Thermal Profiling of Long River Reaches to Characterize Ground-Water Discharge and Preferred Salmonid Habitat

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Purpose

- Identify ground-water discharge locations

- Assess salmon habitat in relation to temperature

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Overview

- Ecological role of thermal regimes and ground-water discharge
- Method for thermal profiling
- Application to Yakima River Basin

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Thermal Regimes: Abiotic Driver of Aquatic Ecosystems

- Dissolved oxygen concentrations, metabolic and decomposition rates
- Algal and invertebrate communities
- Fish assemblages (summer and winter)
- Controls bioenergetics of the riverine system
- Increased biodiversity due to

  thermal diversity (long spatial/temporal variability)

  thermal structure (short spatial/temporal variability)

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Ground-Water Discharge is Basic to Ecological Function

- Provides preferred thermal structure and thus habitat for fish at different life-cycle stages
- Provides nutrients to the aquatic ecosystem
- Provides unique ecotone at interface where it interacts with surface-water (similar ecotones are some of the most productive of all habitats)

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Typical Methods for Measuring:

Streamflow Temperature

- *In situ*, fixed stations
- Remote sensing techniques

'snapshots' in space and time

Ground-water Discharge

- Discharge Measurements
- Mini-piezometers

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Need:

Method for Measuring Temperature and Ground-Water Discharge *in situ* in Large, Modified River Systems.

Yakima River: 1,600 mi network with mean annual discharge of at least 5 cfs

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Developed Thermal Profiling Method

- Longitudinal profile of the near-bottom water temperature, conductivity, and depth
- Measure continuously while drifting in a Lagrangian framework
- Long reaches: 8 ~ 25 km
  (typical study reach : 1 ~ 500 m)

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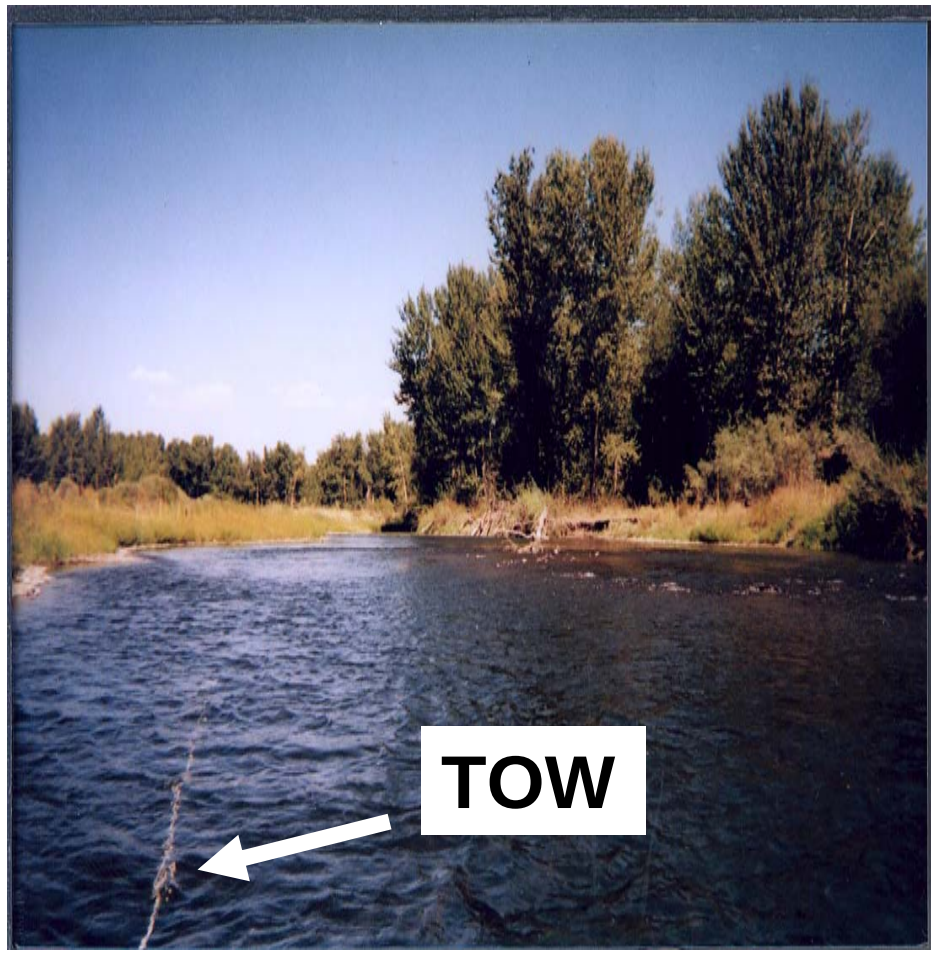
Self-Contained Data Logger & Vehicle

- Stainless steel in PVC container
- No wires to tow
- Sampling rate is adjustable (second to hours)
- ‘Generally’ safe method

Method Details

- Tow data logger(s) set to GPS time
- GPS data collected at 1-sec intervals
- CTD data collected at 1- to 3-sec intervals



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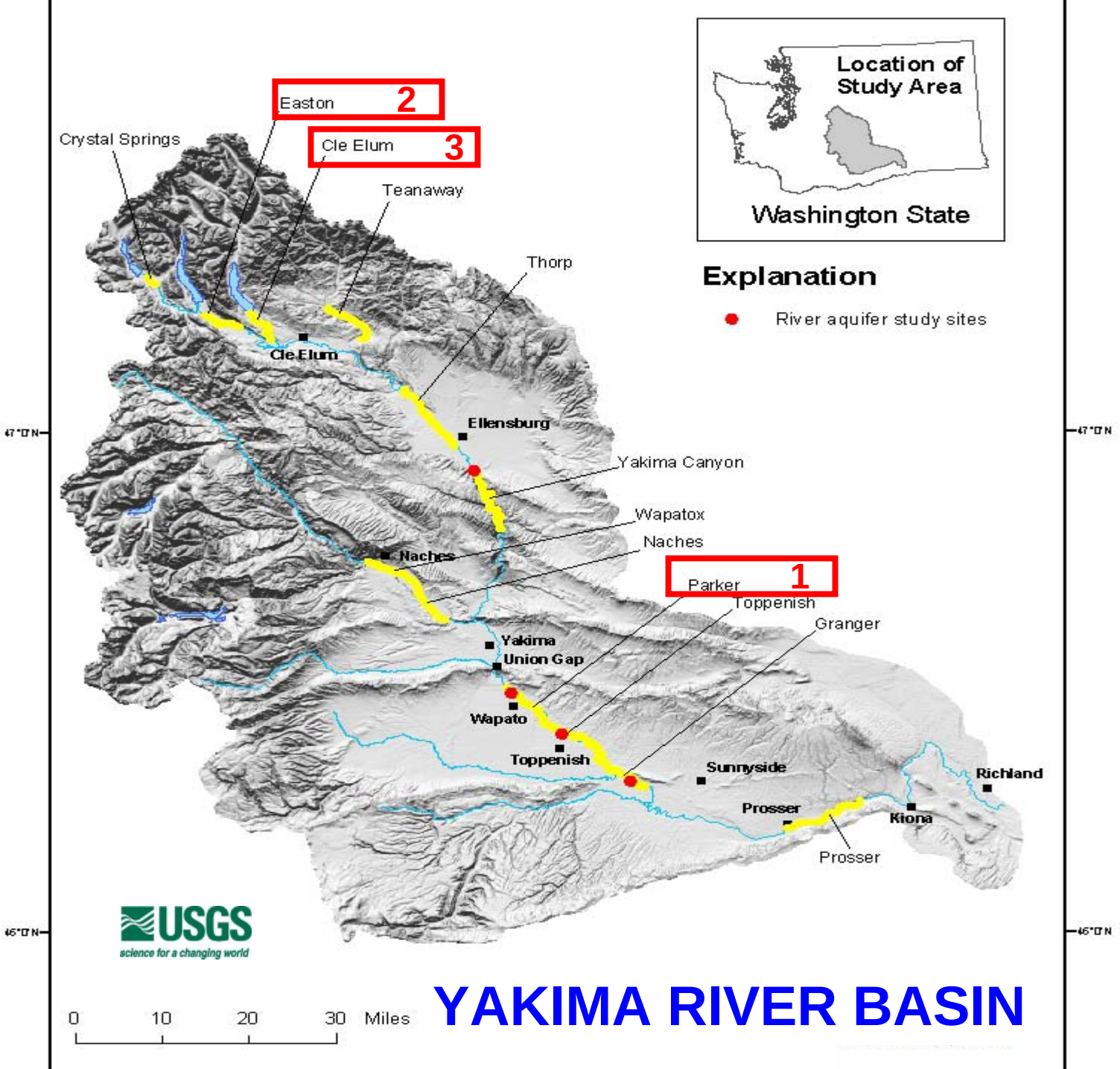
Location of Study Area
Washington State
Explanation
River aquifer study sites
Easton
2
Cle Elum
3
Crystal Springs
Teanaway
Thorp
Cle Elum
Ellensburg
Yakima Canyon
Wapatox
Naches
Naches
Parker
1
Toppenish
Granger
Yakima
Union Gap
Wapato
Toppenish
Sunnyside
Richland
Prosser
Kiona
Prosser
47°0'N
46°0'N
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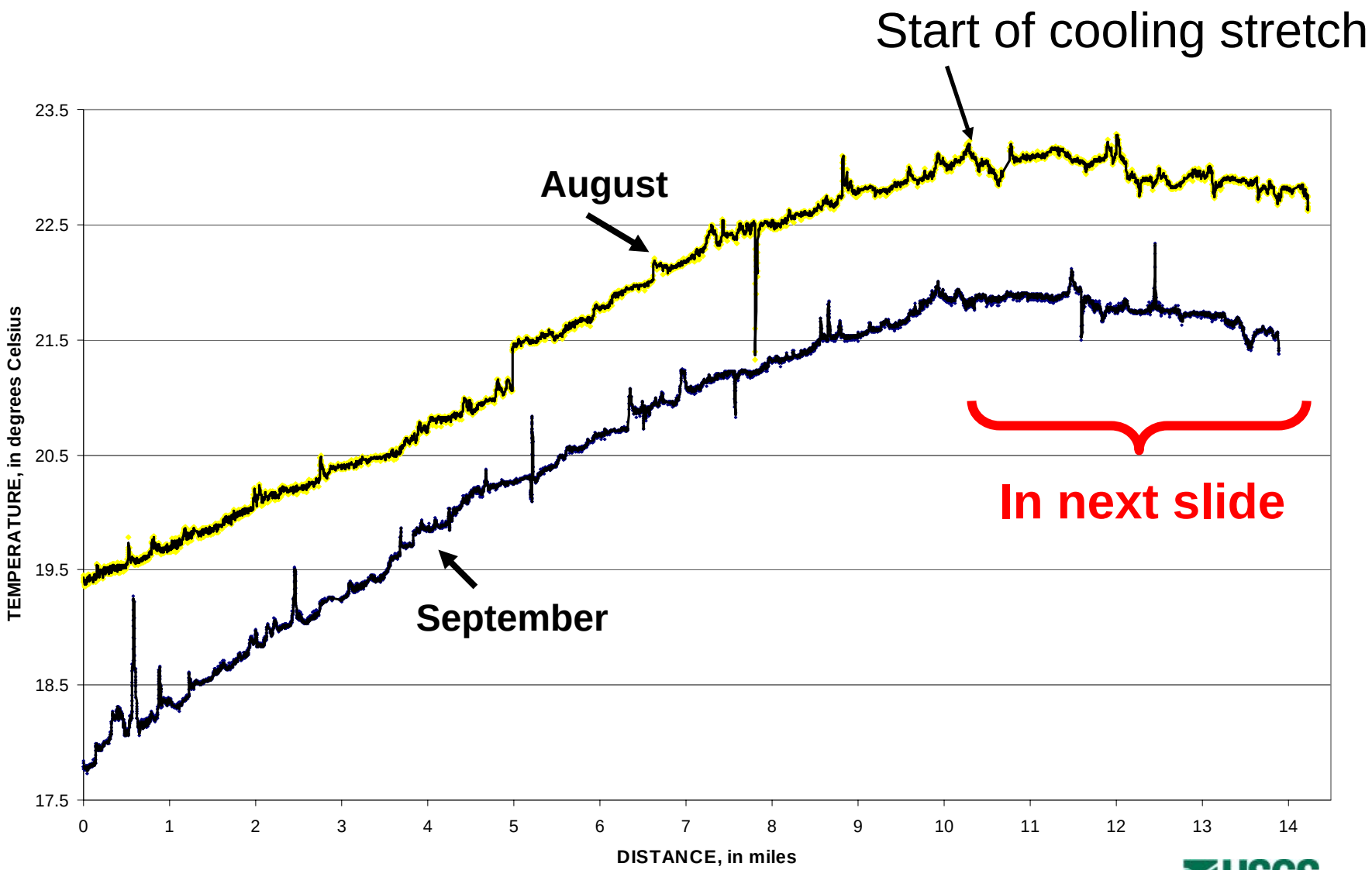
0
10
20
30
Miles
YAKIMA RIVER BASIN

Parker Reach: Reproducibility of Results



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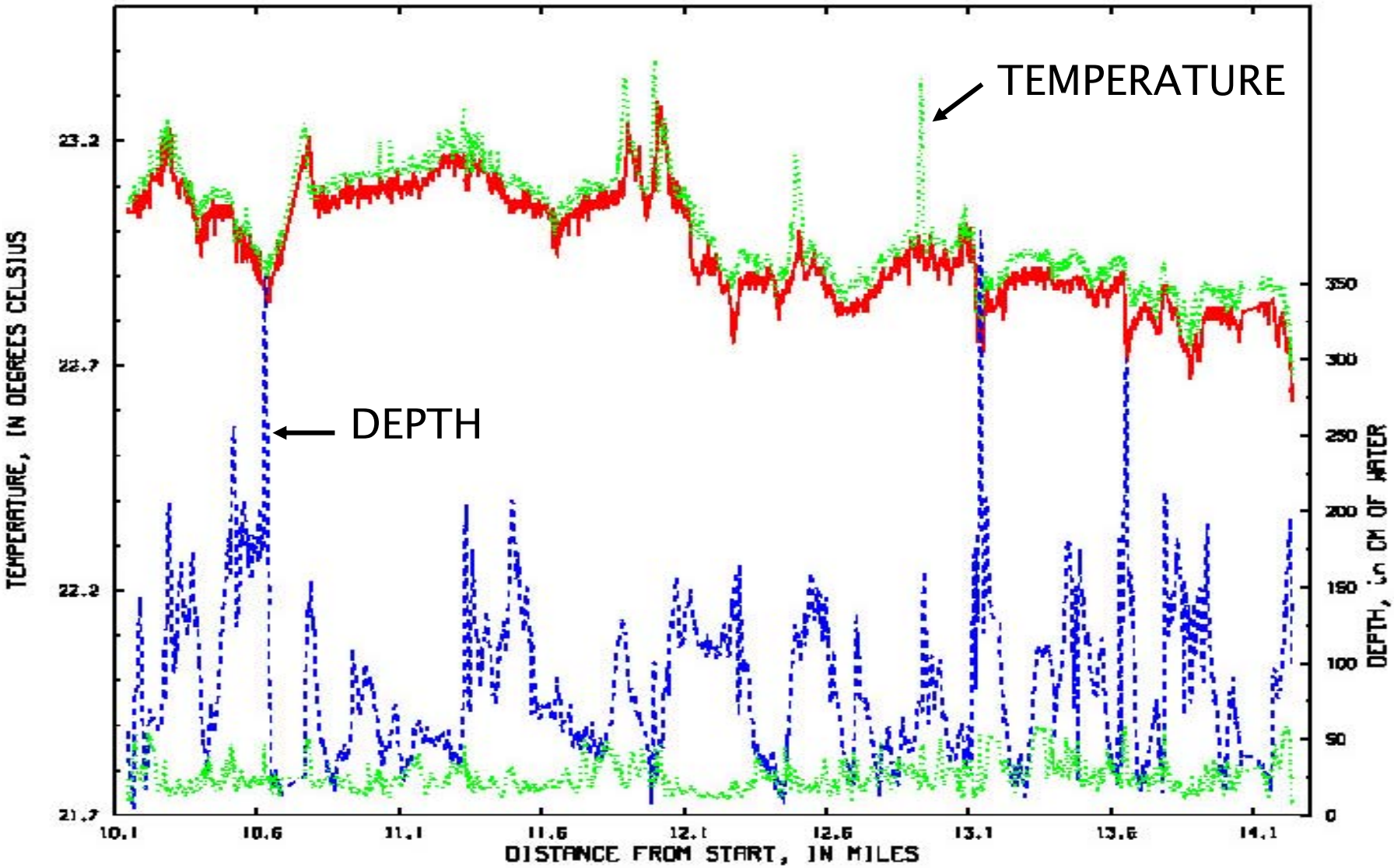
Parker Reach: : 4-mile Cooling Stretch



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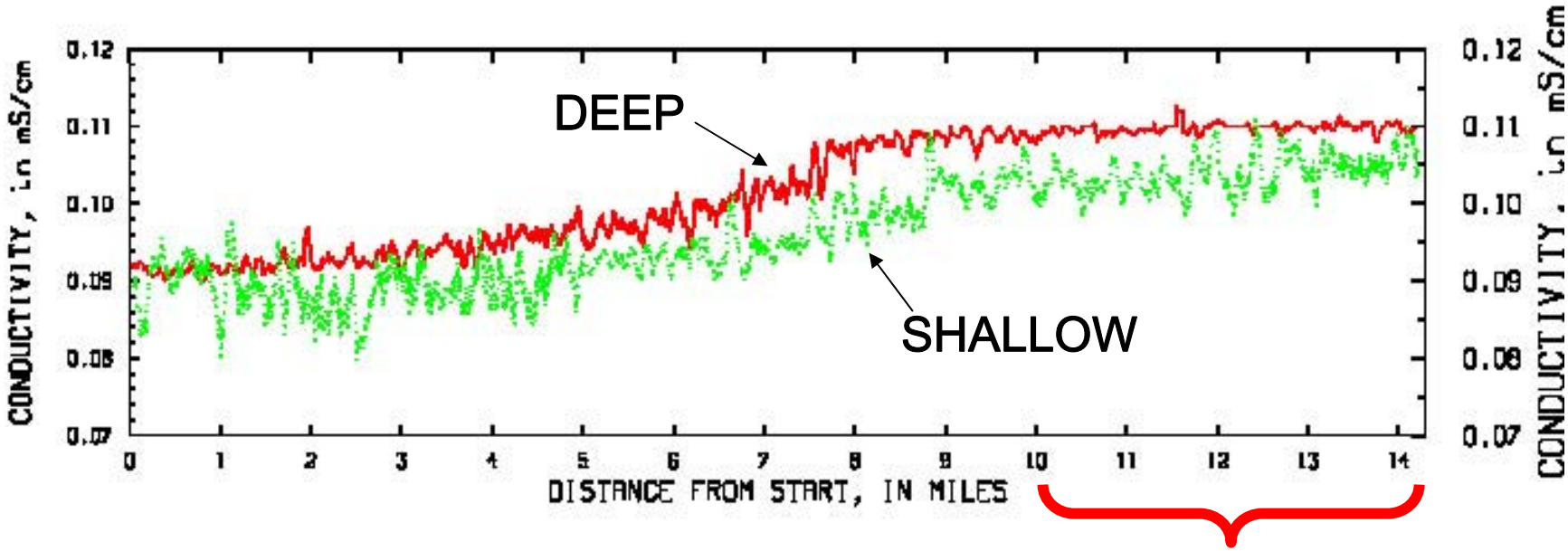
Parker Reach: Conductivity (30-sec moving average)

August 2001



Cooling stretch

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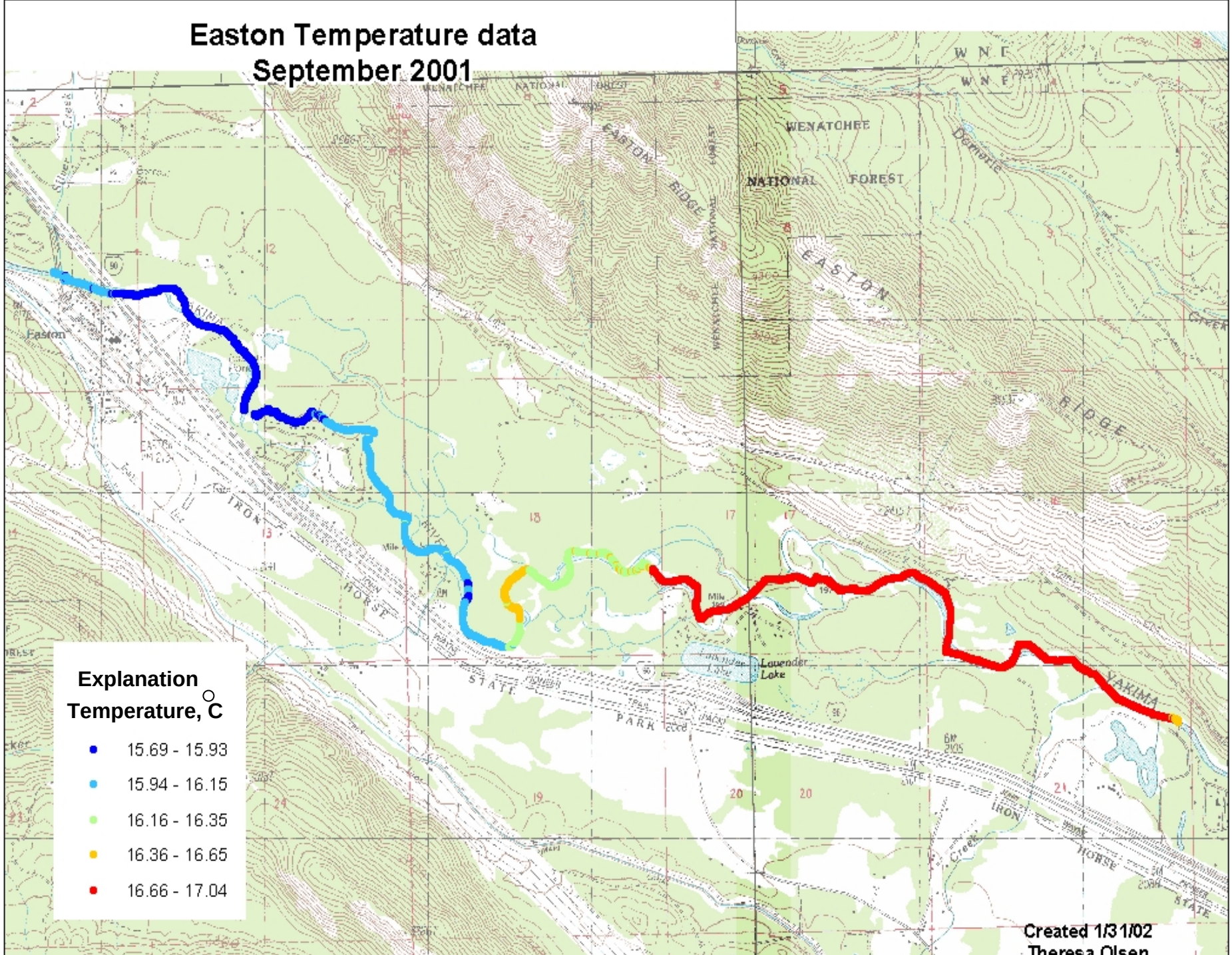
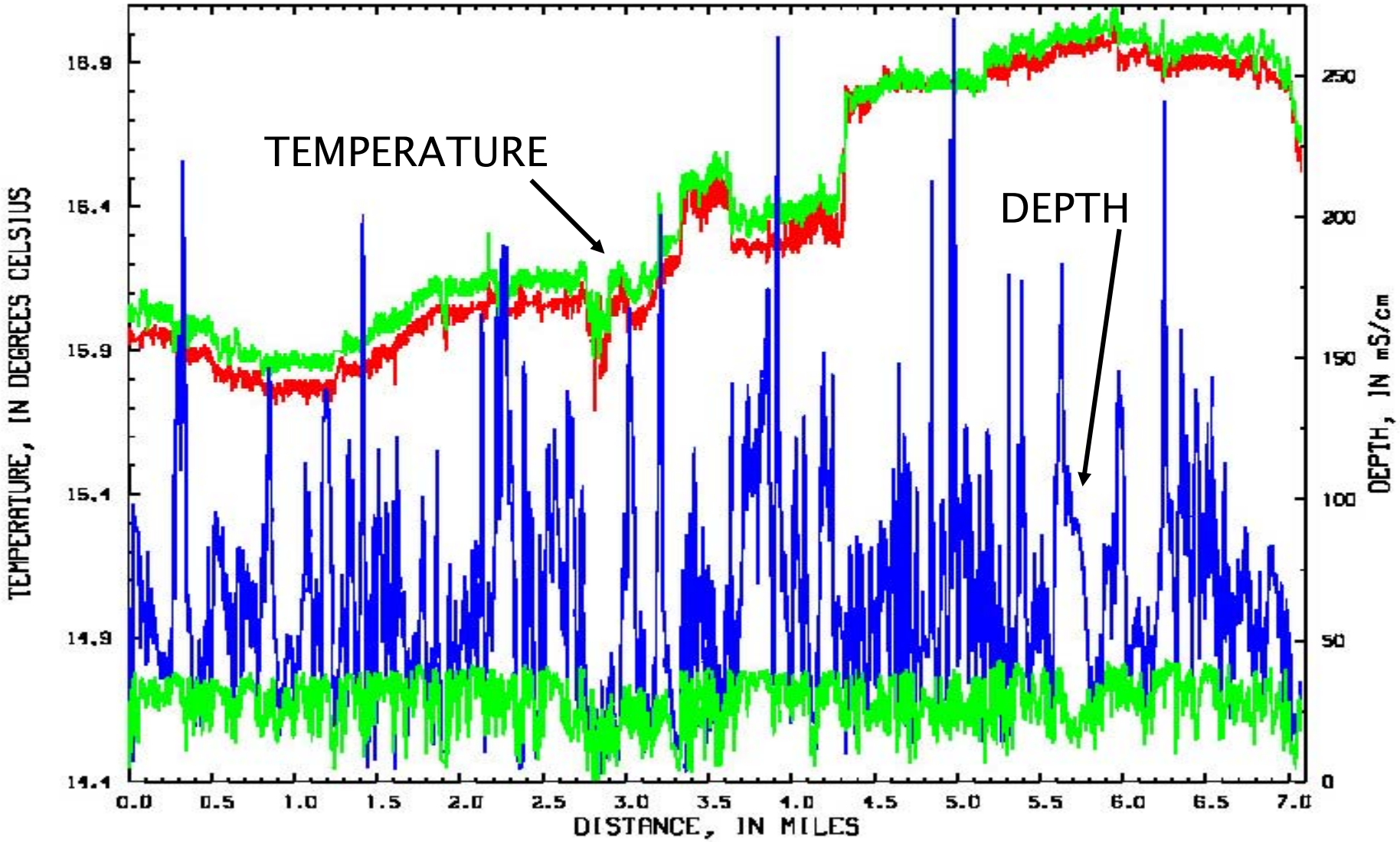

Easton Temperature data
September 2001
Explanation
Temperature, C
15.69 - 15.93
15.94 - 16.15
16.16 - 16.35
16.36 - 16.65
16.66 - 17.04
Created 1/31/02
Theresa Olsen

Easton Reach: Temperature and Depth



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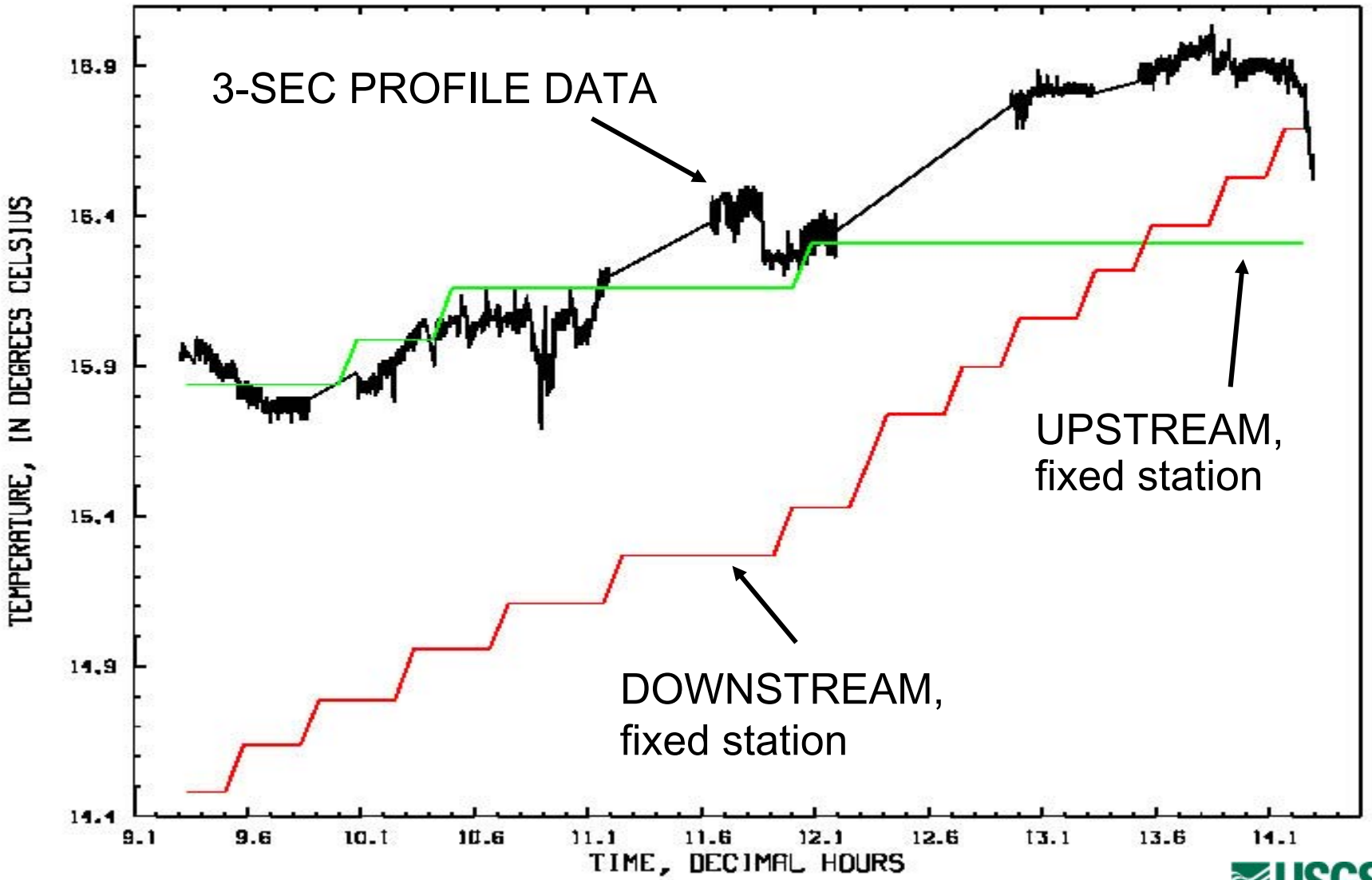
Easton Reach: Profile vs. Fixed-Station Data



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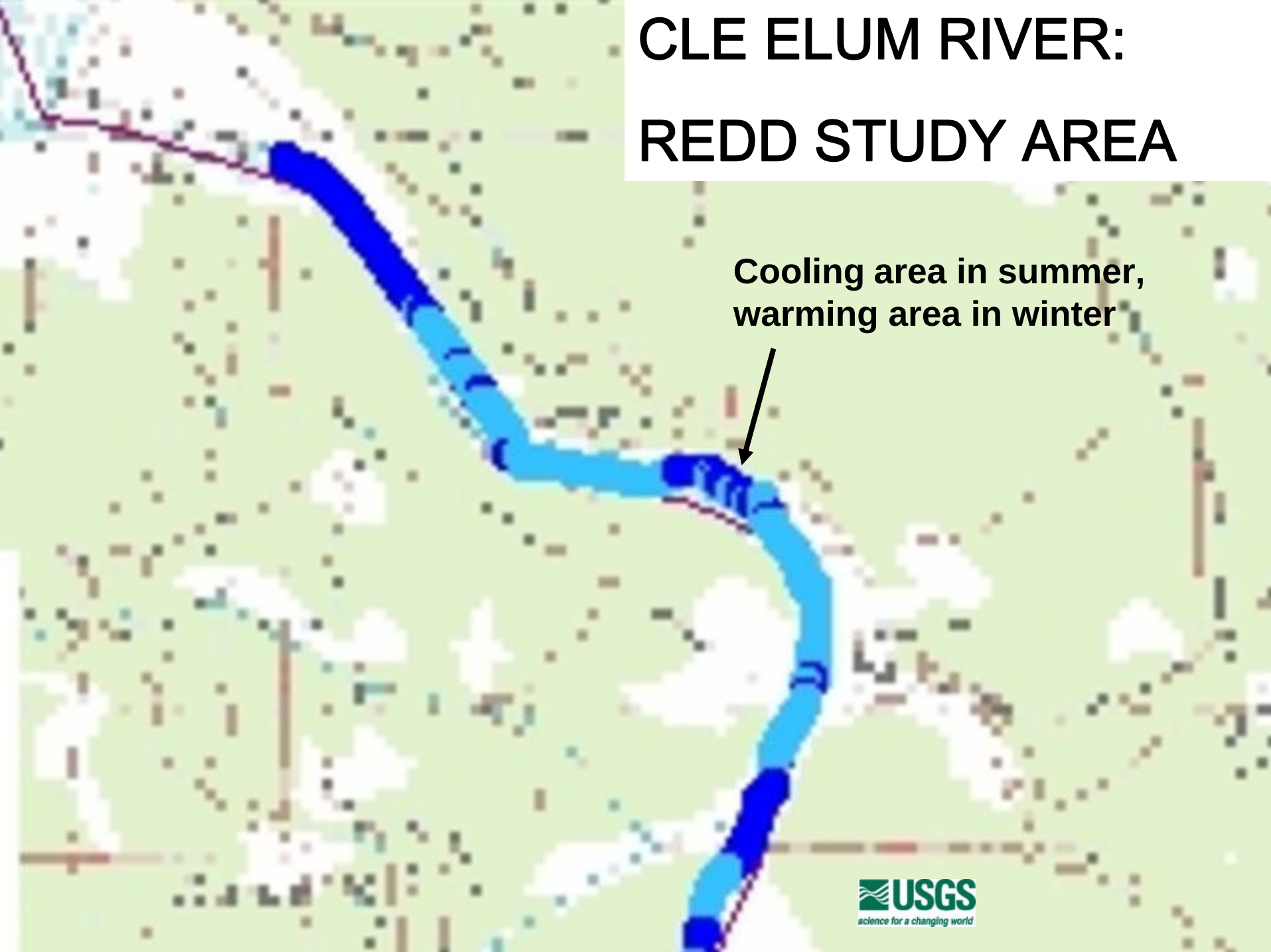
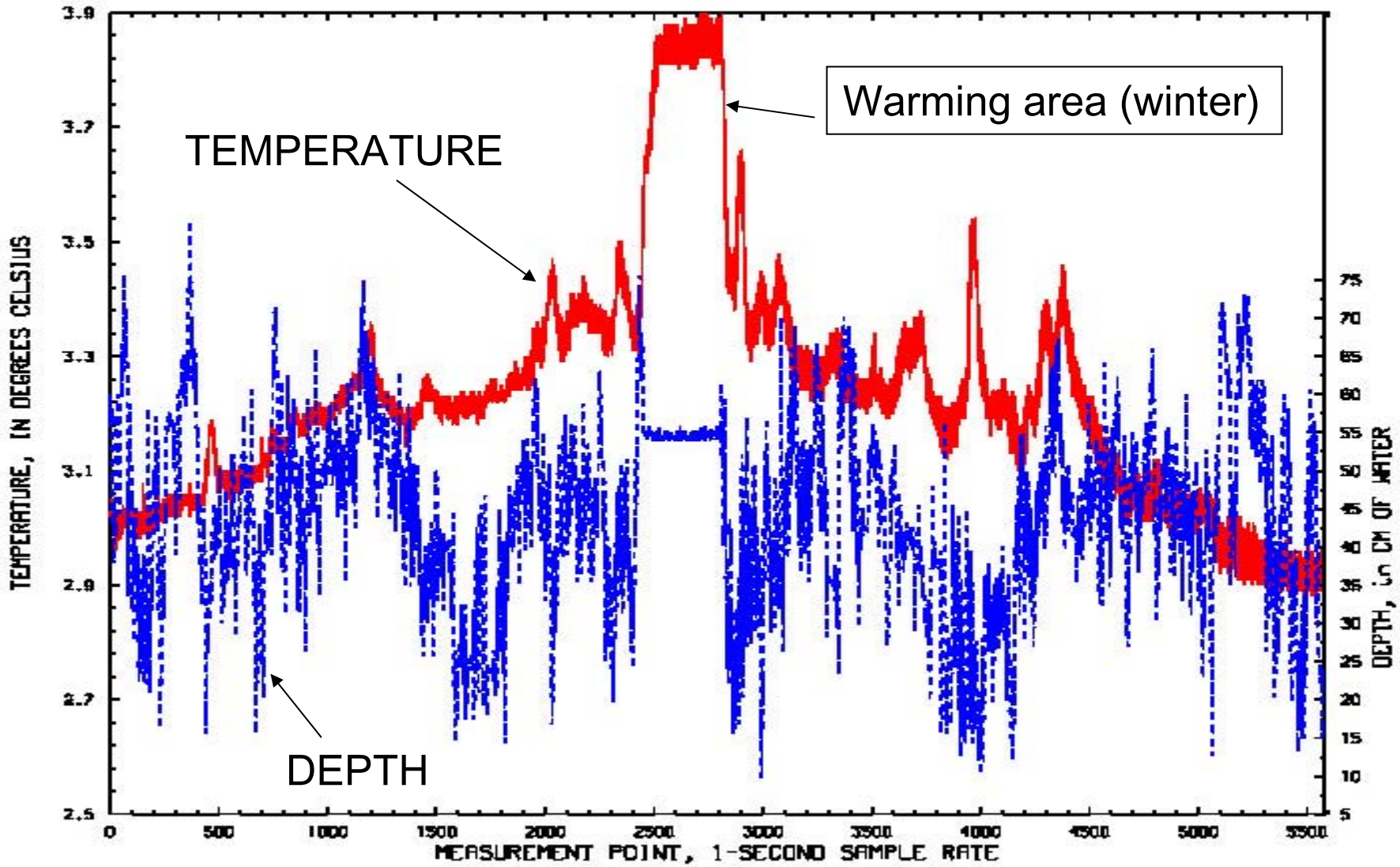
CLE ELUM RIVER:

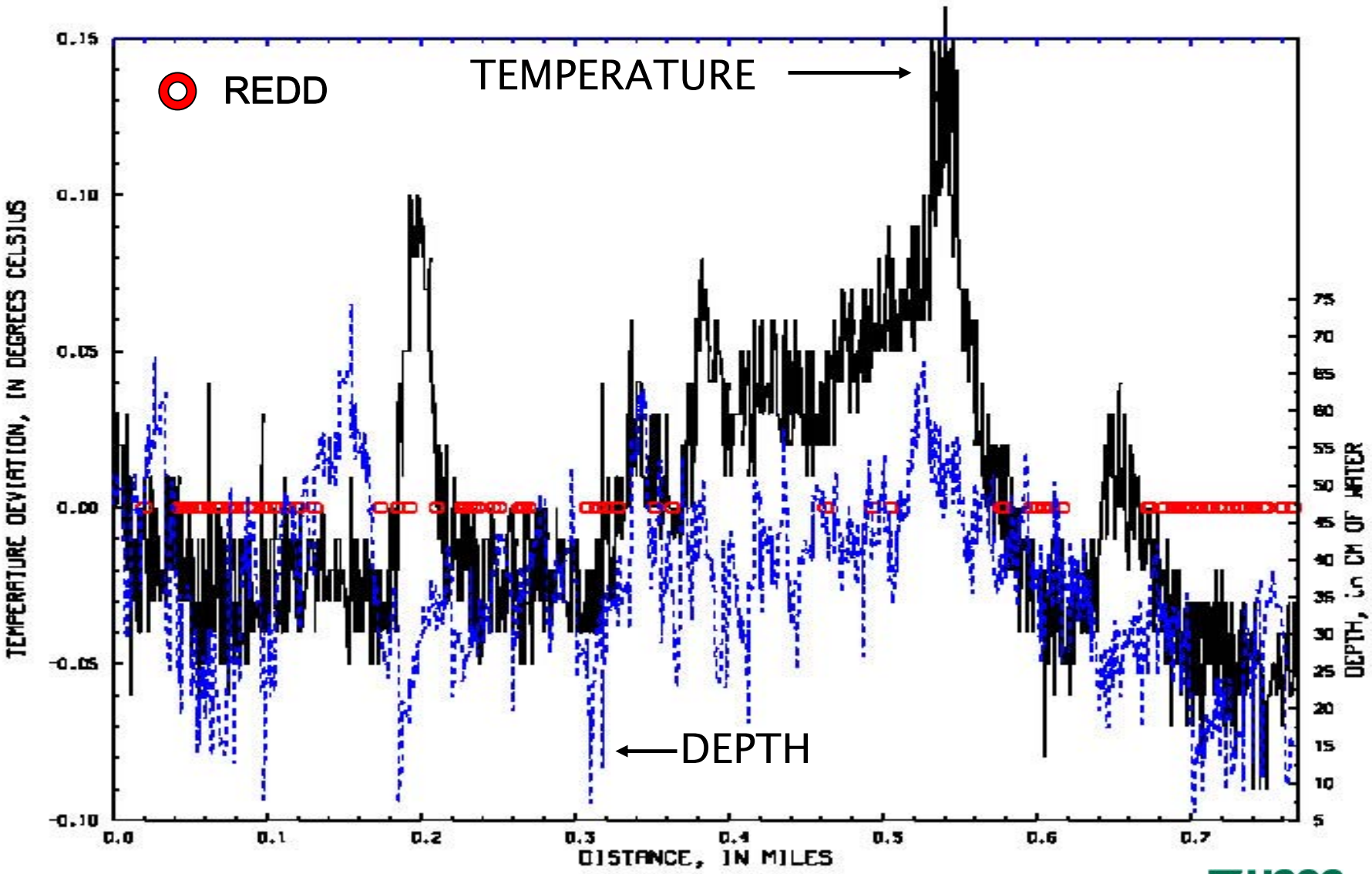
REDD STUDY AREA



Cle Elum River, Redd Study Area, Feb. 2002



Redds in Relation to Temperature deviations from Trends



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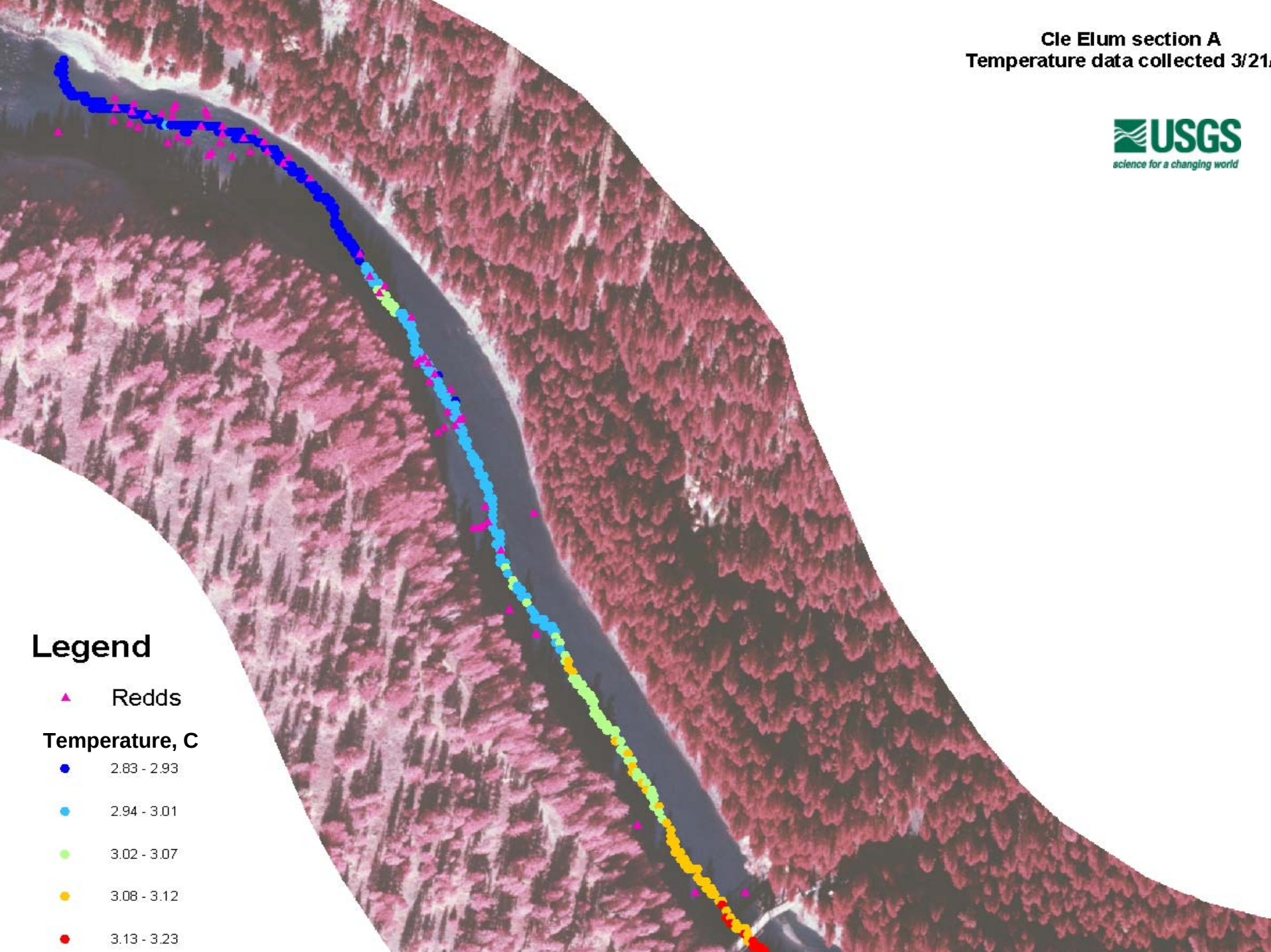
Cle Elum section A
Temperature data collected 3/21
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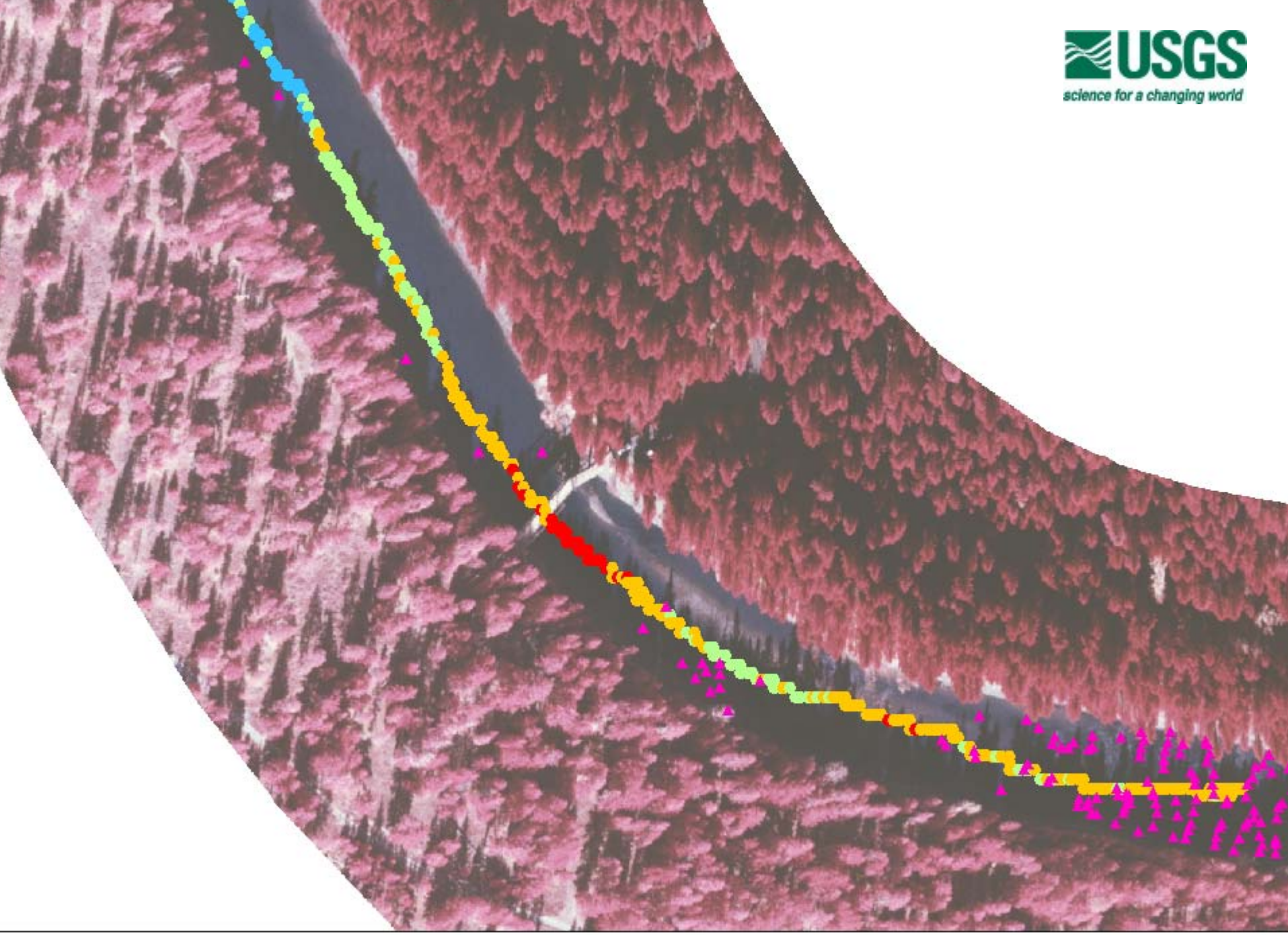
Legend
Redds
Temperature, C
2.83 - 2.93
2.94 - 3.01
3.02 - 3.07
3.08 - 3.12
3.13 - 3.23



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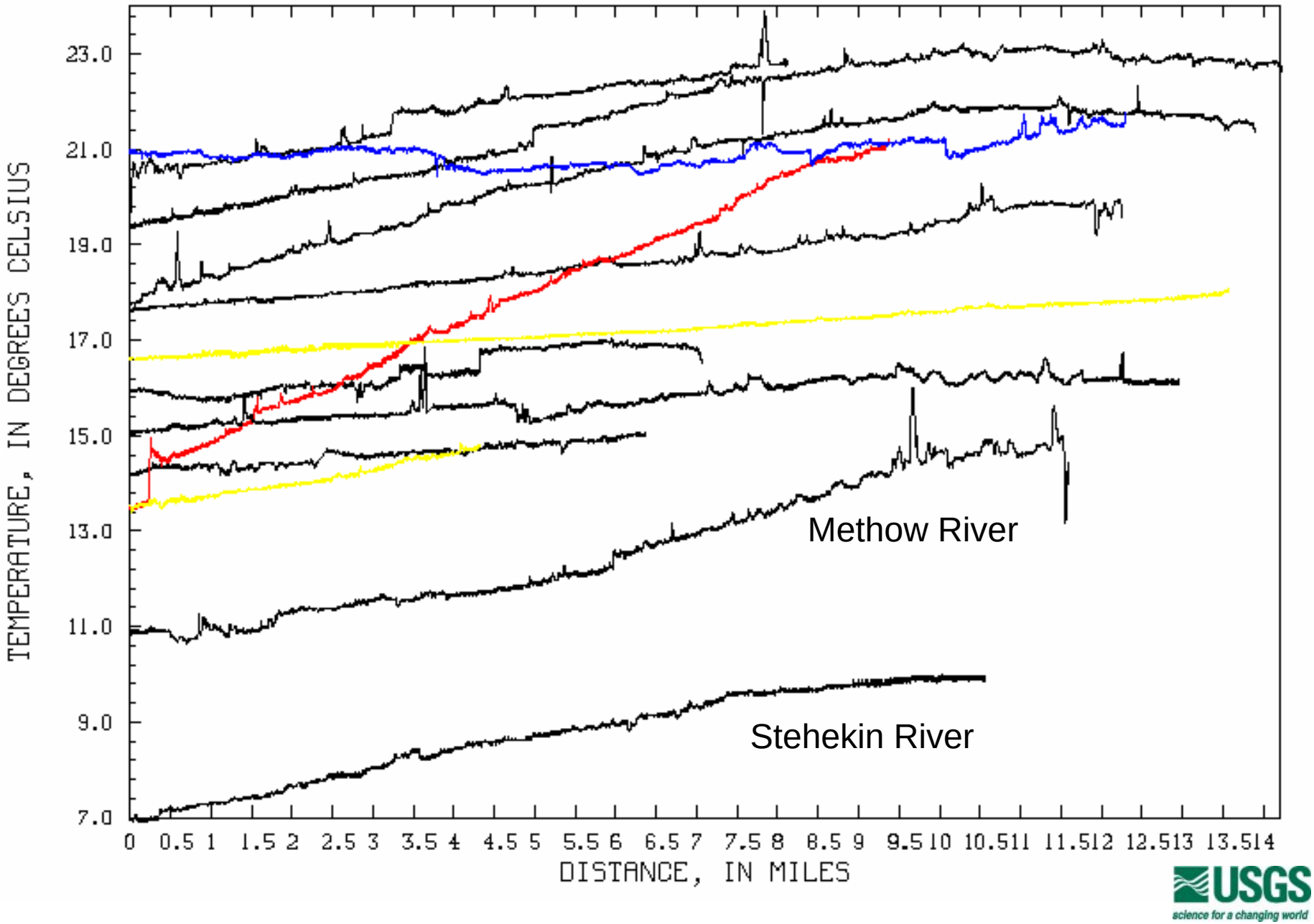

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Conclusions

- Thermal profiles provide a new perspective on the temperature regimes of rivers
- Aquatic habitat templet for lotic community patterns
  - different life stages/life-history patterns of salmonids
  - logical progression of the longitudinal gradient of fish assemblages
- Ground-water discharge occurs over broad areas and very locally
  - localized discharge associated with dry tributaries, side channels, geomorphic controls, springs