



MAPPING OPTIMAL RESTORATION SITES FOR PERSISTENCE OF GREENBACK AND COLORADO RIVER CUTTHROAT TROUT IN ROCKY MOUNTAIN NATIONAL PARK

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Outline

1. Intro

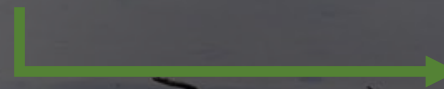
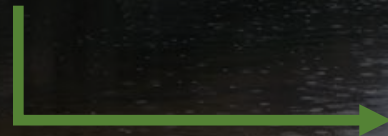
- Background
- Research Questions

2. Methods

- Goals
- Data Collection
- Modeling

3. Results

- Model Results
- Model Problems
- Next Steps



Background

- Greenback Cutthroat Trout (GBCT)
- Colorado River Cutthroat Trout (CRCT)
- Major attractions for Rocky Mountain National Park (ROMO)
- GBCT listed as “threatened”
- Wild GBCT population estimates are smaller than previously understood (Metcalf et al., 2012)



(Colorado Outdoors Magazine)

Greenback Cutthroat Trout (O. c. stomias)

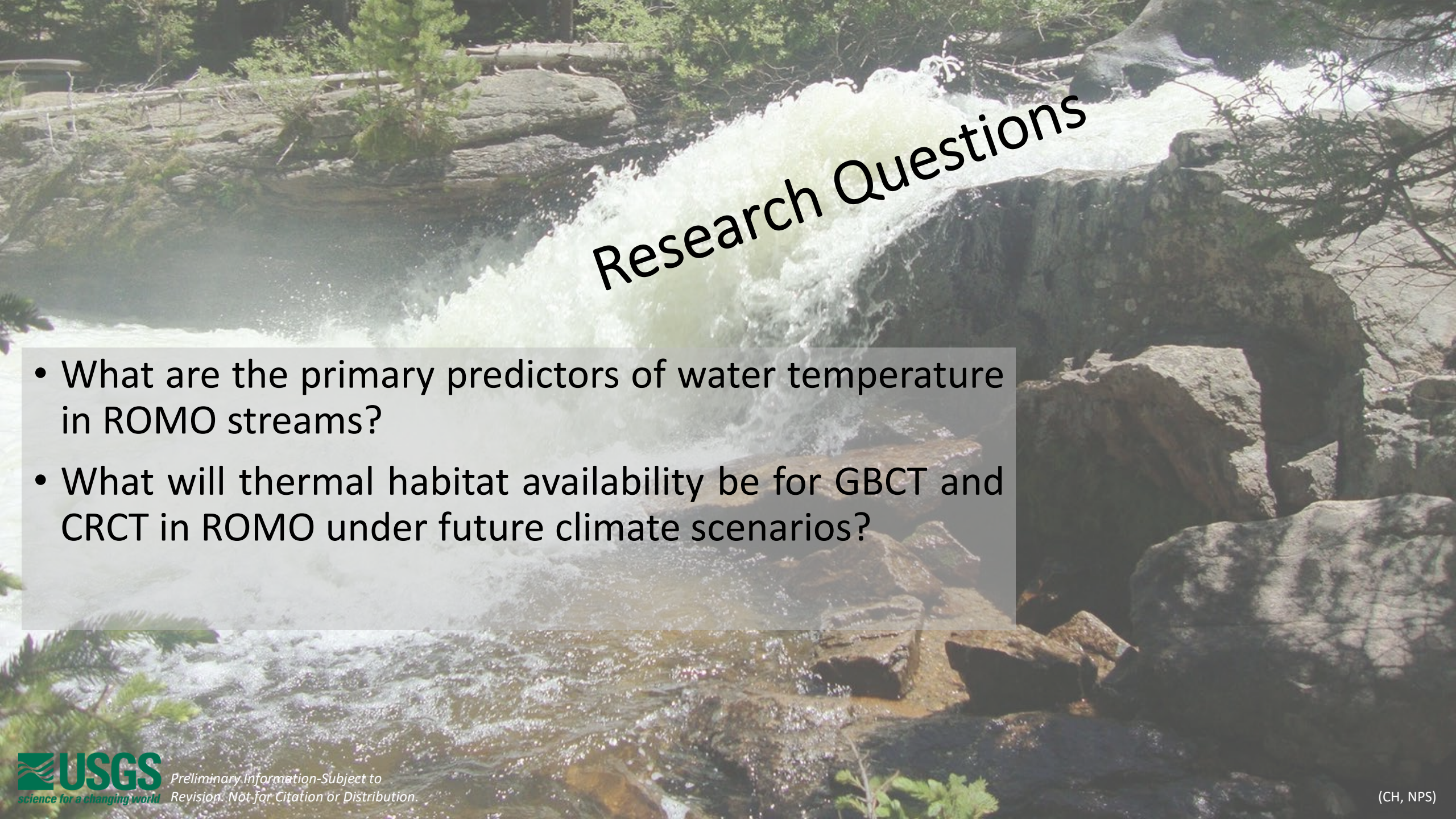


(James Roberts, USGS)

Colorado River Cutthroat Trout (Oncorhynchus clarkii plueriticus)

Problems

- Both CRCT and GBCT are sensitive to changes in water temperature (Isaak et al., 2010).
- Climate change is reducing suitable thermal habitat in streams of ROMO for CRCT and GBCT (Roberts et al., 2013).
- High-resolution data showing locations of suitable thermal habitat are unavailable.



Research Questions

- What are the primary predictors of water temperature in ROMO streams?
- What will thermal habitat availability be for GBCT and CRCT in ROMO under future climate scenarios?

Goals

- Collect water temperature data in ROMO streams.
- Build statistical models to predict current CRCT and GBCT habitat suitability in ROMO at fine scale (1:24,000). NorWeST scale is only (1:100,000) (Isaak et al., 2017).
- Use models to predict habitat suitability under future climate scenarios.



Water temperature data collection at Colorado River site.

Data Collection

- Carried out by James Roberts and Travis Schmidt with the Colorado Water Science Center.
- Continuous water temperature in ROMO
 - 84 sites
 - 30-minute increments
 - collected 1996-2019

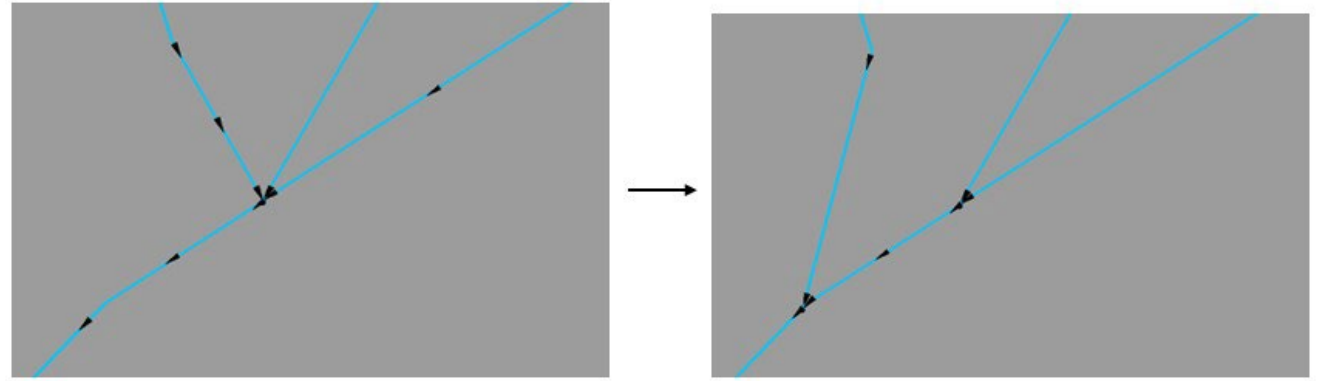


(James Roberts, USGS)

Hobo Pro v2 temperature logger measuring temperature in 30-minute increments.

SSN Modeling

- Built Landscape Network with NHD flowlines
- Spatial Stream Network (SSN) package in R
- Types of autocorrelation used
 - Exponential taildown (downstream)
 - Exponential Euclidian (Euclidean distance)



Confluences of three or more streams needed adjustment

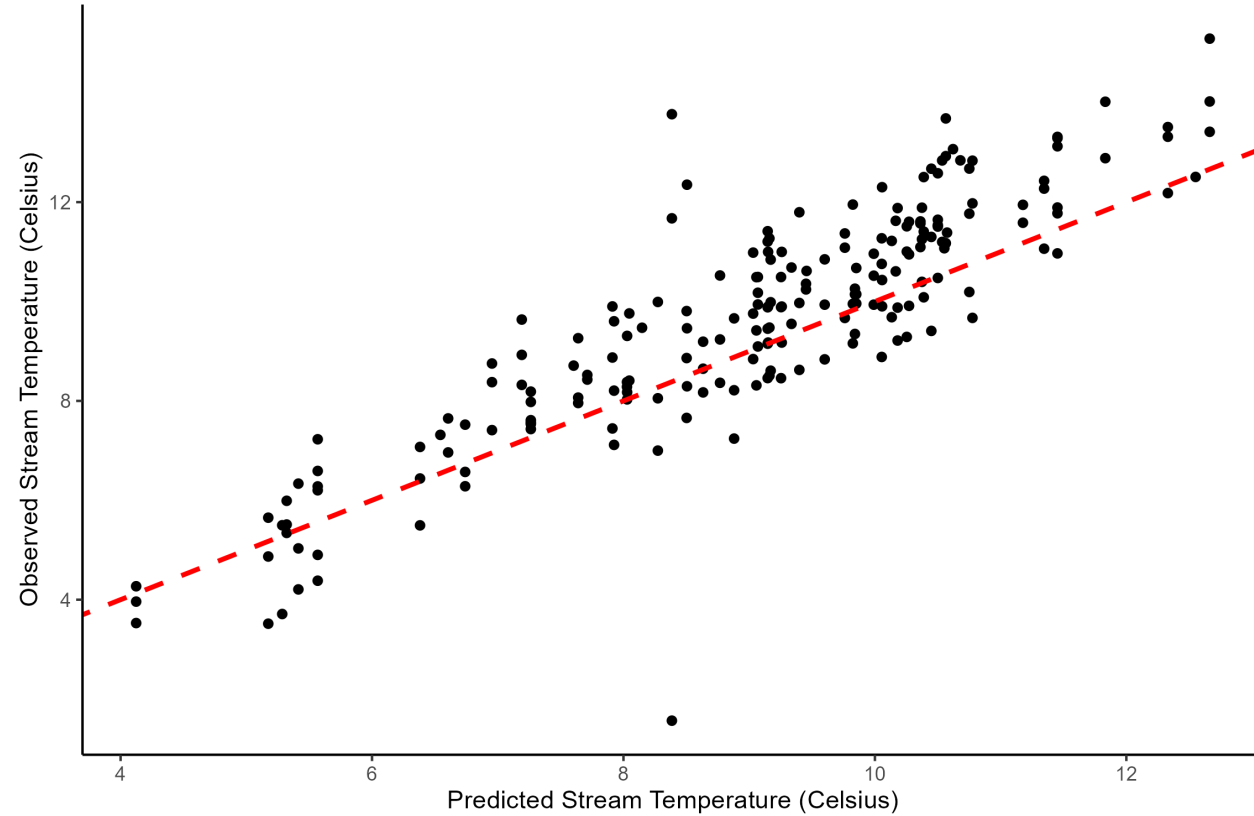


Braided stream segments (in red) were removed.

Results

30 Day Window

Predicted vs Observed

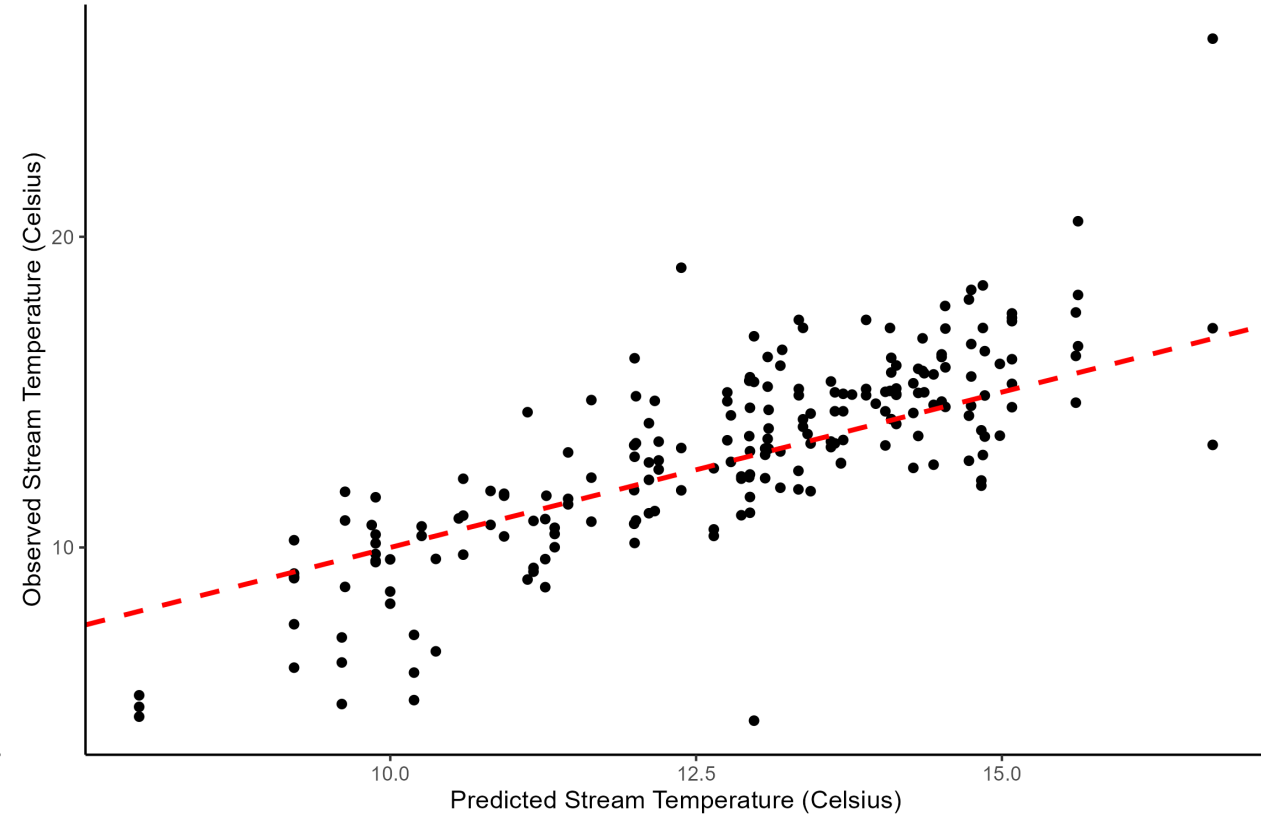


Root Mean-Squared Prediction Error: 1.41 Celsius

Predictors: air temperature

7 Day Window

Predicted vs Observed



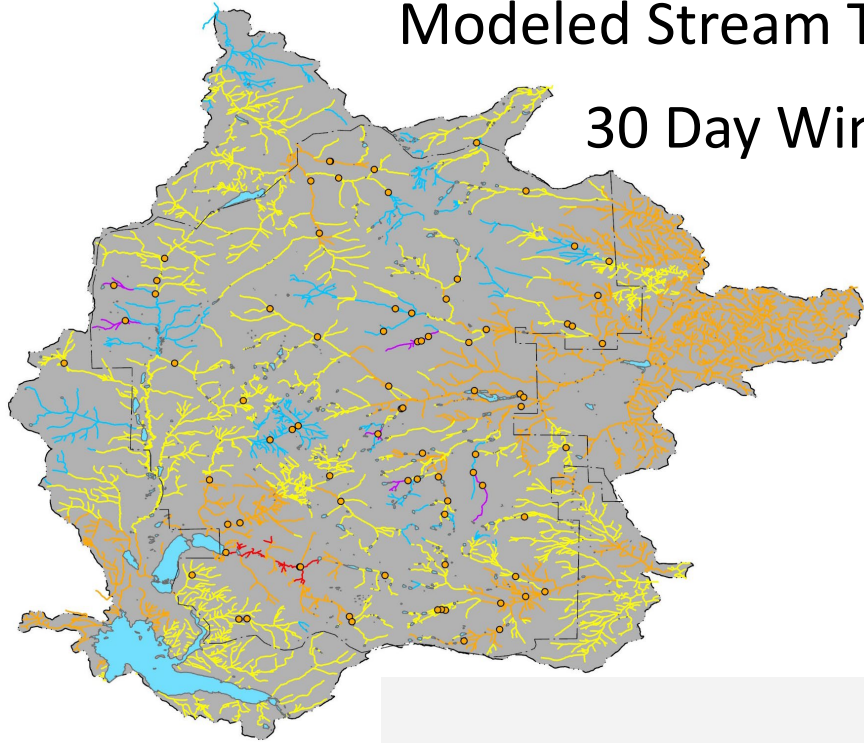
Root Mean-Squared Prediction Error: 2.06 Celsius

Predictors: air temperature, drainage area, and elevation

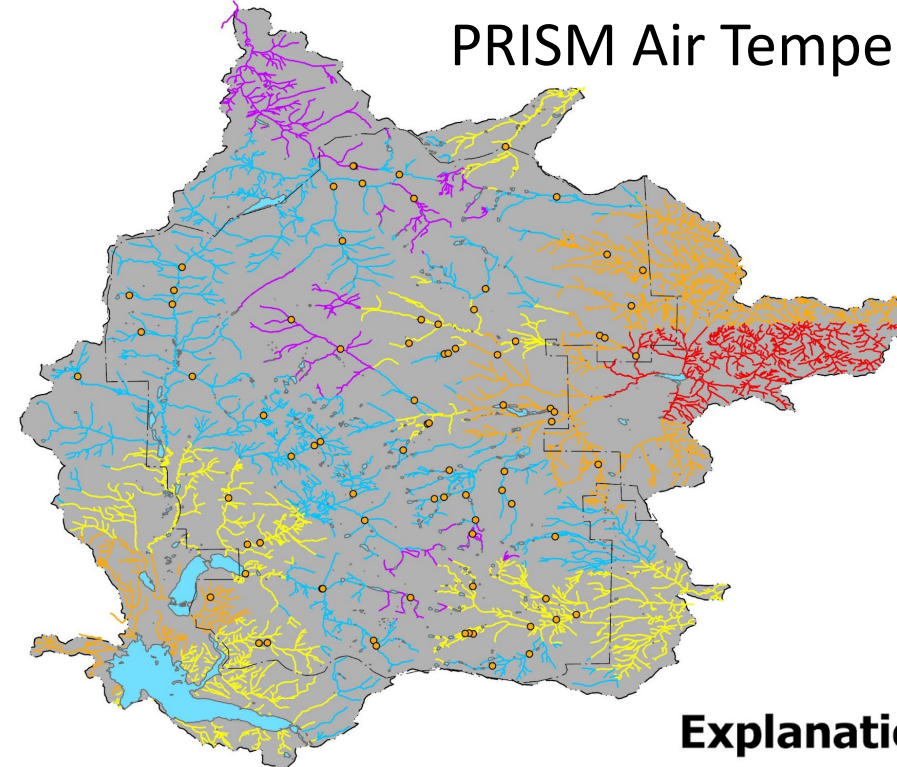
Predicted Stream Temperature vs Observed Air Temperature

Preliminary Information-Subject to Revision. Not for Citation or Distribution.

Modeled Stream Temperature
30 Day Window



PRISM Air Temperature



Explanation

- Sites
 - Lakes
 - ROMO Park Boundary
 - Outer Watershed Boundary
- | Air Temperature (Celsius) | |
|---------------------------|-------------|
| | 10.0 - 12.0 |
| | 12.0 - 14.0 |
| | 14.0 - 16.0 |
| | 16.0 - 18.0 |
| | 18.0 - 20.0 |

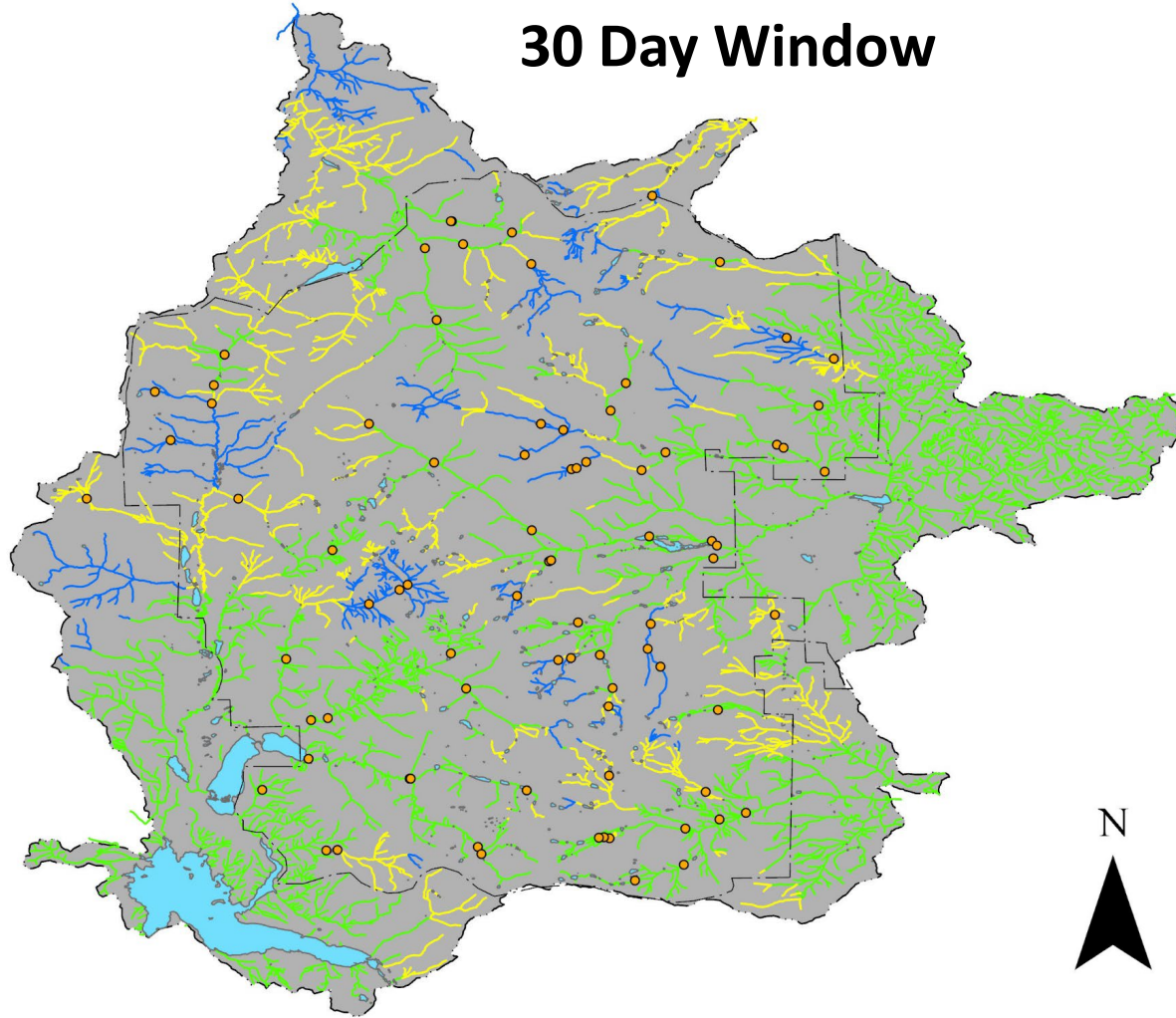


Predicted Thermal Habitat Suitability: Recruitment

Preliminary Information-Subject to
Revision. Not for Citation or Distribution.

30 Day Window

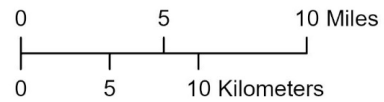
Explanation



- Sites
- Lakes
- ROMO Park Boundary
- Outer Watershed Boundary

- No recruitment: $<8.0\text{ }^{\circ}\text{C}$
- Low recruitment: $8.0\text{--}9.0\text{ }^{\circ}\text{C}$
- Optimal growth and recruitment: $9.1\text{--}18.0\text{ }^{\circ}\text{C}$
- Declining growth: $18.1\text{--}19.9\text{ }^{\circ}\text{C}$
- Low or no growth: $\geq 20.0\text{ }^{\circ}\text{C}$

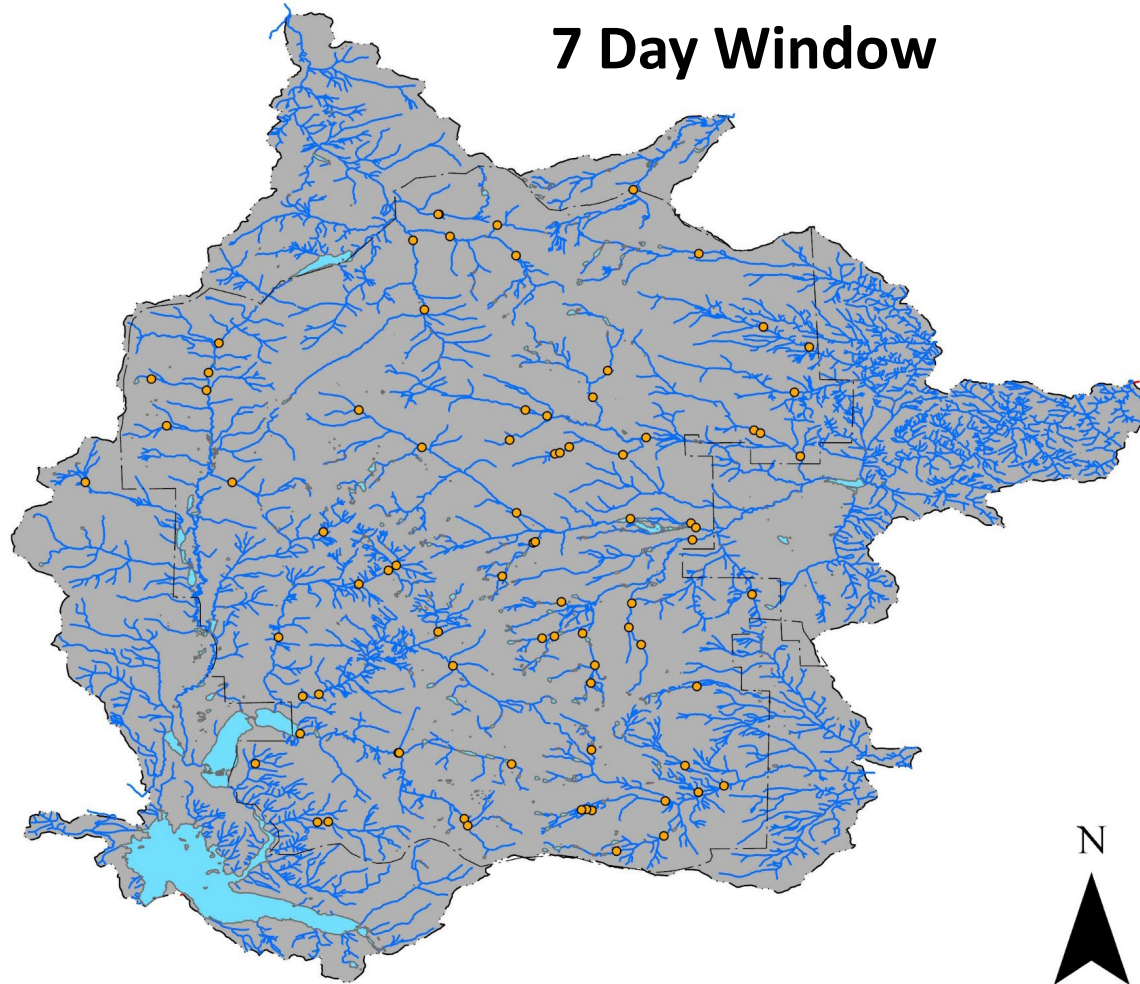
(Roberts et al., 2013)



Predicted Habitat Suitability: Mortality

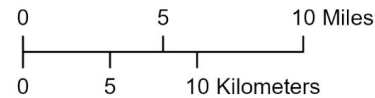
Preliminary Information-Subject to
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7 Day Window



Explanation

- Sites
 - Lakes
 - ROMO Park Boundary
 - Outer Watershed Boundary
 - Survival: $<26\text{ }^{\circ}\text{C}$
 - Mortality: $\geq 26\text{ }^{\circ}\text{C}$
- (Roberts et al., 2013)



Next Steps

- Assign air temperature to streams differently.
- Pick the most representative model (how?).
- Use future climate projections.



(James Roberts, USGS)

Questions?

References

Metcalf JL, et al. (2012) Historical stocking data and 19th century DNA reveal human-induced changes to native diversity and distribution of cutthroat trout. *Molecular Ecology* 21(21):5194-5207.

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Roberts, J.; Fausch, K. D.; Douglas, P. P.; Mevin, H. (2013). Fragmentation and thermal risks from climate change interact to affect persistence of native trout in the Colorado River basin. *Global Change Biology*, 19(5): 1383-1398. <https://doi.org/10.18637/jss.v056.i02>

Pictures

Background photos taken by CH and Ann Schonlau, NPS: <https://www.nps.gov/media/photo/gallery-item.htm?pg=1926875&id=26DCAEBC-155D-451F-676AFA0F24B4D103&gid=2743AD86-155D-451F-67D343C9E1778AB8>

Greenback Cutthroat Trout Photo taken by Colorado Outdoors Magazine: <https://coloradooutdoorsmag.com/2020/12/31/protecting-greenback-cutthroat-trout/>

Colorado Cutthroat Trout Photo taken by Bureau of Land Management: https://commons.wikimedia.org/wiki/File:Colo_river_cutthroat_BLM.jpg#filehistory