USGS
science for a changing world

# Longitudinal water-temperature profiles, zones of cold-water influence, and geomorphology of the Lower Yakima River

Andy Gendaszek
Research Hydrologist
Washington Water Science Center
agendasz@usgs.gov

Lower Yakima River Water Quality and Habitat Coordination Meeting
Prosser, WA
March 4, 2020

U.S. Department of the Interior
U.S. Geological Survey

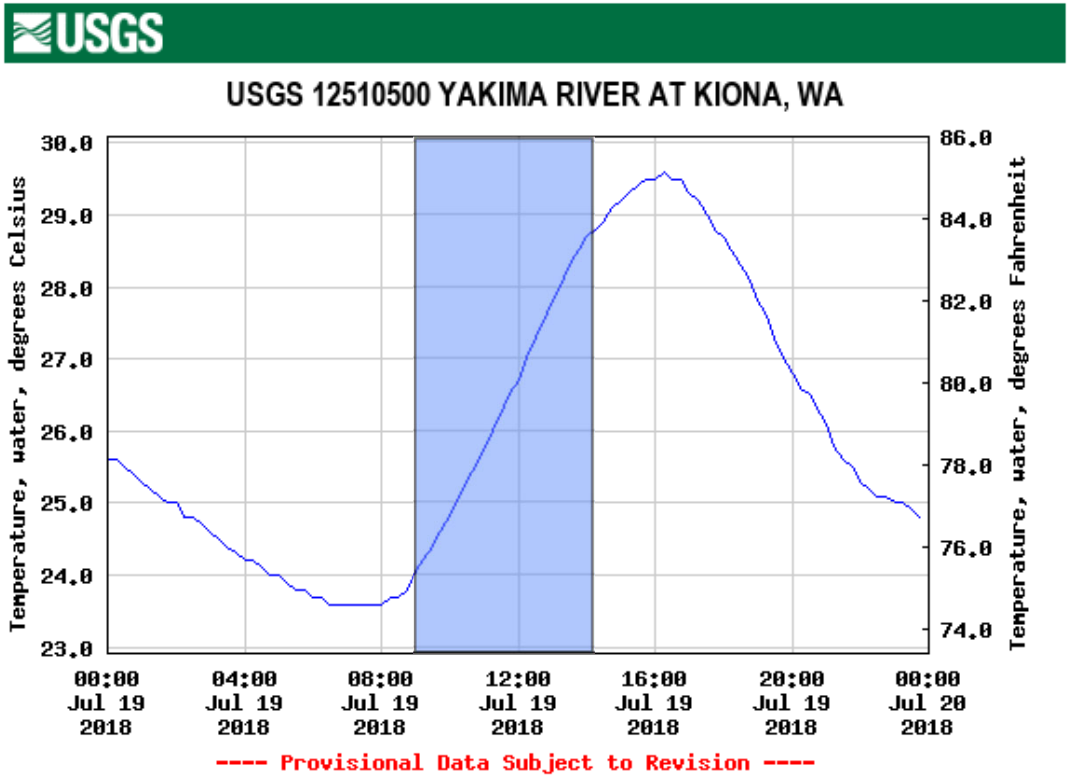
# Purpose and Scope

- Identify potential thermal refuges
- Update previously collected thermal profiles (e.g., Vaccaro, 2011) and document temporal stability of thermal refugia
- What factors contribute to thermal creation and maintenance of thermal refugia?
- Inform resource managers in prioritization and development of thermal refuge habitat enhancement projects

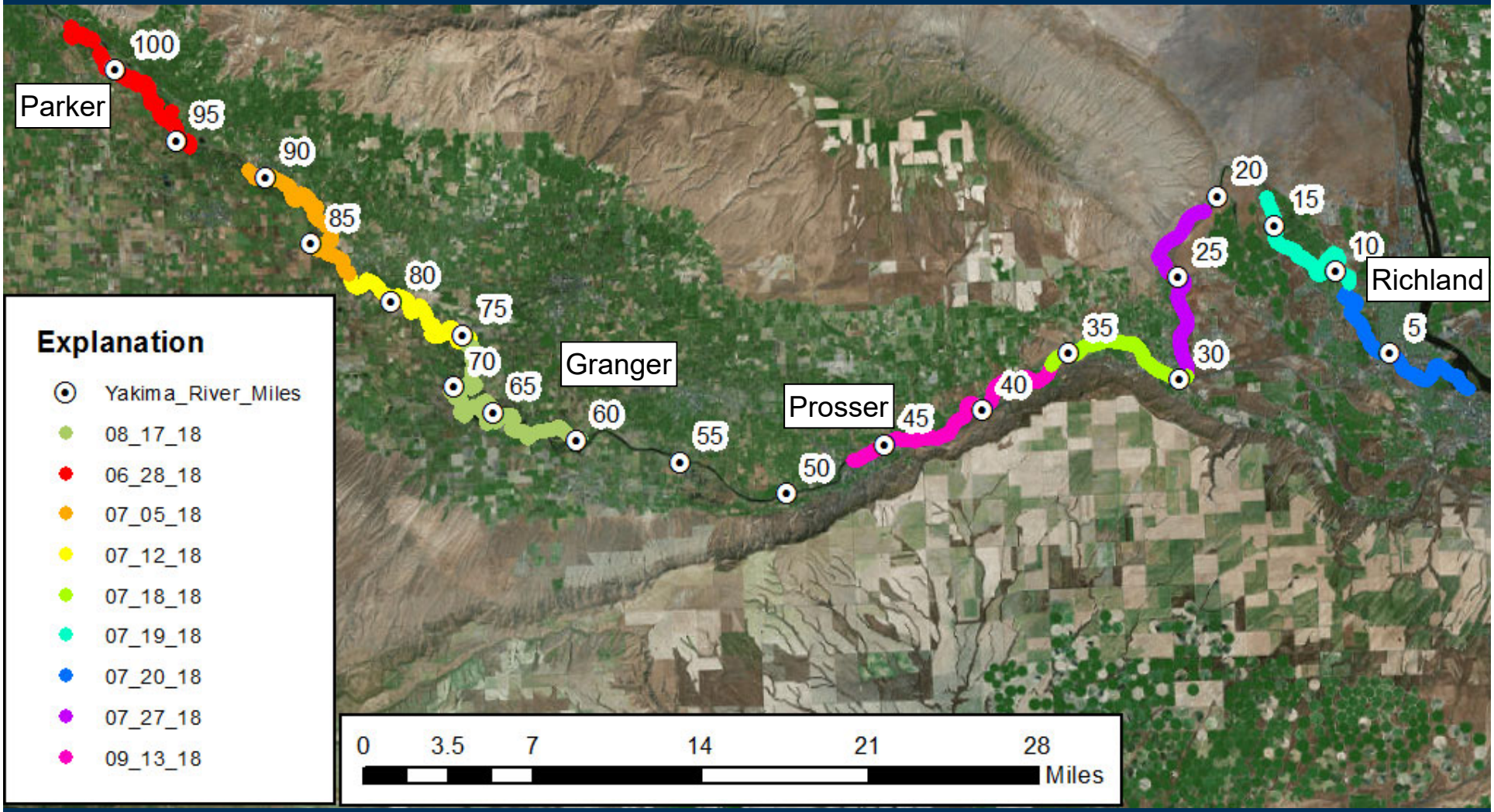
# Method: Longitudinal Thermal Profiles

- Nine reaches  profiled from June to September 2018
- Near-streambed water temperature measured while drifting at ambient river velocity
- Temperature of parcel of water tracked downstream
- Departure of water parcel from diurnal heating may be:
  - Ground-water discharge
  - Surface-water inflows
  - Riparian shading

USGS



# Thermal Profiles – Overview

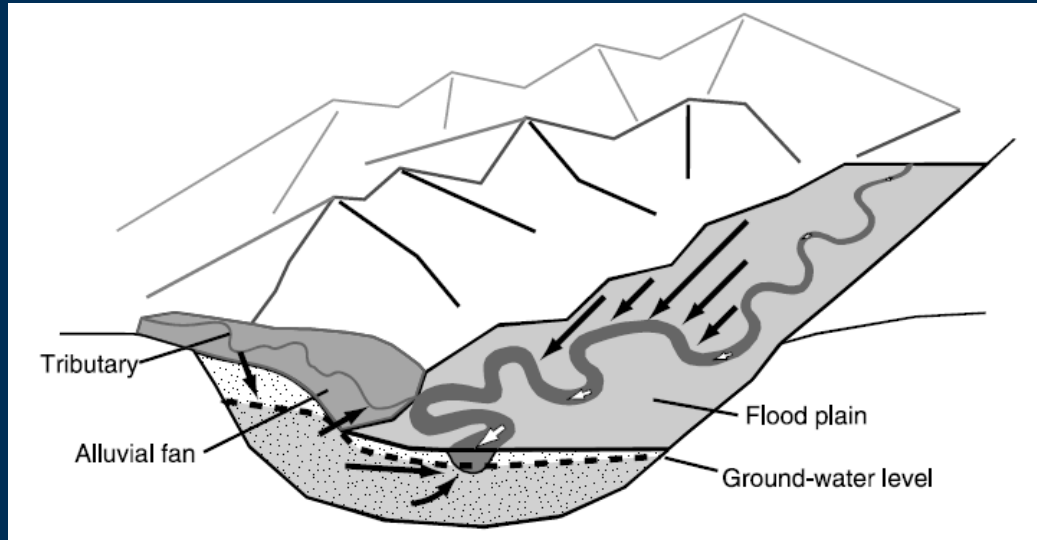


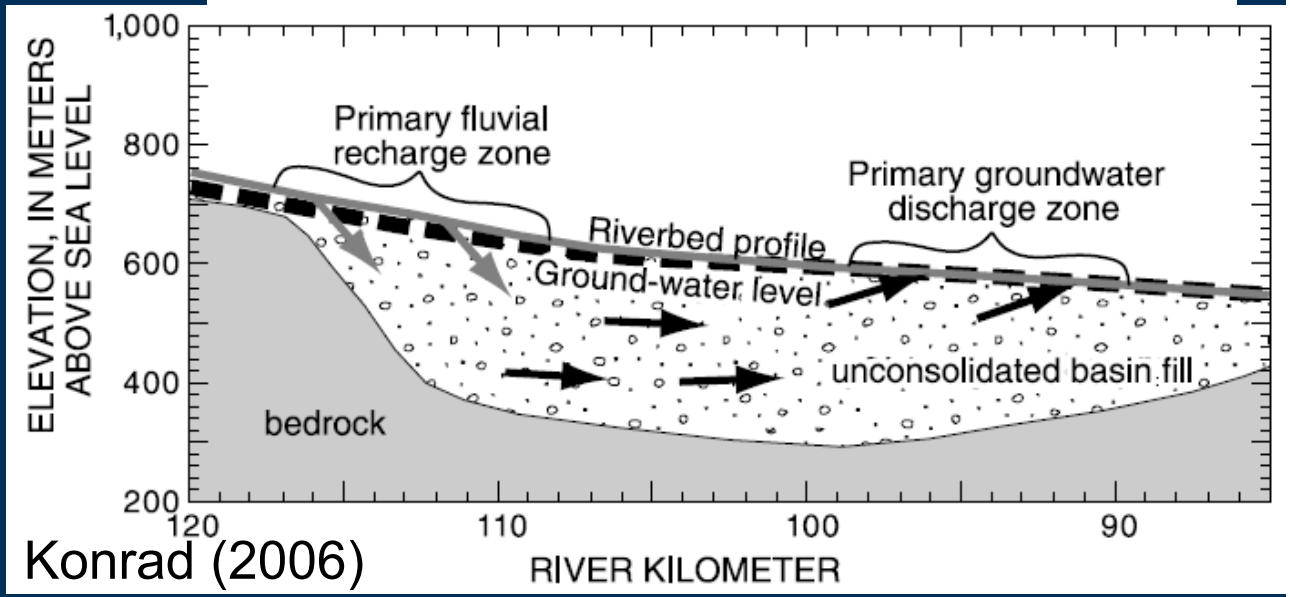

USGS

Preliminary Data – Subject to Revision

# Local vs. Valley-Scale Influences on Groundwater Discharge

- Tributary inputs
- Irrigation Returns
- Deep pools




Konrad (2006)

USGS

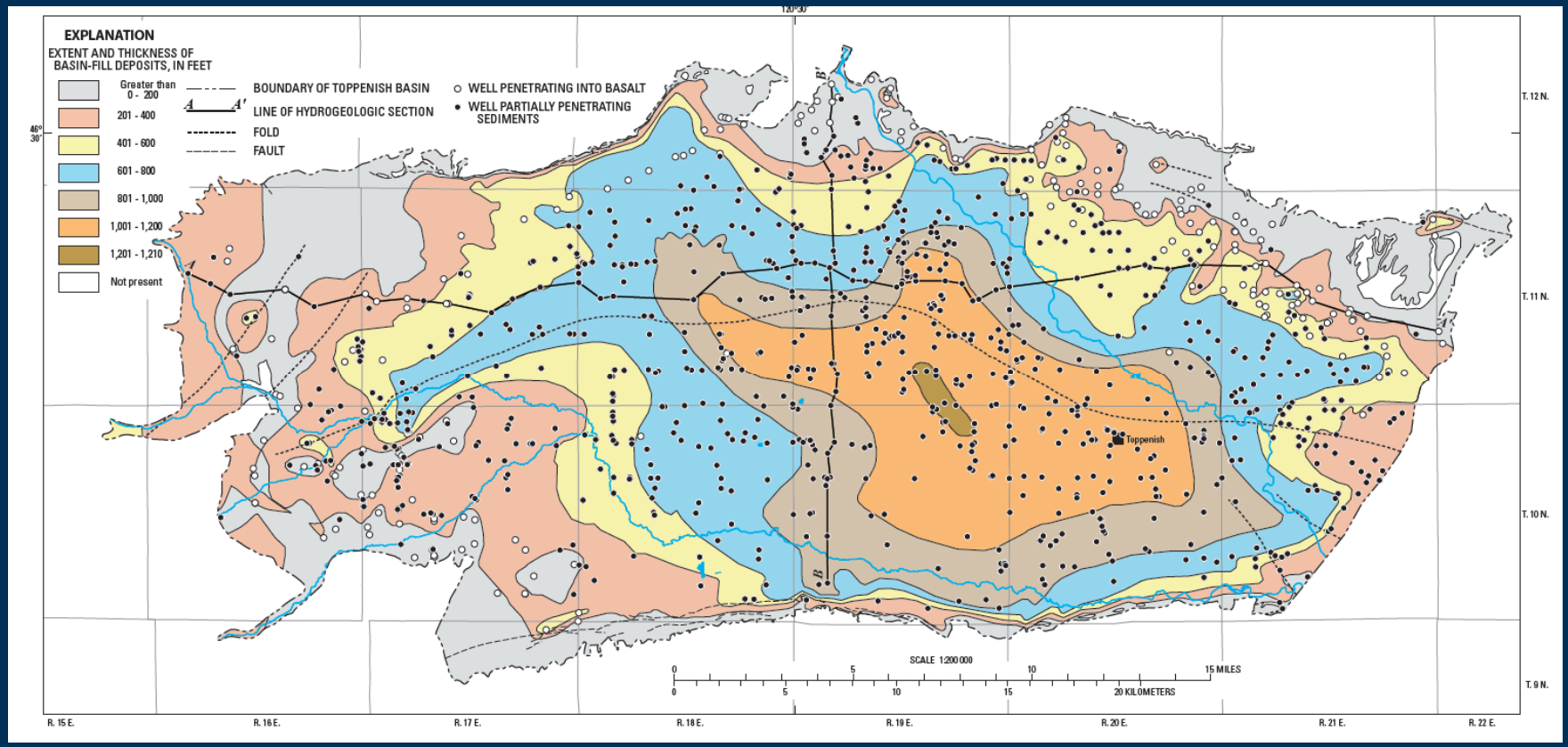
# Assessment of Groundwater Discharge: Geology and Geomorphology

- Geology
  - Extent of Basin-Fill Deposits
  - Jones and others (2006)
- LiDAR (2015) Analysis
  - Height Above Water Surface
  - Channel Slope and Elevation Profile
- NAIP (2017) Digitization
  - Sinuosity
  - Active Channel Width


USGS

Preliminary Data – Subject to Revision

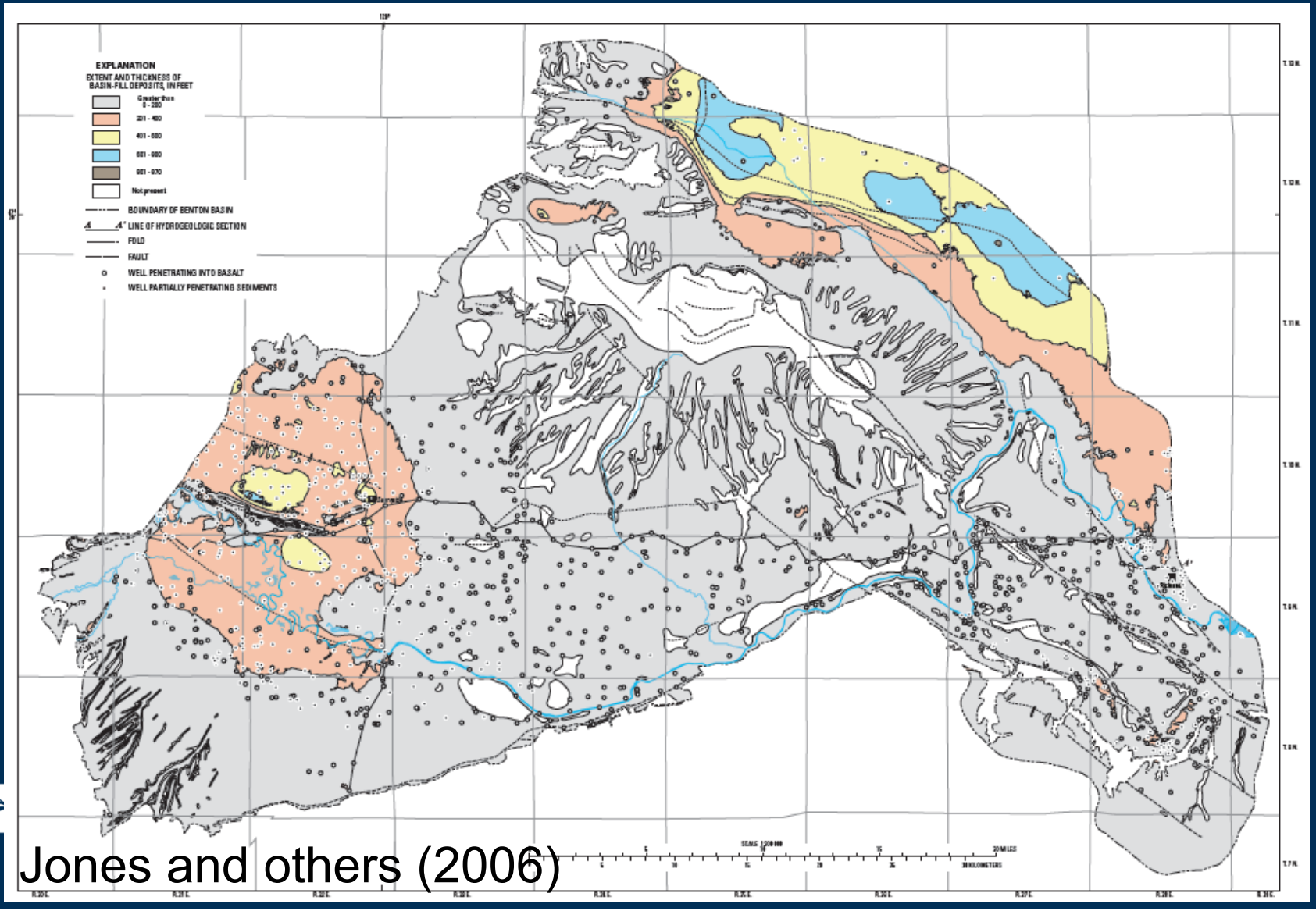
# Extent of Basin-fill Deposits: Toppenish Basin (Parker to Granger)




USGS

Jones and others (2006)

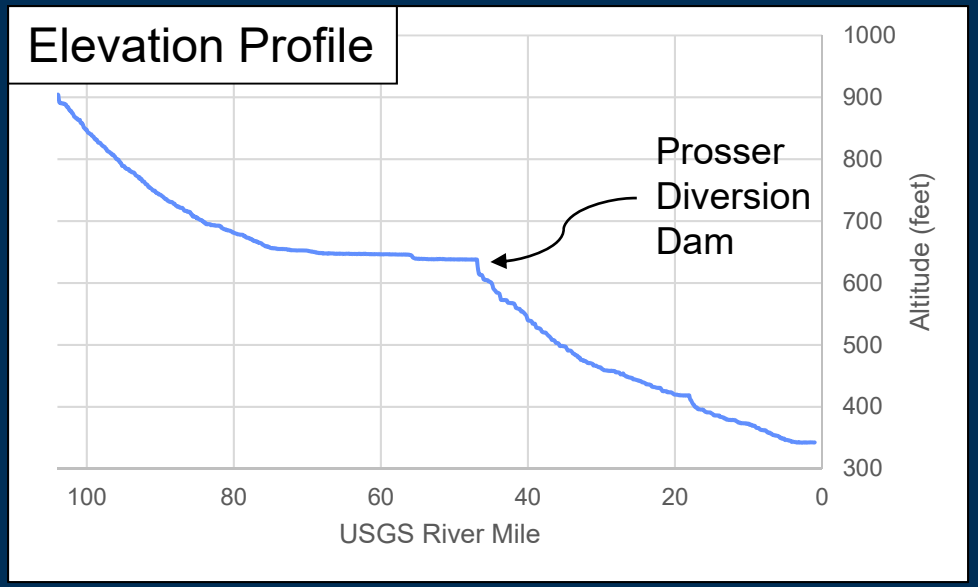
# Extent of Basin-fill Deposits: Benton Basin (Granger to Richland)

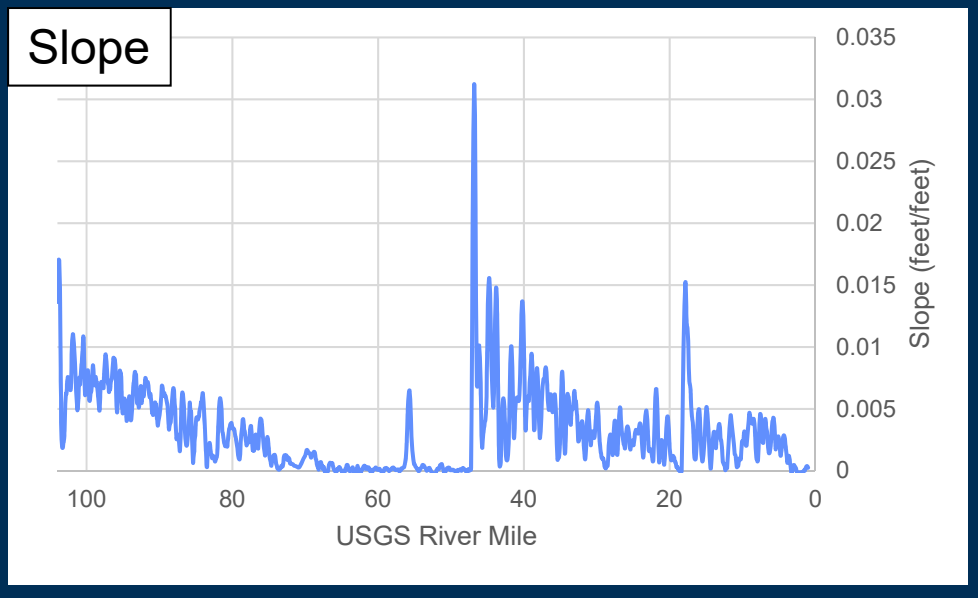



Jones and others (2006)

# Elevation and Slope Profiles

- Estimated from LiDAR
- Elevation values obtained from channel centerline
- Slope averaged over 1-km moving window
- Control on stage and hydraulic gradients
  - Large-Scale: Diversion Dams
  - Small-Scale: Pool-Riffle Sequences



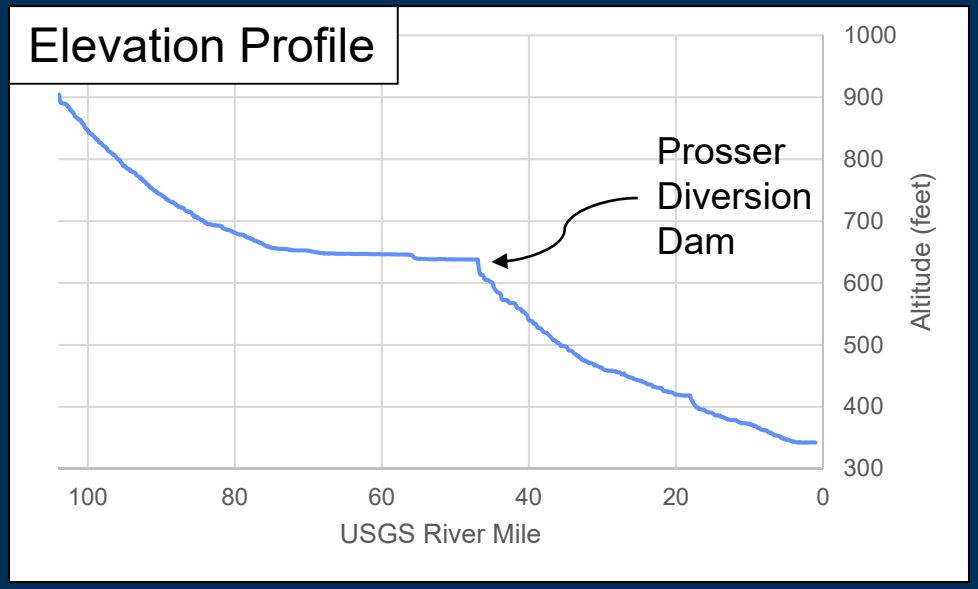



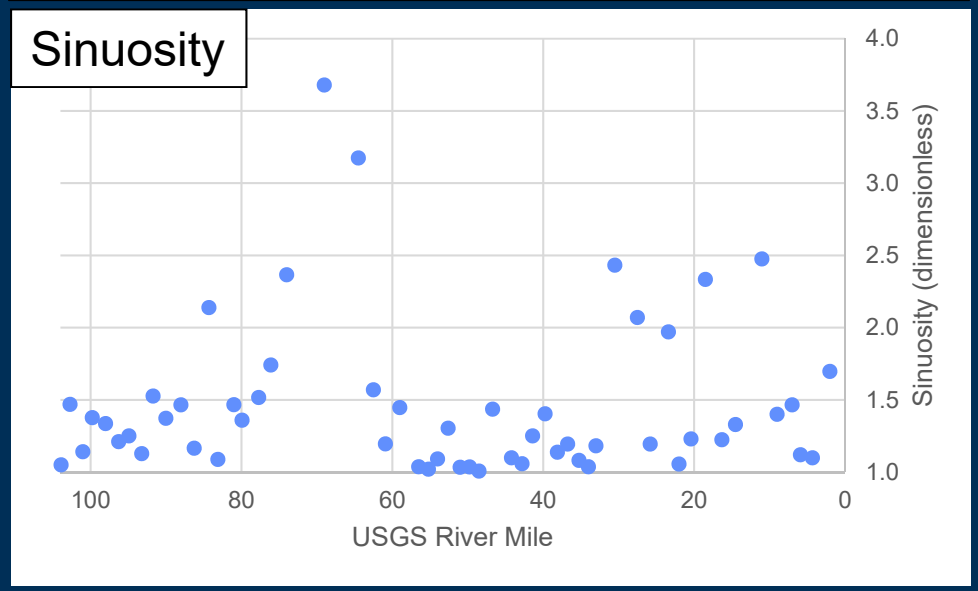

USGS

Preliminary Data – Subject to Revision

# Sinuosity Profile

- Estimated from NAIP
- Calculated over 2-km windows and referenced to USGS River Mile
- Increased sinuosity enhances GW/SW exchange
- Highest sinuosity between Satus and Mabton



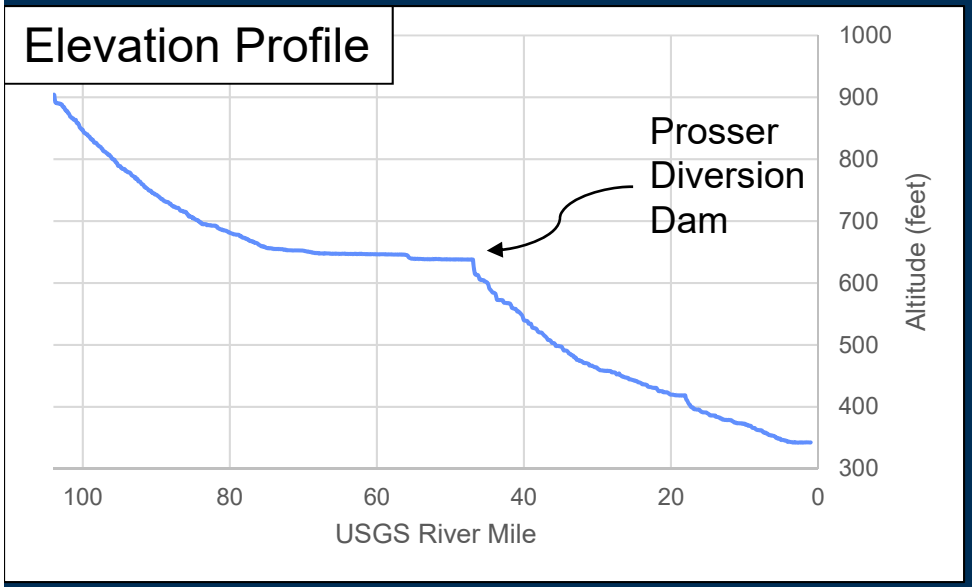

USGS

Preliminary Data – Subject to Revision

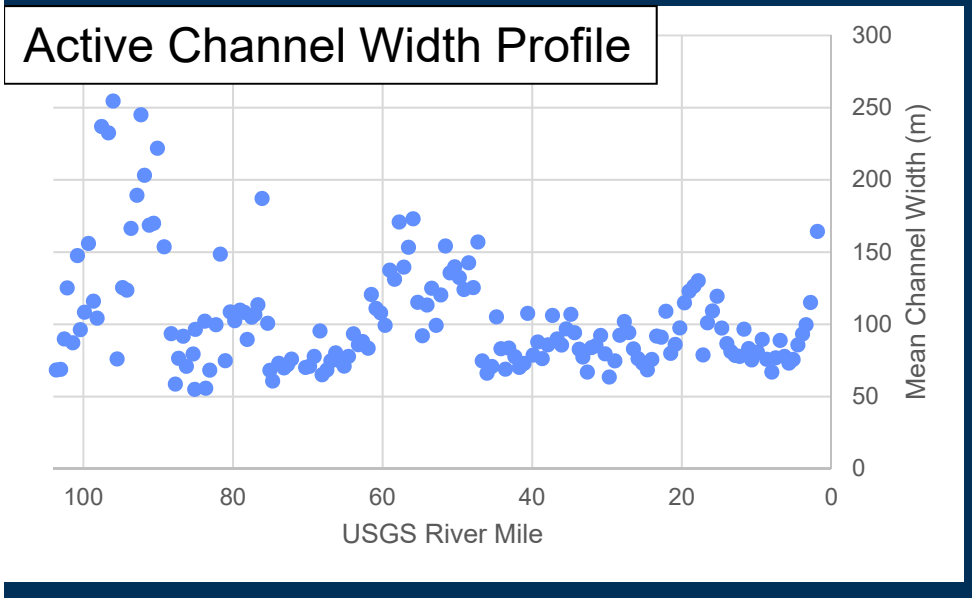
# Active Width Profile

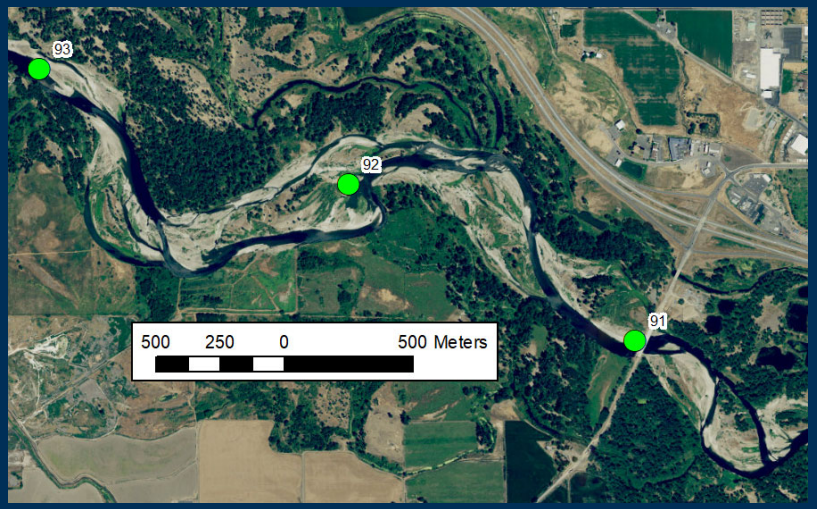
Preliminary Data – Subject to Revision

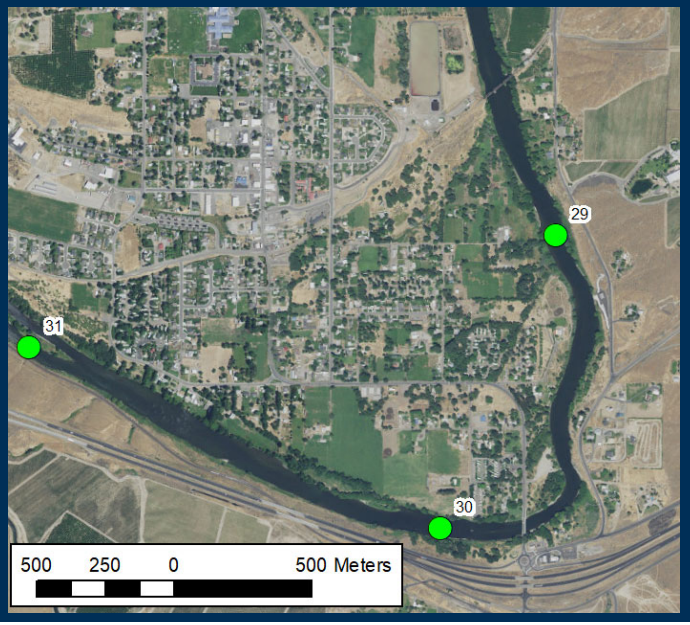
## Elevation Profile



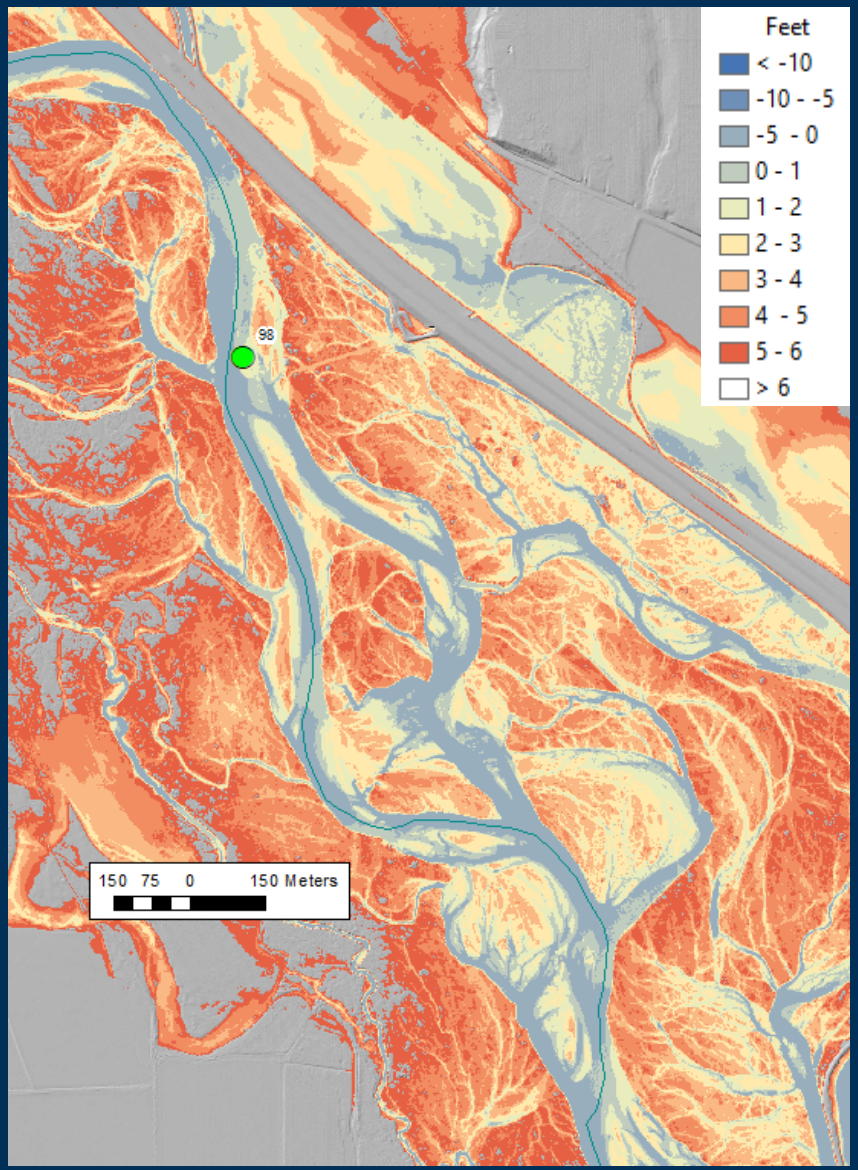

## Active Channel Width Profile

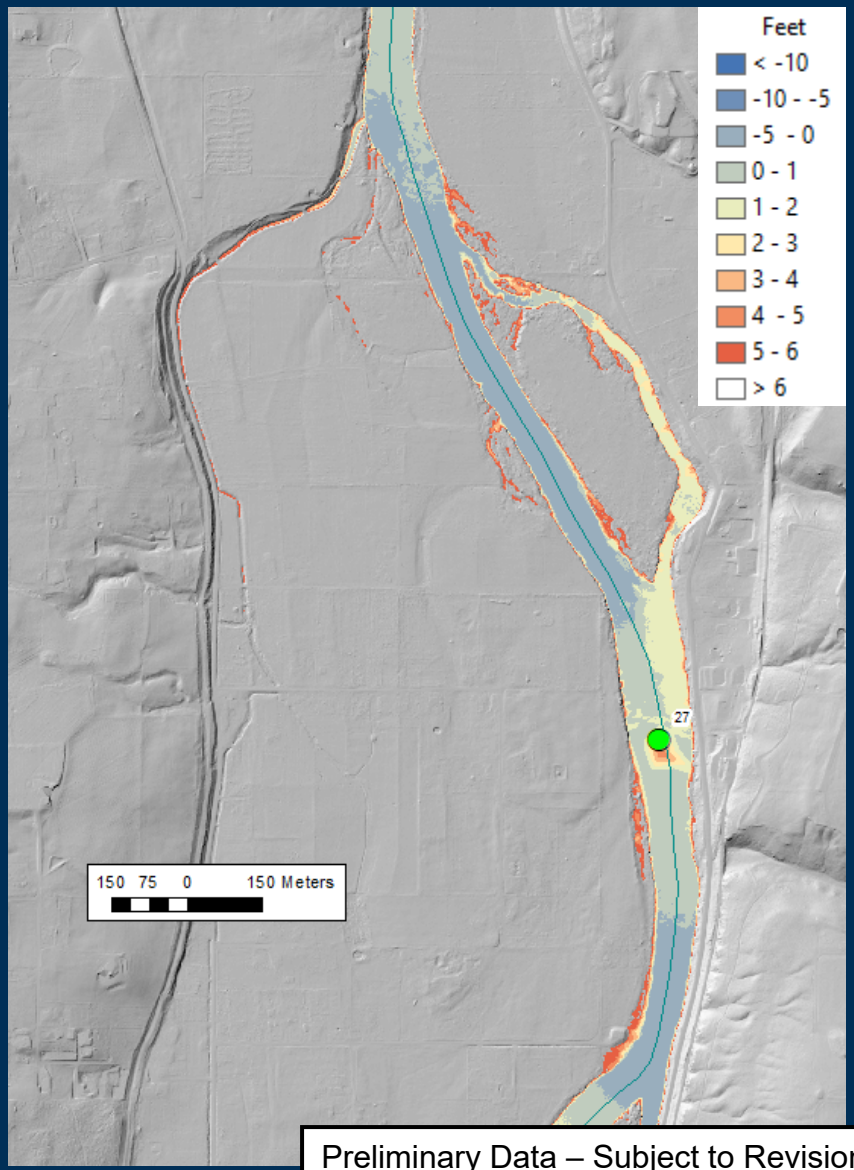


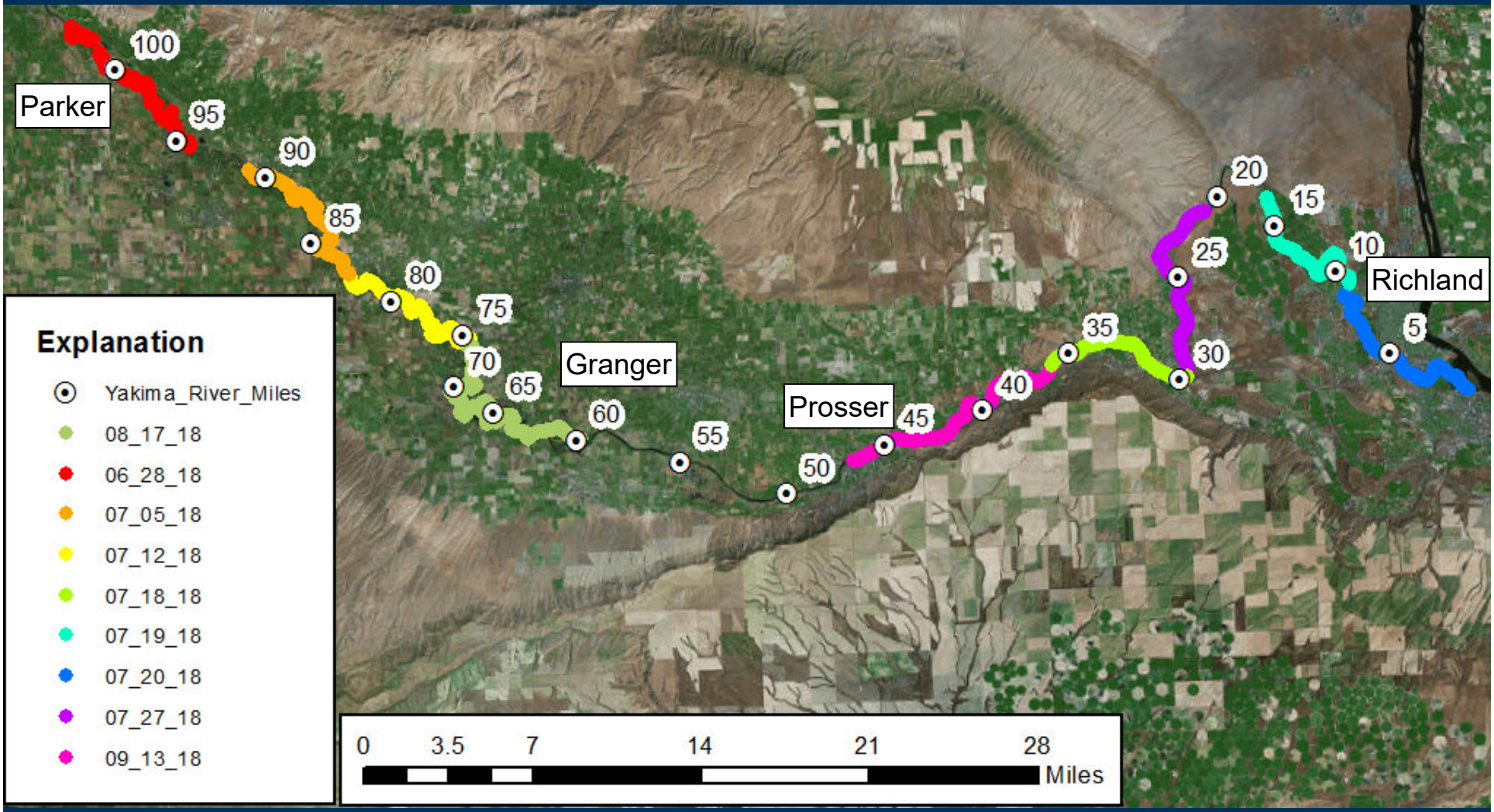
# Height Above Water Surface




Preliminary Data – Subject to Revision

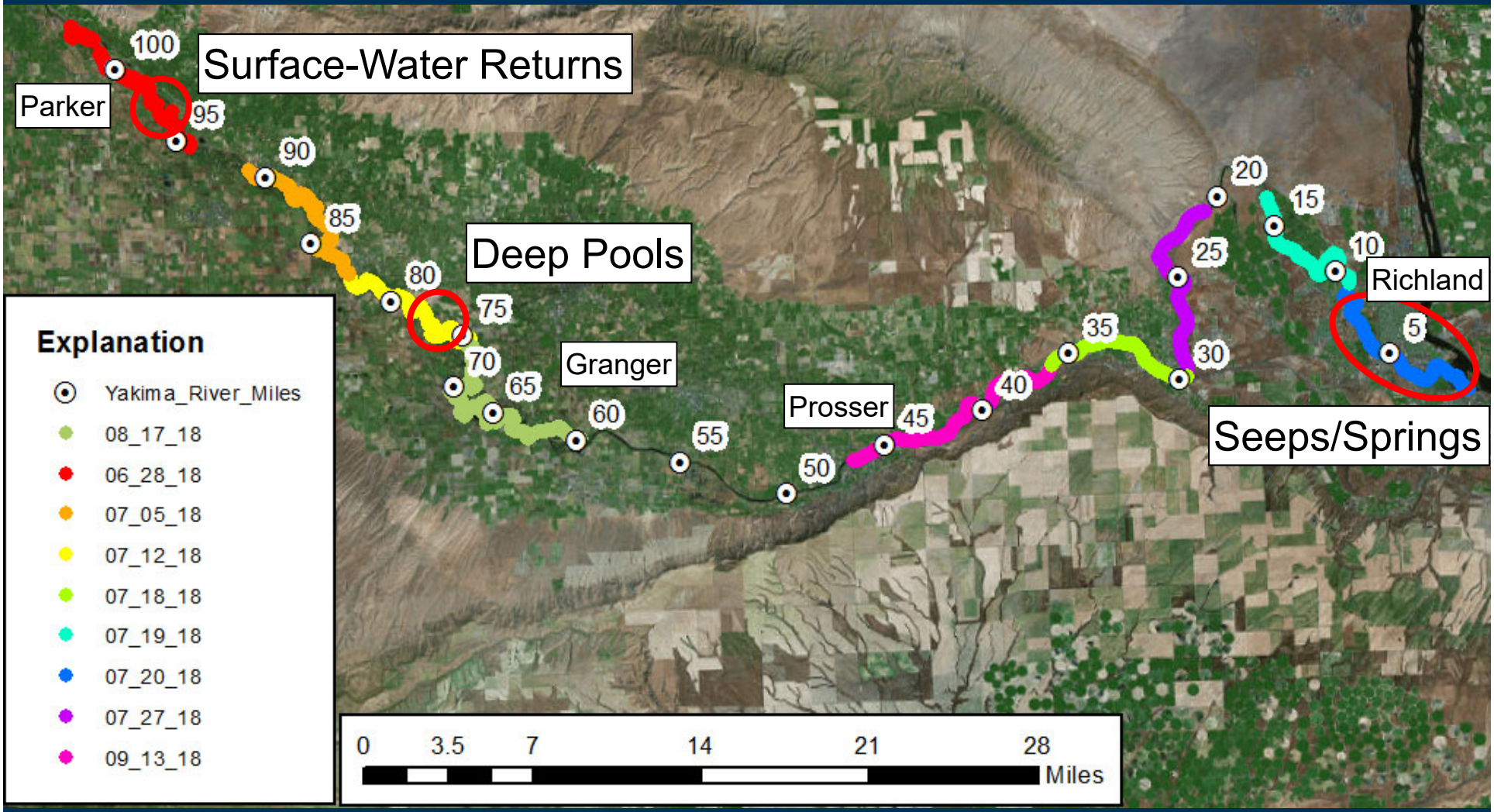
# Thermal Profiles – Overview




USGS

Preliminary Data – Subject to Revision

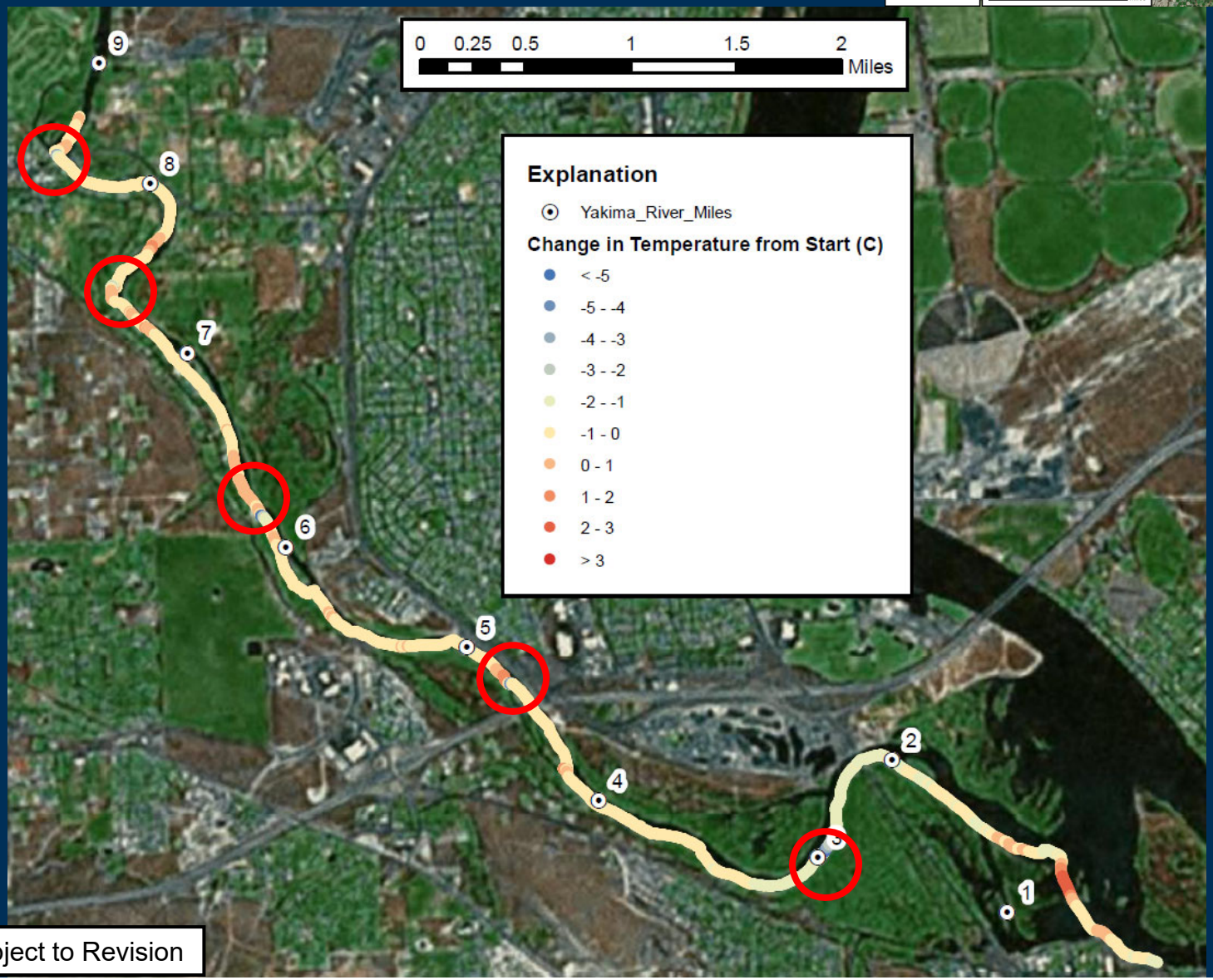
# Examples of Thermal Refugia and Processes




USGS

Preliminary Data – Subject to Revision

# Springs/Seeps/Surface-Water Returns: Confluence Reach

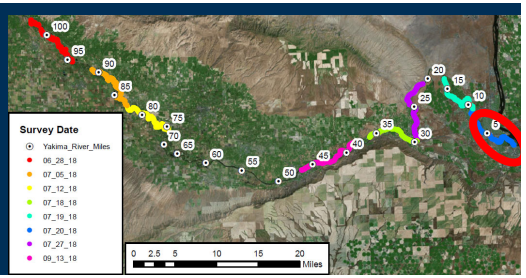




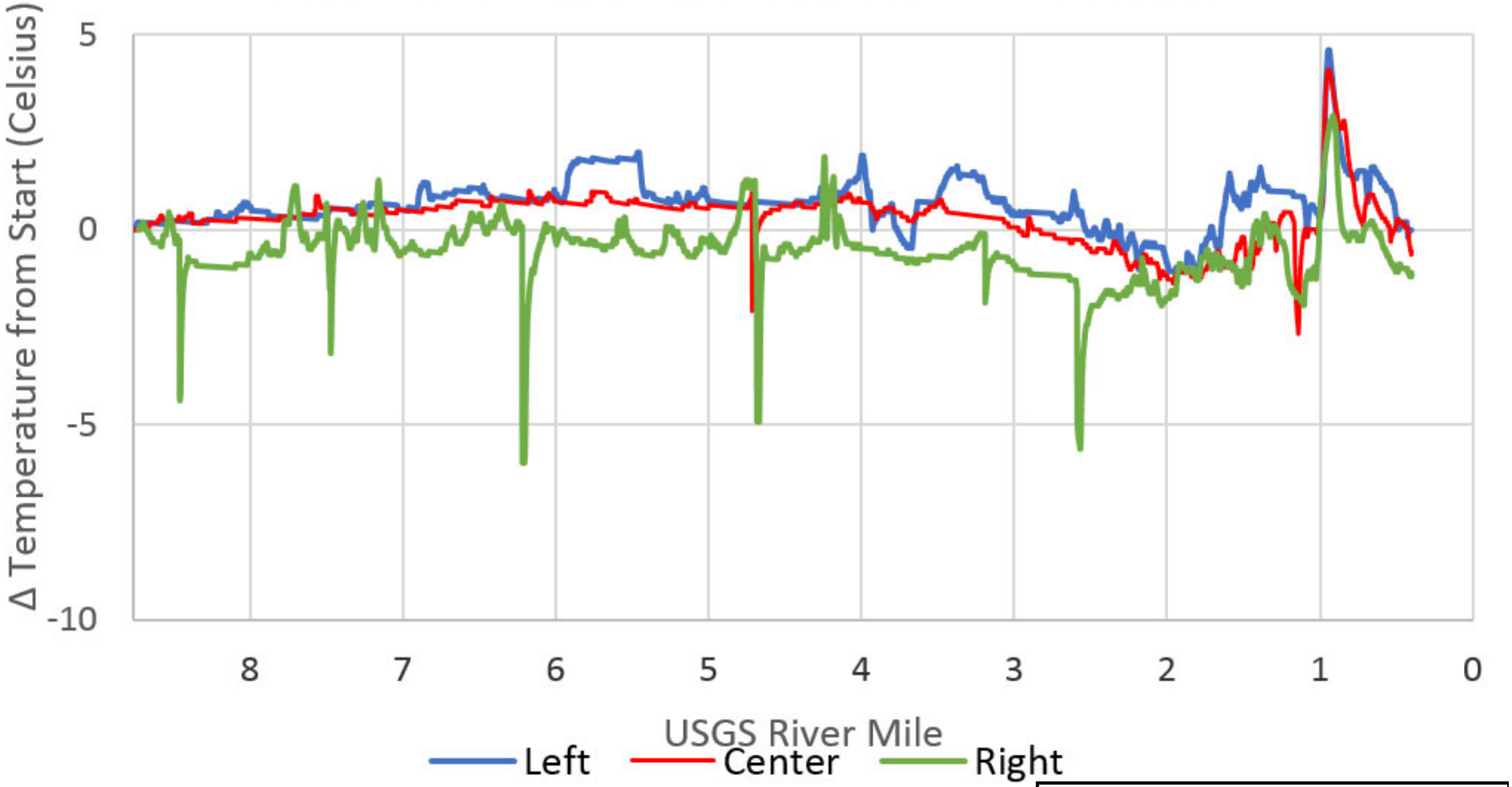
USGS

Preliminary Data – Subject to Revision

# Confluence Reach: 7/20/18

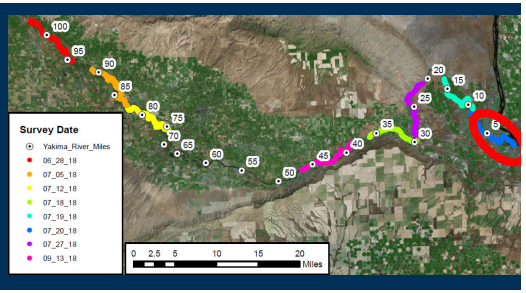



## Van Giesen to Bateman Island

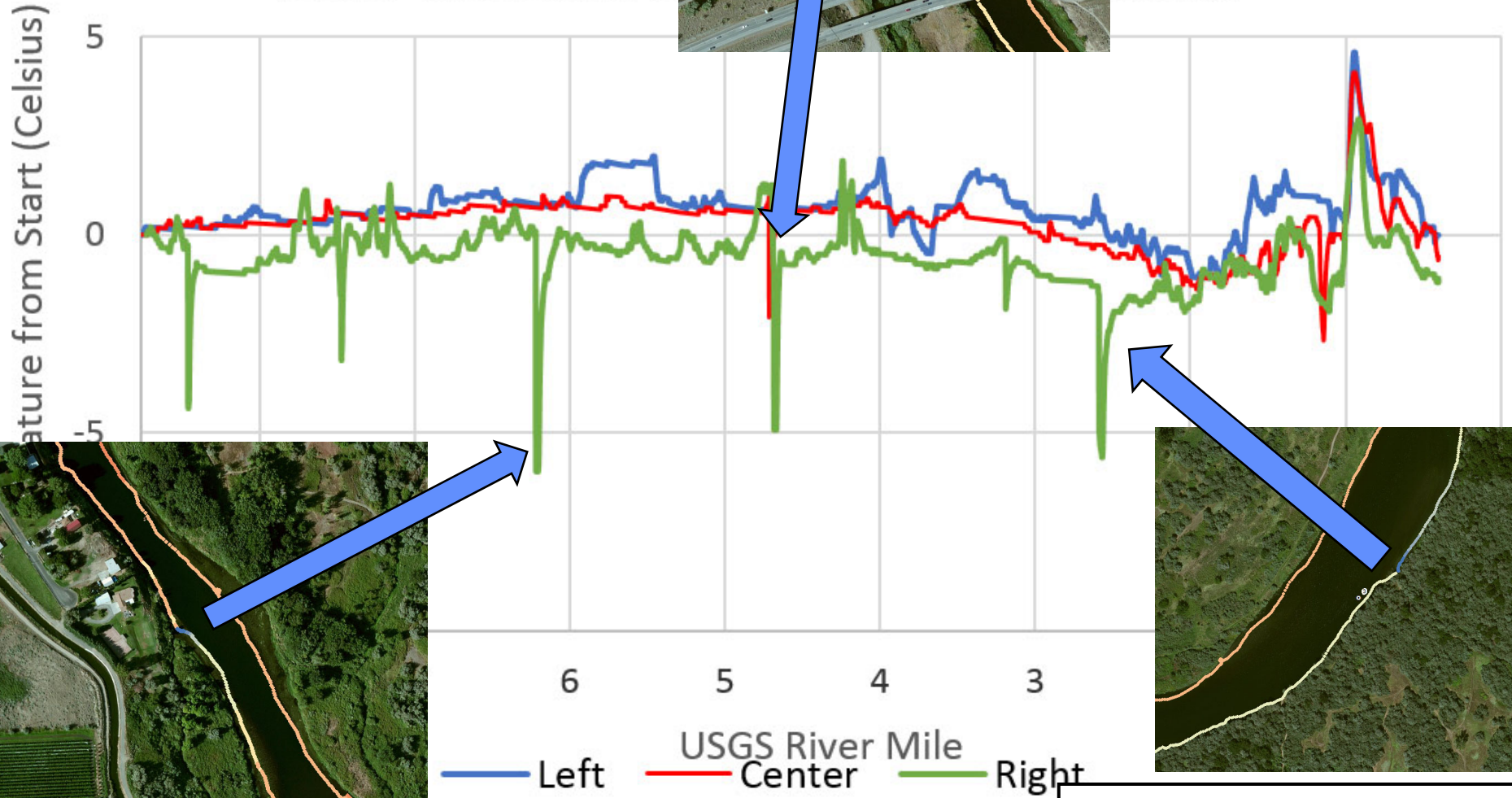



Preliminary Data – Subject to Revision

# Confluence Rch 7/20/18




## Van Giesen t land

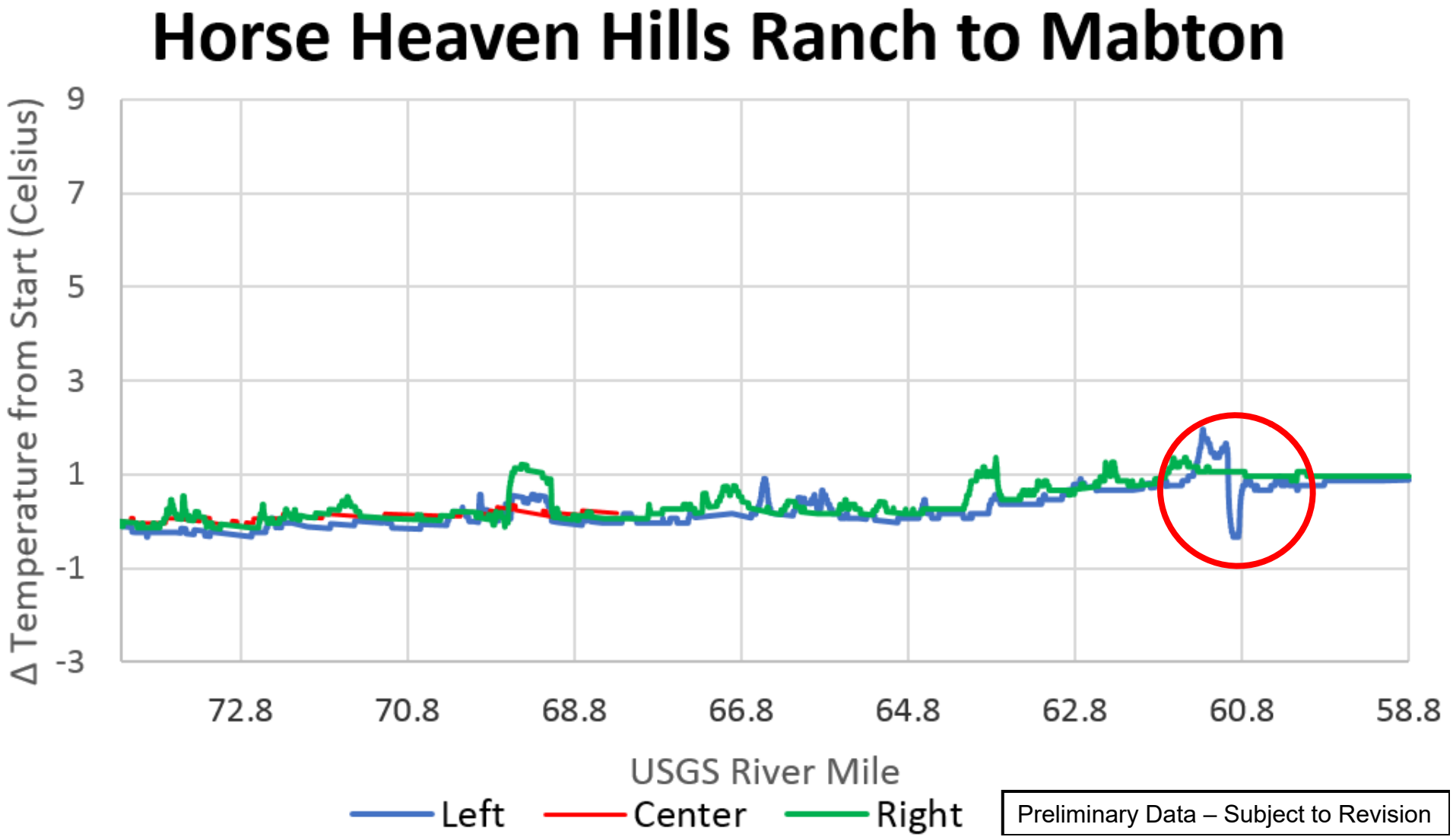






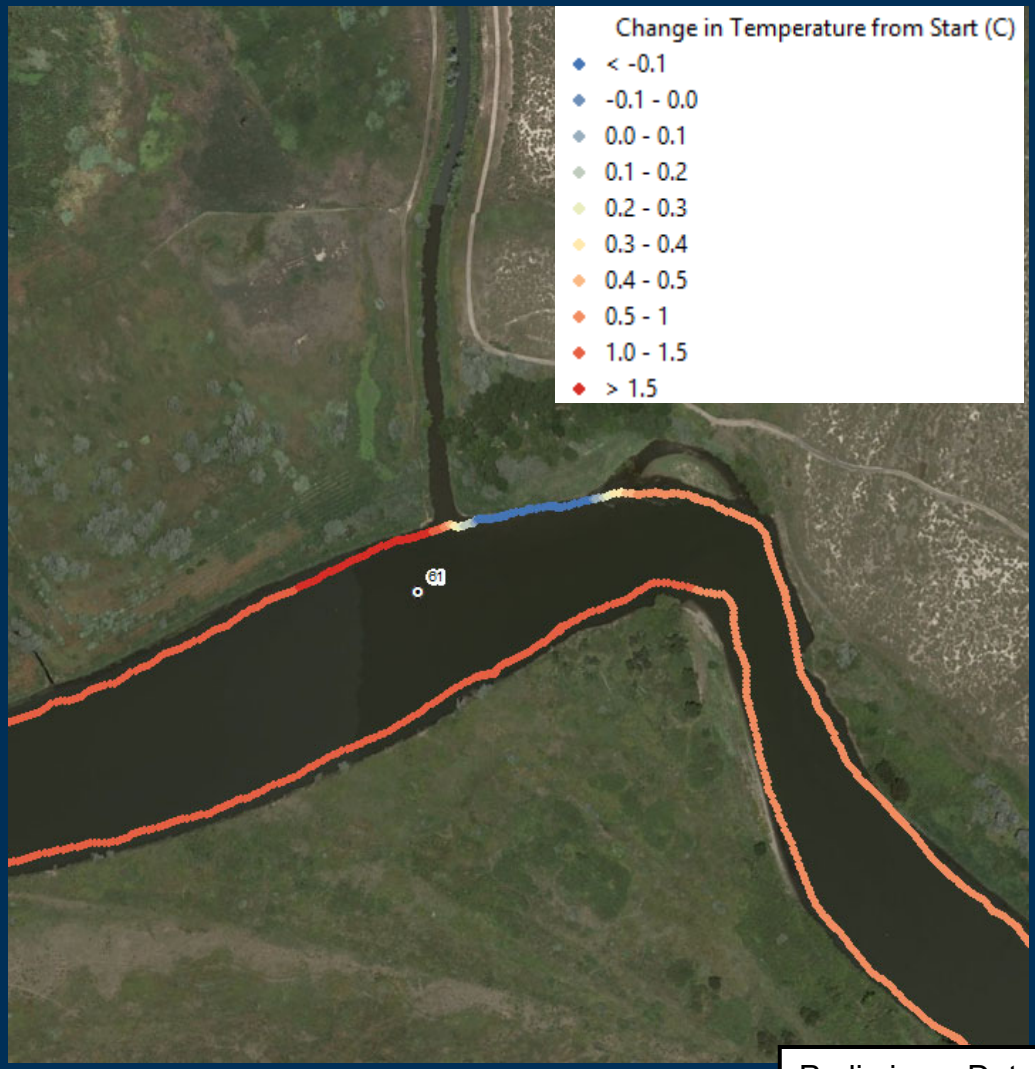

Preliminary Data – Subject to Revision

# Mabton Reach: 8/17/18




Preliminary Data – Subject to Revision

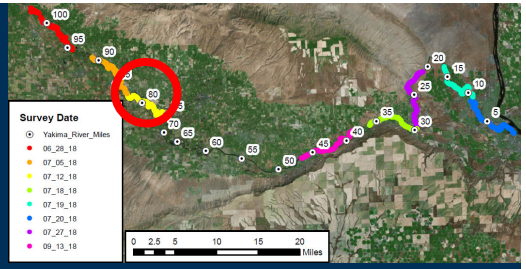
# Surface-Water Return: Sulphur Creek Wasteway



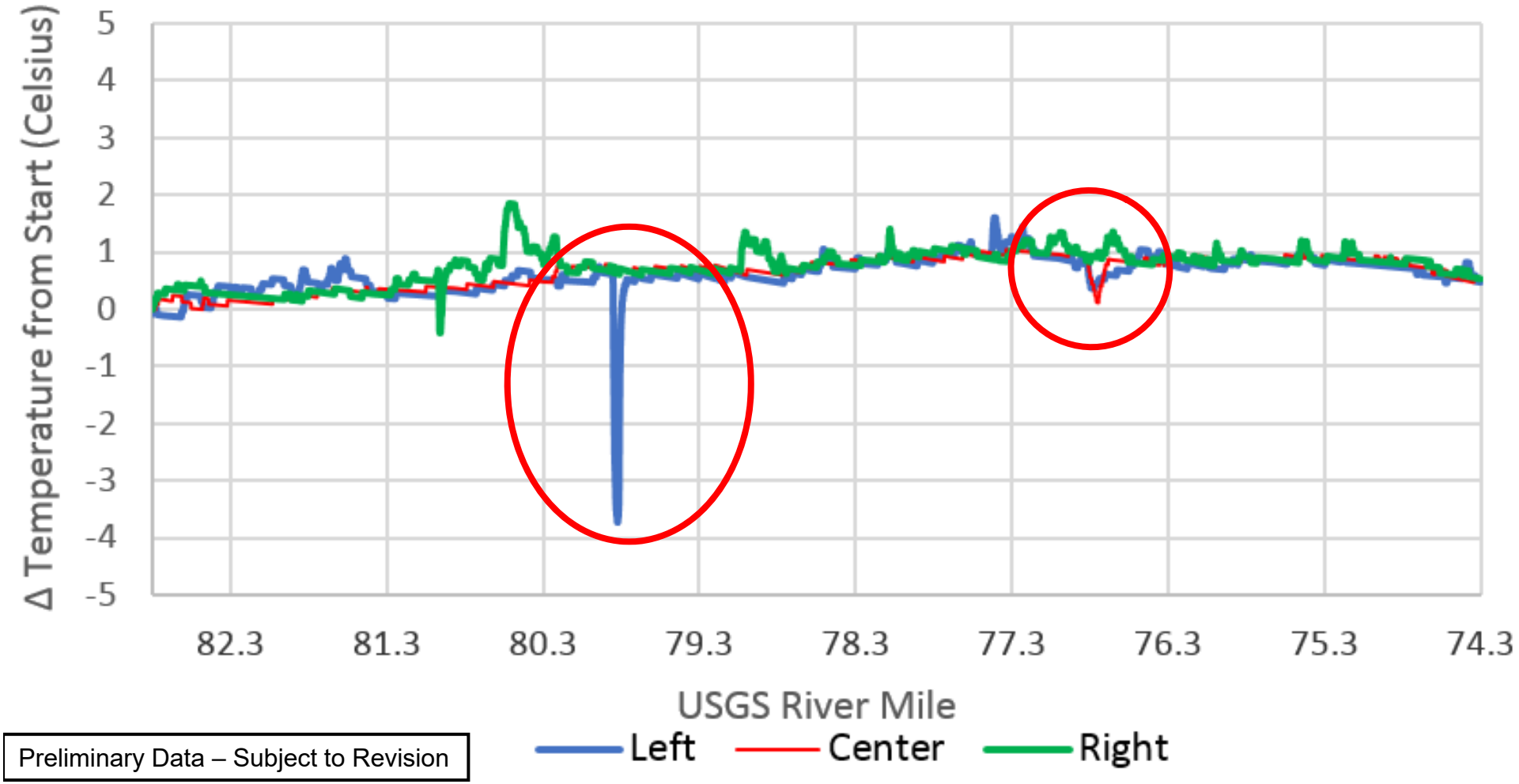

USGS

Preliminary Data – Subject to Revision

# Granger Reach: 7/12/18

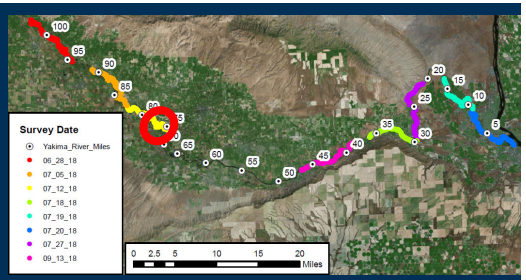


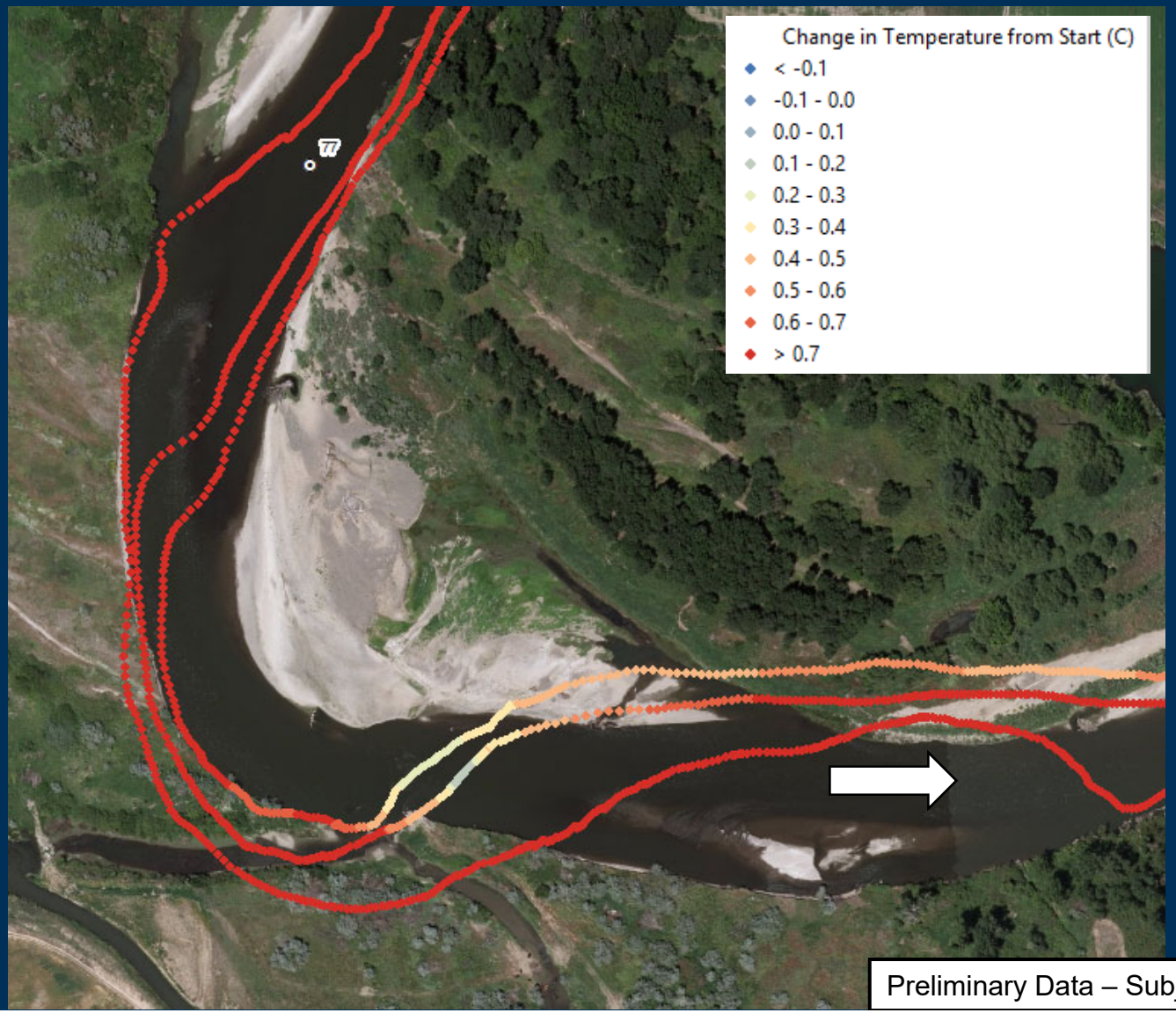

## Granger to Horse Heaven Hills Ranch




Preliminary Data – Subject to Revision

# Deep Pool: Granger Reach

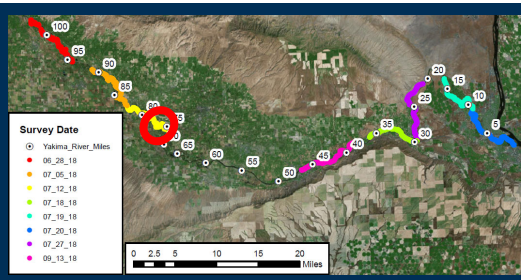



USGS

Preliminary Data – Subject to Revision

# Spring?: Granger Reach




Change in Temperature from Start (C)
- < -0.1
- -0.1 - 0.0
- 0.0 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.4
- 0.4 - 0.5
- 0.5 - 0.6
- 0.6 - 0.7
- > 0.7

USGS

Preliminary Data – Subject to Revision

# Summary and Next Steps

- Nine lower Yakima reaches profiled in 2018
  - Two to three profiles per reach (left, center, right)
  - Complements previous profiles (Vaccaro, 2011)
- 2018 thermal profiles analysis
  - Where are thermal refugia and are they stable over time?
  - Comparison to previous thermal profiles
  - Geomorphic/hydrogeologic conditions
  - Changes in river morphology/basin groundwater/surface-water system between 2018 and 2001-2008 (Vaccaro, 2011)

USGS

# Special thanks to all our partners and local citizens who ferried boats down the river!

Marcie Appel
Jim Carroll
Marlin Colfax
Alex Conley
Amy Cook
Cyrus Dick
Tom Elliott
Amy Fishburn
Sean Gross
Konrad Kauer
Donald Kishwalk
Rachel Little
Jim Loomis
Pat Monk
Evan Newell
Mark Nielson
Connor Parish
Chris Perra
Melissa Pierce
Danielle Squeochs
Hoda Sondossi
Alex Williams
Rebecca Wassell
Karen Wieda

# Acknowledgements


- Funding - Integrated Plan, Department of Ecology and USGS
- Benton Conservation District
- Yakama Nation
- Department of Ecology


# Questions?


- Andy Gendaszek (agendasz@usgs.gov)


USGS

# References


- Konrad, C.P. (2006) Location and Timing of River-Aquifer Exchanges in Six Tributaries to the Columbia River in the Pacific Northwest of the United States. Journal of Hydrology, 329, 444-470. https://doi.org/10.1016/j.jhydrol.2006.02.028
- Vaccaro, J.J., and Maloy, K.J., 2006, A thermal profile method to identify potential ground-water discharge areas and preferred salmonid habitats for long river reaches: U.S. Geological Survey Scientific Investigations Report 2006-5136, 16 p.
- Vaccaro, J.J., 2011, River-aquifer exchanges in the Yakima River basin, Washington: U.S. Geological Survey Scientific Investigations Report 2011-5026, 98 p.


USGS