Corvallis Watershed Stream Temperature Monitoring
Summer 2017
Addendum to the Stream Temperature Monitoring Report for 2015 and 2016
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Introduction

The summer of 2017 is the eighth year of stream temperature monitoring that was begun as a partnership between the Siuslaw National Forest and the City of Corvallis in 2010. Since 2015, it has been a volunteer effort. The ongoing objectives of the stream temperature monitoring since 2015 have been:

1. To characterize and track trends in the stream and air temperatures throughout the watershed.
2. To determine if it is possible to detect effects from the reservoir on downstream temperatures.

See the previous years' reports for maps of the monitoring site locations.

Results from the yearly monitoring are summarized in Table 1, which shows the highest value for the 7-day average of the daily maximum temperatures (abbreviated as "7-day ave max") per year. This value is the basis for the State of Oregon's water quality standards regarding temperature.

Discussion of summer 2017 stream temperatures

Although the air temperatures in 2017 were a half a degree warmer than 2015, and were the warmest air temperatures recorded in the watershed since 2010, the stream temperatures, on average, were slightly cooler than 2015 (Table 1, Table 2, Figure 4). Table 3 ranks the annual watershed air temperatures from highest to lowest since 2010.

It is assumed that the stream temperatures weren't as warm as 2015 because of the difference in precipitation between the preceding winters. During the 2015 water year, it was both dry and warm during the summer. During the 2017 water year, it was a wet winter with a warm summer (See Figures 1-3 for the comparison of temperatures and precipitation.) The higher amount of precipitation during the late winter and early summer of 2017 probably helped to keep flows higher later into the summer than they were in 2015, and helped to mitigate the higher air temperatures. For example, as an indicator of the higher stream flows persisting into the summer in 2017, the spillway stopped flowing July 20, 2017. In 2015, it stopped a month earlier, on July 16, 2015.

Table 1: 7-Day Averages of Daily Maximum Stream Temperatures (2010-2017) (Temperatures above 64F are highlighted in red.)

Report Submitted March 2018STREAM	LOCATION	STATION number	2010 7-day ave max	2011 7-day ave max	2012 7-day ave max	2013 7-day ave max	2014 7-day ave max	2015 7-day ave max	2016 7-day ave max	2017 7-day ave max
S FK Rock Creek	upstream from Connection Creek	2120	59.2	60.12	61.74	no data	61.08	63.52	62.14	Not deployed
Tributary to S FK Connection Creek	Tributary is upstream from and next to Connection Creek	2121	58.8	59.61	60.76	no data	62.59	62.97	61	61.86
S FK Rock Creek	Above weir tied to trash rack	2122	58.8	60.14	61.51	60.99	62.22	63.51	62.04	62.6
S FK Rock Creek AIR TEMP		2122	79.06	79.11	83.22	82.52	81.12	86.25	84.34	86.8
Rock Cr mainstem Water Temp	downstream from confluence of N Fk and S FK Rock Creek	2123	61.9	61.04	63.4	64.34	63.47	64.31	62.24	64.2
Rock Cr mainstem AIR TEMP	downstream from confluence of N Fk and S FK Rock Creek	2123						Not deployed	Not deployed	Not deployed
Stilson Creek	upstream from rd 111	2124	60.2	61.39	62.12	61.86	62.96	64.07	63.29	62.96
Rock Creek mainstem	upstream from rd 111 bridge	2125	63.2	64.4	65.25	64.98	65.82	67.06	65.1	65.5
Middle Fork Rock Creek	upstream from rd 3405	2126	59.6	61.44	62.35	62.16	62.2	64.31	63.15	63.8
Griffith Creek	upstream from weir	2127	59.3	60.19	61.6	61.35	62.14	63.49	61.98	61.89
Rock Creek	below bridge near entrance gate	2128	64.2	65.66	66.33	65.76	67.27	68.83	66.61	67.34

Rock Cr mainstem	at waterline crossing upstream of Griffith Cr	2130	63.9	65.2	65.98	65.71	66.83	68.3	66.32	66.65
Rock Cr mainstem	0.08 miles upstream from Trib "b"	2131	61.9	63.13	LOST	64.29	64.59	65.31	64.86	64.84
Rock Cr mainstem	at City/pvt boundary above outflow in log complex	2132	63.3	64.49	65.84	65.37	66.03	68.05	65.76	65.88
Dam outlet small channel	Just below dam in small channel fed by valve leakage	2135			60.12	62.87	63.92	64.14	63.24	64.88
S Fork Rock Creek	above dam outlet and confluence with N Fork Rock Cr	2136		62.12	62.99	no data	63.5	65.37	64.74	Probe was found floating
Griffith Creek	mouth of creek	2166			62.86	no data	63.65	64.93	63.44	64.28
Rock Creek	just downstream of Griffith Cr mouth	2167			65.81	no data	No data	No data	Not deployed	Not deployed
Spillway/dam outlet channel, 7-day ave. max when spillway is flowing	Just below spillway and dam outlet channel convergence, and upstream of South Fork Rock Creek confluence.	2168			71.4	73.96	72.22	71.29	63.13	66.73
Spillway/dam outlet channel, temperature after spillway stops flowing	Just below spillway and dam outlet channel c, and upstream of South Fork-Rock Creek confluence.	2168			61.1	63.08	69.95	64.1	63.5	64.38

Bottom of Spillway	In gravel channel just below spillway, moved from stagnant pool location used in 2011.	2169			76.99	78.46	78.87	76.03	74.52	76.08
Rock Creek mainstem	Approximately 2200 feet downstream from Trib "b"	2170				65.7	64.85	66.61	64.85	65.18
Rock Creek mainstem	Approximately 4500 feet downstream from Trib "b"	2171				66.77	65.93	66.98	Not deployed	Not deployed

Note: The reservoir, the North Fork Rock Creek above the reservoir, and the South Fork Rock Creek above Connection Creek sites were not monitored in 2017.

Table 2: Comparing the 2017 and 2015 temperature difference in 7-day average maximum stream temperatures.

STREAM	LOCATION	STATION number	2015 7-day ave max	2017 7-day ave max	Difference between 2017 and 2015
S FK Rock Creek	upstream from Connection Creek	**2120**	63.52	Not deployed	
Tributary to S FK Connection Creek	Tributary is upstream from and next to Connection Creek	**2121**	62.97	61.86	-1.11
S FK Rock Creek	Above weir tied to trash rack	**2122**	63.51	62.6	-0.91
S FK Rock Creek AIR TEMP		**2122**	86.25	86.8	0.55
Rock Cr mainstem Water Temp	downstream from confluence of N Fk and S FK Rock Creek	**2123**	64.31	64.2	-0.11
Stilson Creek	upstream from rd 111	**2124**	64.07	62.96	-1.11
Rock Creek mainstem	upstream from rd 111 bridge	**2125**	67.06	65.5	-1.56
Middle Fork Rock Creek	upstream from rd 3405	**2126**	64.31	63.8	-0.51
Griffith Creek	upstream from weir	**2127**	63.49	61.89	-1.6
Rock Creek	below bridge near entrance gate	**2128**	68.83	67.34	-1.49
Rock Cr mainstem	at waterline crossing upstream of Griffith Cr	**2130**	68.3	66.65	-1.65
Rock Cr mainstem	0.08 miles upstream from Trib "b"	**2131**	65.31	64.84	-0.47
Rock Cr mainstem	at City/pvt boundary above outflow in log complex	**2132**	68.05	65.88	-2.17

Dam outlet small channel	Just below dam in small channel fed by valve leakage	**2135**	64.14	64.88	0.74
S Fork Rock Creek	above dam outlet and confluence with N Fork Rock Cr	**2136**	65.37	Probe was found floating	
Griffith Creek	mouth of creek	**2166**	64.93	64.28	-0.65
Rock Creek	just downstream of Griffith Cr mouth	**2167**	No data	Not deployed	
Spillway/dam outlet channel, 7-day ave. max when spillway is flowing	Just below spillway and dam outlet channel convergence, and upstream of South Fork Rock Creek confluence.	**2168**	71.29	66.73	-4.56
Spillway/dam outlet channel, temperature after spillway stops flowing	Just below spillway and dam outlet channel c, and upstream of South Fork-Rock Creek confluence.	**2168**	64.1	64.38	0.28
Bottom of Spillway	In gravel channel just below spillway, moved from stagnant pool location used in 2011.	**2169**	76.03	76.08	0.05
Rock Creek mainstem	Approximately 2200 feet downstream from Trib "b"	**2170**	66.61	65.18	-1.43
Rock Creek mainstem	Approximately 4500 feet downstream from Trib "b"	**2171**	66.98	Not deployed	
Headwaters of South Fork	Bluff Springs above Road 2005	**2176**	46.16	Not deployed	
Headwaters of North Fork	Just downstream of Road 2005	**2177**	51.19	Not deployed	

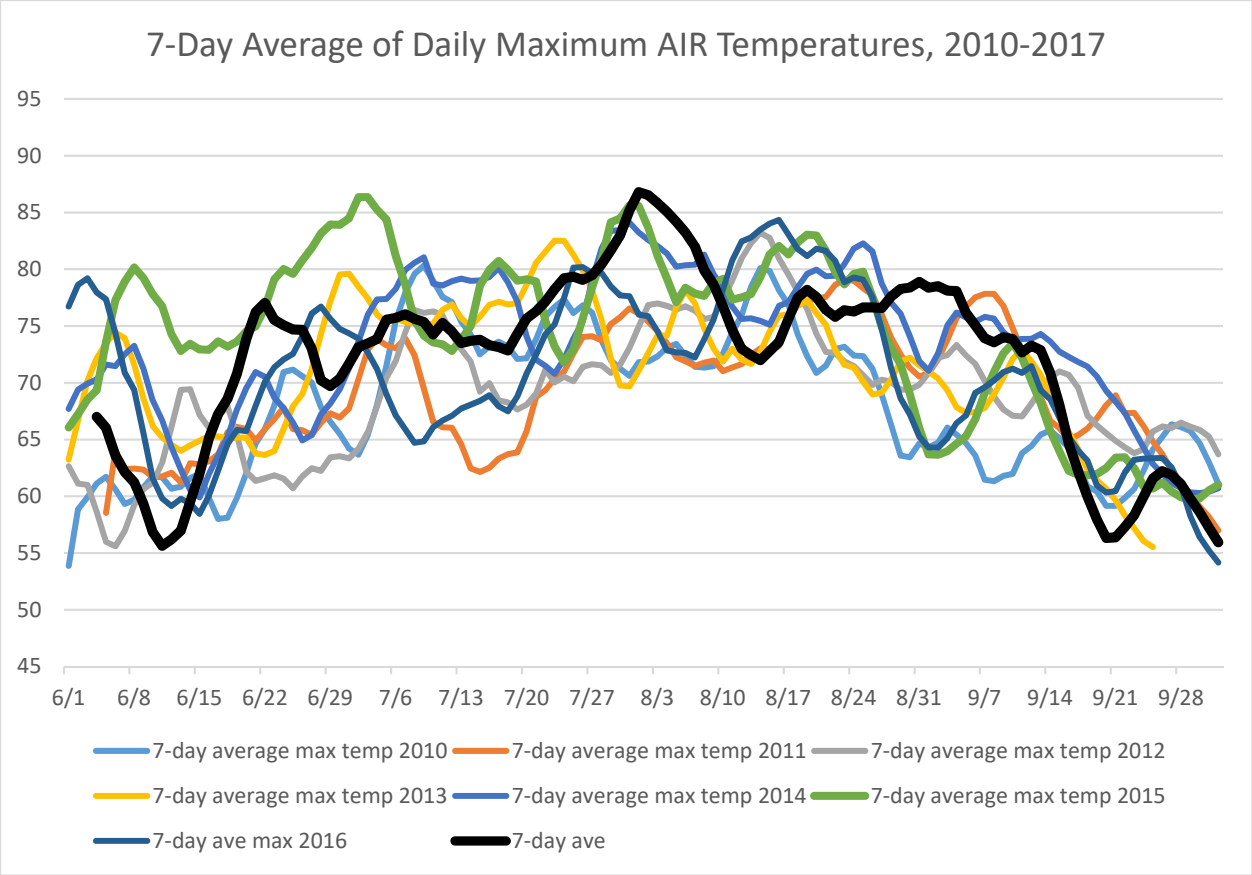

Figure 1. Comparison of air temperatures since 2010, probe was placed in the riparian zone near the South Fork Rock Creek intake. Note that 2017 was the warmest year since 2010, slightly warmer than the second warmest year in 2015. In 2015, the peak temperatures occurred earlier in the season, as well as mid-season.

Table 3. South Fork near intake AIR temperatures, sorted from warmest year to coolest, 2010-2017

year	7-day running average of the maximum daily temperature
2017	86.80
2015	86.25
2016	84.34
2012	83.22
2013	82.52
2014	81.12
2011	79.11
2010	79.06

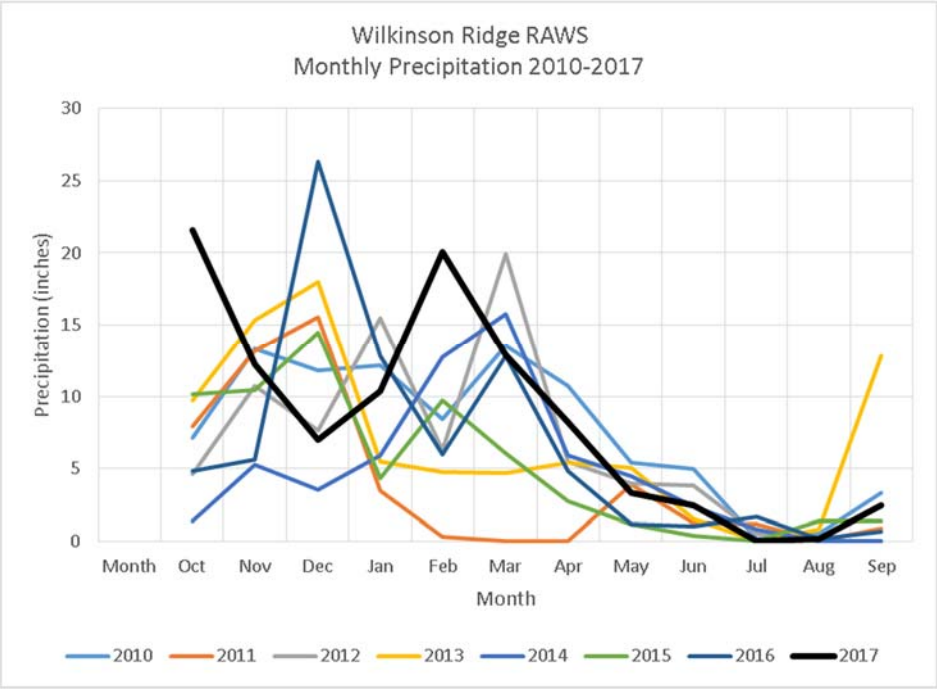

Figure 2. Monthly precipitation for the Wilkinson RAWS (Remote Automated Weather Station), 2010-2017. Note that the late winter and early spring for 2017 was wetter than average.

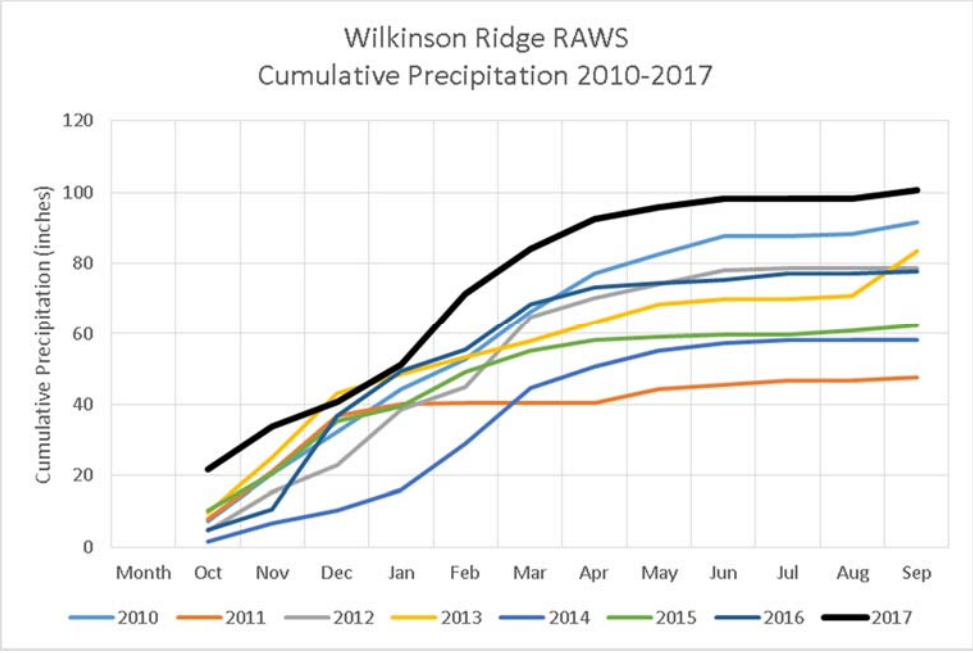

Figure 3. Cumulative precipitation for the water year October through September for the years 2010-2017. At the Wilkinson Ridge RAWS, 2017 was the wettest year since 2010. The higher precipitation amounts probably contributed to higher flows into the early summer.

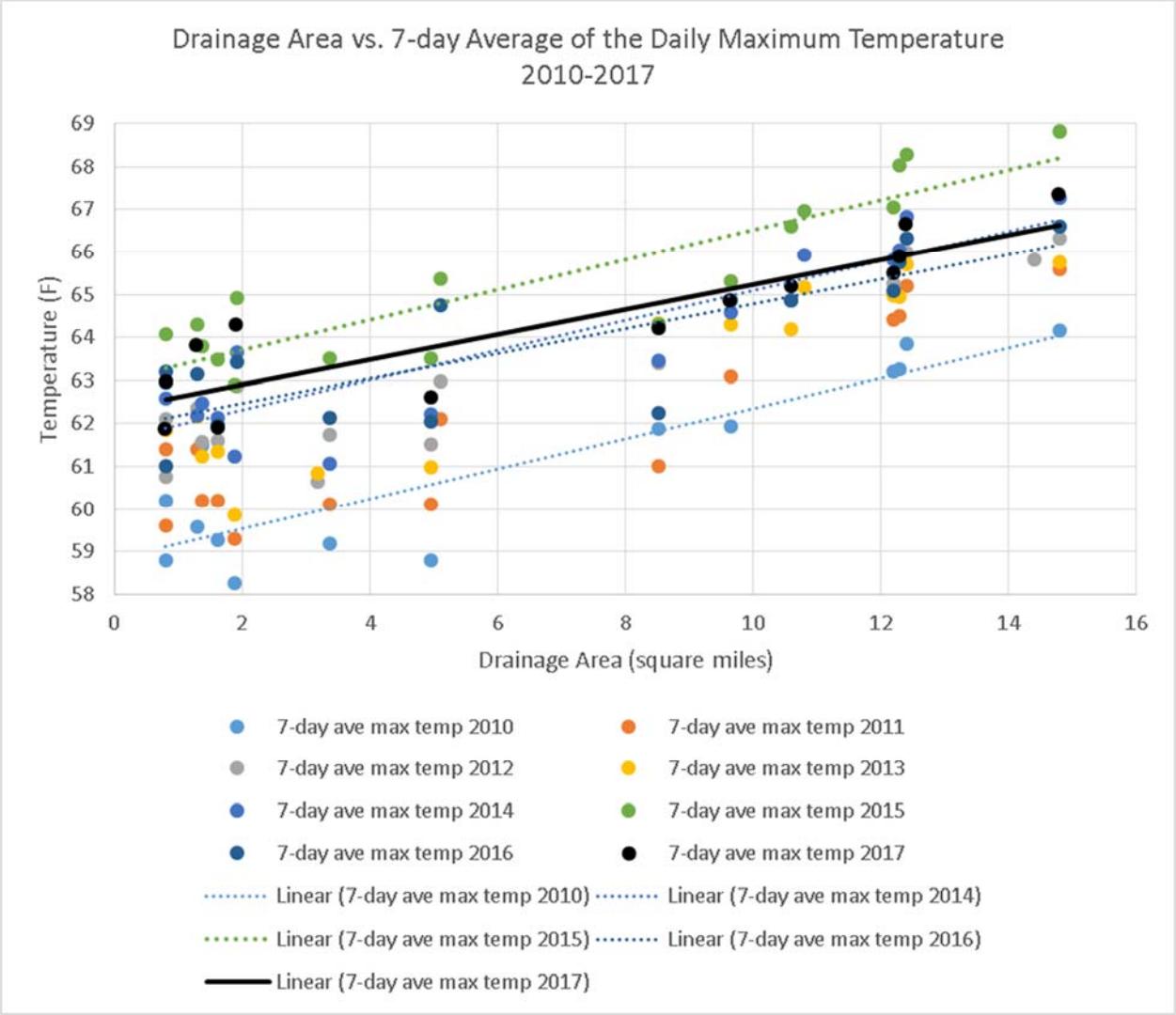

Figure 4. Comparing the 7-day average of the daily maximum stream temperature to the drainage area to that point in the stream. As is typical of watersheds, stream temperatures increase downstream and with larger drainage areas. Although the air temperatures in 2017 were comparable to those in 2015, the stream temperatures were cooler than 2015. The slightly cooler temperatures in 2017 were probably due to the greater amount of precipitation in the preceding winter and spring, which in turn, probably fed higher stream flows during the summer.

Comparing the Difference in Stream Temperature between the South Fork Rock Creek and Rock Creek mainstem temperatures below the dam.

The hypothesis: If the South Fork Rock Creek above the intake, and therefore not influenced by any human flow manipulations, is used as a control, the Rock Creek mainstem sites downstream of the dam can be compared to South Fork to see if there are any differences. If air temperature is the only variable influencing temperature, the DIFFERENCE in temperature should be more or less the same throughout the summer.

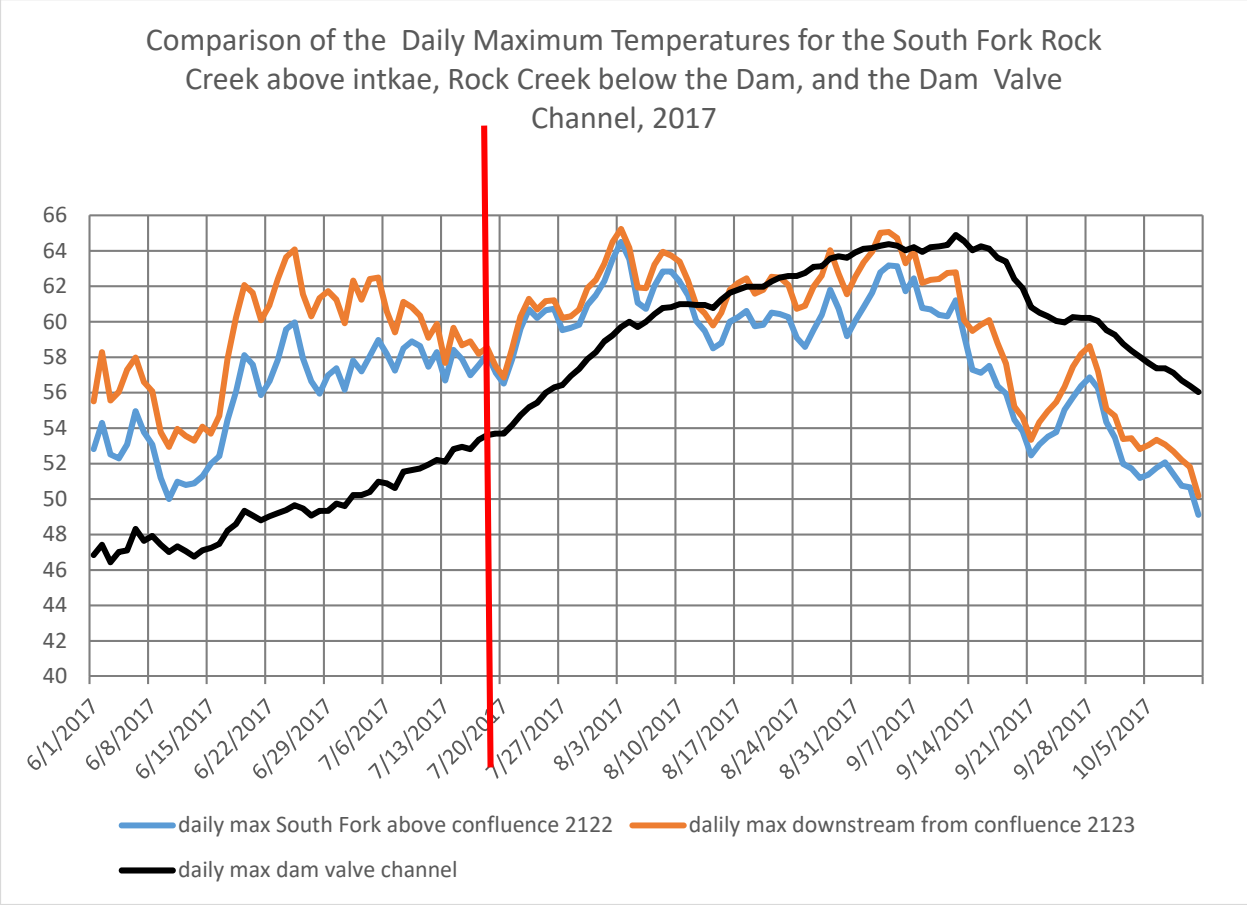

Figure 5: Comparison of daily m maximum temperatures at the South Fork above the intake, Rock Creek below the dam, and the dam valve channel. While the spillway is flowing and contributing warmer water downstream from the top of the reservoir, the difference in temperature is greater between the South Fork and the Rock Creek mainstem below the dam. As the reservoir bottom heats up, which is the source of the dam valve channel flow, the difference in temperature between the South Fork and the mainstem below the dam diverges in late August and September.

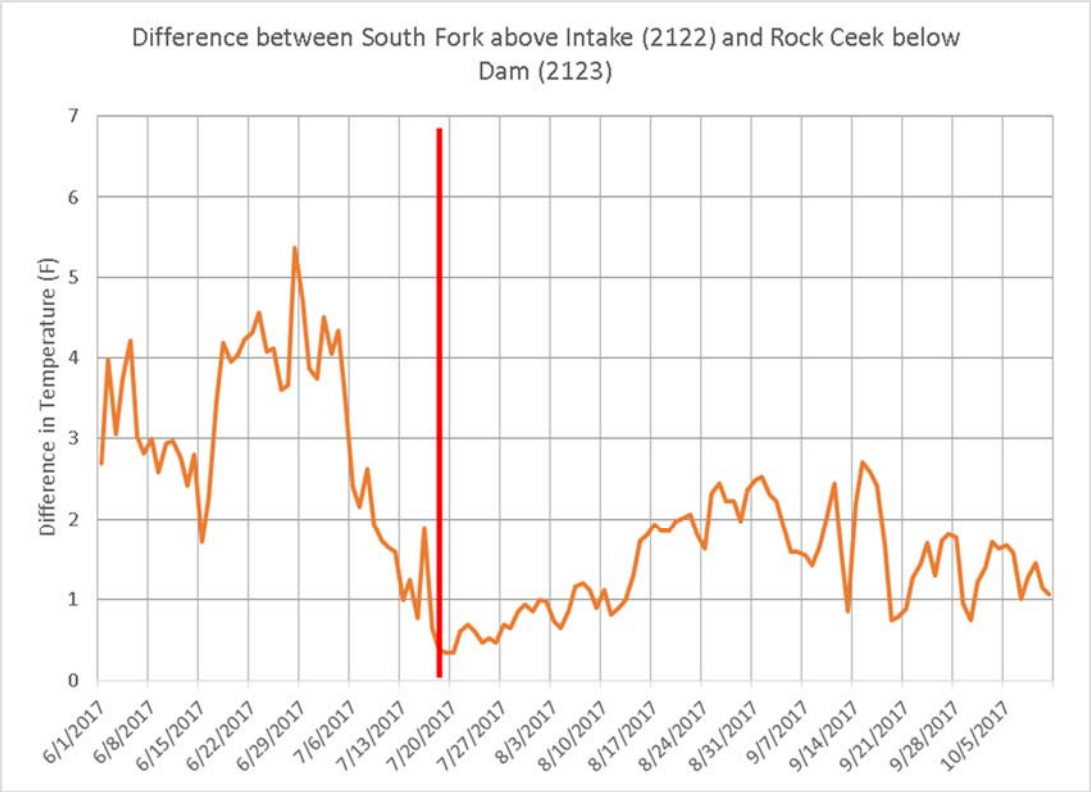

Figure 6: Difference between the stream temperatures at the South Fork and Rock Creek below the dam. The red line is the date when the spillway flow stops.

The South Fork (Site 2122) is above the intake, and therefore not affected by any water withdrawals or artificial additions. Note that the DIFFERENCE between the two sites is greater while the spillway is flowing during June, which takes water from the top of the reservoir. As the spillway flow decreases around the end of June, and then stops flowing July 20, the difference in temperature also decreases. After July 20, the contributions to downstream flow in the mainstem are from the South Fork, and from the leaking valve at the base of the dam (dam valve channel). As the reservoir gradually heats up, the temperature DIFFERENCE is also gradually increasing until mid-September, when water and air temperatures begin to cool down in the fall. Does this graph pattern persist downstream?

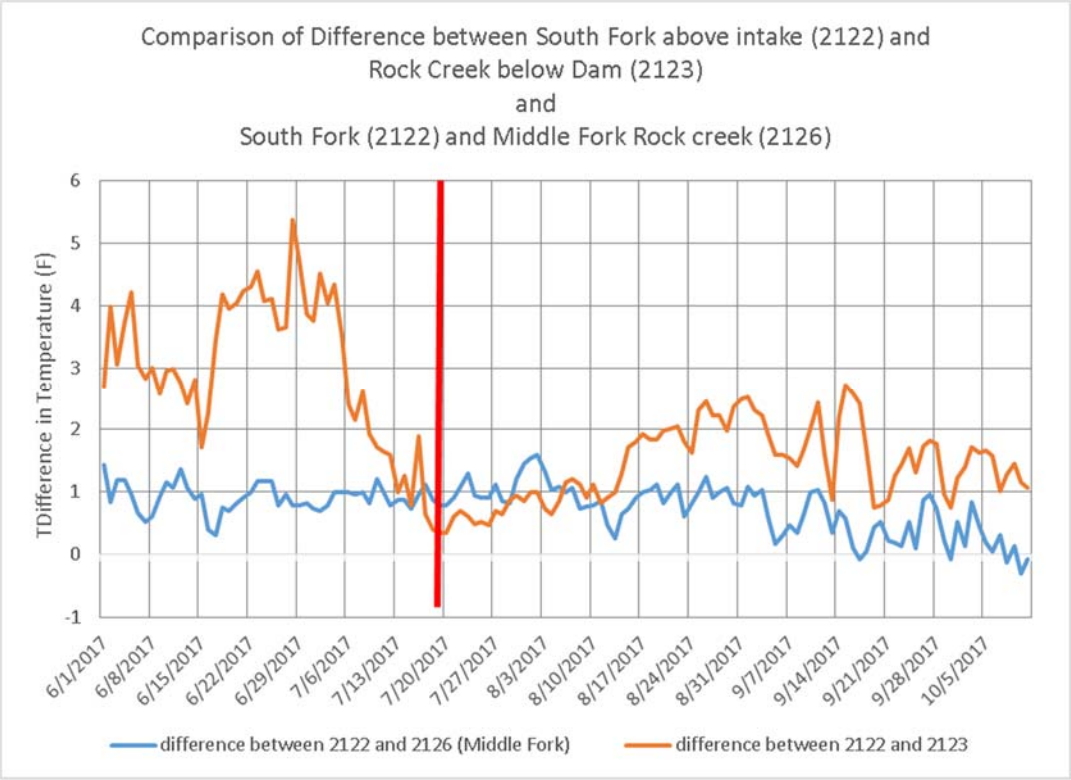

Figure 7. As a validation of the hypothesis, the DIFFERENCE between the South Fork Rock Creek site (2122) and the mainstem below the dam (2123) is compared to the DIFFERENCE between the South Fork (2122) and another unregulated tributary, the Middle Fork (2126). The two lines have distinctly different patterns. The line representing the DIFFERENCE between 2122 and 2123 is influenced by the spillway and dam valve channel; the Middle Fork is not. The DIFFERENCE between the Middle Fork and South Fork is more or less the same throughout the monitoring season.

The following graphs compare the DIFFERENCE between the South Fork above the intake and Rock Creek below the dam with the DIFFERENCE between the South Fork and other sites on Rock Creek downstream of the dam. The pattern of a decreasing difference in temperature as the spillway stops flowing before July 20, and a gradual increase in temperature difference as the reservoir warms up becomes less pronounced going downstream. The loss of the late summer increase in the temperature DIFFERENCE in a downstream direction suggests the flow from the dam valve channel becomes diluted downstream, and is an insignificant flow contribution at the mouth of Rock Creek.

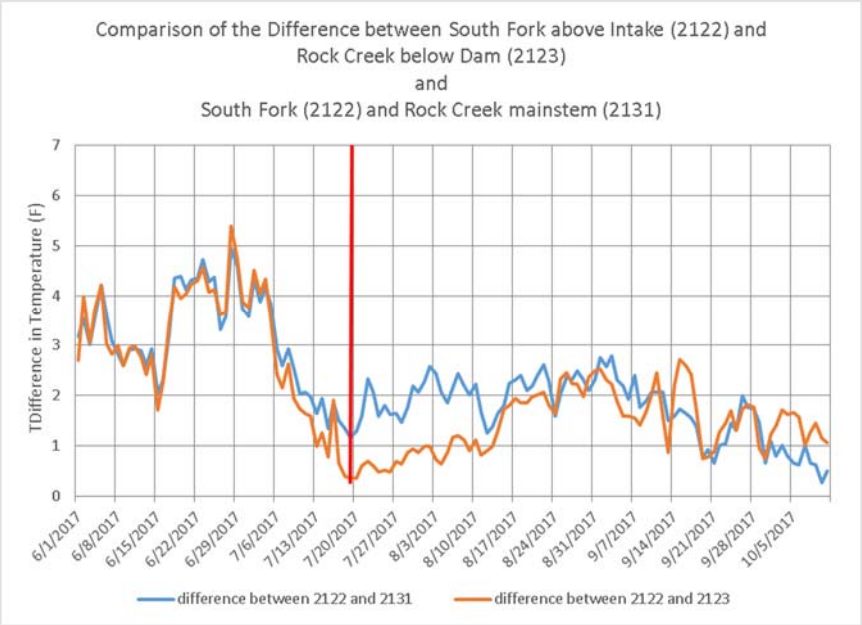

Figure 8: Site 2131 is 0.77 miles downstream from the dam. The spillway still has an effect, and the difference between 2122 and 2131 mirrors the difference between 2122 and 2123. The effect of the dam valve channel after July 20 is subdued. Red line shows the date the spillway stopped flowing.

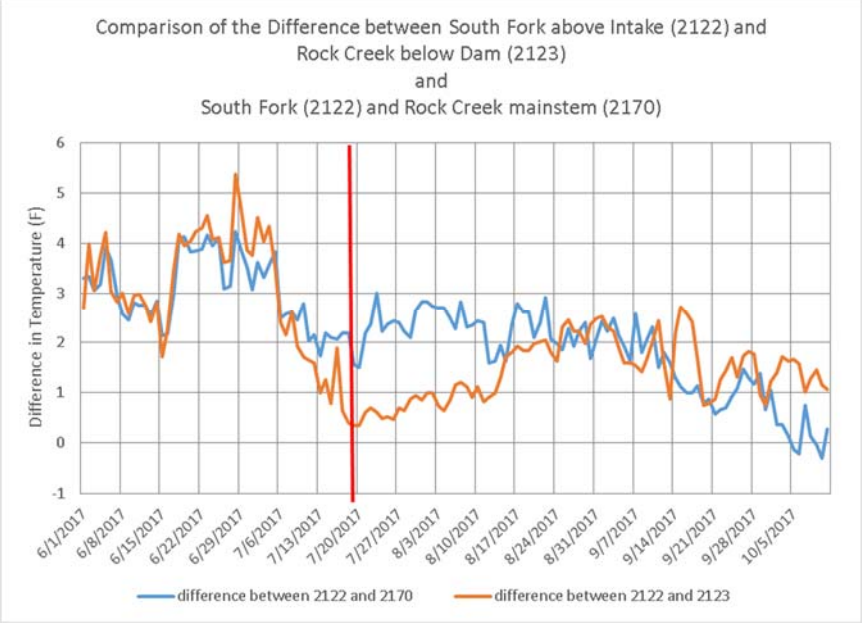

Figure 9: Site 2170 is 1.35 miles downstream from the dam. The effects of the spillway are still evident at this point, the dam valve channel effect after July 20 is not apparent. Red line shows when the spillway stopped flowing.

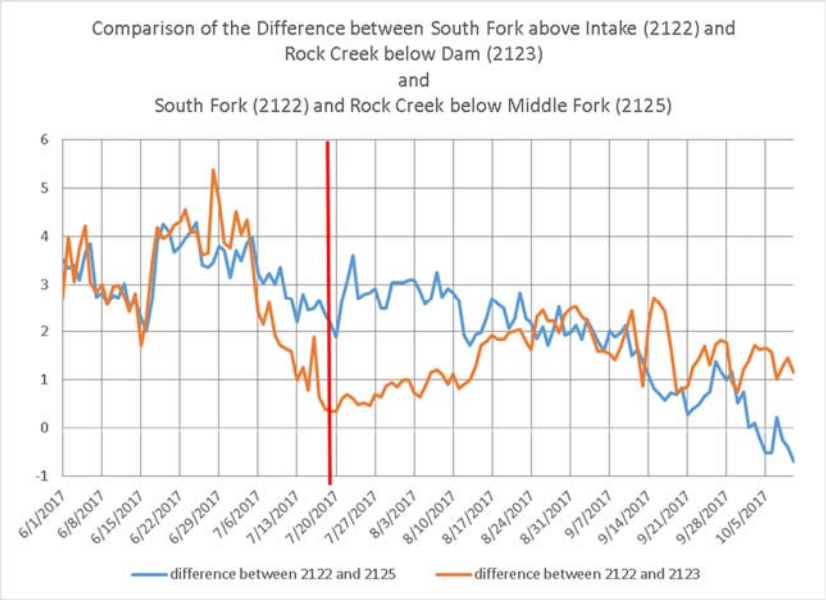

Figure 10: Site 2125 is 2.17, miles downstream from the dam and below the confluence of the mainstem with Middle Fork. As flow from the spillway diminishes, the influence of the spillway is still visible, although its effect downstream becomes less apparent; the lines start to diverge in early July. The effects of the dam valve channel after July 20 are not evident.

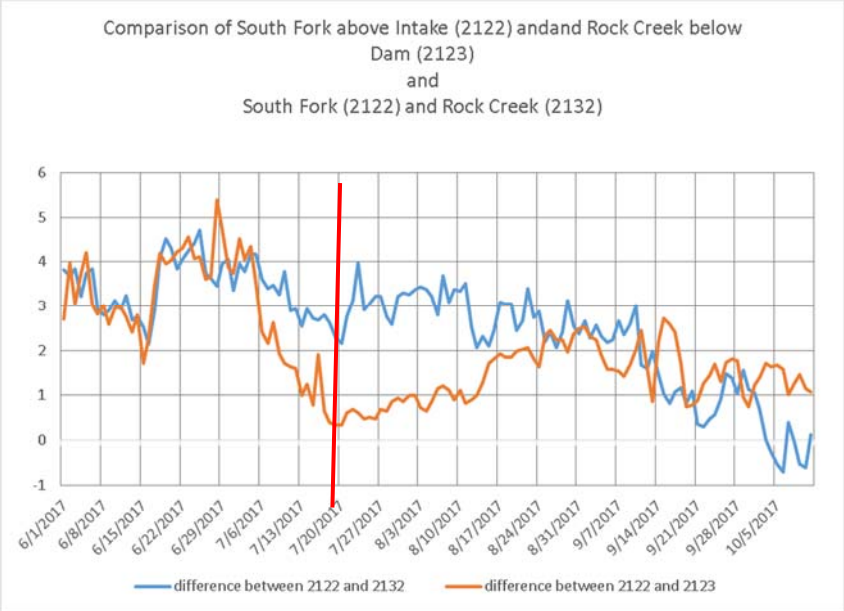

Figure 11: Site 2132 is 2.67 miles downstream from the dam. The effect of the spillway is still suggested by the downward trend of the difference between 2122 and 2132, although the two lines diverge. After July 20, there is no apparent effect from the dam valve channel. The patterns of the lines are not similar.

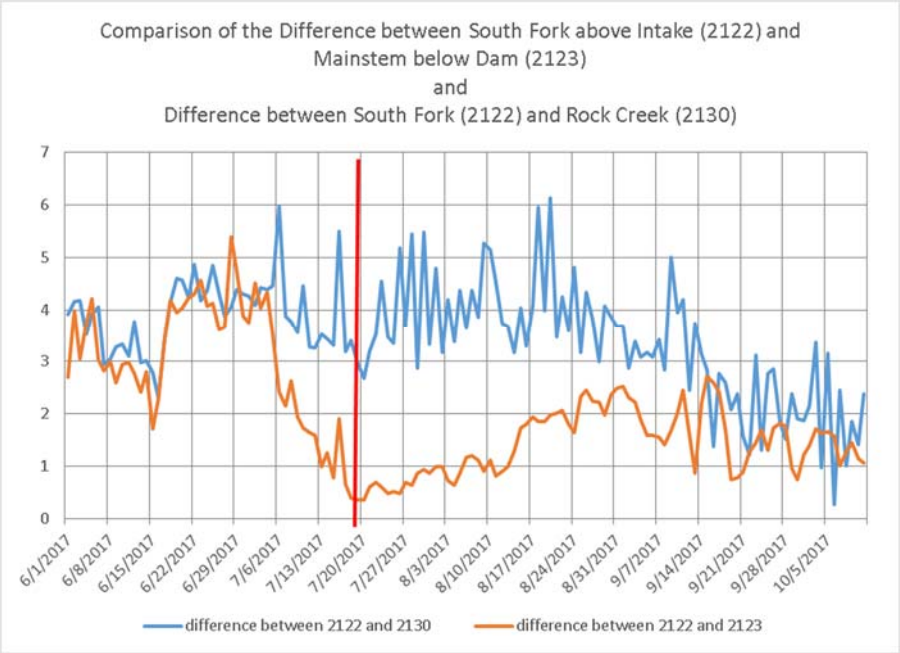

Figure 12: Site 2130 is 2.79 miles downstream from the dam. The period of time when the spillway flow is decreasing from the end of June to July 20 has a slightly downward trend in the difference between sites 2122 and 2130, suggesting there might be a slightly influence of the spillway at this site. There is no similarity between the two lines after July 20, suggesting the dam valve channel flow isn't having an effect this far downstream.

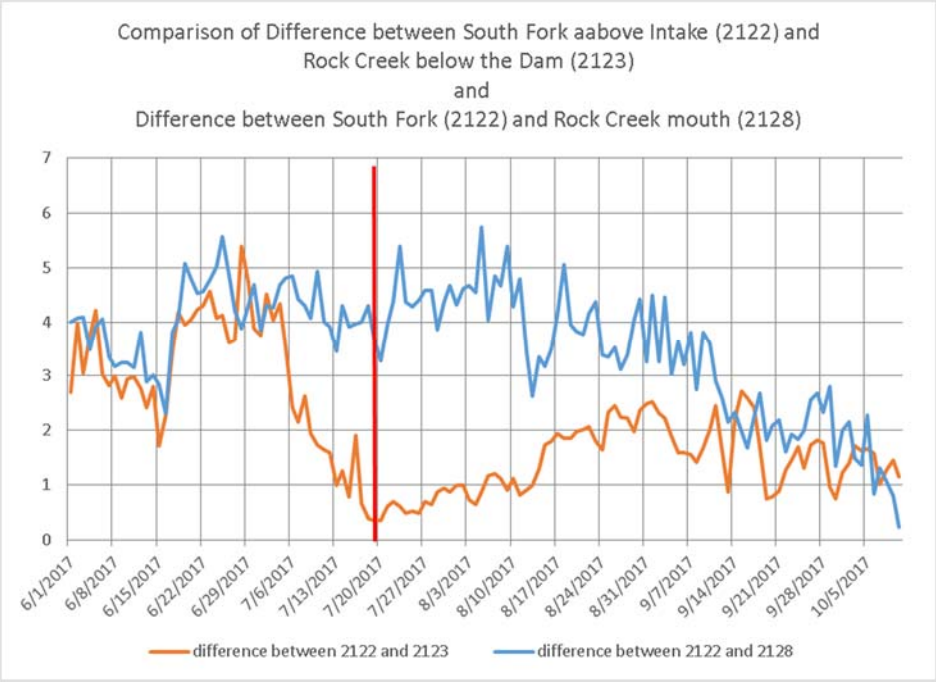

Figure 13. Site 2128 is 3.72 miles downstream from the dam. If the spillway is having an effect, it is slight. There is no similarity in the lines' patterns when the dam valve channel is the sole source of flow from the reservoir.

Summary and Conclusions

Although the 2017 air temperatures were slightly warmer than 2015, the stream temperatures were slightly cooler. The summer of 2015 was hot after a relatively dry winter; the summer of 2017 was hot following the wettest winter since stream temperature monitoring began in 2010. The wet winter probably kept flows higher later into the summer, and helped mitigate the warmer air temperatures, as compared to 2015.

The same analysis on downstream temperature tends was done in 2017 as in previous years. The pattern of decreasing temperature differences between a downstream mainstem site and the South Fork as spillway flow decreases is diminishing downstream. The pattern of gradually increasing temperature differences after July 20, which is due to the influence of the bottom of the reservoir leaking through the dam valve channel, is not apparent at Site 2170 (1.35 miles downstream). The spillway flow may have been larger during the early part of the summer due to higher precipitation amounts during the winter. The wet winter may have contributed to higher stream flows throughout the watershed later into the summer in 2017.