Water and Fish in a Changing Climate

Intermountain Region – Climate Assessment Workshop

May 22, 2018

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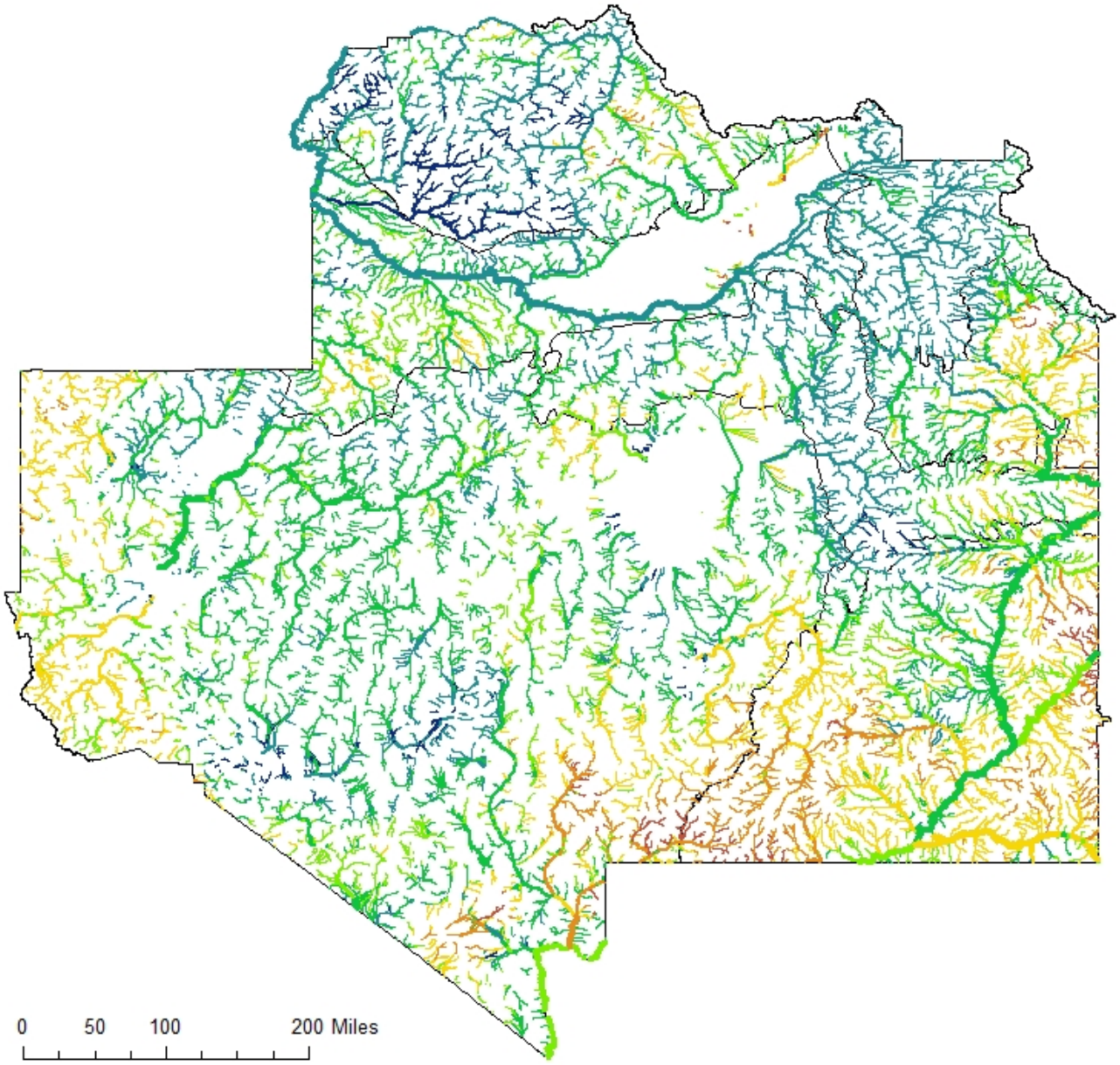
Research Hydrologist

US Forest Service Research

Overview

- Change in Flows
- Change in Temperature
- Change in Habitat Distribution

Percent Change in Mean Annual Flow (historic-2040s)



Percent Change

- -26% - -10%
- -10% - -5%
- -5% - -1%
- -1% - 1%
- 1% - 5%
- 5% - 10%
- 10% - 35%

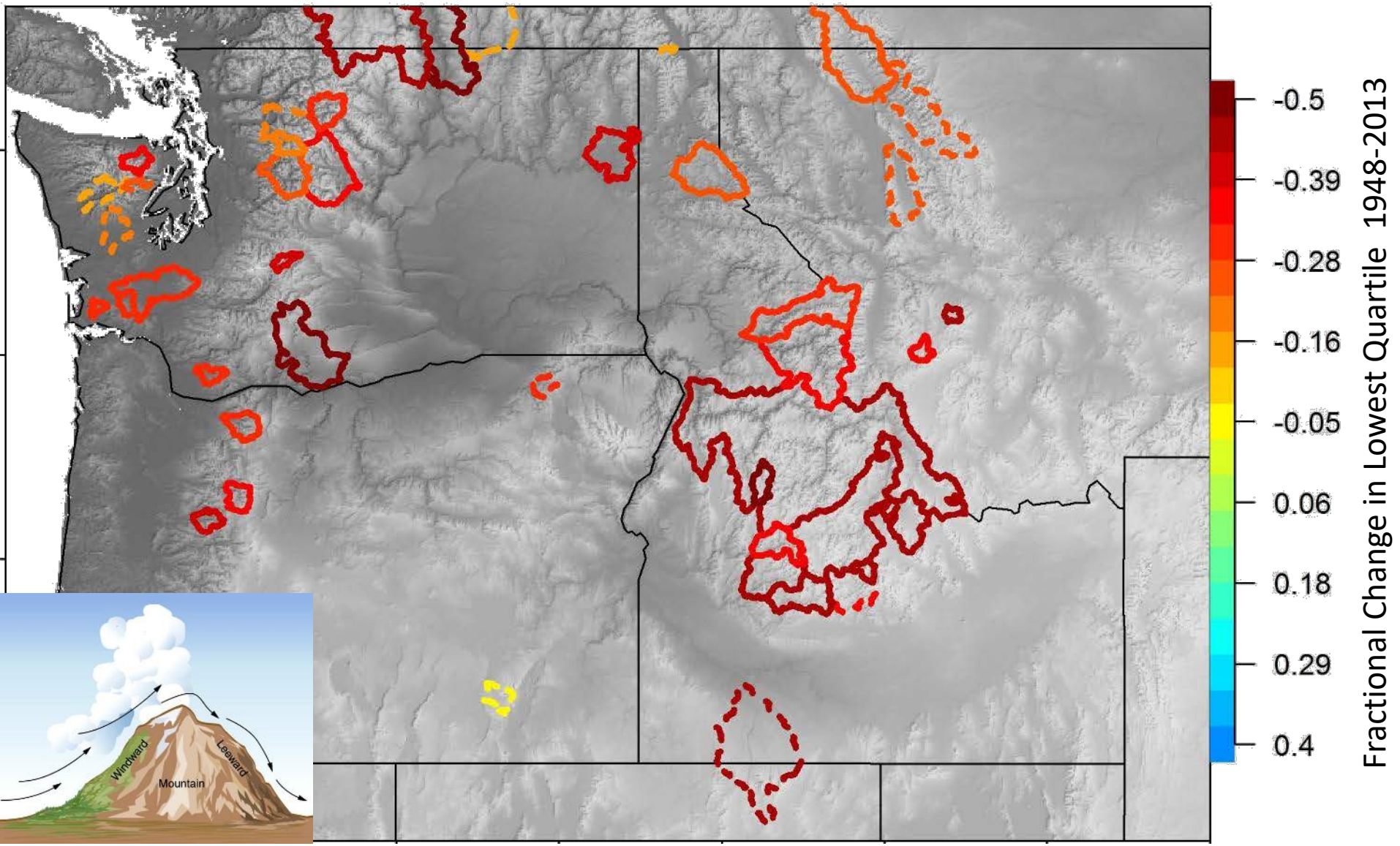
Drainage Area (km^2)

- 30 -150
- 150 - 900
- 900 - 30,000
- > 30,000

IAP Geographic Areas

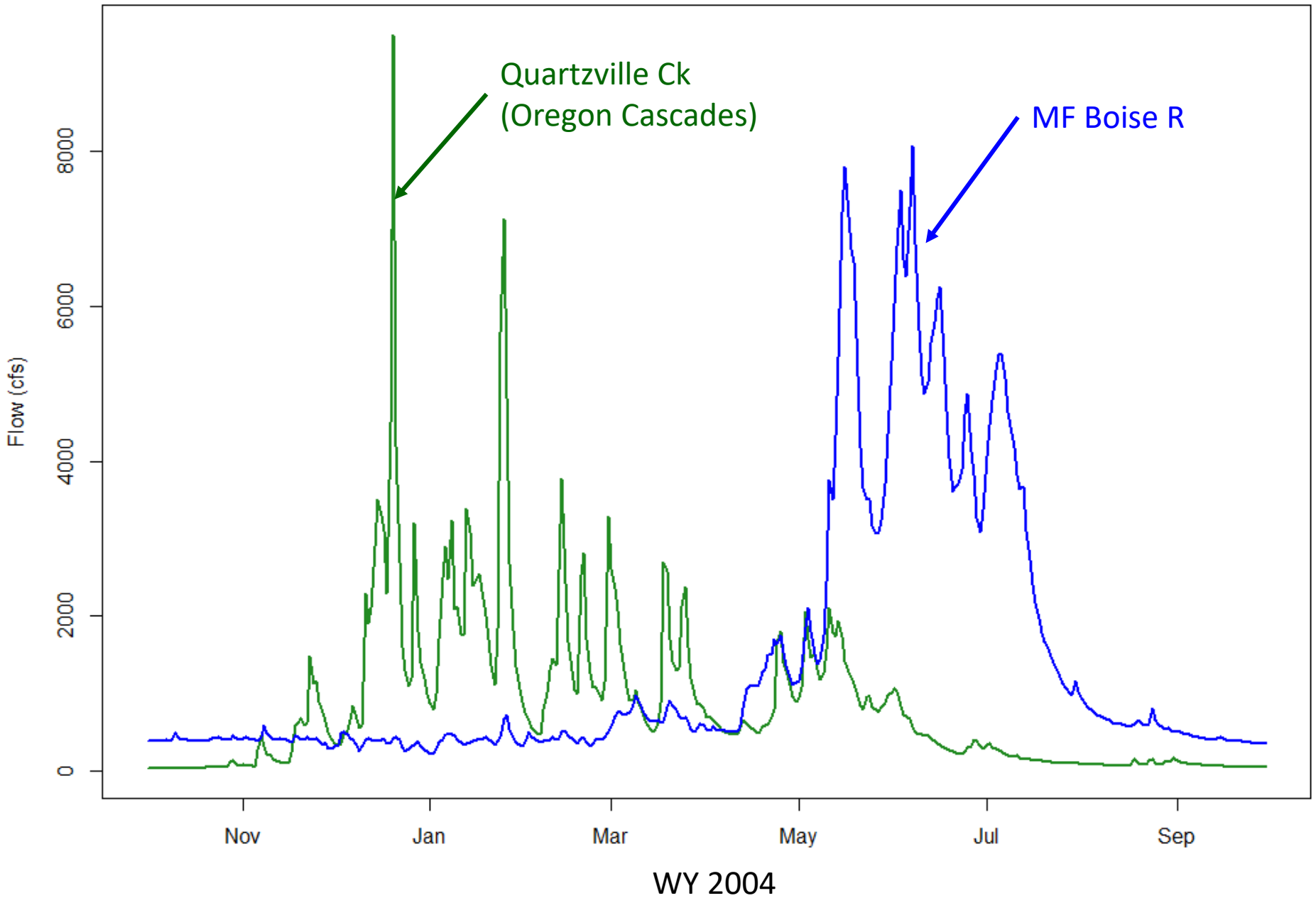
0 50 100 200 Miles

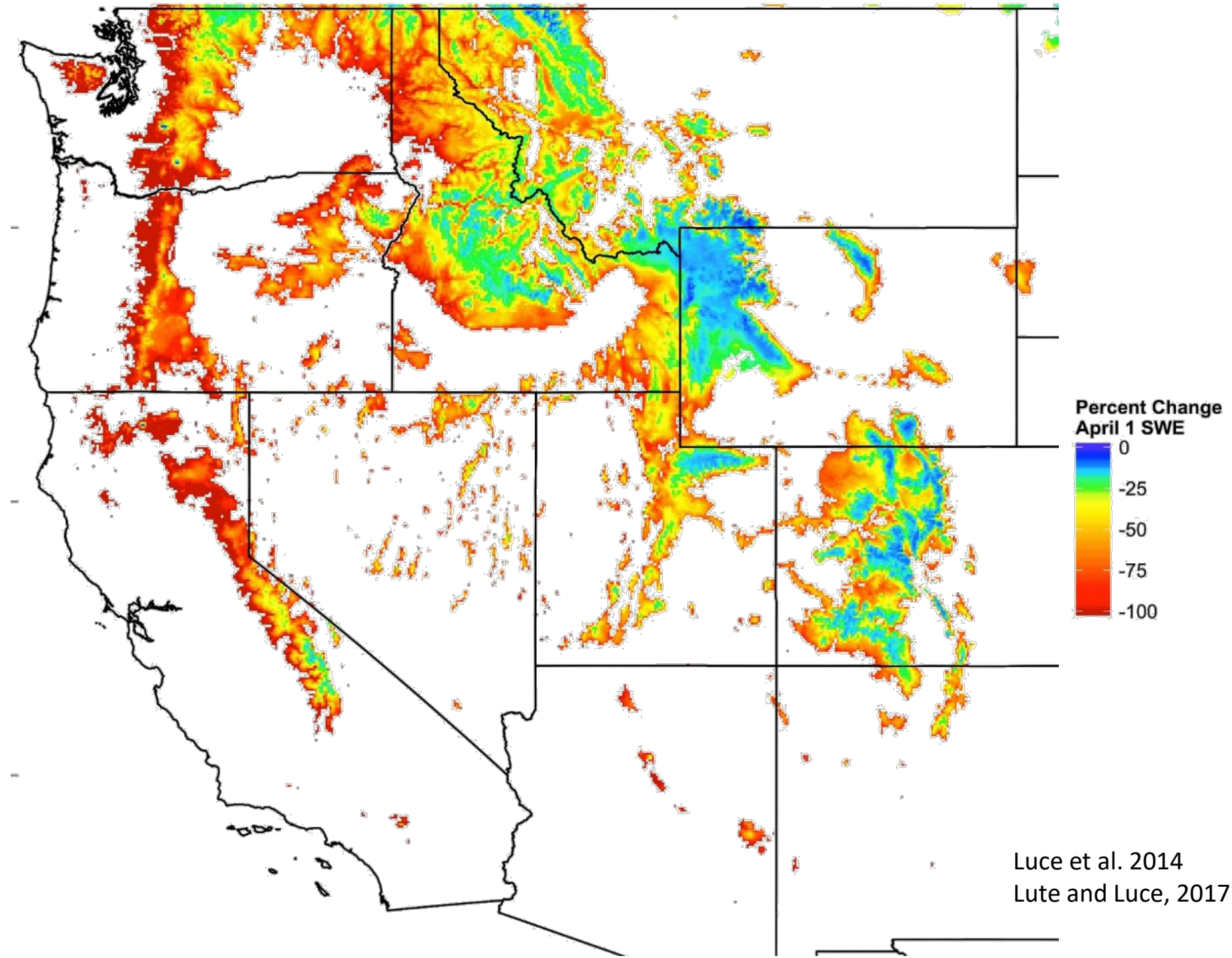
Declines in Mountain Runoff 1948-2013



Luce, Abatzoglou, Holden 2013

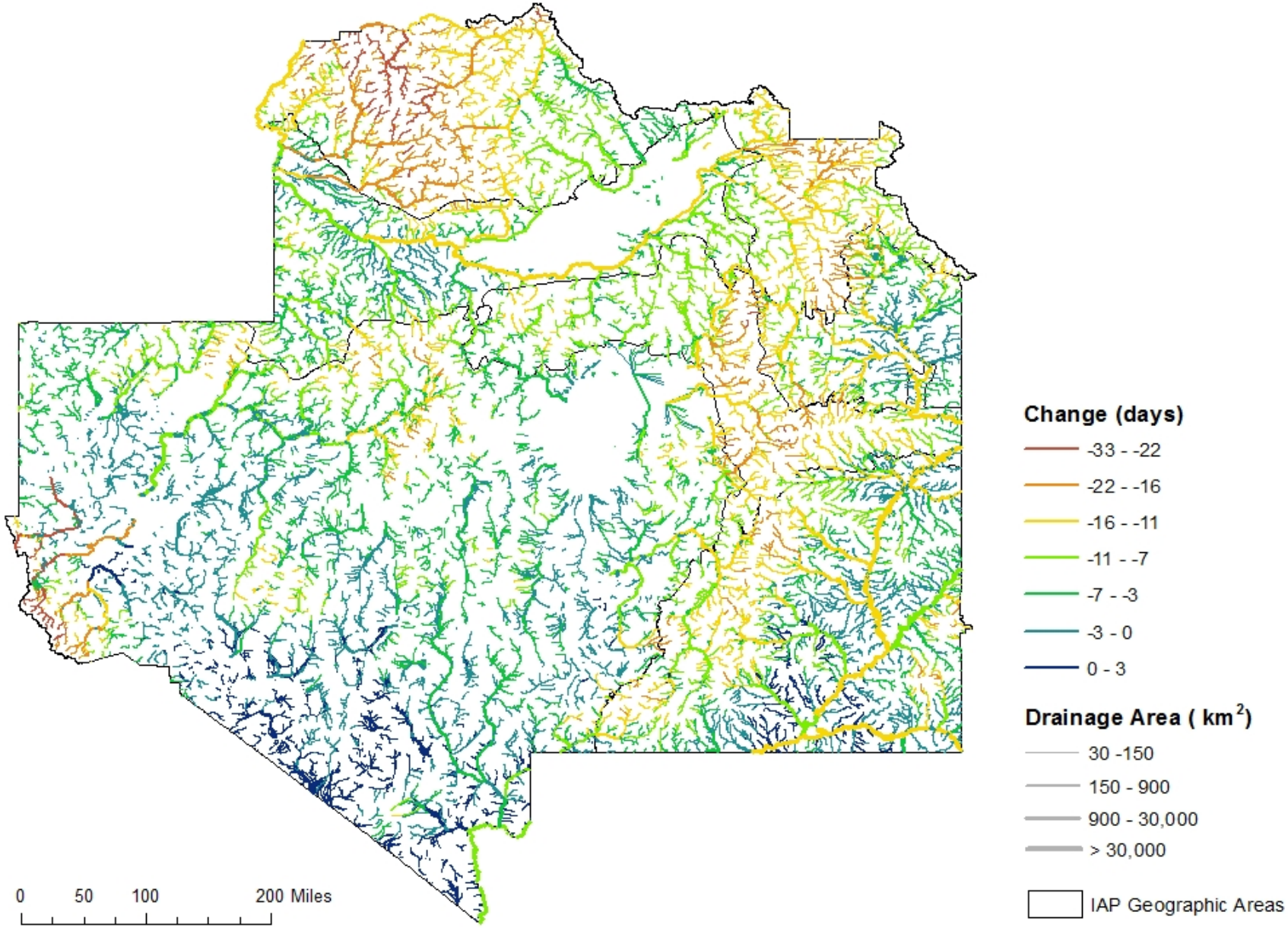
Contrasting Snowmelt Contributions



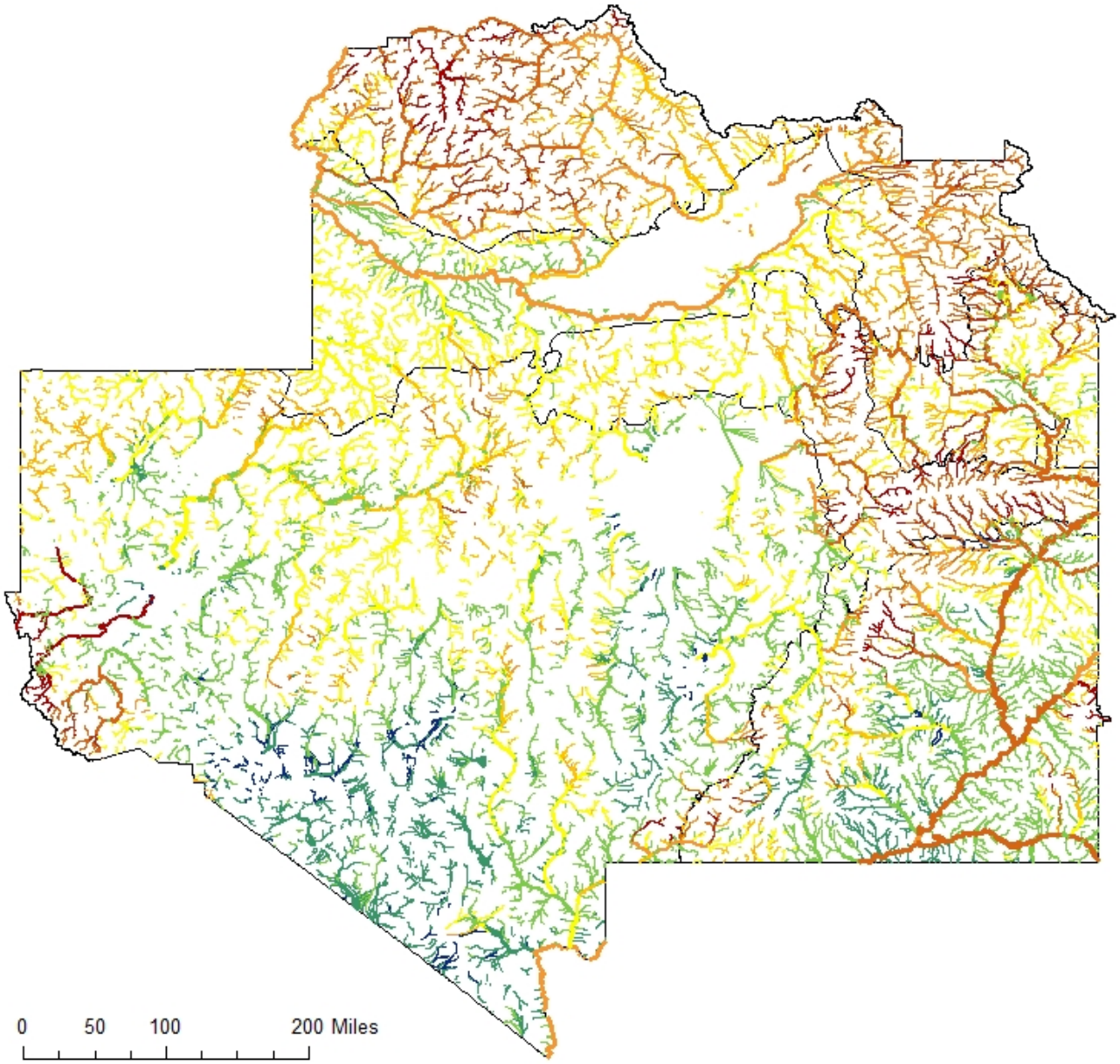


Luce et al. 2014
Lute and Luce, 2017

Change in Center of Flow Mass (historic-2040s)



Percent Change in Mean Summer Flow (historic-2040s)



Percent Change

- -80% - -55%
- -55% - -35%
- -35% - -20%
- -20% - -10%
- -10% - -4%
- -4% - 4%
- 4% - 10%
- 10% - 40%

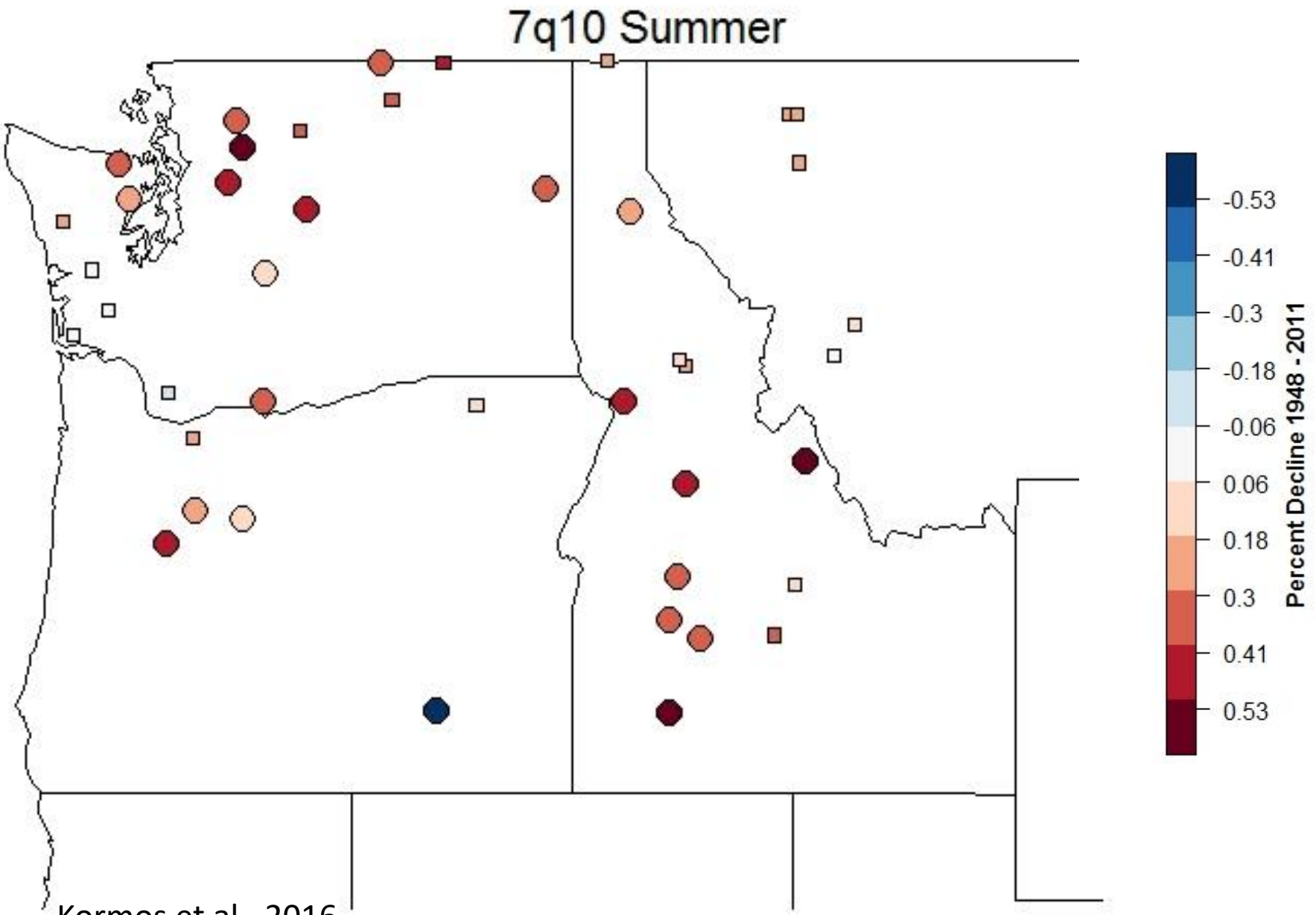
Drainage Area (km^2)

- 30 -150
- 150 - 900
- 900 - 30,000
- > 30,000

IAP Geographic Areas

0 50 100 200 Miles

Historical Trend: Low Flows - Hydrologic Drought



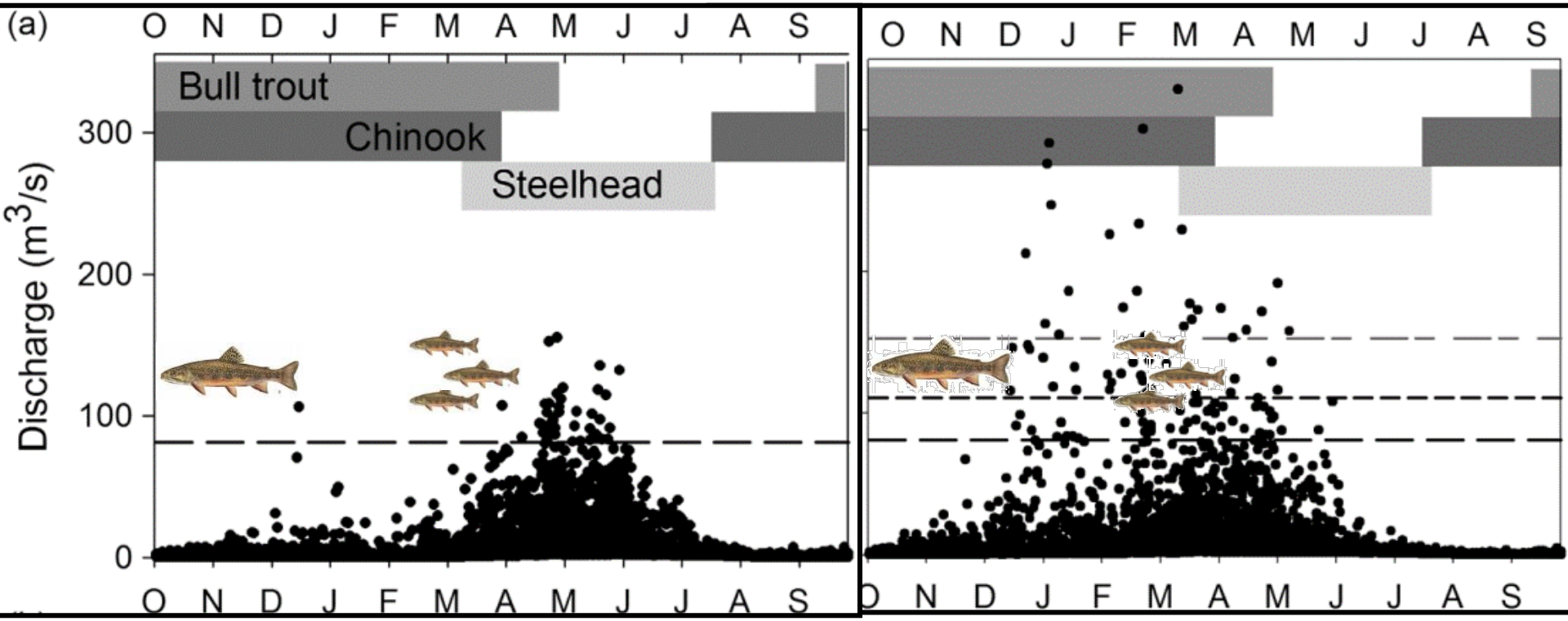
Kormos et al., 2016

More Midwinter Flooding

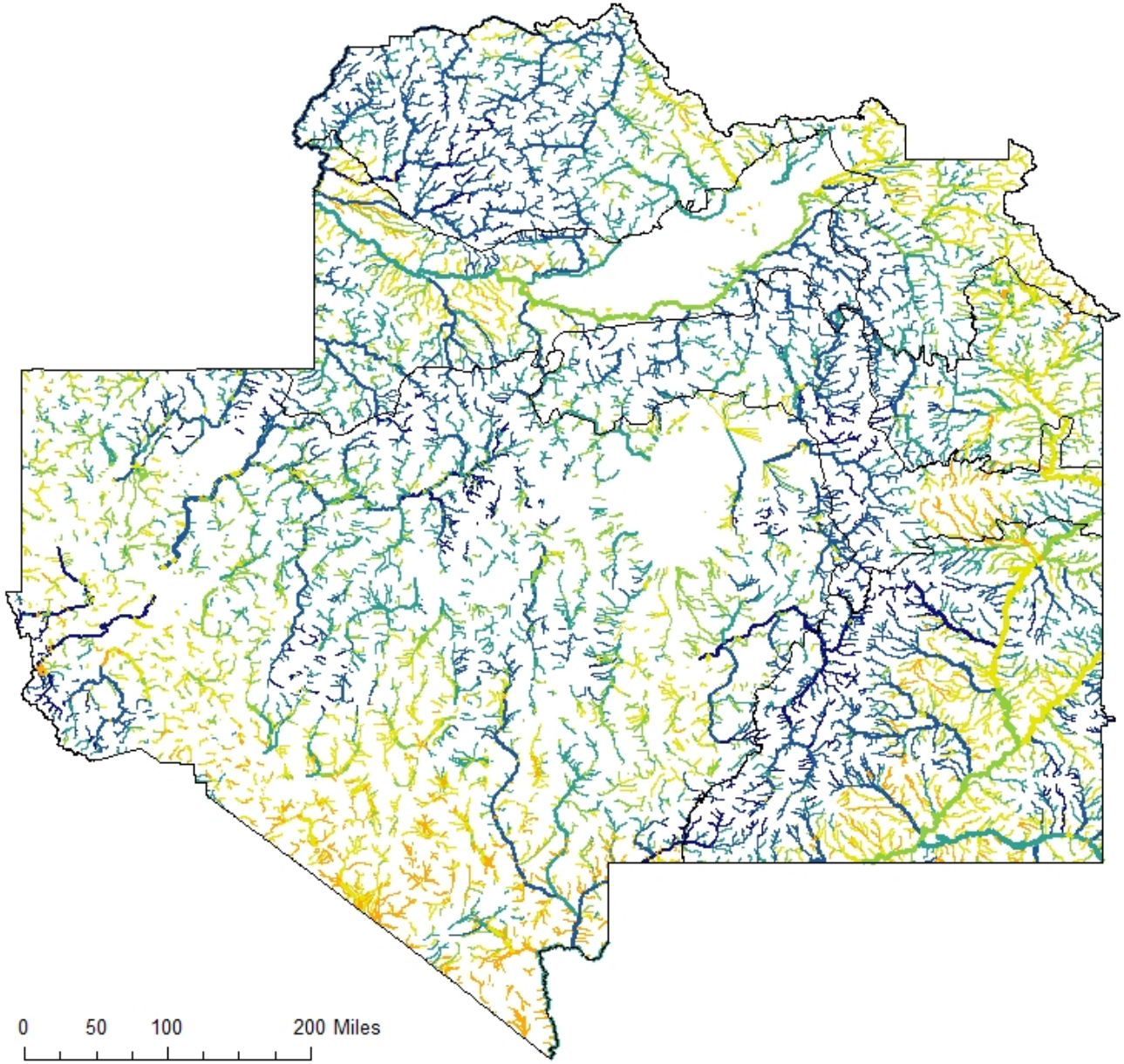
Goode et al. 2013

Historical

Future



Change in Number of Winter Floods (historic-2040s)



Change (days)

- -0.75 - 0
- 0 - 1
- 1 - 2
- 2 - 3.5
- 3.5 - 5
- 5 - 8.8

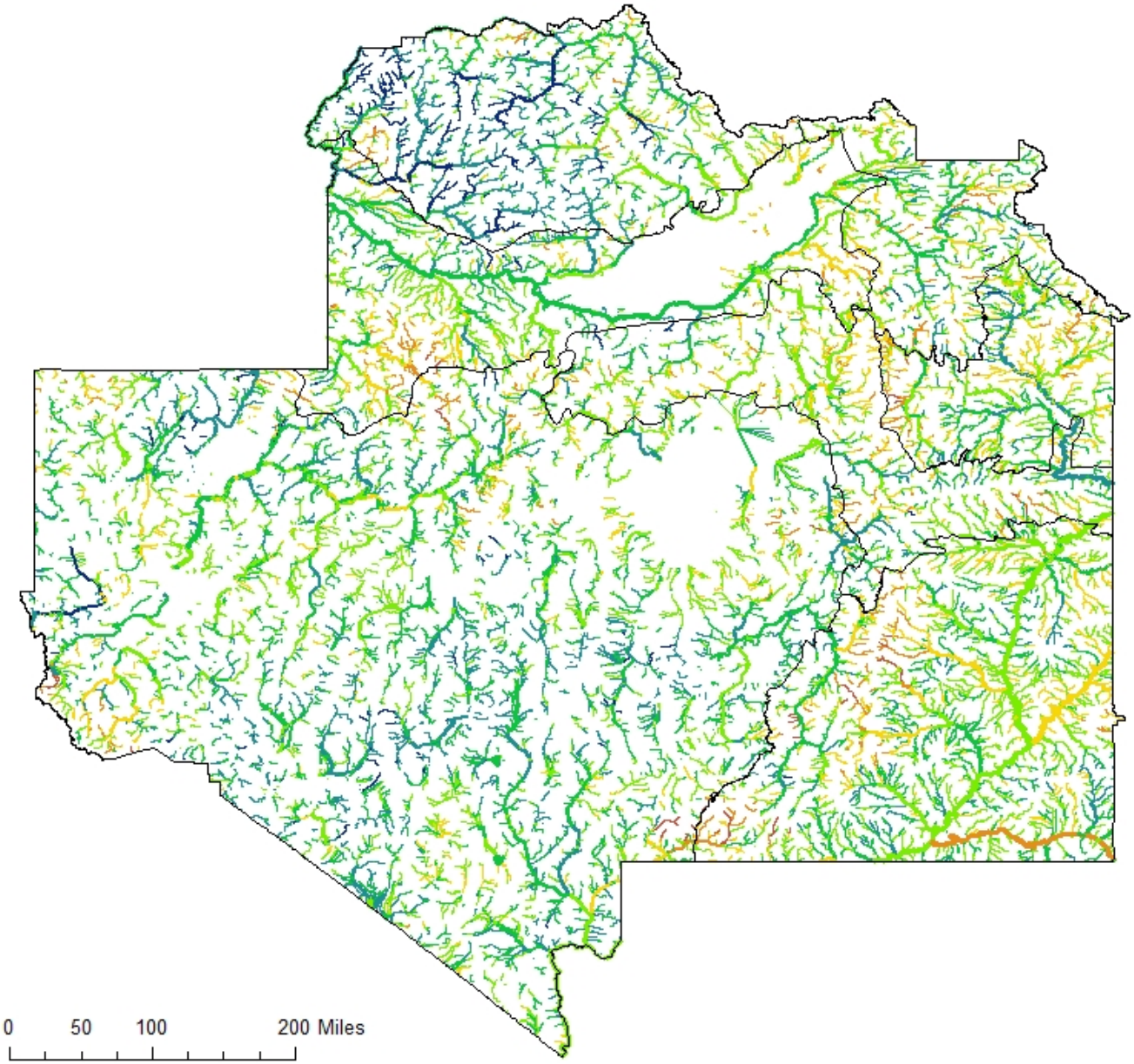
Drainage Area (km^2)

- 30 -150
- 150 - 900
- 900 - 30,000
- > 30,000

IAP Geographic Areas

0 50 100 200 Miles

Percent Change in 1.5 Year Flood (historic-2040s)



Percent Change

- -70% - -30%
- -30% - -15%
- -15% - -5%
- -5% - 5%
- 5% - 15%
- 15% - 30%
- 30% - 105%

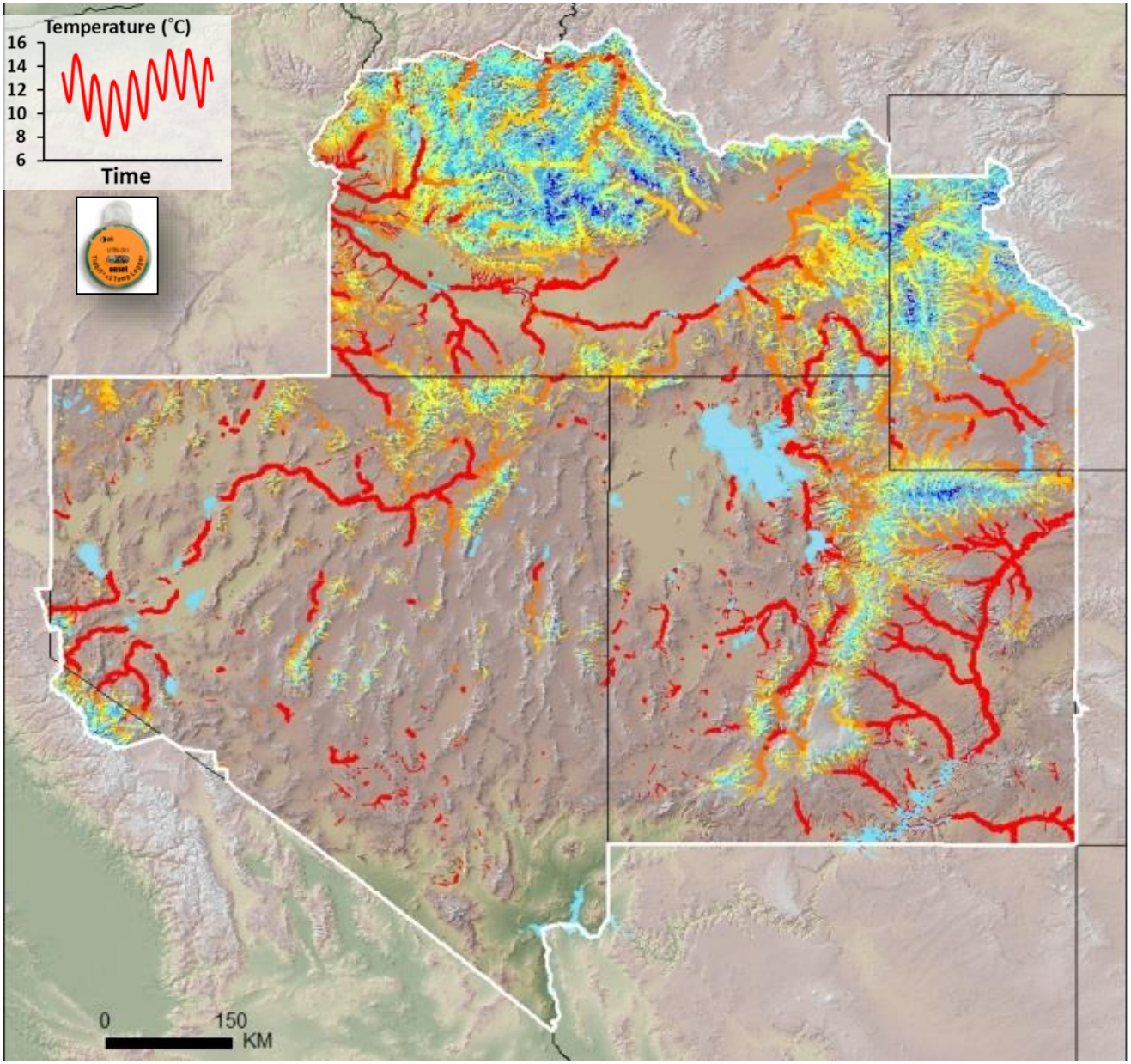
Drainage Area (km^2)

- 30 -150
- 150 - 900
- 900 - 30,000
- > 30,000

IAP Geographic Areas

0 50 100 200 Miles

Regional Stream Temperature Projections



2080s

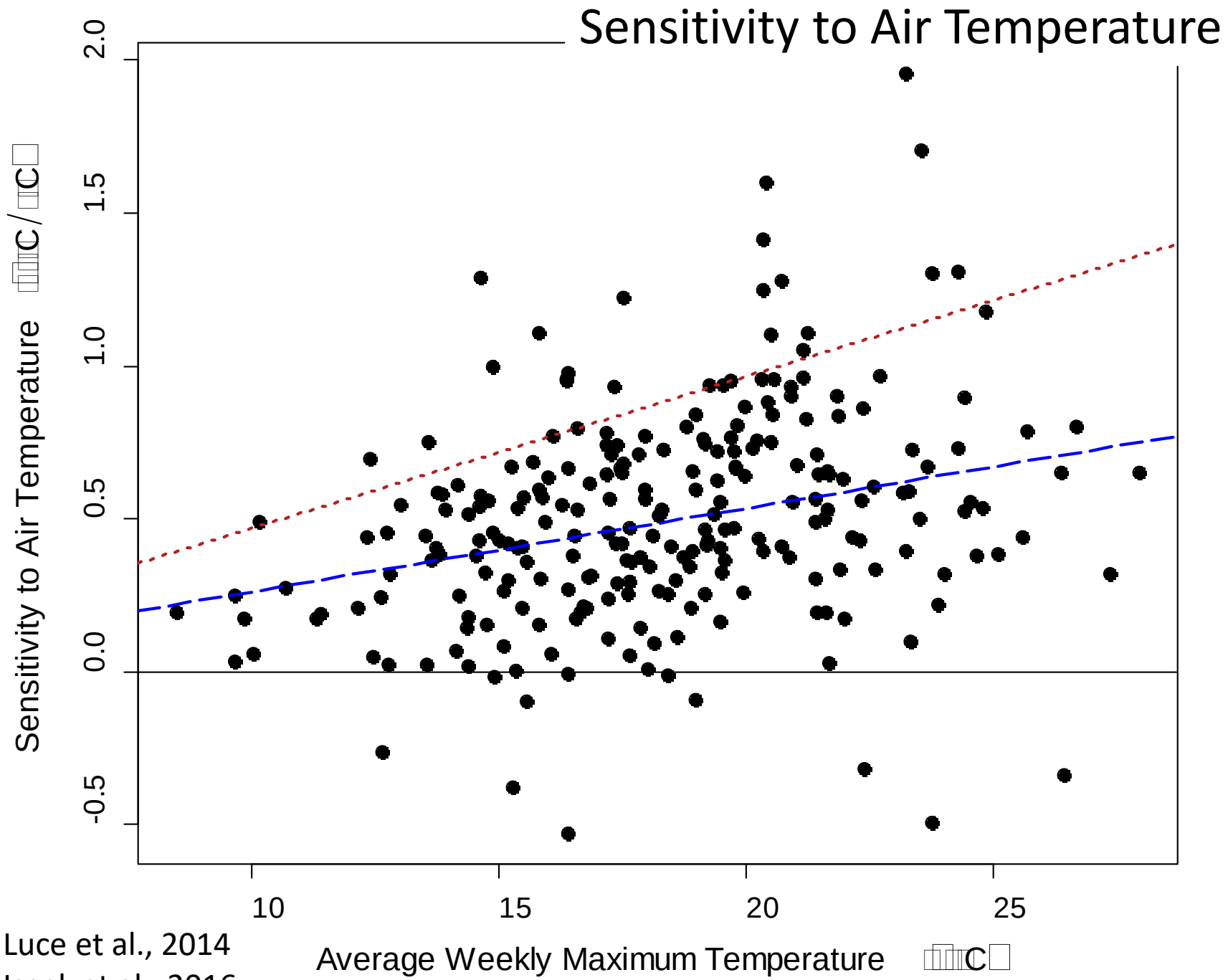
NorWeST Stream Temp

August Mean Temp (°C)

- < 8
- 8 - 11
- 11 - 14
- 14 - 17
- 17 - 20
- > 20

Avg. Increase = 1.75°C

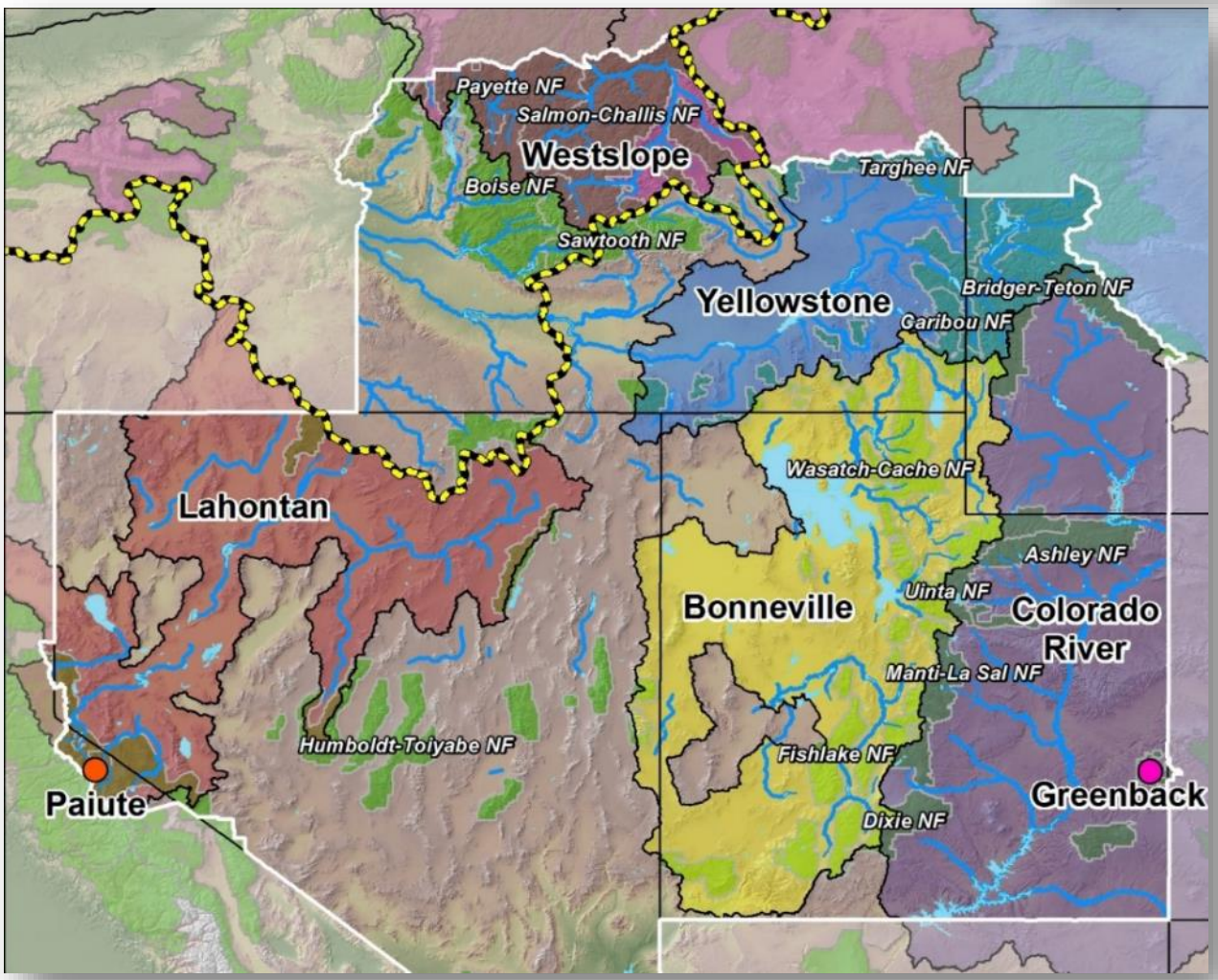
Isaak et al. 2017
IAP Chapter



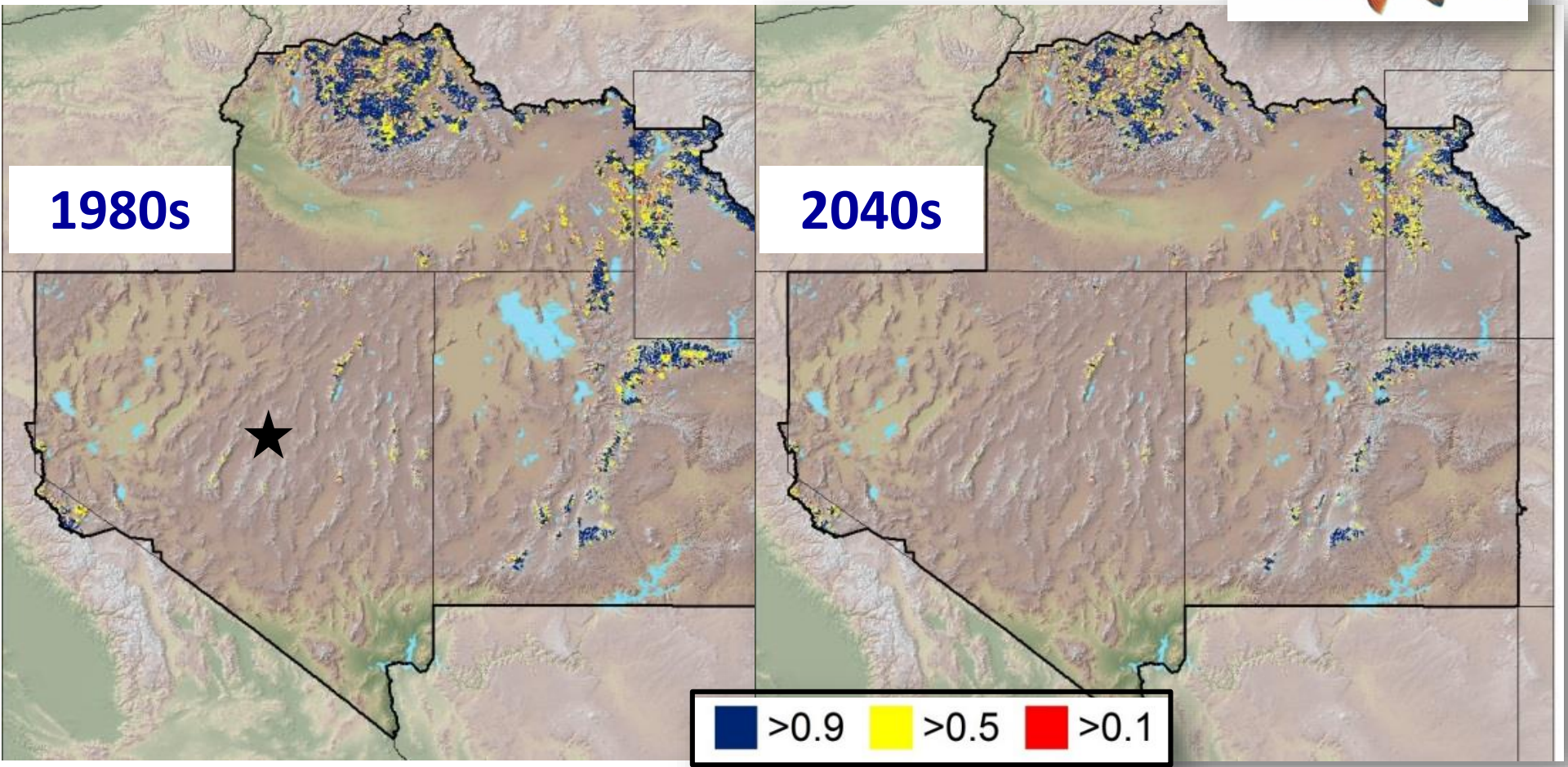
Luce et al., 2014
Isaak et al., 2016

Fish species range maps:

- bull trout (ESA listed)
- cutthroat trout (some subspecies ESA listed)

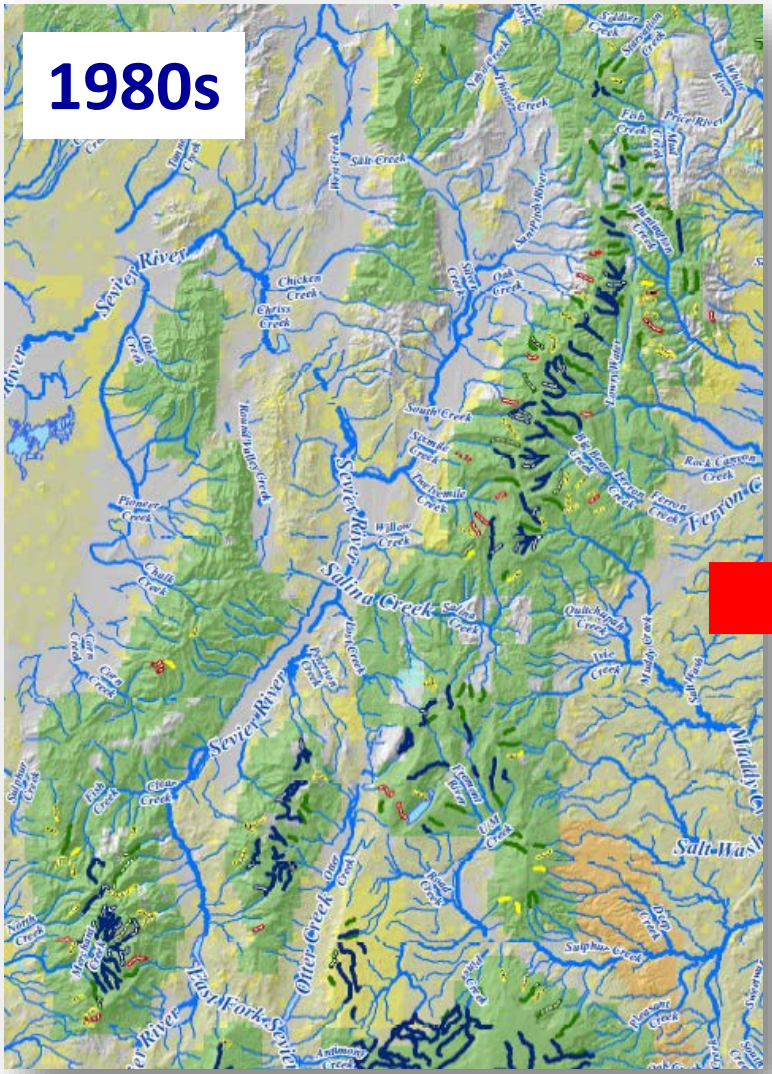


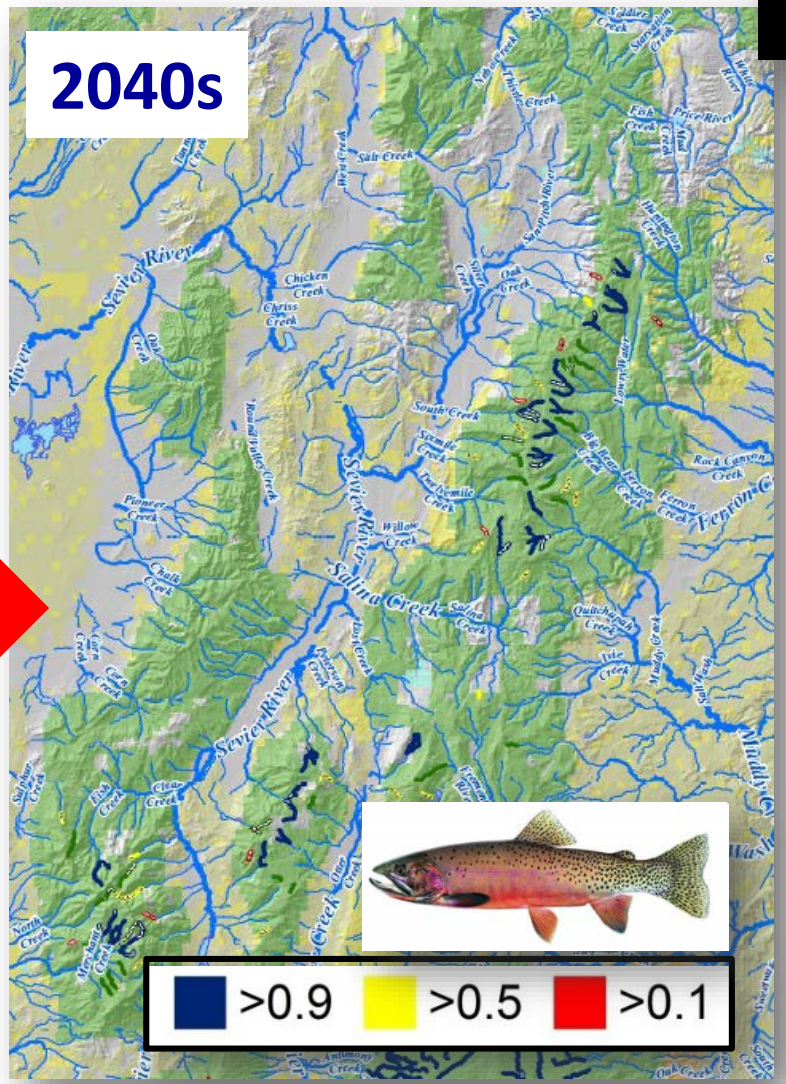
Cutthroat Habitat Occupancy Probability Map



Slide Courtesy of Dan Isaak

Climate Shield Habitat Occupancy Probability Maps





Closeups of Manti La Sal streams…

Slide Courtesy of Dan Isaak

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Effects of Climate Change on Hydrology

Intermountain Region – Climate Assessment Workshop

May 22, 2018

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Overview - Adaptation Strategies & Tactics

- Identify sensitivity to climate variability and change
- Create site specific adaptation strategies and tactics
- Identify where tactics can be applied

Adaptation Strategies
Water and Soil Resources

- Things we do already that are even more important because of climate change
- Small adjustments to improve what we're doing
- Think outside the box – major changes from current management

Adaptation Strategies - Water Resources

- Continue a suite of restoration efforts (e.g. stream channels and floodplains, riparian areas, wet meadows, Groundwater Dependent Ecosystems – GDEs, aquatic habitats and beaver)

- Conduct vegetation management for optimal water balance and healthy watersheds (e.g. mechanical treatments, prescribed fire, wildland fire use)

- Improve livestock water developments and distribution

Adaptation Strategies - Water Resources

- Update existing infrastructure and design any new facilities to better accommodate flooding.
- Continue to implement and improve Best Management Practices (BMPs) for all land disturbing activities.
- Think outside the box example - Snow and avalanche management (e.g. snow fences or encourage snow deposition in steep, confined headwater streams)

Adaptation Strategies – Soil Resources

- Promote native plant species and plant diversity that is adapted to the projected soil properties. Minimize invasive species expansion.

- Maintain or increase soil cover (both canopy and ground cover) to mitigate heating of soil, evaporation, and runoff – keep water on the land longer

- Promote the maintenance and the addition of soil organic matter and soil organic carbon (water holding capacity).

Adaptation Strategies – Soil Resources

- Utilize grazing management systems that can respond quickly to periods of drought and changing temperatures.
- Categorize soils for their resilience to climate change through the completion of soil climate vulnerability mapping at various scales.
- Manage to maintain and restore biological soil crusts where they are ecologically important.

Weblinks & Additional Resources

Intermountain Adaptation Partnership
http://www.adaptationpartners.org/iap/index.php

Adaptation Library
http://adaptationpartners.org/library.php

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Effects of Climate Change on Fisheries Management

Intermountain Region – Climate Assessment Workshop

May 22, 2018

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Key fisheries management variables affected by climate change:

- Water temperature
- Flow regimes
- Instream channel conditions
- Riparian conditions

Water Temperature (WT)– in general this data is lacking especially when compared to flow data.

WT effects :

- overall activity
- food consumption
- Individual growth
- reproduction
- timing of key life events (spawning,migration, seasonal movements)

Flow Regimes – a much more robust dataset in comparison to water temperature.

Flow effects:

- **Volume of habitat**
- **Stream temperature**
- **Delivery of oxygen, nutrients, organic matter, and food**
- **Migration, seasonal movements, spawning**

Stream Environments – effects to channel and riparian conditions

- Increased debris flow as a result from catastrophic fire due to drier conditions
- Altered habitats in small, steep channels through scour of gravels, banks soils, and removal of woody debris
- Change in riparian composition with more drought tolerant species (cheatgrass)

So what are some management options?

- Adapt – actions to adjust to reduce negative impacts to fisheries. This may include both conservation of existing conditions and transition to changing conditions.
- Enhance **resistance and resiliency** – "*interchangeable terms"* but are key to managing adaptation to present and future climate change.
- Reduce **non-climate related stressors** - (cumulative effects)

  - best management practices,
  - habitat improvements,
  - protect native salmonids from non-native invasions,
  - restoration and conservation of complex habitats, etc..

Emphasize conservation and expansion of critical habitat –

- Larger areas that are more complex is the best situation (at least 2 miles)
- Reconnect streams (but only where it make sense)
- Conserve genetic and phenotypic variation

- Prioritize limited management resources (work across FS programs)
- Develop a diverse set of partnerships (state and federal agencies, NGO’s, public, etc…
- Monitor conditions to be able to evaluate trends

In Summary/Conclusion

Various climatic factors could potentially affect fisheries:

Air and water temperature
Flow (both seasonal spikes and baseline)
Channel and riparian conditions
Habitat size and complexity

We need to have good monitoring data and watch for potentially shifting trends and be able to adapt to change.

Weblinks & Additional Resources

- http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.190.9507&rep=rep1&type=pdf (RMRS GTR 250)
- https://www.oecd.org/tad/fisheries/45681668.pdf
- http://journals.sagepub.com/doi/abs/10.1191/1464993403ps060oa

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DIALOGUE AND Q&A

GROUP EXERCISE

BREAK TIME