Final
2013 Klamath River
Continuous Water Quality Monitoring
Summary Report

Yurok Tribe Environmental Program:
Water Division

August 2013

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Acknowledgements

The Yurok Tribe Environmental Program (YTEP) would like to thank those that contributed to the data collection efforts that occurred during the 2013 monitoring season. AmeriCorps Watershed Stewards Project Members Kristin Braun and Sarah Stawasz were instrumental in maintaining and calibrating the datasondes. Funding was provided by PacifiCorp under the Klamath Hydroelectric Settlement Agreement (KHSA) Interim Measure 15 and USEPA under the Clean Water Act Section 106. We would also like to thank Yellow Springs Inc. for their prompt responses to any inquiries regarding maintenance and/or equipment operation.

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I. Introduction

This report summarizes the trends in water quality as measured by Yellow Springs Incorporated (YSI) 6600EDS multi-parameter datasondes on the Klamath and Trinity Rivers from May through November, 2011. The Yurok Tribe Environmental Program (YTEP) measured water quality at several monitoring sites from Weitchpec to the USGS gaging station at Blake's Riffle at half-hour intervals starting in mid-May and ending in early November. This monitoring was performed in an effort to track both temporal and spatial patterns on the lower reaches of the Klamath River during the sampling period. This data was added to previous years' water quality data as part of an endeavor to build a multi-year database on the Lower Klamath River. This summary is part of YTEP's comprehensive program of monitoring and assessment of the chemical, physical, and biological integrity of the Klamath River and its tributaries in a scientific and defensible manner. Datasonde placement along the mainstem of the Klamath and Trinity Rivers and measured parameters were coordinated with the Karuk Tribe and PacifiCorp to expand our understanding of the water quality dynamics in the Klamath basin.

II. Background

The Klamath River Watershed

The Klamath River system drains much of northwestern California and south-central Oregon (Figure 2-1). Thus, even activities taking place on land hundreds miles off the Yurok Indian Reservation (YIR) can affect water conditions within YIR boundaries. For example, upriver hydroelectric and diversion projects have altered natural flow conditions for decades. The majority of water flowing through the YIR is derived from scheduled releases of impounded water from the Upper Klamath Basin that is often of poor quality with regards to human needs as well as the needs of fish and wildlife.

Some historically perennial streams now have ephemeral lower reaches and seasonal fish migration blockages because of inadequate dam releases from water diversion projects along the Klamath and Trinity Rivers. The releases contribute to lower mainstem levels and excessive sedimentation which in turn causes subsurface flow and aggraded deltas. Additionally, the lower slough areas of some of the Lower Klamath tributaries that enter the estuary experience eutrophic conditions during periods of low flow. These can create water quality barriers to fish migration when dissolved oxygen and water temperature levels are inadequate for migrating fish. The Klamath River is on California State Water Resource Control Board's (SWRCB) 303(d) List as impaired for temperature, dissolved oxygen, and nutrients and portions of the Klamath River were recently listed as impaired for microcystin and sedimentation in particular reaches.

The basin's fish habitat has also been greatly diminished in area and quality during the past century by accelerated sedimentation from mining, timber harvest practices, and road construction, as stated by Congress in the Klamath River Act of 1986. Management of private lands in the basin (including fee land within Reservation boundaries) has been, and continues to be, dominated by timber harvest.

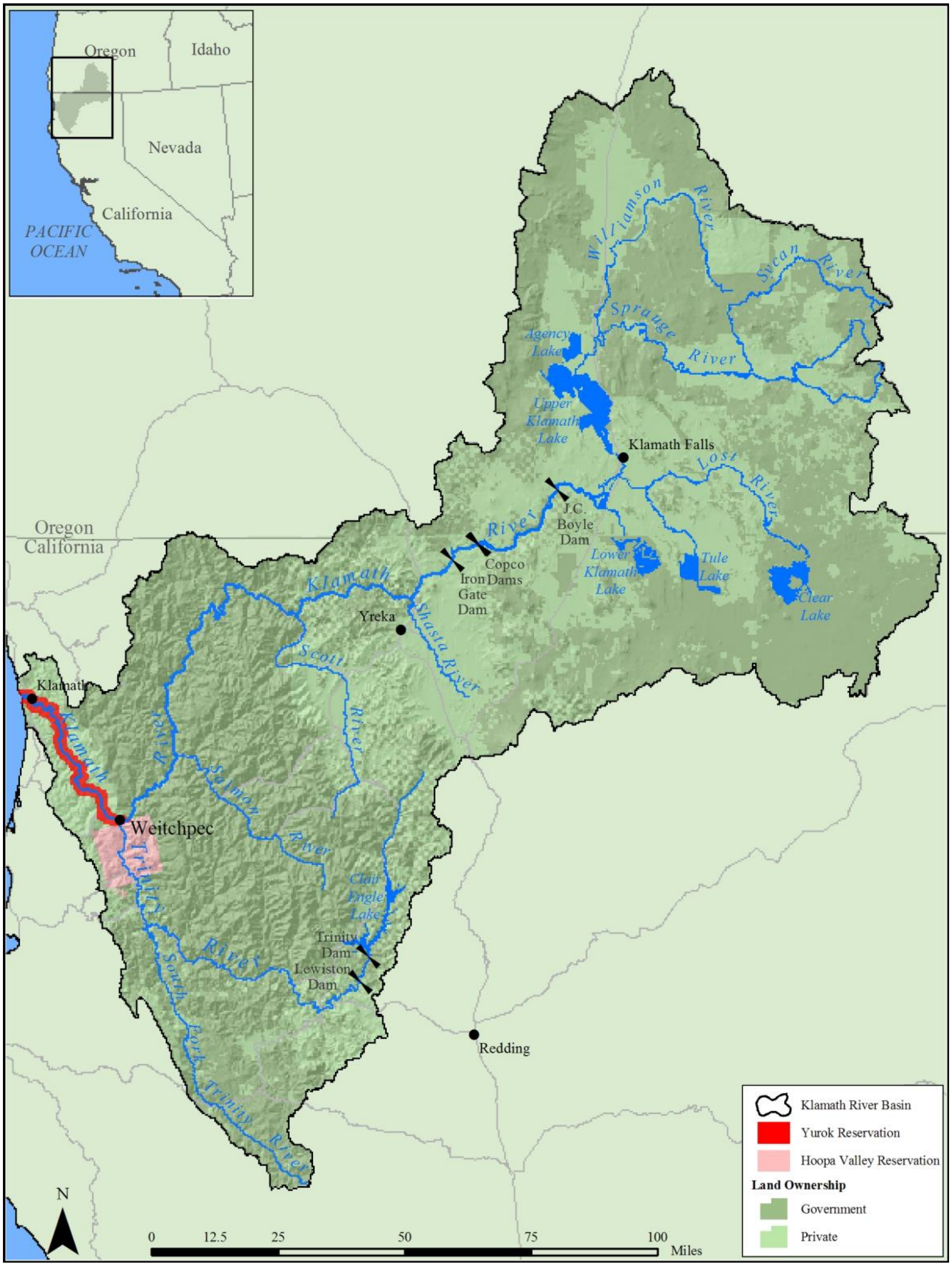

Figure 2-1. Klamath River Basin Map

The Klamath River

The health of the Klamath River and associated fisheries has been central to the life of the Yurok Tribe since time immemorial fulfilling subsistence, commercial, cultural, and ceremonial needs. Yurok oral tradition reflects this. The Yurok did not use terms for north or east, but rather spoke of direction in terms of the flow of water (Kroeber 1925). The Yurok word for salmon, *nepuy*, refers to "that which is eaten". Likewise, the local waterways and watershed divides have traditionally defined Yurok aboriginal territories. Yurok ancestral land encompass approximately 360,000 acres and is distinguished by the Klamath and Trinity Rivers, their surrounding lands, and the Pacific coast extending from Little River to Damnation Creek.

The fisheries resource continues to be vital to the Yurok today. The September 2002 Klamath River fish kill, where a conservative estimate of 33,000 fish died in the lower Klamath before reaching their natal streams to spawn, was a major tragedy for the Yurok people.

The Yurok Indian Reservation

The current YIR consists of a 55,890-acre corridor extending for one mile from each side of the Klamath River from just upstream of the Trinity River confluence to the Pacific Ocean, including the channel and the bed of the river (Figure 2-2). There are approximately two dozen major anadromous tributaries within that area. The mountains defining the river valley are as much as 3,000 feet high. Along most of the river, the valley is quite narrow with rugged steep slopes. The vegetation is principally redwood and Douglas fir forest with little area available for agricultural development. Historically, prevalent open prairies provided complex and diverse habitat.

Yurok Tribe Water Monitoring Division

In 1998, YTEP was created to protect and restore tribal natural resources through high quality scientific practices. YTEP is dedicated to improving and protecting the natural and cultural resources of the Yurok Tribe through collaboration and cooperation with local, private, state, tribal, and federal entities such as the Yurok Tribe Fisheries Program (YTFP), US Fish and Wildlife Service (USFWS), the United States Environmental Protection Agency (USEPA), Green Diamond Resource Company, the NCRWQCB, and the United States Geological Survey (USGS). USEPA funding allocated under the Clean Water Act Section 106 and funding from PacifiCorp primarily fund YTEP's continuous water quality monitoring activities.

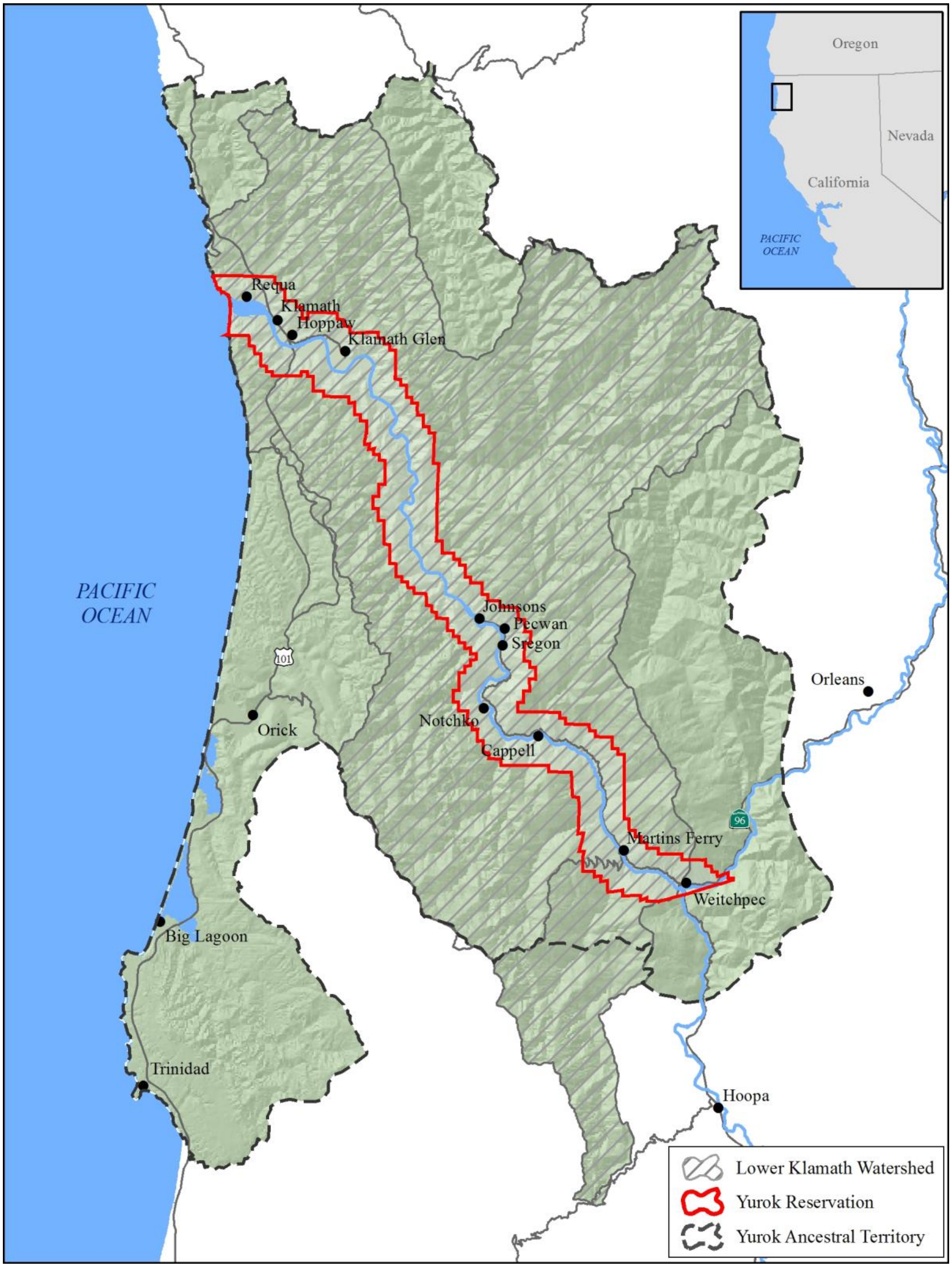

Figure 2-2. Yurok Indian Reservation and Yurok Ancestral Territory Map

III. Methods

The monitoring study initiated in the middle of May, continued throughout the summer months and ended in early November. Continuous water quality information was collected using YSI 6600EDS multi-parameter datasondes equipped with specific conductivity/temperature, pH, DO and phycocyanin probes. ROX DO probes detect concentrations of dissolved oxygen in bodies of water by measuring luminescence as it is affected by the presence of oxygen, while phycocyanin probes are designed to detect the presence of an accessory pigment known to occur in *Microcystis aeurginosa*. These sensors return consistent, high quality measurements.

During this study, many QC measures were undertaken to ensure the data collected with the datasondes were of the highest quality. According to the current datasonde operation protocol (Appendix A), datasondes were pre- and post-calibrated and pre-and post-cleaned on site every two weeks in order to account for electronic drift and bio-fouling. When the datasondes were deployed and extracted, an audit was performed with a freshly calibrated YSI 6600EDS, a portable multi-probe instrument. Effort was made to record the 6600EDS measurements as close as possible to the datasonde and within two minutes of the datasonde recording a measurement.

Once the datasonde was extracted, a pre-clean audit was performed, this time with the site datasonde and reference datasonde in a bucket filled with river water. Once this audit was performed, the site datasonde was cleaned and wiper pads were replaced. Next, a post-clean audit was performed with the site datasonde and reference datasonde in the same bucket of water. After the post clean audit was completed, the dissolved oxygen probe was calibrated using the wet towel method. This protocol requires the user to wrap the datasonde in a wet towel and then place it in a calibration chamber (cylindrical cooler). Dissolved oxygen percent saturation is then calibrated using the current barometric pressure. Barometric pressure was measured using a reliable barometer on site.

Once dissolved oxygen was calibrated, specific conductivity was calibrated, followed by pH with fresh calibration solutions. These were calibrated using the rinse method outlined in the current datasonde operation protocol (Appendix A). Once calibrations were completed the accuracy of the BGA probe was checked by recording readings from DI water, and, during periods of blue-green algae blooms, a solution of rhodamine dye.

After all calibrations and audits were completed, the site datasonde was returned to its housing and redeployed.

IV. Site Selection

The sampling area includes the lower 44 river miles of the mainstem Klamath River on the YIR and the Trinity River above its convergence with the Klamath near the southern boundary of the YIR. In general, the various sampling locations were chosen in order to represent the average ambient water conditions throughout the water column. The sites listed below in bold indicate established sampling locations for the collection of continuous water quality data from May through November.

YTEP collected continuous water quality data at the following mainstem Klamath River locations (Figure 4-1) (river miles are approximate):

- **KAT - Klamath River above Turwar Boat Ramp – RM 8 (Figure 4-2)**
- **TC - Klamath River above Tully Creek – RM 38.5 (Figure 4-3)**
- **WE - Klamath River at Weitchpec (upstream of Trinity River) – RM 43.5 (Figure 4-4)**
- **TR - Trinity River near mouth (above Klamath River confluence) – RM 0.5 (Figure 4-5)**

V. Quality Assurance

During this study, many quality assurance and quality control (QA/QC) measures were undertaken to ensure that the continuous water quality data collected was of the highest quality.

All field personnel that were involved in datasonde maintenance have been trained appropriately by the Water Division Program Manager and are properly supervised to ensure proper protocol is followed consistently throughout the monitoring season. Each field visit requires that staff fill out field data sheets and follow protocols appropriately in the field. Datasonde maintenance is always conducted by at least two staff for safety reasons and to maintain consistency.

Data is thoroughly reviewed once downloaded from the datalogger. YTEP is the primary organization responsible for data review. The data manager will visually inspect all entered data sets to check for inconsistencies with original field data sheets. Where inconsistencies are encountered, data will be re-entered and re-inspected until the entered data is found to be satisfactory or results will be discarded. Any unusual values outside the range of norm will be flagged and all aspects of field data sheets will be reviewed. Outliers will be identified and removed from the dataset if deemed necessary by the QA Officer. The Project Manager will maintain field datasheets and notebooks in the event that the QA Officer needs to review any aspect of sampling for QA/QC purposes. Data is reviewed and finalized once data are merged or entered into a database.

The Yurok Tribe received a grant under the Environmental Information Exchange Network Program and used it to develop the Yurok Tribe Environmental Data Storage System (YEDSS). Continuous water quality data covered in this report have been entered in YEDSS, where each water quality parameter is assigned a grade based on USGS criteria (Appendix B) for each two week deployment, and will be uploaded to USEPA’s WQX database. The data is then adjusted for instrument calibration drift and sensor-fouling errors that occurred during the interval between servicing visits because of

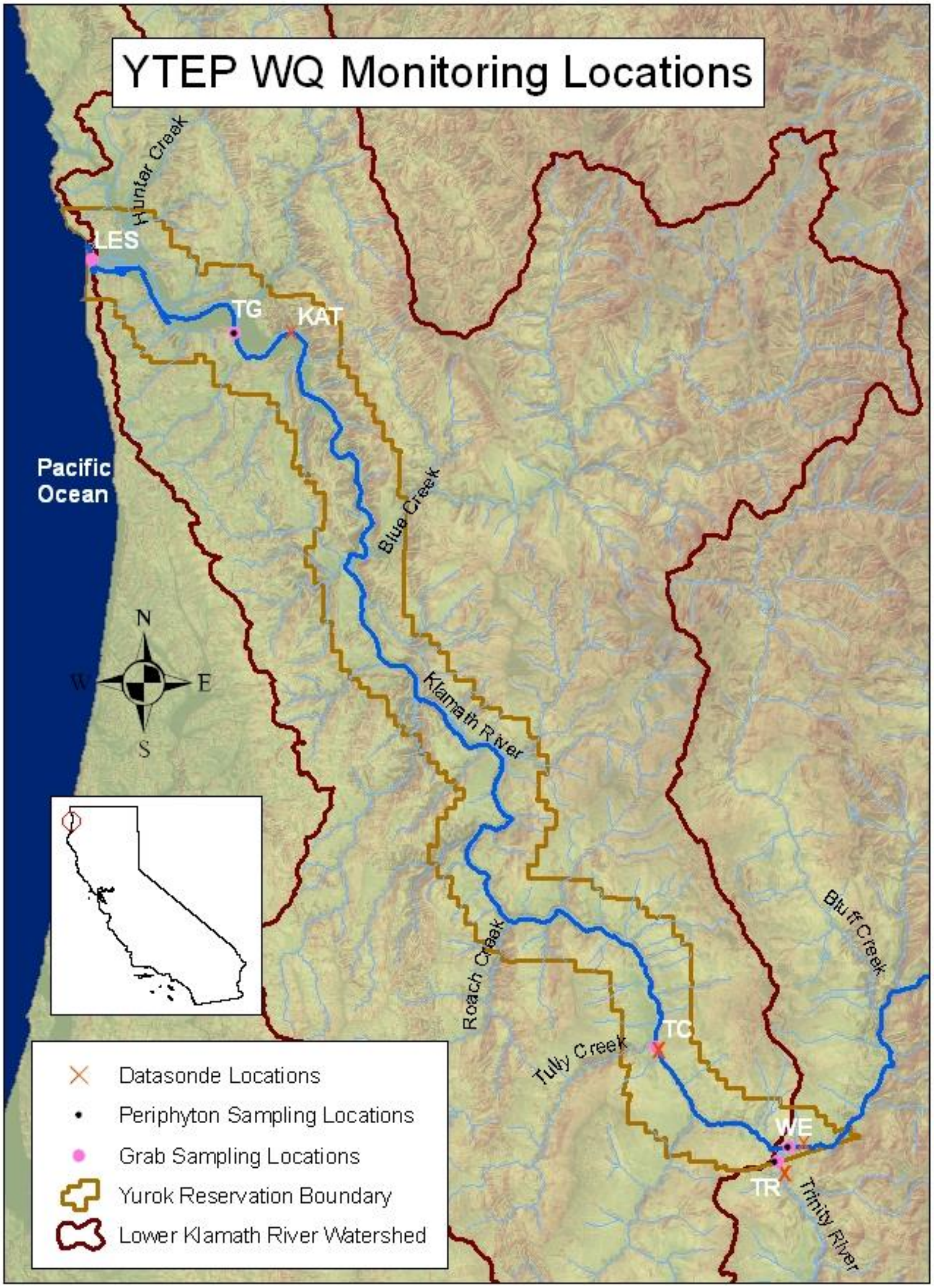

Figure 4-1 .Datasonde Locations for 2012 (as indicated by the brown X's)

Figure 4-2. Klamath Above Turwar (KAT)

Figure 4-3. Klamath Above Tully Creek (TC)

Figure 4- 4. Klamath River at Weitchpec (WE)

Figure 4- 5. Trinity River near Mouth (TR)

environmental or instrumentation effects. These adjustments are made based on USGS criteria for water-quality data corrections and fouling and sensor drift calculations (Wagner et al., 2006). The metadata associated with each data type are also stored within the system and can be easily accessed when questions arise.

VI. Results

Temperature

All Riverine Sites

Water temperatures on the Lower Klamath and Trinity River varied greatly during the 2013 monitoring season. The coolest daily water temperature was 12.36ºC on October 11 at TR. The warmest daily water temperature was 26.36ºC on July 3 at TR. In this discussion, the daily minimum and maximum water temperatures were compared to the Yurok Tribe's water temperature standards in order to assess the water temperatures of the Klamath and Trinity Rivers. The discussion reflects water temperature standards as of November 1, 2005. Temperature standards are under review and will be updated for all salmonid life stages at a later date.

Daily maxima and minima were disregarded when more than five measurements were missing from a 24-hour period and when the daily maximum or minimum was expected to occur during the gap. Gaps in data may occur during service or due to instrument malfunction or vandalism. When gaps occurred in water temperature data, information was filled in using data from U.S. Fish and Wildlife Service (USFWS) HOBO temperature probes. These probes, which are deployed and extracted by YTEP, are placed in close proximity to each datasonde site. These probes record water temperature every hour throughout the entire year, and are switched out twice a year for data upload and probe maintenance and calibration. There is high confidence in the comparability of this temperature data with YTEP's datasonde data since nearly all data for the period of simultaneous deployment is within +/- 0.2ºC. Continuous datasonde water temperature data from the Lower Klamath and Trinity River is available from YTEP upon request. For more information regarding HOBO water temperature data on the Lower Klamath and Trinity River, contact the Arcata office of the U.S. Fish and Wildlife Service.

Klamath River above Turwar (KAT)

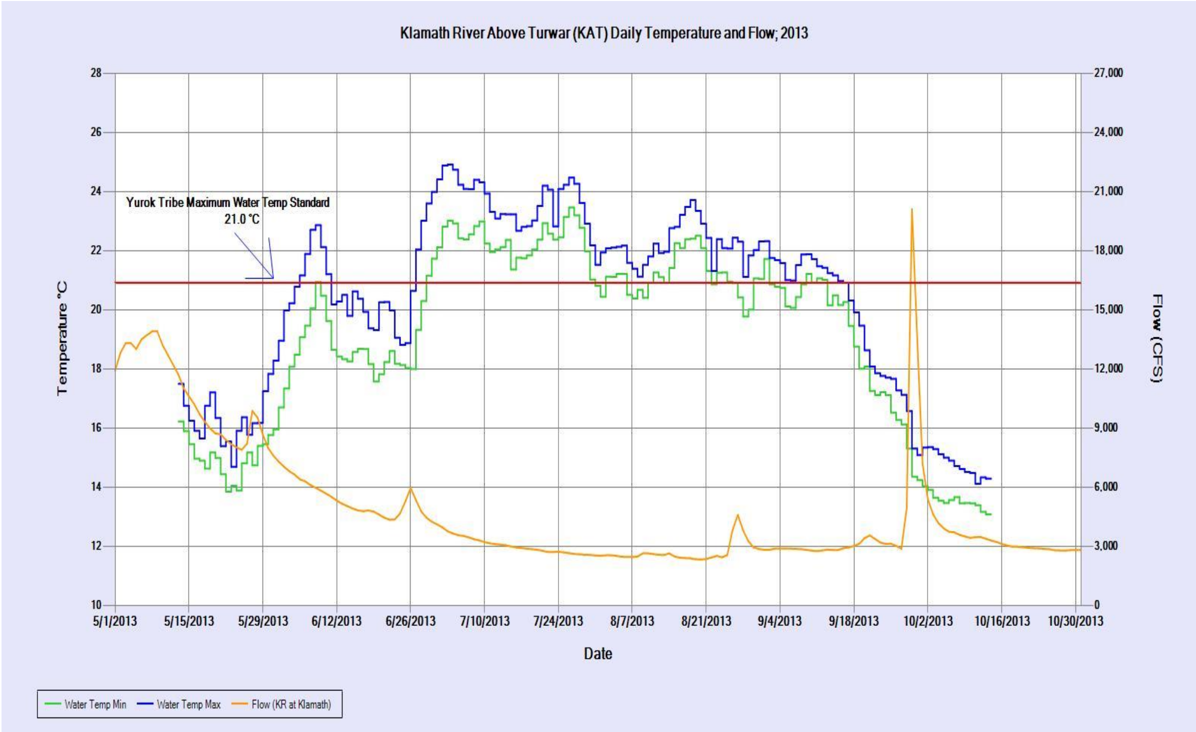

Figure 6-1. KAT Maximum/minimum Water Temperatures and Flow: 2013

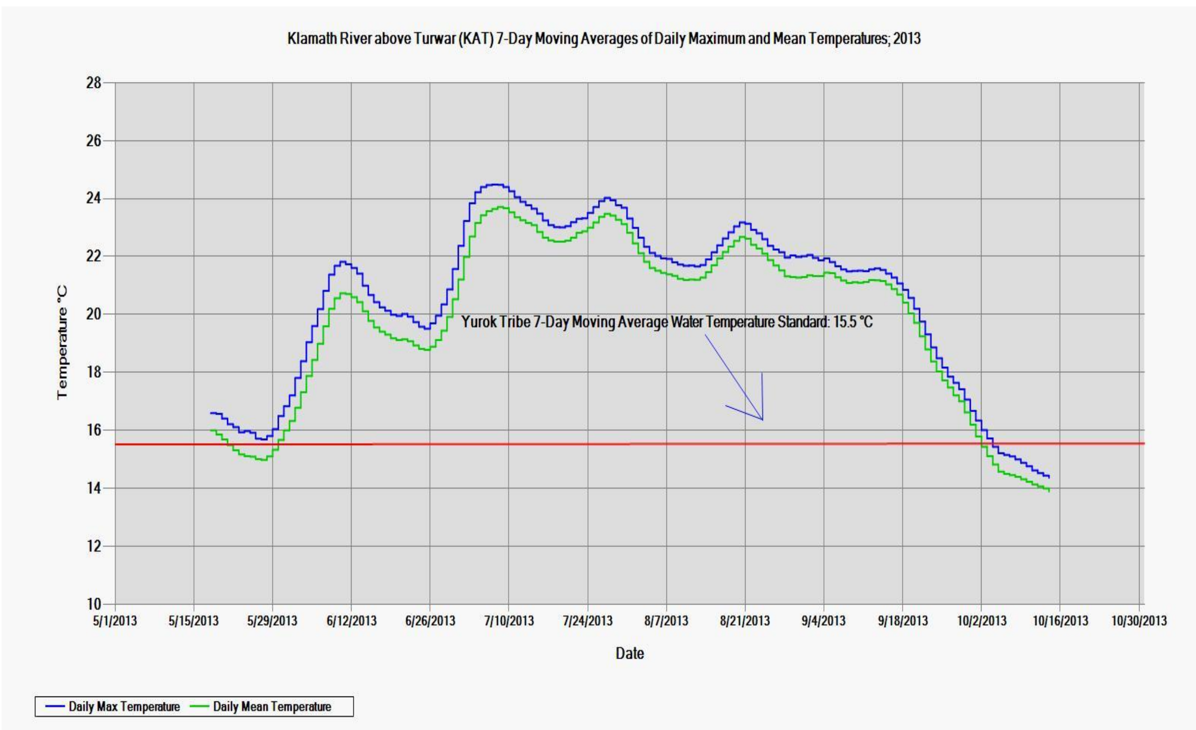

Figure 6-2. KAT 7-Day Moving Averages: 2013

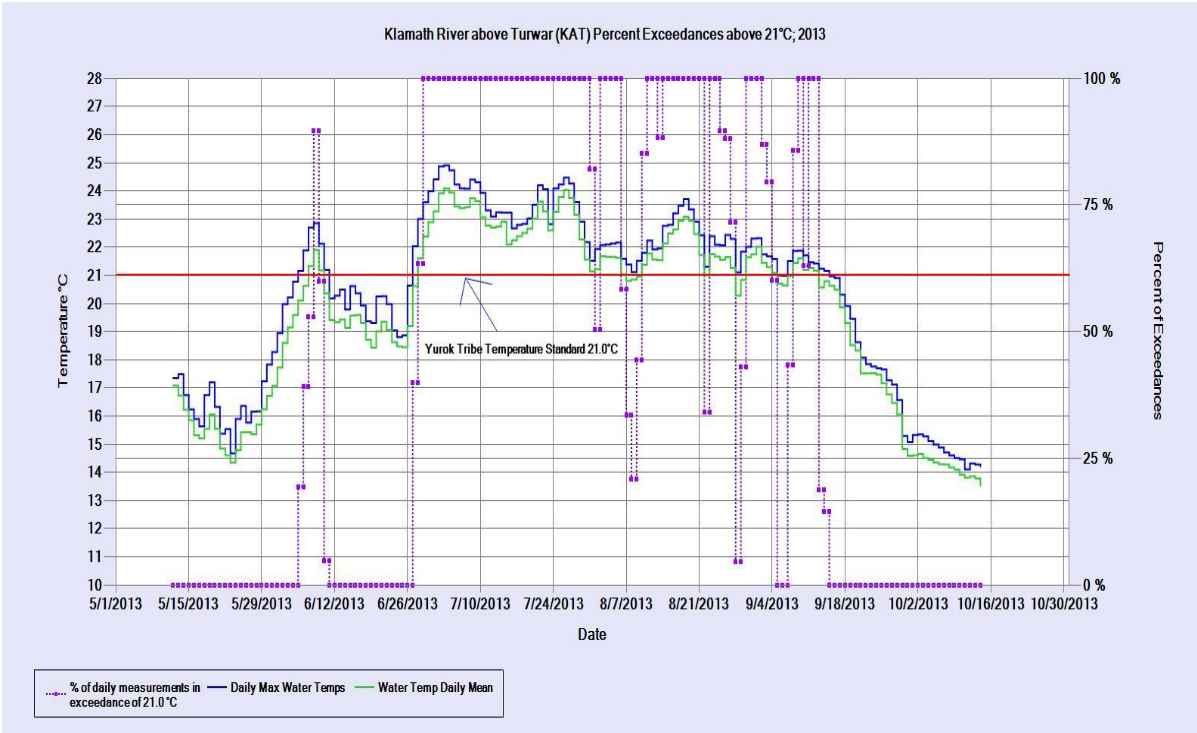

Figure 6-3. KAT Water Temperature Percent Exceedance: 2013

Klamath River above Tully Creek (TC)

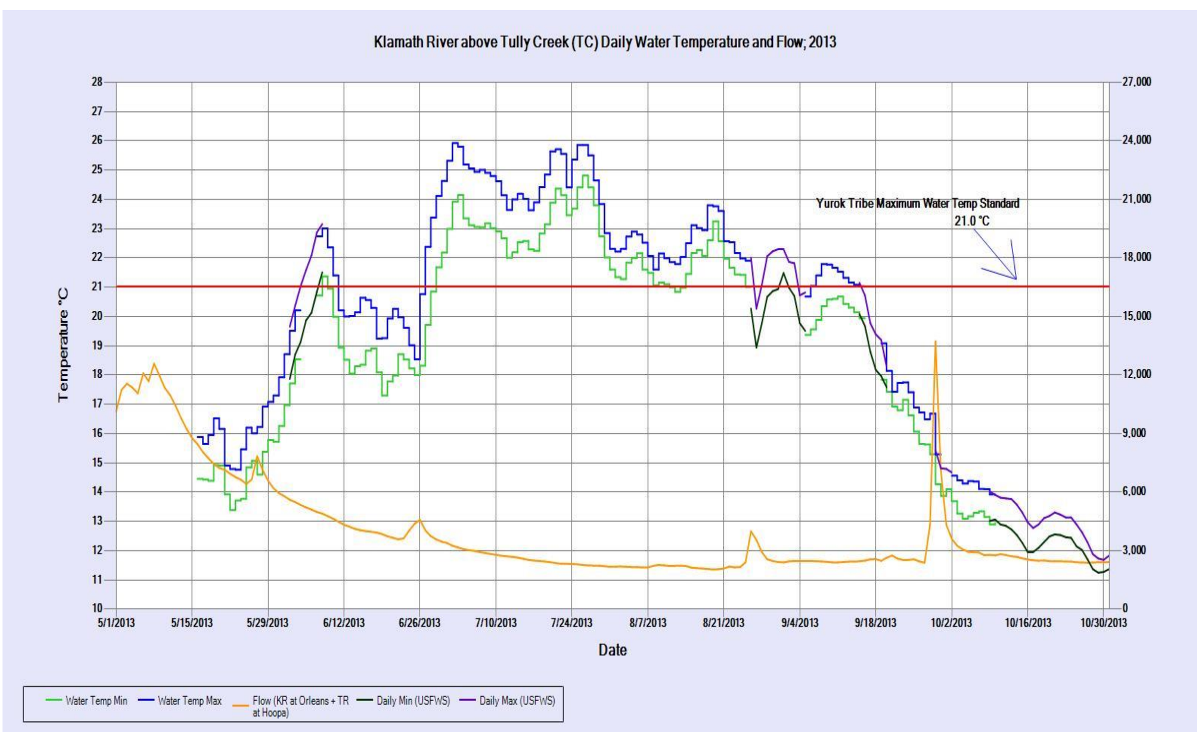

Figure 6-4. TC Maximum/minimum Water Temperature and Flow: 2013

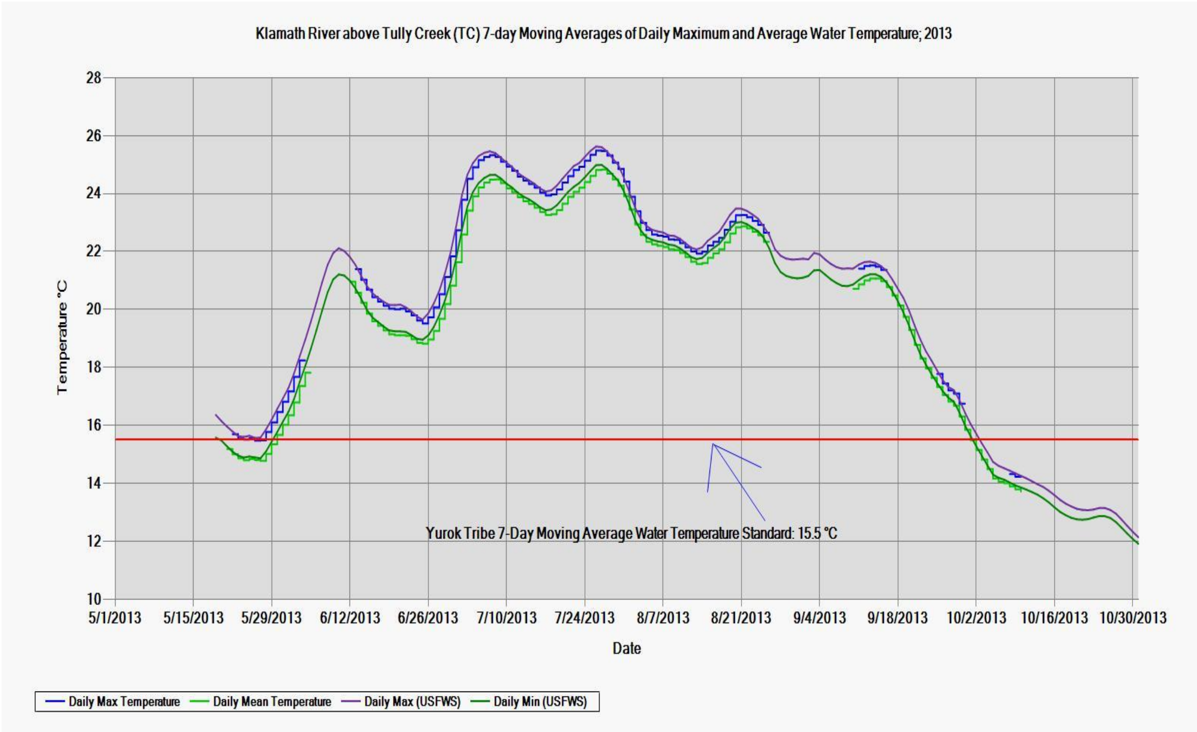

Figure 6-5. TC 7-Day Moving Averages: 2013

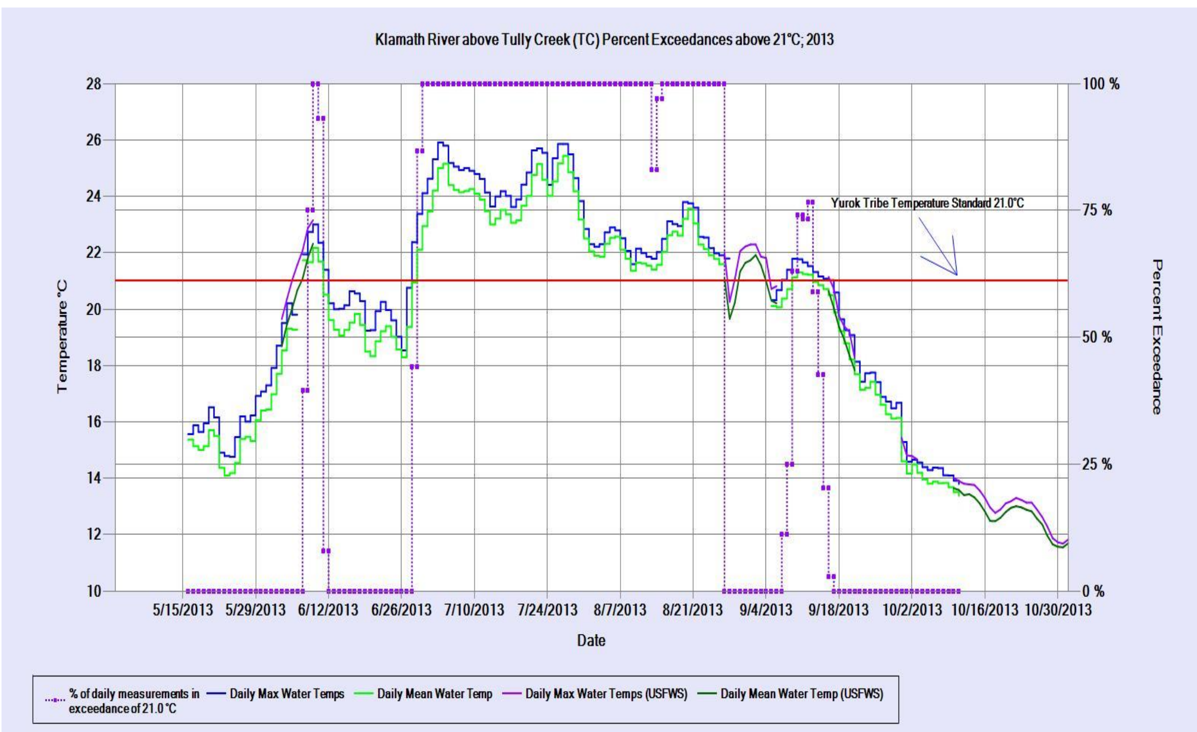

Figure 6-6. TC Water Temperature Percent Exceedance: 2013

Klamath River at Weitchpec (WE)

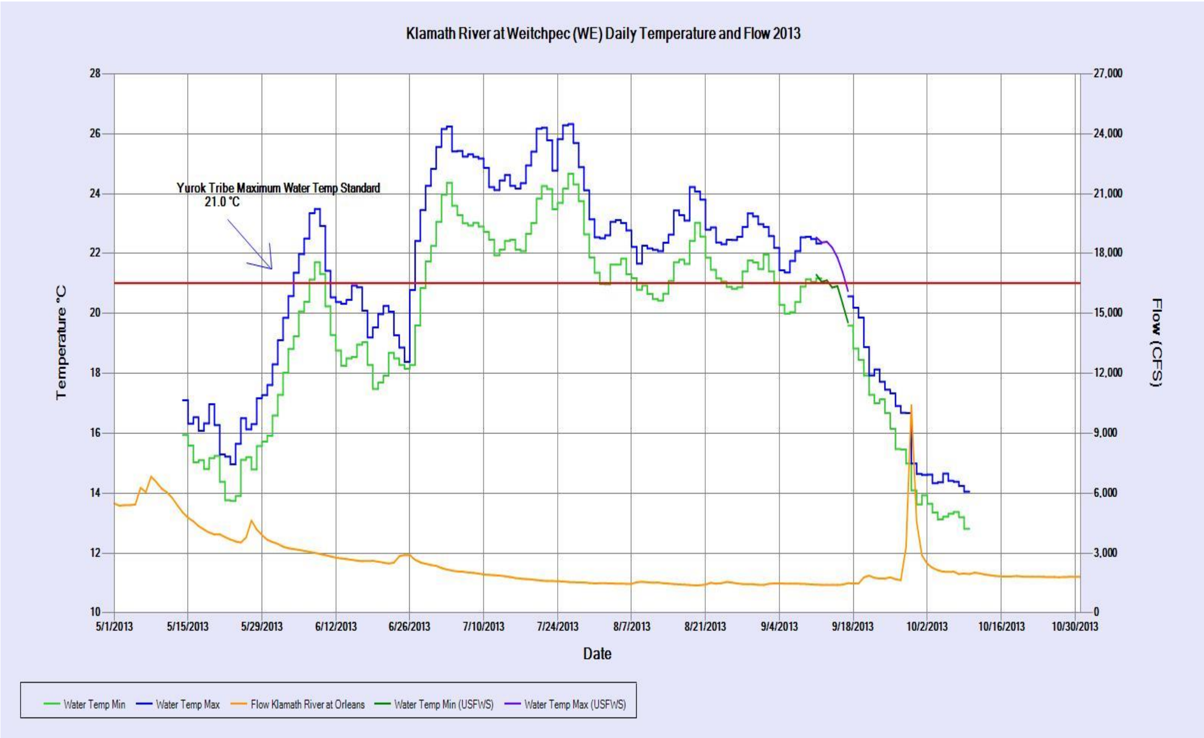

Figure 6-7. WE Maximum/minimum Water Temperature and Flow: 2013

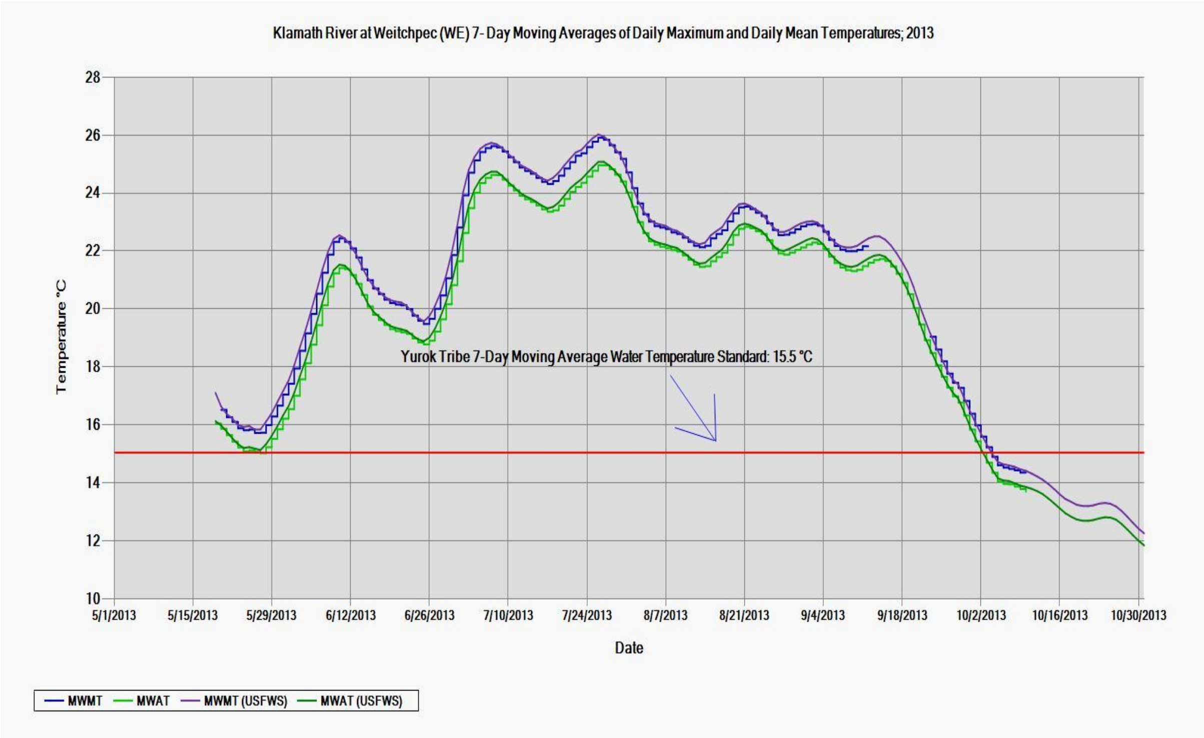

Figure 6-8. WE 7-Day Moving Averages: 2013

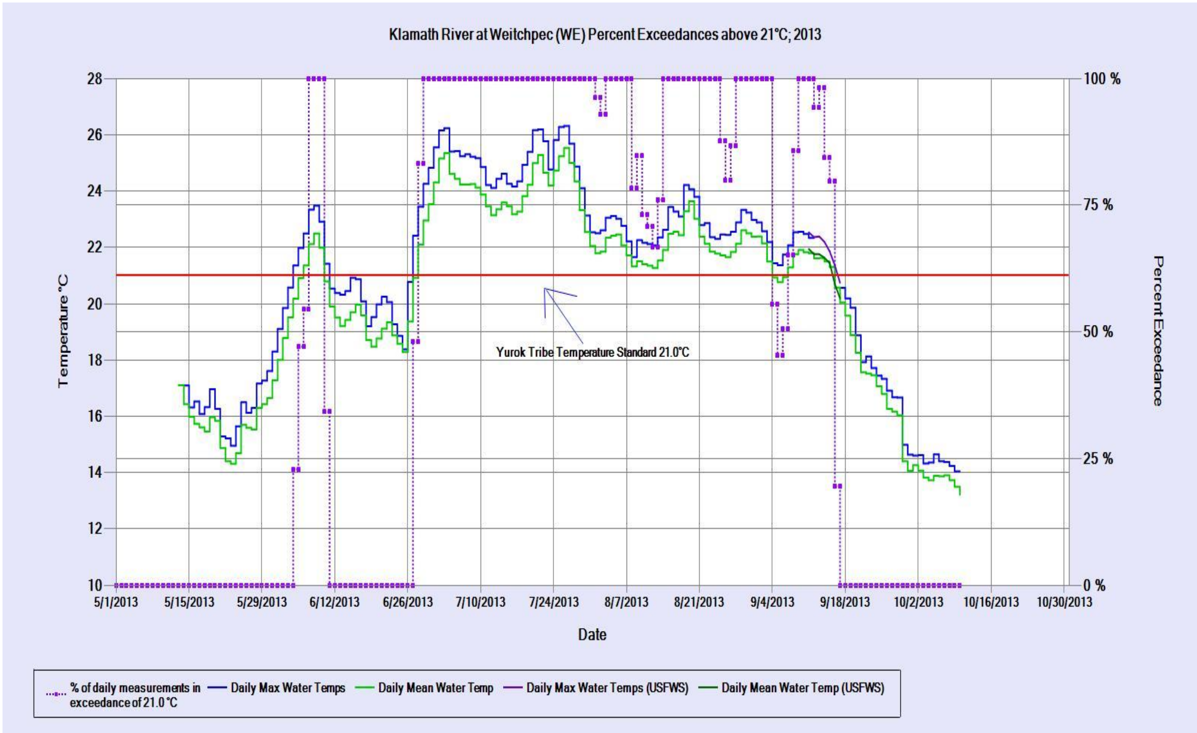

Figure 6-9. WE Water Temperature Percent Exceedance: 2013

Trinity River near mouth (TR)

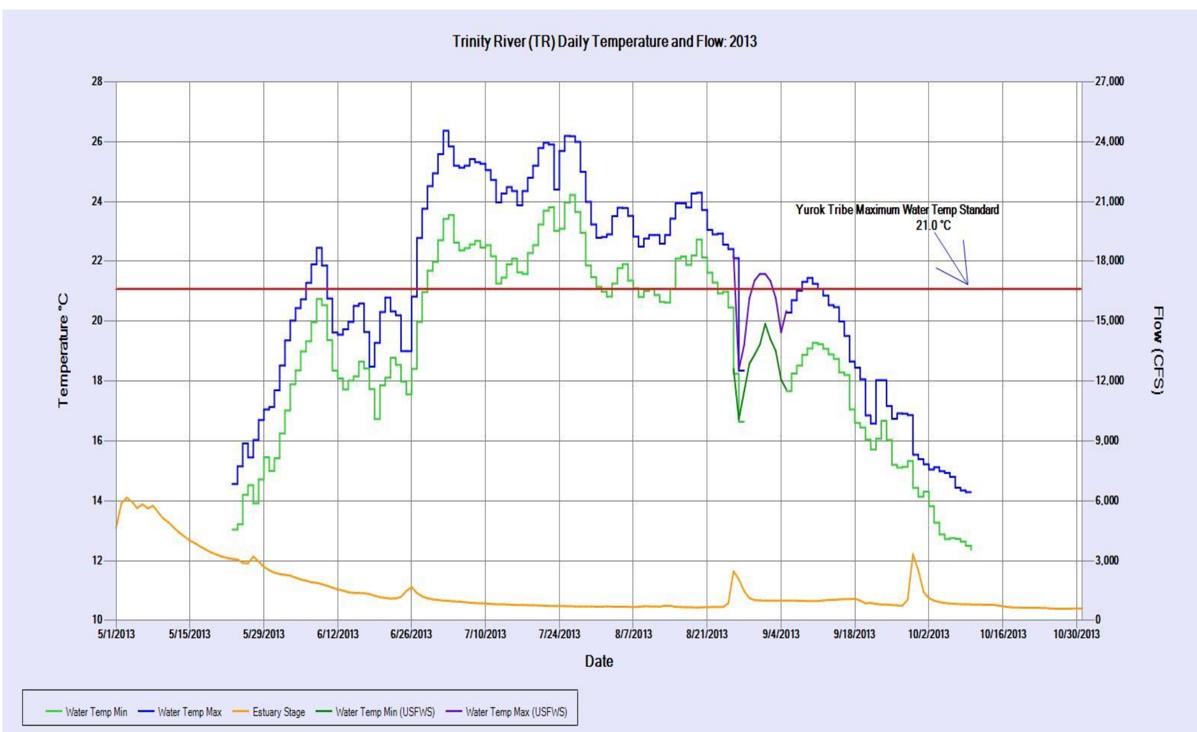

Figure 6-10. TR Maximum/minimum Water Temperature and Flow: 2013

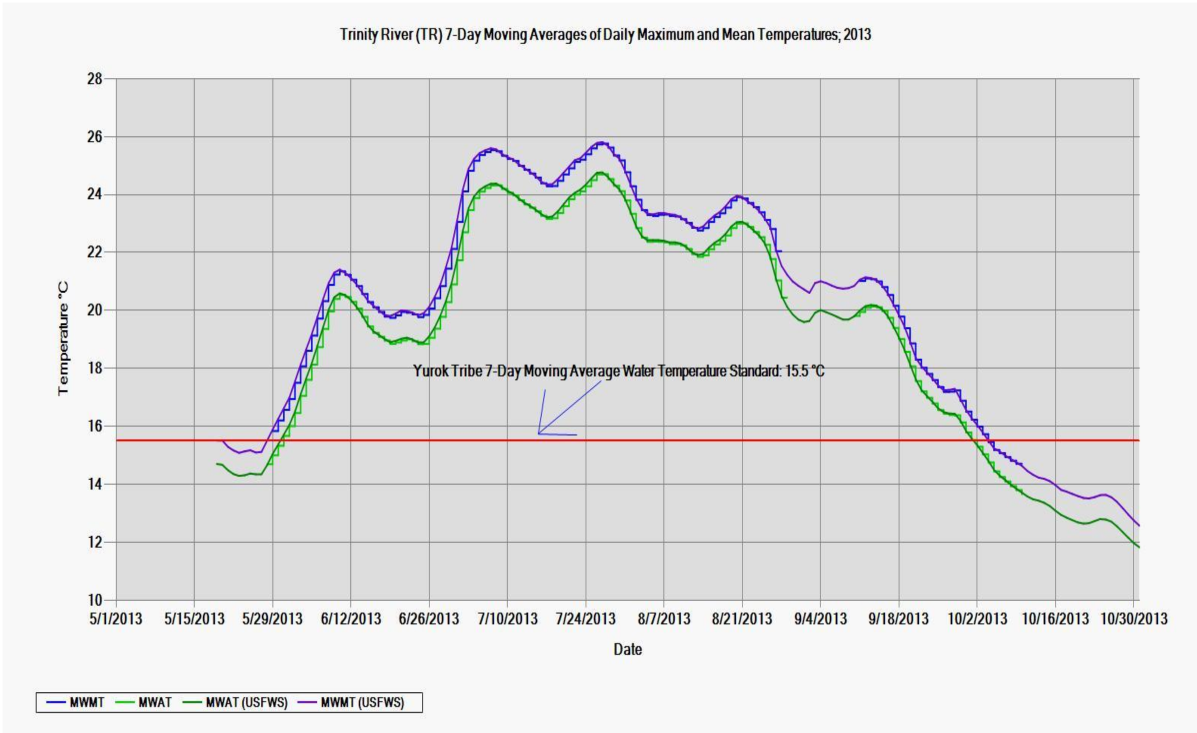

Figure 6-11. TR 7-Day Moving Averages: 2013

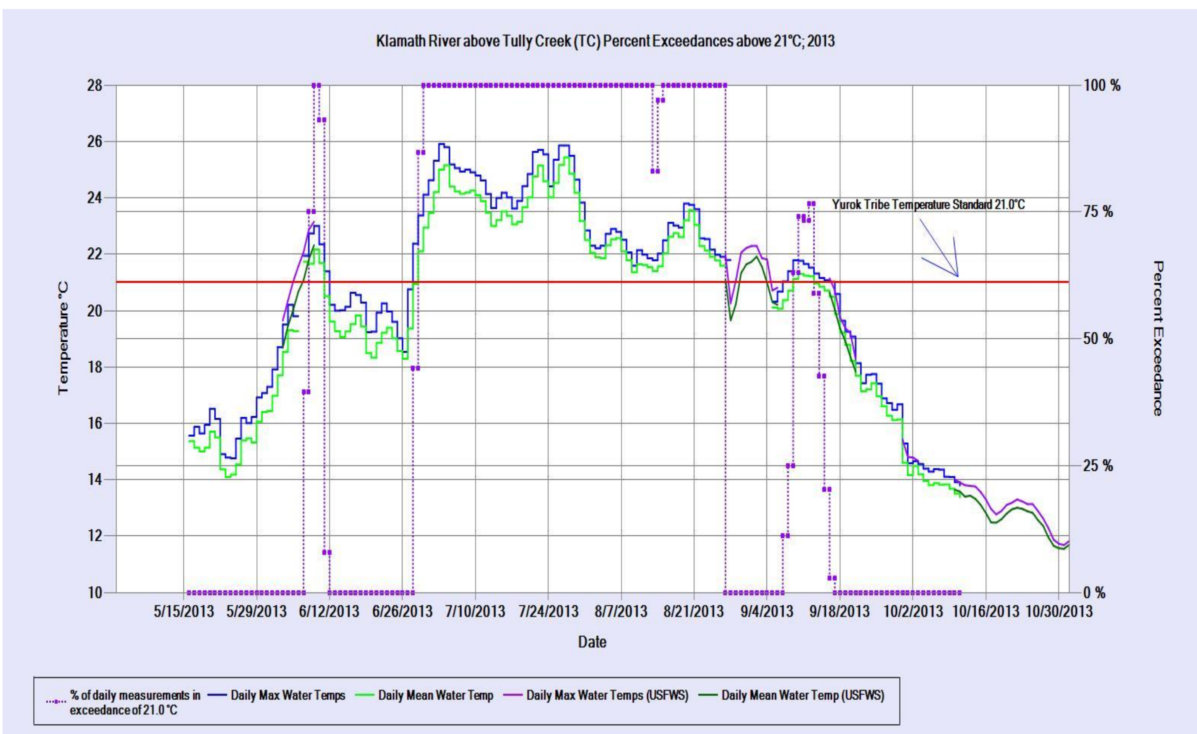

Figure 6-12. TR Water Temperature Percent Exceedance: 2013

Dissolved Oxygen

All Riverine Sites

Dissolved oxygen (DO) concentrations are reported in milligrams per liter (mg/L). The datasonde calculates this concentration based on the DO sensor's percent saturation reading. Percent saturation is the amount of oxygen dissolved in the water compared to the maximum amount that could be present at the same temperature and barometric pressure. Water is said to be 100% saturated if it contains the maximum amount of oxygen at that temperature and pressure. Sometimes water can become supersaturated with oxygen, returning percent saturations readings above 100%. This happens in two main situations. One is in fast-moving, turbulent water, which encourages more air to mix with the water. The other is in situations with large numbers of photosynthetic aquatic plants. These aquatic plants release oxygen into the water during photosynthesis, which mixes with the water as it rises to the surface.

In general, DO levels of the Lower Klamath and Trinity River follow an inverse relationship compared to water temperature. As water temperature rises, its ability to hold oxygen in solution is decreased, causing DO levels to drop. Therefore, as water temperatures increase throughout the summer, DO levels tend to decrease. There is also a diurnal fluctuation within the system, with minimum DO levels occurring late at night and/or early in the morning when aquatic organisms are respiring and photosynthesis is not occurring. Conversely, maximum levels occur late in the afternoon and/or early in the evening when aquatic vegetation is at peak photosynthesis. These diurnal fluctuations can cause large swings in DO throughout the day, which can be harmful to aquatic organisms dependent on DO for respiration.

DO levels at all sites varied greatly during the 2013 monitoring season. The lowest DO concentration recorded was 5.31 mg/L at WE on August 8. The highest DO concentration recorded was 11.04 mg/L at WE on May 23. The lowest DO% saturation recorded was 60.95% at WE on August 7. The highest DO% saturation recorded was 123.45% at WE on August 7. In this discussion, daily minimum and maximum DO concentrations and percent saturation were compared to the Yurok Tribe's dissolved oxygen standards in order to assess dissolved oxygen levels of the Klamath and Trinity Rivers. These standards are 8.0 mg/L for DO concentration and 90% percent saturation from September 1 through May 31 and 85% percent saturation from June 1 through August 31.

Daily maxima and minima were disregarded when more than five measurements were missing from a 24-hour period and when the daily maximum or minimum was expected to occur during the gap. Gaps in data may occur during service or due to instrument malfunction or vandalism. Continuous DO data from the Lower Klamath and Trinity River is available from YTEP upon request.

Klamath River above Turwar (KAT)

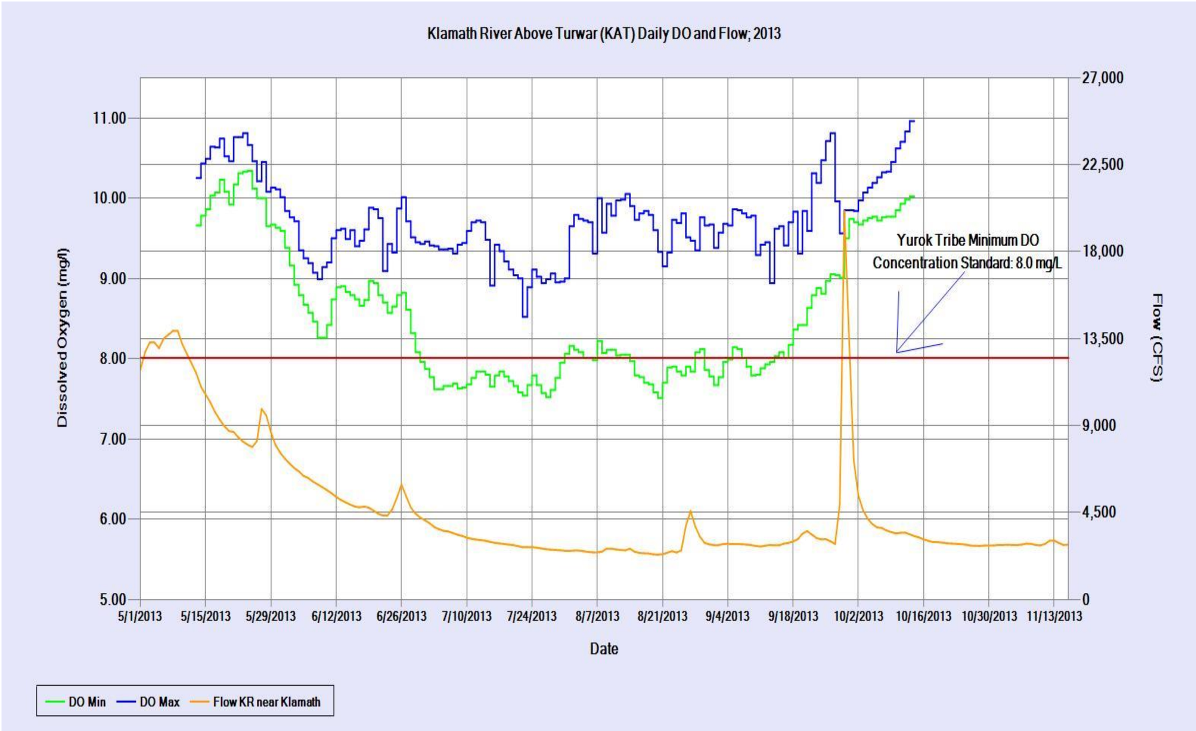

Figure 6-13. KAT Dissolved Oxygen and Flow: 2013

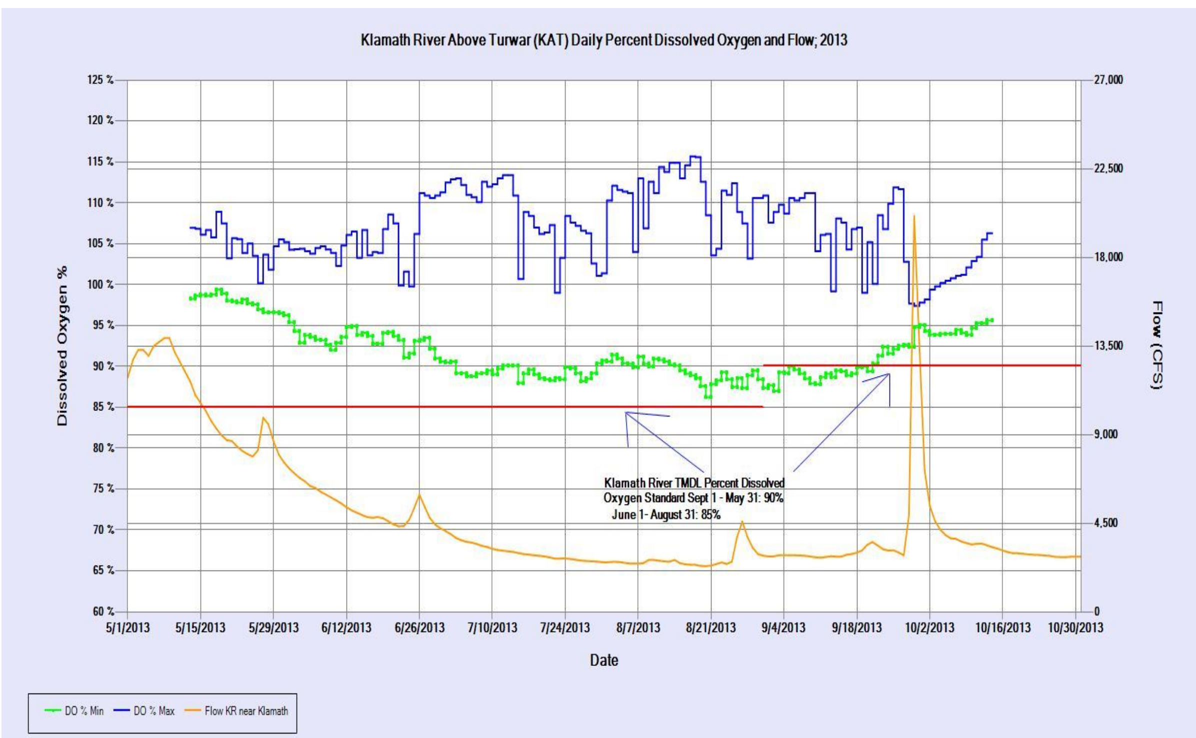

Figure 6-14. KAT Percent Dissolved Oxygen and Flow: 2013

Klamath River above Tully Creek (TC)

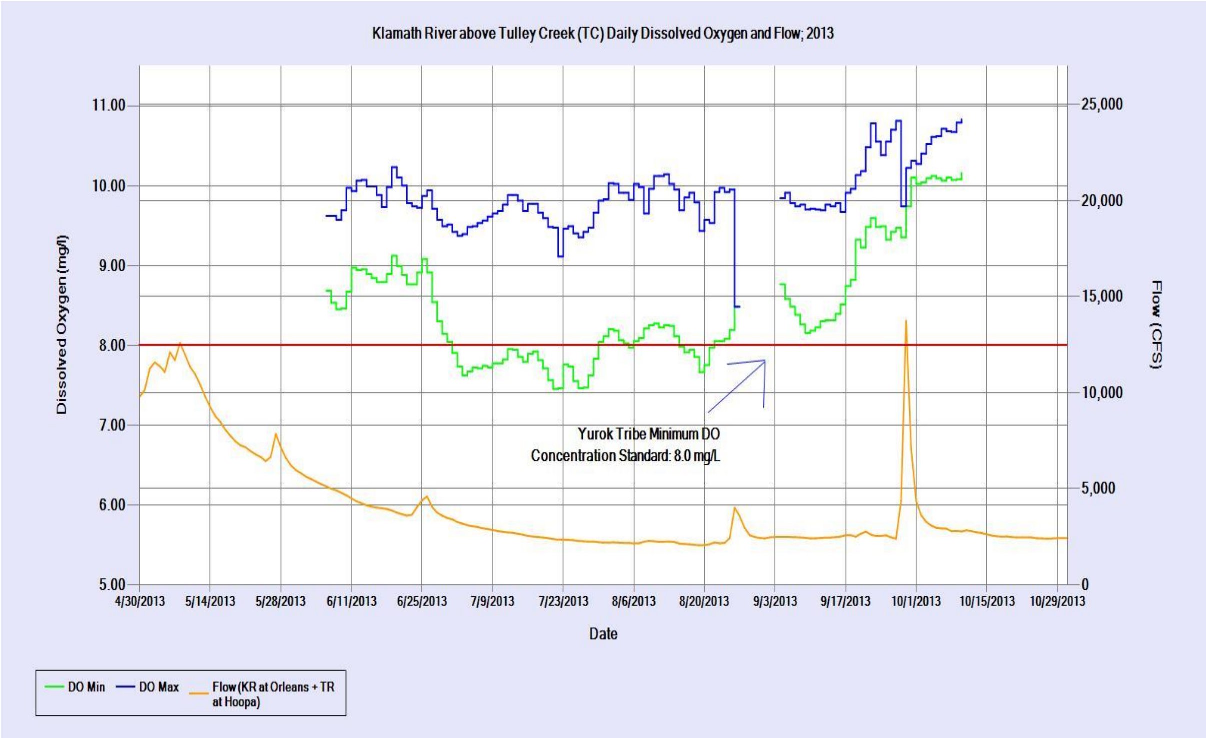

Figure 6-15. TC Dissolved Oxygen and Flow: 2013

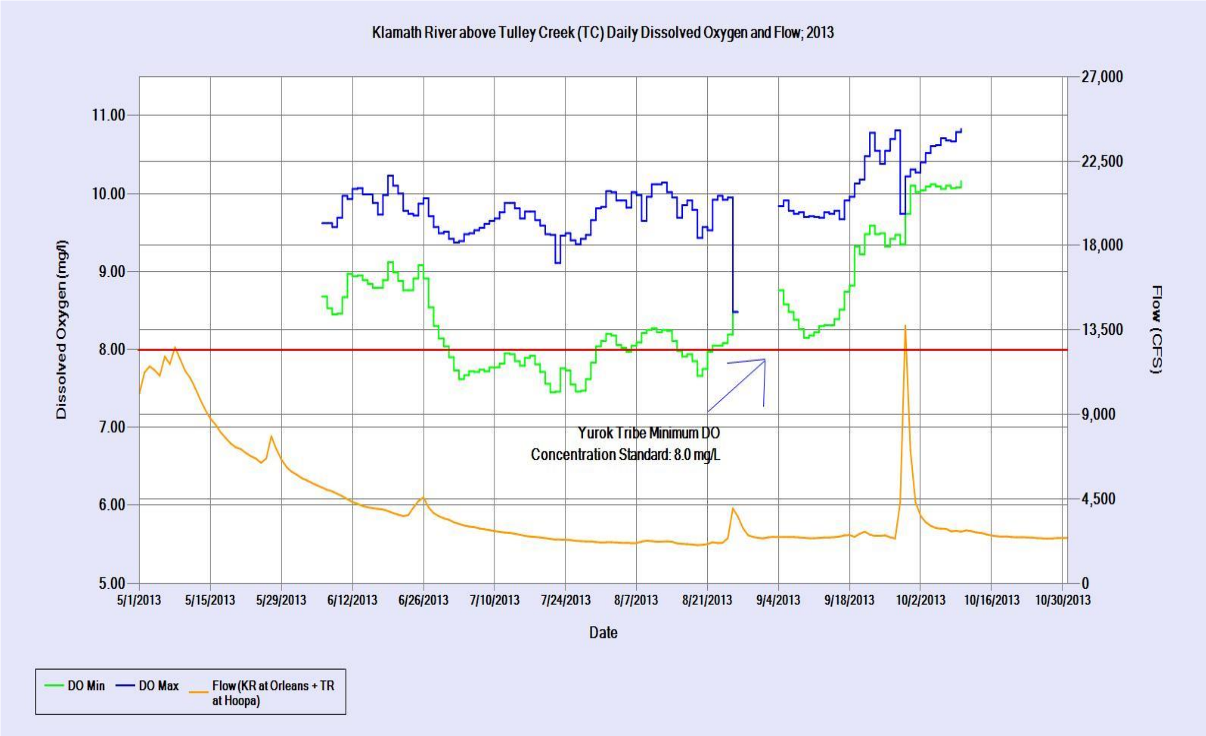

Figure 6-16. TC Percent Dissolved Oxygen and Flow: 2013

Klamath River at Weitchpec (WE)

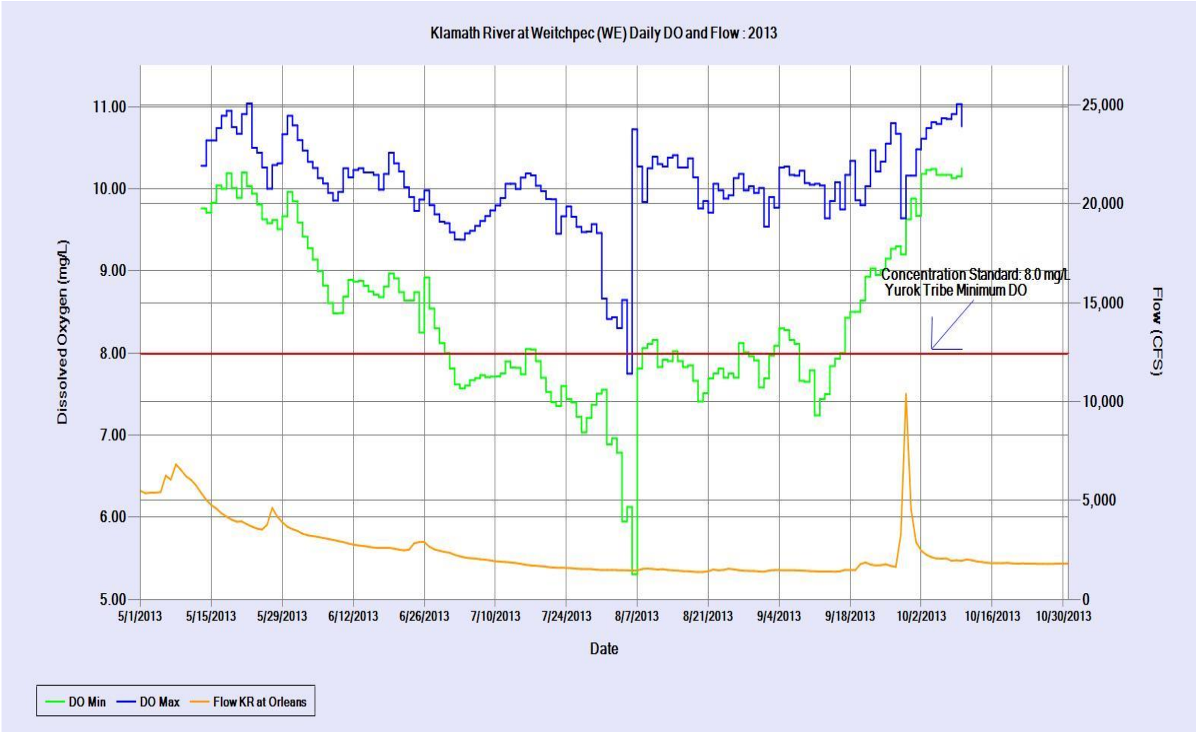

Figure 6-17. WE Dissolved Oxygen and Flow: 2013

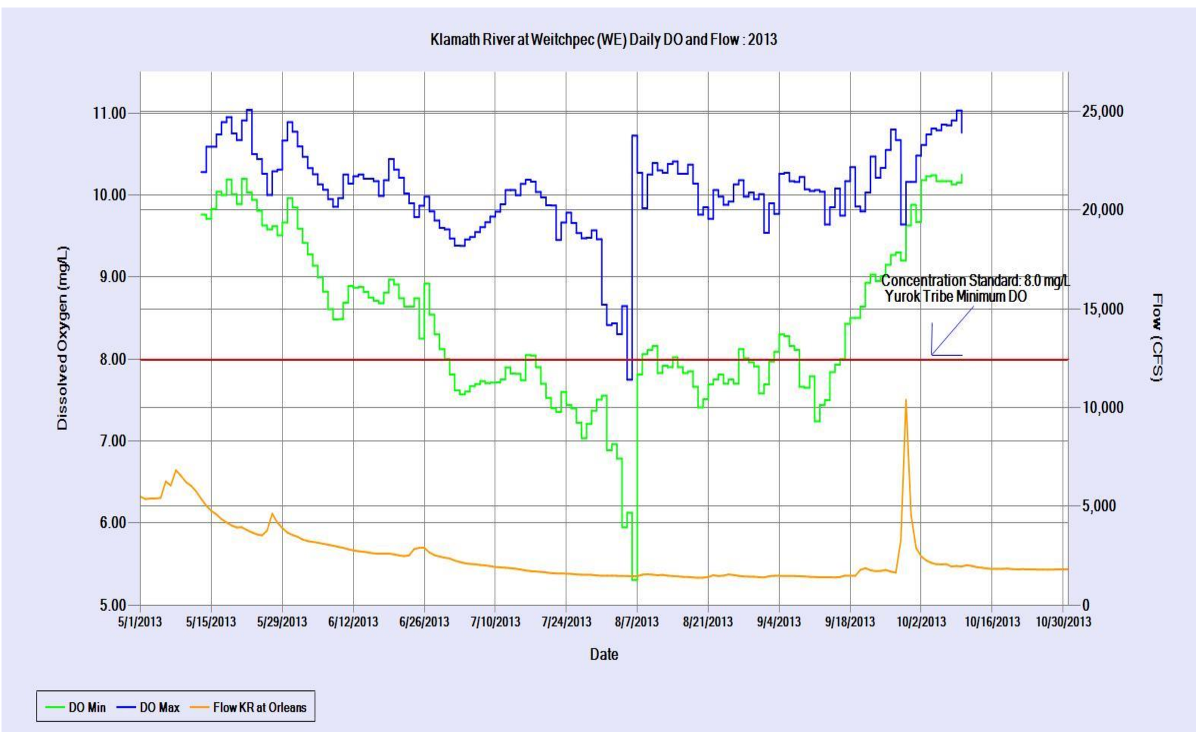

Figure 6-18. WE Percent Dissolved Oxygen and Flow: 2013

Trinity River near Mouth (TR)

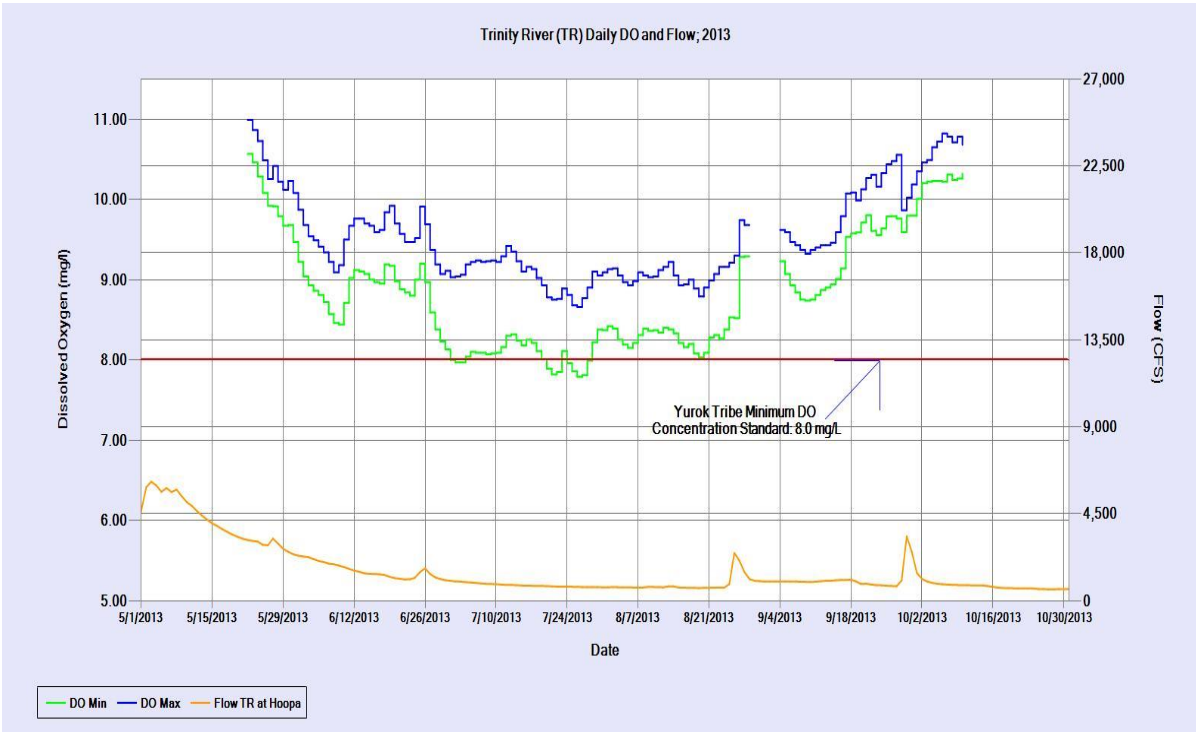

Figure 6-19. TR Dissolved Oxygen and Flow: 2013

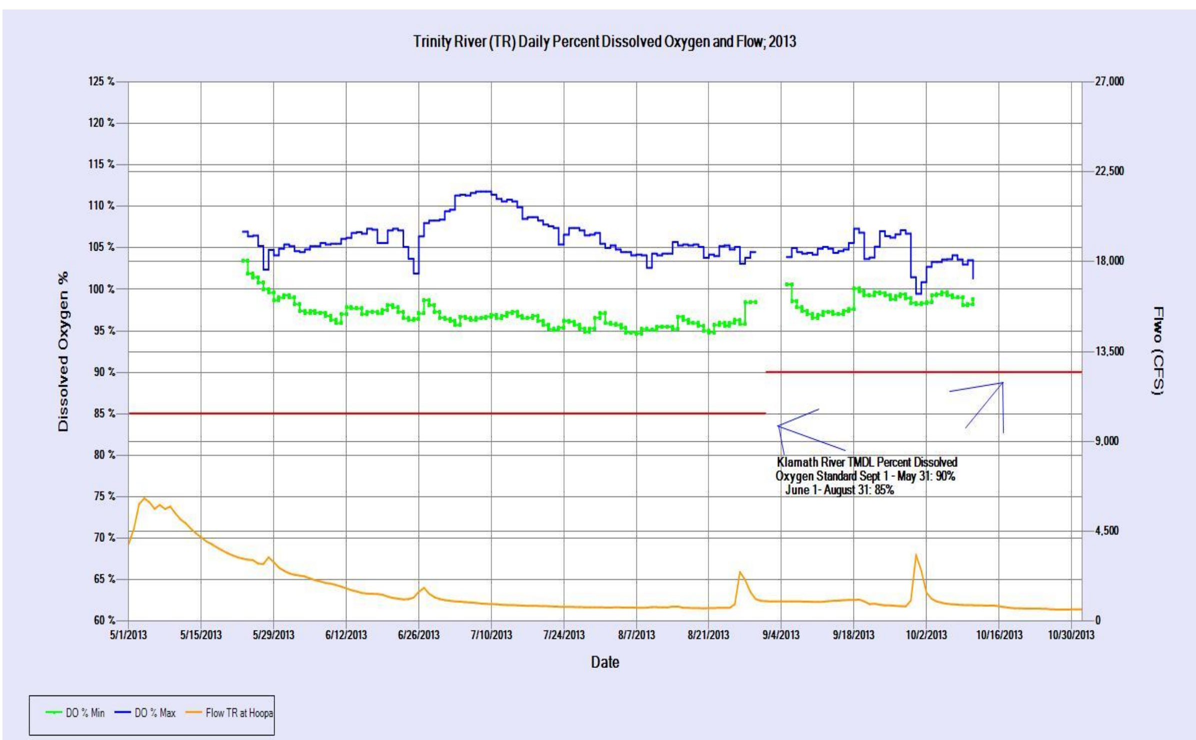

Figure 6-20. TR Percent Dissolved Oxygen and Flow: 2013

pH

All Riverine Sites

pH values on the lower Klamath and Trinity River varied greatly throughout the 2012 monitoring season. The lowest recorded pH was 7.43 at TC on May 20, while the highest recorded pH was 8.81 at WE on July 21, 22, and 23.

Due to its implications for fish health, maximum pH is focused on in this summary. The Yurok Tribe has set a standard of 8.5 for pH on the Lower Klamath and Trinity River. pH values above this standard can cause chronic stress and exhaustion to salmonids. Values above 9.6 are often lethal. The combined effects of high pH and high water temperature increases unionized ammonia, which can be highly toxic to salmon and steelhead. For results of nutrient samples collected on the Lower Klamath and Trinity River, see the Yurok Tribe's 2013 Klamath River Nutrient Summary Report.

Daily maxima and minima were disregarded when more than five measurements were missing from a 24-hour period and when the daily maximum or minimum was expected to occur during the gap. Gaps in data may occur during service or due to instrument malfunction or vandalism. Continuous pH data from the Lower Klamath and Trinity River is available from YTEP upon request.

Klamath River above Turwar (KAT)

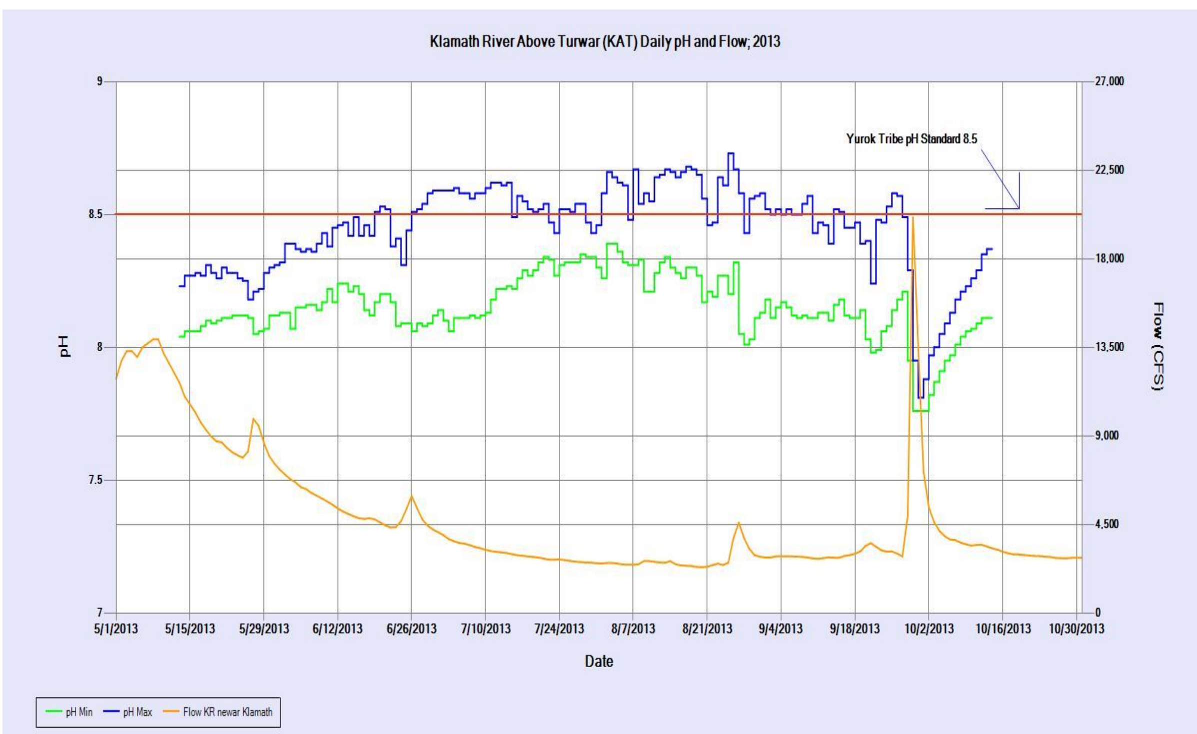

Figure 6-21. KAT Maximum/minimum pH and Flow: 2013

Klamath River above Tully Creek (TC)

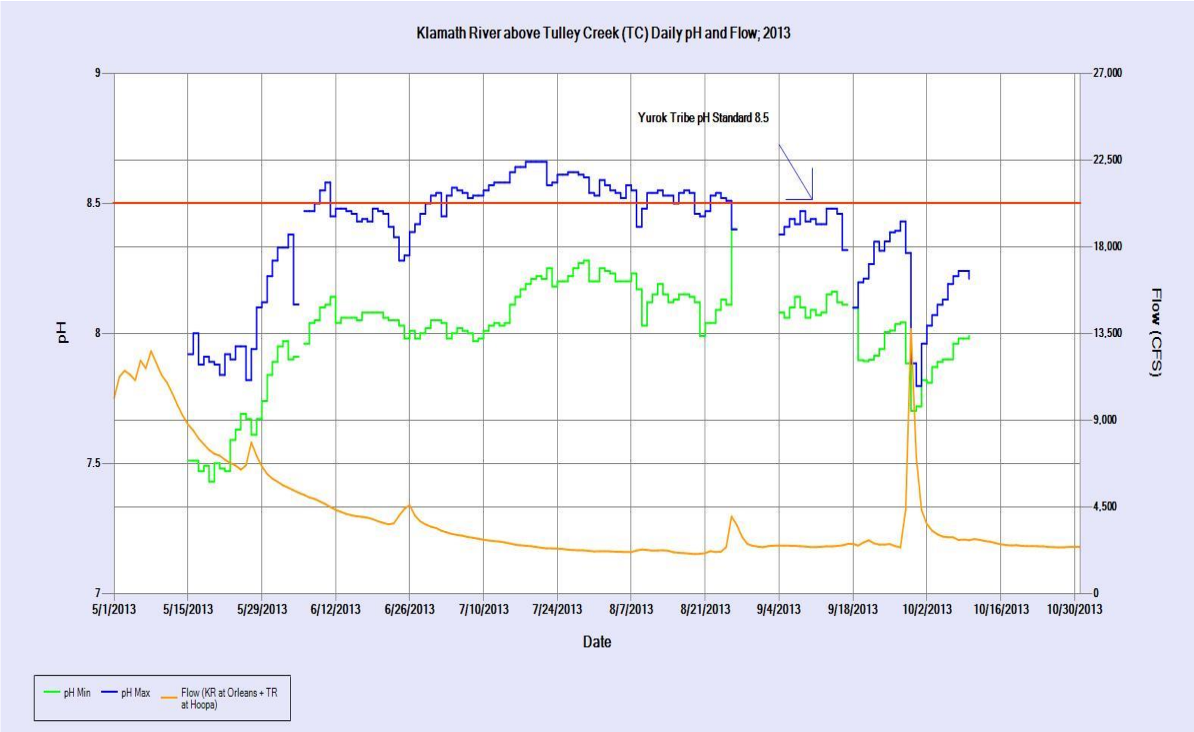

Figure 6-22. TC Maximum/minimum pH and Flow: 2013

Klamath River at Weitchpec (WE)

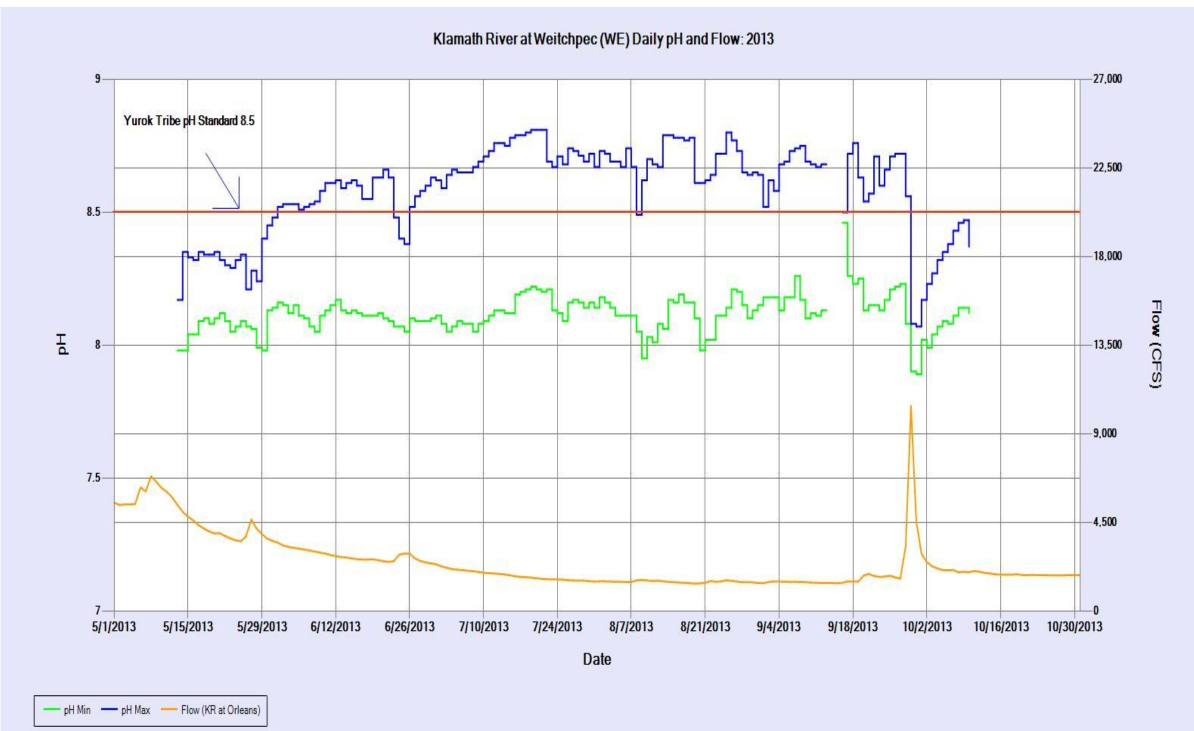

Figure 6-23. WE Maximum/minimum pH and Flow: 2013

Trinity River near Mouth (TR)

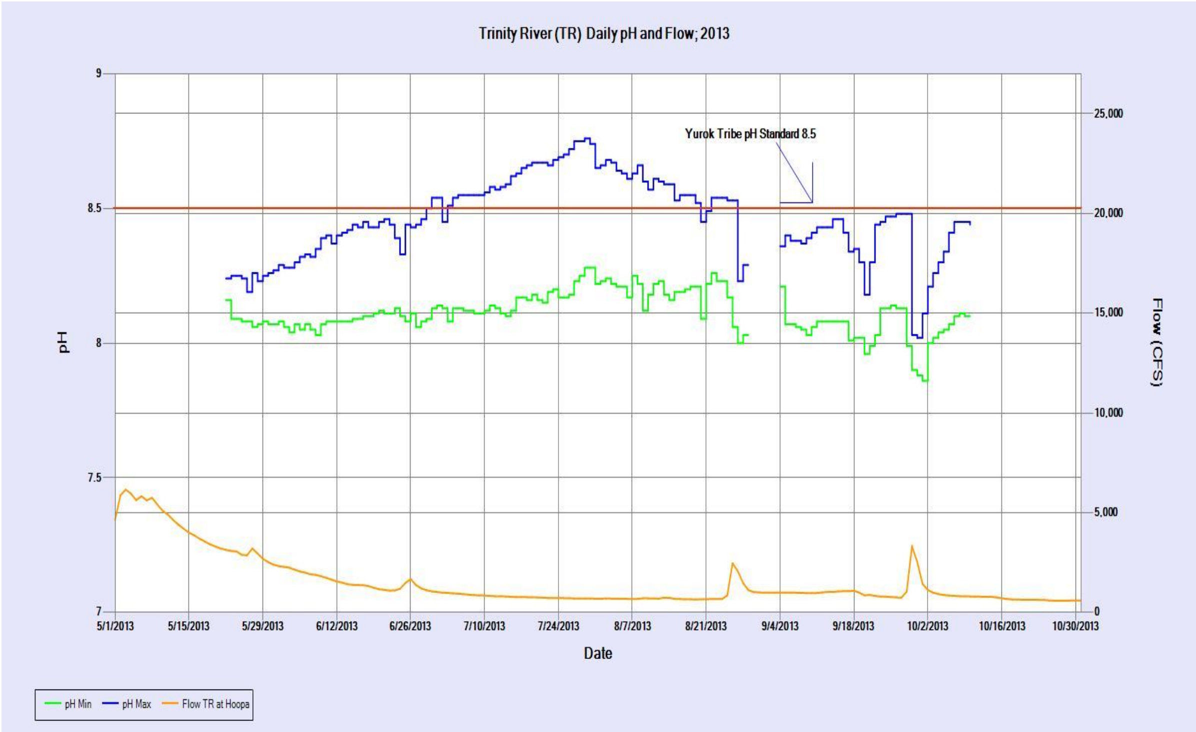

Figure 6-24. TR Maximum/minimum pH and Flow: 2013

Specific Conductivity

All Riverine Sites

Specific conductivity measures how well an aqueous solution can pass an electric current, which increases with the quantity of dissolved ionic substances in the water column, thus another method to determine the level of dissolved substances present. Specific conductivity is measured in microsiemens per centimeter.

Specific conductivity varied greatly at all sites during the 2013 monitoring season. The highest specific conductivity recorded was 197 µS/cm at WE on July 10, while the lowest specific conductivity recorded was 89µS/cm at WE on October 1. At no time did specific conductivity levels exceed the Yurok Tribe's specific conductivity standard, which states that levels shall have a 90% upper limit of 300 µS/cm at 25 ºC, and a 50% upper limit of 200 µS/cm at 25ºC.

Daily maxima and minima were disregarded when more than five measurements were missing from a 24-hour period and when the daily maximum or minimum was expected to occur during the gap. Gaps in data may occur during service or due to instrument malfunction or vandalism. Continuous specific conductivity data from the Lower Klamath and Trinity River is available from YTEP upon request.

Klamath River above Turwar (KAT)

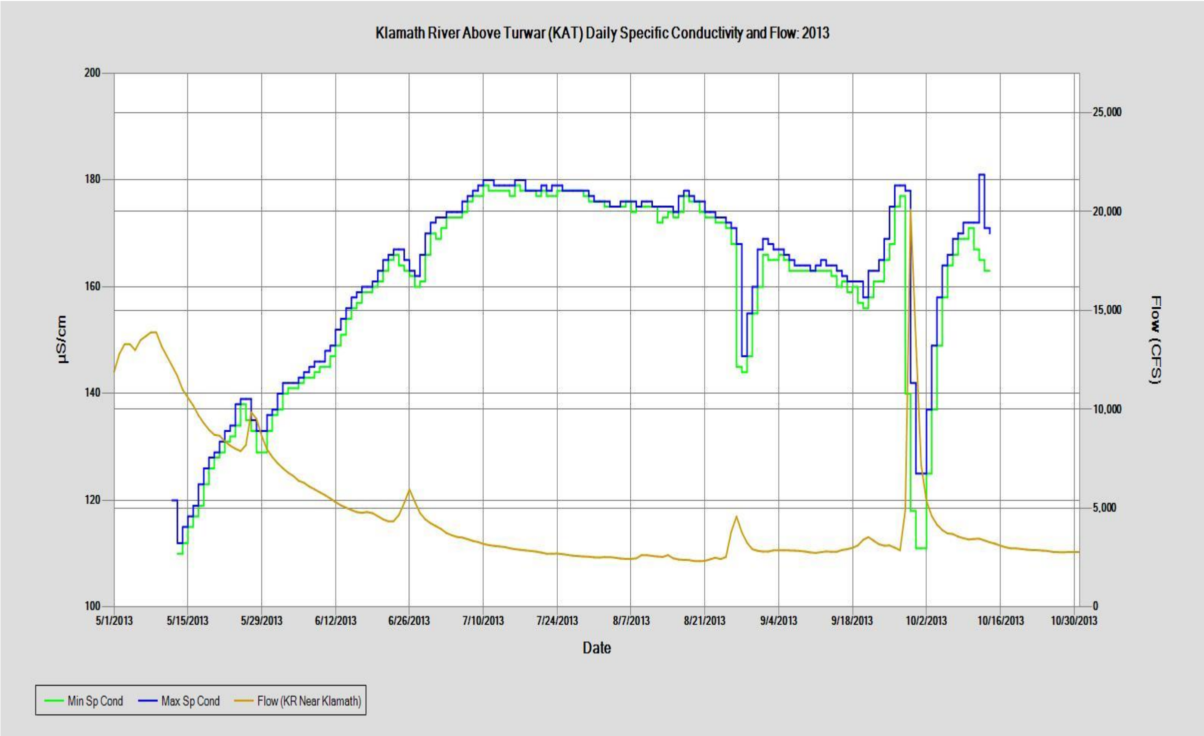

Figure 6-25. KAT Maximum/minimum Specific Conductivity and Flow: 2013

Klamath River above Tully Creek (TC)

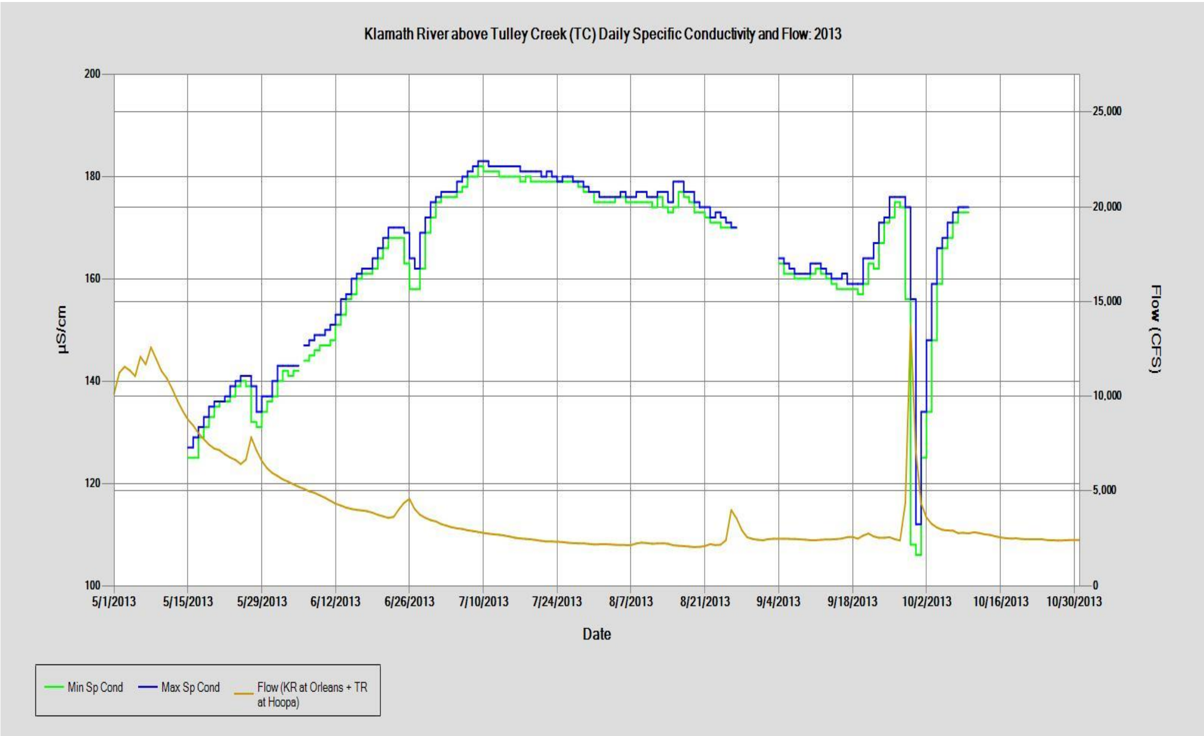

Figure 6-26. TC Maximum/minimum Specific Conductivity and Flow: 2013

Klamath River at Weitchpec (WE)

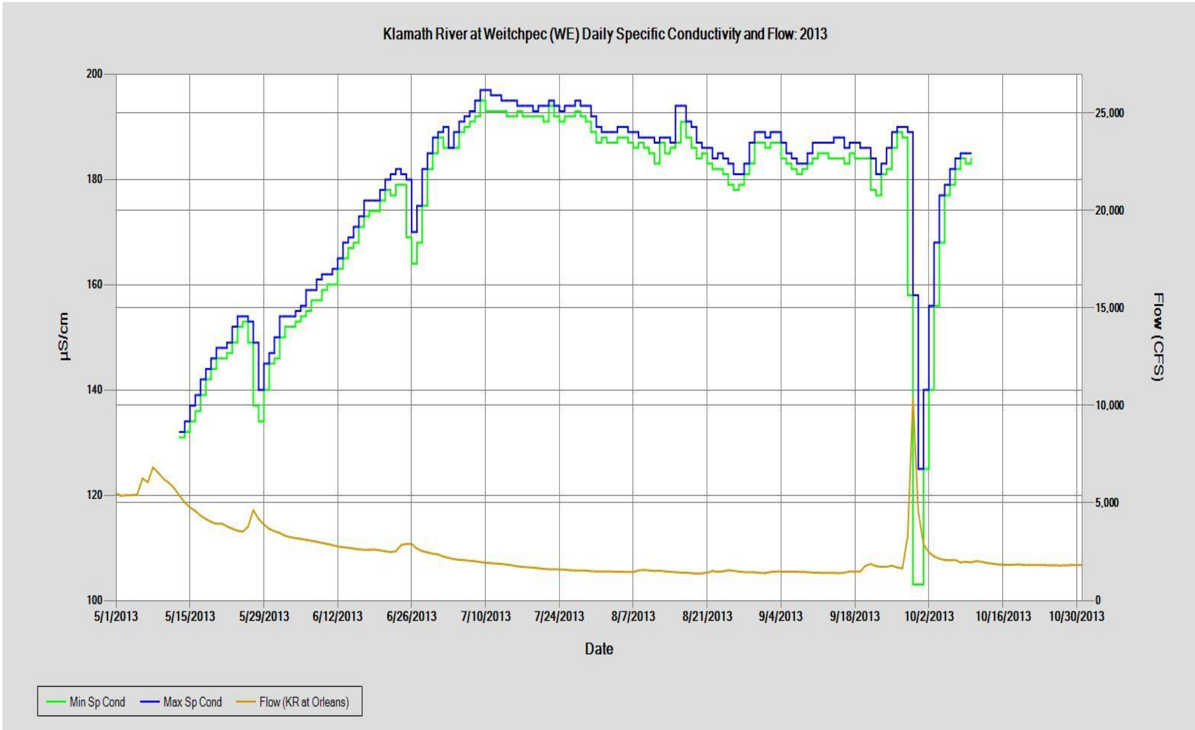

Figure 6-27. WE Maximum/minimum Specific Conductivity and Flow: 2013

Trinity River near Mouth (TR)

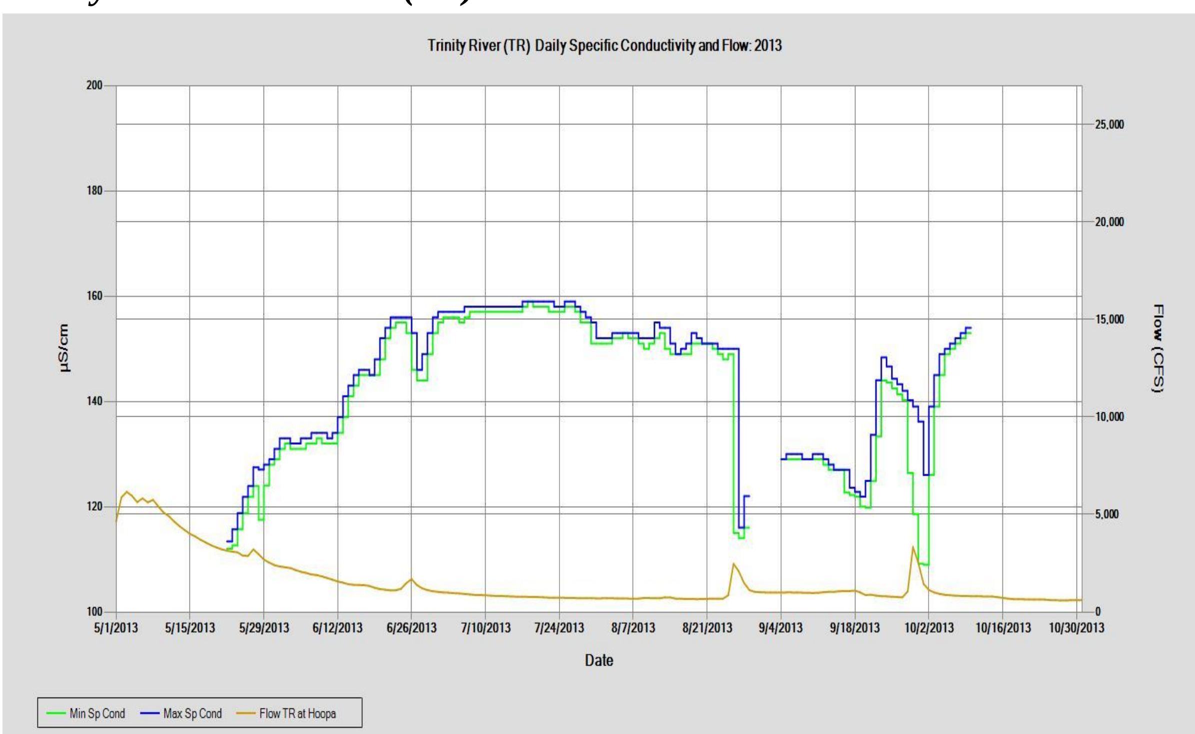

Figure 6-28. TR Maximum/minimum Specific Conductivity and Flow: 2013

Blue-Green Algae (Phycocyanin)

All Riverine Sites

The Blue-Green Algae (BGA) probe is an optical probe that uses “in-vivo" fluorometry (IVF) to measure the fluorescence to detect the phycobilin pigments called phycocyanin that are found in the living cells of blue-green algae (a.k.a. cyanobacteria). The blue-green algae sensors do not provide quantitative pigment concentration data, but rather supply relative data on the biomass of blue-green algae. IVF data can be correlated to quantitative data in order to calibrate the IVF data to provide concentration estimates.

The BGA probe readings varied at all sites from early September to the end of the monitoring season. The minimum BGA reading from the Phycocyanin probe was -2,948 cells/mL at KAT on August 13. The highest BGA reading of the 2013 monitoring season was 8,065 cells/mL which occurred at WE on August 16.

Without correlation, IVF provides a relative cyanobacteria measure that can be used to track trends and trigger more specific tests. YTEP determines the relationship between the IVF readings of the phycocyanin probe by taking open composite grab samples at the same time at the same location as the data sonde. These composite grab samples are poured off into a Nalgene sample bottle with preservative, and shipped to Aquatic Analysts located in Washington. These samples are then graphed with the continuous data to show the general relationship between the probe readings and the lab results. These graphs indicate that when the phycocyanin probes read at elevated levels the lab results also show that *Microcystis aeruginosa* is present in the water column.

Klamath River above Turwar (KAT)

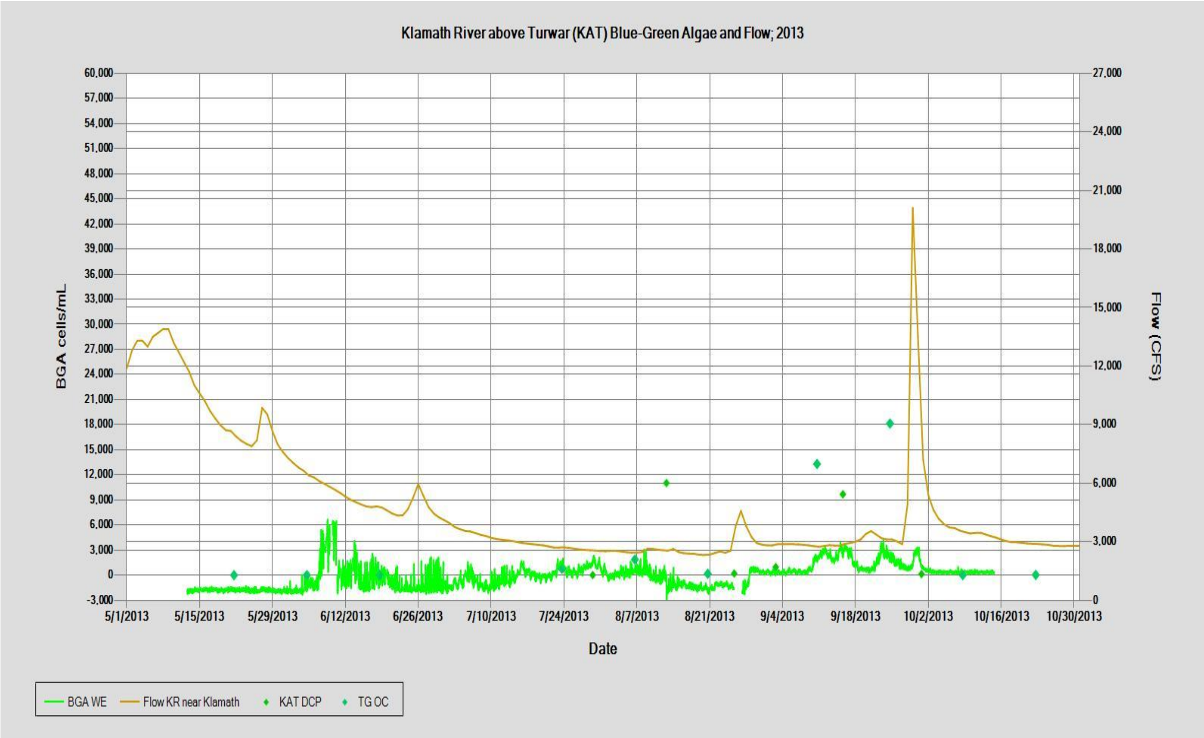

Figure 6-29. KAT BGA and Flow: 2013

Klamath River above Tully Creek (TC)

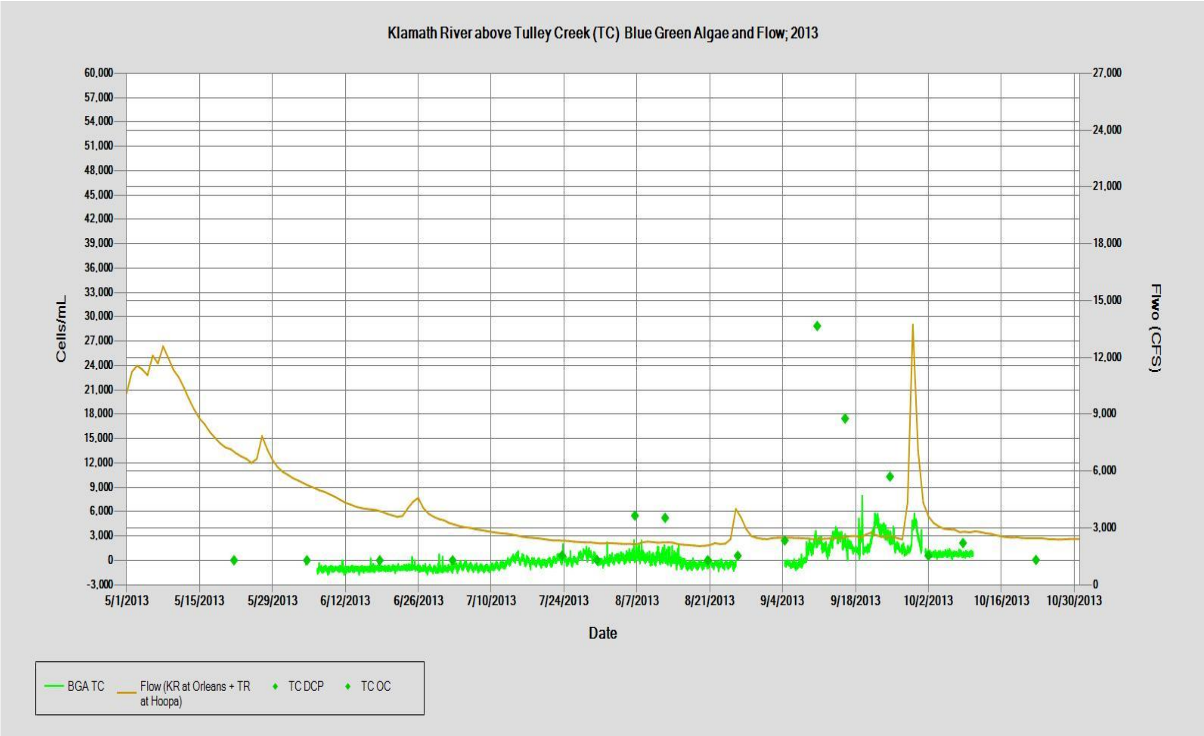

Figure 6-30. TC BGA and Flow: 2013

Klamath River at Weitchpec (WE)

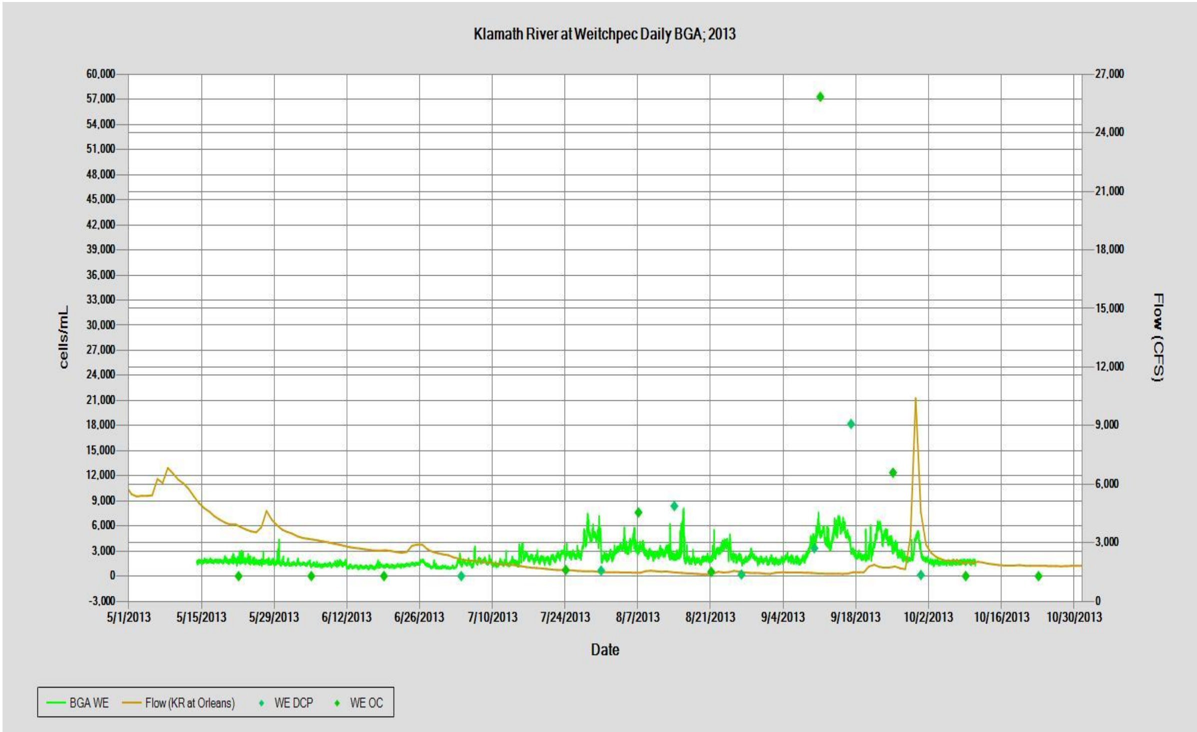

Figure 6-31. WE BGA and Flow: 2013

VII. Discussion

Temperature

All Riverine Sites

After initial deployment in mid-May, all sites experienced fluctuation for highest daily maximum water temperatures. A strong correlation between all sites was observed at the end of May through the first quarter of June. (Figure 7-1). The highest temperatures of the year were recorded at TR during the month of July, with a maximum temperature of 26.36°C. From May until August, TR held the highest monthly average temperature; KAT had the lowest monthly average temperature during that time period. A rapid decrease in temperature was observed among all sites beginning Mid-September. From late September into the beginning of October the highest temperatures were variable among sites. From early October until extraction in early November, highest daily maximum temperatures were recorded at KAT. There was only one significant rain event that effected temperatures among all sites occurring late September.

Daily average flow was graphed with water temperature to illustrate how water temperatures may have been affected by volume of water present in the river at any given time. These graphs are shown in Section VI. Flow discharge data used to generate these graphs was downloaded from the USGS website.

Klamath River above Turwar (KAT)

Minimal rain events occurred during the period of data logging. Sporadic precipitation was noted during the latter part of June with accumulation of less than an inch throughout; thus, not affecting water temperature. The most significant rainfall occurred at the end of September. This rain event seems to have decreased maximum water temperature at KAT gradually until extraction mid-October. During the period leading up to the rain event in late September, maximum water temperature shows a pattern of declination beginning late August.

When compared to all sites, KAT had the lowest monthly average water temperature from May until August. A maximum water temperature of 24.42ºC was recorded on July 2nd. One month later on August 2nd maximum water temperature was 21.03 ºC, a difference of 3.39 ºC. Minimum water temperature occurred before extraction on October 15th with a recorded temperature of 12.99 ºC.

Klamath River above Tully Creek (TC)

From the time of deployment in mid-May through the end of May, average daily minimum and maximum temperature fluctuated within 1ºC of each other. The beginning of June brought an increase of approximately 2ºC in both minimum and maximum temperatures at TC. TC experienced site maximum temperatures throughout the month of July with a minimum temperature of 22.00ºC and a maximum temperature of 25.92 ºC.

Minimal rain events occurred between the time of sonde deployment and extraction. One notable rain event occurring in late-September appears to have decreased maximum temperature for TC by 2.105 ºC. (Figures 6-4 and 6-5). During the time leading up to the rain event in late September, maximum water temperature showed a gradual decrease.

The pulse flow from Lewiston Dam on the Trinity River in late-August appears to have influenced the maximum water temperature at TC (Figures 6-1 and 6-2). After the pulse flow, a maximum water temperature of 20.112ºC was recorded on September 5th which showed a reduction of 3.451ºC in the maximum temperature from August 20th.

Klamath River at Weitchpec (WE)

Upon sonde deployment in mid-May temperatures increased gradually until July. WE experienced rapid maximum temperature change at the end of June, beginning of July. On June 26th an average daily maximum temperature of 18.283ºC was recorded; on July 3rd, only one week later, the average daily maximum temperature was recorded at 25.162ºC, a change of 6.879ºC. WE experienced site maximum temperatures throughout the month of July with a gradual decline in temperature beginning July 31st.

During the reporting period there was only one significant rain event late September. Temperatures leading up to the September rain event show a gradual decline consistent with temperature decline from all sites. On September 29th, during the rain event, the daily average temperature was reduced to 14.403ºC, a reduction of 1.634ºC from the day before (Figures 6-8 and 6-9). Temperatures showed a continued gradual decline from that point until extraction. WE minimum temperature of the season was 12.81ºC on October 10th.

Trinity River near Mouth (TR)

Of all the sites during this reporting period, TR had several events occur that affected water temperature. The temperatures, both minimum and maximum daily averages, show a steady incline from time of deployment in late-May until the first of July. TR experienced the maximum temperature for all sites on July 3rd with a temperature of 26.36ºC. Minimum and maximum temperatures averaged 22-25ºC through the month of July with a steady decline beginning August 1st.

There were two flow releases from Lewiston Dam this year. The first flow release occurred before sonde deployment in late April and continued through the beginning of May. The second release was a pulse flow on August 25th which resulted in a rapid reduction of daily average temperatures at TR by 2.399 ºC on August 28th.

During the time of deployment in May until extraction mid-October, there was only one signification rain event occurring in late September. Prior to the September rain event, daily maximum temperatures show a steady decline. The rain events impact on daily maximum water temperature at TR was minimal (Figures 6-10 and 6-11).

Impacts of the Trinity River on Water Temperature in the Klamath River

During the 2013 monitoring season, the Trinity River had a variable effect on water temperature in the Klamath River. From early May to August, it appears that the Trinity River had minimal effect on the Klamath River, with daily maximum temperature at TC slightly lower than at WE (Figure 7-2). This cooling effect was less than 0.5ºC for the majority of this time period. From the beginning of August until late-August, the Trinity River had higher daily maximum temperatures than WE; thus having no cooling effect on the Klamath River. Daily maximum temperature at TC for this time period was usually slightly lower than at WE. This temperature difference could be contributed to the variance in sunlight received by TC compared to WE. Of the two sites, WE receives the most daily sunlight due to the lack of sunlight obstruction at the site; whereas TC is mostly shaded by the mountain until late morning. Again, this cooling effect was less than 0.5ºC for most of this time period.

From late-August to mid-September, the Trinity River had a significant cooling effect, averaging around 1ºC, on the Klamath River. Prior to datasonde extraction in early November, the Trinity River again did not have a cooling influence on the Klamath River.

The pulse flow from Lewiston Dam in late August appears to have caused a short-term reduction in water temperature in the Klamath River below the Trinity River confluence. After the pulse flow, water temperature at both KAT and TC was reduced by several degrees for a short period of time (Figures 6-1 and 6-4). Temperature at WE was also reduced, but the difference between the daily max temperature of WE and TC substantially increased from about 0.5 ºC to 1.0 ºC. Temperature at the WE site was reduced around this time, consistent with gradual decline.

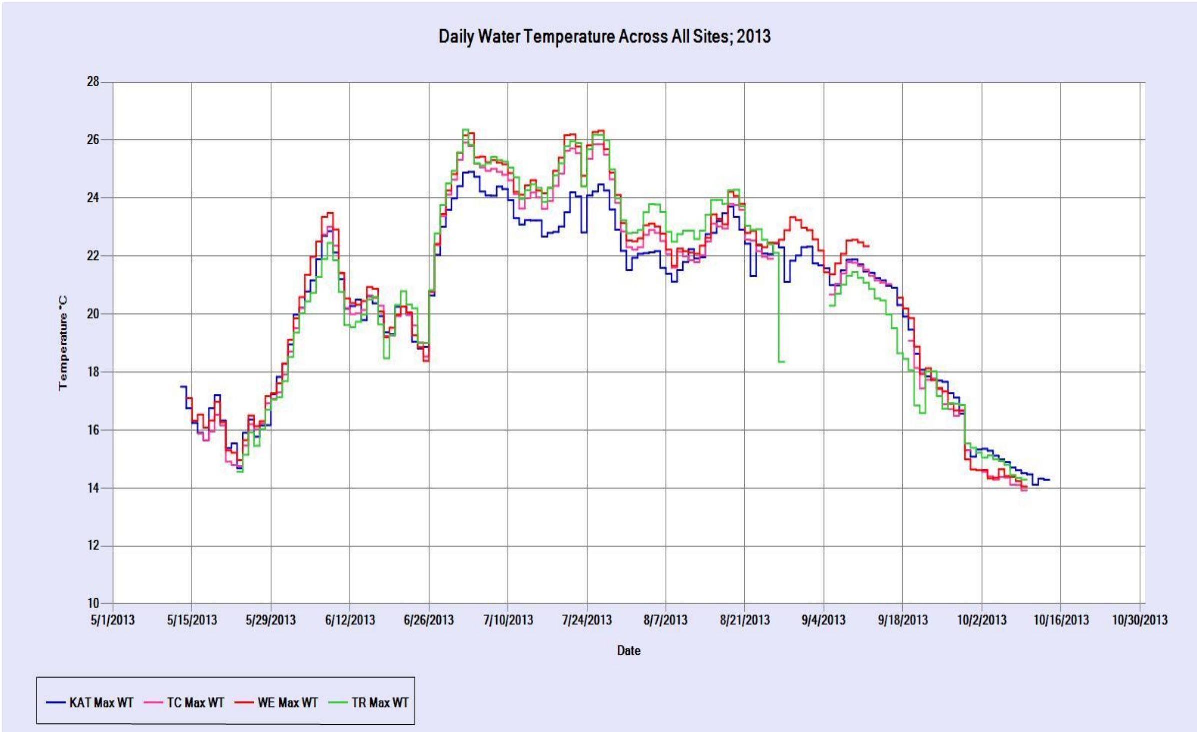

Figure 7-1.Daily Maximum Temperature Across All Sites: 2013

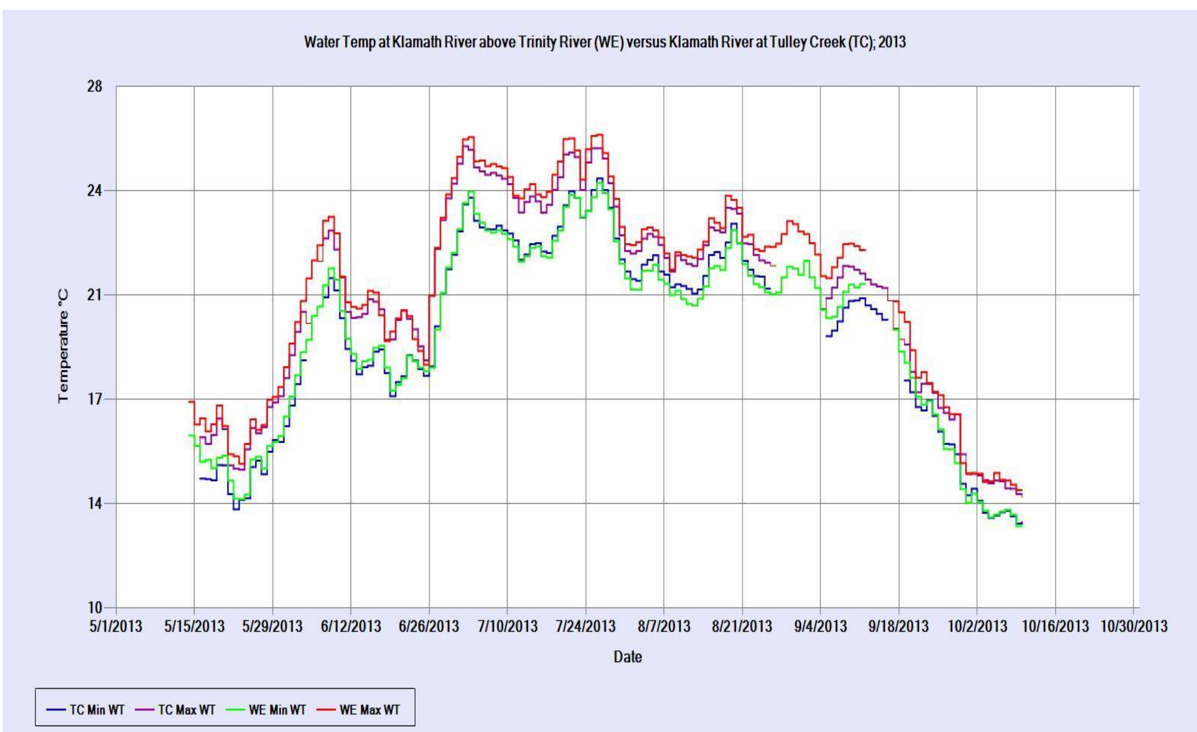

Figure 7-2.WE vs. TC Water Temperature: 2013

Dissolved Oxygen (DO)

All Riverine Sites

Throughout the 2013 monitoring season TR consistently showed the highest minimum dissolved oxygen concentrations (7-3). Exceptions to this occurred from late May to mid-June when WE recorded the highest minimum concentration. During the beginning of June through the end of July, sites WE, TC and KAT minimum DO concentrations had gradually declined. TR stabilized mid-June with variance of ±2%; this pattern of stability continued through the month of August. Data received indicates WE's minimum concentration dropped mid-August, while the other sites continued to correlate. WE site resumed concentration pattern relative to readings prior to the dramatic decline mid-August.

In the DO graphs shown in Section VI, daily average flow was graphed with DO to illustrate how DO concentrations may have been affected by volume of water present in the river at that time. Flow discharge data used to generate these graphs was downloaded from the USGS website. These graphs provide additional information when trying to determine the impact flow has on DO concentrations.

Klamath River above Turwar (KAT)

Minimal rain events occurred during the 2013 reporting period. During the latter part of June, sporadic precipitation was noted with accumulation of less than an inch throughout; briefly affecting minimum DO concentrations. The most significant rain event of the year occurred at the end of September. Beginning in mid-September, prior to the rain event in late September, minimum dissolved oxygen concentrations at KAT were gradually increasing. During the September rain event, minimum DO concentrations at KAT were briefly increased.

When compared to all sites, KAT had the lowest minimum dissolved oxygen concentrations from May until August. From the beginning of August until mid-August, WE had the lowest minimum dissolved oxygen concentration of all sites. KAT and WE showed similar minimum concentrations from mid-August until October. Concentrations were the lowest for the year on August 21 at 7.51 mg/L. Maximum DO concentration of 10.96 mg/L was recorded just before extraction mid-October. Beginning October 3rd through extraction, KAT had the lowest minimum concentrations of all the sites.

Pulse flow from the Lewiston Dam to the Trinity River at the end of August did not seem to affect minimum dissolved oxygen concentrations at KAT. After comparing concentrations prior to the pulse flow release to the concentrations after the release, the DO continued a steady diurnal rhythm.

Klamath River above Tully Creek (TC)

There were complications in data logging due to equipment malfunction from the time of deployment in mid-May until the beginning of June. Usable data for the TC site is available beginning June 7th through extraction mid-October. Dissolved oxygen concentration summary for TC will be compared to all other sites during the available reporting period only.

From the time of deployment at the beginning of June until the end of July dissolved oxygen concentration for TC were extremely similar to KAT and WE sites. From the time of deployment until mid-June minimum dissolved oxygen concentrations fluctuate within 1 mg/L daily; minimum concentrations peaked at 9.11 mg/L on June 20th. At the end of June, minimum dissolved oxygen concentrations at TC began to steadily decrease. 7.45 mg/L, the lowest minimum DO concentration for this site for the reporting year, was recorded at the end of July. Minimum dissolved oxygen concentrations seemed to increase gradually at the end of August, which could have resulted from the pulse flow release from Lewiston Dam on August 25th. Data was not available from August 28th through September 4th due to datasonde being out of water; however, data collection was resumed on September 5th. From September 5th through extraction, minimum DO concentrations gradually increased following diurnal rhythm.

Steady precipitation and increased flow were observed during sonde calibration on June 26th; however, this rain event did not affect minimum DO concentrations. There was only one significant rain event during the reporting period for 2013 where elevated minimum dissolved oxygen concentrations were observed which occurred late September. Prior to the September rain event, minimum DO concentrations were 9.35 mg/L; after the rain event minimum DO concentrations were recorded at 10.12 mg/L. DO concentrations increased gradually until extraction; however, the highest maximum DO concentration for this site during the reporting period occurred on October 11th with a reading of 10.83 mg/L.

Klamath River at Weitchpec (WE)

Shortly after deployment in mid-May, on May 19th, minimum DO concentrations were recorded at 10.19 mg/L; one month later on June 19th, minimum DO concentrations had decreased 1.38 mg/L to 8.81 mg/L. Intermittent precipitation and increased algae were observed during on site sonde calibration on June 26th; however, this rain event did not affect minimum DO concentrations. Biofouling on probes was also observed during site sonde calibration pre-clean.

Minimum DO concentrations continued to gradually decrease consistent with TR and TC sites through July. At the beginning of August, data for the minimum dissolved oxygen levels show a dramatic decrease from 7.553 mg/L to 5.307 mg/L; this data is inconclusive and is attributed to equipment malfunction.

During mid-August until mid-September, minimum DO concentrations fluctuated from 7.41 mg/L to 8.5 mg/L; a difference of 1.09 mg/L. In late September, one substantial rain event occurred, resulting in an increase in minimum dissolved oxygen concentrations of 1 mg/L. The day prior to extraction, October 10th, recorded the highest site maximum dissolved oxygen concentration of 11.03 mg/L.

WE did not seem to be impacted by the pulse flow released from Lewiston Dam to the Trinity River on August 25th.

Trinity River near Mouth (TR)

Minimum dissolved oxygen concentrations upon deployment in late-May were recorded ≥10 mg/L. A gradual decrease in minimum DO concentrations is observed with a season low of 7.79 mg/L in late July, two months after deployment. The beginning of August recorded variable increases in minimum DO concentrations. From the middle of June until extraction, TR maintained the highest minimum DO concentrations of all the sites. Data was unavailable August 29-September 5 resulting from loss of power due to equipment malfunction.

Minimal rain events occurred during the 2013 reporting period. During the latter part of June, sporadic precipitation was noted with accumulation of less than an inch throughout; briefly affecting minimum DO concentrations. The most significant rain event of the year occurred at the end of September. Beginning in mid-September, prior to the rain event in late September, minimum dissolved oxygen concentrations at TR were increasing gradually. During the September rain event, minimum DO concentrations at TR were briefly increased.

The pulse flow from Lewiston Dam in late-August appears to have briefly influenced minimum DO concentrations at TR. (Figures 6-19 and 6-20). Leading up to the pulse flow in late August, minimum DO was steadily increasing. On August 28th, however, minimum DO was 9.28 mg/L, an increase of 0.9 mg/L from August 25th. TR continued to show a gradual increase in minimum DO concentrations until extraction mid-October.

Impacts of the Trinity River on Dissolved Oxygen in the Klamath River

During the 2013 monitoring season it appears that the Trinity River had effect on DO concentrations in the Klamath River. The effect of TR on TC seems to have no effect from May through the end of July. Beginning late July through the end of September TC consistently had slightly higher minimum and maximum DO concentrations. (Figure 7-4). The pulse flow from Lewiston at the end of August appeared to have increased DO concentrations at TC. At the time the pulse flow reached TC Daily minimum and maximum DO concentrations at TC showed a more dramatic increase than the upward trend that occurred at WE. (Figure 6-15 and 6-16).

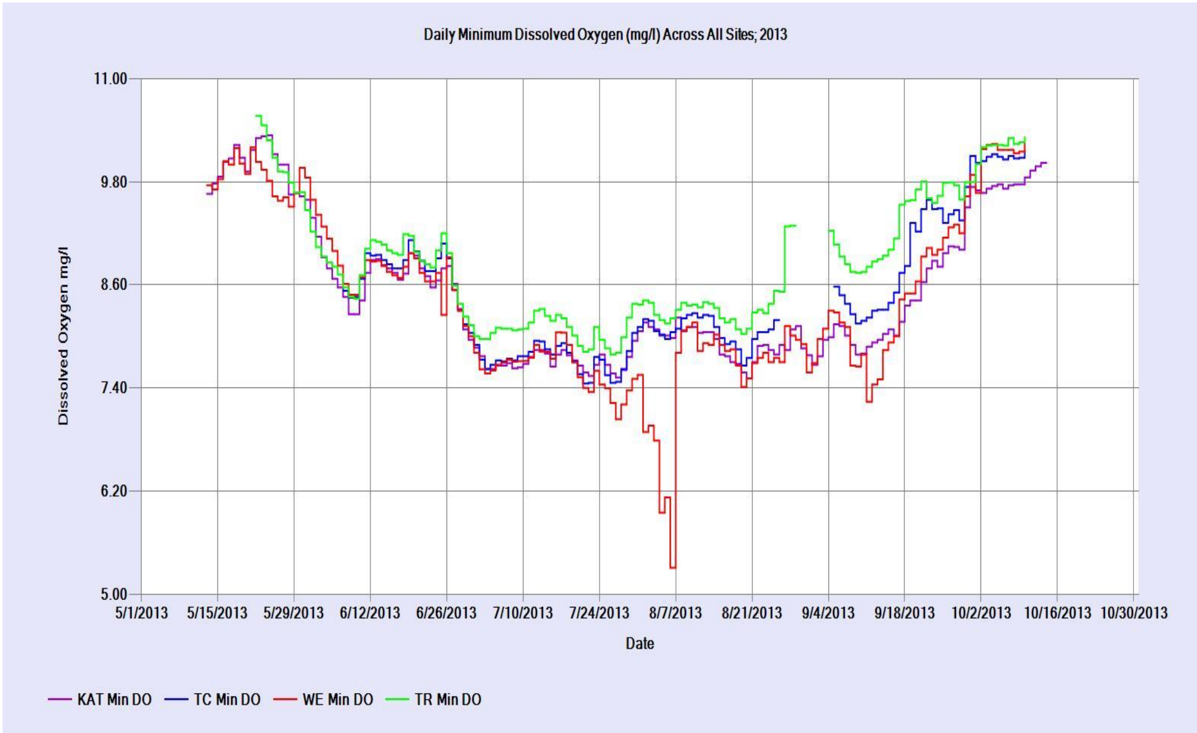

Figure 7-3.Daily Minimum Dissolved Oxygen Across All Sites: 2013

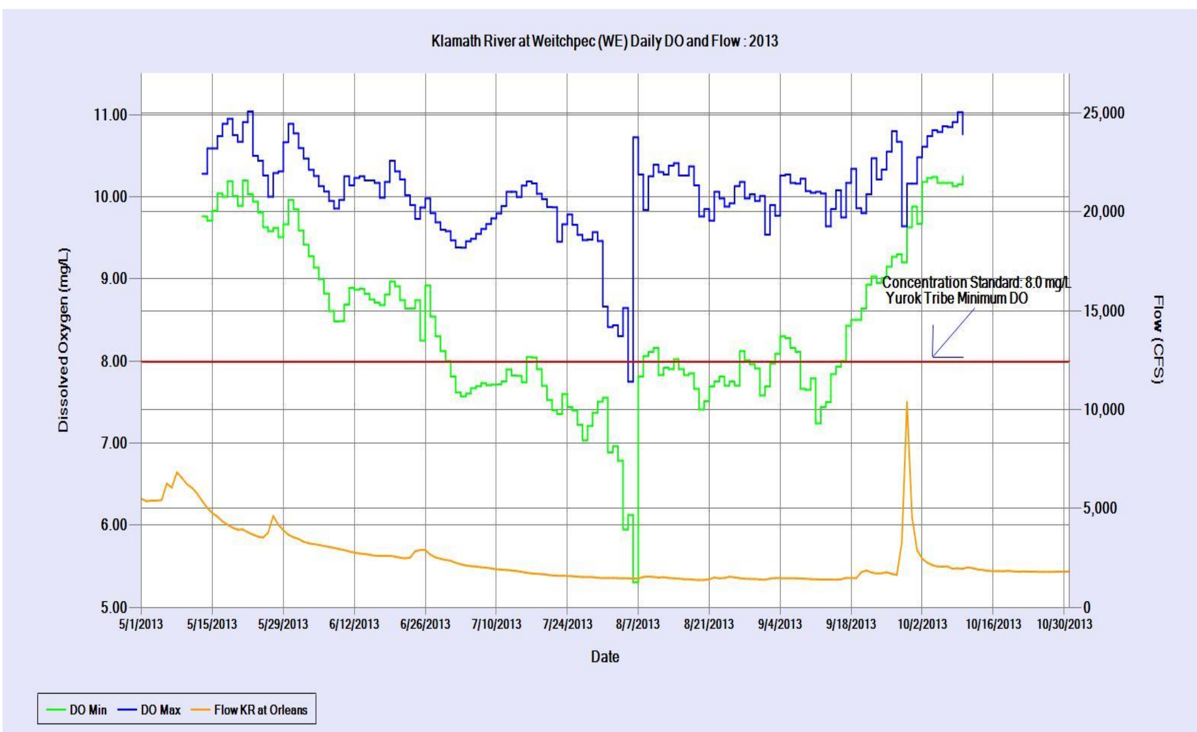

Figure 7-4.WE vs. TC Dissolved Oxygen: 2013

pH

All Riverine Sites

Throughout a majority of the 2013 monitoring season, WE had the highest maximum pH values of all sites (Figure 7-5). The exception to this was a period from late July to the beginning August in which TR had the highest maximum pH values. From mid-October until the end of the monitoring, pH concentration at TR again exceeded WE for a few intermittent days.

In the pH graphs shown in Section VI, daily average flow was graphed with pH to illustrate how pH values may have been affected by volume of water present in the river at that time. Flow discharge data used to generate these graphs was downloaded from the USGS website. These graphs provide additional information when trying to determine the impact flow has on pH.

Klamath River above Turwar (KAT)

Rain events seem to have decreased daily maximum pH at KAT for short periods of time (Figure 6-21). During the latter part of June, sporadic precipitation was noted with accumulation of less than an inch in a 48 hour period; briefly decreasing pH. During the time leading up to the rain event in late June, pH was slightly increasing. On June 25, however, maximum pH was 8.31, a decrease of 0.21 from June 22. pH values leading up to the rain event in late September had a downward trend, this rain event, (Figure 6-21), reduced pH values substantially. During this rain event, flow increased approximately 17,000 cfs. After the rain event, on October 2nd, pH maximum was recorded as 7.88 which was a decrease of 0.7 from September 26th.

The pulse flow from Lewiston Dam in late August appears to have influenced maximum pH at KAT very minimally (Figure 6-21).

Klamath River above Tully Creek (TC)

Rain events seem to have decreased daily maximum pH at TC for short periods of time (Figure 6-22). During the time leading up to the rain event in late June, pH was slightly increasing. On June 25, however, maximum pH was 8.28, a decrease of 0.18 from June 22. Data was not available from August 28th through September 4th due to datasonde being out of water; however, data collection was resumed on September 5th. After data logging resumed, pH seemed to be fairly stable, fluctuating in a diurnal rhythm until the rain event late September.

TC pH values leading up to the rain event in late September were variable. During this rain event, flow increased approximately 11,000 CFS. After the rain event, on October 2nd, pH maximum was recorded as 7.96, which was a decrease of 0.42 from September 26th.

The pulse flow from Lewiston Dam in late August may have influenced maximum pH at TC very briefly; however, due to lack of data collection during that time period it is indiscernible (Figure 6-22).

Klamath River at Weitchpec (WE)

Rain events seem to have decreased daily maximum pH at WE for short periods of time (Figure 6-23). During the time leading up to the lite precipitation in late June, pH was slightly increasing. On June 25, however, maximum pH was 8.40, a decrease of 0.26 from June 22. From the latter part of June through the end of July, pH continued a gradual increasing trend. On July 23rd, maximum pH dropped to 8.69, a 0.12 difference from the day before.

WE pH values leading up to the rain event in late September were variable. During this rain event, flow increased approximately 8,700 CFS. After the rain event, on October 2nd, pH maximum was recorded as 8.17, which was a decrease of 0.54 from September 26th.

The pulse flow from Lewiston Dam to the Trinity River in late August did not seem to influence data collected at WE (Figure 6-22).

Trinity River near Mouth (TR)

Rain events seem to have decreased daily maximum pH at TR for short periods of time (Figure 6-24). During the time leading up to the minimal precipitation in late June, pH was slightly increasing. Moisture received affected maximum pH minimally. For example on June 25 maximum pH was 8.33, a decrease of 0.13 from June 22. From the latter part of June through the end of July, pH continued a gradual increasing trend. On July 30th, maximum pH peaked at 8.76. After July 30th, pH began gradually decreasing.

pH values leading up to the rain event in late September were variable. During this rain event, flow increased approximately 2,800 CFS. After the rain event, on October 2nd, pH maximum was recorded as 8.11, which was a decrease of 0.36 from September 26th.

The pulse flow from Lewiston Dam in late August also appears to have briefly influenced pH at TR (Figure 6-24). Leading up to the pulse flow in late August, maximum pH was variable. On August 29, however, maximum pH was 8.29, a reduction of 0.25 from August 24.

Impacts of the Trinity River on pH in the Klamath River

During the 2013 monitoring season, the Trinity River had a variable effect on pH in the Klamath River with no clear trend apparent of the impacts of the Trinity River on pH in the Klamath River (Figures 7-6 and 7-7). Daily maximum pH at TC was nearly always lower than daily maximum pH at WE throughout the 2013 monitoring season. The exception occurs in Late July and early August, when TR eclipsed WE as having the highest pH. This indicates there may be factors other than the influx of water from the Trinity River affecting pH in the Klamath River in the reach from the confluence of the Klamath and Trinity Rivers to the Klamath River above Tully Creek.

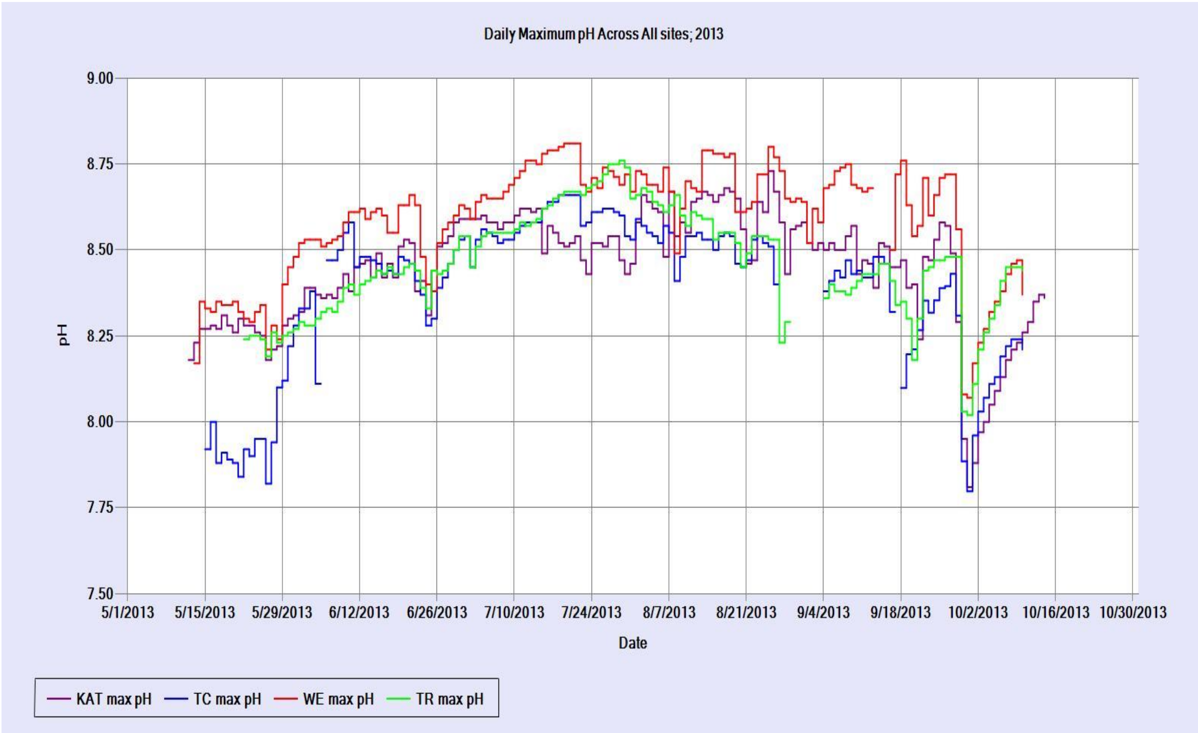

Figure 7-5. Daily Maximum pH Across All Sites: 2013

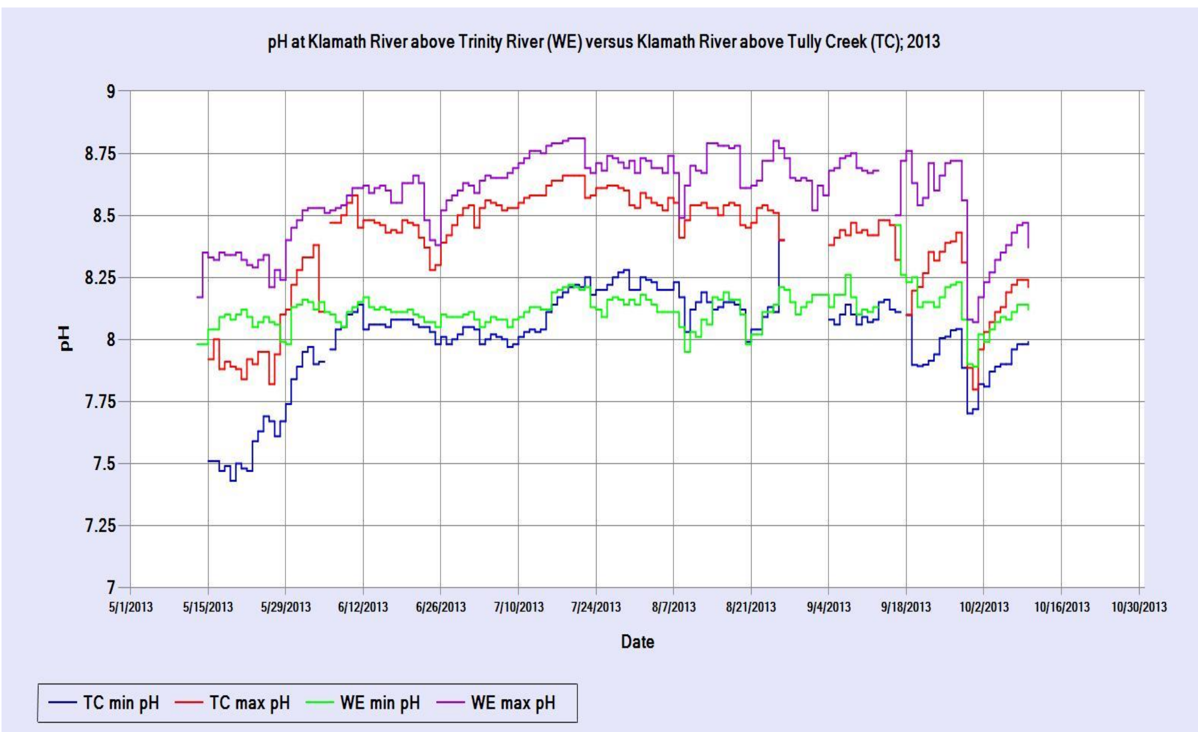

Figure 7-6. WE vs. TC pH: 2013

Specific Conductivity

All Riverine Sites

Throughout the monitoring season, the highest daily maximum specific conductivity occurred at WE and the lowest daily maximum specific conductivity occurred at TR (Figure 7-7); however, on October 1st, TR had the highest daily maximum specific conductivity and TC had the lowest daily maximum specific conductivity. Precipitation occurring during the latter part of both May and June seemed to decrease daily maximum specific conductivity at all sites. TR, KAT and TC maximum specific conductivity decreased at the end of August in response to pulse flow released from Lewiston Dam. All sites recorded decreased maximum specific conductivity at the end of September due to a significant rain event.

In the specific conductivity graphs shown in Section VI, daily average flow was graphed with specific conductivity to illustrate how specific conductivity may have been affected by volume of water present in the river at that time. Flow discharge data used to generate these graphs was downloaded from the USGS website. These graphs provide additional information when trying to determine the impact flow has on specific conductivity.

Klamath River above Turwar (KAT)

Rain events seem to have decreased daily maximum specific conductivity at KAT for short periods of time (Figure 6-25). During the time leading up to the precipitation in late May, specific conductivity was increasing. On May 30th, however, maximum specific conductivity was 133 µS/cm, a decrease of 6 µS/cm from May 27. Specific conductivity values leading up to the rain event in late June were increasing. This rain event was observed as steady yet lite precipitation over a period of a few days. On June 28th, KAT recorded maximum specific conductivity as 162 µS/cm, a reduction of 5 µS/cm from values recorded on June 25th. There was one substantial rain event during this monitoring period occurring late September through early October which resulted in dramatic decrease of maximum specific conductivity. After the rain event, on October 1st, maximum specific conductivity values were reduced to 125 µS/cm, a decrease of 53 µS/cm from September 29th.

The pulse flow from Lewiston Dam in late August also appears to have significantly reduced specific conductivity at KAT (Figure 6-25). Leading up to the pulse flow in mid-August, maximum specific conductivity was gradually decreasing. On August 29th, however, maximum specific conductivity dropped to 147 µS/cm, a reduction of 24 µS/cm from August 27th. Specific Conductivity values did not exceed 169 µS/cm until September 26th.

Klamath River above Tully Creek (TC)

Rain events seem to have decreased daily maximum specific conductivity at TC for short periods of time (Figure 6-26). During the time leading up to the precipitation in late May, specific conductivity was increasing. On May 30th, however, maximum specific conductivity was 137 µS/cm, a decrease of 4 µS/cm from May 27th. Specific conductivity values leading up to the rain event in late June were increasing. This rain event was observed as steady yet lite precipitation over a period of a few days. On June 28th, TC recorded maximum specific conductivity as 162 µS/cm, a reduction of 8 µS/cm from values recorded on June 25th. There was one substantial rain event during this monitoring period occurring late September through early October which resulted in dramatic decrease of maximum specific conductivity. After the rain event, on October 1st, maximum specific conductivity values were reduced to 112 µS/cm, a decrease of 64 µS/cm from September 28th.

The pulse flow from Lewiston Dam in late August also appears to have reduced specific conductivity at TC (Figure 6-26). Leading up to the pulse flow in mid-August, maximum specific conductivity was gradually decreasing. Unfortunately, during this period there is a gap in data collection due to equipment malfunction. On September 5th, however, maximum specific conductivity dropped to 164 µS/cm, a reduction of 6 µS/cm from August 27th. Specific Conductivity values did not exceed 167 µS/cm until September 24th.

Klamath River at Weitchpec (WE)

Throughout the monitoring season, WE recorded the highest daily maximum specific conductivity of all the sites with exception of two days at the beginning of October. On July 10th and 11th, WE maximum specific conductivity values peaked at 197 µS/cm.

Rain events seem to have decreased daily maximum specific conductivity at WE for short periods of time (Figure 6-27). During the time leading up to the precipitation in late May, specific conductivity was increasing. On May 29th, however, maximum specific conductivity was 140 µS/cm, a decrease of 13 µS/cm from May 27. Specific conductivity values leading up to the rain event in late June were increasing. This rain event was observed as steady yet lite precipitation over a period of a few days. On June 28th, WE recorded maximum specific conductivity as 175 µS/cm, a reduction of 6 µS/cm from values recorded on June 25th. There was one substantial rain event during this monitoring period occurring late September through early October which resulted in dramatic decrease of maximum specific conductivity. After the rain event, on October 1st, maximum specific conductivity values were reduced to 125 µS/cm, a decrease of 65 µS/cm from September 28th.

The pulse flow from Lewiston Dam in late August did not appear to have affected specific conductivity at WE (Figure 6-27). Leading up to the pulse flow in mid-August, maximum specific conductivity was generally decreasing. Maximum daily specific conductivity values were 183 µS/cm on August 26th and August 30th indicating no change due to pulse flow release on the Trinity River.

Trinity River near Mouth (TR)

Throughout the monitoring season, TR consistently recorded the lowest maximum daily specific conductivity values. July 26th and 27th, TR maximum specific conductivity peaked at 159 µS/cm.

Rain events seem to have decreased daily maximum specific conductivity at TR for short periods of time (Figure 6-26). During the time leading up to the precipitation in late May, specific conductivity was increasing. On May 30th, maximum specific conductivity was 128 µS/cm, an increase of 4.097 µS/cm from May 27th indicating that the May rain event did not affect maximum specific conductivity values.

Specific conductivity values leading up to the rain event in late June were increasing. This rain event was observed as steady yet lite precipitation over a period of a few days. On June 28th, TR recorded maximum specific conductivity as 146 µS/cm, a reduction of 10 µS/cm from values recorded on June 25th. There was one substantial rain event during this monitoring period occurring late September through early October which resulted in dramatic decrease of maximum specific conductivity. After the rain event, on October 2nd, maximum specific conductivity values were reduced to 126 µS/cm, a decrease of 18.298 µS/cm from September 26th.

The pulse flow from Lewiston Dam in late August also appears to have significantly reduced specific conductivity at TR (Figure 6-28). Leading up to the pulse flow in mid-August, maximum specific conductivity was gradually decreasing. On August 28th, however, maximum specific conductivity dropped to 116 µS/cm, a reduction of 34 µS/cm from August 27th. Specific Conductivity values did not exceed 130 µS/cm until September 22nd.

Impacts of the Trinity River on Specific Conductivity in the Klamath River

From the time of deployment until extraction, the Trinity River tended to decrease daily maximum specific conductivity in the Klamath River, with lower daily maximum and minimum specific conductivity values at TC than WE (Figure 7-8). In fact, for large portions of time daily minimum specific conductivity at TC was lower than daily maximum specific conductivity at WE during the monitoring period. This is especially prevalent during the release from Lewiston dam from August 25th to September 21st.

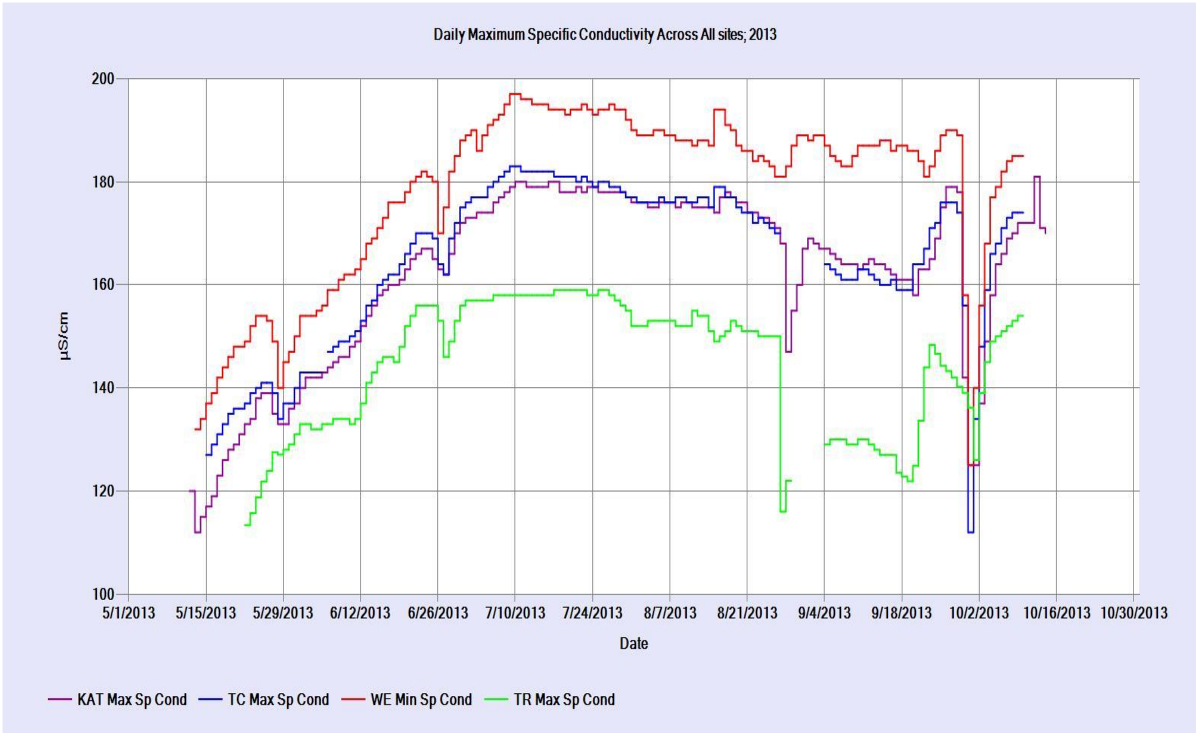

Figure 7-7. Daily Maximum Specific Conductivity Across All Site: 2013

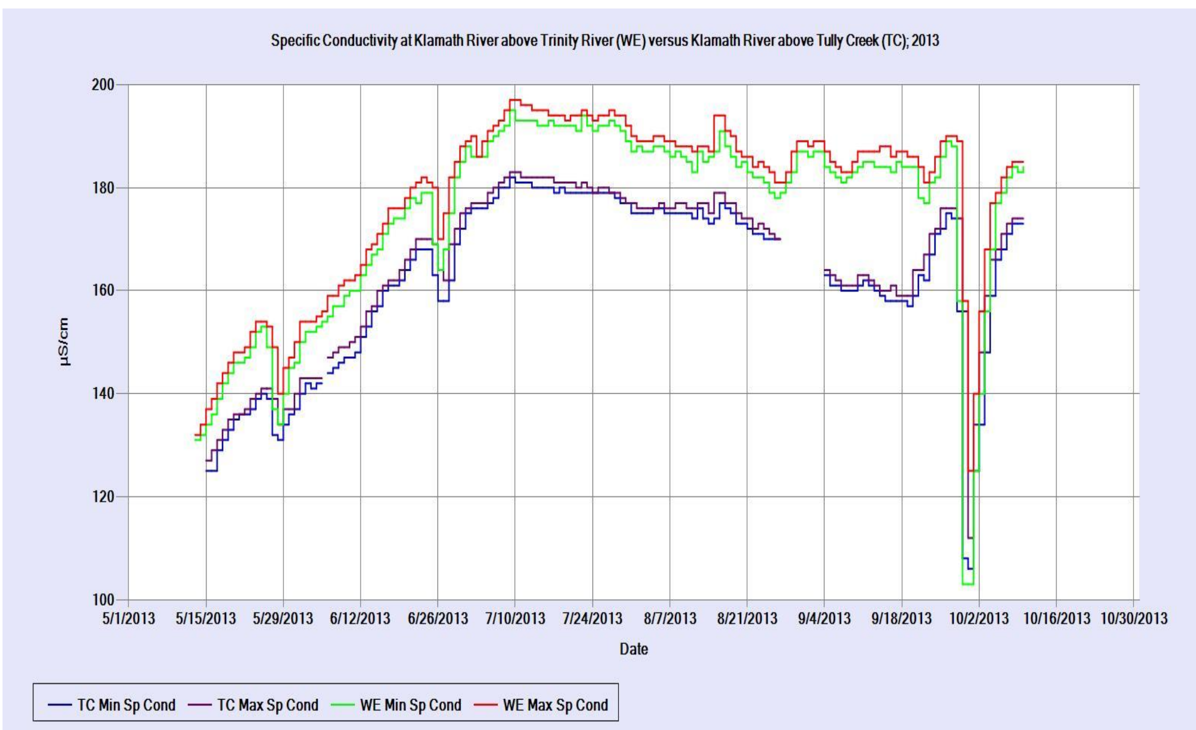

Figure 7-8. WE vs. TC Specific Conductivity: 2013

Blue-Green Algae (Phycocyanin)

All Riverine Sites

From early May to early July the concentration of BGA (BGA) in the Klamath River was minimal for TC and WE. In mid-June, at KAT, there was a small spike in BGA data that may be contributed to a sensor parking over the wiper. The biggest occurrence of Blue Green Algae being detected by the probes is in early to late September. All sites show similar trends for BGA. WE was the first site to show signs of BGA in the river along with having the highest concentrations of BGA on the YIR.

In the BGA graphs shown in Section VI, daily average flow was graphed with cells/mL to illustrate how Algae concentration may have been affected by volume of water present in the river at that time, along with how dam releases may have brought BGA downstream. Flow discharge data used to generate these graphs was downloaded from the USGS website. These graphs provide additional information when trying to determine the impact flow has on Algal concentrations.

Open water composite samples are taken at each of the sonde sites to validate the phycocyanin probes. These samples are collected using a 4L churn splitter, and samples are poured off into a bottle and shipped to a phycologist for identification and toxic algae numeration. These samples follow the same general trends as the phycocyanin probes at all sites. They show that the phycocyanin probes are inferior when reading high concentrations of BGA, greater than or equal to 5,000 cells/mL. From early May to early September the concentration of BGA (BGA) in the Klamath River was minimal among all sites. In early September, following a dam release from Iron Gate Dam, BGA levels in the Klamath began to rise at all sites (figures 6-29, 6-30, and 6-31). WE was the first site to show signs of BGA in the river for 2013, along with having the highest concentrations of BGA on the YIR.

In the BGA graphs shown in Section VI, daily average flow was graphed with cells/mL to illustrate how Algae concentration may have been affected by volume of water present in the river at that time, along with how dam releases may have brought BGA downstream. Flow discharge data used to generate these graphs was downloaded from the USGS website. These graphs provide additional information when trying to determine the impact flow has on Algal concentrations.

Open water composite samples are taken at each of the sonde sites to validate the phycocyanin probes. These samples are collected using a 4L churn splitter, and samples are poured off into a bottle and shipped to a phycologist for identification and toxic algae numeration. These samples follow the same general trends as the phycocyanin probes at all sites. They show that the phycocyanin probes are inferior when reading high concentrations of BGA, greater than or equal to 5,000 cells/mL.

Klamath River above Turwar (KAT)

Sufficient flow and temperature in the Klamath may have deterred BGA from being present in the river before early June. A small increase in BGA occurred in early June, but as was stated before the wiper may have been parking on the sensor, and this probe later failed in late August, which can be seen on the graph as a data gap. The other scenario is that there was presence of Blue Green Algae in the Lower Klamath early on, and a rain event in late June helped to dilute the concentration. A release from Lewiston Dam in early May also helped to dilute this concentration of BGA in the water column. An increase of BGA occurs in Mid-September, which correlates with numeration data from open composite grab samples. A significant rain event, totaling almost four inches on September 29 and 30th, helped flus the river of Blue-Green Algae in 2013.

Klamath River above Tully Creek (TC)

Sufficient flow and temperature in the Klamath may have deterred BGA from being present in the river before early August. A significant increase in BGA occurred in mid-September. A release from Lewiston Dam in early May and late August may have helped dilute the river and kept BGA numbers at a minimum. A major rain event in late September helped to flush the river of Blue-Green Algae and dilute any concentrations left in the river.

Klamath River at Weitchpec (WE)

Sufficient flow and temperature in the Klamath may have deterred BGA from being present in the river before late July. A small increase in BGA that correlates with a numeral count from an open composite grab sample occurs in mid-August. A significant increase in BGA occurred in mid-September. A release from Lewiston Dam in early May and late August may have helped dilute the river and kept BGA numbers at a minimum. A major rain event in late September helped to flush the river of Blue-Green Algae and dilute any concentrations left in the river.

Impacts of the Trinity River on Blue-Green Algae in the Klamath River

From Early May to Early September the Trinity River had no apparent effects on the concentrations of BGA in the Klamath River, as BGA was not present at elevated levels. From late July to Early October BGA levels at WE are consistently higher than BGA at TC or KAT. (Figure 7-9) Furthermore, the concentration gap between WE and TC closes as water stops coming from Lewiston Dam in late September (figure7-10). This can also be seen in the open composite samples that are on the graph.

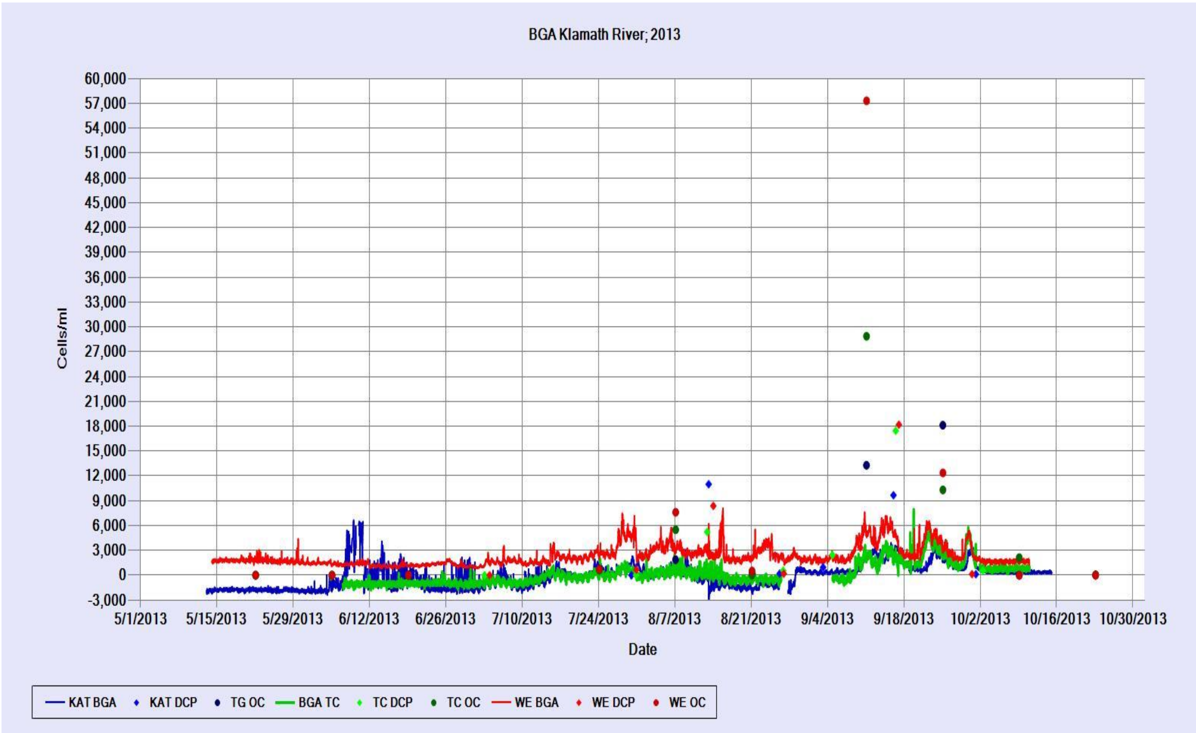

Figure 7-9. BGA across all sites: 2013

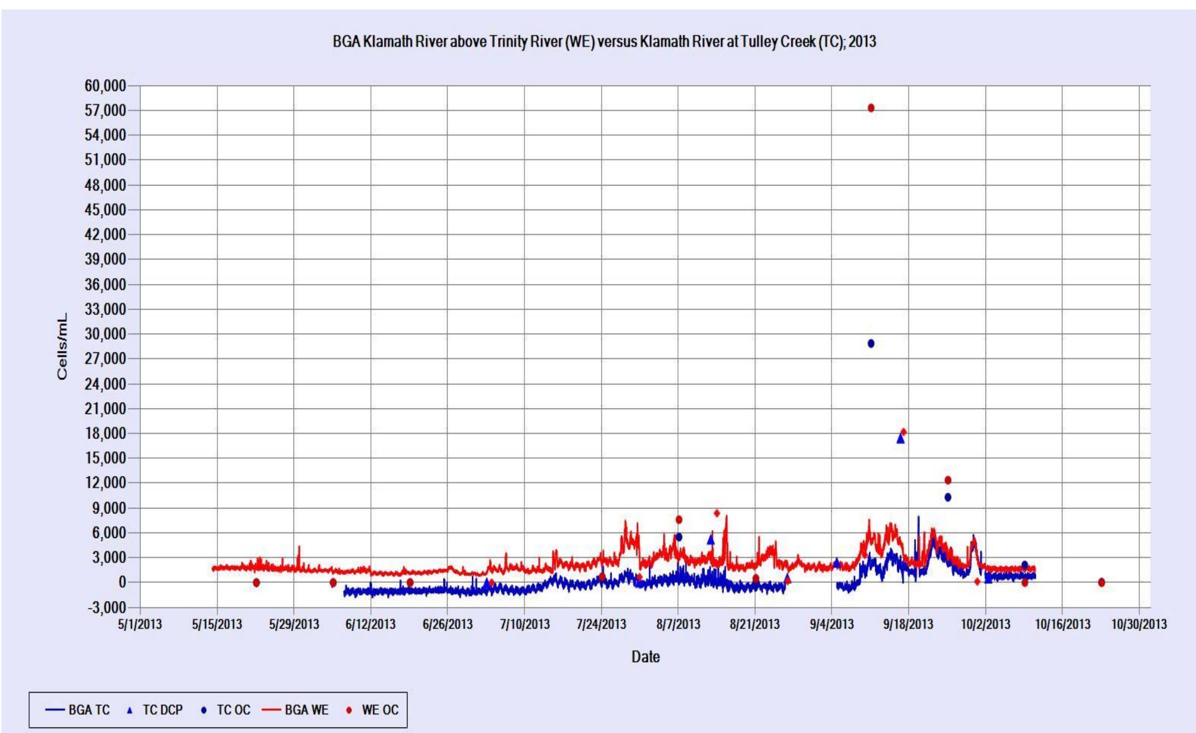

Figure 7-10. WE vs. TC BGA: 2013

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Appendix A: YSI Calibration SOP

Upon arrival at each monitoring site, numerous tasks must be performed to successfully meet the QA/QC protocol and service the Sonde. Properly filling out the calibration sheet is critical to collecting all the data that is needed for the evaluation of the sonde file. Here is an overview of a typical field tour consisting of extracting the sonde, performing scheduled maintenance and redeploying.

- Arrive on site: Record current barometric pressure and temperature using DeltaCal barometer at the site. Also record other environmental conditions, such as: weather, changing water levels, color of water, water clarity, etc on the datasheet. If at KAT or TC calibrate dissolved oxygen of reference sonde to current barometric pressure onsite.

- Audit the site sonde (datasonde that is dedicated to the site) by placing the reference sonde as close as possible to the lock box that contains the site sonde. As close to the half hour or top of the hour as possible (+/- 2 minutes), record the reference sonde water quality parameters on the datasheet. Remove the lock box containing the site sonde from the water no earlier than2 minutes after the 30 minute or top of the hour reading. Carefully remove the site sonde from the housing trying not to disturb any fouling on the probes. Inspect the probes and determine if the wiper was properly wiping all of the sensors and make any notes such as extreme biofouling was present or the probes were extremely silted in by sand.

- Fill insulated water jug with river water.

- Connect site sonde to hand held and put in run mode by going to the sonde menu, highlight **Run** and press ENTER, highlight **Discrete Sample** and press ENTER, highlight **Start Sampling** and press ENTER.

- Place the site sonde, reference sonde, and NIST thermistor in the water jug and record pre-cleaning readings after WQ parameters have stabilized (Temp, SpCond, DO %, DO mg/L, pH, BGA) of site sonde in addition to readings of reference sonde and NIST thermistor in bucket.

- Turn off the site sonde. Remove site sonde and thoroughly clean.

- Cleaning site sonde: **Note: only site sonde is cleaned during cleaning process**

- YSI Sonde cleaning Procedure is as follows:

- Remove sondegaurd
- Use an Alan head wrench to remove the wiper brush and the wiper on the BGA probe.
- Clean conductance probe with wire brush.
- To clean the probes carefully loosen any built up sediment or algae by brushing sides (**NOTMEMBRANE SURFACES**) with toothbrush. When completed, use squirt bottle with DI water to rinse surfaces of probes.
- Swipe the sides of the probes with a Q-tip moistened with alcohol. **DO NOT APPLY TO MEMBRANE SURFACES**
- Swipe membrane surfaces with Q-tip moistened with DI water.
- Rinse all surfaces once more with squirt bottle of DI water.
- Install wiper brush and wiper (with new wiper pads) back onto probes with the proper gap (width of Rite-In-The-Rain paper).
- Put sonde guard back on.

WHILE SOMEONE IS CLEANING THE SONDE THE OTHER CAN:

- Take the big brush and thoroughly clean the inside and outside of the sonde lock box and outside of conduit.

- Get new wiper brush from cleaning kit and apply new wiper pad. Apply new wiper pad to wiper.

- Clean the site sonde sensor guard with a toothbrush and Q-tips.

- Take a Q-tip and clean out the data line connection on the data line ensuring it is free of water and sand.

- Download data from logger.
  - **If you are at the KAT site you do not download data until USGS is present**

  - **If you are at the Weitchpec or Trinity River site then follow the attached SOP to download data off of the H-350 XL data logger using the compact flash card.**

  - **If you are at the TC site then follow the other SOP to swap linear flash cards from the H-350 data logger.**

After site sonde has been cleaned:

- Replace site sonde, reference sonde, and NIST thermistor in bucket and record post-clean readings of YSI site sonde and reference sonde in bucket after WQ parameters have stabilized.

- **Post calibrate site sonde DO probe:** Remove any water from the optical DO probe with Q-tip or Kim wipe **(careful not to push too hard on membrane)**. Wrap the wet towel over the sensor guard and entire datasonde to provide insulation. Place the entire sonde with wet towel into the DO calibration chamber (red jug with lid on) and make sure the sonde will not fall over.
- Go to the sonde main menu, highlight calibrate and press enter. Select **ODOsat %** and then **1-Point** to access the DO calibration procedure. Enter the current barometric pressure in **mm of Hg.** Press **Enter** and the current values of all enabled sensors will appear on the screen and change with time as they stabilize. Observe the readings under ODO mg/L. **After the DO stabilizes = shows no significant change for approximately 30 seconds, r**ecord the temp and the initial in DO mg/L and press **ENTER** to calibrate. The screen will indicate that the calibration has been accepted , record the Final DO in mg/L

- **Next: post calibrate the Specific Conductivity Probe**
- Rinse probes two times with DI water.
- Rinse probes two times with specific conductivity standard.
- Fill calibration cup with fresh specific conductivity standard.
- Under the main menu highlight calibrate and hit enter
- Highlight **Conductivity** and hit ENTER
- Highlight **SpCond** and hit ENTER
- Enter the value of calibration standard (for 1,000 µS/cm, enter 1.0) and press ENTER.
- Wait at least 30 seconds until specific conductivity stabilizes and record the temperature and initial specific conductivity value onto data sheet.
- Press ENTER to calibrate the sonde
- Never accept an “Out of Range” message – if this occurs ensure there are no bubbles in the hole where the SpCond probe is located and that the standard covers the hole completely
- Record the final value of specific conductivity onto data sheet.
- Press ESCAPE several times to go to the Main Menu and highlight **Advanced** and hit ENTER
- Highlight **Cal constants** and hit ENTER
- Record conductivity cell constant onto data sheet and verify the number ranges between 4.5 to 5.5
- Dump conductivity standard into rinse jar.

- **Next: post calibrate the pH probe**
- Rinse two times with DI water
- Rinse two times with pH 7.0_ standard.
- Fill calibration cup with fresh pH 7.0_ standard ensuring that the temp probe is covered with calibration standard
- Press ESCAPE twice to the main menu and highlight **RUN** and hit ENTER
- Highlight **Discrete Sample** and hit ENTER
- Highlight **Start Sampling** and hit ENTER

- Wait until temp stabilizes and record the temperature of the pH 7.0_ standard and the temperature compensated value for the pH standard, this is done to determine the temperature compensation for the pH standard, for example if the temp is 18 degrees C then determine the value of the pH 7 standard at 20 degrees C on the look up table on the datasheet and fill it out in the pH standard line on the datasheet
- Press ESCAPE 3 times to go to the Main Menu
- Highlight **Calibrate** and hit ENTER
- Highlight **ISE1 pH** and press ENTER
- Highlight **2 point** and press ENTER
- Enter the temperature compensated value for the pH 7._ calibration standard for the first calibration point and hit ENTER.
- Wait at least 30 seconds until pH stabilizes and record the initial pH 7._ value onto the data sheet.
- Press ENTER to calibrate the sonde
- **DO NOT press enter or escape!**
- Record the final value of pH onto data sheet.
- Record pH mv onto data sheet and verify that the value ranges between -50 and +50
- Dump pH standard into rinse jar.
- Rinse two times with DI water.
- Rinse two times with pH 10._ standard.
- Fill calibration cup with fresh pH 10._ standard., ensuring that the pH probe is completely submerged
- Record the temperature of the pH 10.0_ standard and the temperature compensated value for the pH standard onto the datasheet
- Press ENTER once and enter the temperature compensated pH 10.0_ value as the second point and hit ENTER.
- Wait until pH stabilizes and record the initial pH 10 value onto data sheet
- Press ENTER to calibrate the sonde
- Record the final value of pH onto data sheet
- Record pH mv onto data sheet and verify that the value ranges between -130 and -230
- calculate the pH slope onto data sheet by subtracting the difference between the two numbers (using absolute value of the two numbers) and enter the value onto the datasheet, ensure the value ranges between 165 and 180
- Dump pH 10.0_ standard into rinse jar
- Rinse with two times with DI water

- **Next: IF YOU ARE AT THE WE, KAT or TC SITES THEN YOU NEED TO DO A 0 CHECK OF THE OPTICAL BGA PROBE.**
- Fill calibration cup ¾ of the way with DI water so that the BGA and temp probe are fully immersed.

- Be sure to engage only one thread on the calibration cup during this procedure to avoid a small interference from the cup bottom
- Highlight **Run** in the main menu and press ENTER, highlight **Discrete Sample** and press ENTER, highlight **Interval** and change it from 0.5 to 4 and highlight **Start Sampling** and press ENTER.
- On the 650 activate the wiper to clean the optics to remove any bubbles that may be present
- **After BGA has stabilized.** Record initial temperature and BGA on data sheet. Do not calibrate

- **Once BGA is present in the Klamath River do a rhodamine dye check for the BGA probes.**
- Rinse two times with DI water
- Rinse two times with rhodamine dye standard that was prepared in the lab.
- Fill calibration cup with fresh rhodamine dye standard ensuring that the temp probe is covered with calibration standard
- Press ESCAPE twice to the main menu and highlight **Run** and hit ENTER
- Highlight **Discrete Sample** and hit ENTER
- Highlight **Start Sampling** and hit ENTER
- Wait until temp stabilizes and record the temperature of the rhodamine dye standard and the temperature compensated value for the rhodamine dye standard, this is done to determine the temperature compensation for the rhodamine dye standard, for example if the temp is 18 degrees C then determine the value of the rhodamine dye standard at 18 degrees C on the look up table on the datasheet and fill it out in the rhodamine dye standard line on the datasheet
- After BGA has stabilized record the BGA number on the datasheet, if BGA number does not stabilize on any one number record the range after you watch it carefully for a couple of minutes
- Dump the rhodamine dye standard into the waste jug and rinse two times with distilled water

- Disconnect the sonde and 650.
- Connect sonde to site data cable, attach carabiner, and insert into aluminum sonde box. Deploy sonde at least 5 minutes before it is set to take a measurement. Record the time of deployment
- Place the reference sonde next to the datasonde at least 5 minutes before it is set to take a measurement and record WQ parameters as close as possible to the half hour or top of the hour (+/- 2 minutes).
- Check logger to ensure that sonde is communicating with logger and logger is recording data.

H350 XL Datalogger Instructions

Klamath River at Weitchpec(WE) and Trinity River at Weitchpec (TR)

To Download Data

- Insert 256 MB Compact Flash Card with PC Card Adapter into Datalogger
- Scroll Down to ‘Data Options’
- Press Arrow →
- Scroll Down to ‘Copy .NEW to Card?’
- Press Enter
- Wait Until Datalogger reads ‘Done, Press Enter to Erase .NEW’
- Press Esc/Cancel to Main Menu
- Remove Data Card by pushing eject button next to card slot

H350 data download for the TC site

Data Download (Linear Flash card swap out)

1. Open Gaging Station by unlocking metal box.
2. Disconnect the two metal rings holding lid on display board.
3. Press**ON**.
4. Scroll Down to <**CHANGE DATA CARD>**and hit **ENTER**.
5. Hit **ENTER** for **YES**.
6. Pull card and hit **ENTER**.
7. Install new blank card (from office) and press **ENTER**.
8. Hit **ENTER** for **YES** to format card.
9. On the data logger, scroll down to **<FLASH MEMORY CARD>**, hit **ENTER**.
10. Scroll down to **<VIEW DATA FILE>**, hit **ENTER**. (If the data headings are there, it is accepting data.) Hit **ESCAPE**.
11. Scroll up to **<LOGGING PARAMETER>**, hit **ENTER.** (Screen should say **<LOGGING [ON]>**, if it doesn’t, it needs to be turned on.)
12. Close lid on data logger.
13. Lock door on Gaging Station.

Method to remove and install a probe

- First carefully unscrew the stainless steel probe nut with the provided tool. Carefully dry the base of the probe with a chem wipe. Tilt the probes to be pointing towards the ground. Firmly grasp the probe at its base and pull in a slow downward motion until the o-rings on the probe have cleared the probe port. Blow out the probe port with compressed air to dry it thoroughly.
- Prepare the new probe by lightly greasing the o-rings on the probe. Insert the probe into the correct port and gently rotate the probe until you feel the connector engage. Now push the probe in towards the bulkhead until you feel the o-ring seat in its bore. You will experience some resistance as you push the probe inward. Once you feel the o-ring seat, gently rotate the stainless steel probe nut clockwise with your fingers while you are holding the probe in place.
- **DO NOT USE THE TOOL! The nut must be seated by hand, if the nut is difficult to turn STOP back off and attempt again to prevent cross threading the threads on the sonde. The nut will seat flat against the bulkhead and rotate easily when the parts are properly aligned. Use the tool to snug up the nut so it cannot come loose. DO NOT OVER TIGHTEN!!!!!!**
- If you are removing probe from the spare sonde make sure to install a port plug in the same way you install a probe. (grease o-rings and hand screw in first then tighten with the tool)
- Document what you did on the data sheet

Sensor Settings for Datasonde that is used in mainstem monitoring activities
(does not matter if hooked up to a logger or not)

- **Time is on**
- **Temperature is on**
- **Sp. Conductivity is on**
- **ISE1 pH is on**
- **Dissolved Oxy is OFF**
- **Optic-T – Dissolved Oxy is ON**
- **Battery is OFF**
- **Pressure is OFF**
- **ISE-2 is off**
- **Optic C - BGA is ON (except for TR sonde that has turbidity probe keep it off)**

Report Settings for Datasonde that is Hooked up to a datalogger at WE,TC, KAT and TR:

- **Date and Time is OFF**
- **Temperature is on: °C**
- **Specific Conductivity is on: microsiemens µ**
- **pH is on**
- **pH mv is on**
- **ODO Sat % and mg/L is on**
- **Turbidity is OFF**
- **BGA is ON (at KR sites only)**

Report Settings for Datasonde that is **NOT** Hooked up to a datalogger:

- **Same as above but Date and Time is turned on**

To download data and create files on sondes that are not hooked up to a datalogger

Before post calibrating DO follow the below instructions to download data off of the internal datasonde memory.

- **If the sonde is not hooked up to the datalogger then this is a good time to download the data off of the sonde.**

- Turn the logging off by selecting run, unattended sample, and stop logging
- Download the data (page 55 in the 650 manual) by selecting the sonde menu in the 650 Main Menu
- Highlight File and hit enter
- Highlight Quick Upload and hit enter
- Select PC6000 for the File Type and hit enter
- Do the same process again for the same file but download it as a different data file, a ASCII Text file this time

- Create a file after you do your final calibration of pH or the BGA check

- Create a new file in the Sonde Run Menu unattended sample menu. Make sure the start time is two minutes before the half hour or top of the hour (i.e, 10:28 or 10:58). The interval is 30 minutes. The parameters to log should be date and time, temperature, conductivity, pH, pH mv, and battery voltage, ODO mg/L, ODO % Saturation (and BGA for KR sites). Set the stop time to run for 21 days. Set the file name to site id and start date, example-(TR061606). Scroll down to the bottom of the screen and start logging. To verify that logging is activated go to file status and it will say logging active.

Appendix B: Water Quality Grades

Water quality data from sondes is entered into the Yurok Environmental Data Storage System (YEDSS) where each water quality parameter is assigned a grade based on USGS criteria (Wagner et al., 2006) for each two week deployment (Table B-1). Any grade of 'D' or lower is considered "poor" data and is flagged as such. Low grades can be caused by instrument drift due to biofouling or aging of probes, or damage to datasonde. For more information regarding YEDSS and/or grading of data please contact YTEP. (Tables B-2 through B-5).

Table B- 1. Water Quality Ratings for Raw Data

Quality Ratings For Raw Data				
Parameter	**A (excellent)**	**B (Good)**	**C (Fair)**	**D (Poor)**
Water Temperature	≤ ± 0.2 °C	> ± 0.2-0.5 °C	> ± 0.5-0.8 °C	> ± 0.8 °C
Specific Conductivity	≤ ± 3%	> ± 3 to 10%	> ± 10 to 15%	> ± 15%
pH	≤ ± 0.2 units	> ± 0.2 to 0.5 units	> ± 0.5 to 0.8 units	> ± 0.8 units
Dissolved Oxygen (% Sat)	≤ ± 0.3 mg/L	> ± 0.3 to 0.5 mg/L	> ± 0.5 to 0.8 mg/L	> ± 0.8 mg/L

Table B-2. KAT Grades: 2013

Table B-2 KAT Grades 2013				
Date	Water Temperature Grade	Specific Conductivity Grade	pH Grade	Dissolved Oxygen Grade
5/28/2013	A	D	A	C
6/4/2013	D	A	B	D
6/11/2013	A	A	A	A
6/25/2013	B	A	A	A
7/2/2013	A	A	A	A
7/15/2013	B	A	A	A
7/30/2013	C	A	A	A
8/13/2013	A	A	D	A
8/26/2013	B	A	A	A
9/3/2013	A	D	A	A
9/16/2013	A	B	A	A
10/1/2013	A	A	A	A
10/14/2013	A	A	A	A

Table B-3. TC Grades: 2013

Table B-3 TC Grades 2013				
Date	Water Temperature Grade	Specific Conductivity Grade	pH Grade	Dissolved Oxygen Grade
5/29/2013	A	D	B	A
6/6/2013	A	A	B	A
6/12/2013	A	A	A	A
6/26/2013	A	A	A	A
7/3/2013	A	A	A	A
7/16/2013	A	A	A	A
7/31/2013	A	A	A	A
8/14/2013	A	A	A	A
8/27/2013	A	A	A	A
9/5/2013	A	A	A	A
9/17/2013	A	A	A	A
10/2/2013	D	D	C	D
10/11/2013	A	A	A	A

Table B-4. WE Grades: 2013

Table B-4 WE Grades 2013				
Date	Water Temperature Grade	Specific Conductivity Grade	pH Grade	Dissolved Oxygen Grade
5/29/2013	A	A	A	A
6/12/2013	A	A	A	C
6/26/2013	A	A	A	B
7/3/2013	C	A	A	A
7/16/2013	A	A	A	A
7/31/2013	A	A	A	A
8/8/2013	A	A	A	D
8/14/2013	A	A	A	A
8/27/2013	A	A	A	B
9/5/2013	A	A	A	A
9/17/2013	A	A	B	B
10/2/2013	A	B	A	A
10/11/2013	D	A	B	A

Table B-5. TR Grades: 2013

Table B-5 TR Grades 2013				
Date	Water Temperature Grade	Specific Conductivity Grade	pH Grade	Dissolved Oxygen Grade
5/14/2013	A	A	A	C
5/29/2013	A	B	A	B
6/12/2013	A	A	A	A
6/26/2013	A	A	A	A
7/3/2013	A	A	A	A
7/16/2013	B	A	A	A
7/31/2013	A	A	A	A
8/14/2013	B	A	A	A
8/27/2013	A	B	A	A
9/5/2013	A	A	A	A
9/17/2013	A	A	A	A
10/2/2013	A	C	A	B
10/11/2013	A	A	A	A