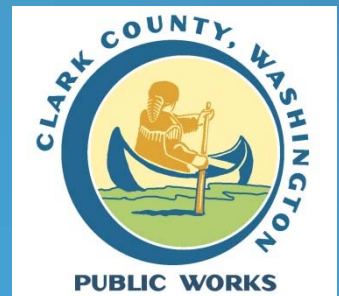


Simple Graphical Analyses of Average Maximum Temperatures to Target Restoration of Stream Reaches

Case Study: Whipple Creek Watershed

Presenter: Bob Hutton, Clark County Department of Public Works
River Restoration Northwest Symposium, February 9, 2017

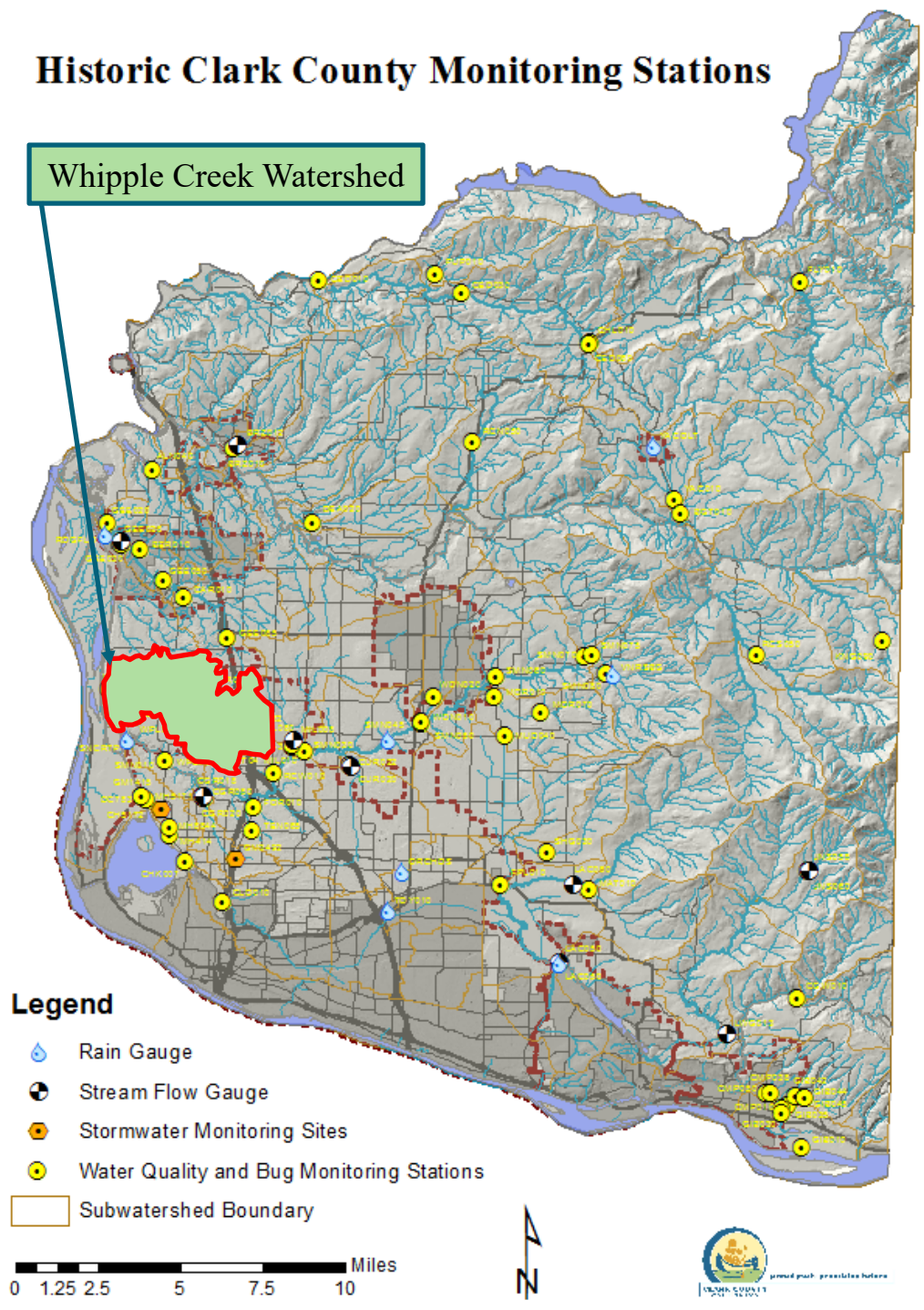


Stream Temperature Analyses - Introduction






- *Goal* – temperature insights
- *Issues* – sensitive species impacts, but “data deluge”
- *Solution* – intuitive plots
- *Case Study* -
Whipple Creek Watershed

Historic Clark County Monitoring Stations

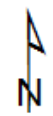
Whipple Creek Watershed



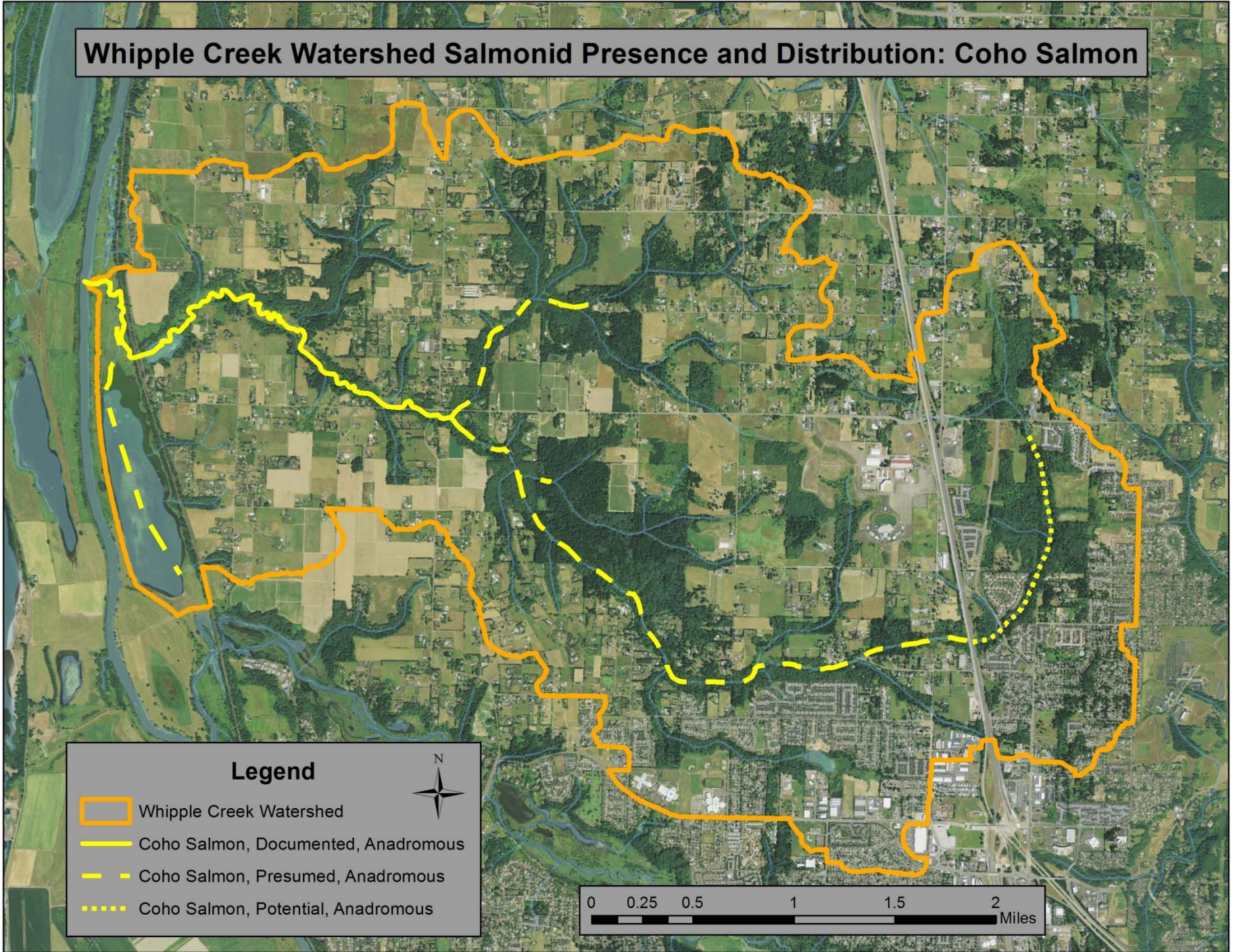
Legend

-  Rain Gauge
-  Stream Flow Gauge
-  Stormwater Monitoring Sites
-  Water Quality and Bug Monitoring Stations
-  Subwatershed Boundary

0 1.25 2.5 5 7.5 10 Miles



Whipple Creek Watershed Salmonid Presence and Distribution: Coho Salmon



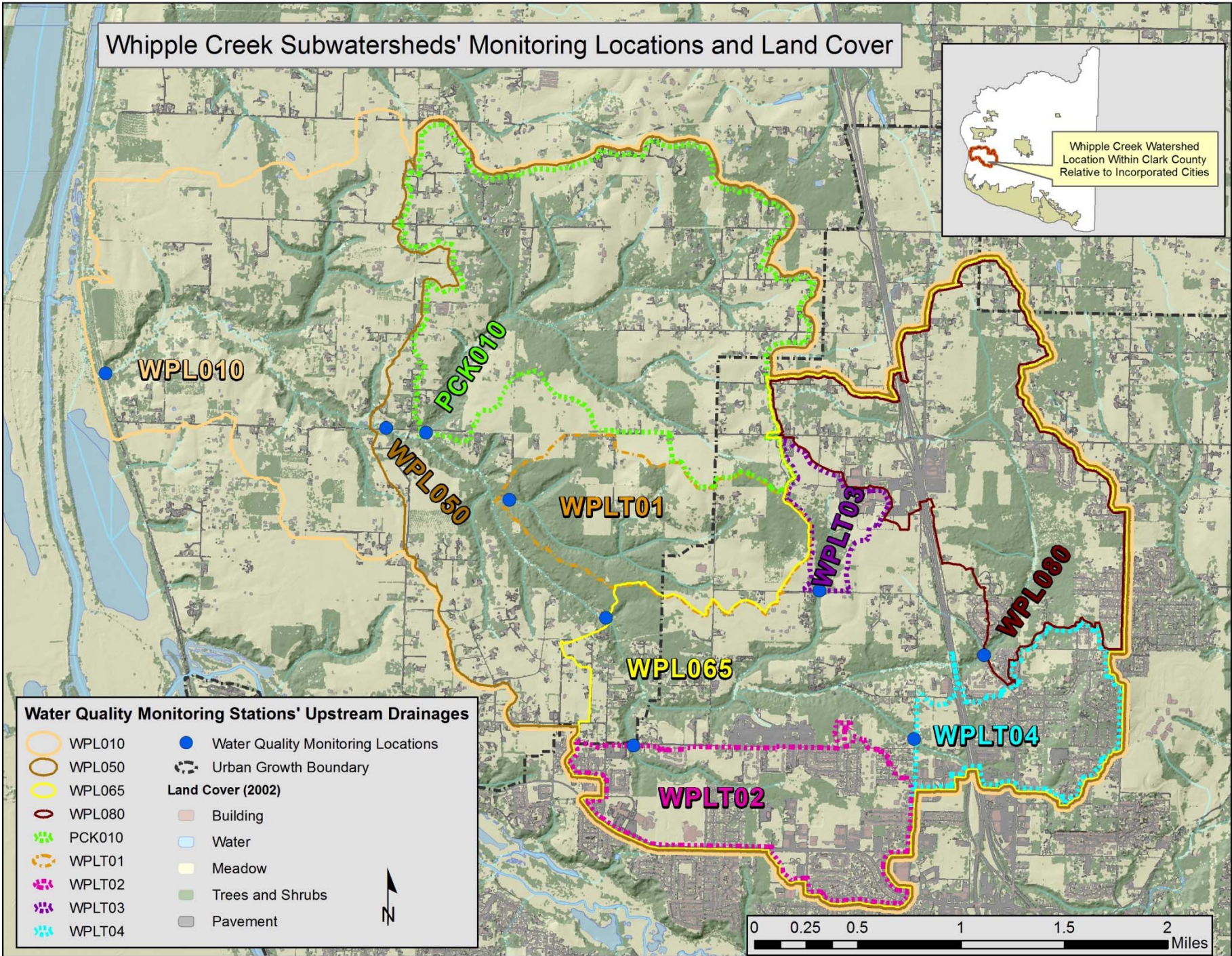
Stream Temperature Analyses - Methods

- Continuous summer stream temperature – 10 subwatersheds
- Weather context –NWS (PDX)
- Exploratory data analyses plots - contrast sites
- Emphasis - patterns / anomalies



Temperature sensor/logger deployed in shadow near bottom of creek

Whipple Creek Subwatersheds' Monitoring Locations and Land Cover



Water Quality Monitoring Stations' Upstream Drainages

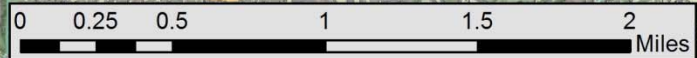
- WPL010
- WPL050
- WPL065
- WPL080
- PCK010
- WPLT01
- WPLT02
- WPLT03
- WPLT04

Water Quality Monitoring Locations

- Water Quality Monitoring Locations
- Urban Growth Boundary

Land Cover (2002)

- Building
- Water
- Meadow
- Trees and Shrubs
- Pavement





Stream Temperature Analyses - Results

- **Weather context** - departures from normal
- **Long-term monitoring site** - criteria exceedances
- **Watershed-wide** - criteria exceedances
- **Temperature patterns** - anomalies

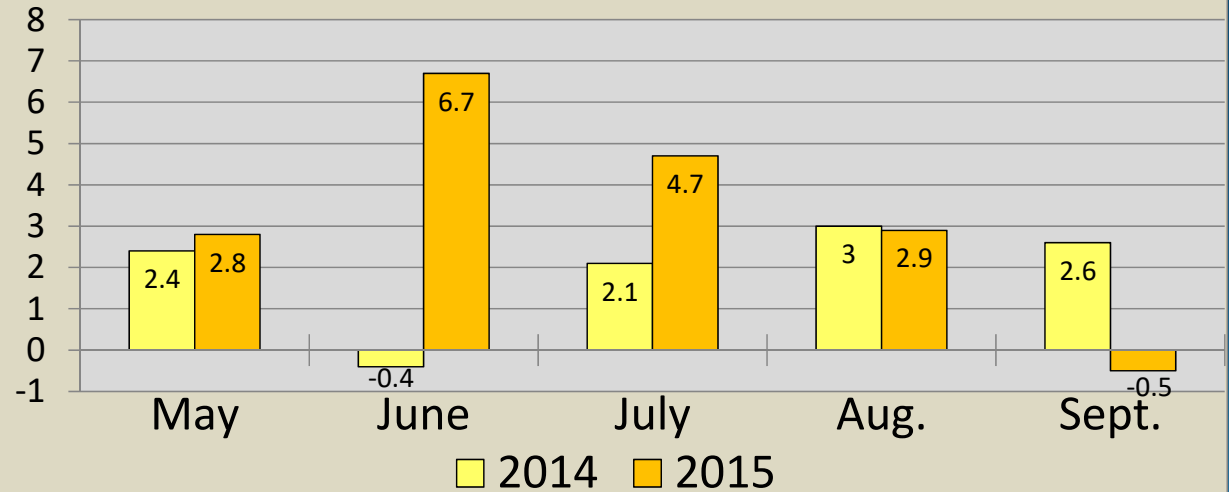
Weather Context

Summer Temperatures:
2014 - warmer
2015 - hotter

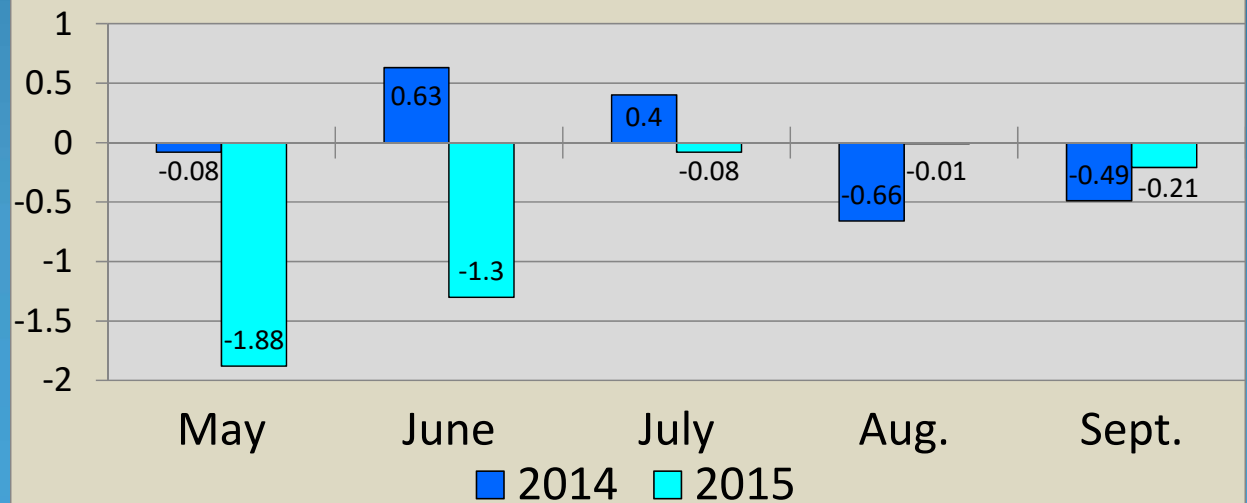
Summer Rainfall:
2014 - normal
2015 - drier

Sequence is important:
can exacerbate impacts

PDX Weather Station Departures from Normal: Mean Monthly Temperatures



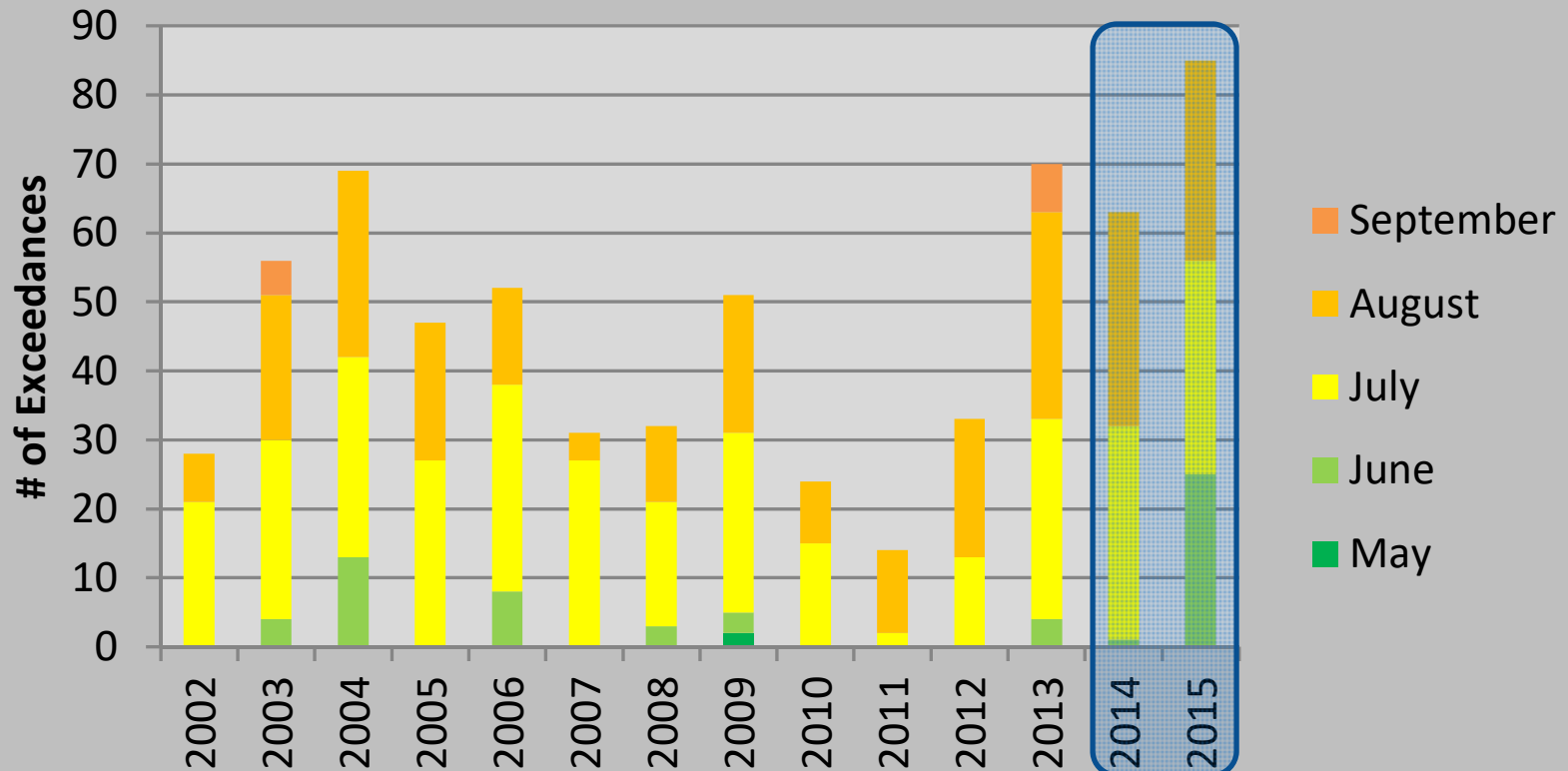
PDX Weather Station Departures from Normal: Total Monthly Rainfall



WPL050 for Historical Context But Study Focuses on Watershed-wide 2014 & 2015 Summer Temperatures

Whipple Creek at WPL050 Water Temperature

Daily Exceedances of 17.5°C (63.5°F) 7-Day Avg. Daily Maximums

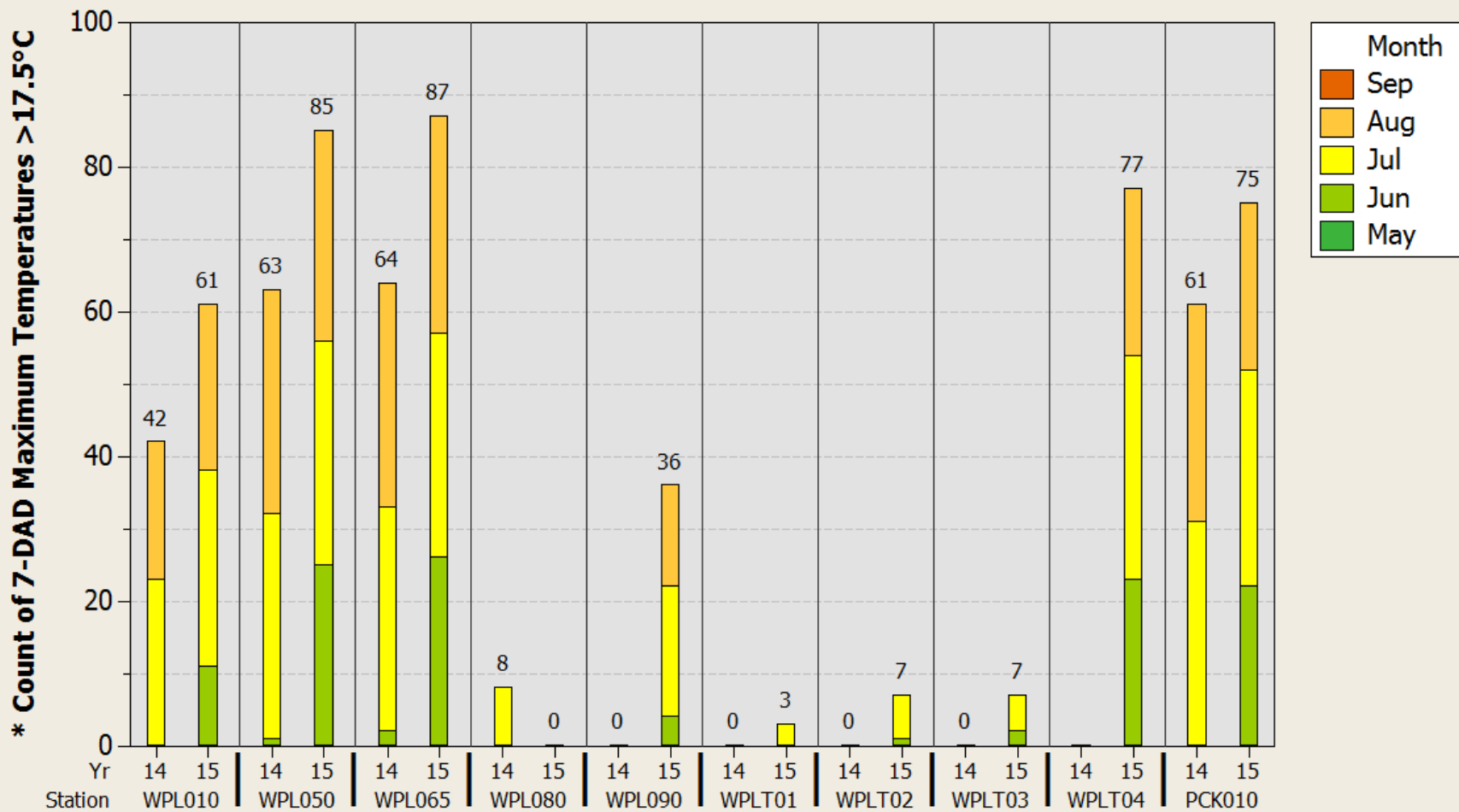


Subwatershed Comparison Over Two Summers

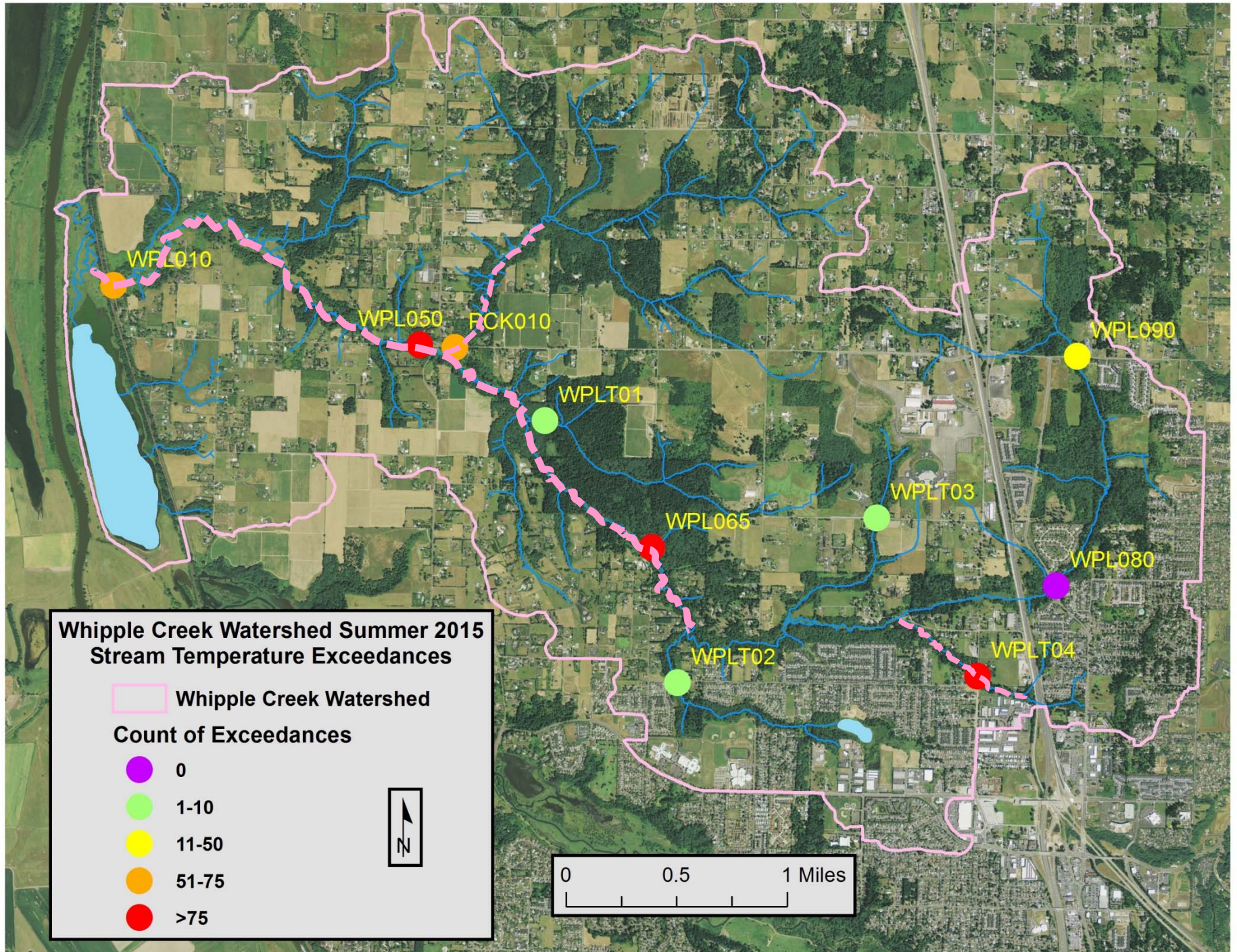
Stream Temperature Criteria Exceedances

Summer 2014 & 2015 Whipple Creek Subwatersheds

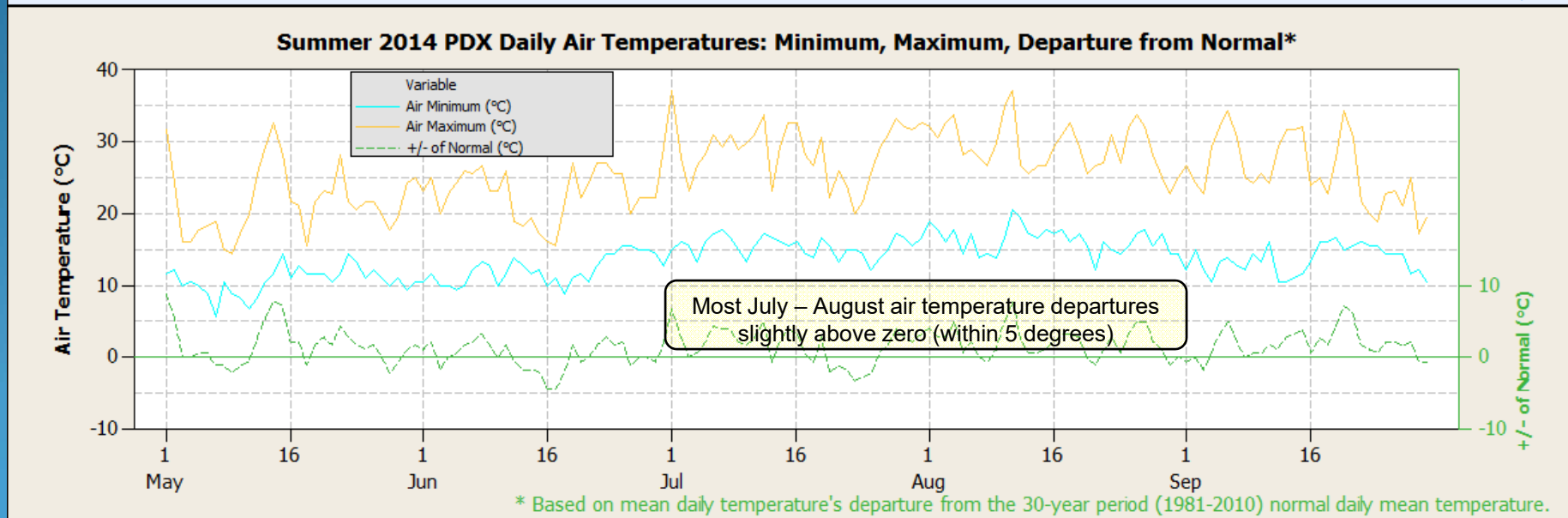
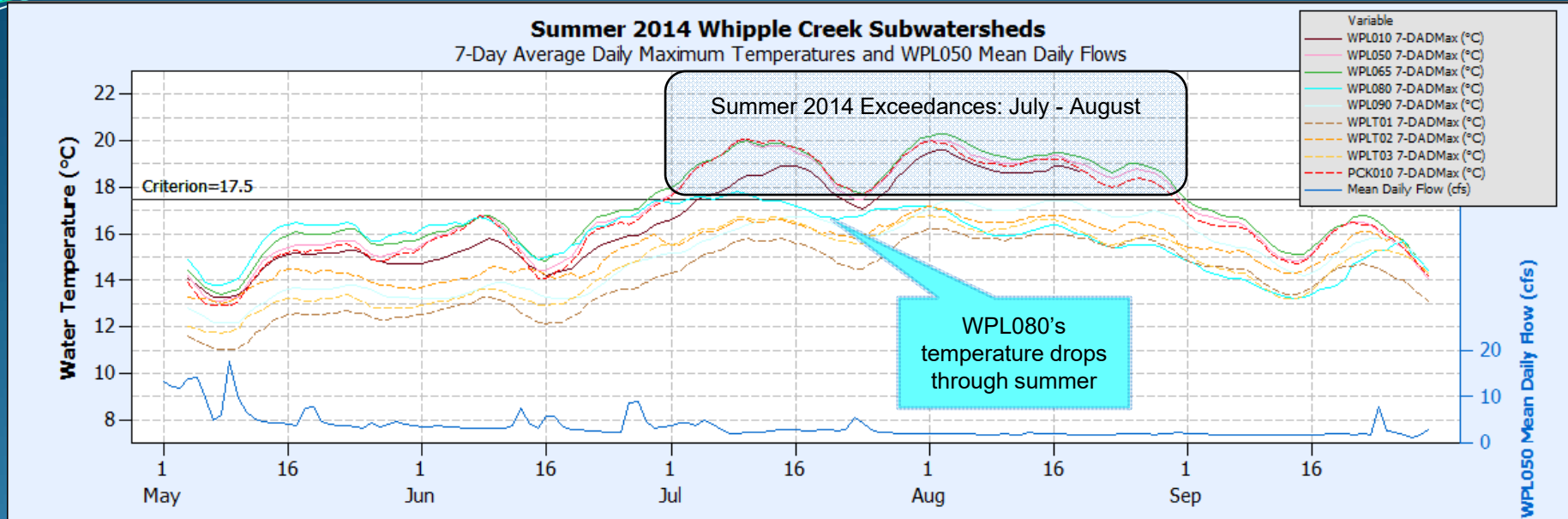
Monthly and Annual 7-DAD Maximum Stream Temperatures >17.5°C



* Counts exclude WPL010 August and September of 2014 when probe exposed to air and when no WPLT04 monitoring was done in 2014.

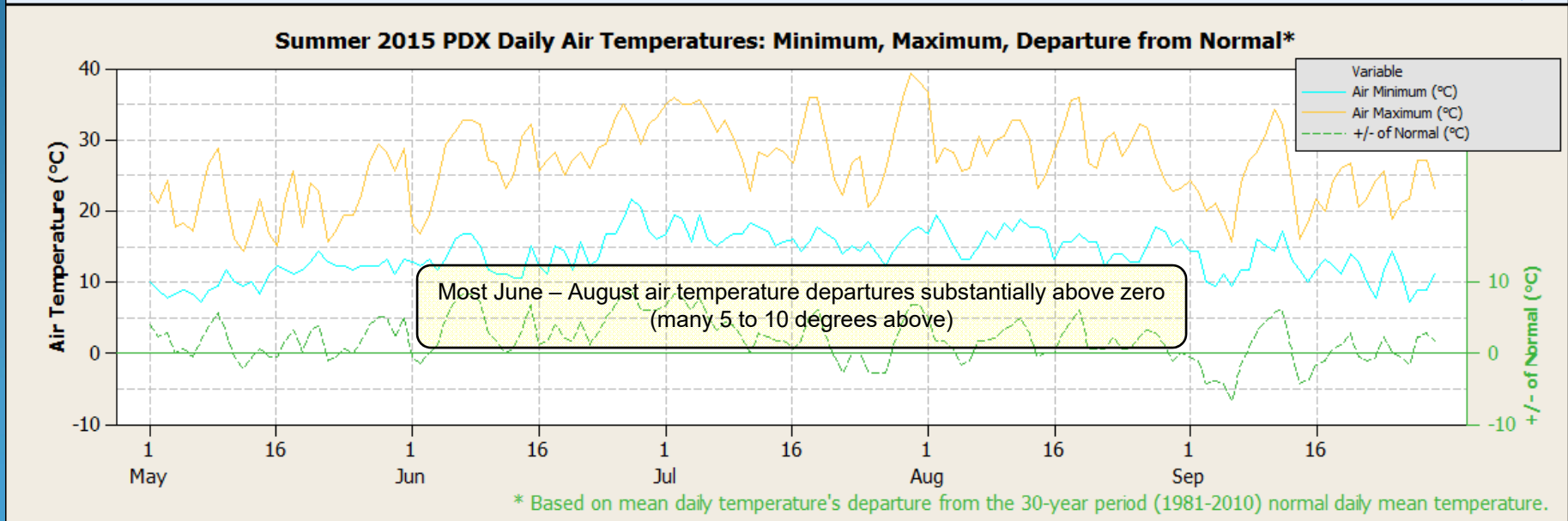
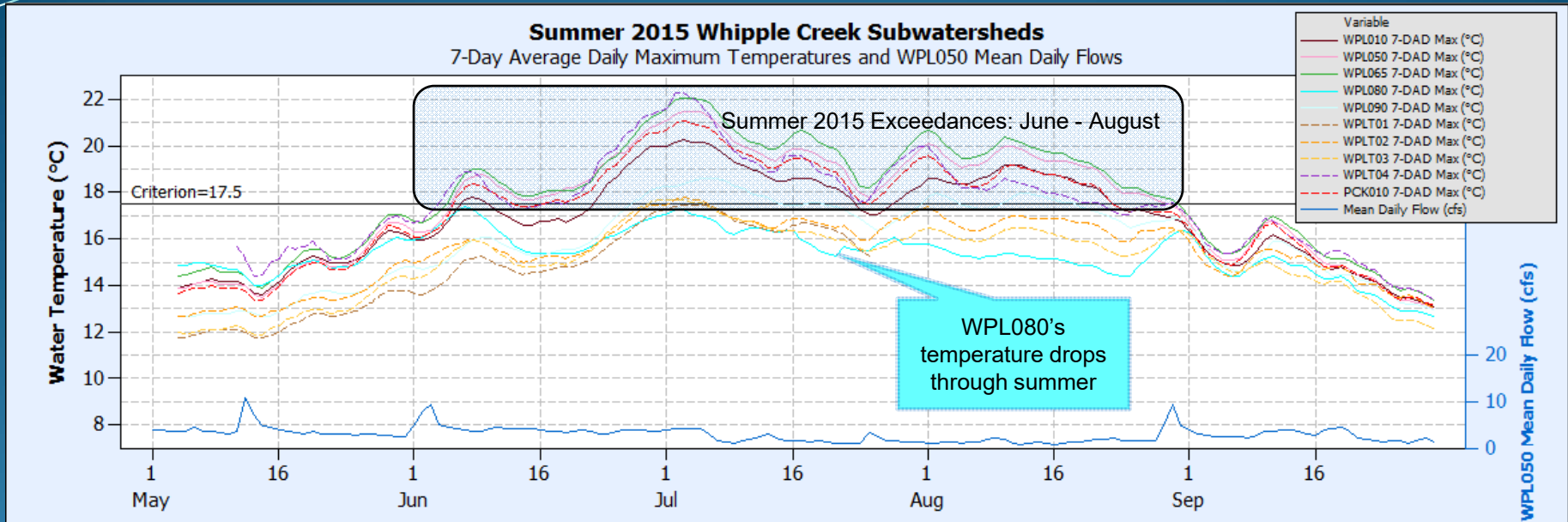


Time Series Plots: Summer 2014



* Based on mean daily temperature's departure from the 30-year period (1981-2010) normal daily mean temperature.

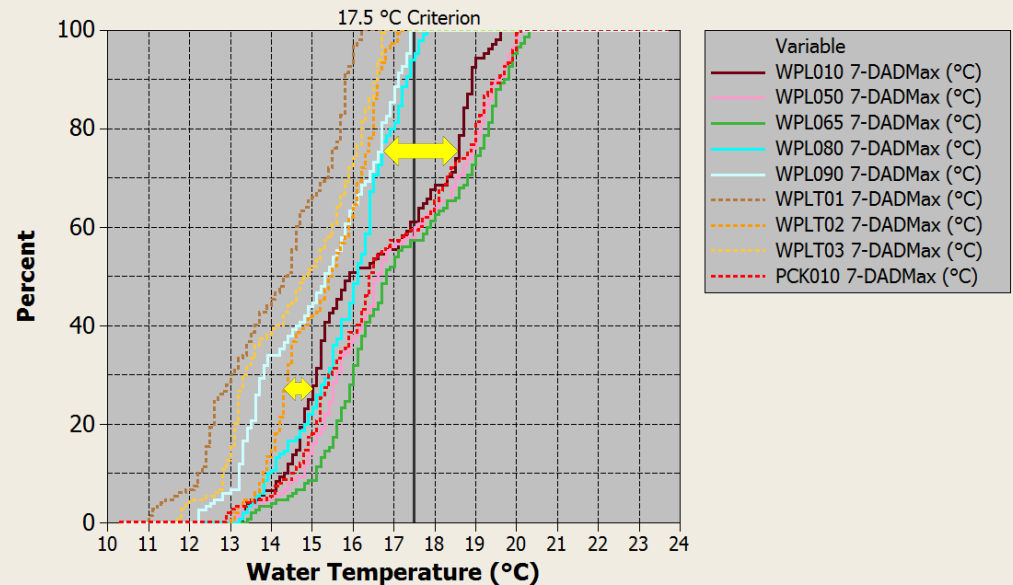
Time Series Plots: Summer 2015



CDF Plots: Summer 7-DAD Max Stream Temperatures

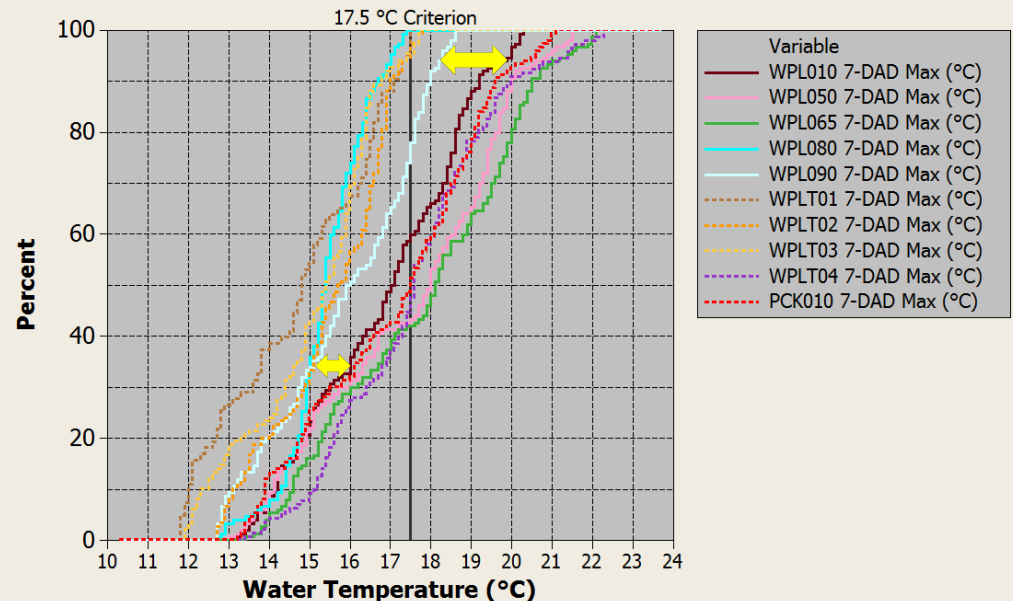
- Increasing separation of lower main stem sites from tributaries
- Tributaries - more shading / groundwater
- Main stem – cumulative heat loading

Whipple Creek Subwatersheds Summer 2014 7-DAD Max Empirical CDF*



* Excludes WPL010's August and September 2014 temperatures when probe likely exposed to air and WPLT04 since not monitored during 2014.

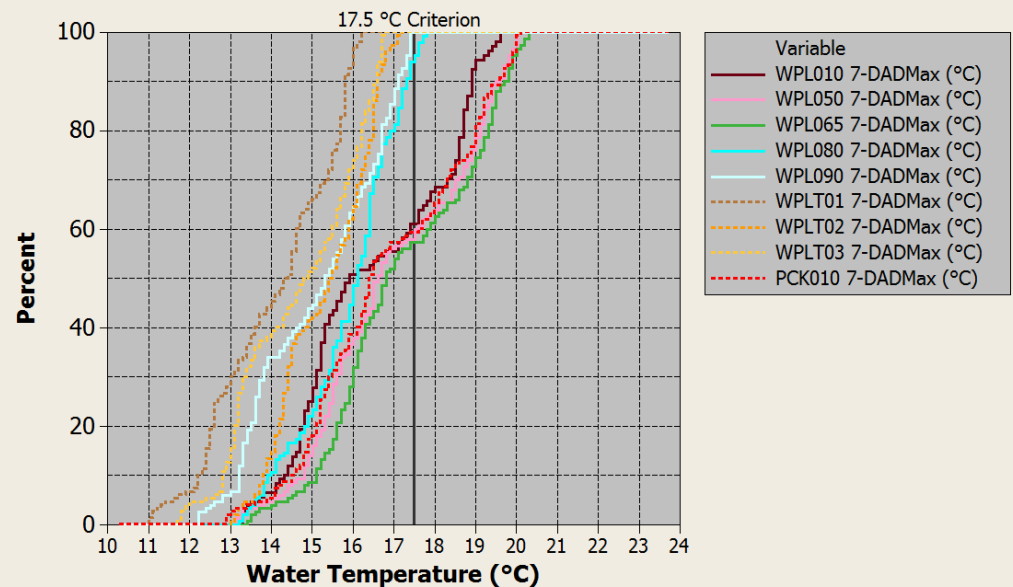
Whipple Creek Subwatersheds Summer 2015 7-DAD Max Empirical CDF



CDF Plots: Summer 7-DAD Max Stream Temperatures

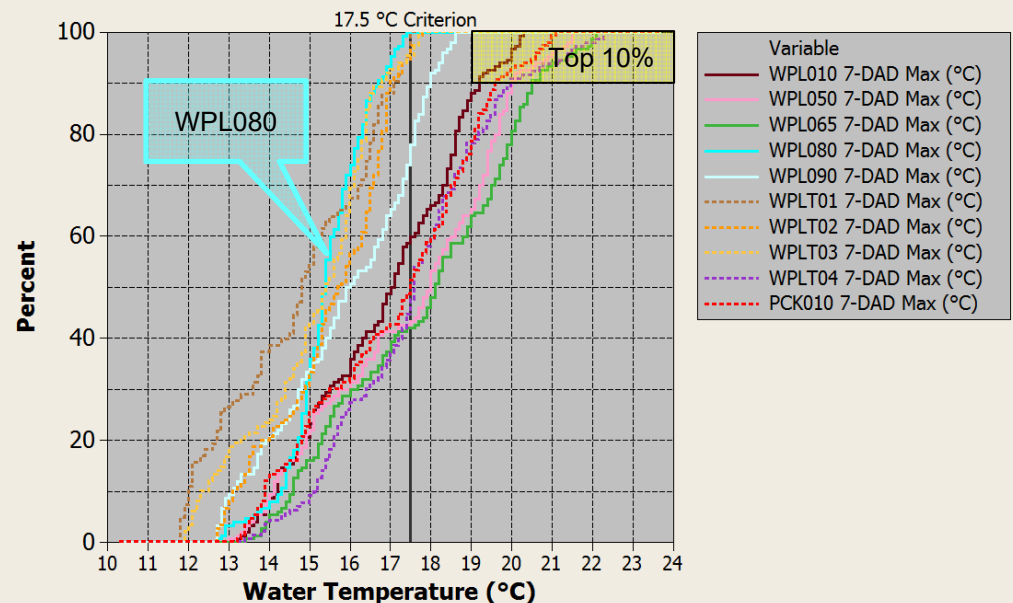
- WPLo8o steeper (heats less)
- Lower main stem, Packard, & WPLTo4 – 2015’s top 10% heating intensifies.
- Feedback mechanisms beyond air temperature

Whipple Creek Subwatersheds Summer 2014 7-DAD Max Empirical CDF*



* Excludes WPL010's August and September 2014 temperatures when probe likely exposed to air and WPLT04 since not monitored during 2014.

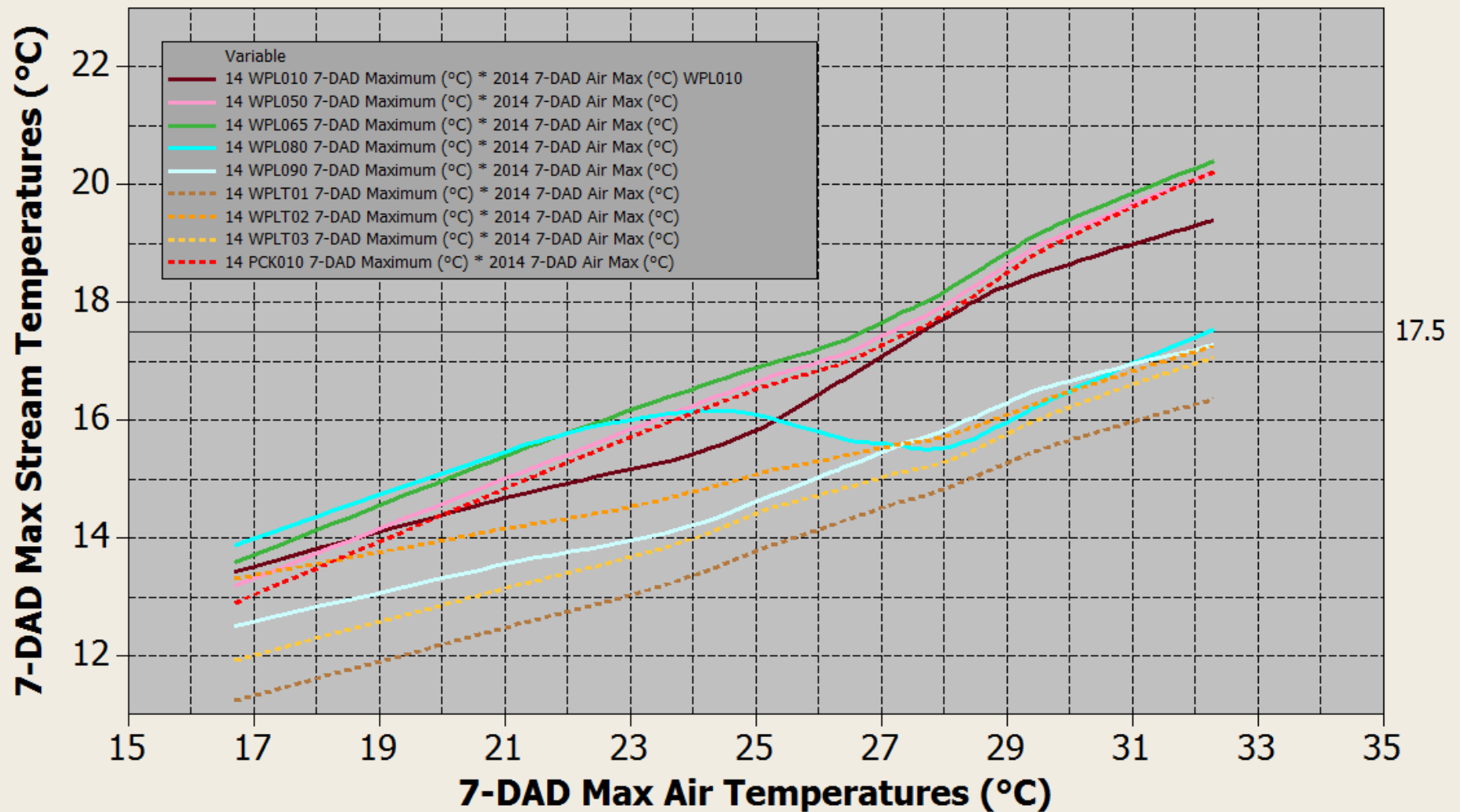
Whipple Creek Subwatersheds Summer 2015 7-DAD Max Empirical CDF



Scatterplot: Stream vs. Air Temperatures Summer 2014

Summer 2014 Same Date 7-DAD Maximums

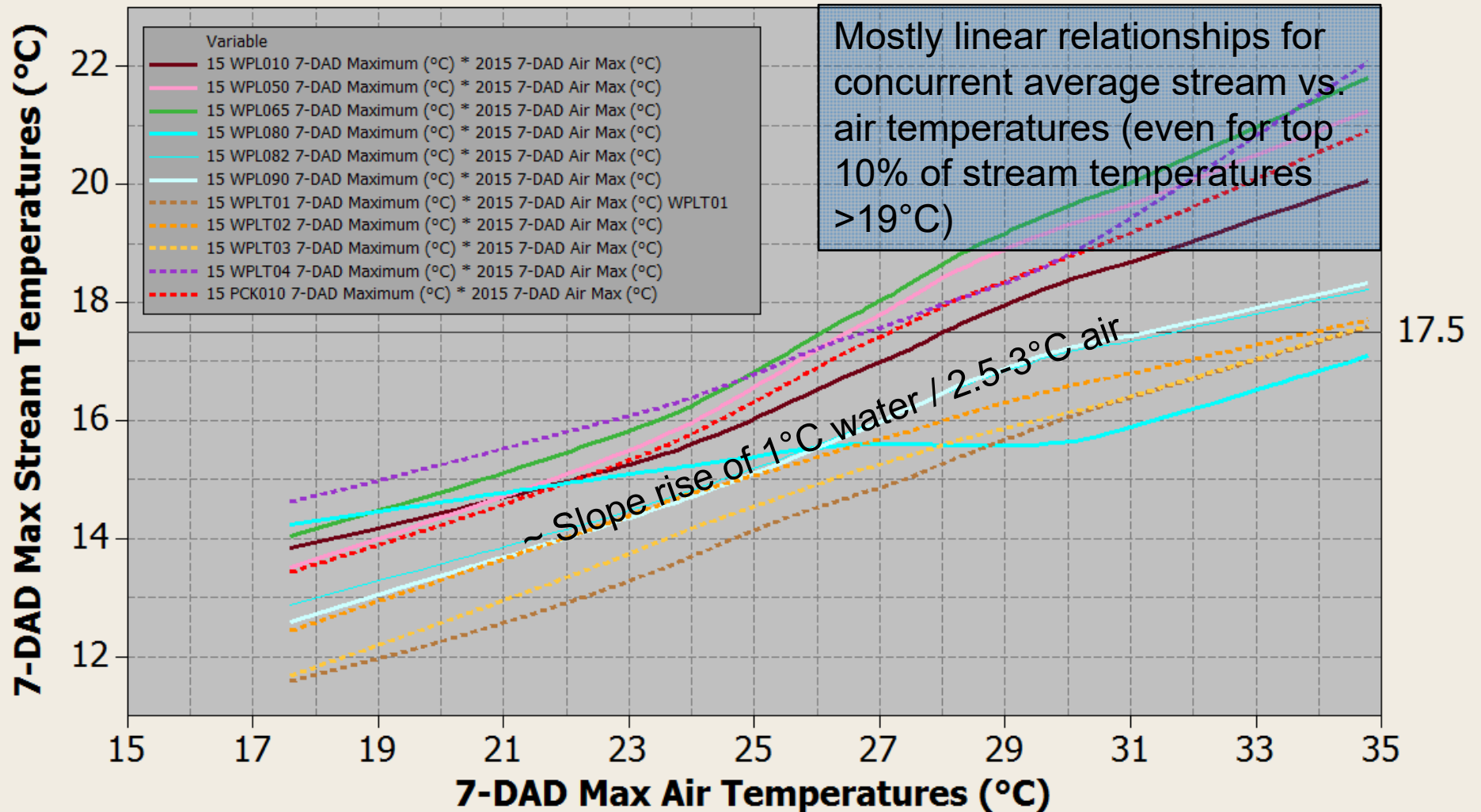
Whipple Creek Subwatershed Streams' vs PDX Air Temperatures



Scatterplot: Stream vs. Air Temperatures Summer 2015

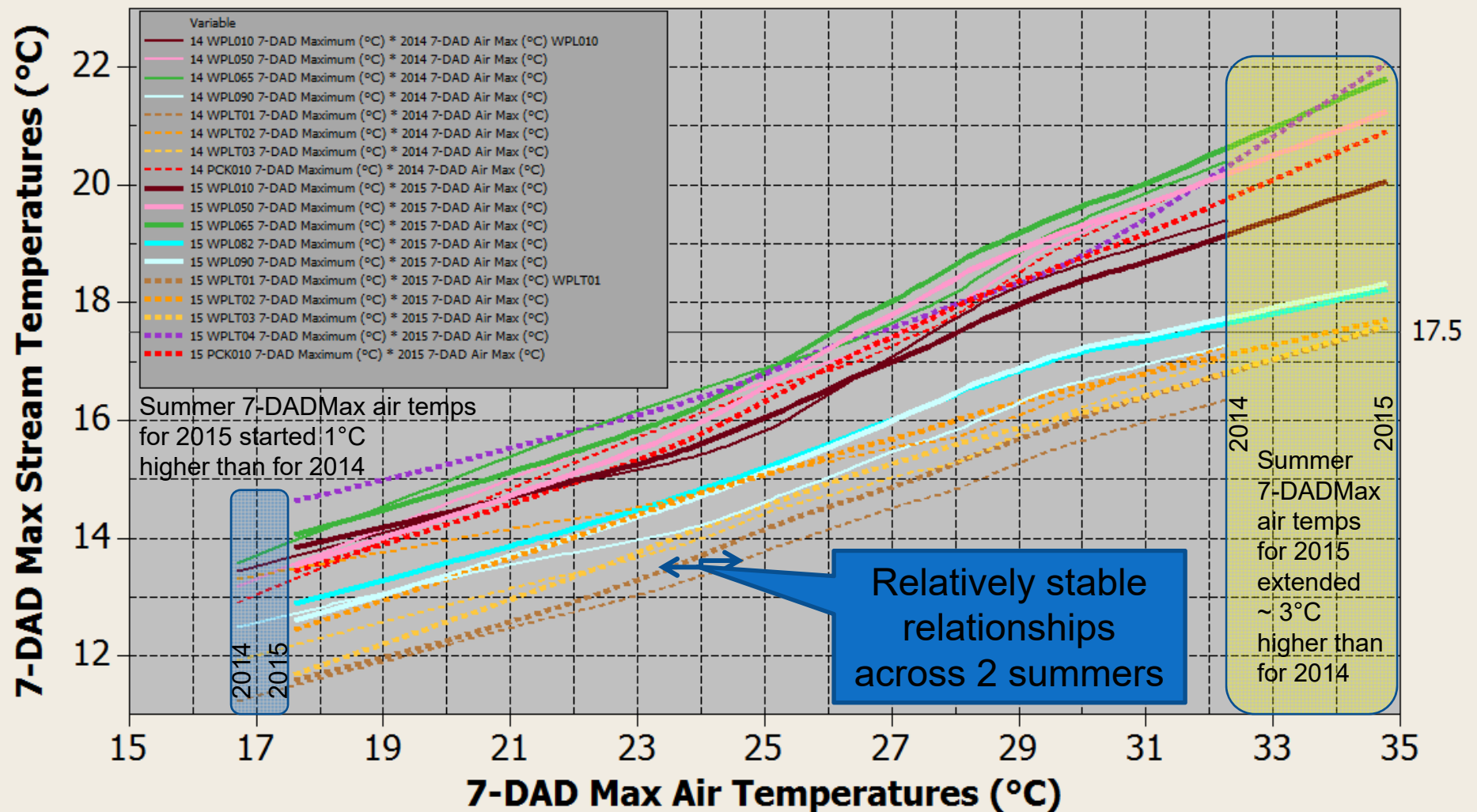
Summer 2015 Same Date 7-DAD Maximums

Whipple Creek Subwatershed Streams' vs PDX Air Temperatures



Scatterplot: Stream vs. Air Temperatures Summer 2014/2015

Summer 2014 and 2015 Same Date 7-DAD Maximums Whipple Creek Subwatershed Streams' vs PDX Air Temperatures



Stream Temperature Analyses - Conclusions

- **Graph patterns** - suggest heating susceptibility
- **Sequencing plots** - provide increasingly detailed insights
- **Plots' anomalies** - can reveal impacts and refuges.