

## Memorandum

February 17, 2017

**To:** John Palmer, USEPA

**From:** Peter Leinenbach, USEPA

**Subject:** Tributary and Columbia River Measured Temperature Data Summary

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**Results** - Temperature data collected in the lower and middle Columbia River, along with the tributaries that drain into this section of the Columbia, indicated that many of the tributary streams have water temperatures colder than the Columbia River (**Table 1** and **Figure 1**). It appears that warmest tributary temperatures are generally observed in streams located on the east side of the Cascades, with the coldest tributary temperatures generally observed in streams draining the crest of the Cascade Mountain range. It also appears that there is a seasonality to this relationship, with the relatively warmest temperatures observed in the early spring period for tributaries located on the east side of the Cascade crest, however many of these streams transitioned into cooler temperatures, relative to the Columbia River, during the late spring/summer period. Finally, most of the “cooler” tributary streams located west of the Cascade crest maintain this relatively cold temperature throughout the entire summer period.

**Datasets Used** - Measured temperature data summaries for sites located along the Lower and Middle Columbia River, along with the tributaries that discharge into the Columbia, were primarily obtained from the NorWeST website ([www.fs.fed.us/rm/boise/AWAE/projects/NorWeST.html](http://www.fs.fed.us/rm/boise/AWAE/projects/NorWeST.html)) on January 23, 2017. Additional temperature data was obtained from additional sources for tributaries not included in the NorWeST database: 1) USGS Gauge near the Deschutes River mouth (#1410300); 2) 2016 USEPA sampling efforts (i.e., Elochoman Creek, 15-Mile Creek, and Willow Creek); and 3) 2016 Washington Department of Ecology sampling efforts (i.e., Lewis River).

**Methods Used** - The average monthly temperature difference between tributary site data and the Columbia River was estimated from these datasets. The most downstream monitoring location along the tributary was primarily used as the tributary site in this comparison, however if multiple sites were located near the mouth of the tributary, the site with the most years of data used in this comparison. There were situations where multiple sites were located in close proximity to each other near the tributary mouth (It appeared that the sampling location was slightly moved from one year to the next - i.e., see Little White Salmon River site location map). In this case, data collected at all of these close proximity sites were used in tributary estimates. Similarly, the closest Columbia River site was used in the comparison, however if there was another Columbia River site in the near vicinity with a greater number of years of data, then that site was used in the comparison analysis.

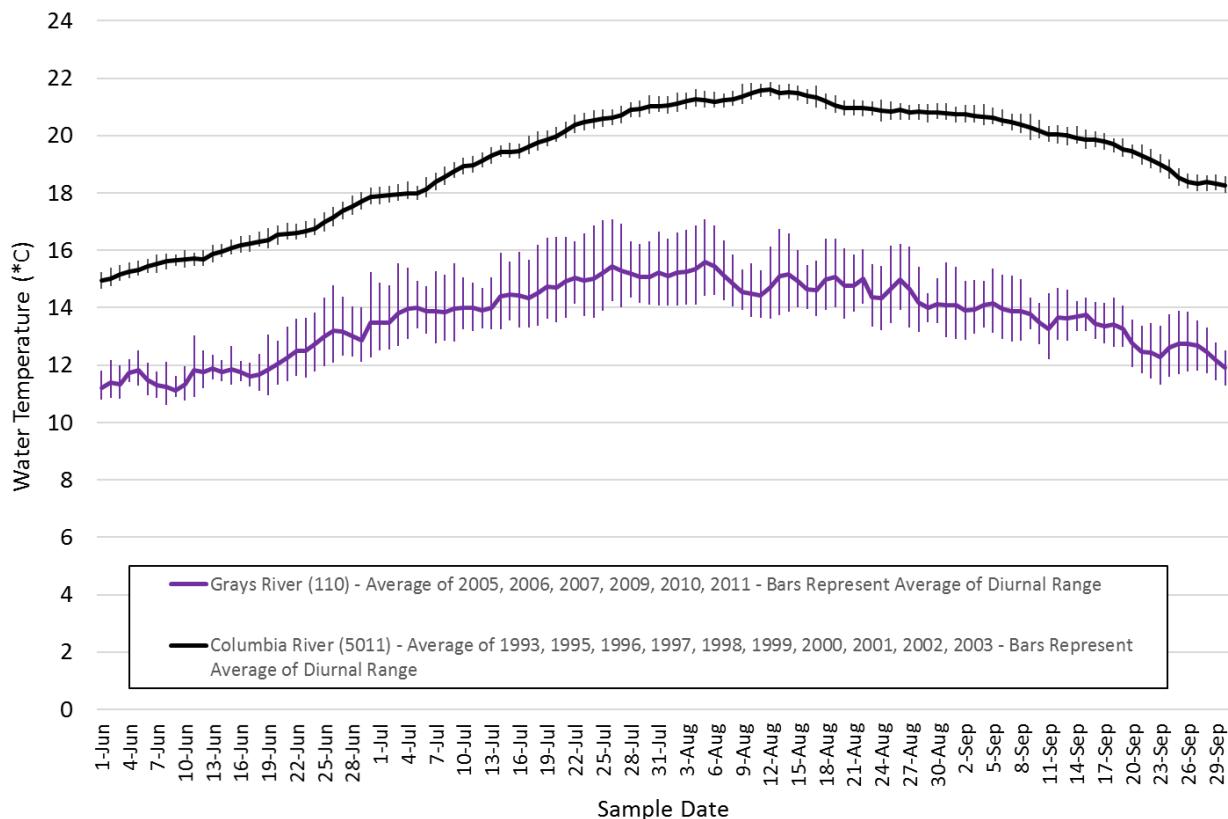
Note – The 100K NHDPlus dataset indicated that there are 191 tributaries that discharge into this reach of the Lower and Middle Columbia River. The tributary number presented in this document represents the sequential order which a particular tributary discharges into the Columbia River, as defined by the NHDPlus dataset. For example, Hood River is the 116<sup>th</sup> tributary stream to discharge into the Columbia River, relative to the mouth of the Columbia River. This number was used as a unique identifier during tributary analysis presented in this document.

**Table 1.** Observed Average Monthly Temperature Difference (\*C) between the tributary and the Columbia River

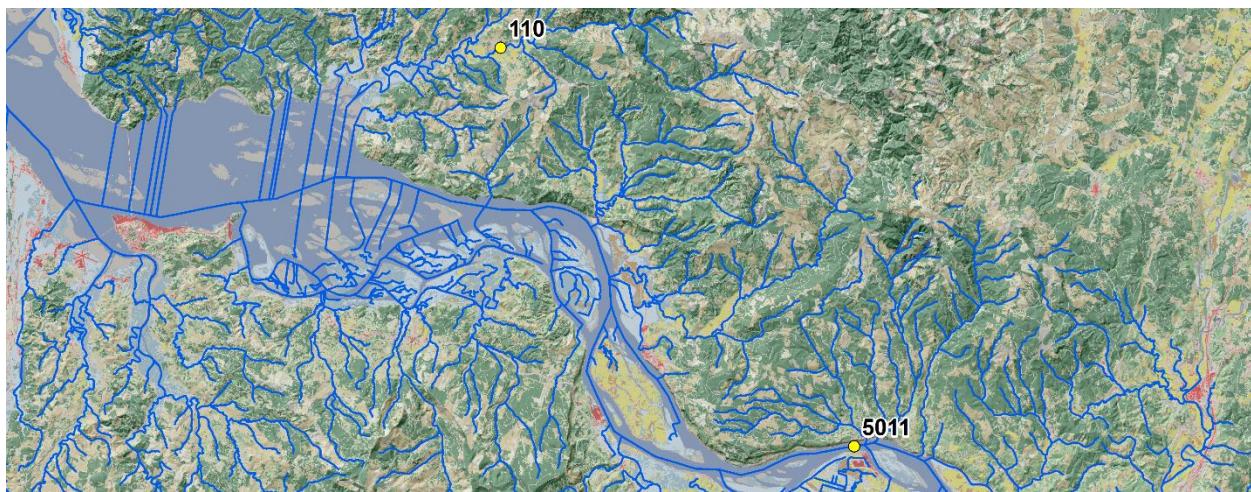
Site Name	June	July	August	September
Tributary #18 – Grays River	4.2	5.1	6.4	6.4
Tributary #30 – Elochoman River	0.5	2.0	2.5	4.6
Tributary #37 – Clatskanie River	No Data	1.8	3.3	5.5
Tributary #38 – Mill Creek	4.3	4.9	6.4	7.0
Tributary #40 – Abernethy Creek	No Data	4.6	5.5	6.0
Tributary #41 – Germany Creek	3.7	3.7	5.2	6.2
Tributary #49 – Cowlitz River	No Data	4.1	5.8	5.8
Tributary #52 – Kalama River	4.8	4.1	5.4	6.3
Tributary #62 – Multnomah Channel	-0.4	-1.8	-0.9	-0.6
Tributary #70 – Willamette River	-0.1	-1.2	-0.9	0.4
Tributary #77 – Sandy River	1.6	0.9	2.8	3.8
Tributary #78 – Washougal River	1.8	0.3	2.2	3.8
Tributary #83 – Bridal Veil Creek	6.4	7.5	9.0	8.4
Tributary #85 – Wahkeena Creek	6.2	8.8	10.9	10.0
Tributary #88 – Woodward Creek	4.7	6.2	7.6	6.6
Tributary #88b – Hamilton Creek	4.3	4.9	5.8	5.8
Tributary #91 – Tanner Creek	5.8	7.7	9.3	9.2
Tributary #92 – Eagle Creek	4.3	3.9	5.2	6.0
Tributary #94 – Rock Creek	2.7	2.7	3.7	4.7
Tributary #96 – Herman Creek	4.3	7.2	9.2	8.9
Tributary #100 – Wind River	2.7	4.6	6.6	7.3
Tributary #112 – LWS River	6.3	7.6	9.1	8.4
Tributary #115 – White Salmon River	4.7	8.0	10.4	10.2
Tributary #116 – Hood River	3.7	4.4	5.8	6.9
Tributary #119 – Rock Creek	0.2	3.1	5.1	6.3
Tributary #120 – Mosier Creek	0.8	0.8	2.5	4.3
Tributary #123 – Major Creek	-1.3	-0.9	1.6	4.3
Tributary #125 – Klickitat River	2.5	2.6	4.7	6.0
Tributary #127 – Chenoweth Creek	-1.4	-0.1	1.5	4.1
Tributary #127a – Mill Creek	-1.3	0.3	1.8	3.7
Tributary #129 – 15 Mile Creek	-1.1	-0.7	1.8	4.1
Tributary #135 – Deschutes River	-1.6	0.4	2.9	3.7
Tributary #147 – John Day River	-5.0	-3.9	-1.2	1.0
Tributary #153 – Rock Creek	-1.2	1.0	2.1	2.6
Tributary #159 – Chapman Creek	-0.3	1.8	3.8	4.4
Tributary #166 – Pine Creek	-0.1	1.1	2.6	3.2
Tributary #167 – Willow Creek	-4.1	-0.5	2.2	4.3
Tributary #170 – Alder Creek	-1.6	0.3	2.8	4.2
Tributary #176 – Umatilla River	-2.7	-3.0	0.0	1.9
Tributary #188 – Walla Walla River	-4.3	-6.0	-2.5	1.3

**Figure 1.** Measured Tributary Water Temperature - Tributary #18 – Grays River

Average Daily Average Water Temperature and Average Diurnal Range

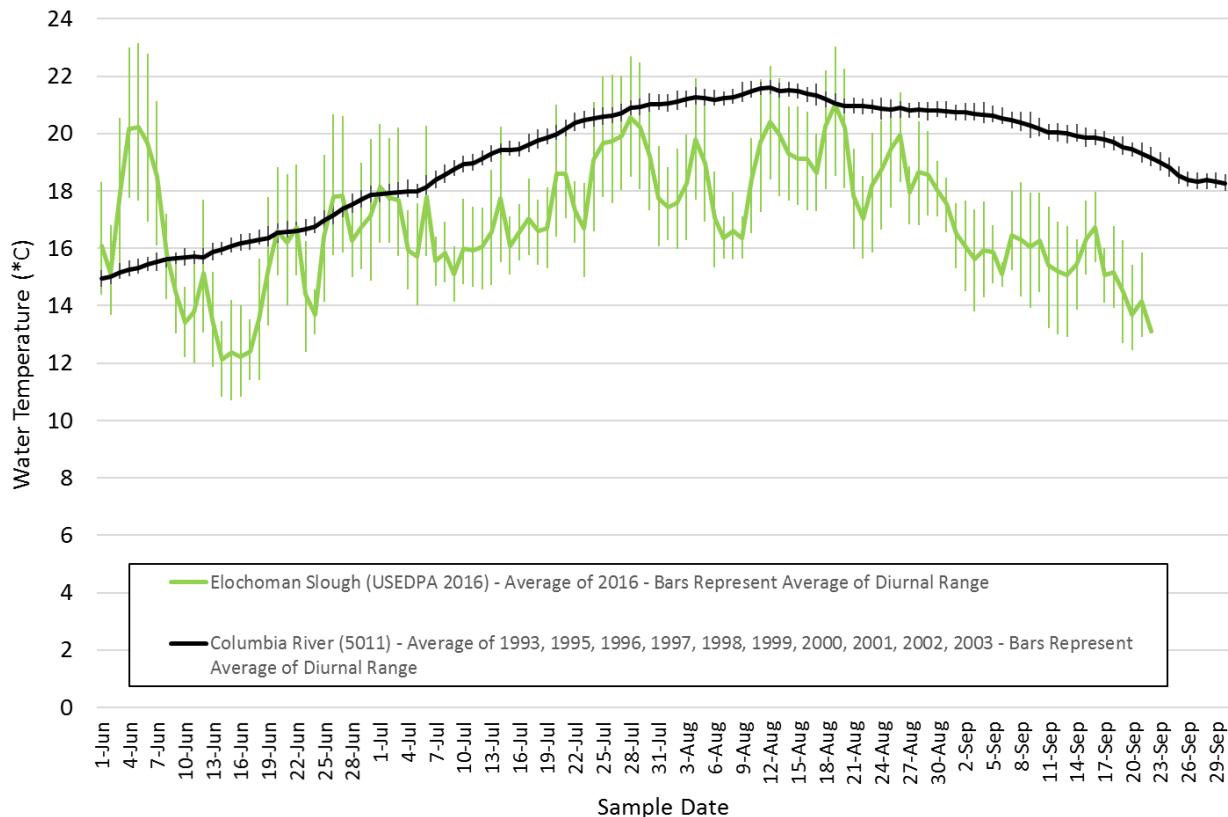


Site Name	Average Monthly Temperature Difference ( $^{\circ}\text{C}$ )			
	June	July	August	September
Tributary #18 – Grays River	4.2	5.1	6.4	6.4

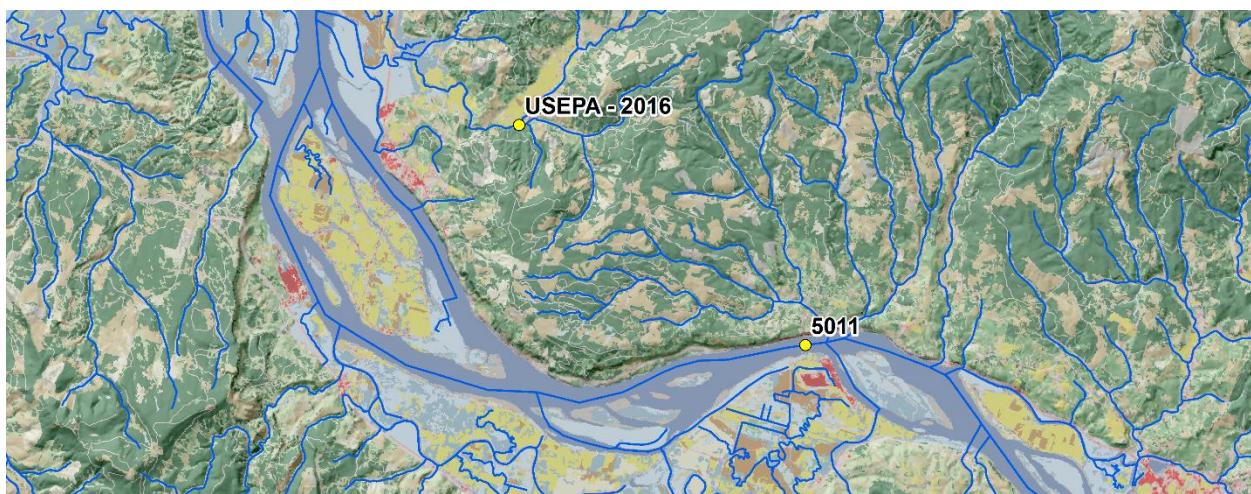


**Figure 1 (Continued).** Measured Tributary Water Temperature - Tributary #30 – Elochoman River

*Average Daily Average Water Temperature and Average Diurnal Range*

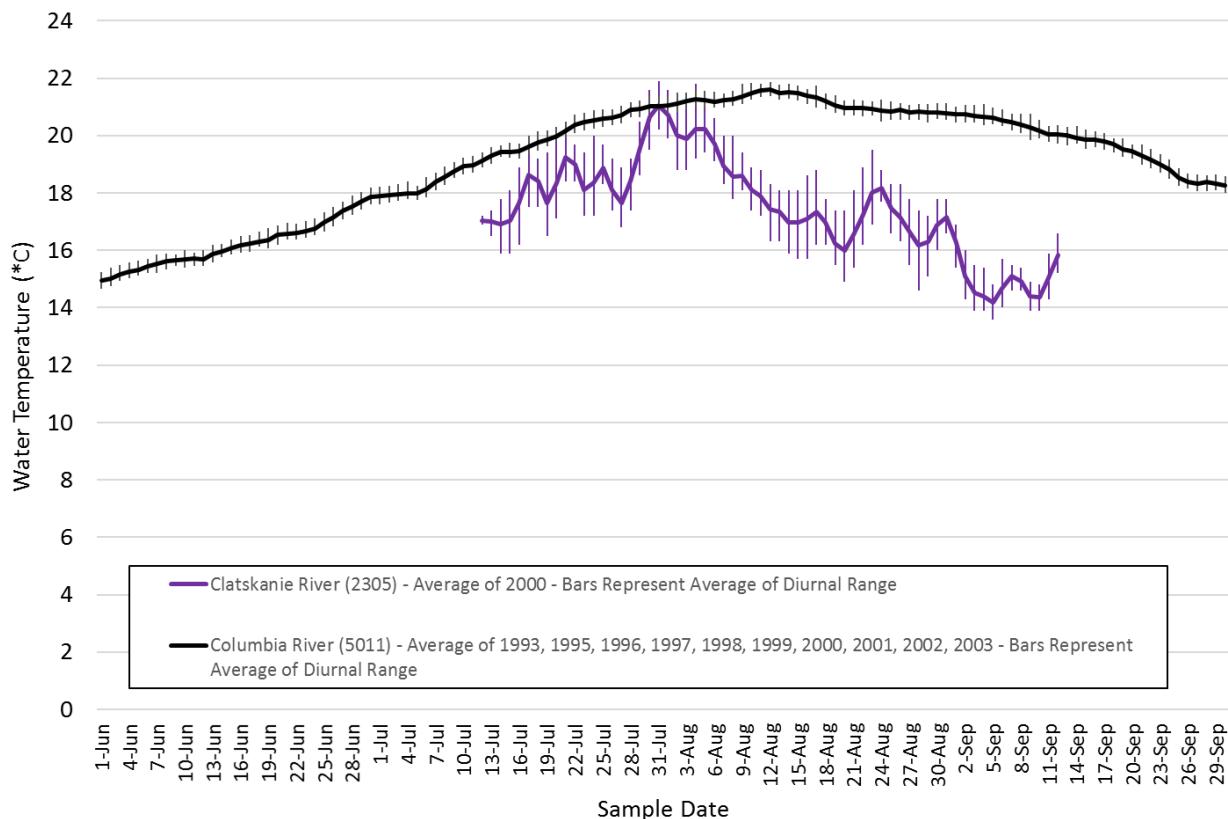


Site Name	Average Monthly Temperature Difference (*C)			
	June	July	August	September
Tributary #30 – Elochoman River	0.5	2.0	2.5	4.6

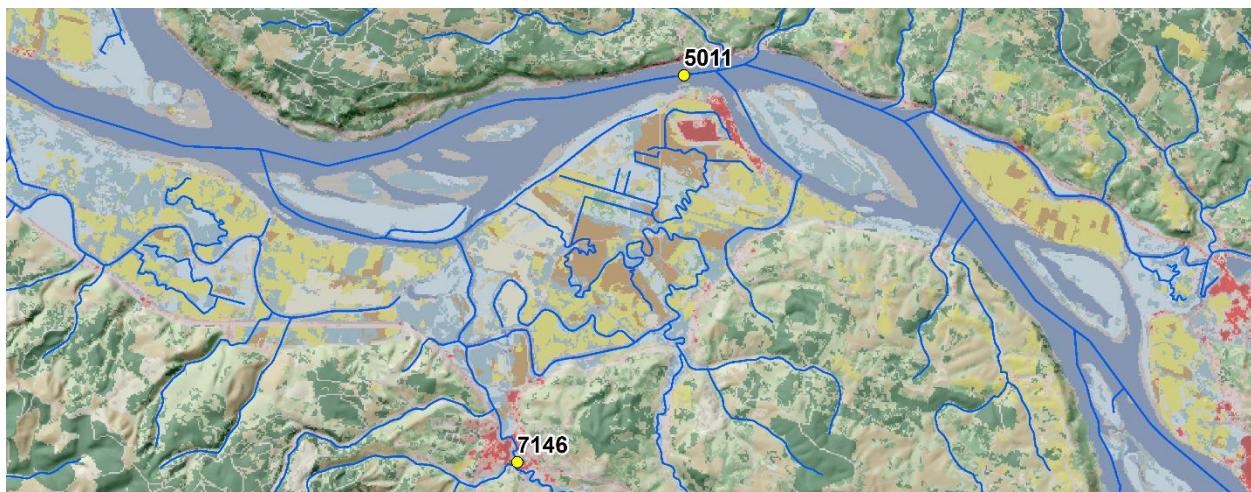


**Figure 1 (Continued).** Measured Tributary Water Temperature - Tributary #37 – Clatskanie River

*Average Daily Average Water Temperature and Average Diurnal Range*

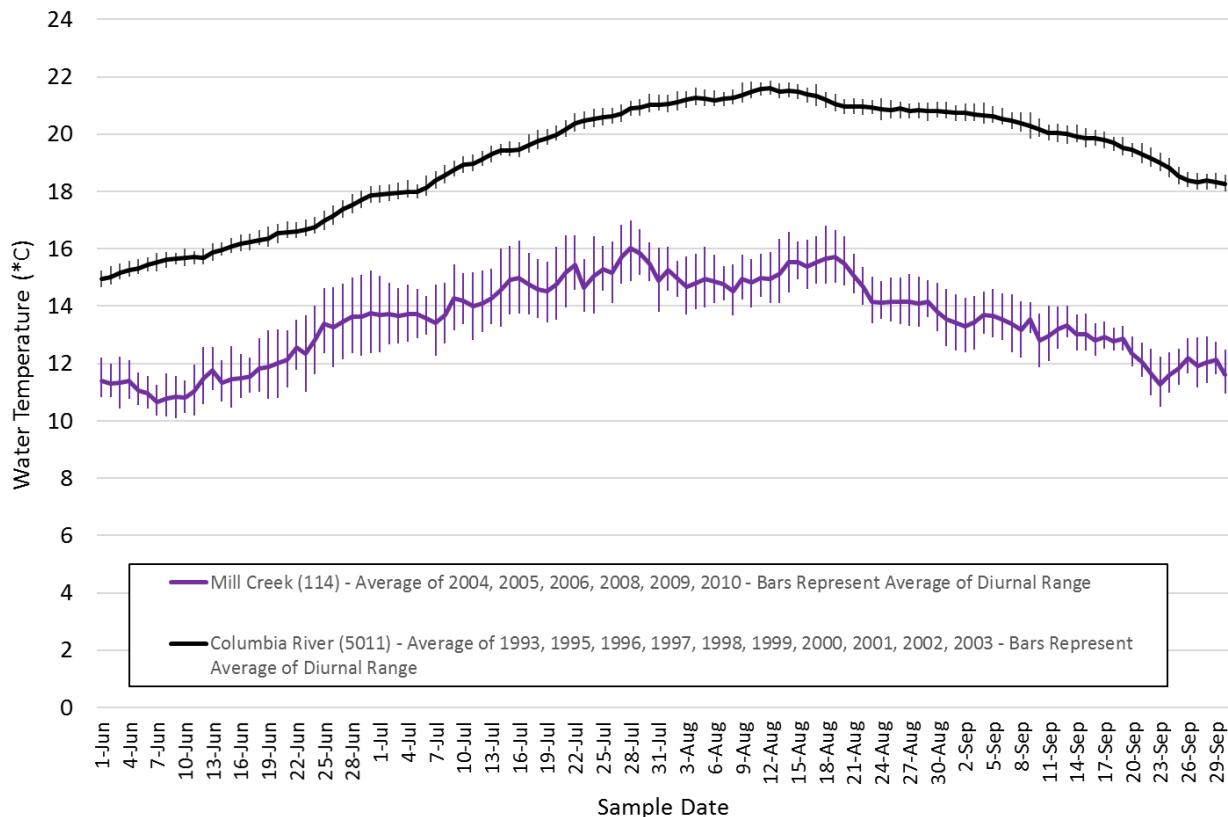


Site Name	Average Monthly Temperature Difference ( $^{\circ}\text{C}$ )			
	June	July	August	September
Tributary #37 – Clatskanie River	No Data	1.8	3.3	5.5

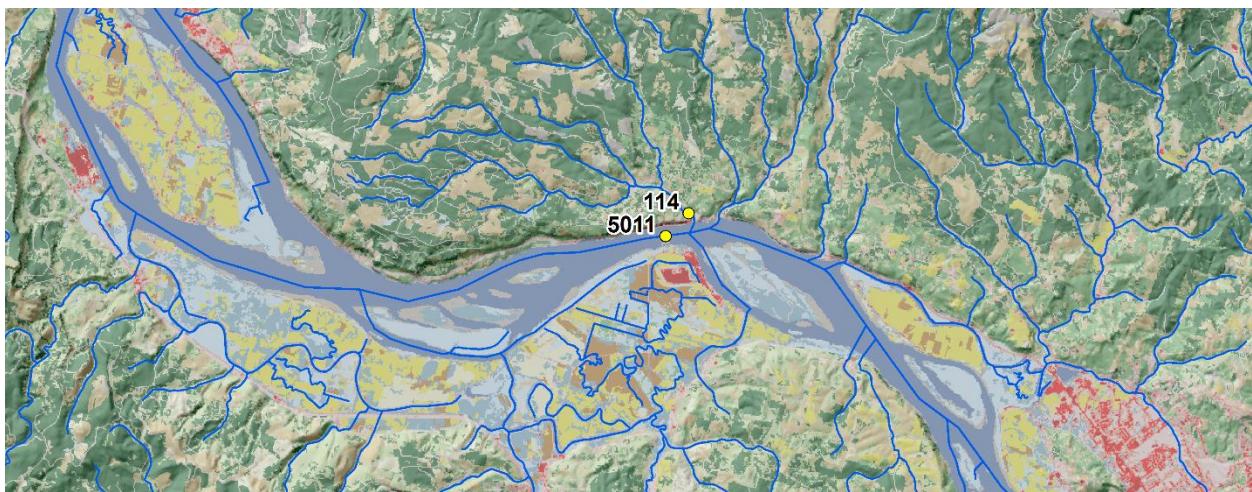


**Figure 1 (Continued).** Measured Tributary Water Temperature - Tributary #38 – Mill Creek

Average Daily Average Water Temperature and Average Diurnal Range

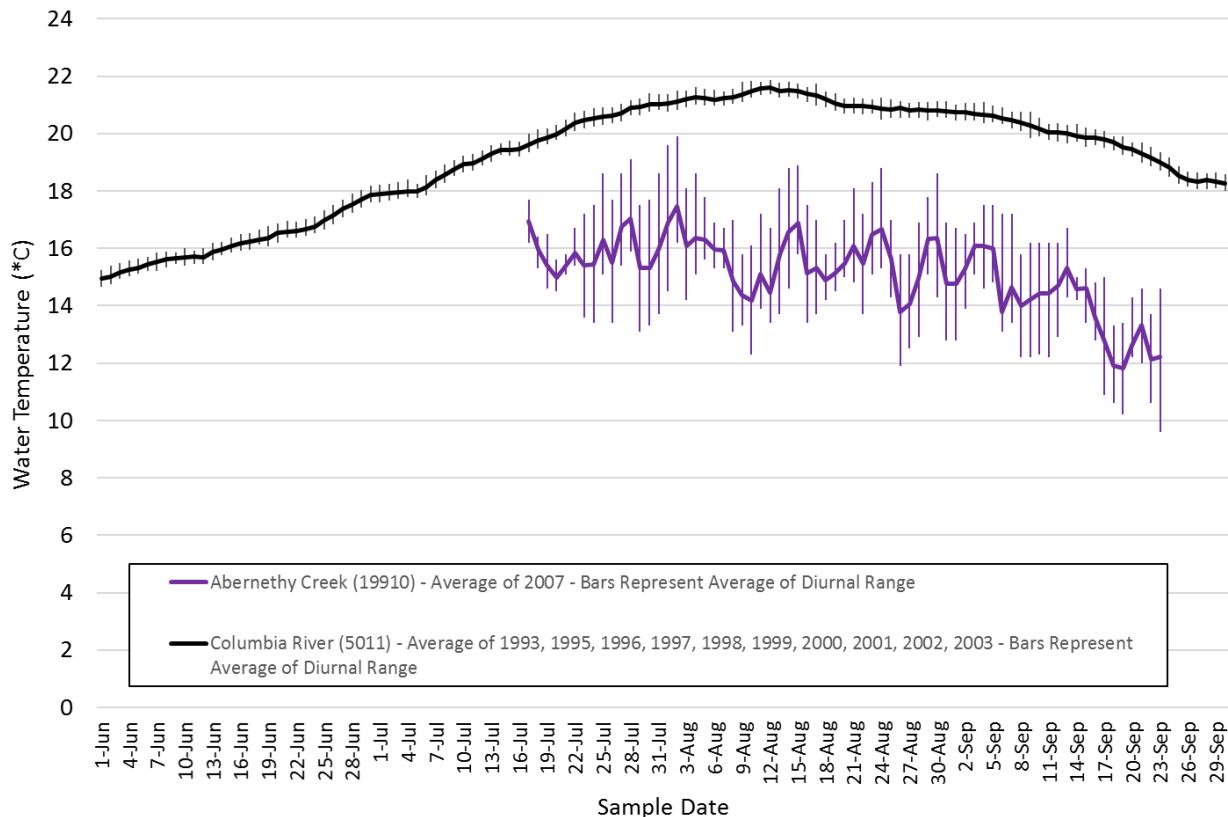


Site Name	Average Monthly Temperature Difference ( $^{\circ}\text{C}$ )			
	June	July	August	September
Tributary #38 – Mill Creek	4.3	4.9	6.4	7.0

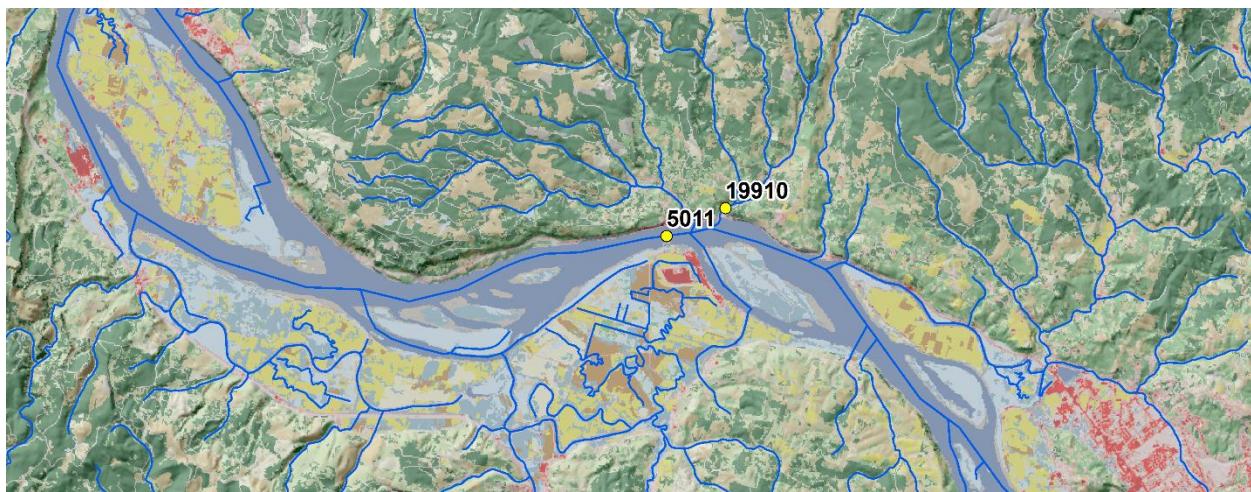


**Figure 1 (Continued).** Measured Tributary Water Temperature - Tributary #40 – Abernethy Creek

*Average Daily Average Water Temperature and Average Diurnal Range*

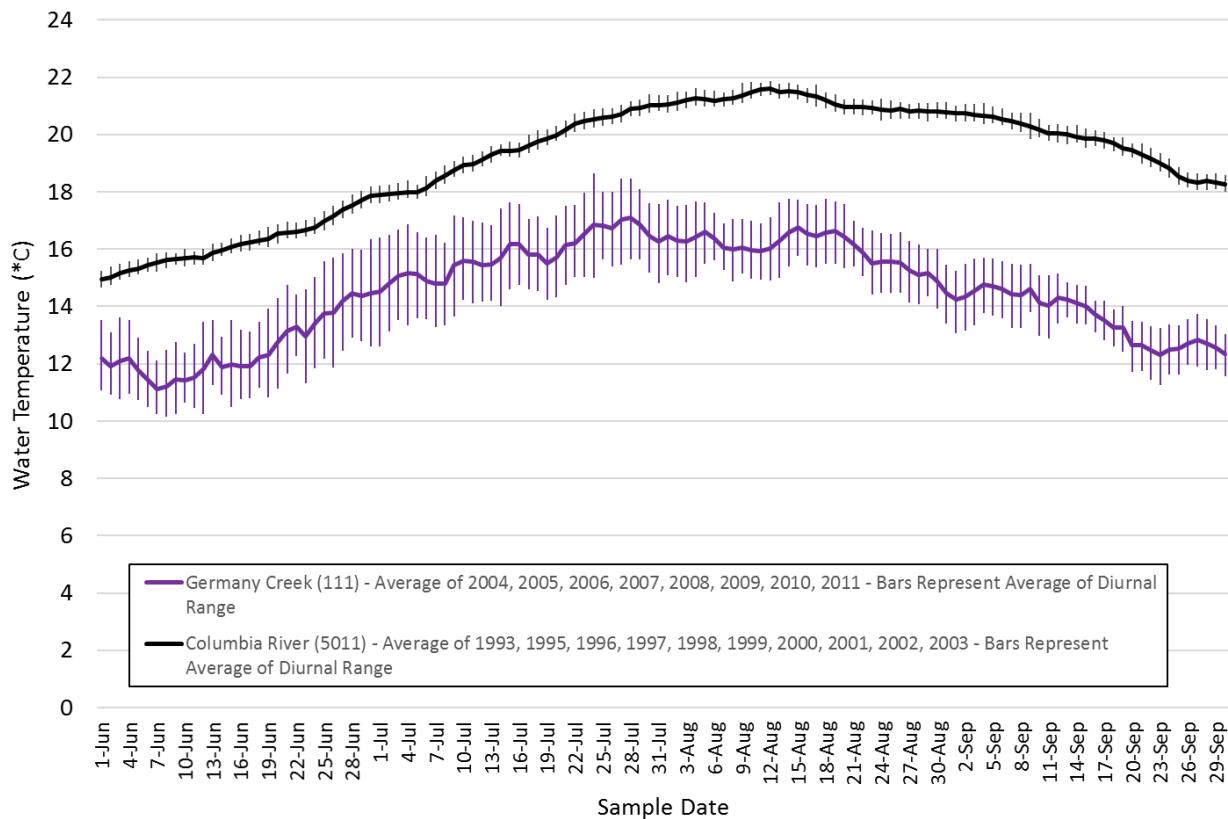


Site Name	Average Monthly Temperature Difference ( $^{\circ}\text{C}$ )			
	June	July	August	September
Tributary #40 – Abernethy Creek	No Data	4.6	5.5	6.0

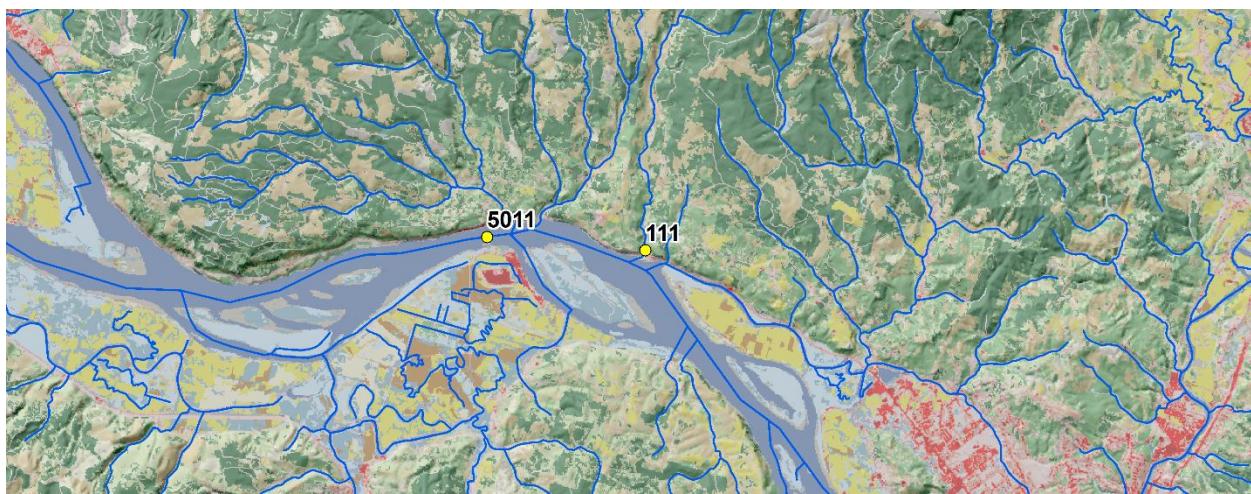


**Figure 1 (Continued).** Measured Tributary Water Temperature - Tributary #41 – Germany Creek

*Average Daily Average Water Temperature and Average Diurnal Range*

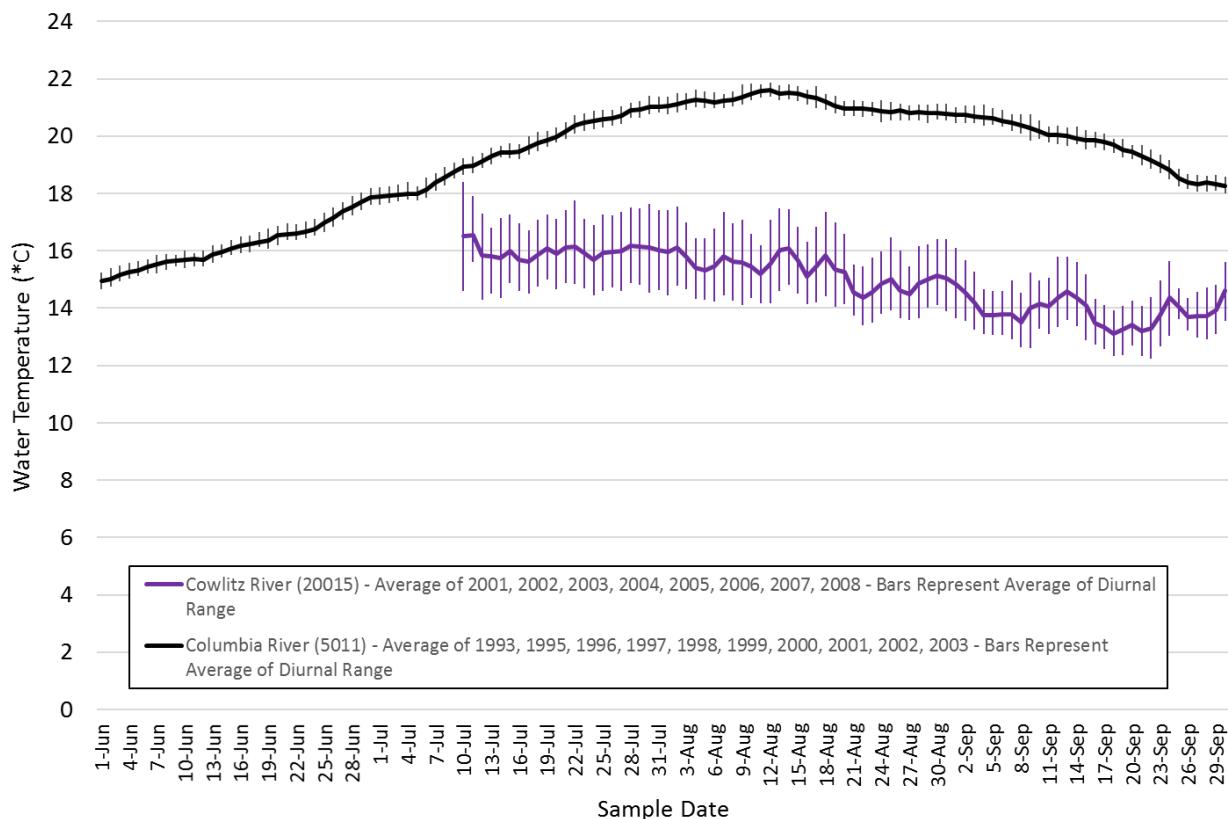


Site Name	Average Monthly Temperature Difference ( $^{\circ}\text{C}$ )			
	June	July	August	September
Tributary #41 – Germany Creek	3.7	3.7	5.2	6.2

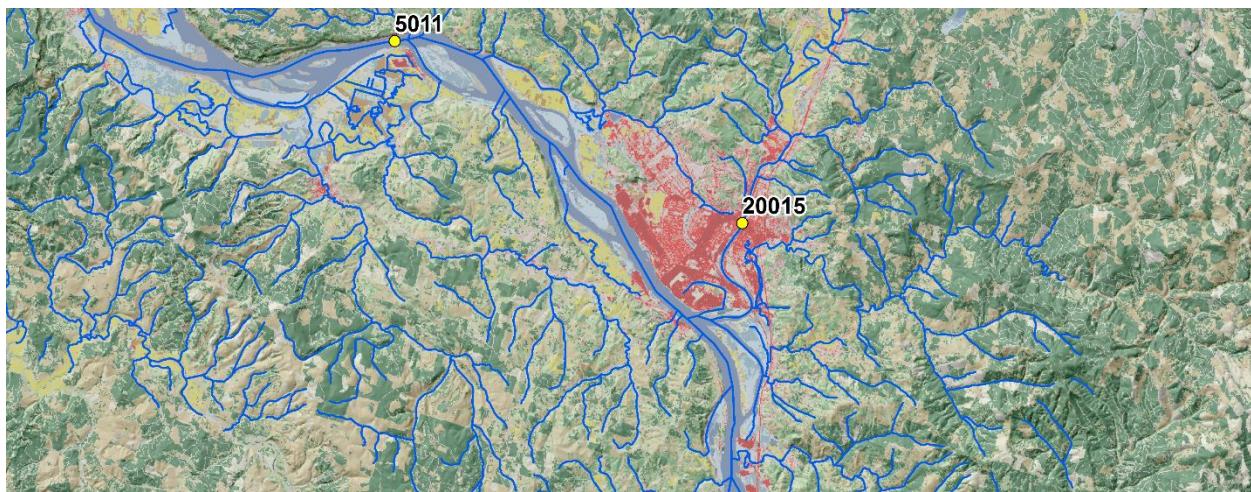


**Figure 1 (Continued).** Measured Tributary Water Temperature - Tributary #49 – Cowlitz River

*Average Daily Average Water Temperature and Average Diurnal Range*

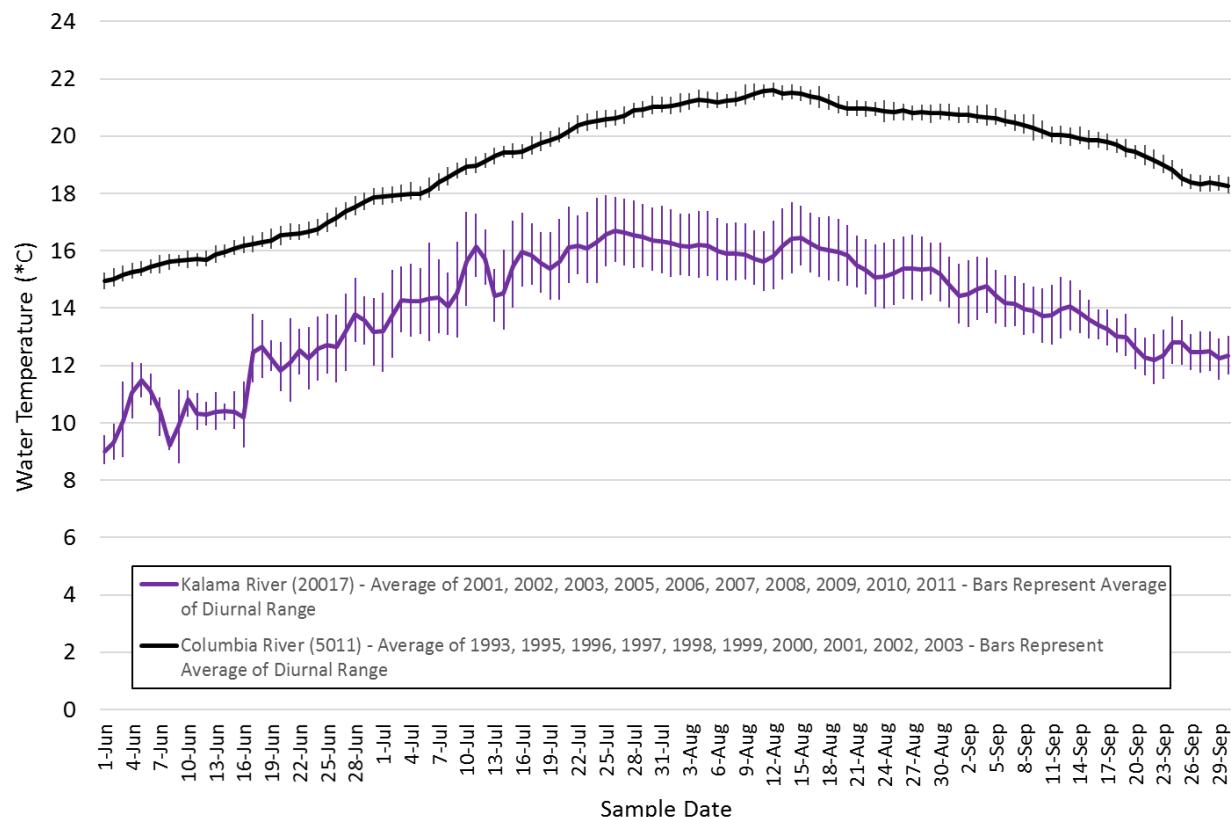


Site Name	Average Monthly Temperature Difference (*C)			
	June	July	August	September
Tributary #49 – Cowlitz River	No Data	4.1	5.8	5.8

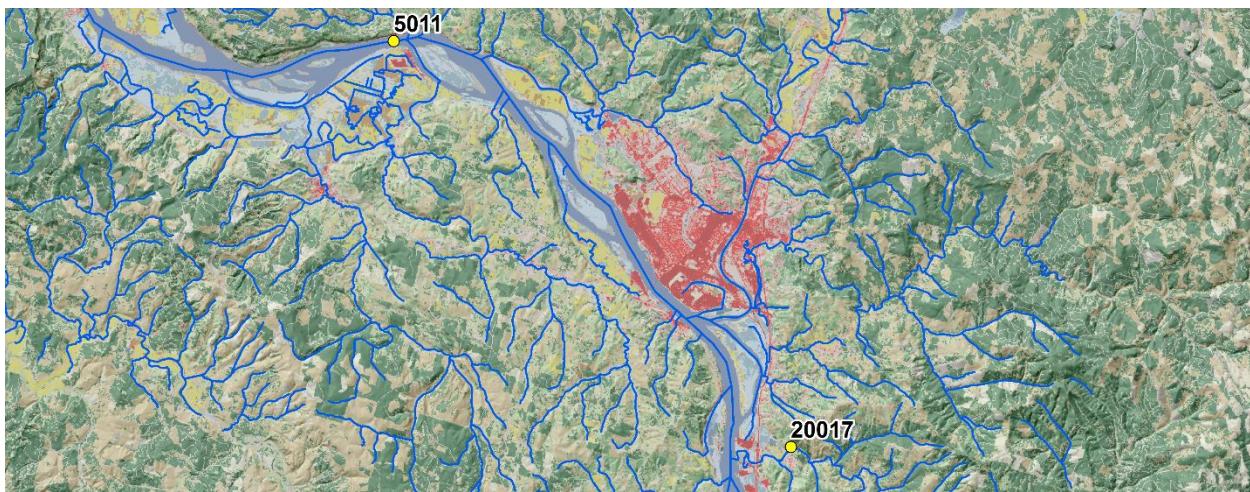


**Figure 1 (Continued).** Measured Tributary Water Temperature - Tributary #52 – Kalama River

*Average Daily Average Water Temperature and Average Diurnal Range*

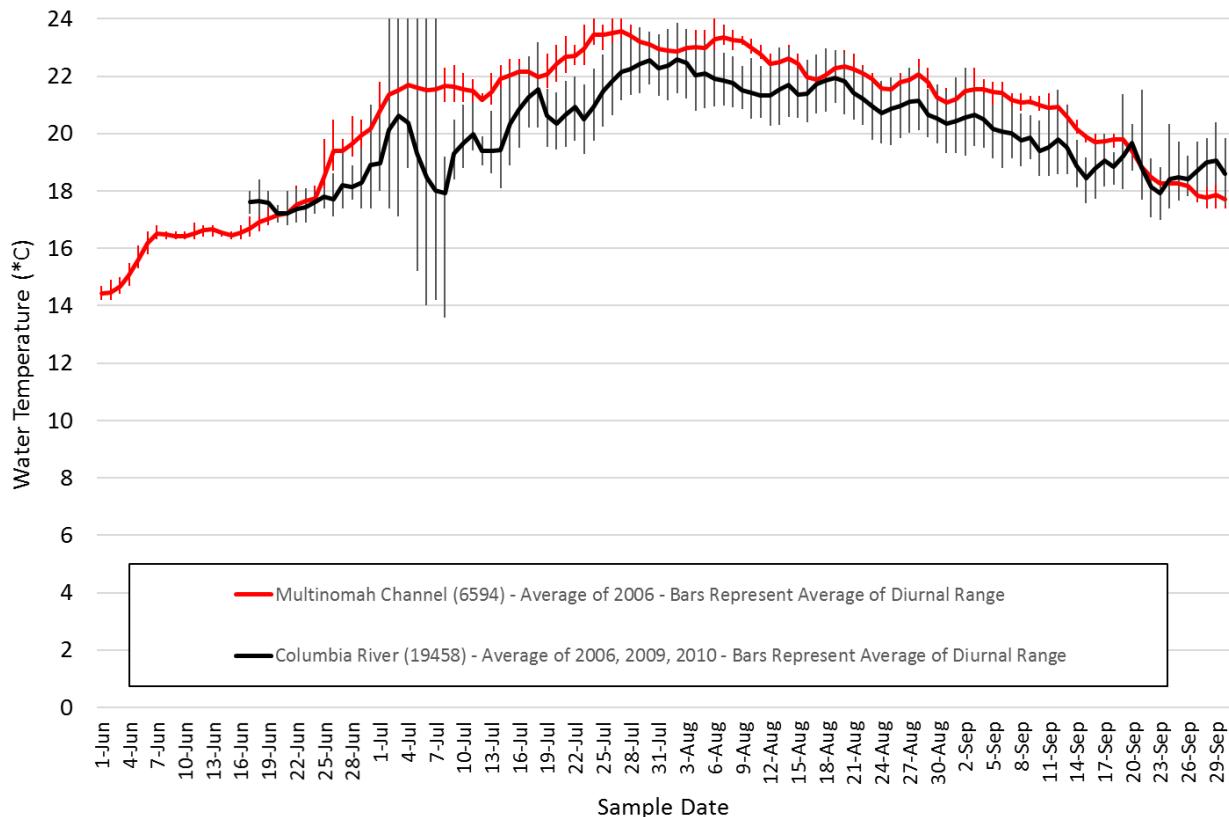


Site Name	Average Monthly Temperature Difference ( $^{\circ}\text{C}$ )			
	June	July	August	September
Tributary #52 – Kalama River	4.8	4.1	5.4	6.3

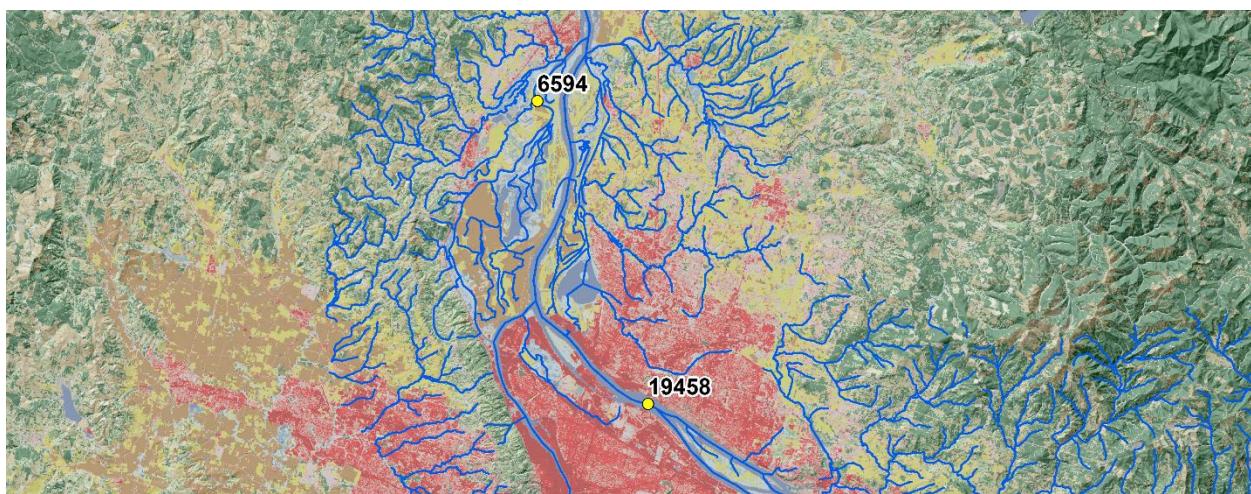


**Figure 1 (Continued).** Measured Tributary Water Temperature - Tributary #62 – Multnomah Channel

*Average Daily Average Water Temperature and Average Diurnal Range*

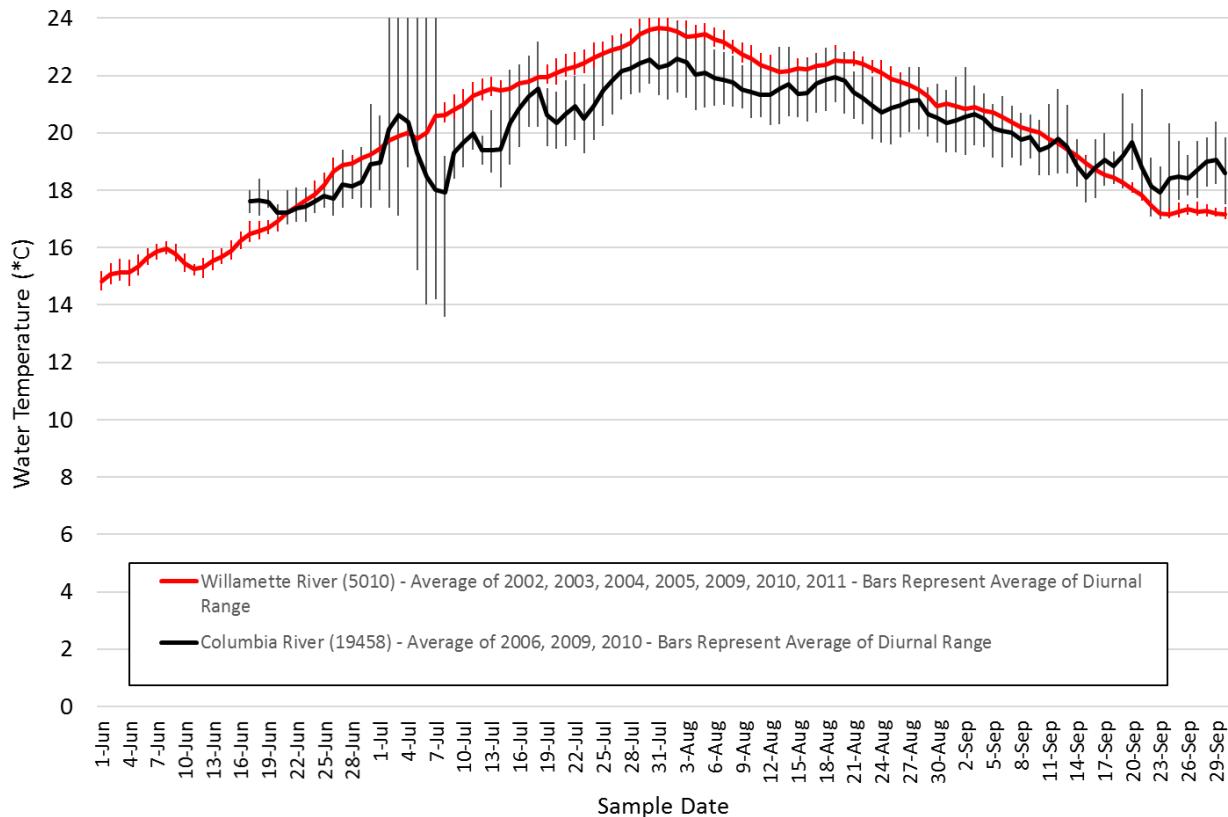


Site Name	Average Monthly Temperature Difference ( $^{\circ}\text{C}$ )			
	June	July	August	September
Tributary #62 – Multnomah Channel	-0.4	-1.8	-0.9	-0.6

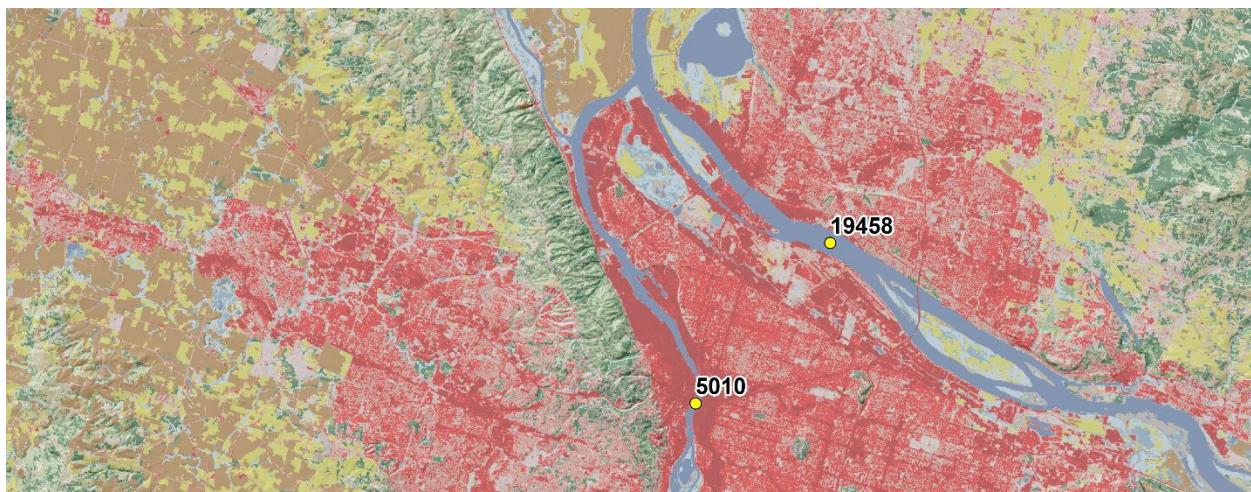


**Figure 1 (Continued).** Measured Tributary Water Temperature - Tributary #70 – Willamette River

*Average Daily Average Water Temperature and Average Diurnal Range*

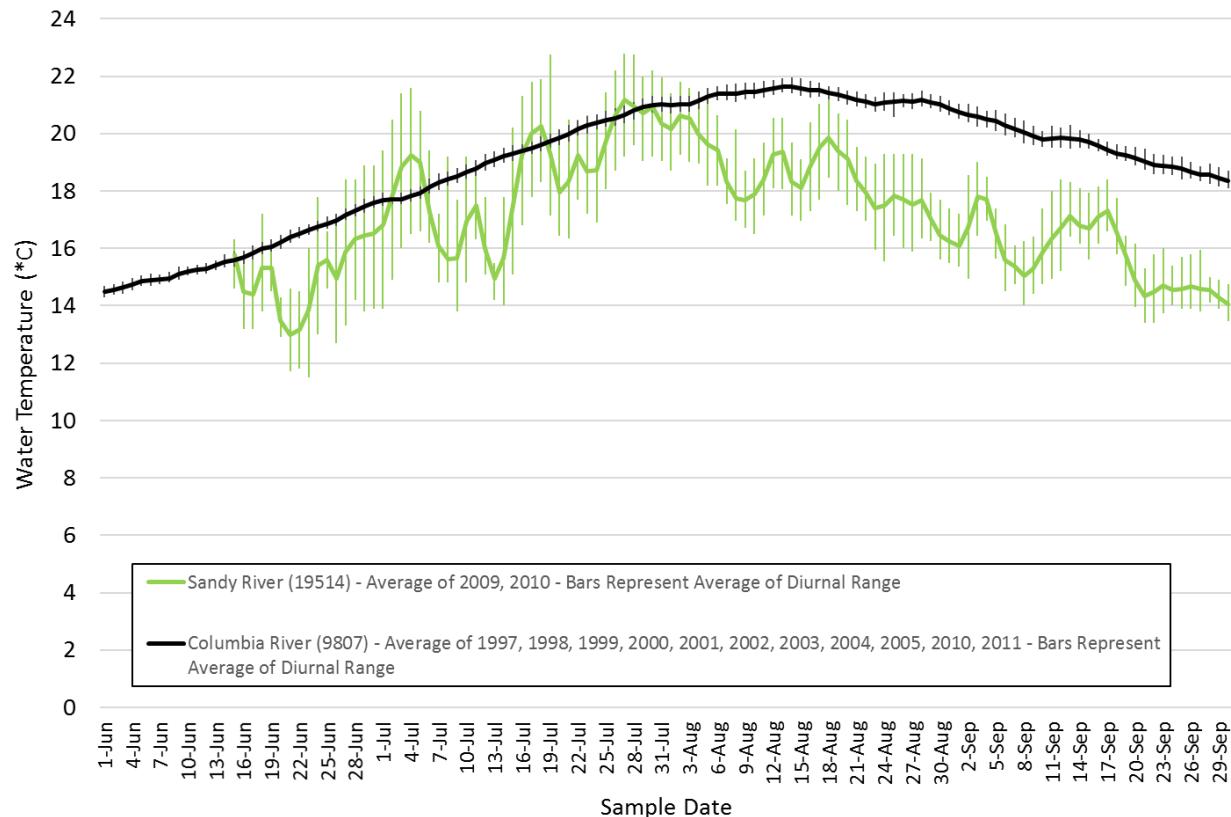


Site Name	Average Monthly Temperature Difference ( $^{\circ}\text{C}$ )			
	June	July	August	September
Tributary #70 – Willamette River	-0.1	-1.2	-0.9	0.4

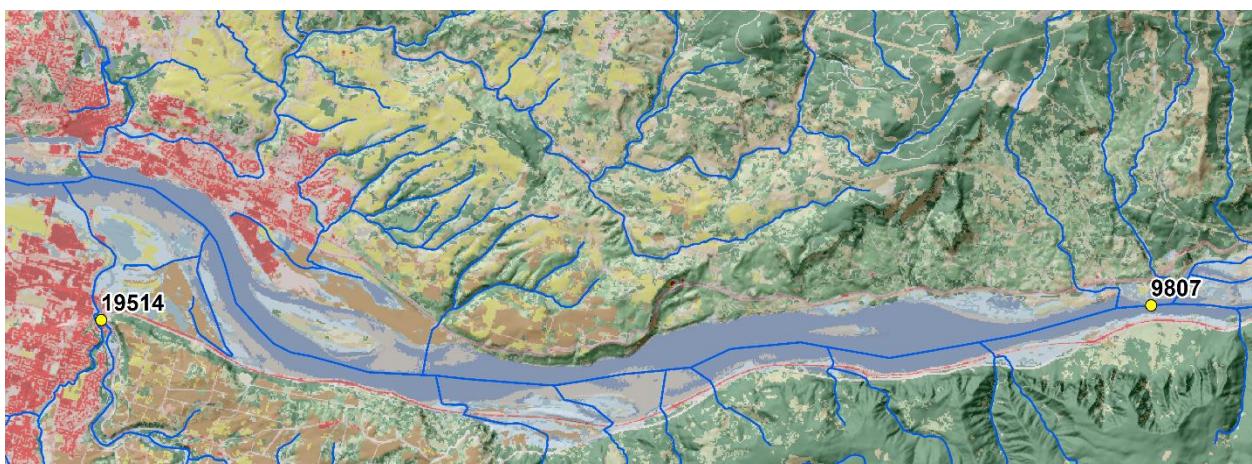


**Figure 1 (Continued).** Measured Tributary Water Temperature - Tributary #77 – Sandy River

Average Daily Average Water Temperature and Average Diurnal Range

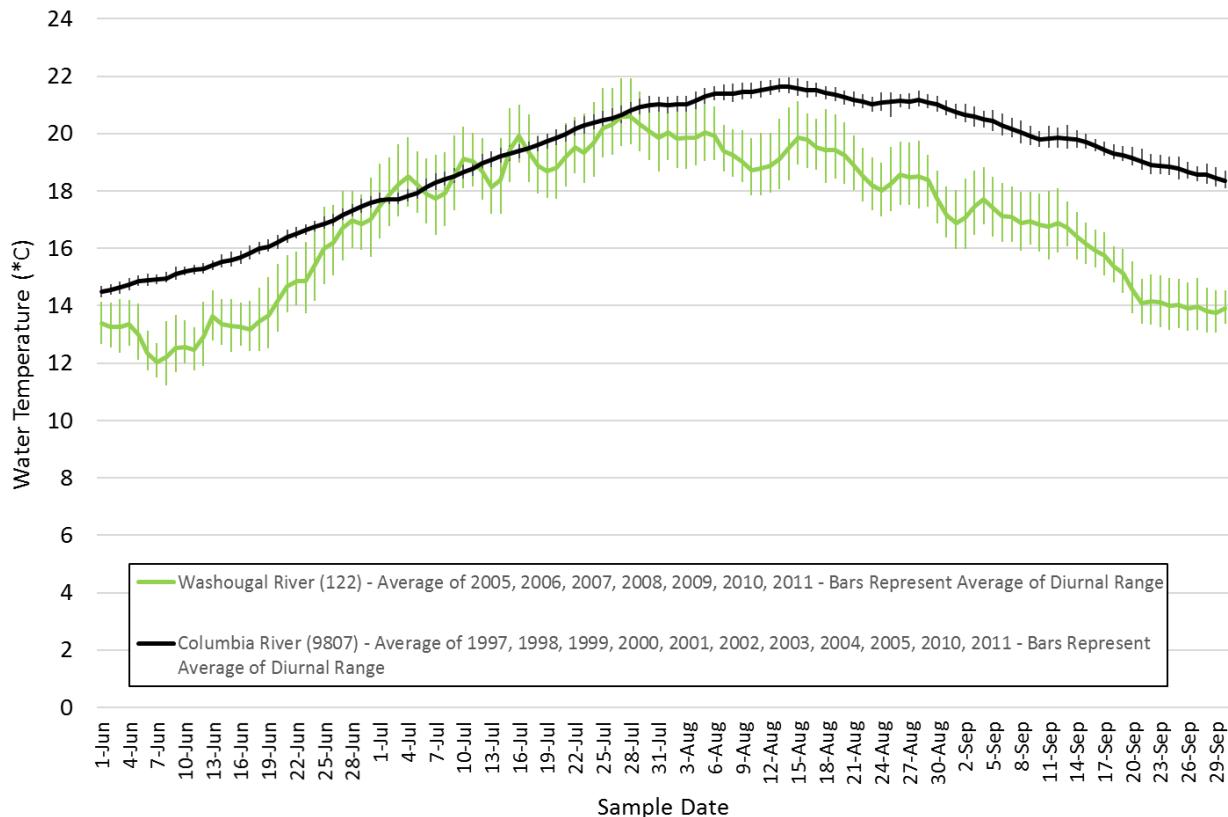


Site Name	Average Monthly Temperature Difference ( $^{\circ}\text{C}$ )			
	June	July	August	September
Tributary #77 – Sandy River	1.6	0.9	2.8	3.8

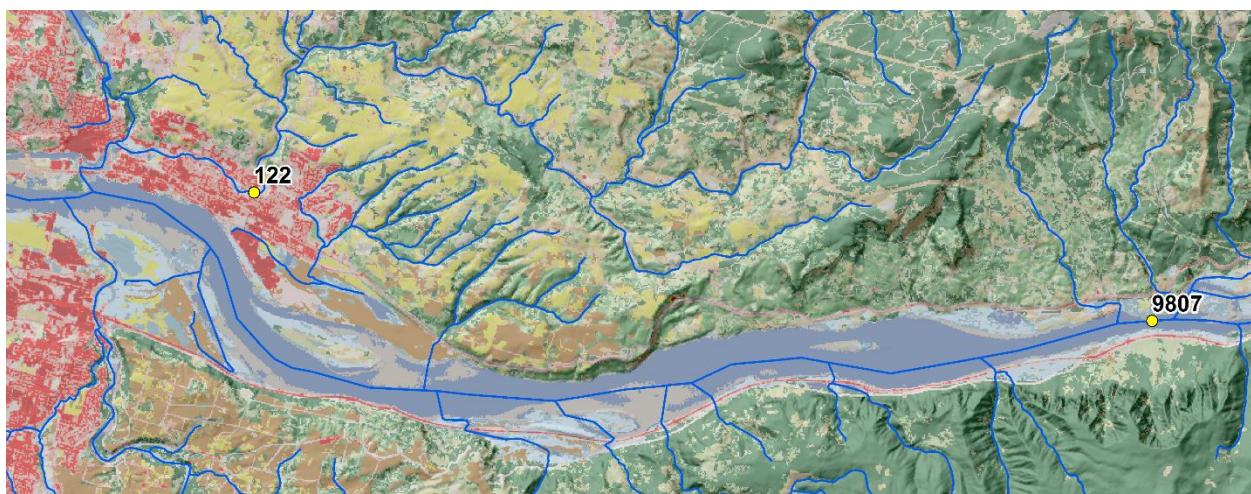


**Figure 1 (Continued).** Measured Tributary Water Temperature - Tributary #78 – Washougal River

Average Daily Average Water Temperature and Average Diurnal Range

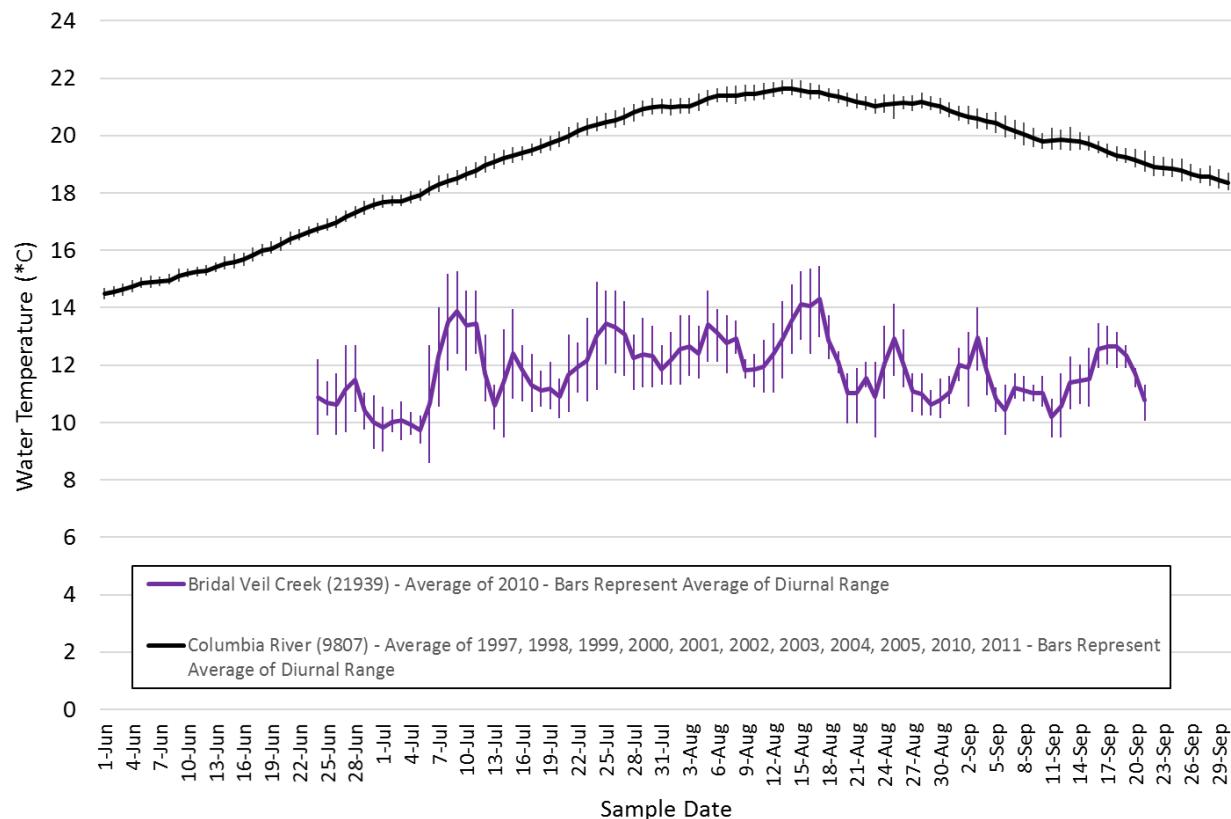


Site Name	Average Monthly Temperature Difference ( $^{\circ}\text{C}$ )			
	June	July	August	September
Tributary #78 – Washougal River	1.8	0.3	2.2	3.8

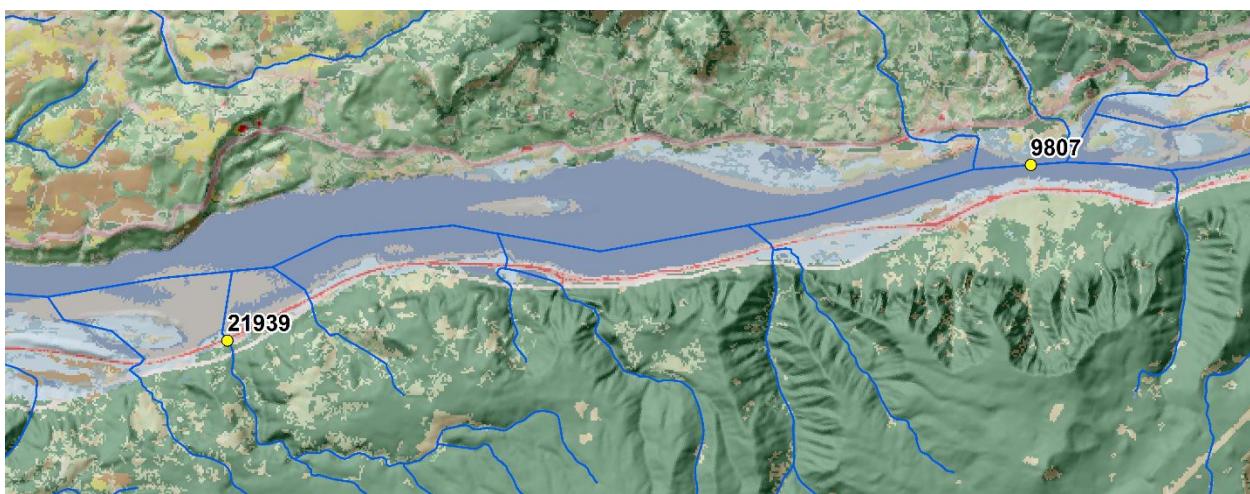


**Figure 1 (Continued).** Measured Tributary Water Temperature - Tributary #83 – Bridal Veil Creek

*Average Daily Average Water Temperature and Average Diurnal Range*

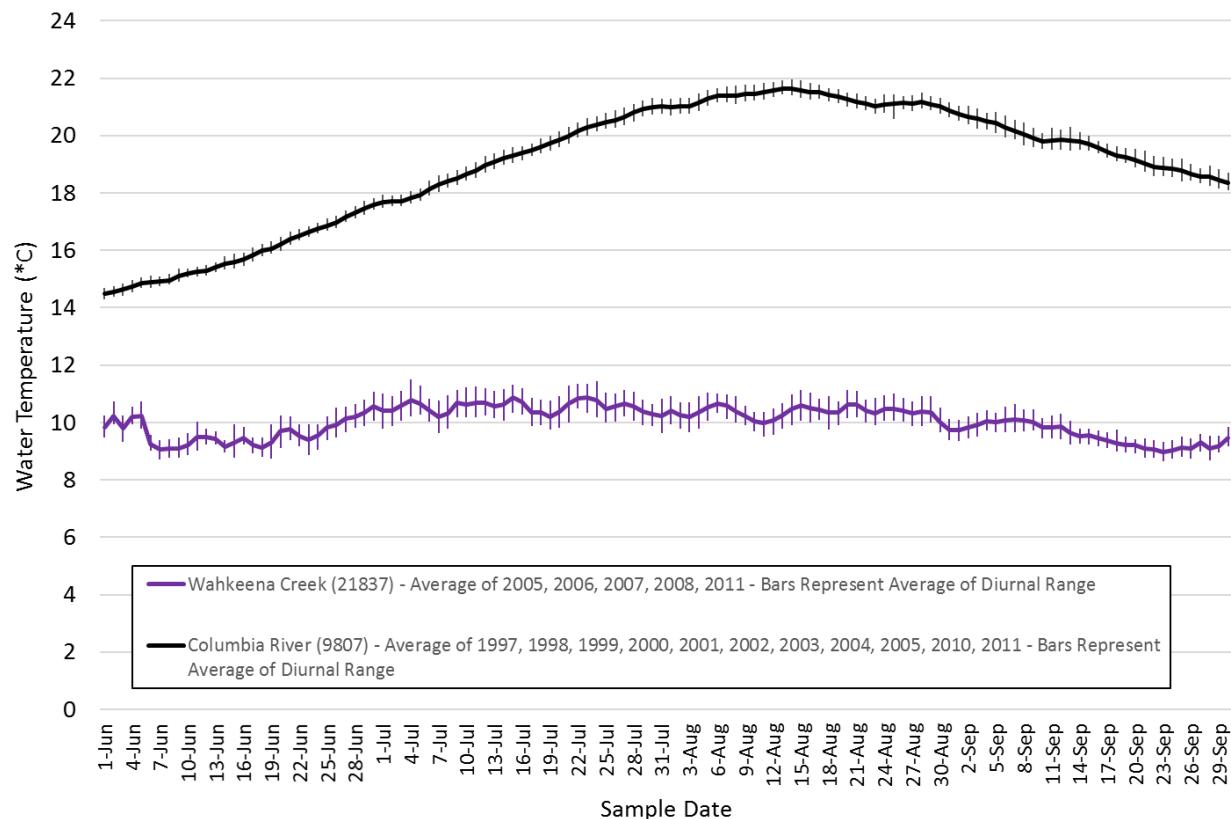


Site Name	Average Monthly Temperature Difference ( $^{\circ}\text{C}$ )			
	June	July	August	September
Tributary #83 – Bridal Veil Creek	6.4	7.5	9.0	8.4



**Figure 1 (Continued).** Measured Tributary Water Temperature - Tributary #85 – Wahkeena Creek

*Average Daily Average Water Temperature and Average Diurnal Range*

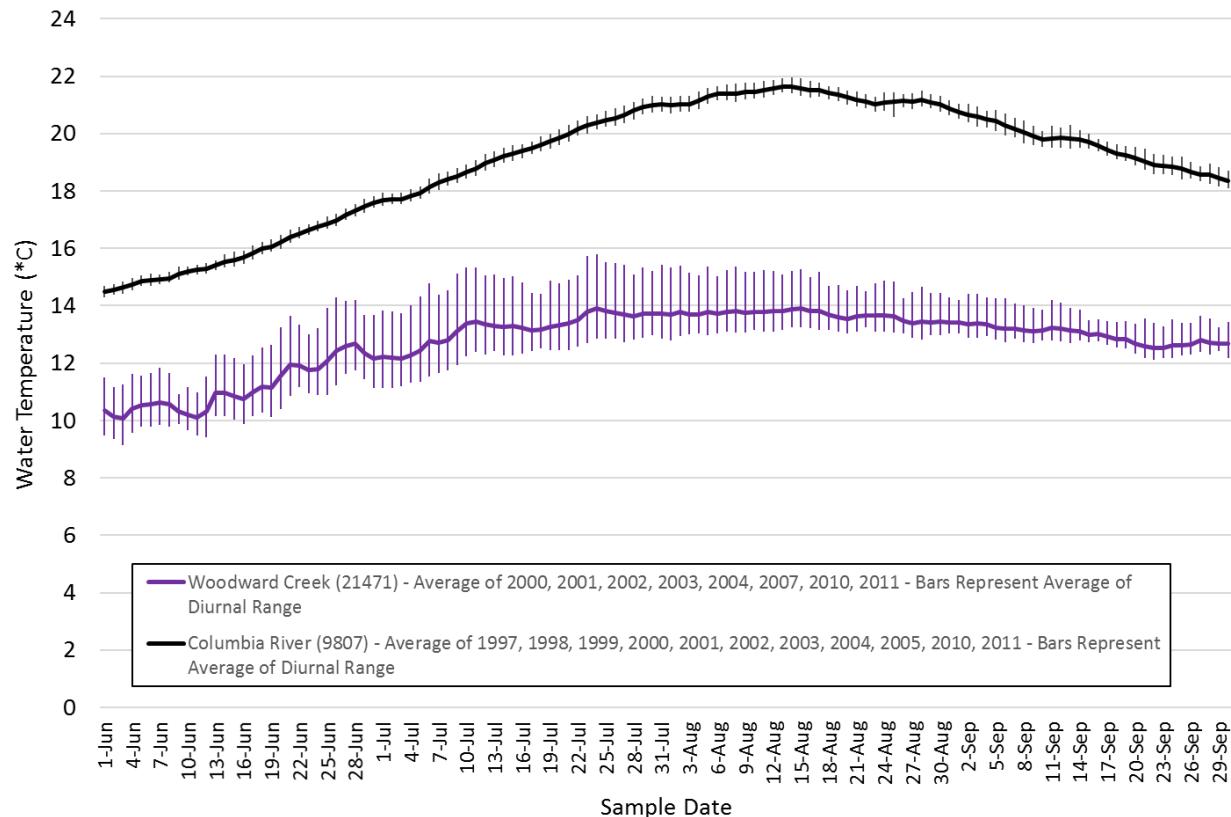


Site Name	Average Monthly Temperature Difference (*C)			
	June	July	August	September
Tributary #85 – Wahkeena Creek	6.2	8.8	10.9	10.0

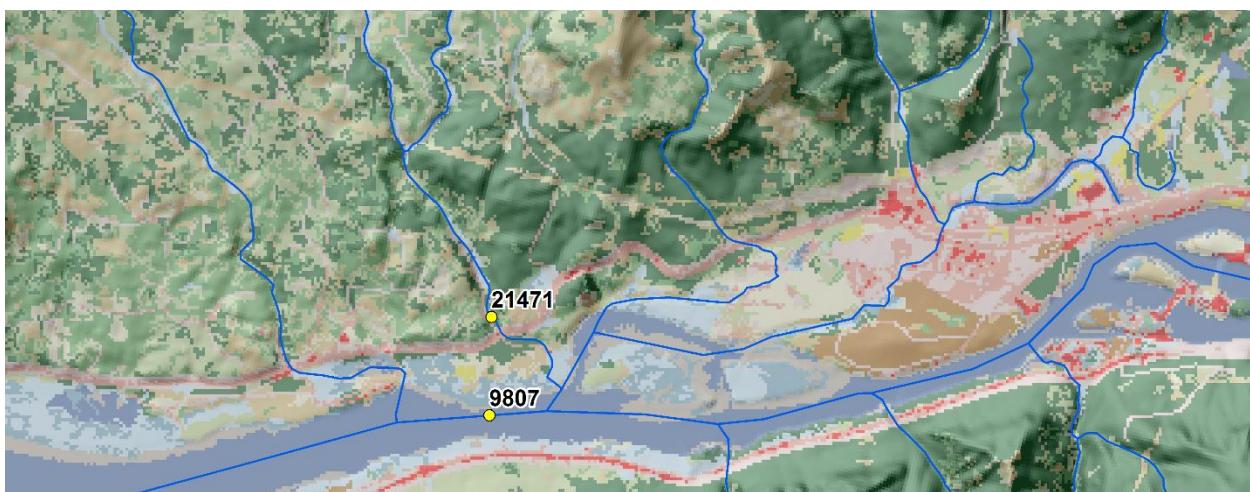


**Figure 1 (Continued).** Measured Tributary Water Temperature - Tributary #88 – Woodward Creek

*Average Daily Average Water Temperature and Average Diurnal Range*

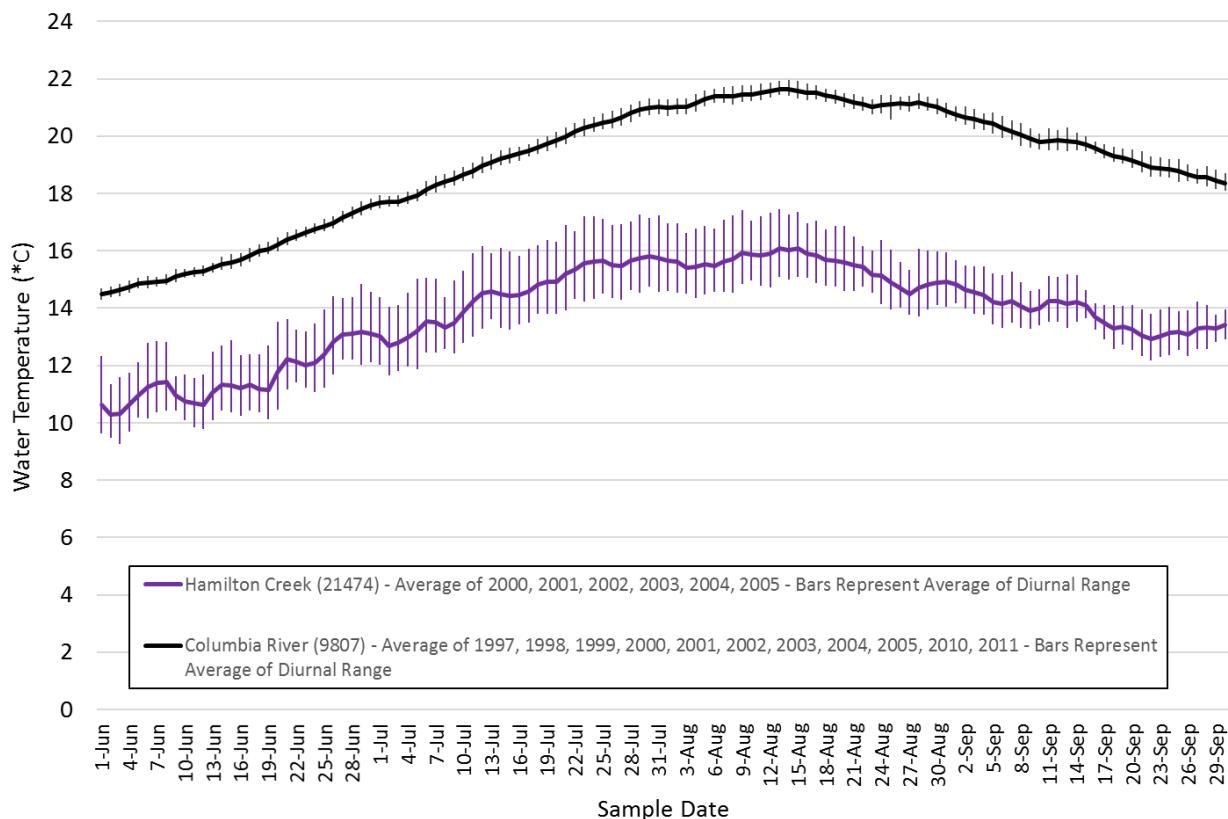


Site Name	Average Monthly Temperature Difference ( $^{\circ}\text{C}$ )			
	June	July	August	September
Tributary #88 – Woodward Creek	4.7	6.2	7.6	6.6

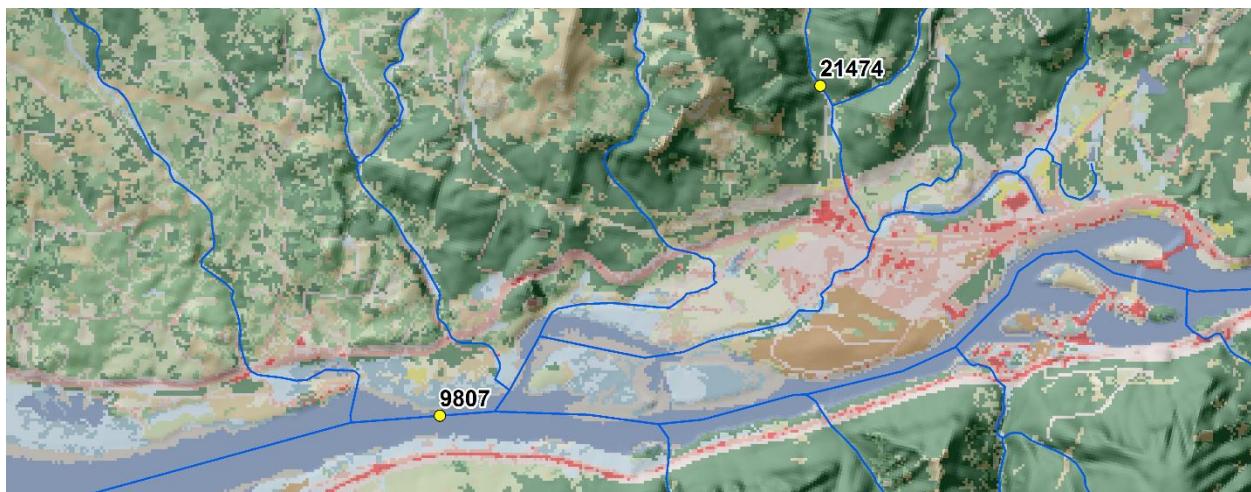


**Figure 1 (Continued).** Measured Tributary Water Temperature - Tributary #88b – Hamilton Creek

*Average Daily Average Water Temperature and Average Diurnal Range*

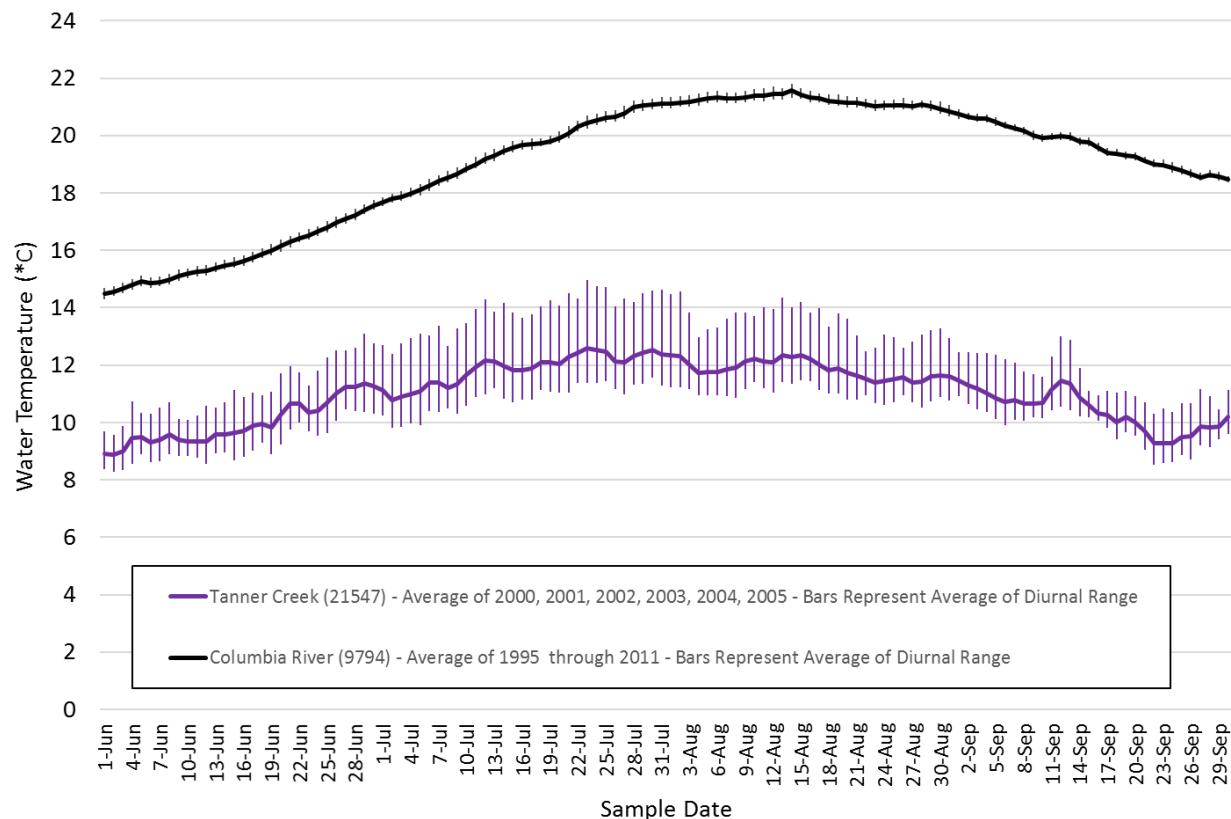


Site Name	Average Monthly Temperature Difference ( $^{\circ}\text{C}$ )			
	June	July	August	September
Tributary #88b – Hamilton Creek	4.3	4.9	5.8	5.8

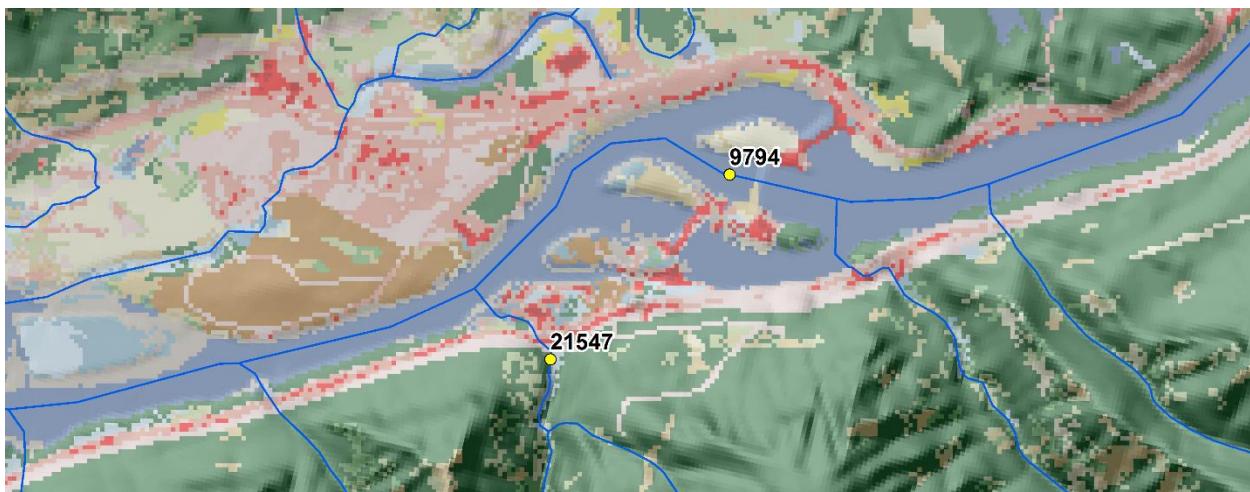


**Figure 1 (Continued).** Measured Tributary Water Temperature - Tributary #91 – Tanner Creek

*Average Daily Average Water Temperature and Average Diurnal Range*

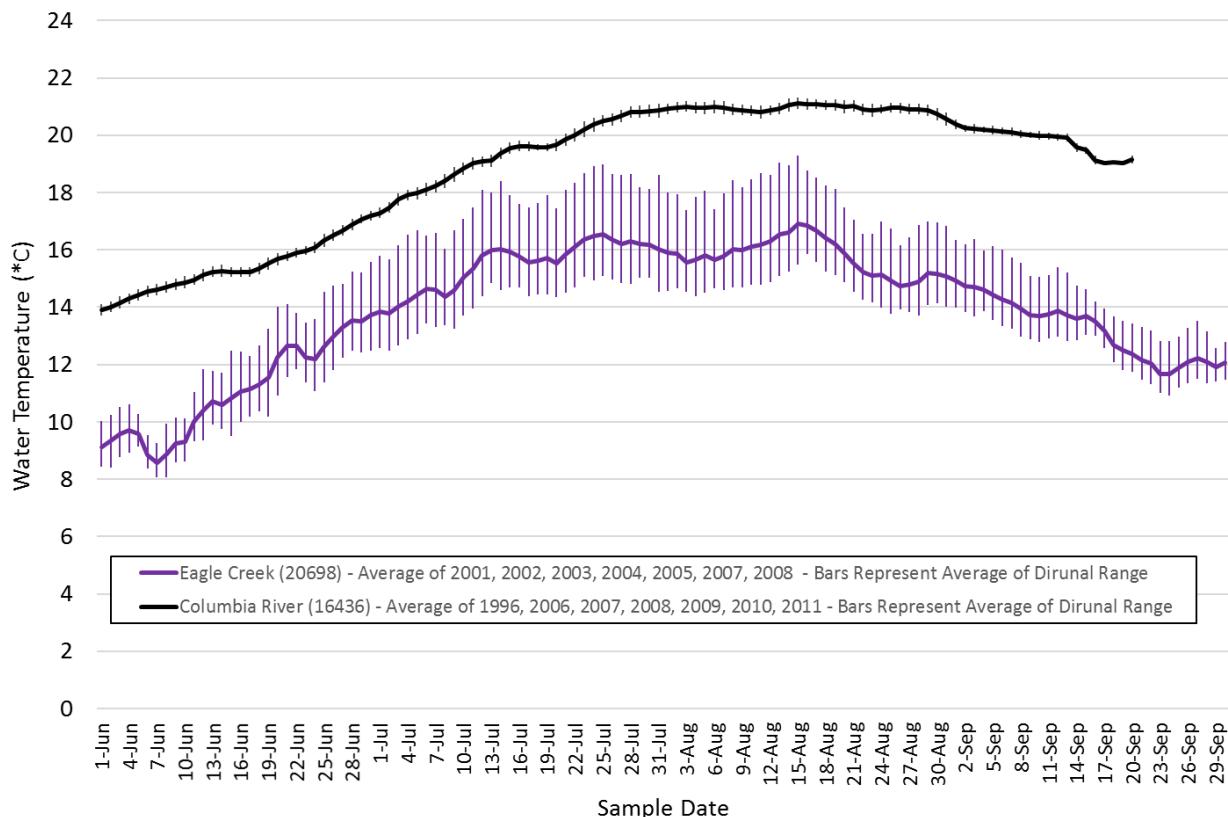


Site Name	Average Monthly Temperature Difference (*C)			
	June	July	August	September
Tributary #91 – Tanner Creek	5.8	7.7	9.3	9.2

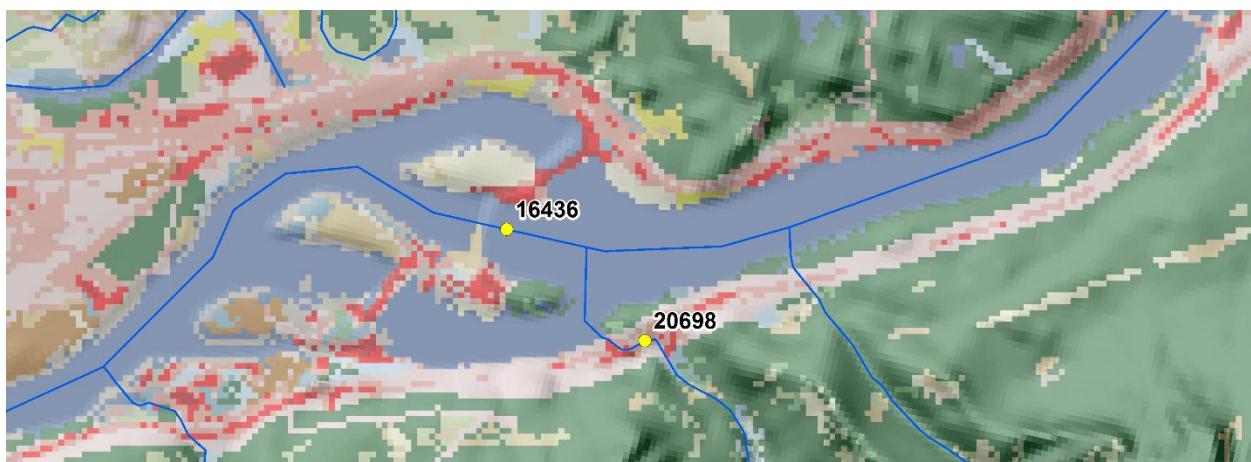


**Figure 1 (Continued).** Measured Tributary Water Temperature - Tributary #92 – Eagle Creek

Average Daily Average Water Temperature and Average Diurnal Range

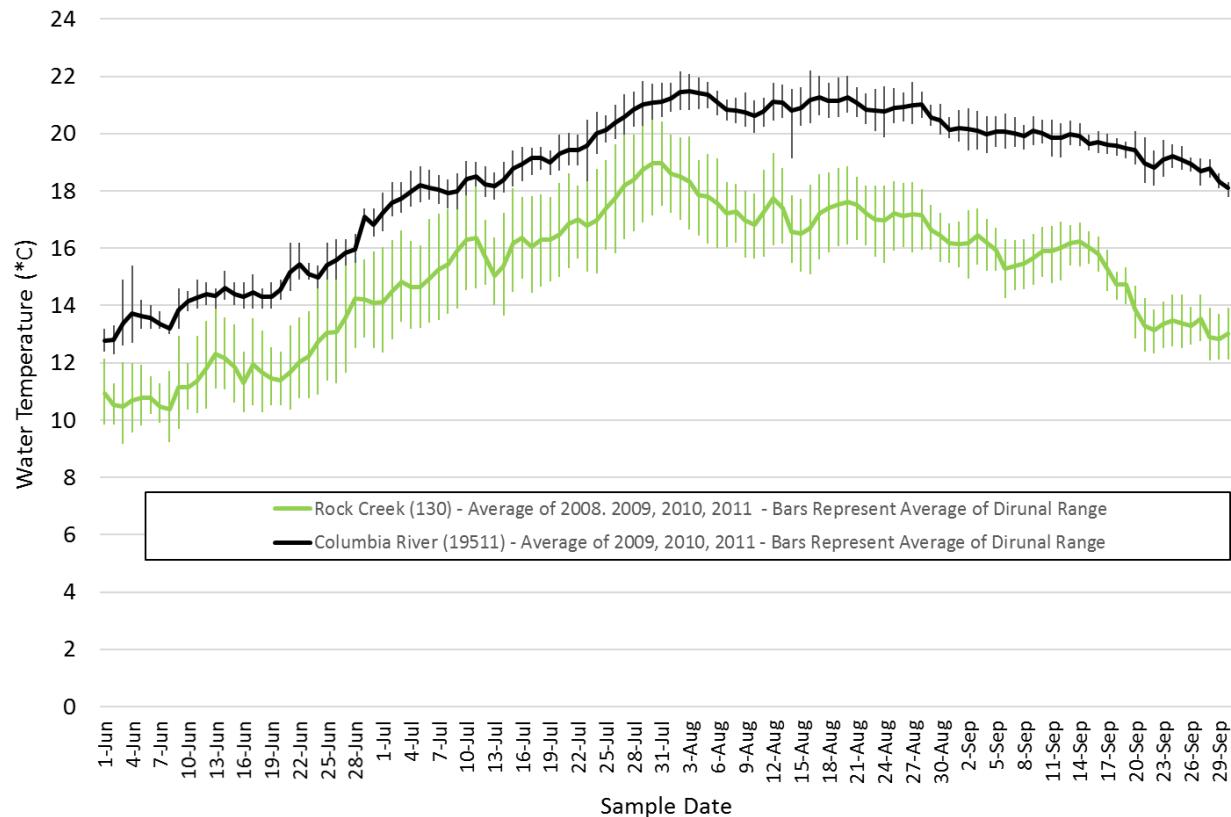


Site Name	Average Monthly Temperature Difference ( $^{\circ}\text{C}$ )			
	June	July	August	September
Tributary #92 – Eagle Creek	4.3	3.9	5.2	6.0

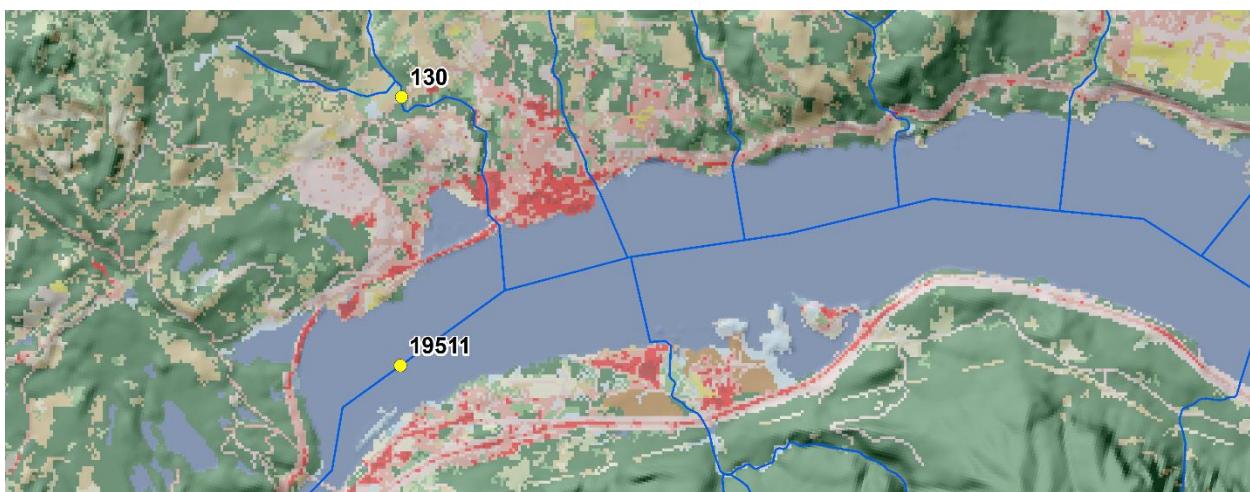


**Figure 1 (Continued).** Measured Tributary Water Temperature - Tributary #94 – Rock Creek

*Average Daily Average Water Temperature and Average Diurnal Range*

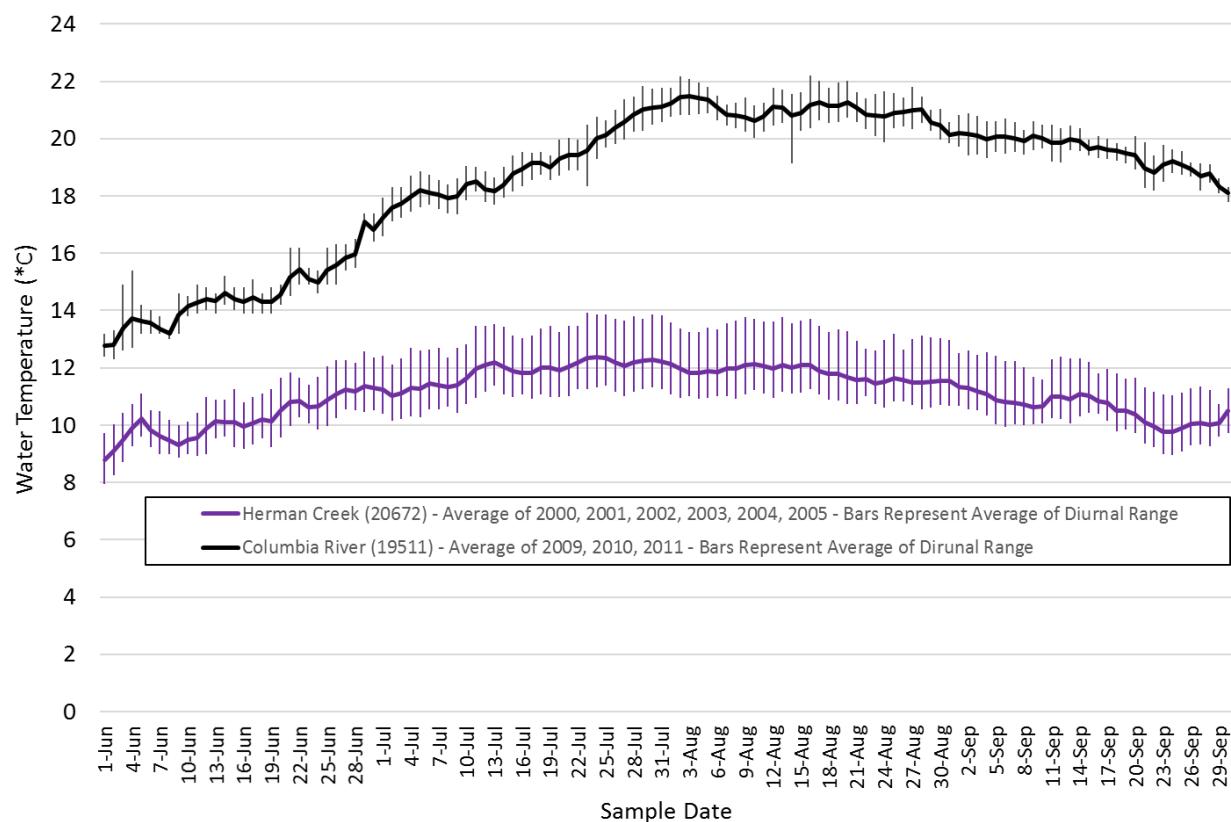


Site Name	Average Monthly Temperature Difference (*C)			
	June	July	August	September
Tributary #94 – Rock Creek	2.7	2.7	3.7	4.7

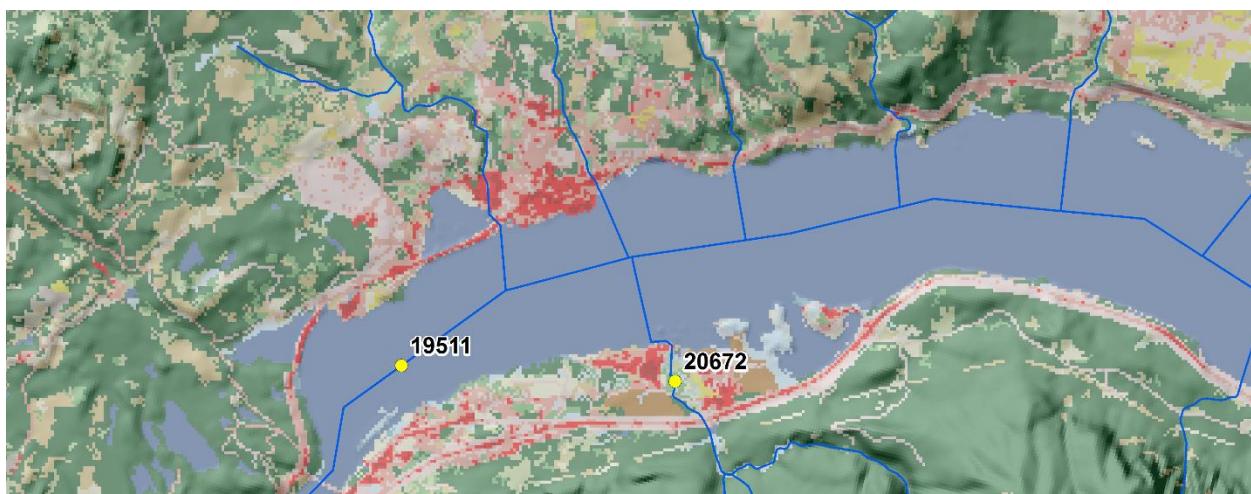


**Figure 1 (Continued).** Measured Tributary Water Temperature - Tributary #96 – Herman Creek

Average Daily Average Water Temperature and Average Diurnal Range

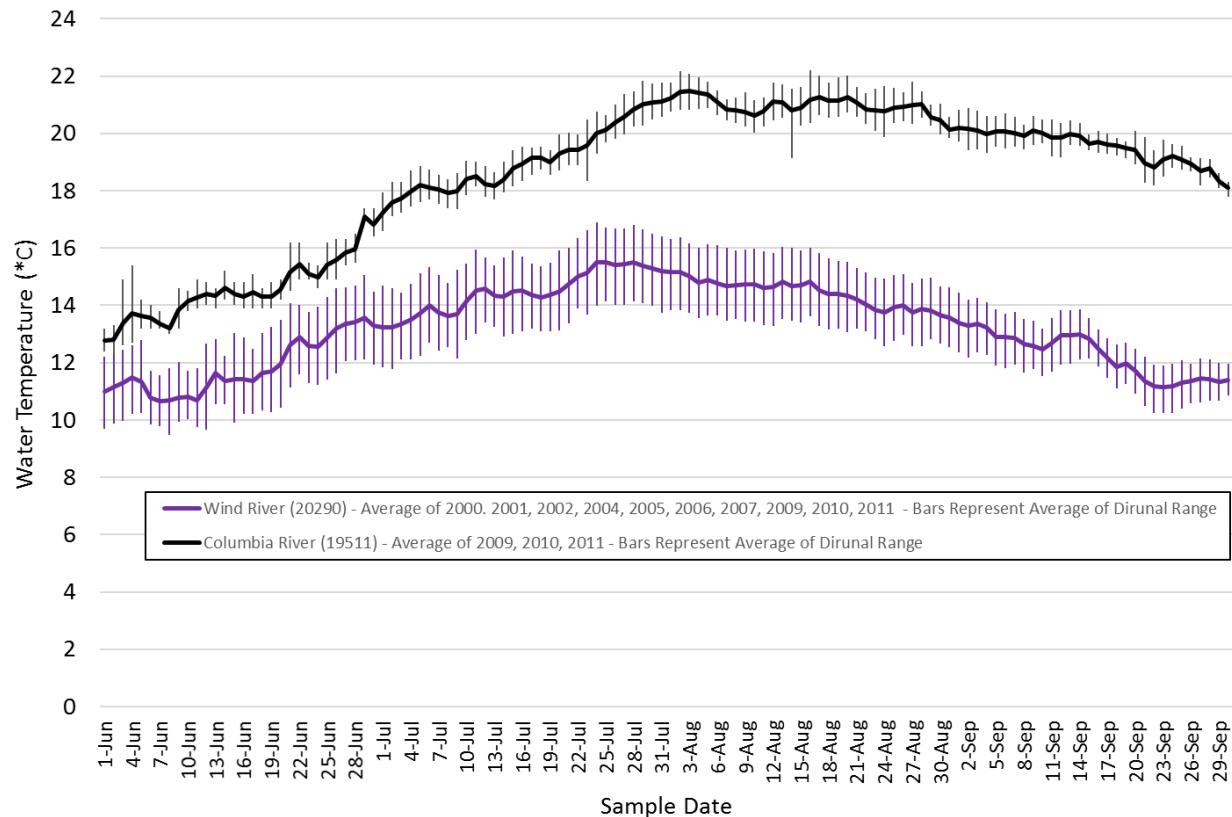


Site Name	Average Monthly Temperature Difference (*C)			
	June	July	August	September
Tributary #96 – Herman Creek	4.3	7.2	9.2	8.9

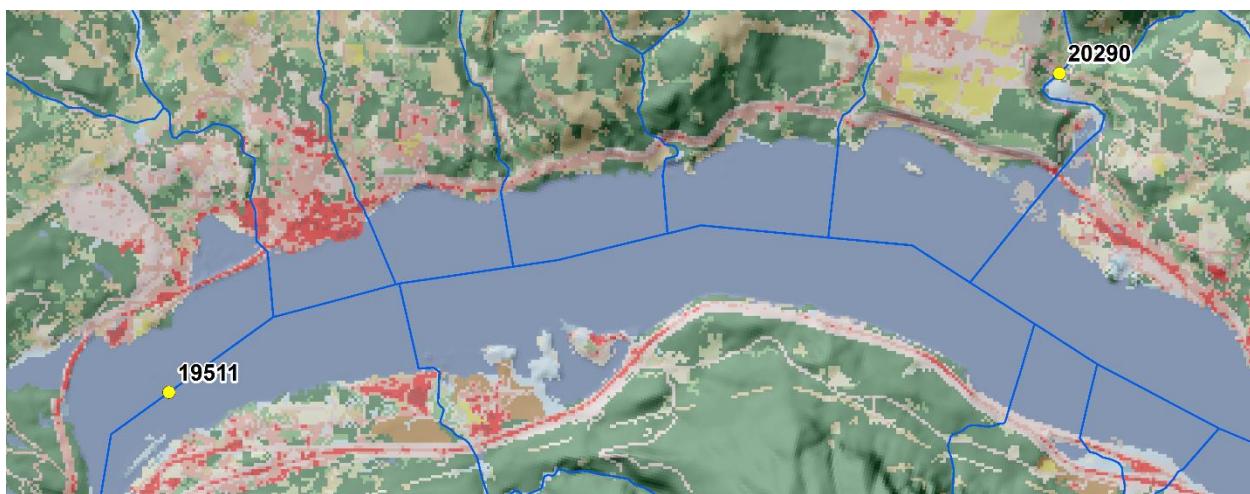


**Figure 1 (Continued).** Measured Tributary Water Temperature - Tributary #100 – Wind River

*Average Daily Average Water Temperature and Average Diurnal Range*

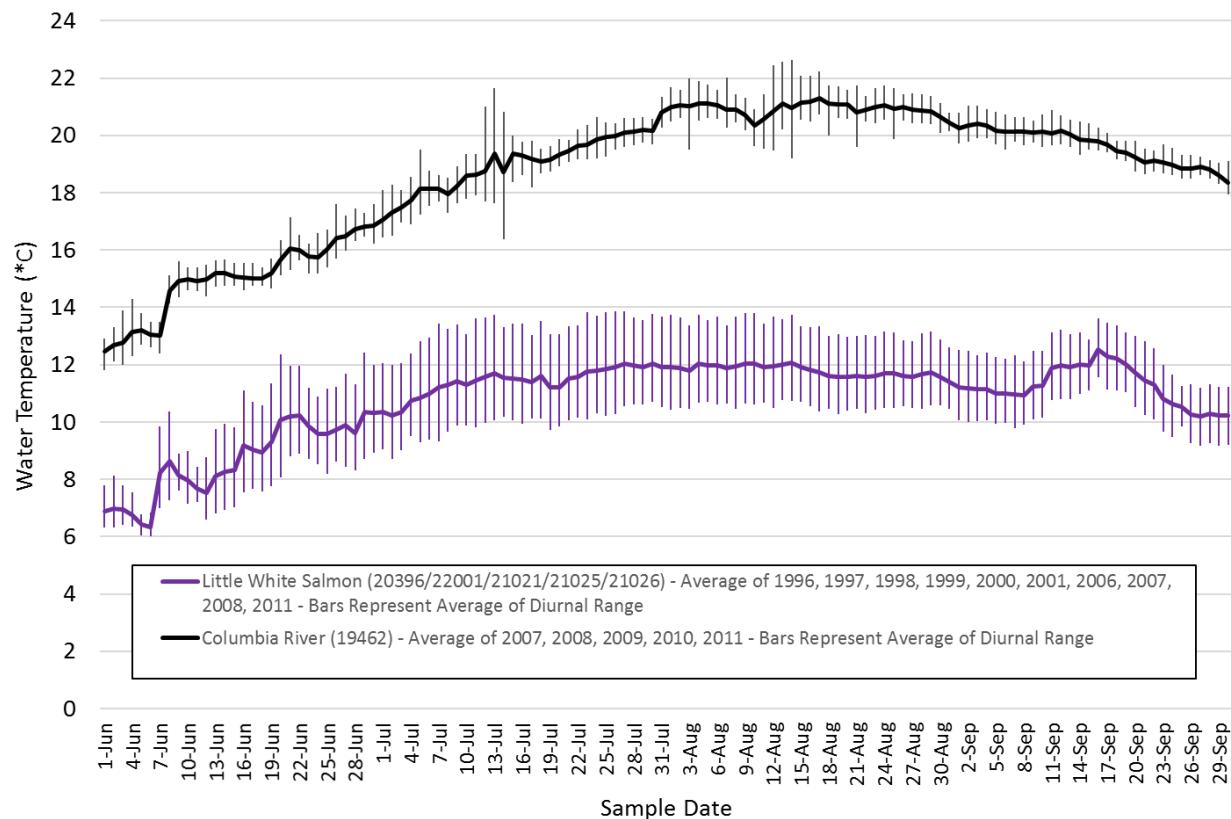


Site Name	Average Monthly Temperature Difference (*C)			
	June	July	August	September
Tributary #100 – Wind River	2.7	4.6	6.6	7.3

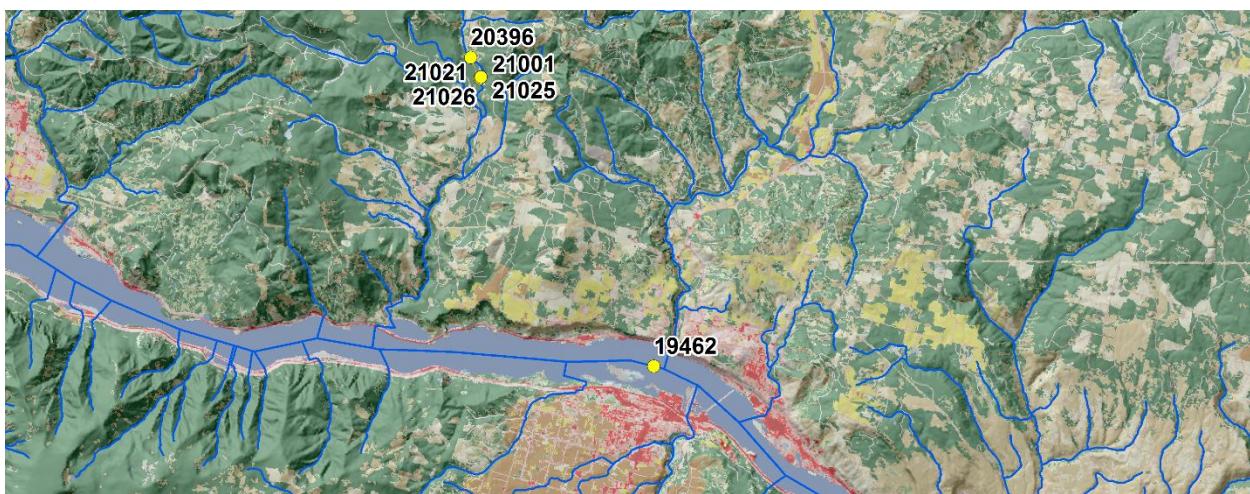


**Figure 1 (Cont.).** Measured Tributary Water Temperature - Tributary #112 – Little White Salmon River

*Average Daily Average Water Temperature and Average Diurnal Range*

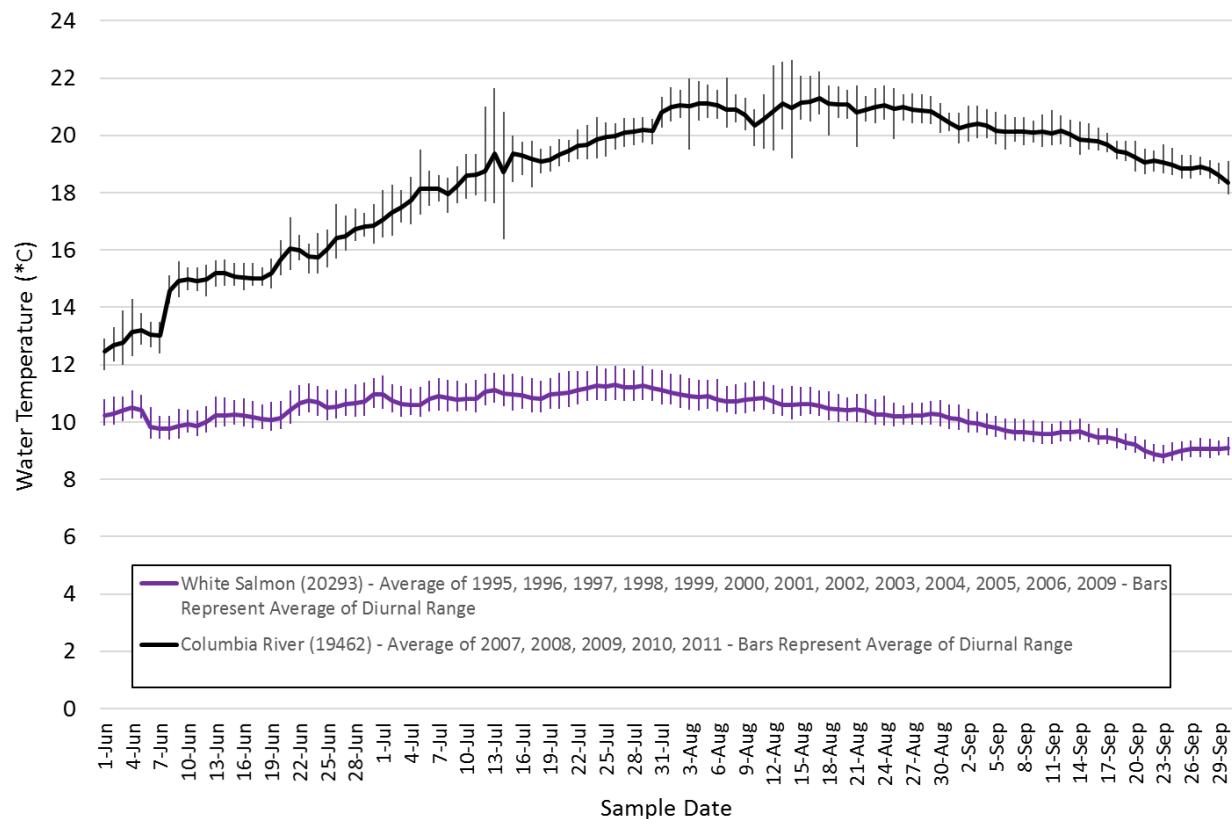


Site Name	Average Monthly Temperature Difference ( $^{\circ}\text{C}$ )			
	June	July	August	September
Tributary #112 – Little White Salmon River	6.3	7.6	9.1	8.4

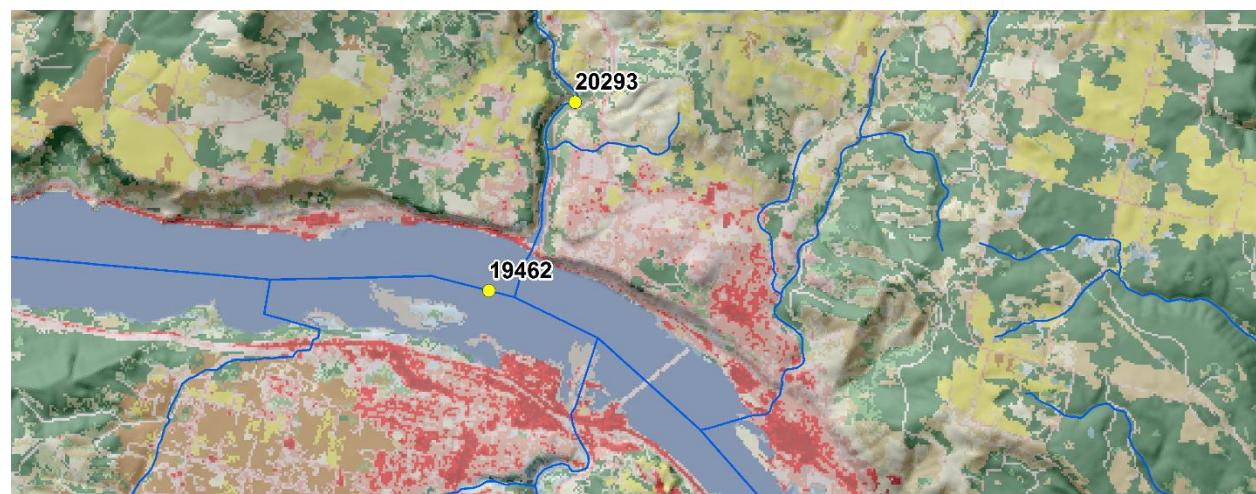


**Figure 1 (Continued).** Measured Tributary Water Temperature - Tributary #115 – White Salmon River

Average Daily Average Water Temperature and Average Diurnal Range

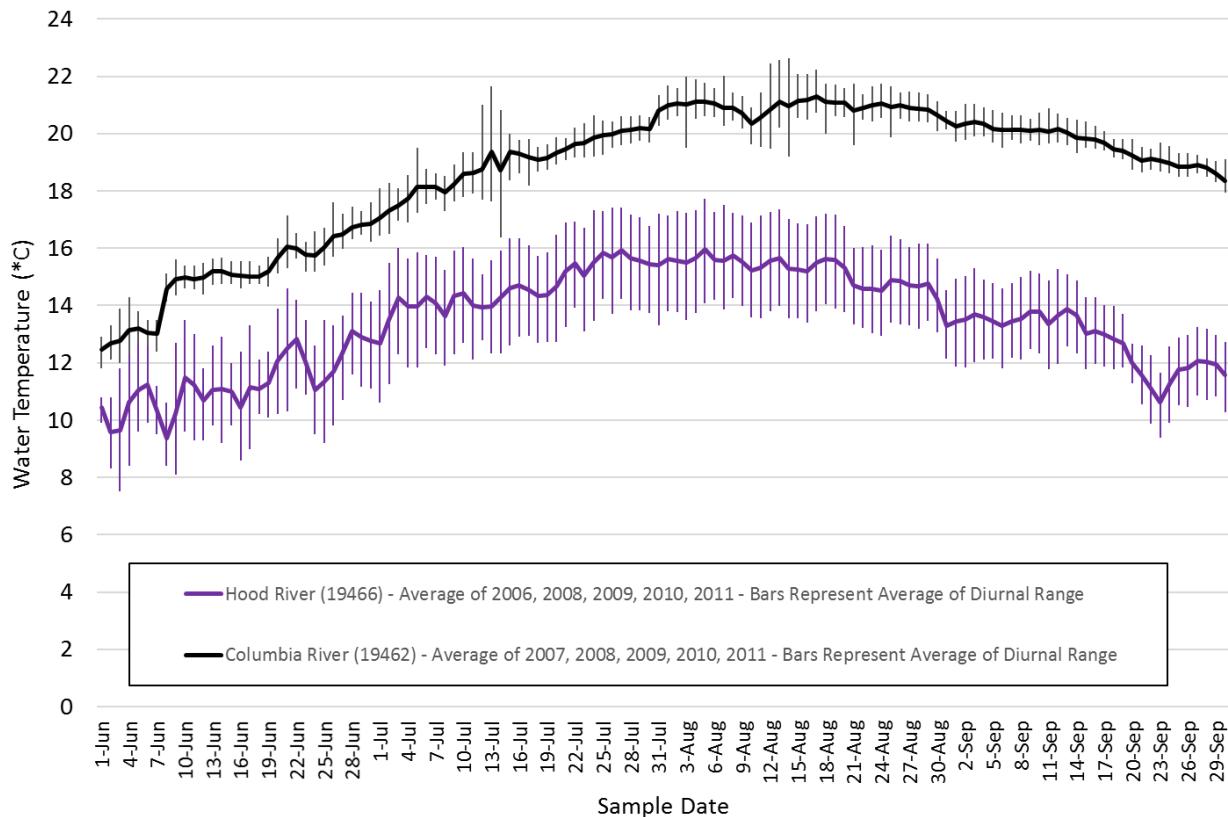


Site Name	Average Monthly Temperature Difference (*C)			
	June	July	August	September
Tributary #115 – White Salmon River	4.7	8.0	10.4	10.2

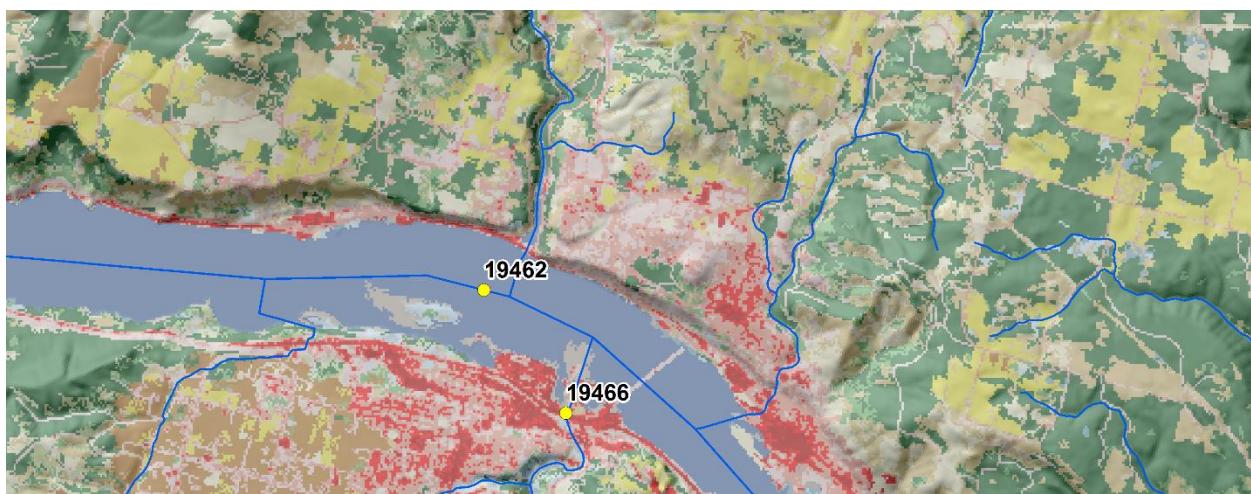


**Figure 1 (Continued).** Measured Tributary Water Temperature - Tributary #116 – Hood River

*Average Daily Average Water Temperature and Average Diurnal Range*

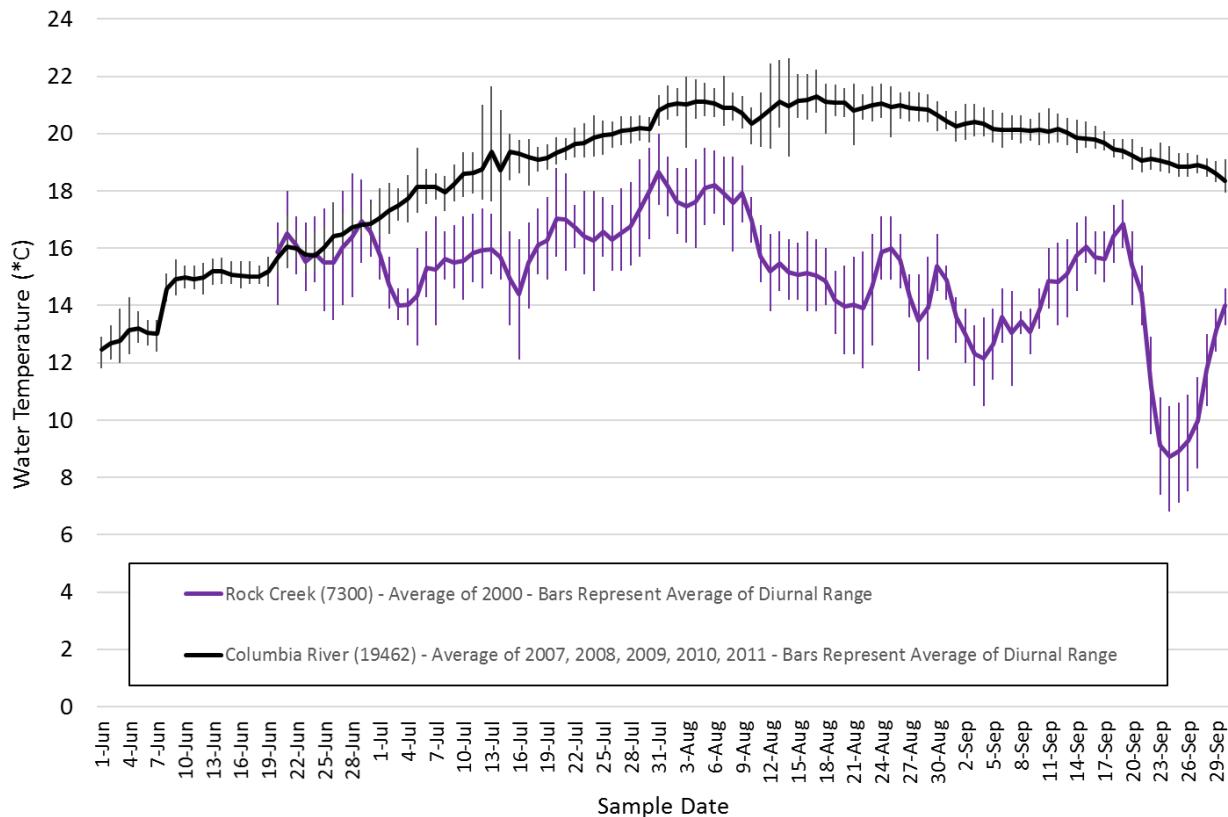


Site Name	Average Monthly Temperature Difference (*C)			
	June	July	August	September
Tributary #116 – Hood River	3.7	4.4	5.8	6.9

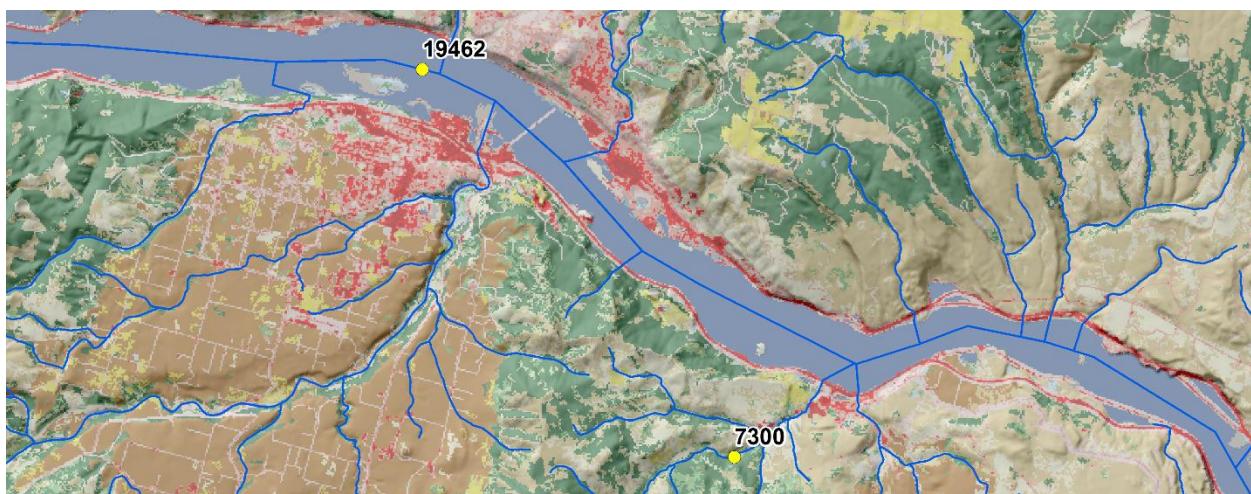


**Figure 1 (Continued).** Measured Tributary Water Temperature - Tributary #119 – Rock Creek

*Average Daily Average Water Temperature and Average Diurnal Range*

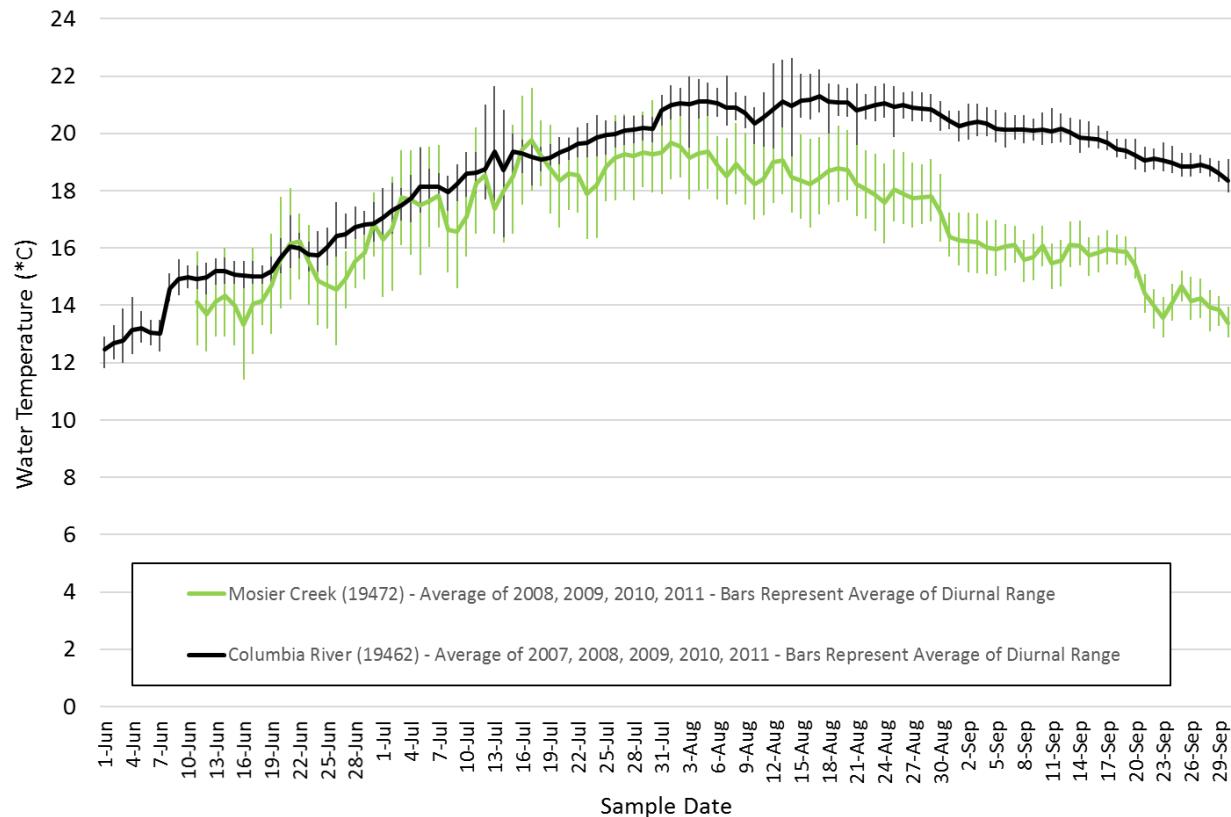


Site Name	Average Monthly Temperature Difference (*C)			
	June	July	August	September
Tributary #119 – Rock Creek	0.2	3.1	5.1	6.3

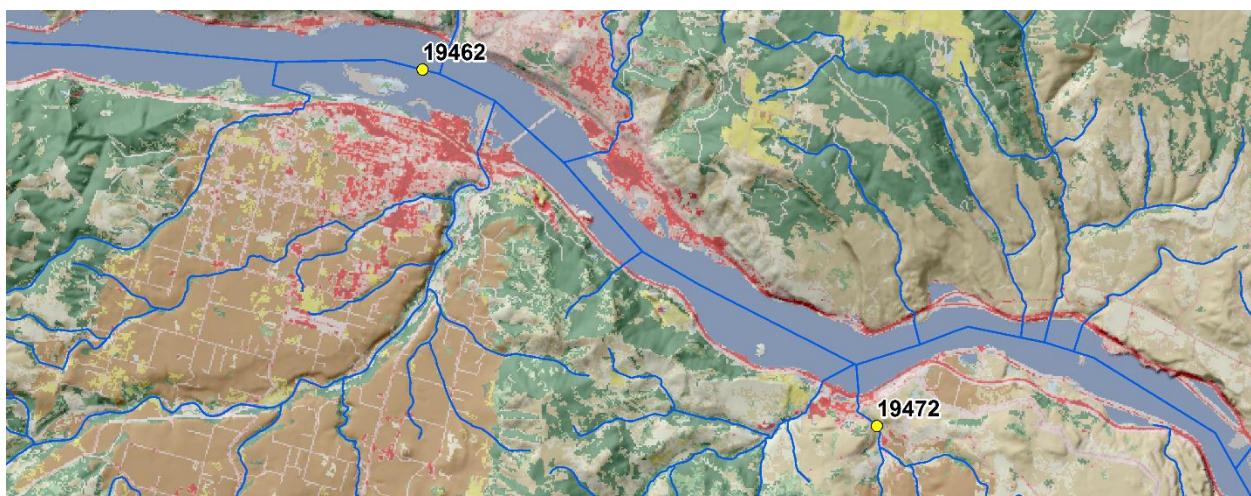


**Figure 1 (Continued).** Measured Tributary Water Temperature - Tributary #120 – Mosier Creek

Average Daily Average Water Temperature and Average Diurnal Range

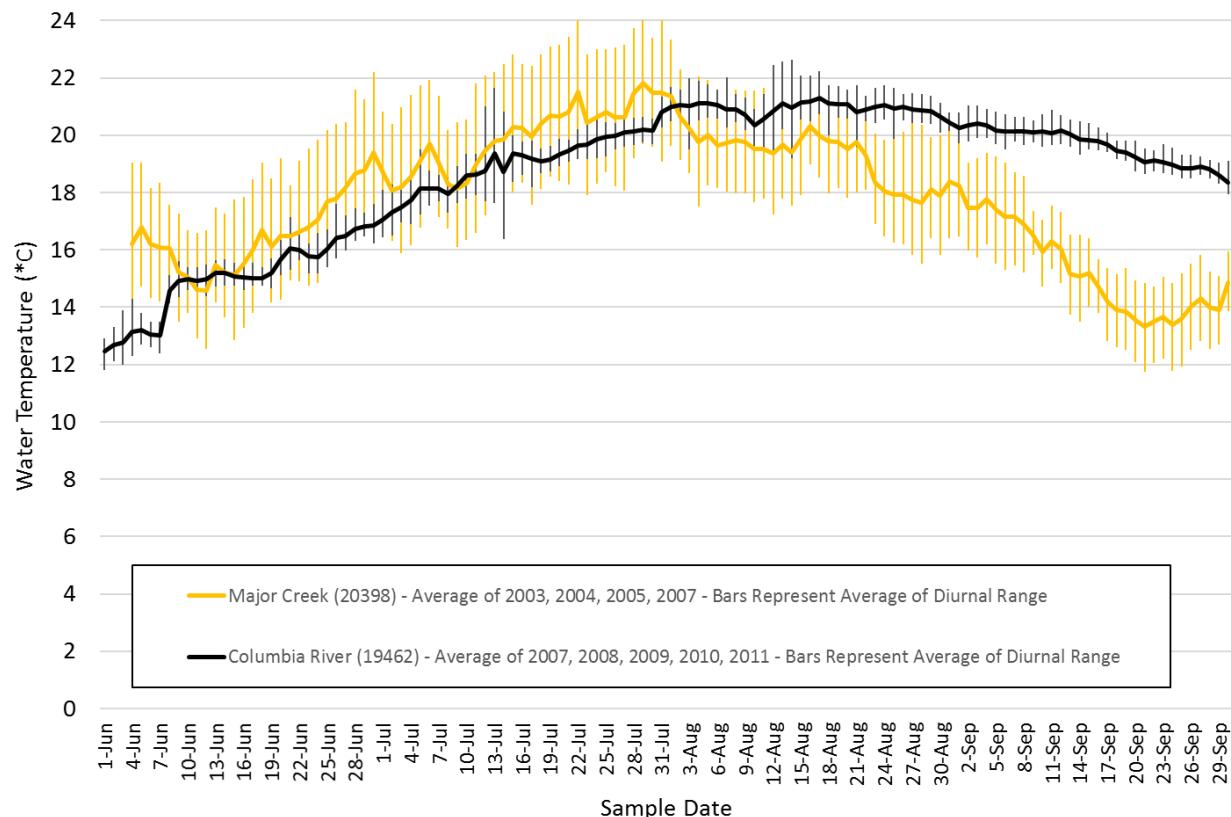


Site Name	Average Monthly Temperature Difference (*C)			
	June	July	August	September
Tributary #120 – Mosier Creek	0.8	0.8	2.5	4.3

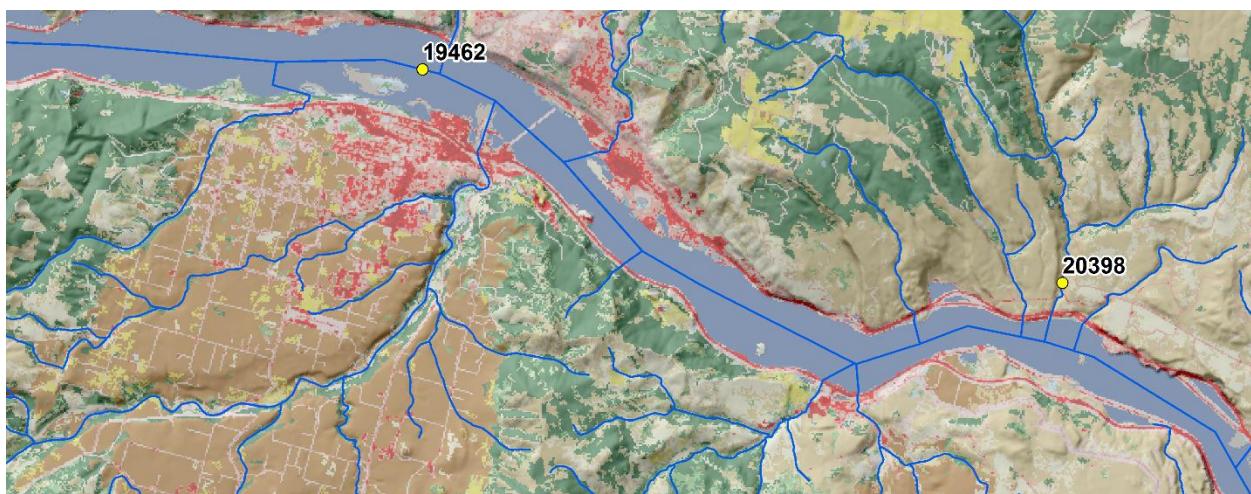


**Figure 1 (Continued).** Measured Tributary Water Temperature - Tributary #123 – Major Creek

*Average Daily Average Water Temperature and Average Diurnal Range*

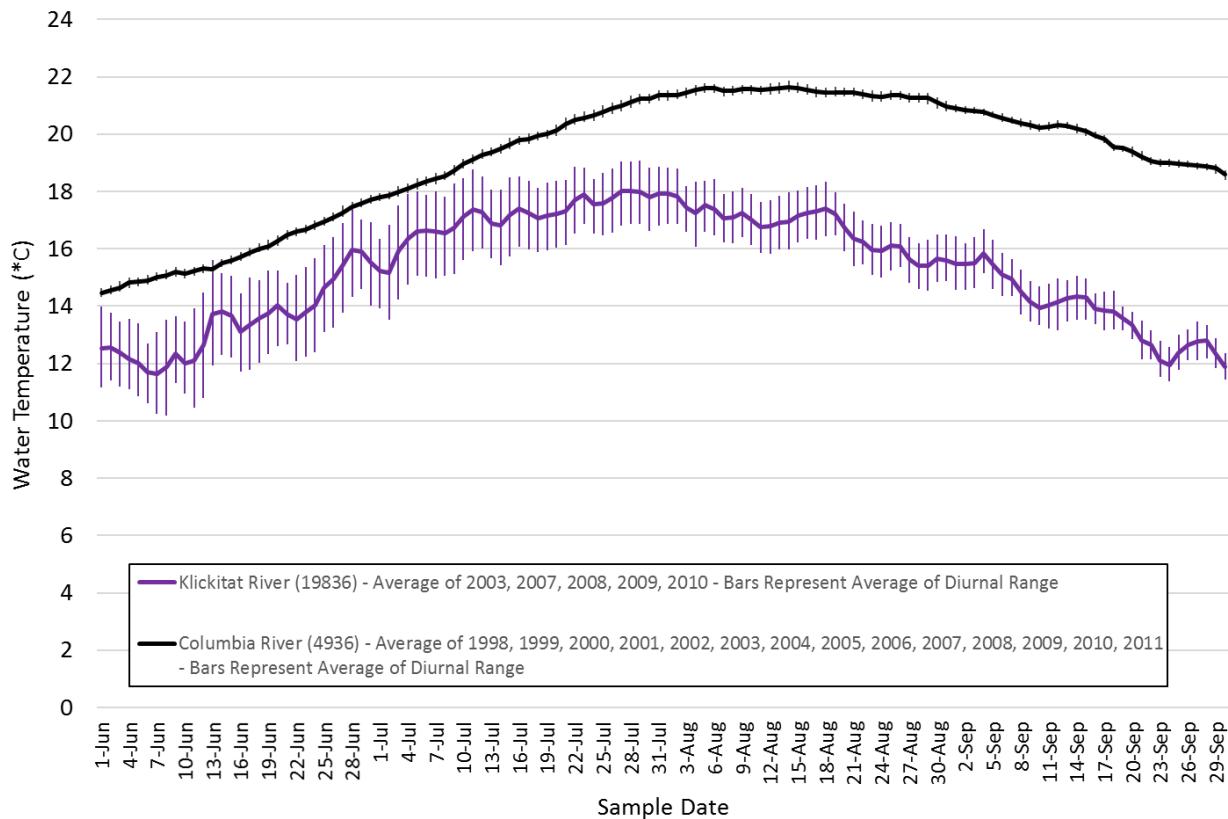


Site Name	Average Monthly Temperature Difference (*C)			
	June	July	August	September
Tributary #123 – Major Creek	-1.3	-0.9	1.6	4.3

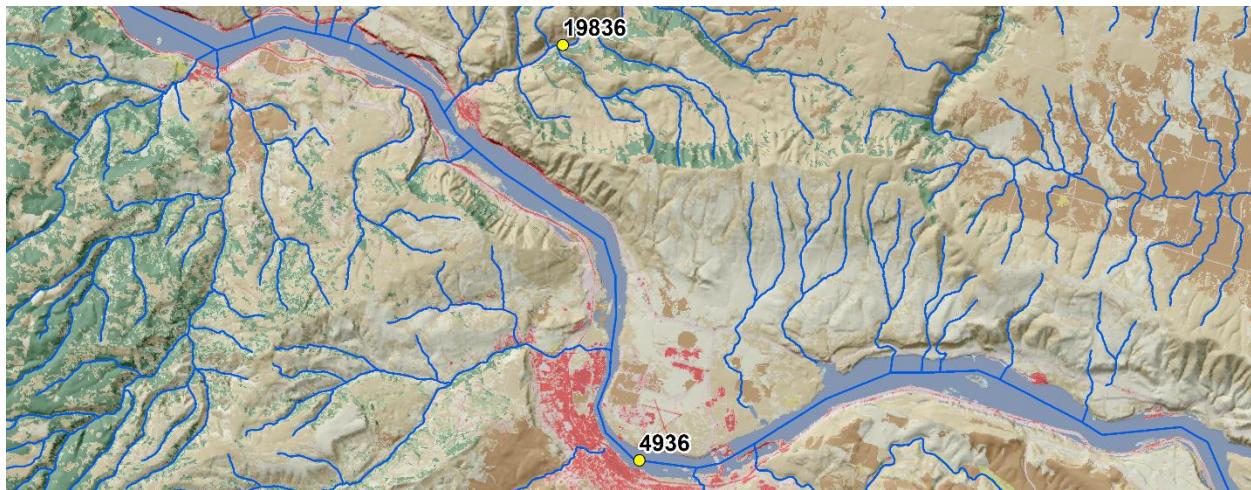


**Figure 1 (Continued).** Measured Tributary Water Temperature - Tributary #125 – Klickitat River

*Average Daily Average Water Temperature and Average Diurnal Range*

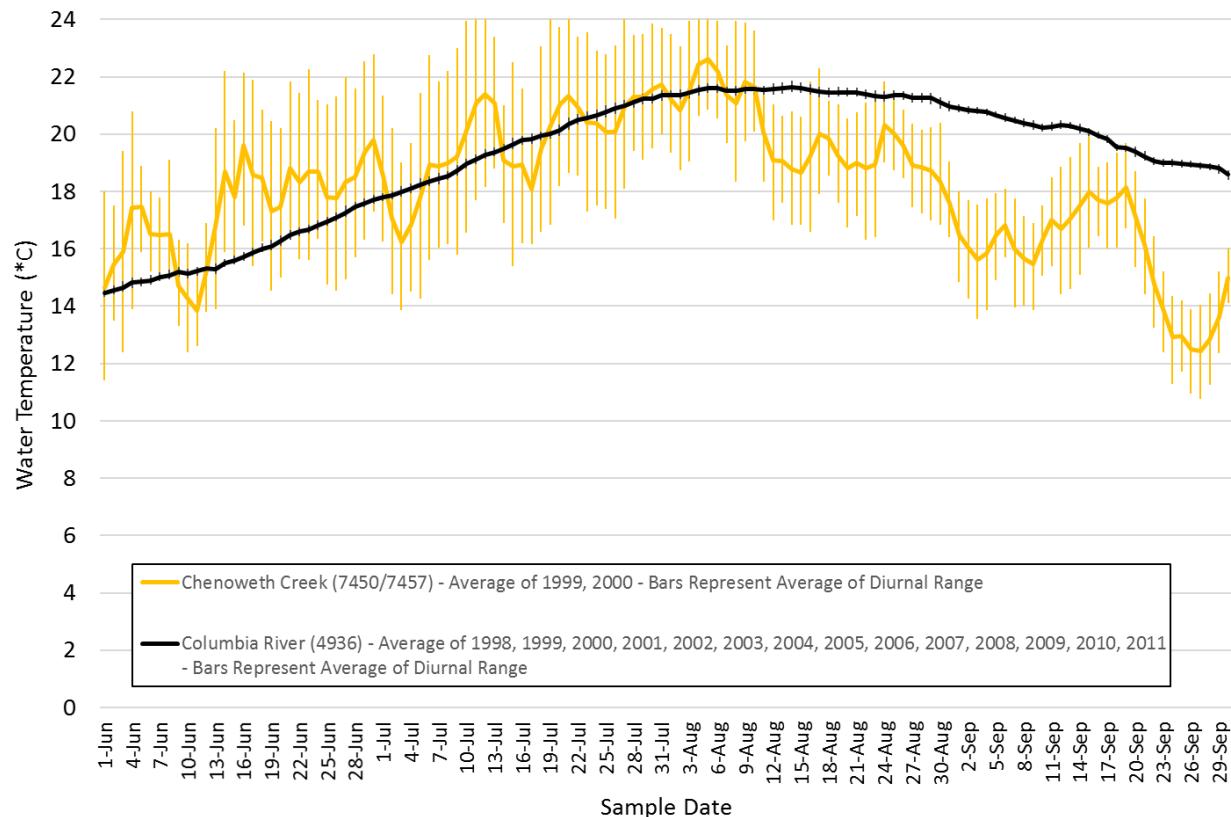


Site Name	Average Monthly Temperature Difference ( $^{\circ}\text{C}$ )			
	June	July	August	September
Tributary #125 – Klickitat River	2.5	2.6	4.7	6.0

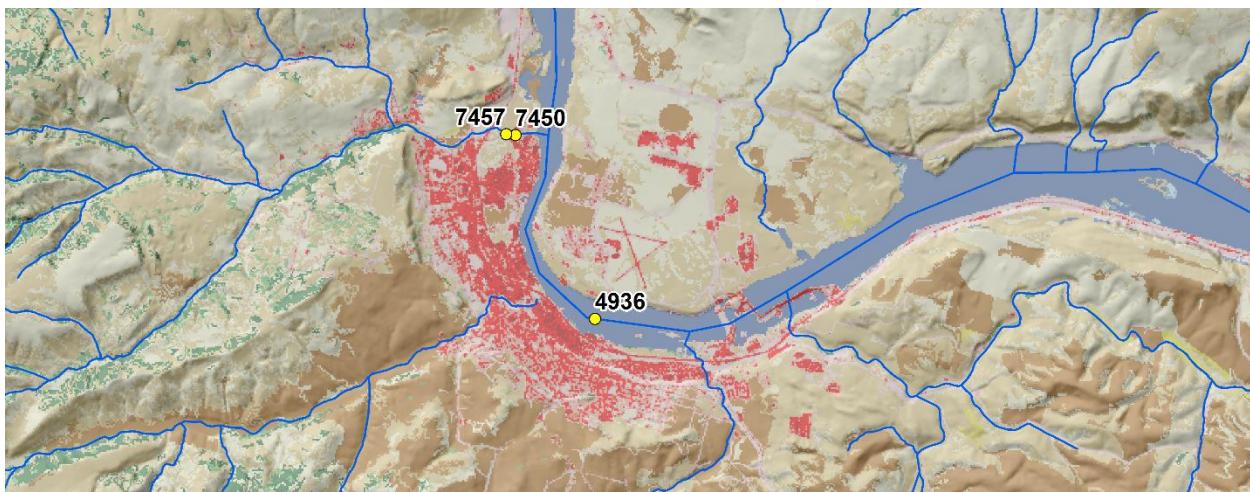


**Figure 1 (Continued).** Measured Tributary Water Temperature - Tributary #127 – Chenoweth Creek

*Average Daily Average Water Temperature and Average Diurnal Range*

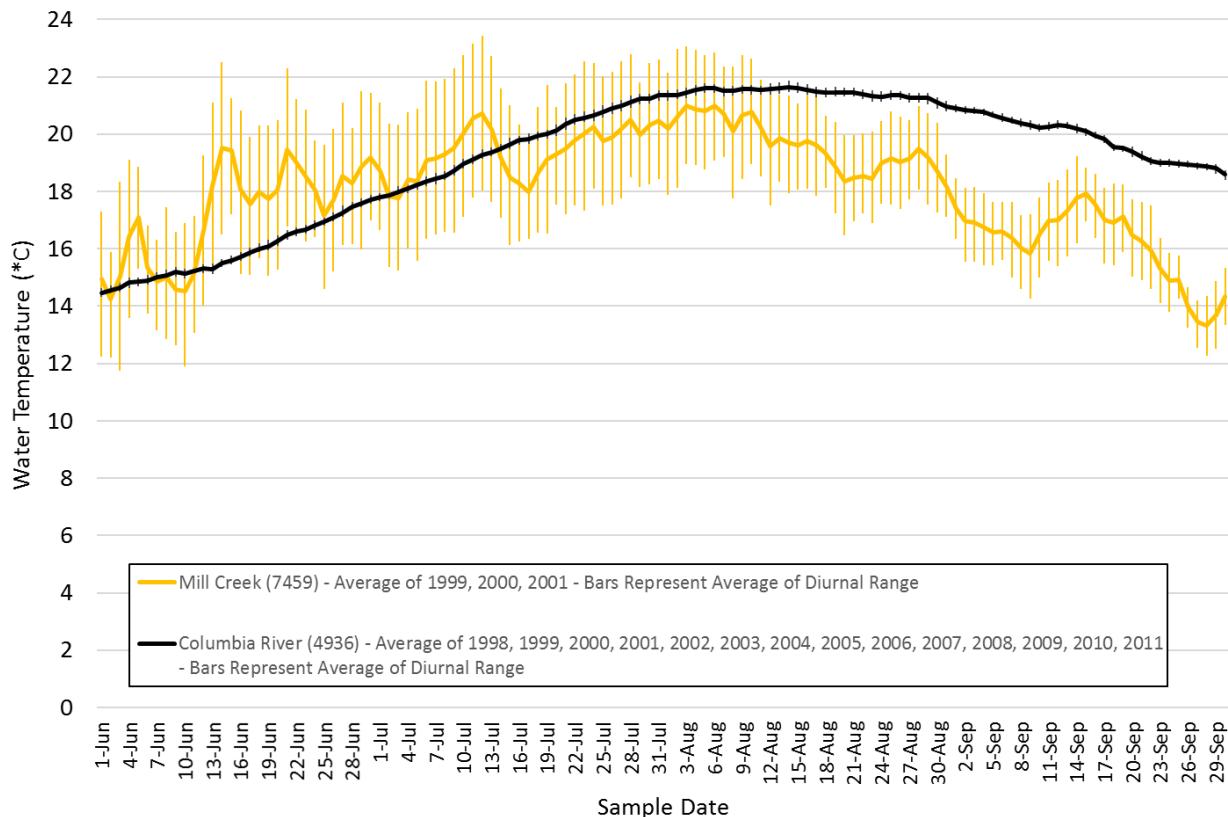


Site Name	June	July	August	September
Tributary #127 – Chenoweth Creek	-1.4	-0.1	1.5	4.1

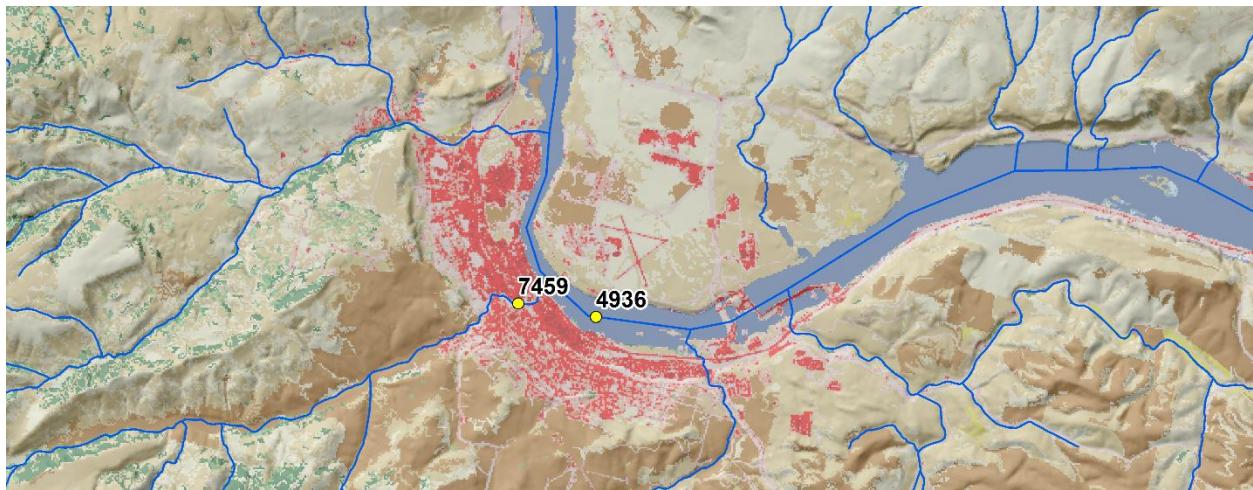


**Figure 1 (Continued).** Measured Tributary Water Temperature - Tributary #127a – Mill Creek

*Average Daily Average Water Temperature and Average Diurnal Range*

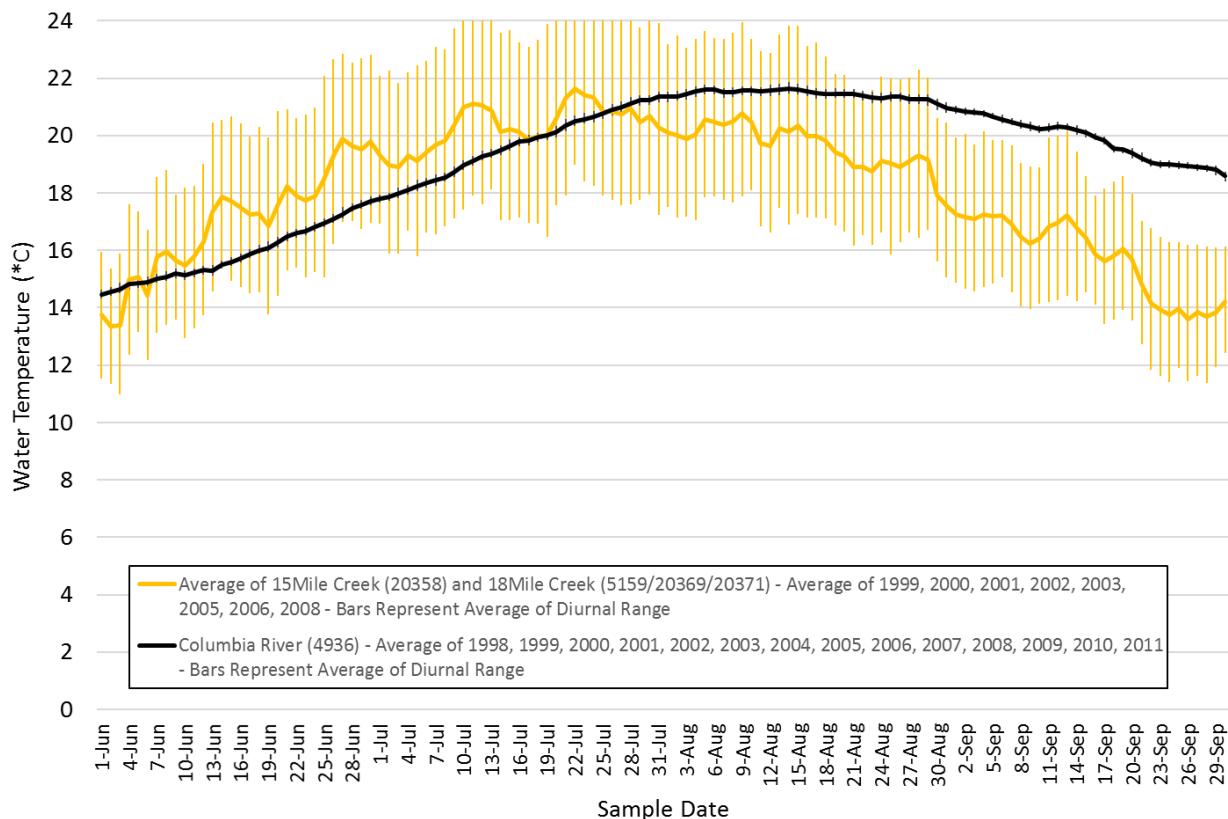


Site Name	Average Monthly Temperature Difference ( $^{\circ}\text{C}$ )			
	June	July	August	September
Tributary #127a – Mill Creek	-1.3	0.3	1.8	3.7

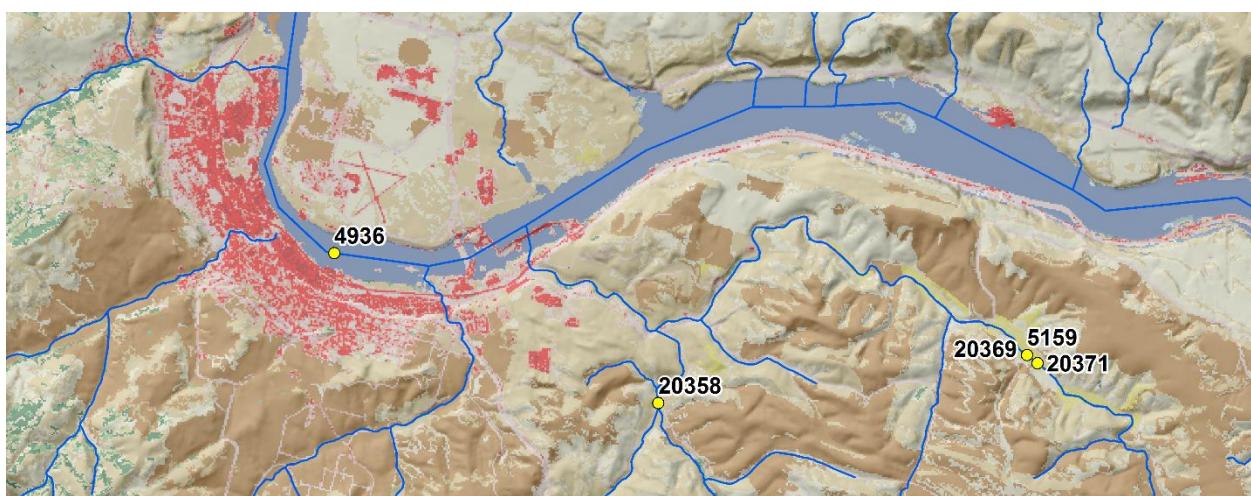


**Figure 1 (Continued).** Measured Tributary Water Temperature - Tributary #129 – 15 Mile Creek

*Average Daily Average Water Temperature and Average Diurnal Range*

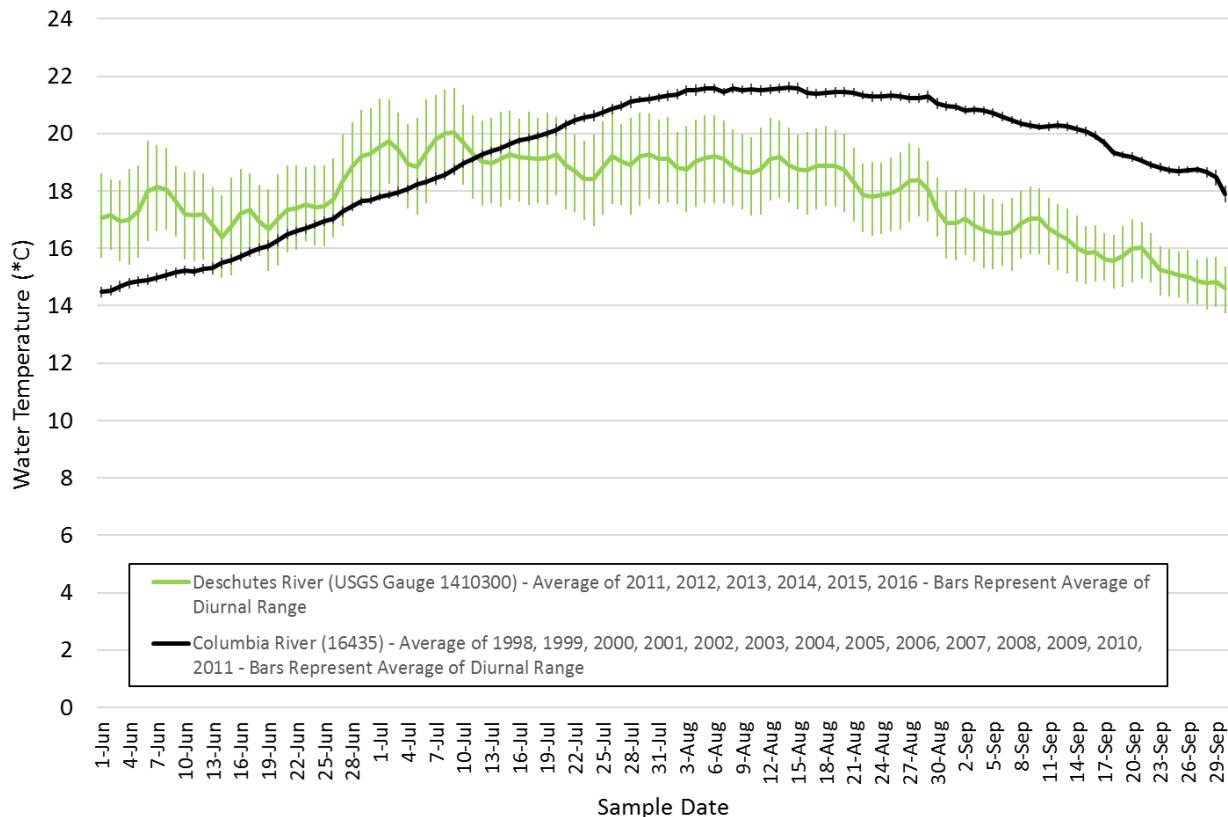


Site Name	Average Monthly Temperature Difference (*C)			
	June	July	August	September
Tributary #129 – 15 Mile Creek	-1.1	-0.7	1.8	4.1



**Figure 1 (Continued).** Measured Tributary Water Temperature - Tributary #135 – Deschutes River

*Average Daily Average Water Temperature and Average Diurnal Range*

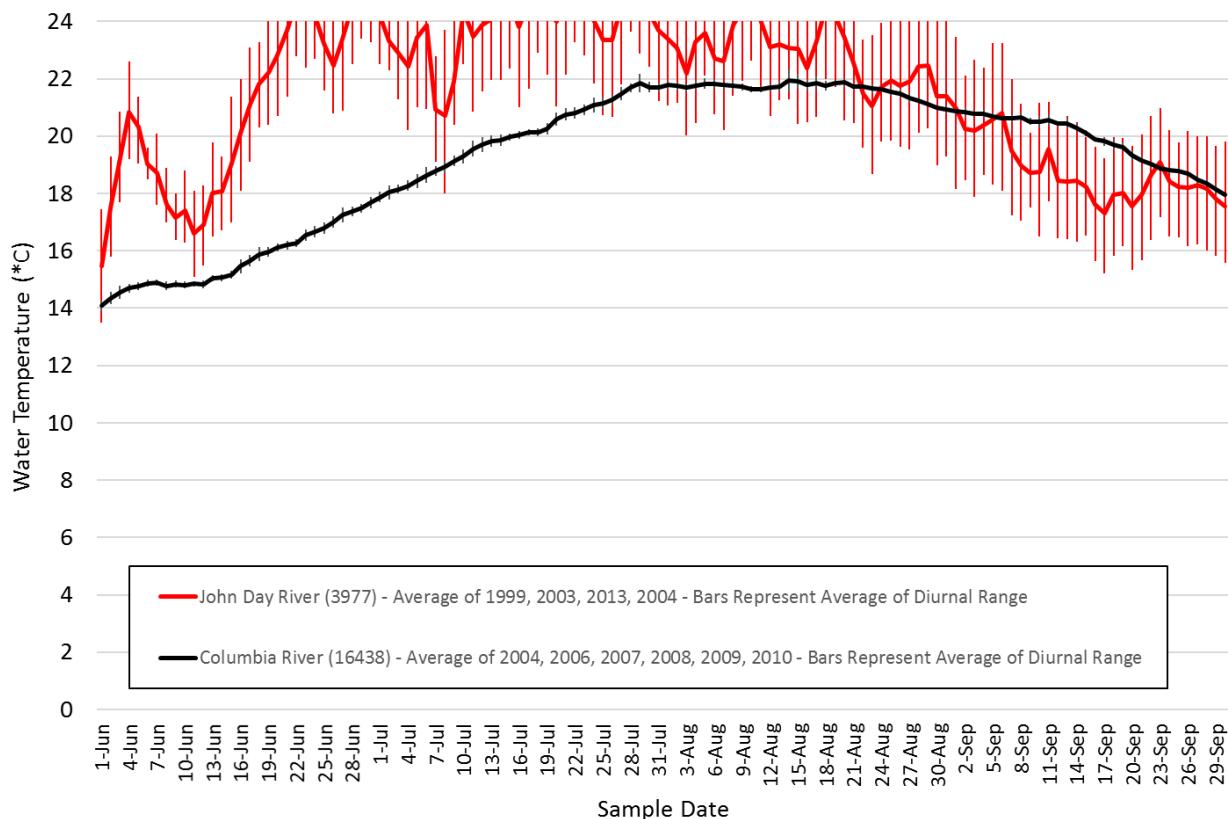


Site Name	Average Monthly Temperature Difference ( $^{\circ}\text{C}$ )			
	June	July	August	September
Tributary #135 – Deschutes River	-1.6	0.4	2.9	3.7

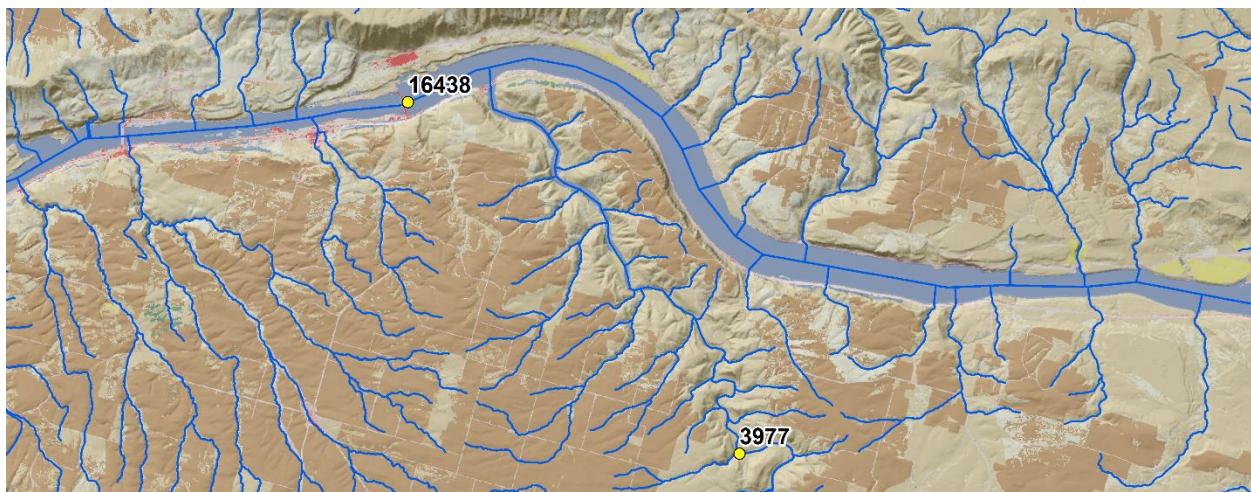


**Figure 1 (Continued).** Measured Tributary Water Temperature - Tributary #147 – John Day River

*Average Daily Average Water Temperature and Average Diurnal Range*

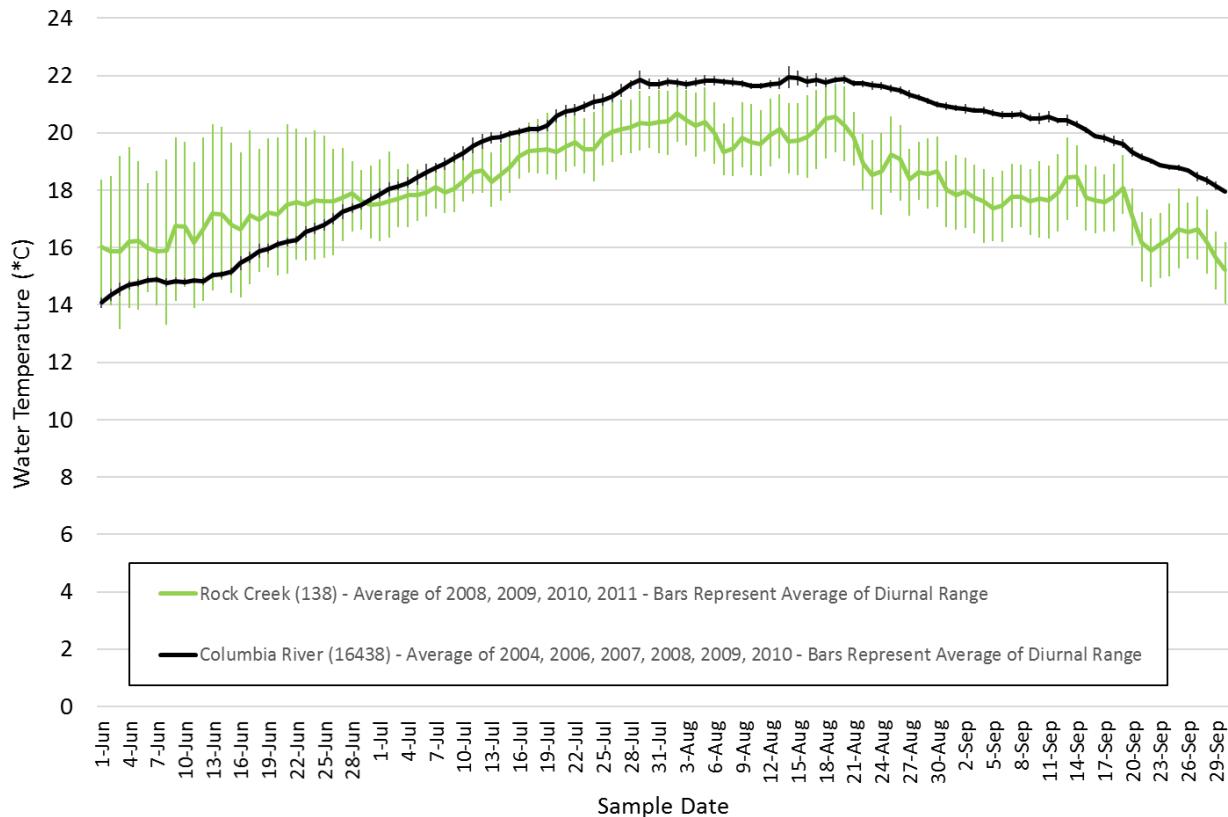


Site Name	Average Monthly Temperature Difference ( $^{\circ}\text{C}$ )			
	June	July	August	September
Tributary #147 – John Day River	-5.0	-3.9	-1.2	1.0

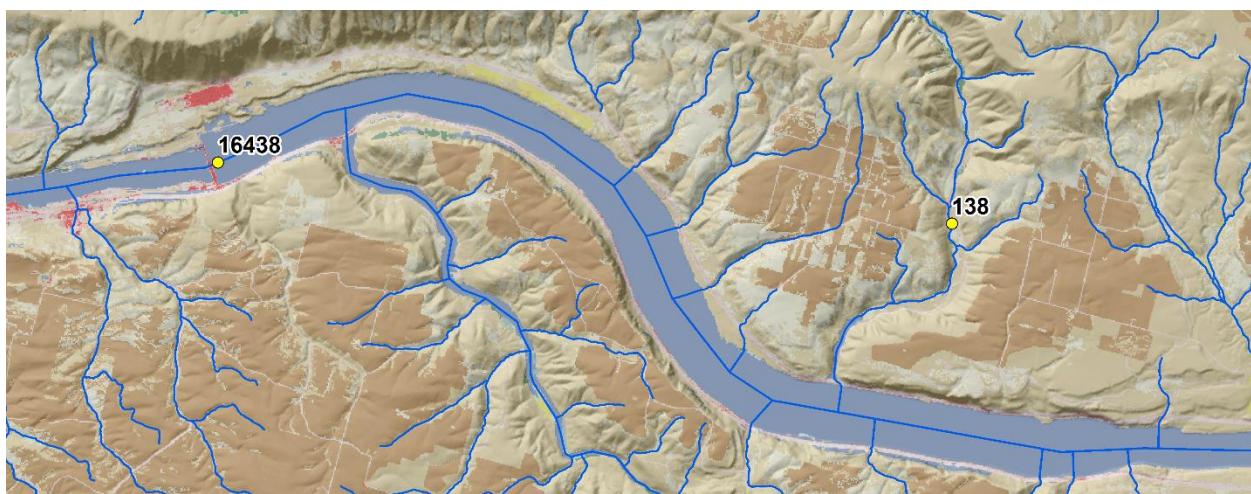


**Figure 1 (Continued).** Measured Tributary Water Temperature - Tributary #153 – Rock Creek

*Average Daily Average Water Temperature and Average Diurnal Range*

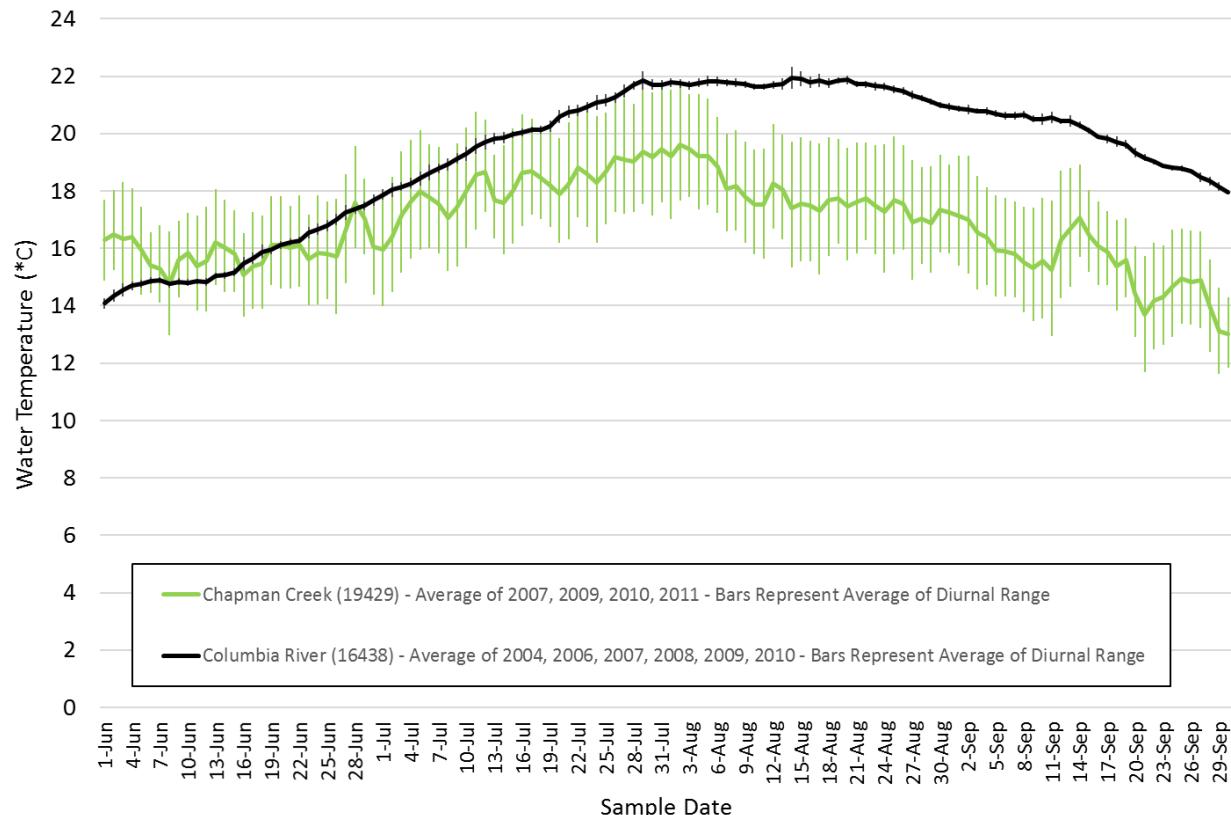


Site Name	Average Monthly Temperature Difference ( $^{\circ}\text{C}$ )			
	June	July	August	September
Tributary #153 – Rock Creek	-1.2	1.0	2.1	2.6

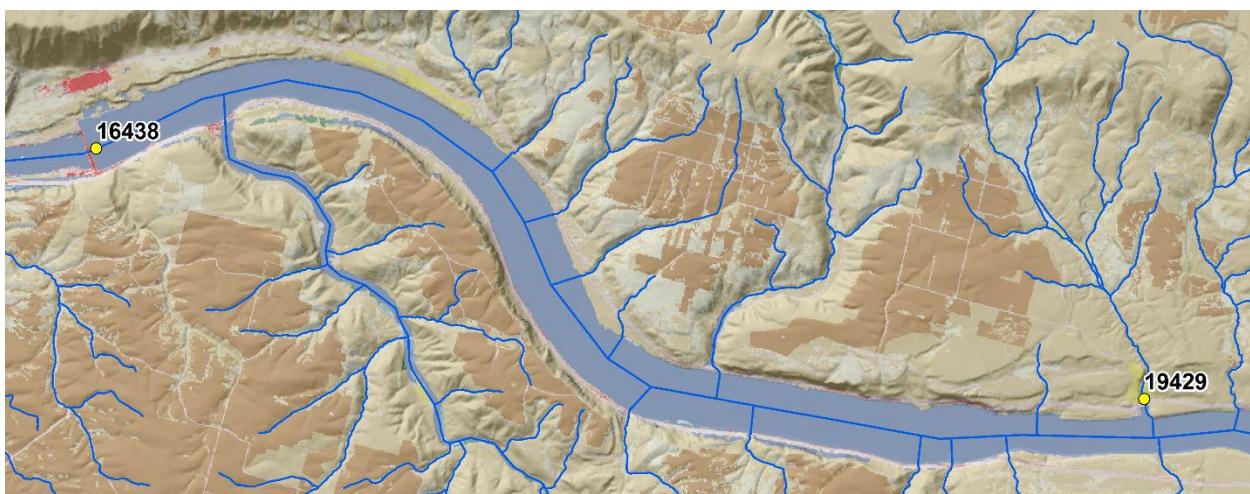


**Figure 1 (Continued).** Measured Tributary Water Temperature - Tributary #159 – Chapman Creek

*Average Daily Average Water Temperature and Average Diurnal Range*

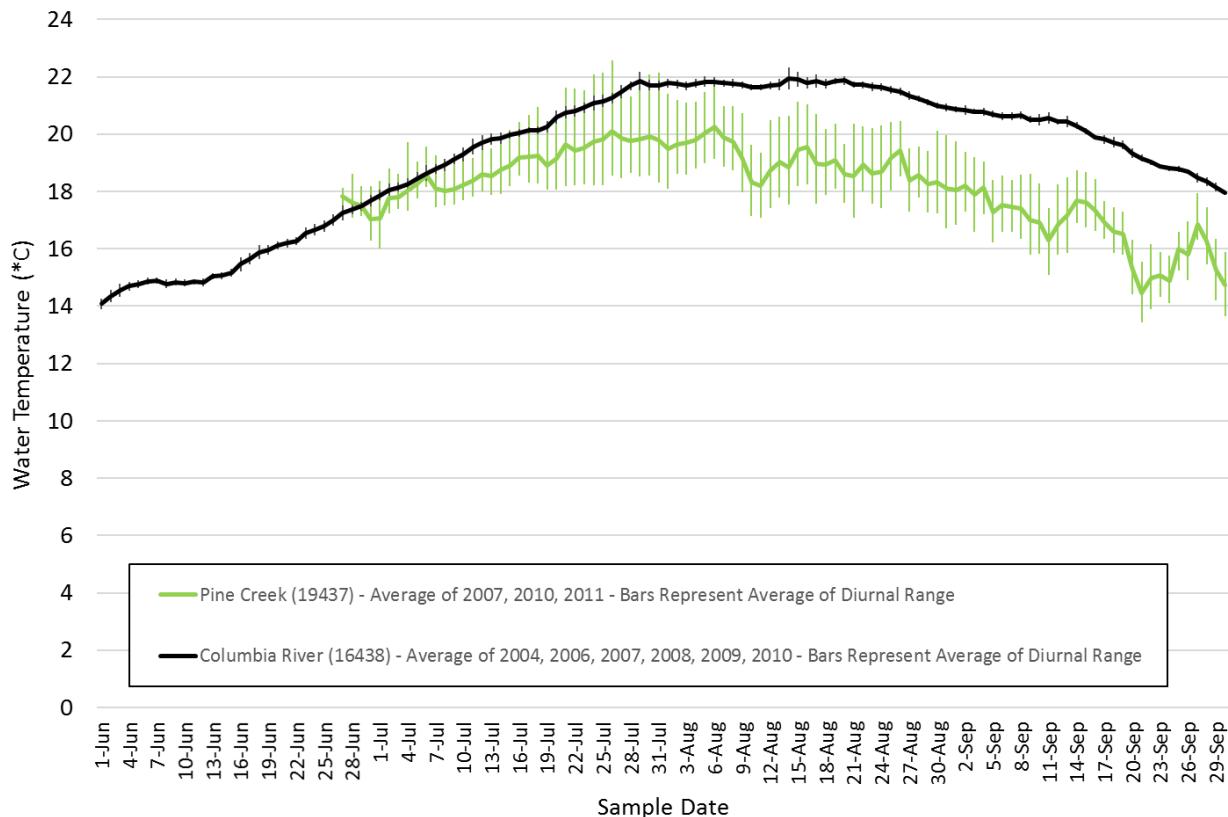


Site Name	Average Monthly Temperature Difference ( $^{\circ}\text{C}$ )			
	June	July	August	September
Tributary #159 – Chapman Creek	-0.3	1.8	3.8	4.4

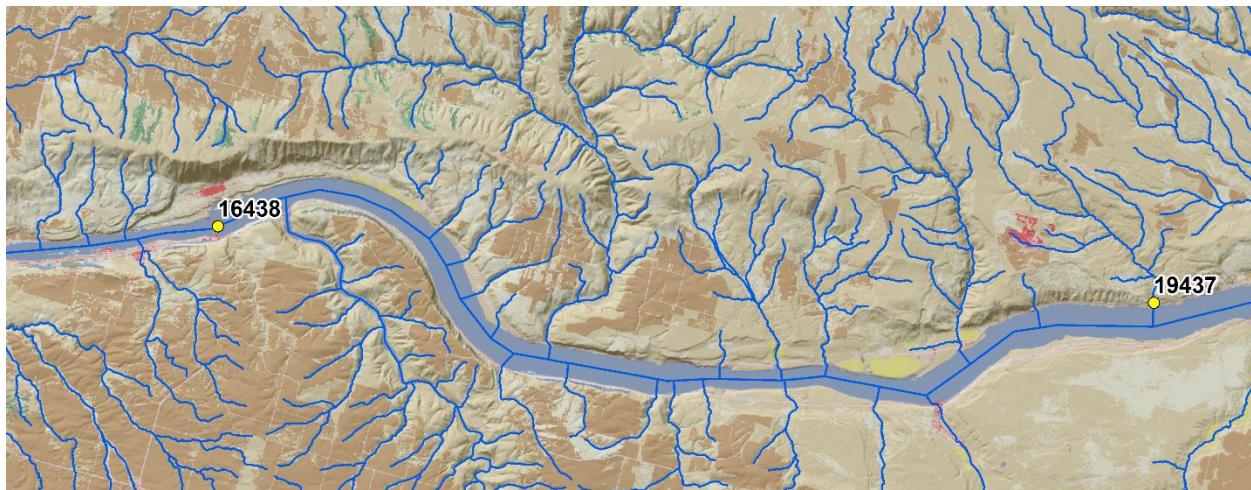


**Figure 1 (Continued).** Measured Tributary Water Temperature - Tributary #166 – Pine Creek

Average Daily Average Water Temperature and Average Diurnal Range

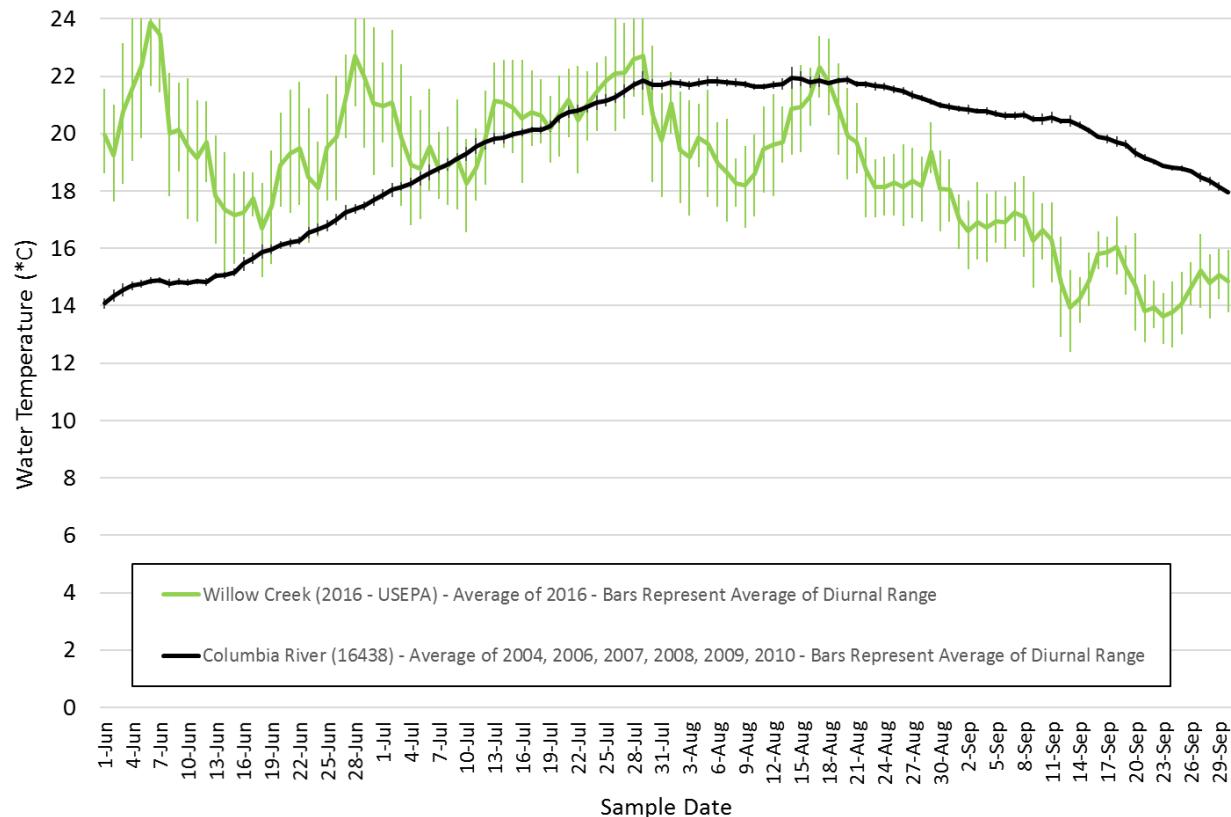


Site Name	Average Monthly Temperature Difference ( $^{\circ}\text{C}$ )			
	June	July	August	September
Tributary #166 – Pine Creek	-0.1	1.1	2.6	3.2

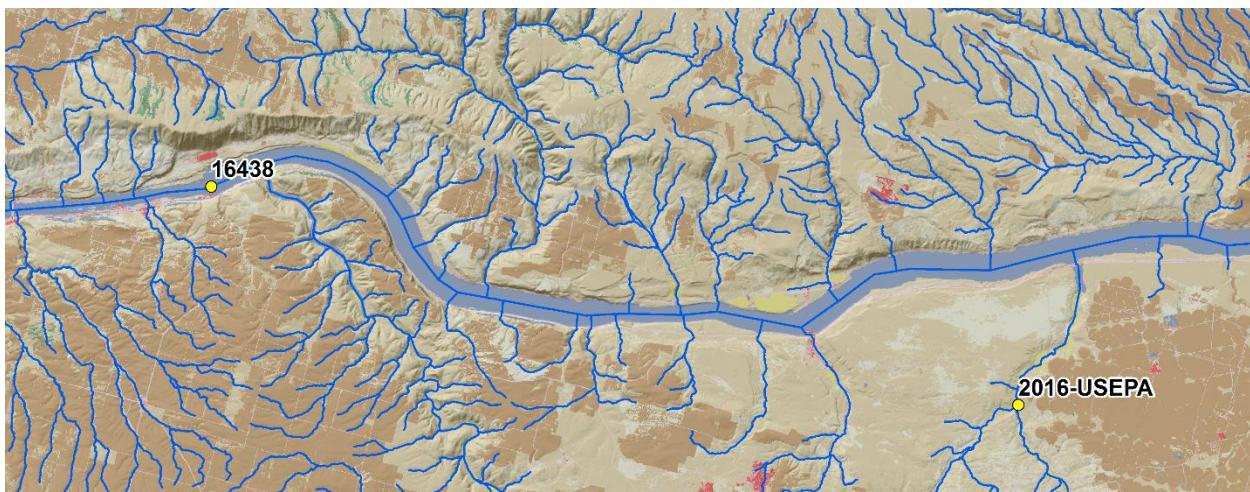


**Figure 1 (Continued).** Measured Tributary Water Temperature - Tributary #167 – Willow Creek

*Average Daily Average Water Temperature and Average Diurnal Range*

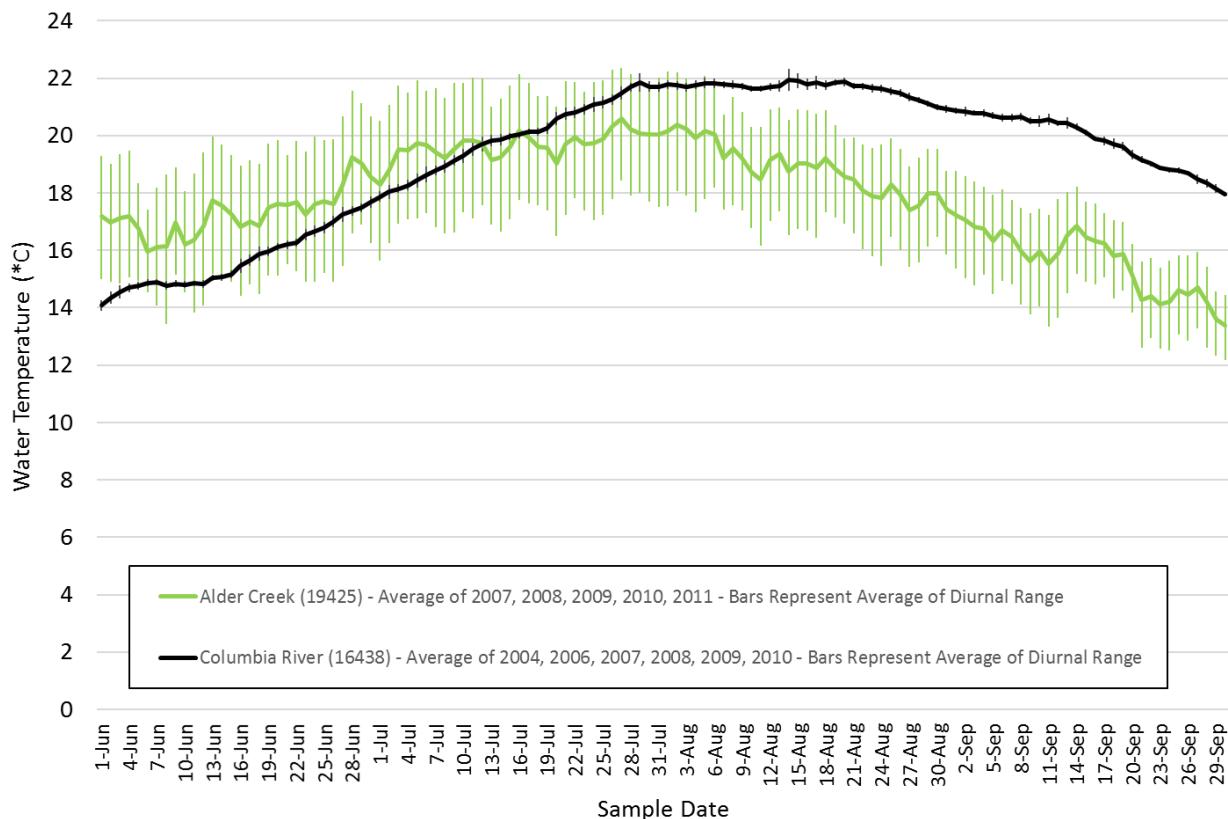


Site Name	Average Monthly Temperature Difference (*C)			
	June	July	August	September
Tributary #167 – Willow Creek	-4.1	-0.5	2.2	4.3

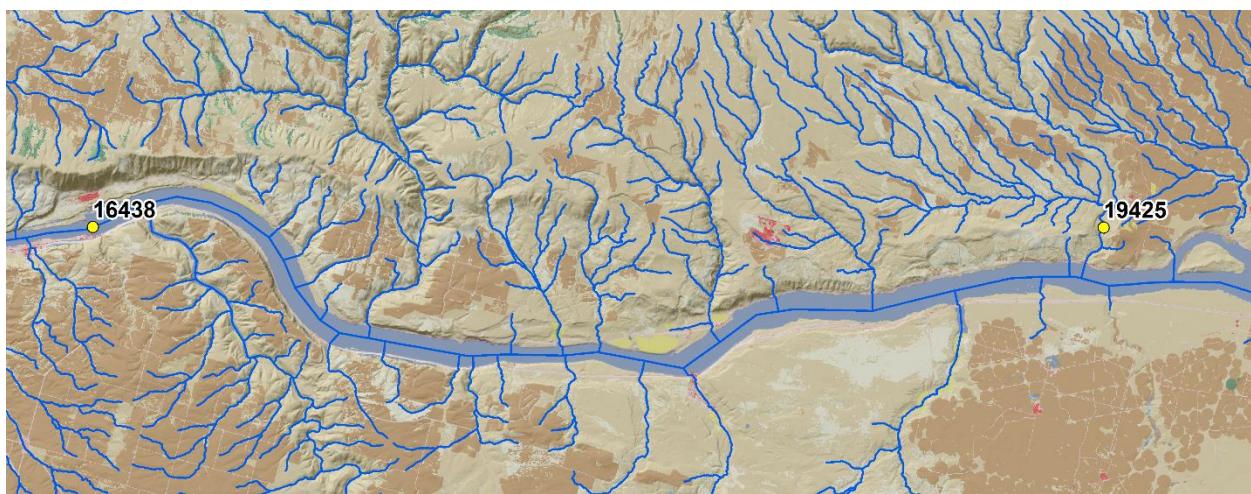


**Figure 1 (Continued).** Measured Tributary Water Temperature - Tributary #170 – Alder Creek

*Average Daily Average Water Temperature and Average Diurnal Range*

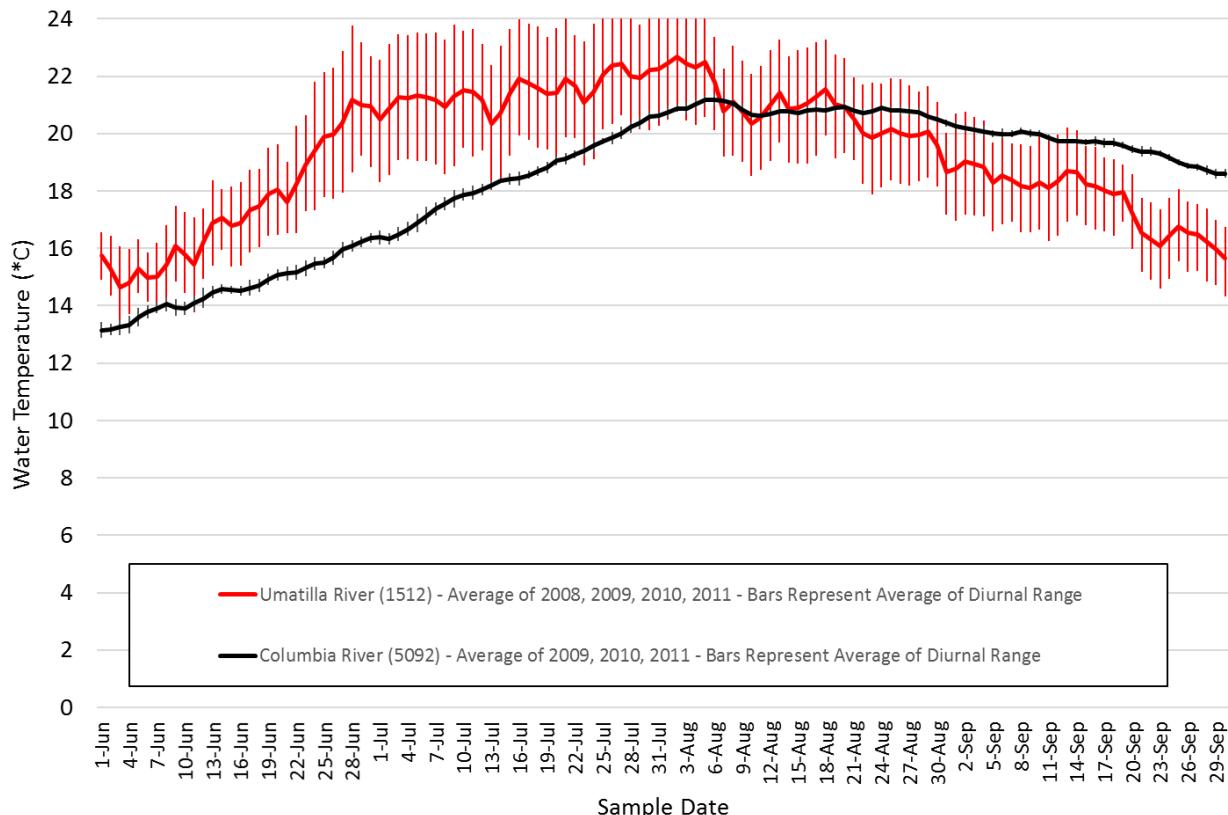


Site Name	Average Monthly Temperature Difference (*C)			
	June	July	August	September
Tributary #170 – Alder Creek	-1.6	0.3	2.8	4.2

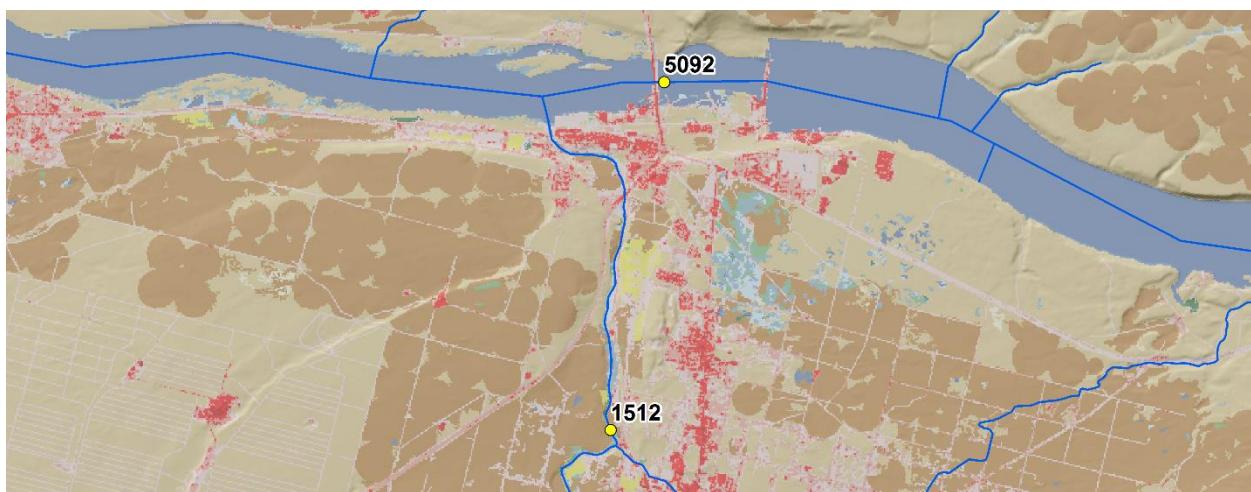


**Figure 1 (Continued).** Measured Tributary Water Temperature - Tributary #176 – Umatilla River

*Average Daily Average Water Temperature and Average Diurnal Range*

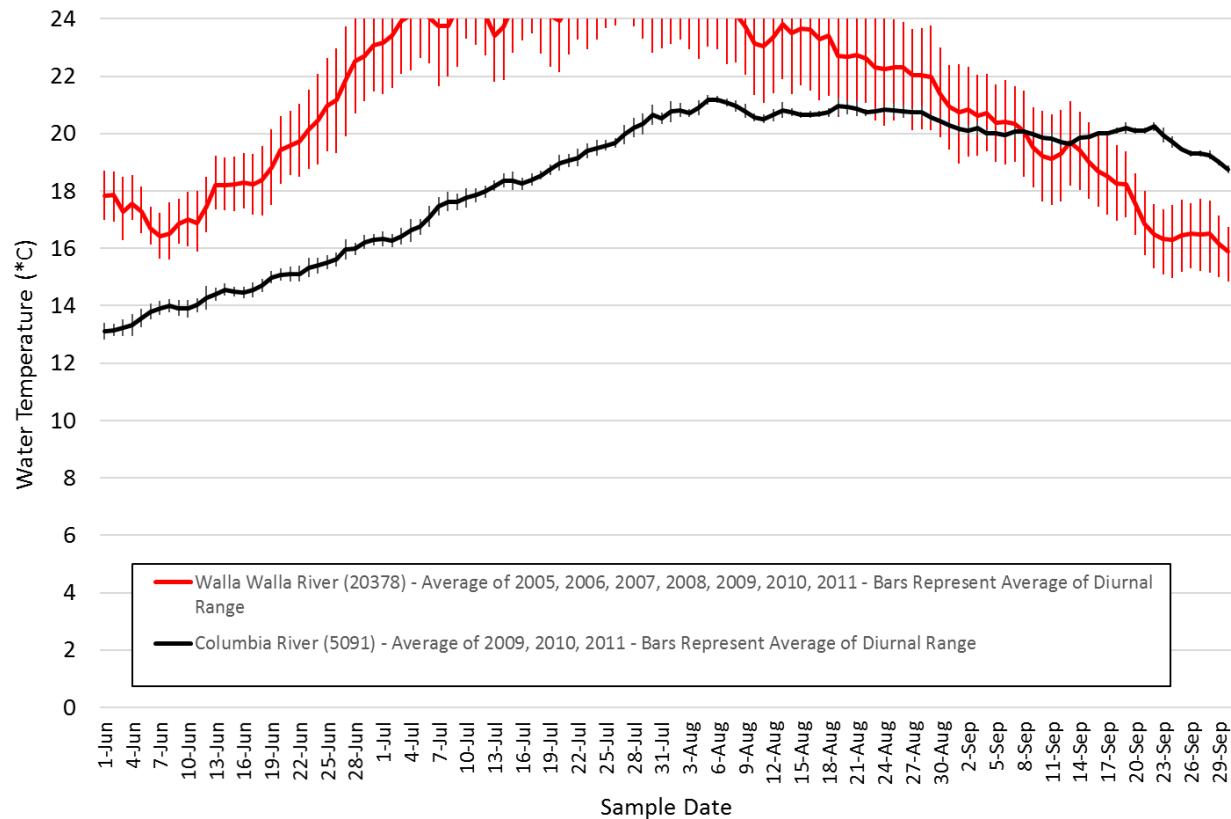


Site Name	Average Monthly Temperature Difference ( $^{\circ}\text{C}$ )			
	June	July	August	September
Tributary #176 – Umatilla River	-2.7	-3.0	0.0	1.9



**Figure 1 (Continued).** Measured Tributary Water Temperature - Tributary #188 – Walla Walla River

*Average Daily Average Water Temperature and Average Diurnal Range*



Site Name	Average Monthly Temperature Difference ( $^{\circ}\text{C}$ )			
	June	July	August	September
Tributary #188 – Walla Walla River	-4.3	-6.0	-2.5	1.3

