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

Goal: Develop & Apply Novel Approaches Integrating Remote Sensing, Genomics, and Demography to Inform Conservation

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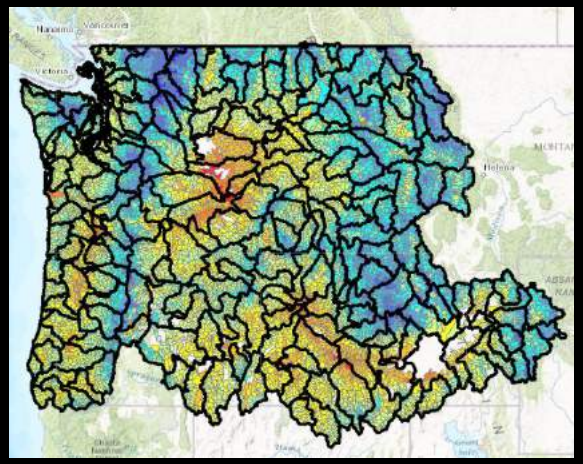
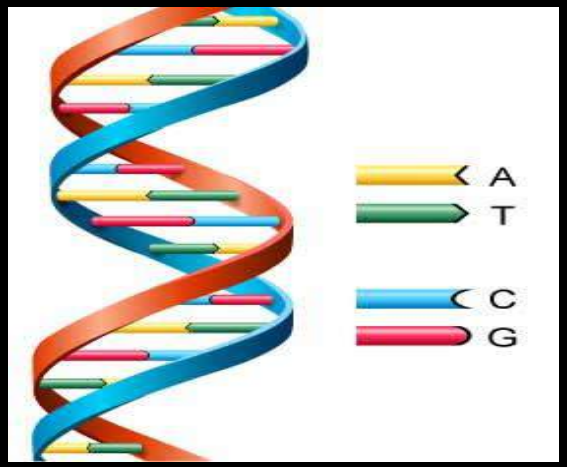




pacific northwest aquatic monitoring partnership

NOAA

IDAHO FISH & GAME

U.S. FISH & WILDLIFE SERVICE

Montana Fish, Wildlife & Parks

Columbia River Inter-Tribal Fish Commission

Wild Fish Conservancy NORTHWEST

USGS

Questions crucial to conservation management

1) How will climate change affect population size, the effective population size, & number of breeders (Nb)?

2) How will climate change connectivity (dispersal & gene flow)?

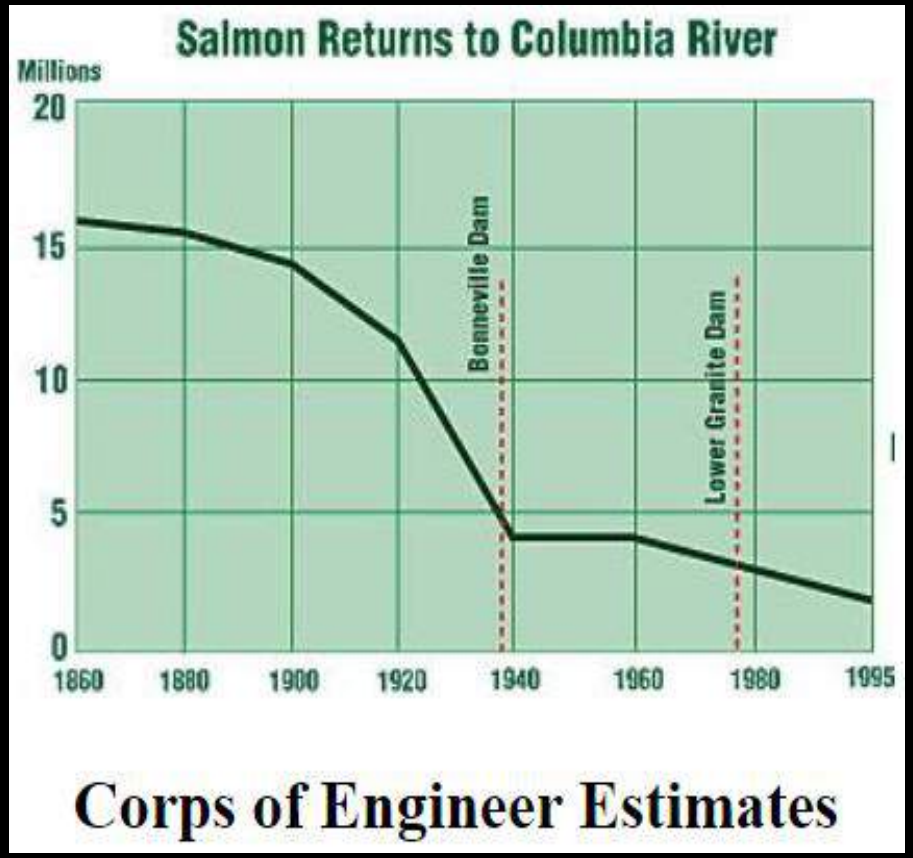
3) Which populations and habitats are most vulnerable to climate change, and what drives vulnerability?

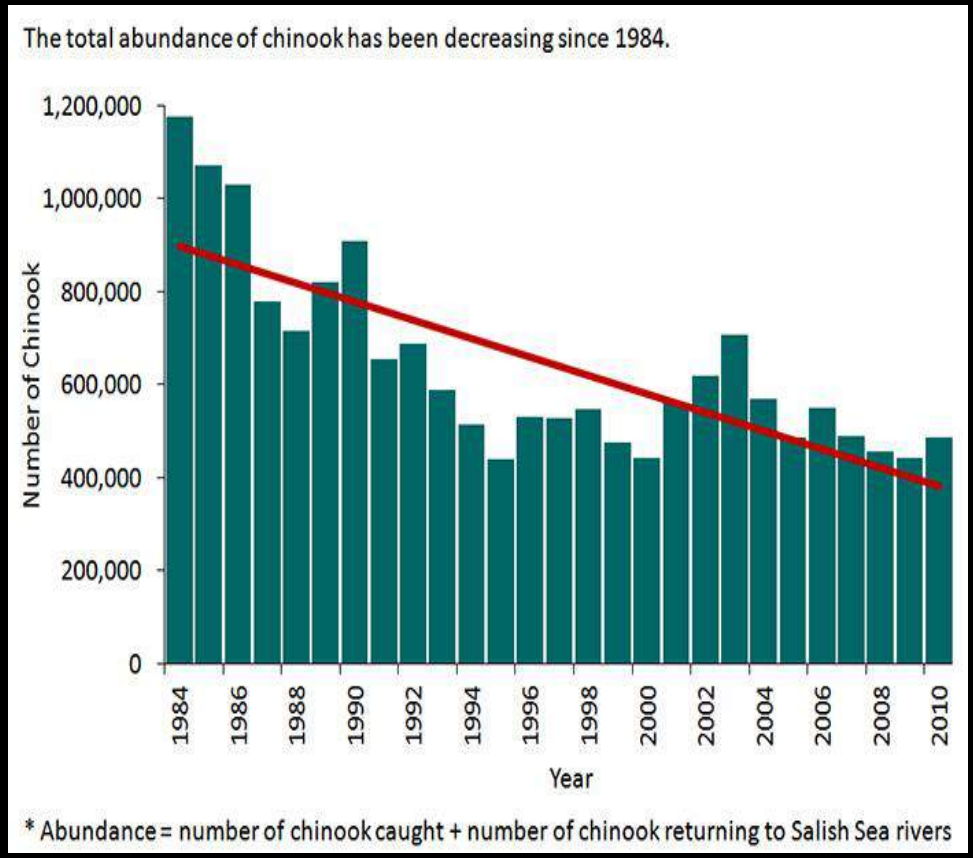
We developed & applied new tools to address all 3

Why are salmon and trout important?

- **<u>Ecosystem health</u>:** "keystone" species in rivers & ***terrestrial*** ecosystems. Canaries of climate change
- **<u>Economic wealth</u>:** Billions annually from commercial and sports fishing, tourism, hatcheries
- **<u>Cultural persistence</u>:** subsistence harvest is fundamental to Native cultures

Salmon are declining. Many runs are extinct!





Three causes: Habitat, Harvest, Hatchery

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

Glick et al. 2011

Integrate as key elements of VULNERABILITY

Exposure

Adaptive Capacity – rapid response

Sensitivity – physiological response

Habitat (Remotely Sensed)

Climate

Physical habitat characteristics

Genomics

Number of Effective Breeders

Genetic diversity

Demographics

Abundance

Life History Diversity

Productivity

Spawning bull trout

CCVA results vary with elements included

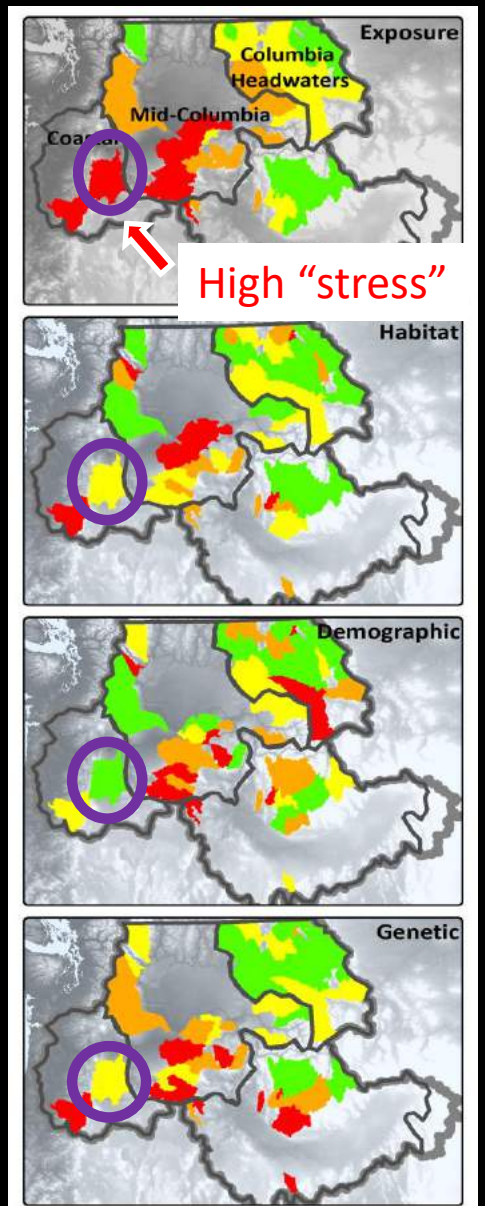
RESULTS

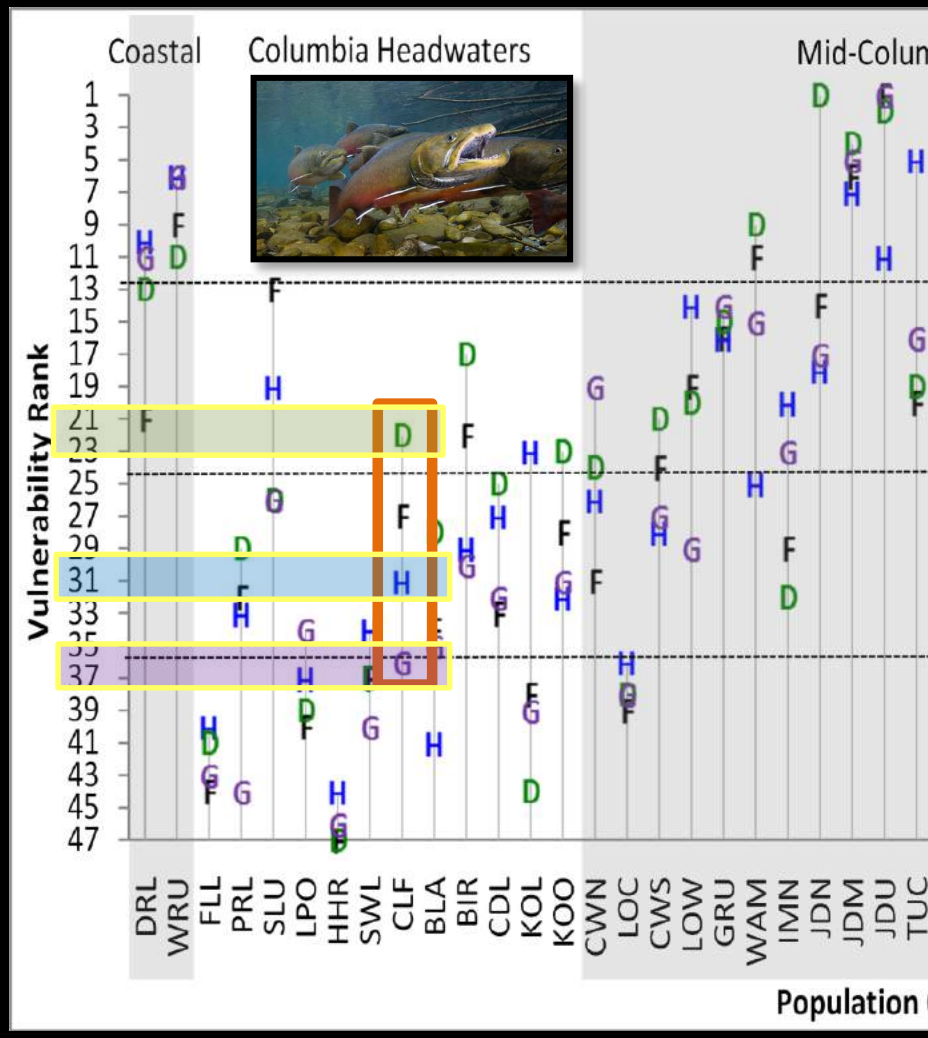
Wade et al. 2016. *Cons Biol*

New research into how habitat, demography, and genetics interact with climate across populations…

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

CCVA elements





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

Conclusions

CCVA results vary with elements included

CCVA's require uncertainty assessments

Combining remote sensing & genomics enormous potential to improve conservation

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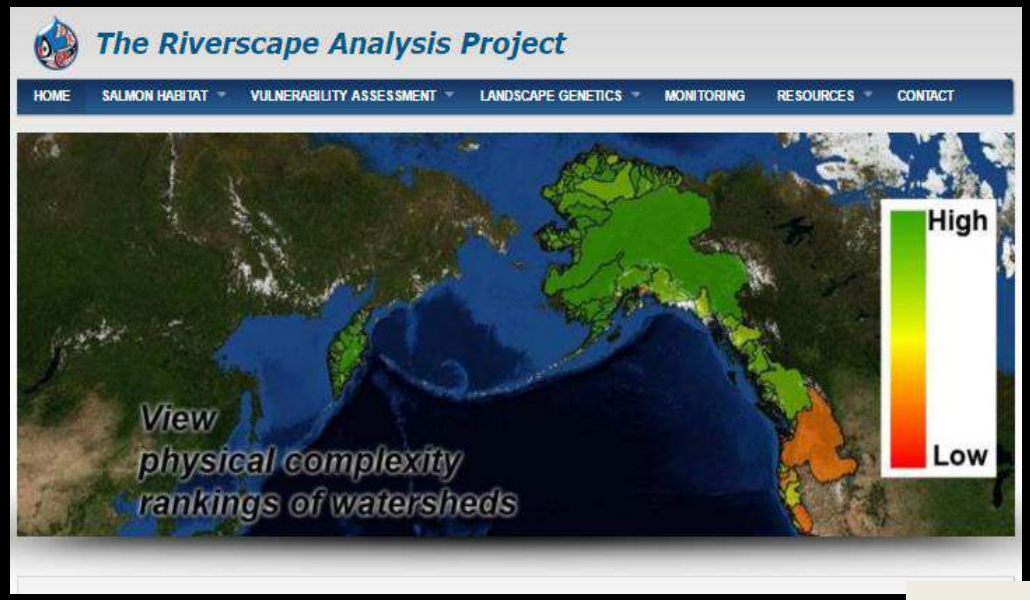
USGS science for a changing world

The Riverscape Analysis Project (RAP): An integrated platform for salmonid conservation



Web-based support tool for salmonid conservation

Basin scale data for the Pacific NW and fine scale (HUC 12) for the Columbia River Basin

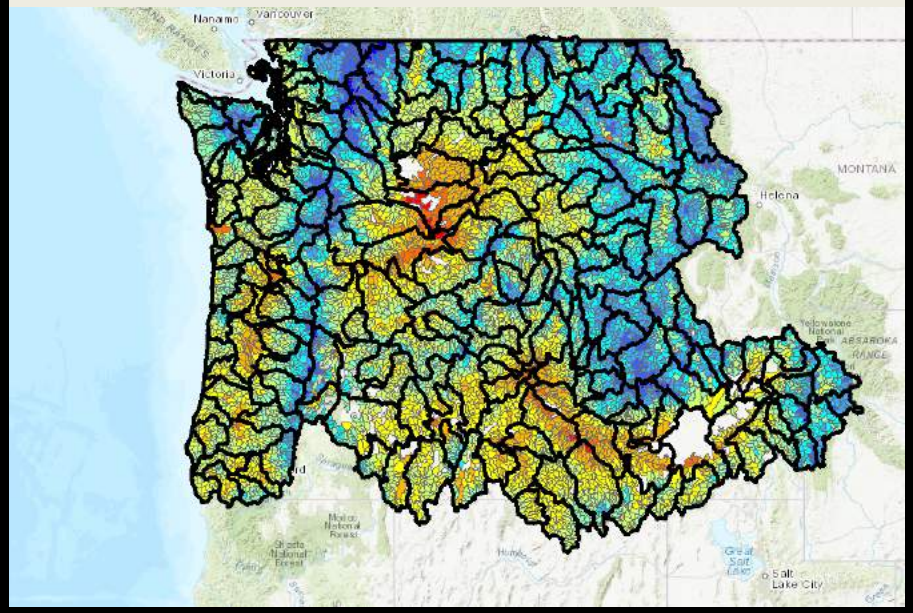
Data

- Expanded access to remotely-sensed climate/habitat data

Tools

- Basic CCVA
- Demogenetic monitoring (Nb)
- Landscape genetic tools

Columbia River Basin



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

Riverscape Analysis Project
http://www.ntsg.umt.edu/rap/

Nb tool
http://flbs-rap1.flbs.umt.edu/NB/