize trends in Nb
- Test for significant population declines
- Available on Windows, Mac and Linux

AgeStrucNb allows users to test for slopes significant from 0.



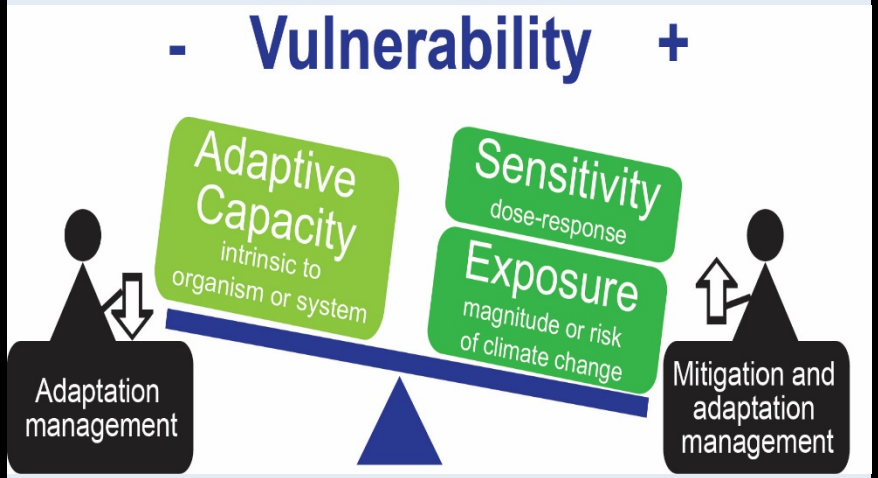
Best Practices and Outreach: Guidance for improving research and management

Best practices

CCVA Pseudo to Science

Wade et al. 2017 in Biodiversity and Conservation

- Improving rigor in CCVAs
- Accounting for uncertainty
- Methods for validation



Integration of new technologies

Riverscape management

Hand et al. accepted in Frontiers in Ecology and the Environment

- Environmental (e)DNA for detection of rare and invasive species
- Citizen-science initiatives
- Crowdsourcing data

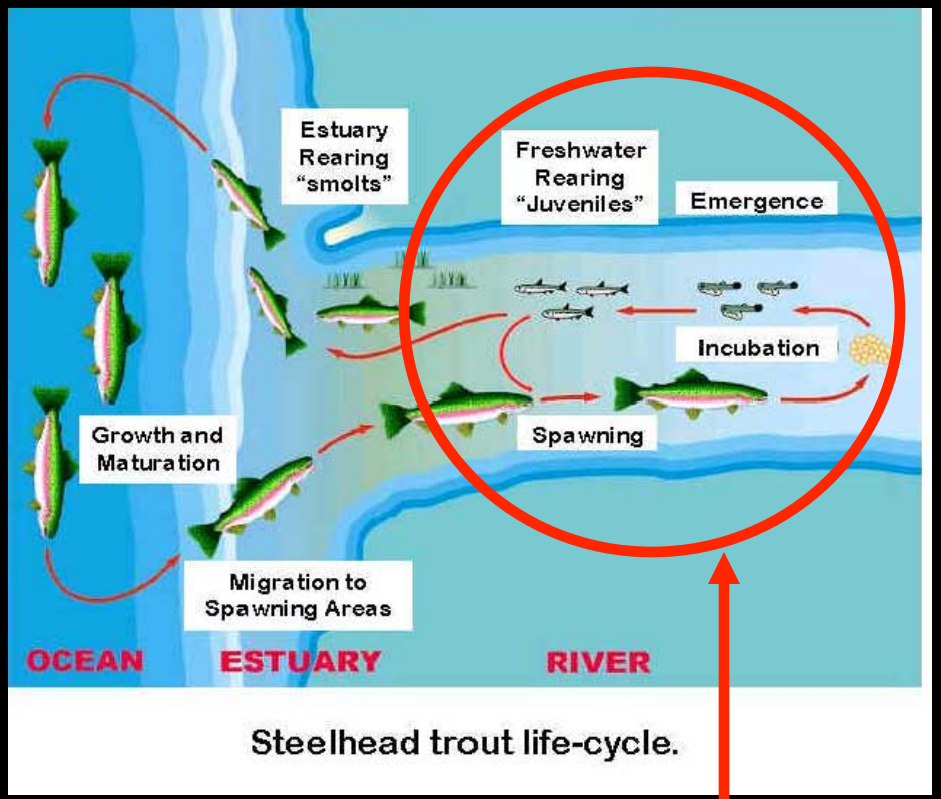
Climate change scenarios of steelhead survival in the Puget Sound

Alisa Wade UM,
Jeff Hard NOAA &
Phil Sandstrom WDFW

- NOAA-developed life cycle model to estimate steelhead abundance
- **In current models, habitat capacity is modeled based on "intrinsic potential" of habitat (river slope and width).**

Improvements we can provide for the model

1) Include remotely-sensed data of habitat quality in intrinsic potential
2) Compare scenarios of stream temperature change



Steelhead trout life-cycle.

Dependent on habitat quality and quantity

Advance training for project collaborators and conservation professionals

"To provide training in conceptual and practical aspects of data analysis to understand the evolutionary and ecological genomics of natural and managed populations. Special sessions on the use of GIS and remote sensing data to identify environmental variables influencing genetic diversity and connectivity."

NASA

AGA

Flathead Lake Biological Station

For more information visit the website:
www.umt.edu/sell/cps/congen2017/
Or contact Brian Hand or Gordon Luikart
Brian.Hand@umontana.edu
Gordon.Luikart@umontana.edu

Thanks!

Integrating remotely-sensed habitat quality and quantity, demographic, & genomic data

Integrating data, tools, & support (outreach) for salmonid conservation

pacific northwest aquatic monitoring partnership

Columbia River Inter-Tribal Fish Commission

Wild Fish Conservancy NORTHWEST

USGS science for a changing world