FINAL
2011 Klamath River
Continuous Water Quality Monitoring
Summary Report

Yurok Tribe Environmental Program:
Water Division

April 2012

Prepared by: Scott Sinnott

Acknowledgements

The Yurok Tribe Environmental Program (YTEP) would like to thank those that contributed to the data collection efforts that occurred during the 2011 monitoring season. AmeriCorps Watershed Stewards Project Members Tim Sandborn and Nick Pence 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.

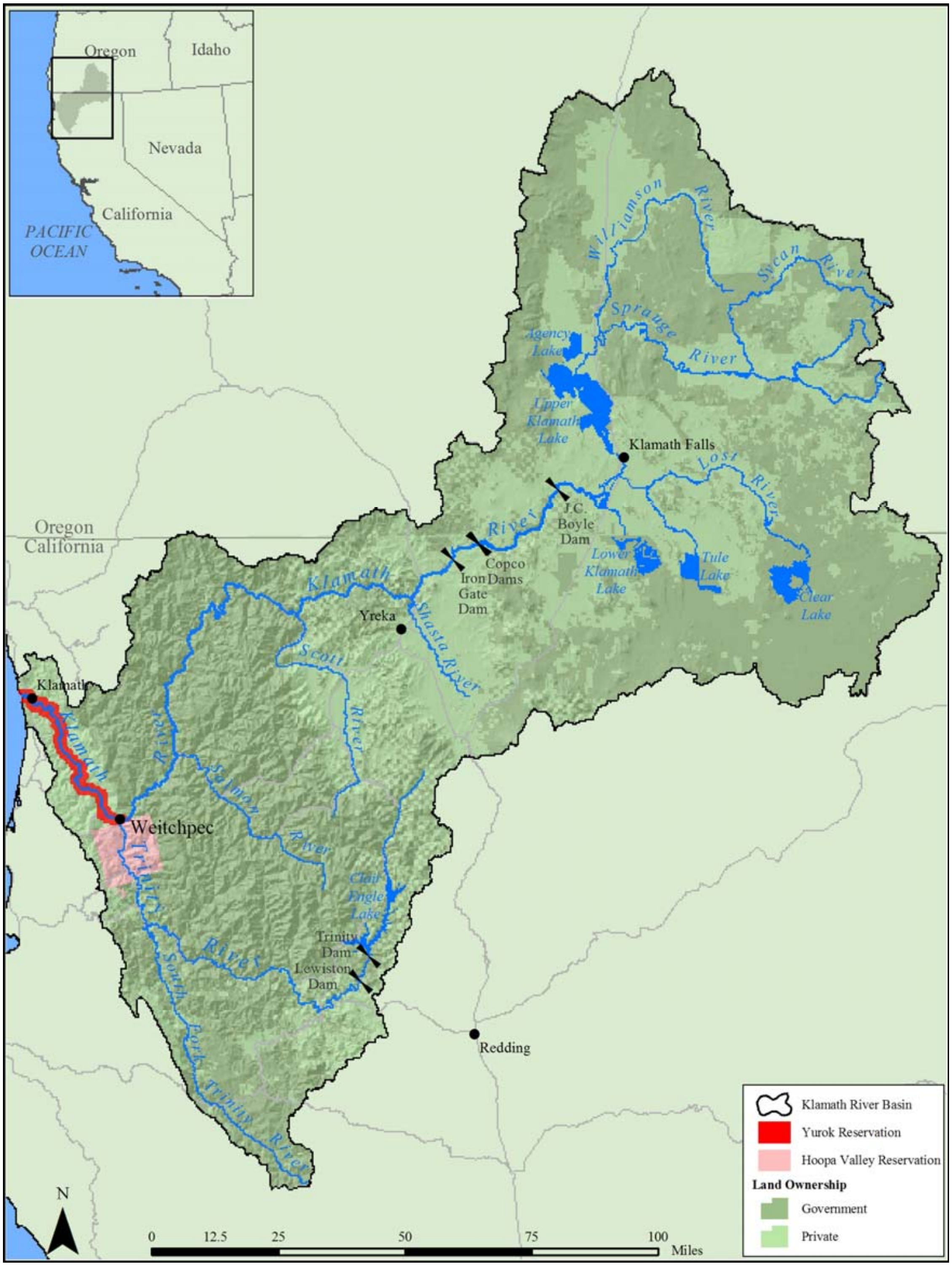

Figure 2-1. Klamath River Basin Map

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.

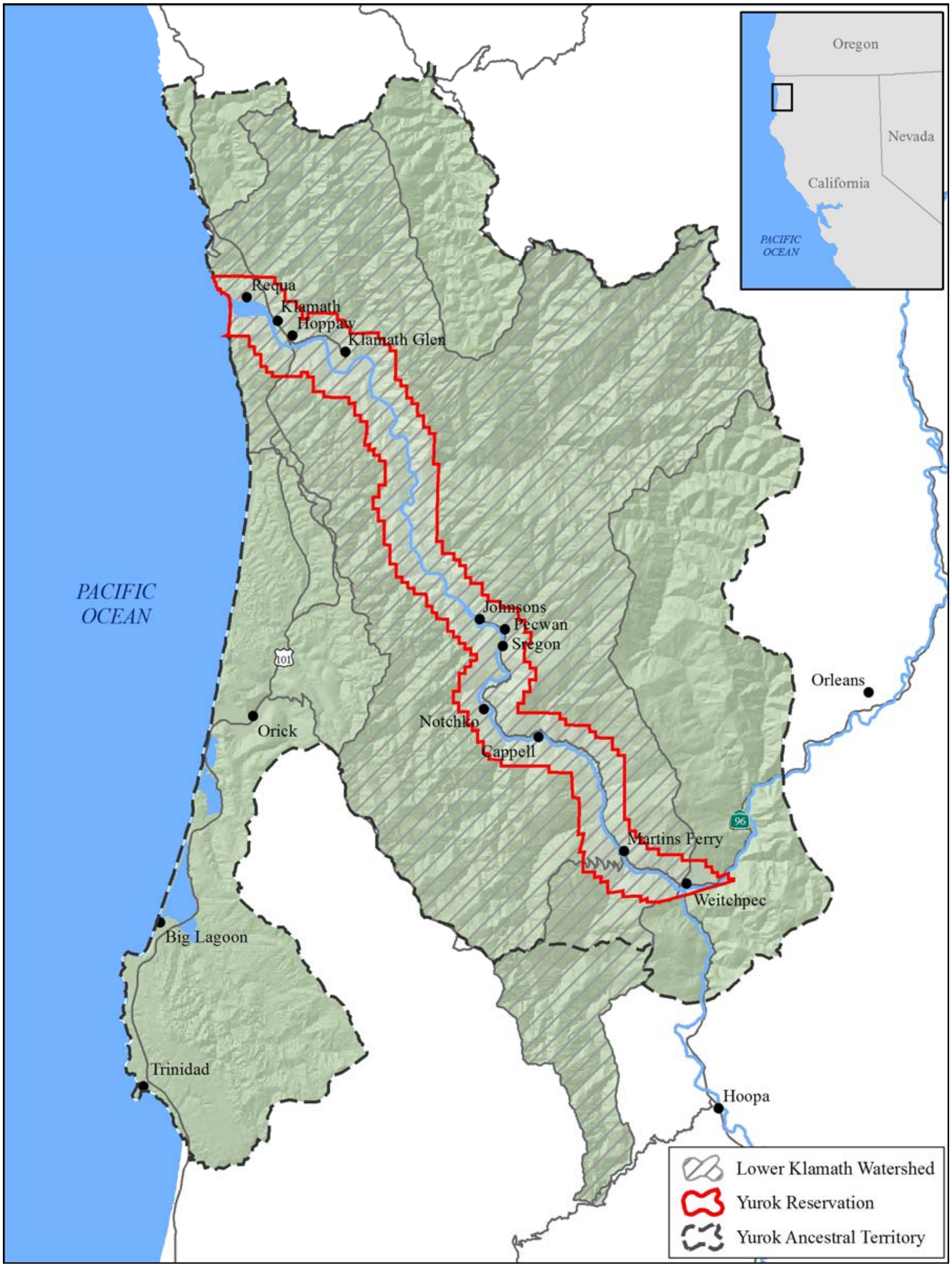

Figure 2-2. Yurok Indian Reservation and Yurok Ancestral Territory Map

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 five 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 (To view results of continuous blue-green algae data please see the Yurok Tribe's 2011 Blue-green Algae Summary Report).

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)**

YTEP collected water samples for nutrient analysis at the following major tributary locations:

- **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

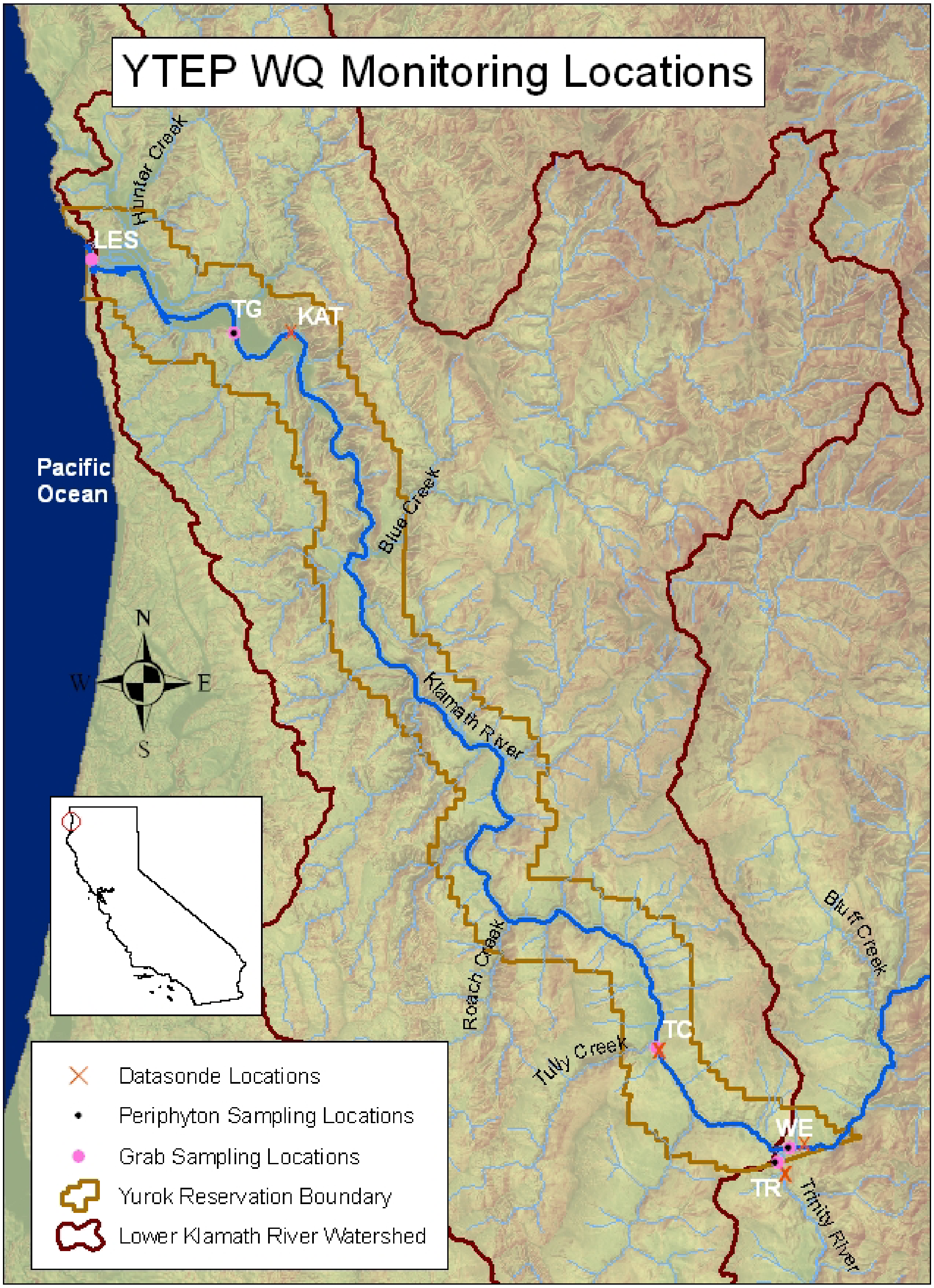

Figure 4-1 .Datasonde Locations for 2011 (as indicated by the brown X's)

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 2011 monitoring season. The coolest daily water temperature was 8.67°C on November 6 at TR. The warmest daily water temperature was 23.84°C on August 24 at WE. 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 +/- 0.2°C. 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)

Maximum water temperature at KAT increased during the first couple days of deployment in mid-May then decreased until late May. After late May, water temperature generally increased until late July, with small dips in temperature in late June and mid-July (Figures 6-1 and 6-2). After late July maximum water temperature generally held steady until late August. In late August water temperature gradually decreased until late September, with a sharp reduction in temperature in early October, followed by a gradual increase in water temperature until mid-October. After mid-October, temperatures decreased until datasondes were removed for the season in early November.

The lowest temperature recorded at KAT during 2011 was 9.61°C on November 6 and the highest temperature recorded was 23.41°C on July 31. The daily maximum water temperature at KAT exceeded 21°C beginning on July 22 and remained above this standard until September 2, exceeding it again from September 6-13 (Figure 6-1).

Daily maximum water temperatures at KAT exceeded 21°C 31.68% of the time, or 51 out of 161 days of the monitoring season (Figure 6-3). Water temperature exceeded 21°C 20.89% of the time, or 1,655 out of 7,923 readings for all half-hour measurements during the monitoring season (Figure 6-3). The seven-day moving average of the daily maximum water temperature exceeded 15.5°C from June 20 to July 7, July 22 to October 11 and October 13 to October 27 (Figure 6-2). Due to equipment malfunction, a seven-day moving average was not able to be calculated at KAT from July 8-21; however, the seven-day moving average of the daily maximum water temperature for USFWS temperature probes exceeded 15.5 °C during this time period.

Klamath River above Tully Creek (TC)

Maximum water temperature at TC increased slightly for the first few days after initial deployment then decreased until late May. Water temperature then increased steadily until late July, with small dips in late June and mid-July (Figures 6-4 and 6-5). After late July, maximum temperature generally held steady until late August. After late August water temperature steadily decreased until early October, with a significant dip in late August/early September. In early October, water temperature decreased sharply then increased into mid-October. After mid-October, temperature decreased until datasondes were extracted in early November.

The lowest temperature recorded at TC during 2011 was 9.05°C on November 6 and the highest temperature recorded was 23.46°C on August 24. The daily maximum water temperature at TC exceeded 21°C beginning on July 23 and remained above this temperature until August 30, exceeding it again from September 4-14 (Figure 6-4).

Daily maximum water temperatures at TC exceeded 21°C 29.65% of the time, or 51 out of 172 days of the monitoring season (Figure 6-6). Water temperatures exceeded 21°C 23.07% of the time, or 1,912 out of 8,287 readings for all half-hour measurements during the 2011 monitoring season (Figure 6-6). The seven-day moving average of the daily maximum water temperature exceeded 15.5°C from June 22 until October 8 and then again from October 16-25 (Figure 6-5).

Klamath River at Weitchpec (WE)

Water temperature at WE decreased from deployment in mid-May until late May. (Figures 6-7 and 6-8). Temperature then increased until late July, with dips in late June and mid-July. After late July, water temperature generally held steady until late August. After late August temperature gradually decreased until early October, with small dips in early and late September. In early October, water temperature decreased sharply then increased until mid-October. Water temperature then decreased until the datasonde was removed on November 7 for the season.

The lowest temperature recorded at WE during 2011 was 9.14°C on November 6, while the highest recorded temperature was 23.84°C on August 24. The daily maximum water temperature at WE exceeded 21°C beginning on July 22 and remained above this temperature until September 15 (Figure 6-7).

Daily maximum water temperature at WE exceeded 21ºC 32.56% of the time, or 56 out of 172 days of the monitoring season (Figure 6-9). Water temperatures exceeded

21°C 28.15% of the time, or 2,144 out of 7,617 readings for all half-hour measurements during the 2011 monitoring season (Figure 6-9). The seven-day moving average of the daily maximum water temperature exceeded 15.5°C from June 24-28, July 20 through October 9, and October 16-25 (Figure 6-8). Due to equipment malfunction, a seven-day moving average was not able to be calculated at WE from June 29 through July 1, however, the seven-day moving average for USFWS temperature probes exceeded 15.5 °C during this time period.

Trinity River near Mouth (TR)

Maximum water temperature at TR decreased from deployment in mid-May until early June (Figures 6-10 and 6-11). Water temperature then generally increased until late August with dips in late June and mid-July. In late August, water temperature decreased sharply until early September then increased until mid-September, at which time temperature gradually decreased until early October. In early October, water temperature decreased significantly then increased quickly until the middle of the month. Water temperature then steadily decreased until datasondes were removed on November 7.

The lowest temperature recorded at TR during 2011 was 8.67°C on November 6, and the highest temperature recorded was 23.51°C on August 26. The daily maximum water temperature at TR exceeded 21 °C beginning on July 23 and remained above this temperature until August 30, exceeding it again from September 4-14 (Figure 6-10).

Daily maximum water temperature at TR exceeded 21°C 29.07% of the time, or 50 out of 172 days of the monitoring season (Figure 6-12). Water temperatures exceeded 21°C 18.28% of the time, or 1,514 out of 8,284 readings for all half-hour measurements during the 2011 monitoring season (Figure 6-12). The seven-day moving average of the daily maximum water temperature exceeded 15.5°C from June 15 through October 7 and then again from October 16-26 (Figure 6-11).

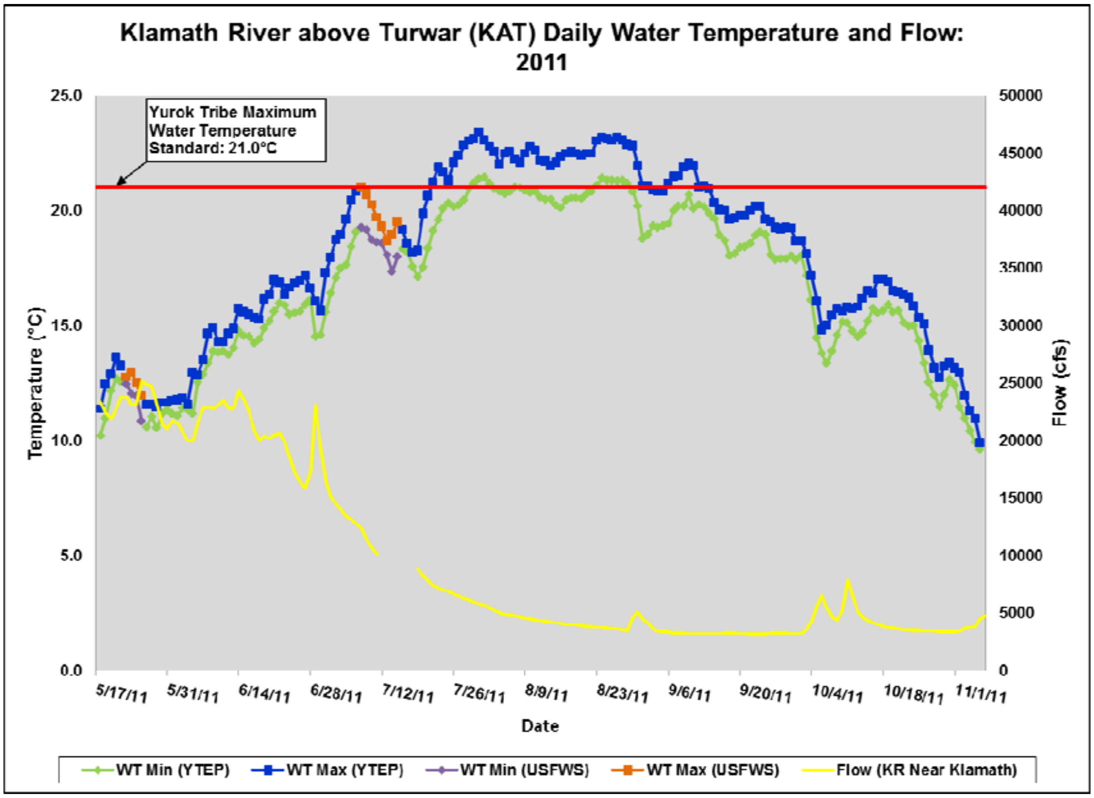

Figure 6-1. KAT Maximum/minimum Water Temperatures and Flow: 2011

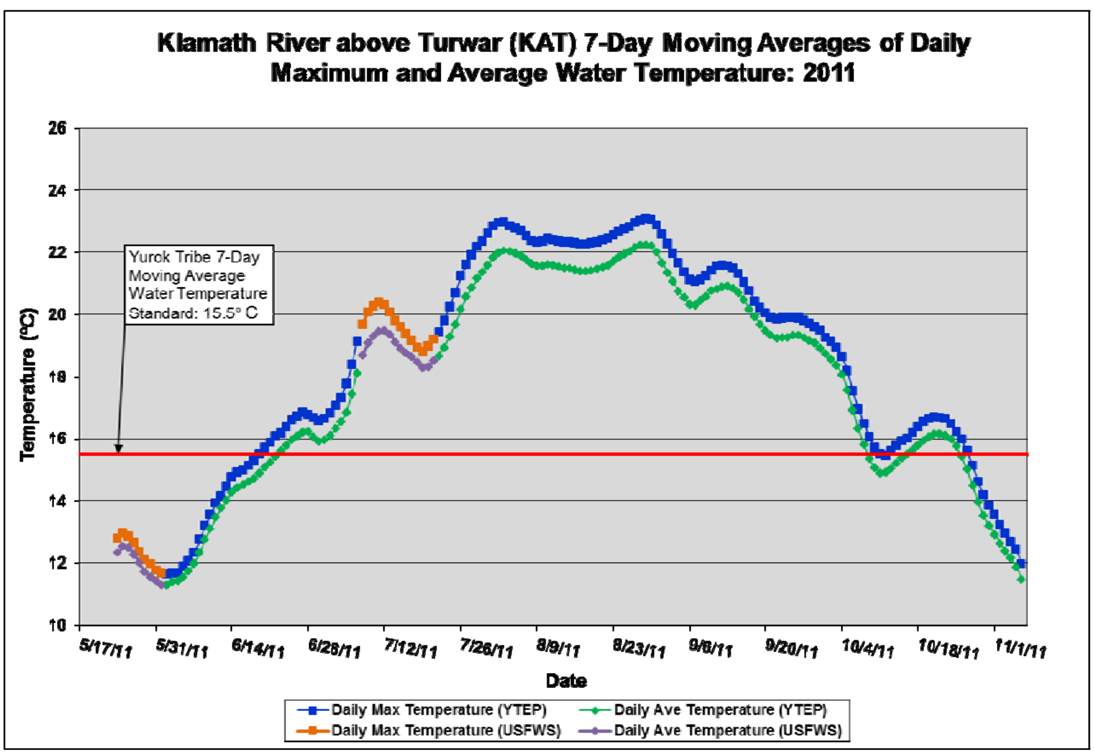

Figure 6-2. KAT 7-Day Moving Averages: 2011

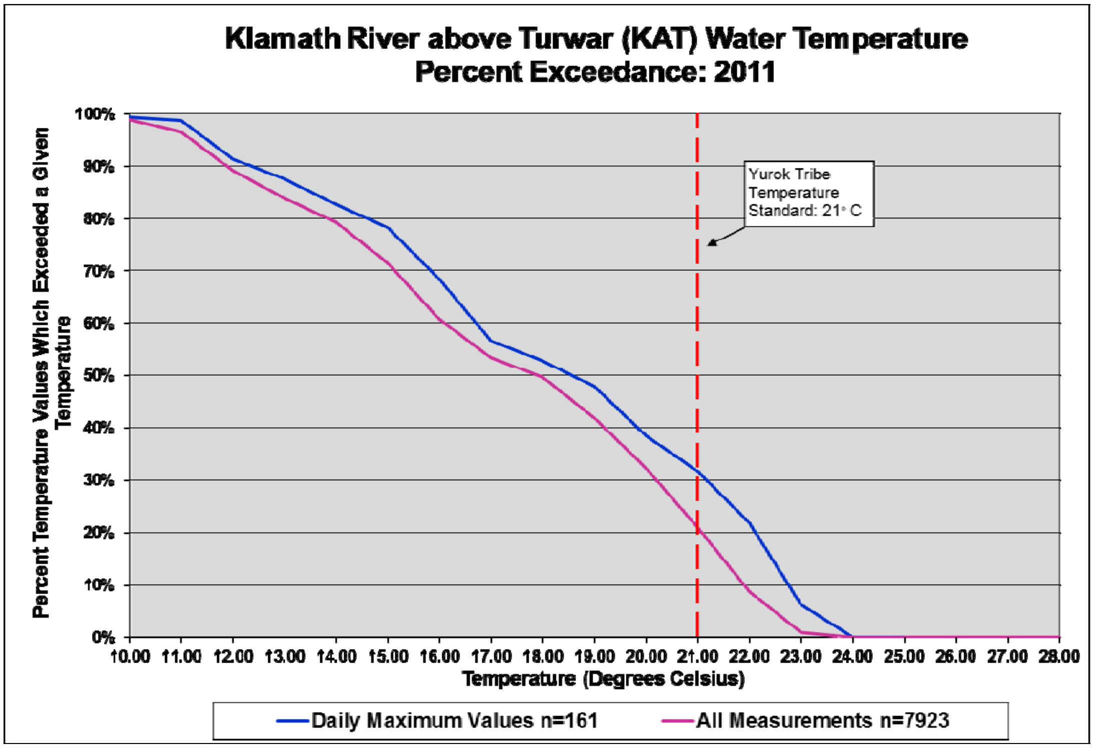

Figure 6-3. KAT Water Temperature Percent Exceedance: 2011

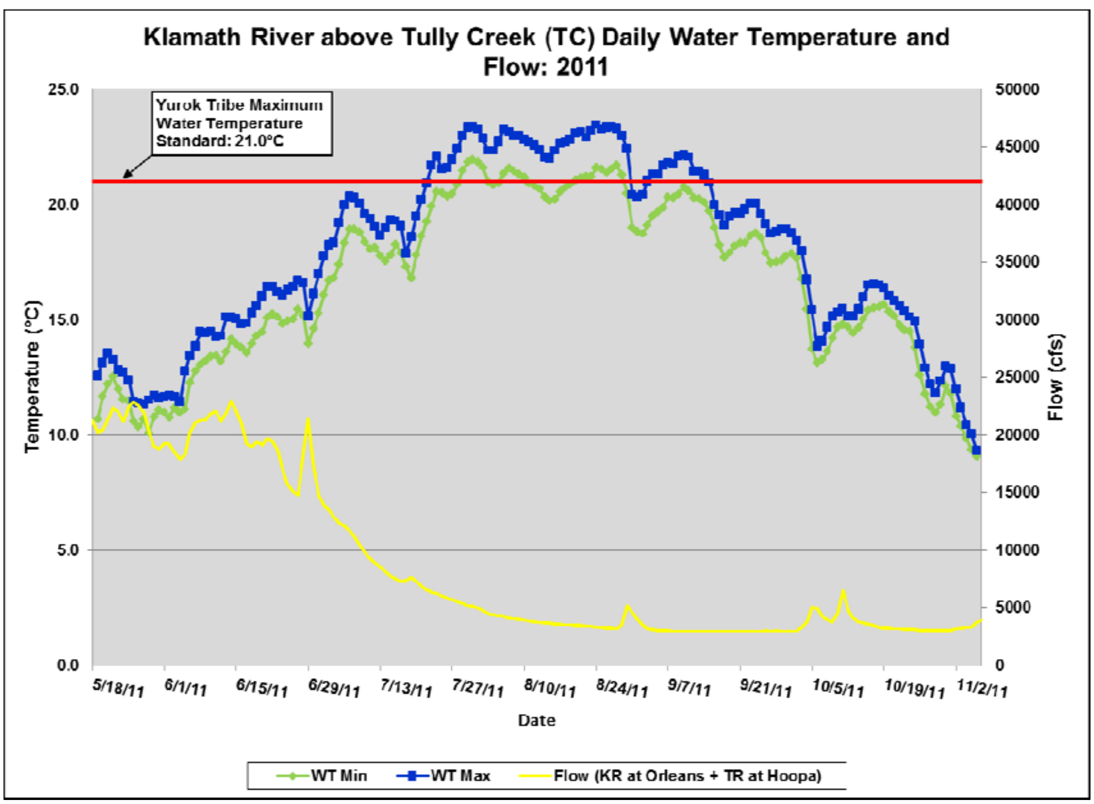

Figure 6-4. TC Maximum/minimum Water Temperature and Flow: 2011

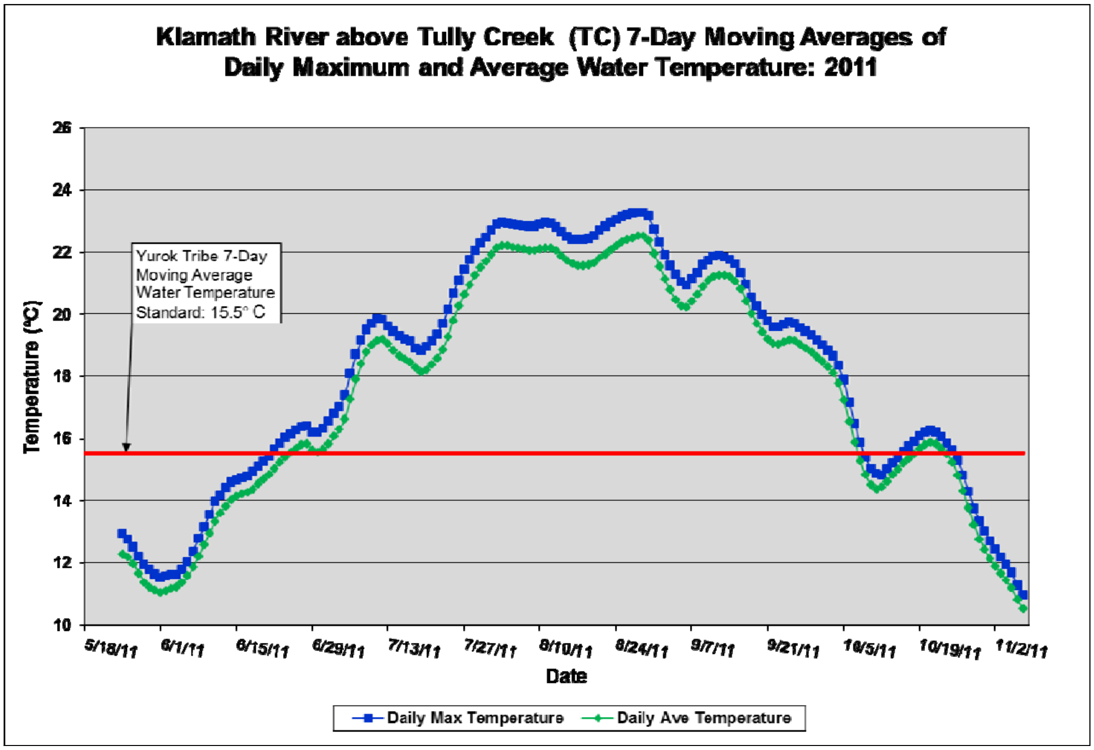

Figure 6-5. TC 7-Day Moving Averages: 2011

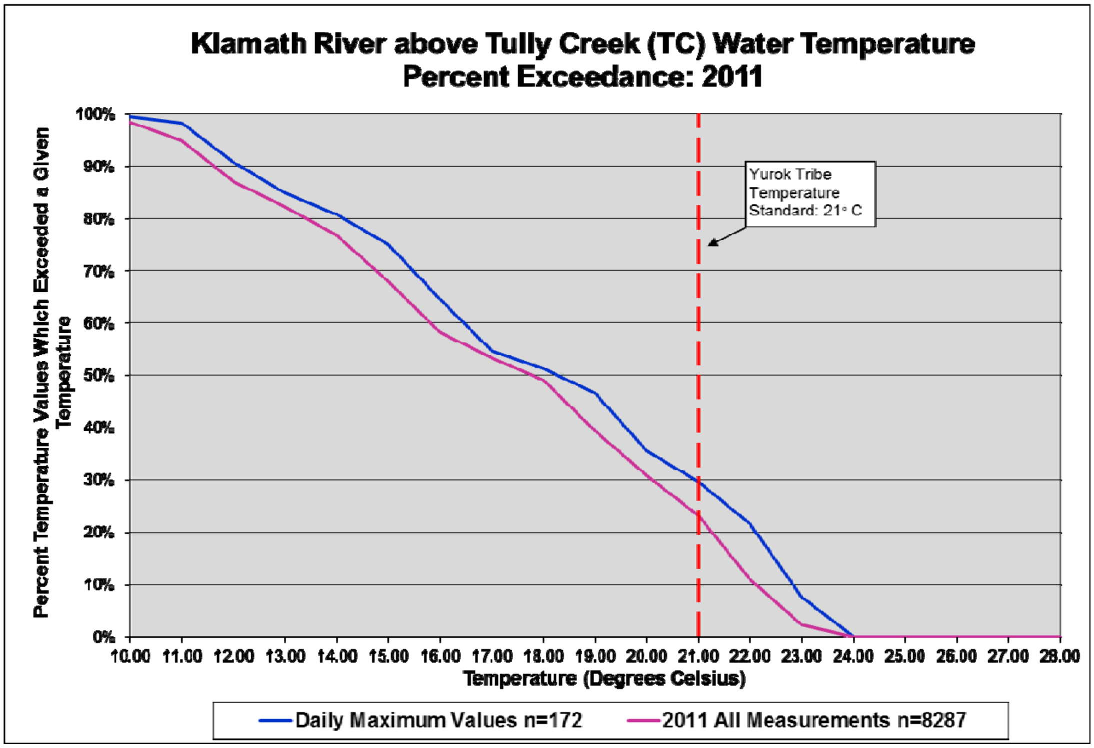

Figure 6-6. TC Water Temperature Percent Exceedance: 2011

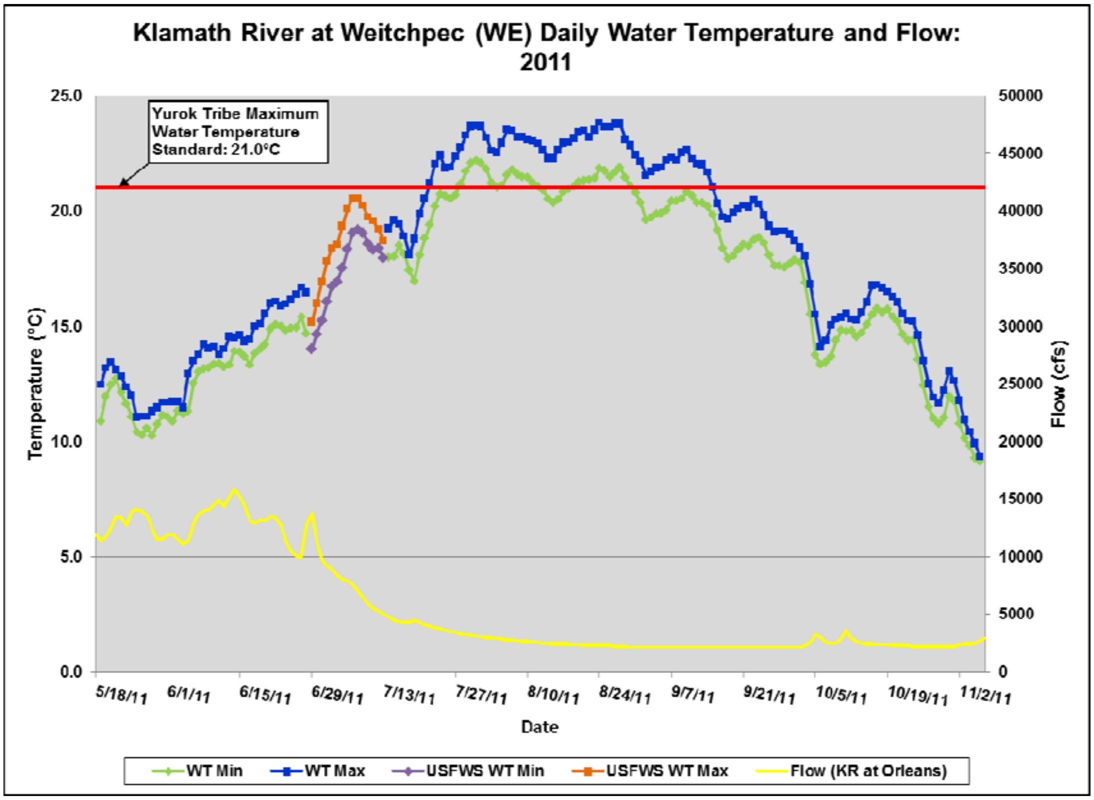

Figure 6-7. WE Maximum/minimum Water Temperature and Flow: 2011

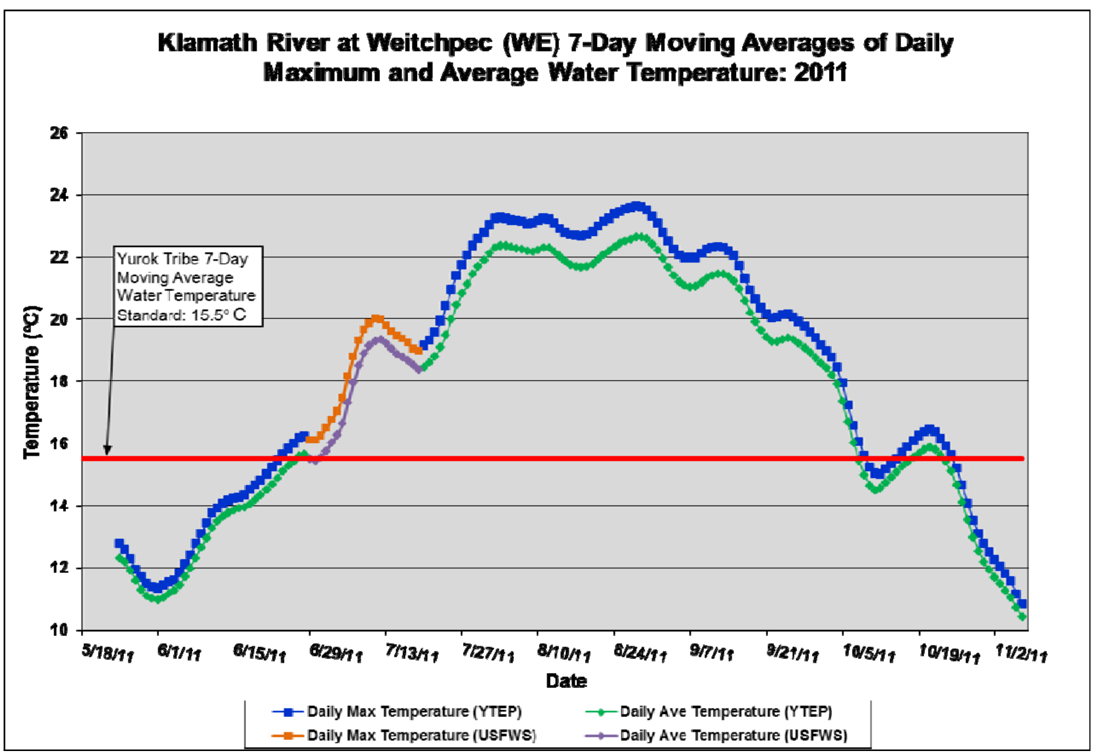

Figure 6-8. WE 7-Day Moving Averages: 2011

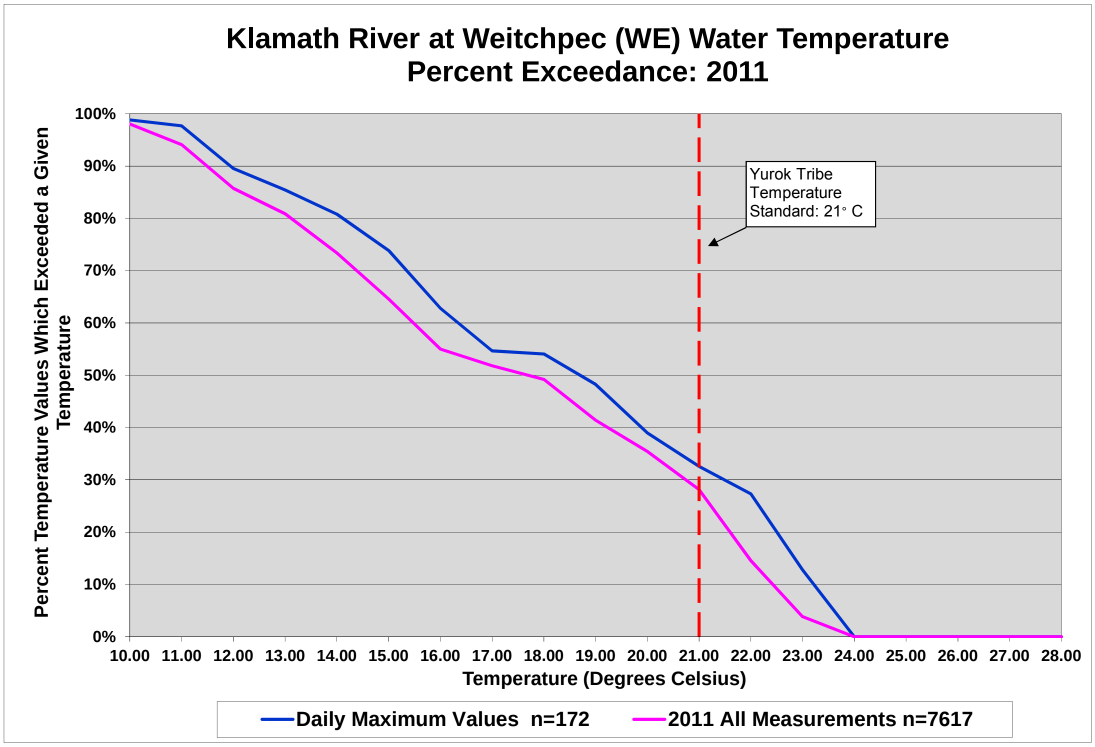

Figure 6-9. WE Water Temperature Percent Exceedance: 2011

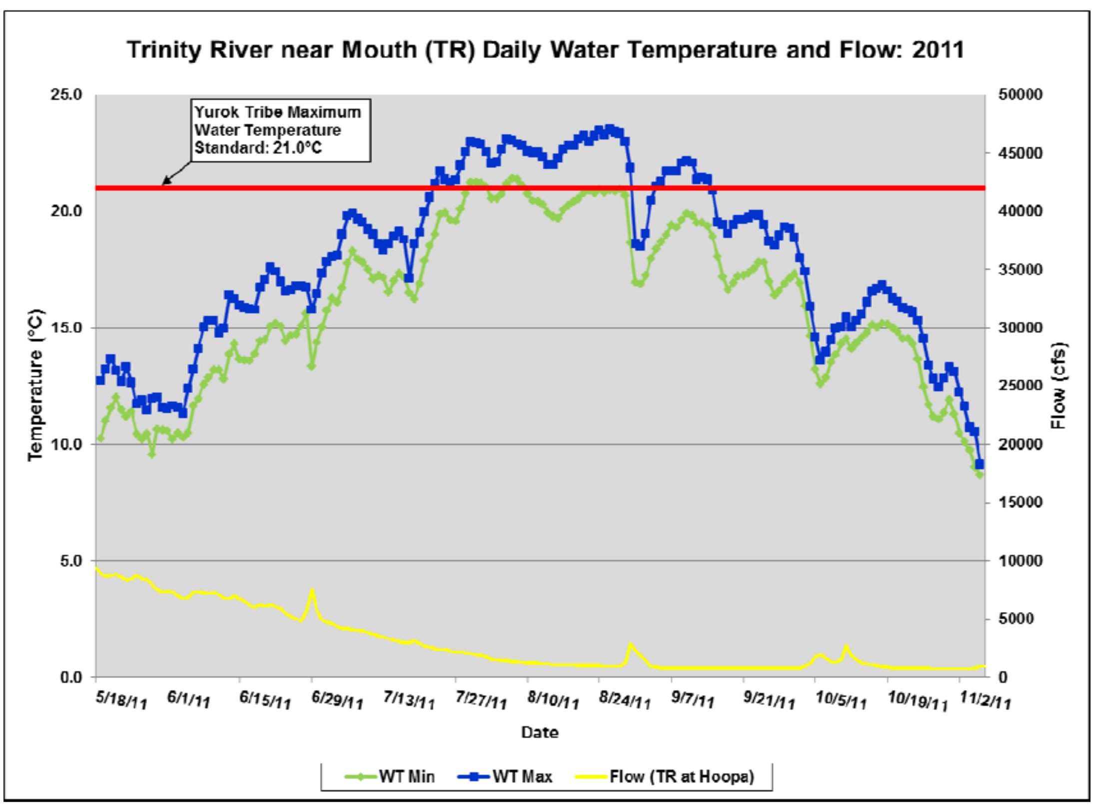

Figure 6-10. TR Maximum/minimum Water Temperature and Flow: 2011

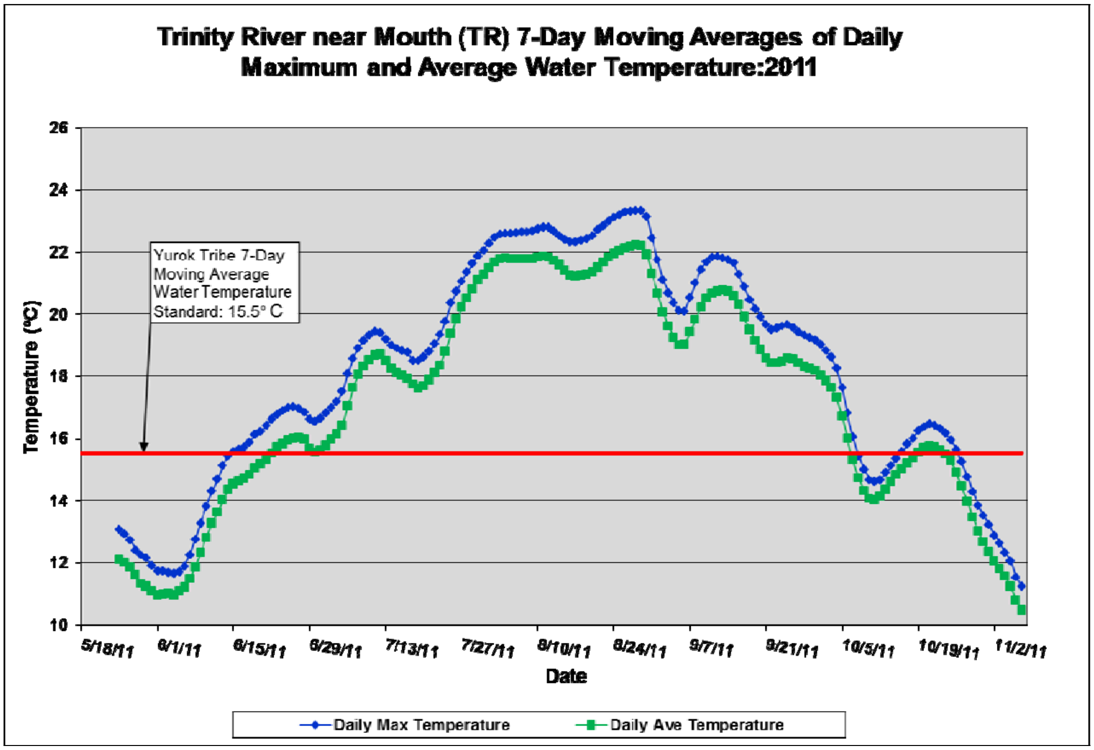

Figure 6-11. TR 7-Day Moving Averages: 2011

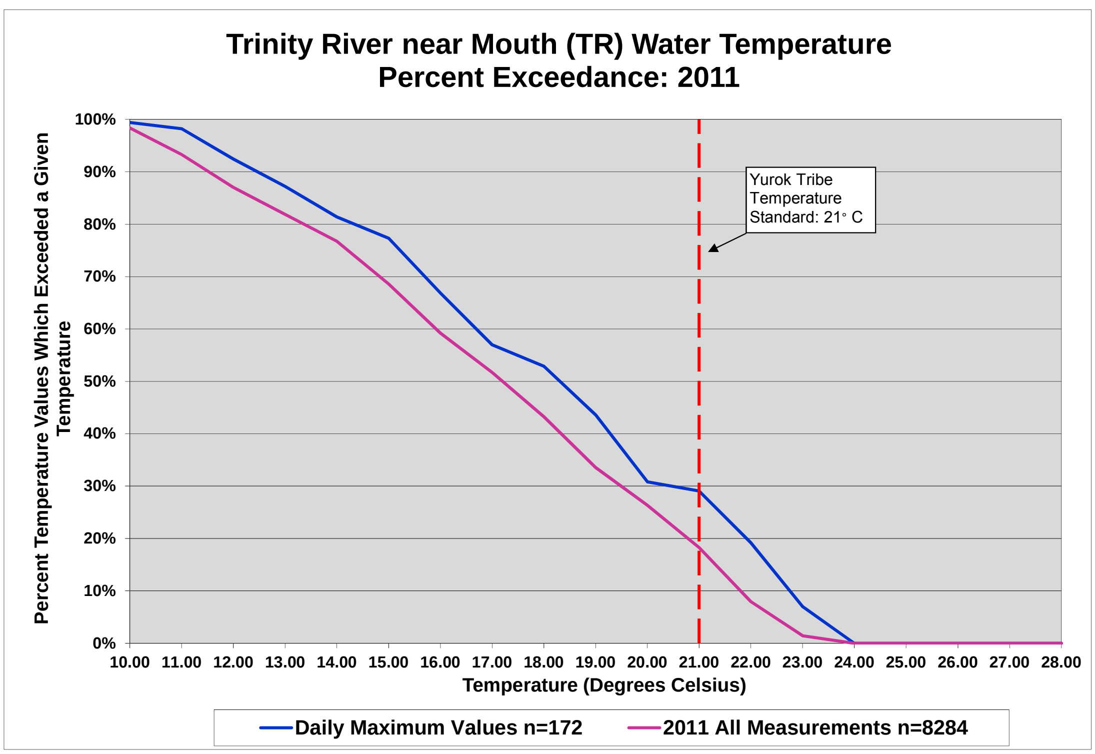

Figure 6-12. TR Water Temperature Percent Exceedance: 2011

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 planss. 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 2011 monitoring season. The lowest DO concentration recorded was 7.80 mg/L at KAT on September 11. The highest DO concentration recorded was 11.96 mg/L at WE on November 4. The lowest DO% saturation recorded was 86.9% at KAT on September 11. The highest DO% saturation recorded was 115.0% at WE on August 28. 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)

Minimum DO concentrations at KAT tended to drop from May until mid-September, with spikes in late May, late June, mid-July and late August/early September (Figure 6-13). DO concentrations then gradually increased until datasonde extraction in early November, with spikes in mid-September and early October.

The lowest DO concentration recorded at KAT was 7.80 mg/L on September 11, while the highest DO concentration recorded was 11.81 mg/L on May 29 (Figure 6-13). Daily minimum dissolved oxygen concentration dropped below 8.0 mg/L from August 27-29 and September 8-12, for a total of 8 out of 161 days, or 4.97% of the time. Measurements of DO dropped below 8.0 mg/L 0.53% of the time, or 42 out of 7,907 readings for all half-hour measurements during the 2011 monitoring season. The lowest percent saturation was 86.9% on September 11, and the highest recorded percent saturation was 111.9% on October 25 (Figure 6-14). From September 1 to May 31, daily minimum DO percent saturation dropped below 90% on September 4-15, September 24 and September 30 through October 4, for a total of 17 out of 161 days, or 10.56% of the time. Measurements of DO percent saturation dropped below 90% for 83 out of 7,907 readings, or 1.16% of all half-hour measurements during the 2011 monitoring season. DO percent saturation did not fall below 85% from June 1 through August 31.

Klamath River above Tully Creek (TC)

Minimum DO concentrations at TC generally decreased from May until mid-September, with spikes in late May, late June, mid-July and late August/early September (Figure 6-15). DO concentrations then gradually increased until datasonde extraction in early November, with spikes in mid-September and early October.

The lowest DO concentration recorded at TC was 8.00 mg/L on August 28 and September 11, while the highest was 11.81 mg/L on November 6 (Figure 6-15). Daily minimum dissolved oxygen concentration did not drop below 8.0 mg/L during the 2011 monitoring season. The lowest recorded percent saturation was 90.8% on September 11, and the highest was 110.7% on September 19 (Figure 6-16). Daily minimum DO percent saturation did not drop below 90% from September 1 to May 31, and did not drop below 85% from June 1 to August 31.

Klamath River at Weitchpec (WE)

Minimum DO concentrations at WE tended to drop from May until mid-September, with spikes in late May and mid-July (Figure 6-17). DO concentrations then gradually increased until datasonde extraction in early November, with spikes in mid-September, early October and late October.

The lowest DO concentration recorded at WE was 8.07 mg/L on September 11, while the highest was 11.96 mg/L on November 4 (Figure 6-17). Daily minimum dissolved oxygen concentration did not drop below 8.0 mg/L during the 2011 monitoring season. The lowest recorded percent saturation was 90.8% on September 10 and 11, and the highest was 115.0% on August 28 (Figure 6-18). Daily minimum DO percent saturation did not drop below 90% from September 1 to May 31, and did not drop below 85% from June 1 to August 31.

Trinity River near Mouth (TR)

Minimum DO concentrations at TR generally dropped from early June until late August, with peaks in late June, and mid-July (Figure 6-19). DO concentrations then increased until datasonde extraction in early November, with peaks in early September and early October.

The lowest DO concentration recorded at TR was 8.34 mg/L on August 26-28, while the highest was 11.47 mg/L on November 6 (Figure 6-19). Daily minimum dissolved oxygen concentration did not drop below 8.0 mg/L during the 2011 monitoring season. The lowest recorded percent saturation was 94.4% on August 3, and the highest was 106.7% on August 18 (Figure 6-20). Daily minimum DO percent saturation did not drop below 90% from September 1 to May 31, and did not drop below 85% from June 1 to August 31.

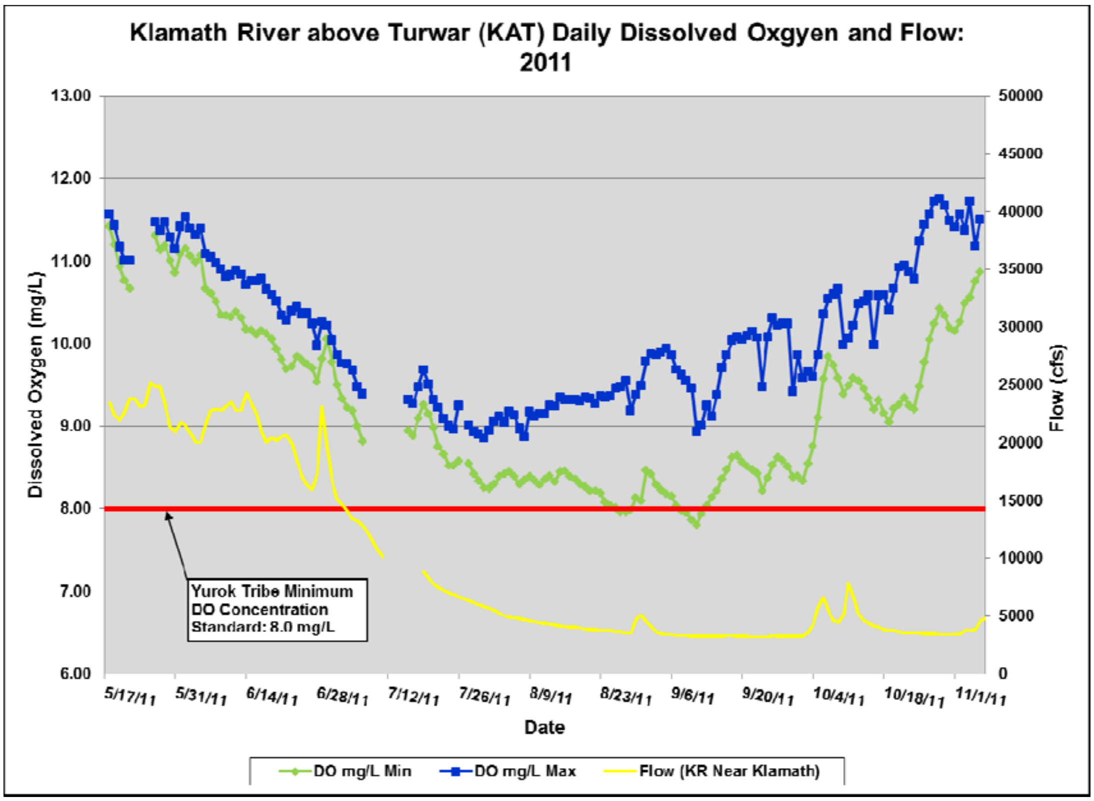

Figure 6-13. KAT Dissolved Oxygen and Flow: 2011

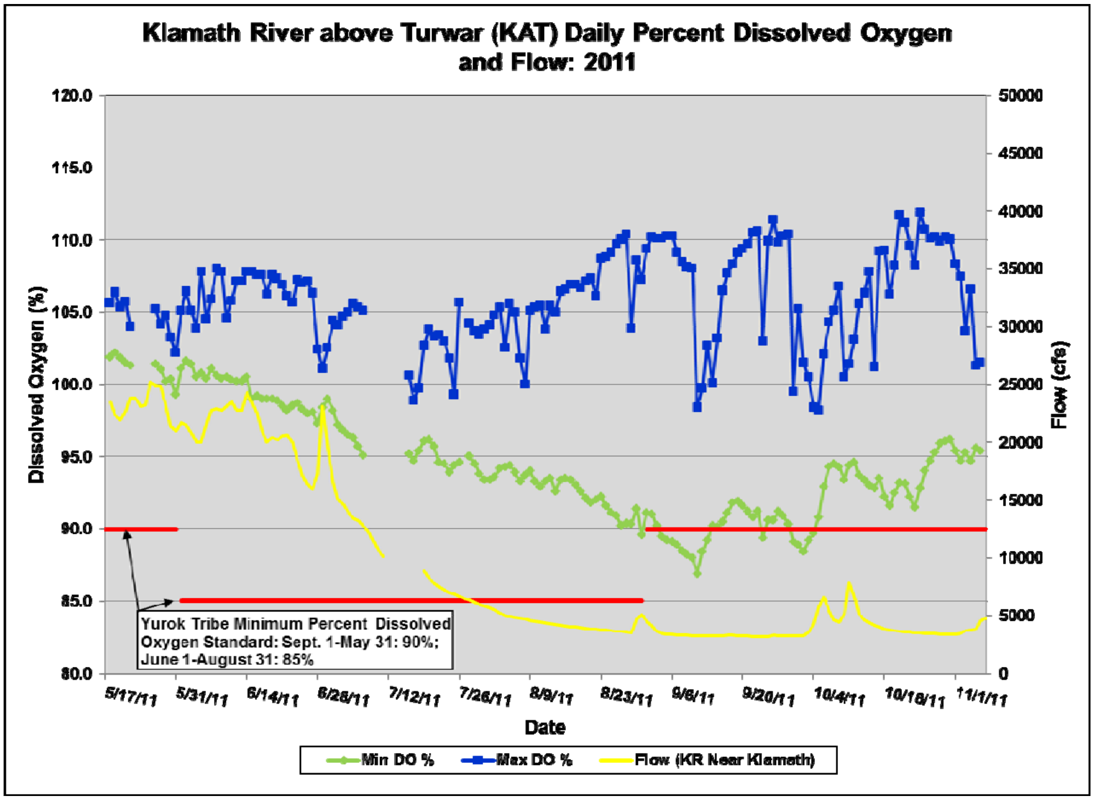

Figure 6-14. KAT Percent Dissolved Oxygen and Flow: 2011

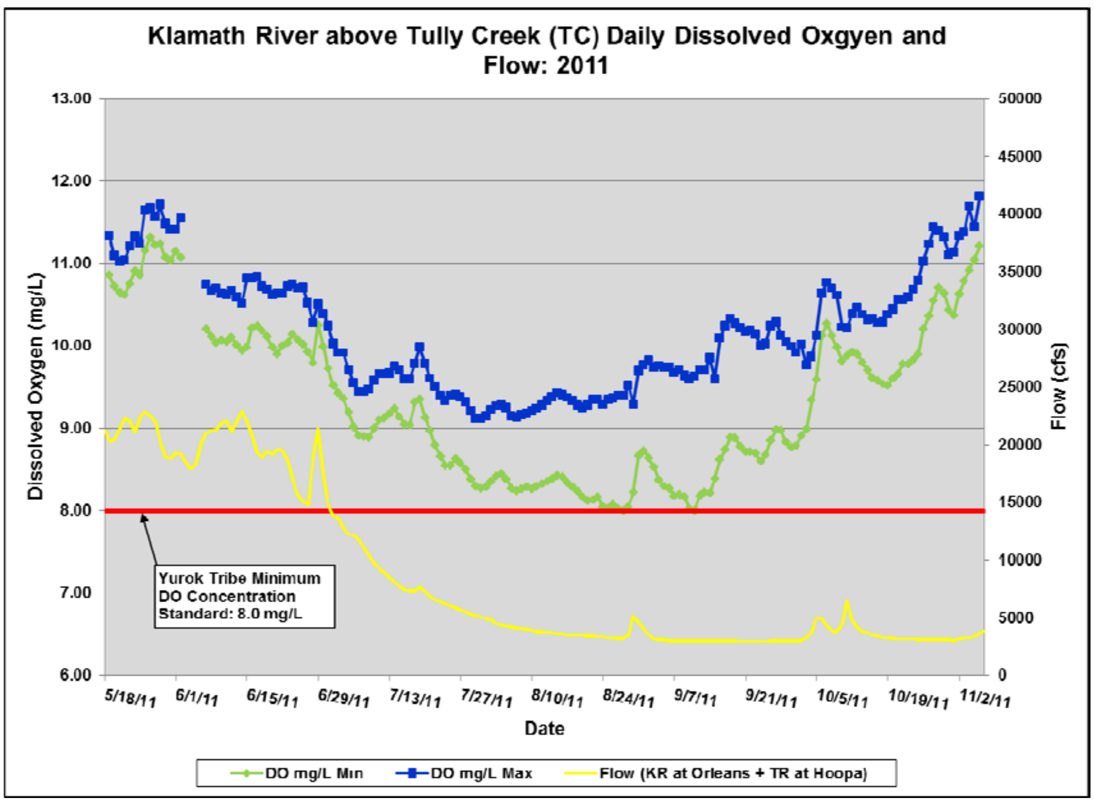

Figure 6-15. TC Dissolved Oxygen and Flow: 2011

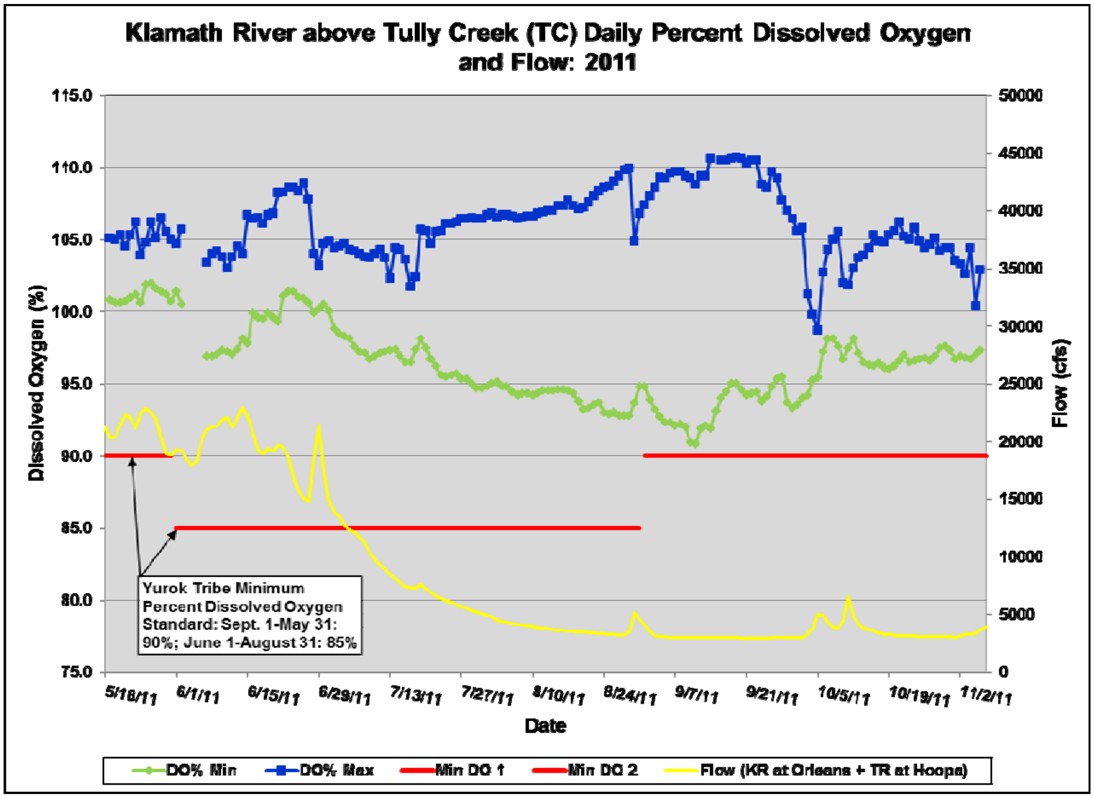

Figure 6-16. TC Percent Dissolved Oxygen and Flow: 2011

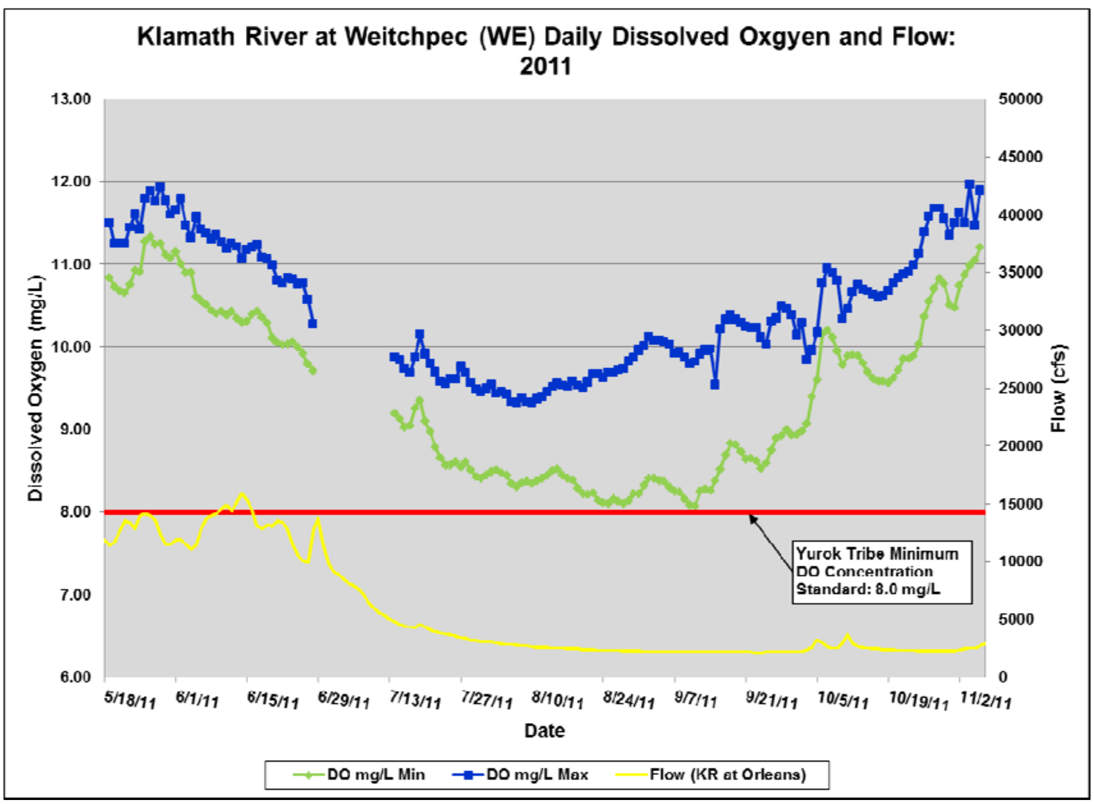

Figure 6-17. WE Dissolved Oxygen and Flow: 2011

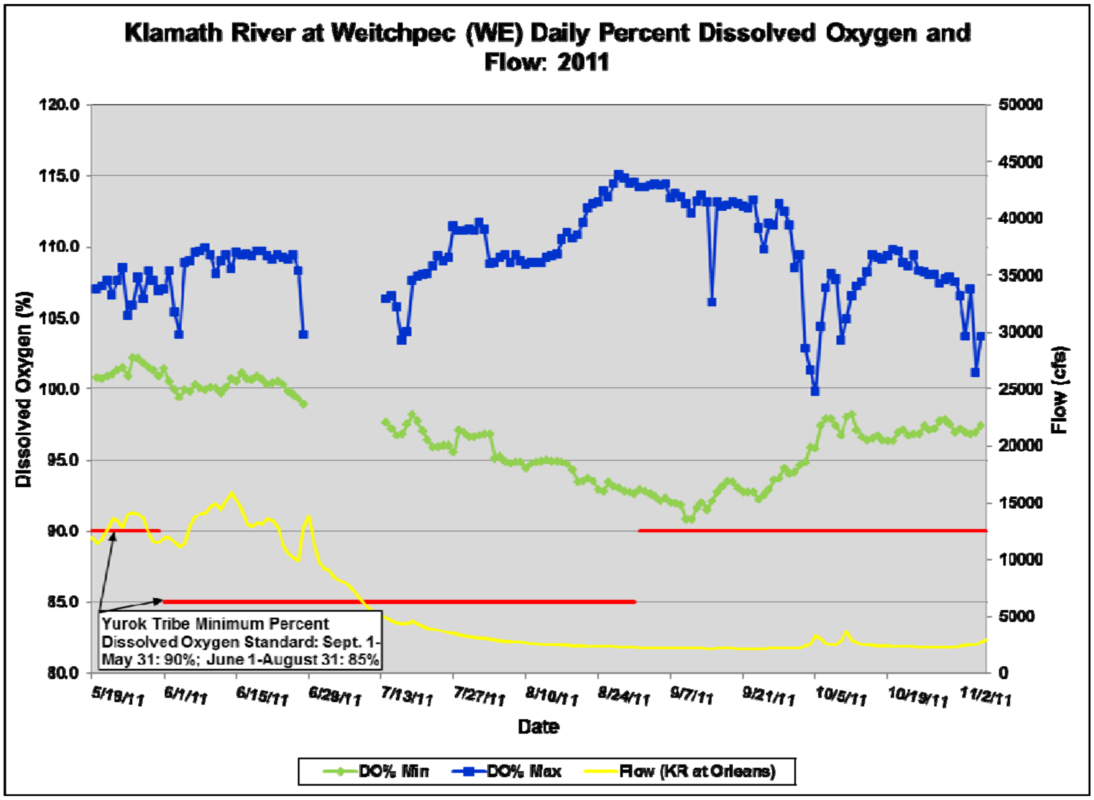

Figure 6-18. WE Percent Dissolved Oxygen and Flow: 2011

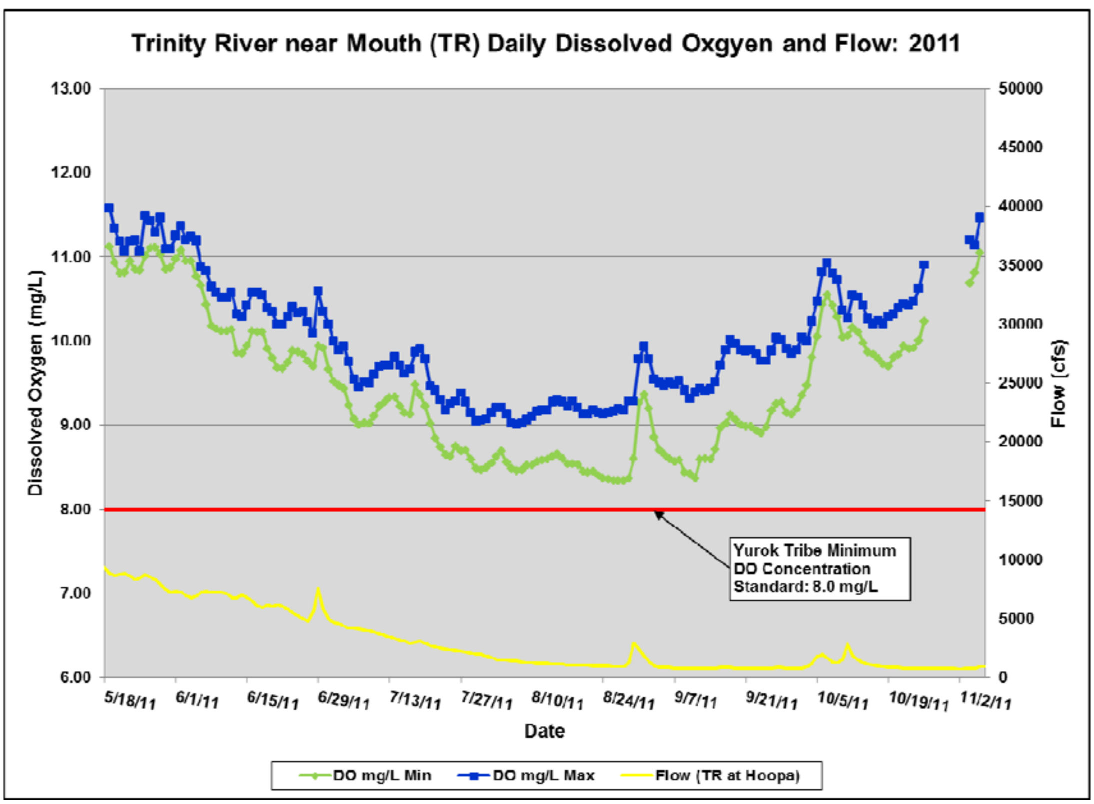

Figure 6-19. TR Dissolved Oxygen and Flow: 2011

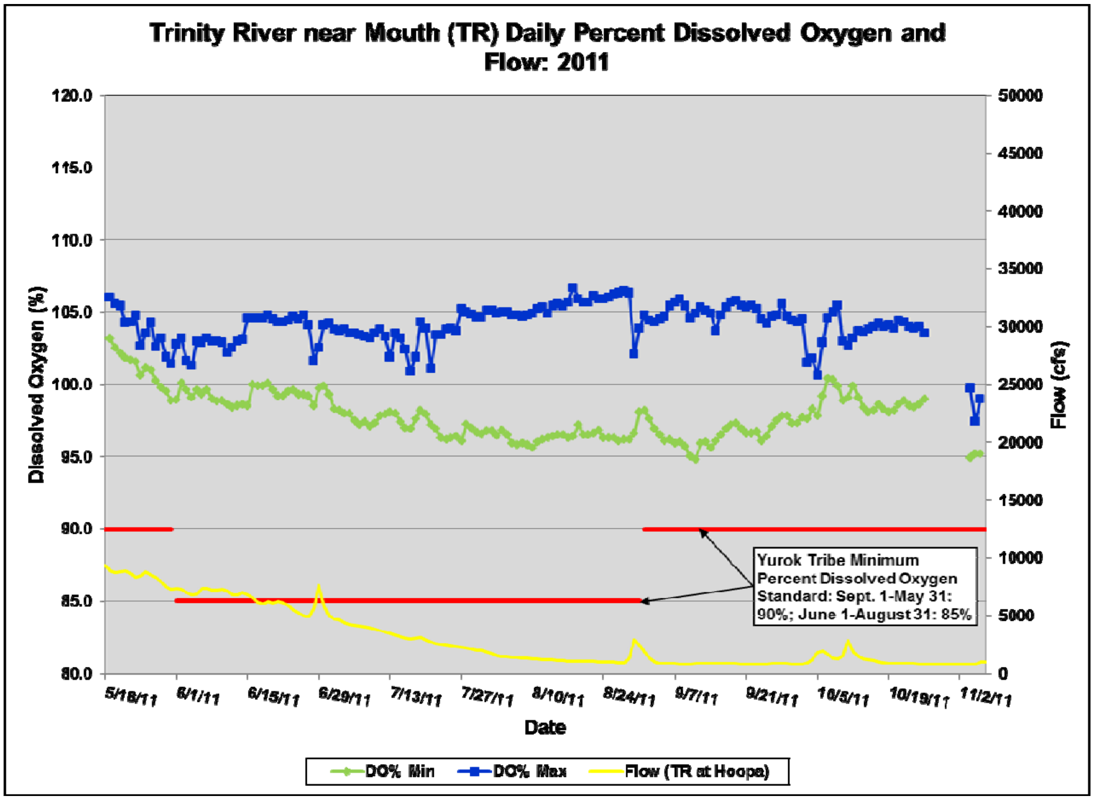

Figure 6-20. TR Percent Dissolved Oxygen and Flow: 2011

pH

All Riverine Sites

pH values on the lower Klamath and Trinity River varied greatly throughout the 2011 monitoring season. The lowest recorded pH was 7.73 at TC on June 29, while the highest recorded pH was 8.77 at WE on September 1.

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 2011 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)

Maximum pH at KAT generally increased from deployment in mid-May until early September, with a dip in late June (Figure 6-21). pH then decreased until mid-

September, followed by a gradual increase into late September. In early October, pH values decreased sharply, experienced a short dramatic spike, then decreased quickly again by mid-October. After mid-October, pH levels increased until late October; then decreased until datasonde extraction in early November.

The lowest pH recorded at KAT was 7.98 on June 30, while the highest recorded pH was 8.63 on October 25 (Figure 6-21). Daily maximum pH initially exceeded the standard of 8.5 on August 28, fluctuated around this value into early September then dropped below 8.5 on September 8. pH then steadily increased until it exceeded 8.5 from September 25-29. pH did not exceed 8.5 again until October 17, when it stayed above this value until November 2, rising above 8.5 again for one day on November 4. Daily maximum pH values exceeded the standard of 8.5, 19.88% of the time, or 32 out of 161 days. Measurements of pH surpassed 8.5 for 279 out of 7,911 readings, or 3.53% of all half-hour measurements during the 2011 monitoring season.

Klamath River above Tully Creek (TC)

Maximum pH at TC initially increased from mid-May until late May then decreased gradually until late June (Figure 6-22). In late June, pH decreased sharply then gradually increased until early August. Values then held steady until early October, with one dip in late August/early September. In early October, pH values decreased sharply, experienced a short dramatic spike, then decreased quickly again by mid-October. After mid-October, pH levels increased until late October, held generally steady until the beginning of November then decreased until datasonde extraction in early November.

The lowest recorded pH at TC was 7.73 on June 29, while the highest was 8.46 on May 30 and September 11 (Figure 6-22). At no point during the 2011 monitoring season did daily maximum pH exceed the standard of 8.5.

Klamath River at Weitchpec (WE)

Maximum pH at WE fluctuated around 8.5 from deployment in mid-May until late June, at which time pH decreased significantly (Figure 6-23). After this decrease, pH values rose steadily until late July then generally remained stable until early October. As with KAT and TC, pH values in early October decreased sharply, experienced a short dramatic spike, then decreased quickly again by mid-October. After mid-October, pH levels increased until late October then decreased until datasonde extraction in early November.

The lowest recorded pH at WE was 7.97 on June 15 and 21, while the highest was 8.77 on September 1 (Figure 6-23). Daily maximum pH initially exceeded the standard of 8.5 on May 19, fluctuated around this value until June 27, then dropped below 8.5 until late July. On July 25 pH exceeded 8.5 and remained above this value until October 2. After October 8, pH fluctuated around 8.5 until datasonde extraction in early November. Daily maximum pH values exceeded the standard of 8.5, 58.60% of the time, or 92 out of 157 days. Measurements of pH surpassed 8.5 for 1,175 out of 7,612 readings, or 15.44% of all half-hour measurements during the 2011 monitoring season.

Trinity River near Mouth (TR)

Maximum pH values at TR fluctuated around 8.25 from initial deployment in mid-May until late July (6-24). After late July, pH increased slowly until early August, after which values remained generally stable until datasonde extraction in early November, with dips in late August/early September and early October.

The lowest recorded pH at TR was 7.97 on June 29, while the highest pH was 8.46 on August 14-15 (Figure 6-24). At no point during the 2011 monitoring season did daily maximum pH exceed the standard of 8.5.

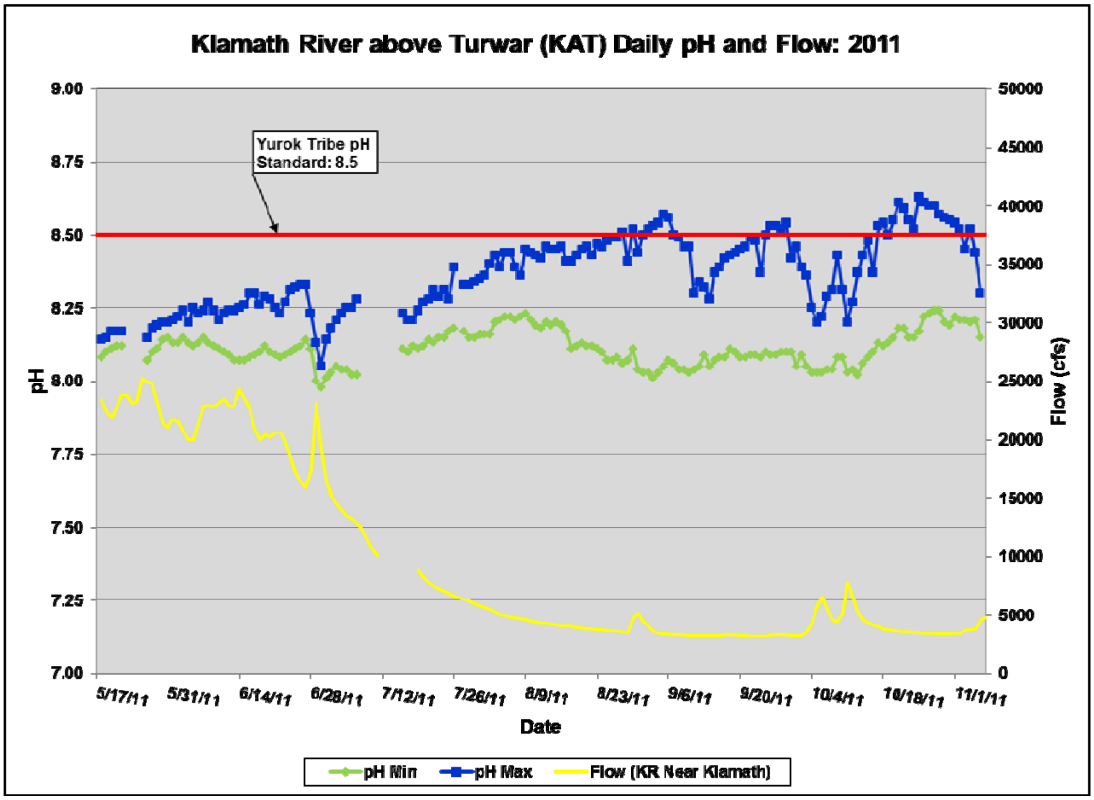

Figure 6-21. KAT Maximum/minimum pH and Flow: 2011

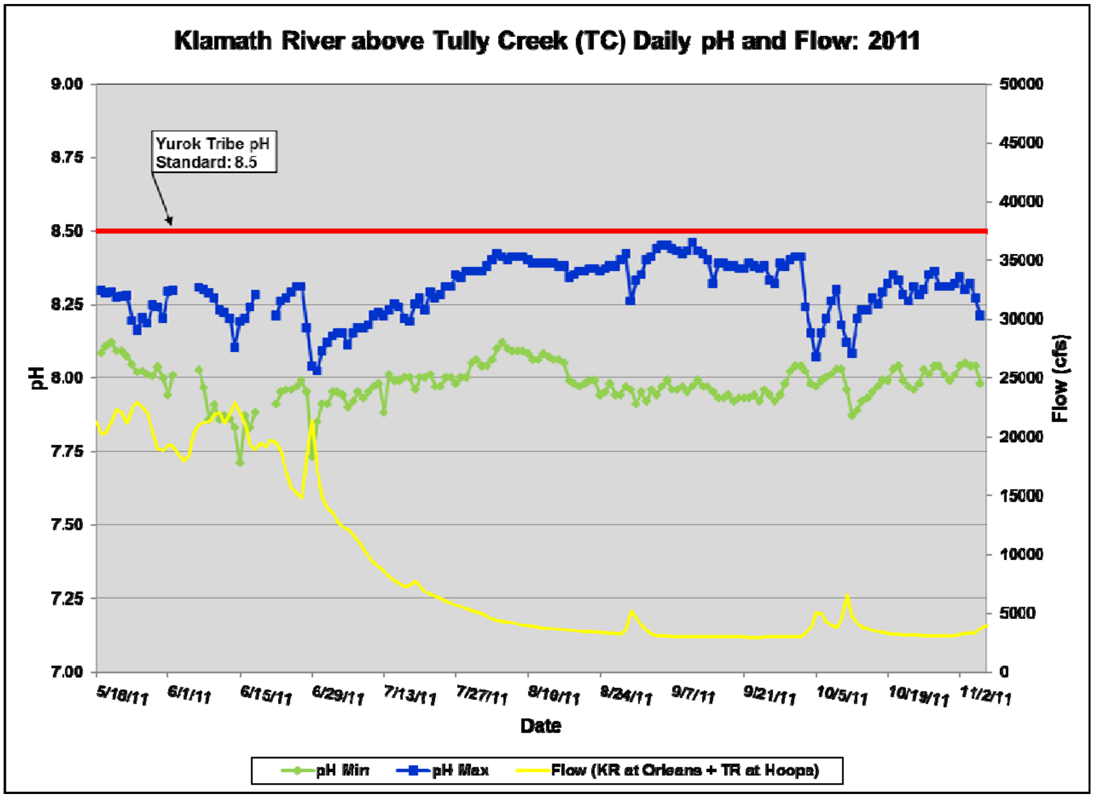

Figure 6-22. TC Maximum/minimum pH and Flow: 2011

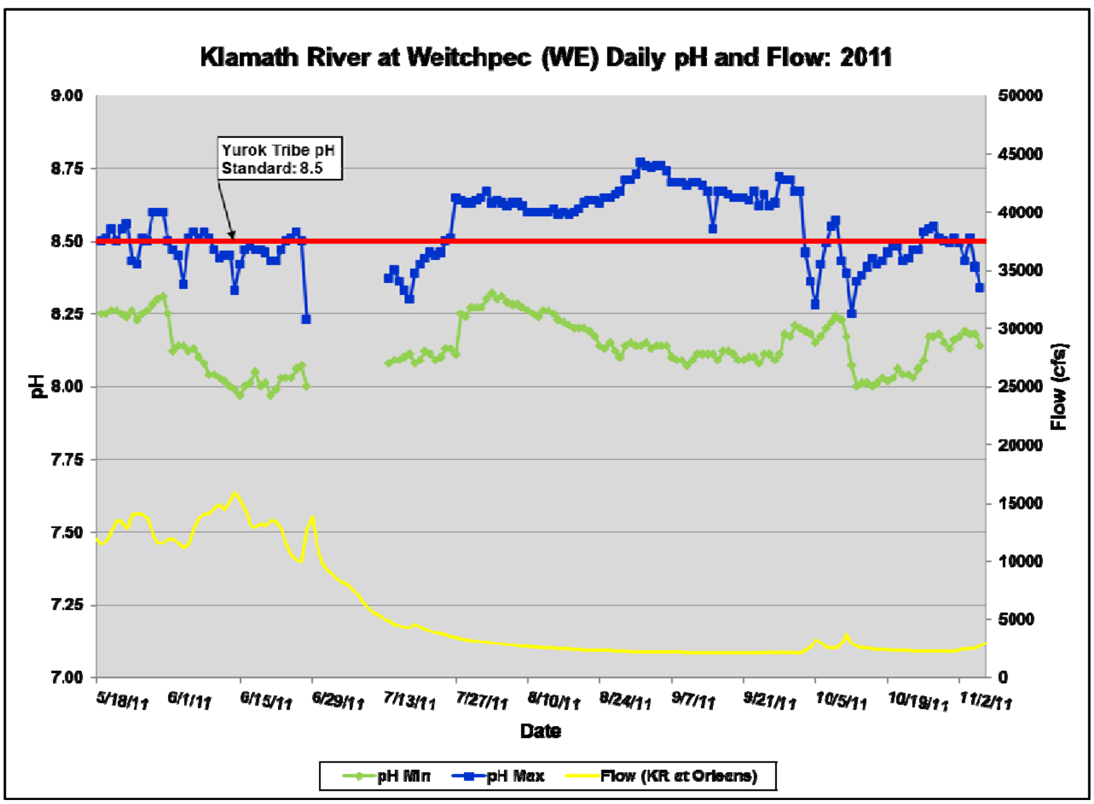

Figure 6-23. WE Maximum/minimum pH and Flow: 2011

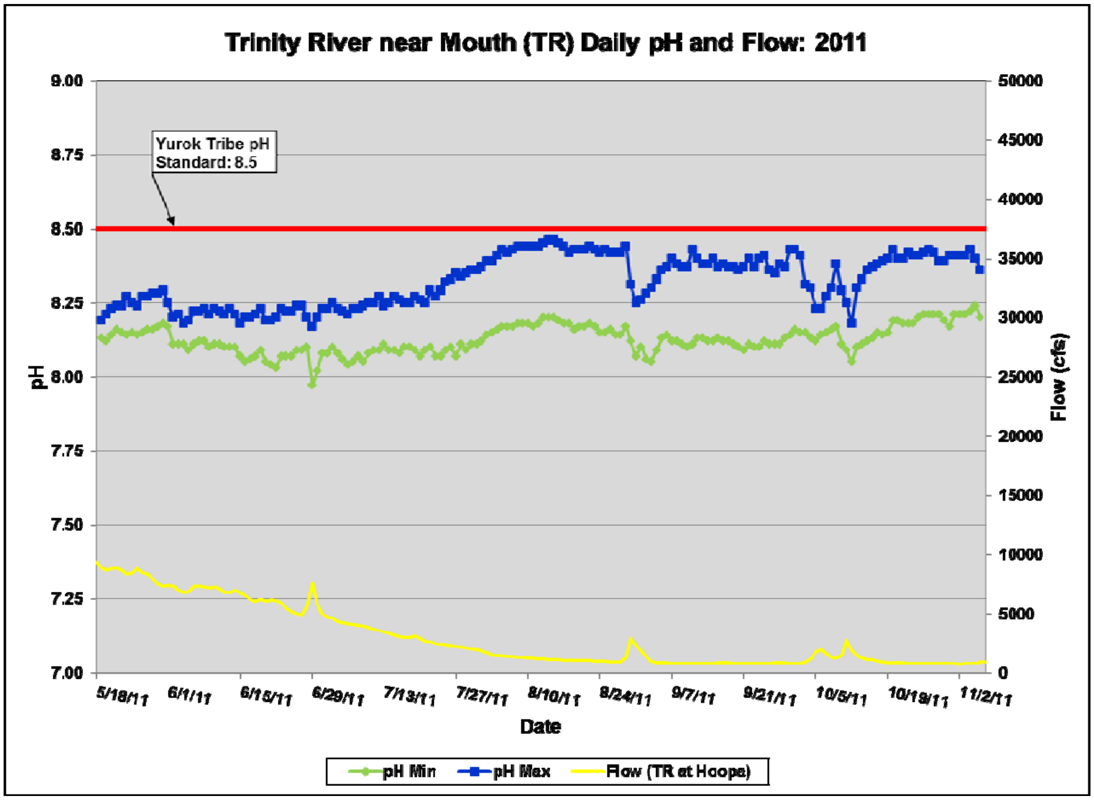

Figure 6-24. TR Maximum/minimum pH and Flow: 2011

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 2011 monitoring season. The highest specific conductivity recorded was 195 µS/cm at WE on November 3-4, while the lowest specific conductivity recorded was 81µS/cm at TR on June 29. 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 °C, and a 50% upper limit of 200 µS/cm at 25°C.

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)

Specific conductivity at KAT increased slightly initially, decreased in late May, then increased into early June (Figure 6-25). In early June specific conductivity decreased sharply. After early June values increased steadily until early November, with dips in late August, early October and mid-October. Specific conductivity values were decreasing when monitoring was suspended on November 7.

The lowest recorded specific conductivity reading at KAT was 84 µS/cm on June 29, while the highest recorded specific conductivity reading was 184 µS/cm on November 4 (Figure 6-25).

Klamath River above Tully Creek (TC)

Specific conductivity at TC increased slightly initially, decreased in late May, then increased into early June (Figure 6-26). In early June specific conductivity decreased sharply. After early June values increased steadily until early November, with dips in late June, late August, and early to mid-October. Specific conductivity values were decreasing when monitoring was suspended on November 7.

The lowest specific conductivity reading at TC was 82 µS/cm on June 29, while the highest recorded reading was 191 µS/cm on November 4 (Figure 6-26).

Klamath River at Weitchpec (WE)

Specific conductivity at WE decreased from deployment until late May, then increased until earl June (Figure 6-27). In early June specific conductivity decreased significantly until mid-June, then increased gradually until early November, with dips in early and mid-October. In early November, values began decreasing and were decreasing when datasondes were extracted on November 7.

The lowest recorded specific conductivity reading at WE was 82 µS/cm on June 28, while the highest recorded reading was 195 µS/cm on November 3-4 (Figure 6-27).

Trinity River near Mouth (TR)

Specific conductivity at TR decreased slightly from initial deployment in mid-May until late May (Figure 6-28). Values then increased slightly into early June, subsequently dropping until late June. After late June, specific conductivity increased steadily until mid-August, then generally held steady until early October, with a dip in late August. In early October there was a short, small spike in values, then a decrease in values into mid-October. After mid-October, specific conductivity increase quickly until late October, leveling out from late October into early November. Values were just beginning to decrease when datasondes were extracted on November 7.

The lowest recorded specific conductivity reading at TR was 81 µS/cm on June 29, while the highest recorded specific conductivity was 182 µS/cm on November 1-3 and November 5 (Figure 6-28).

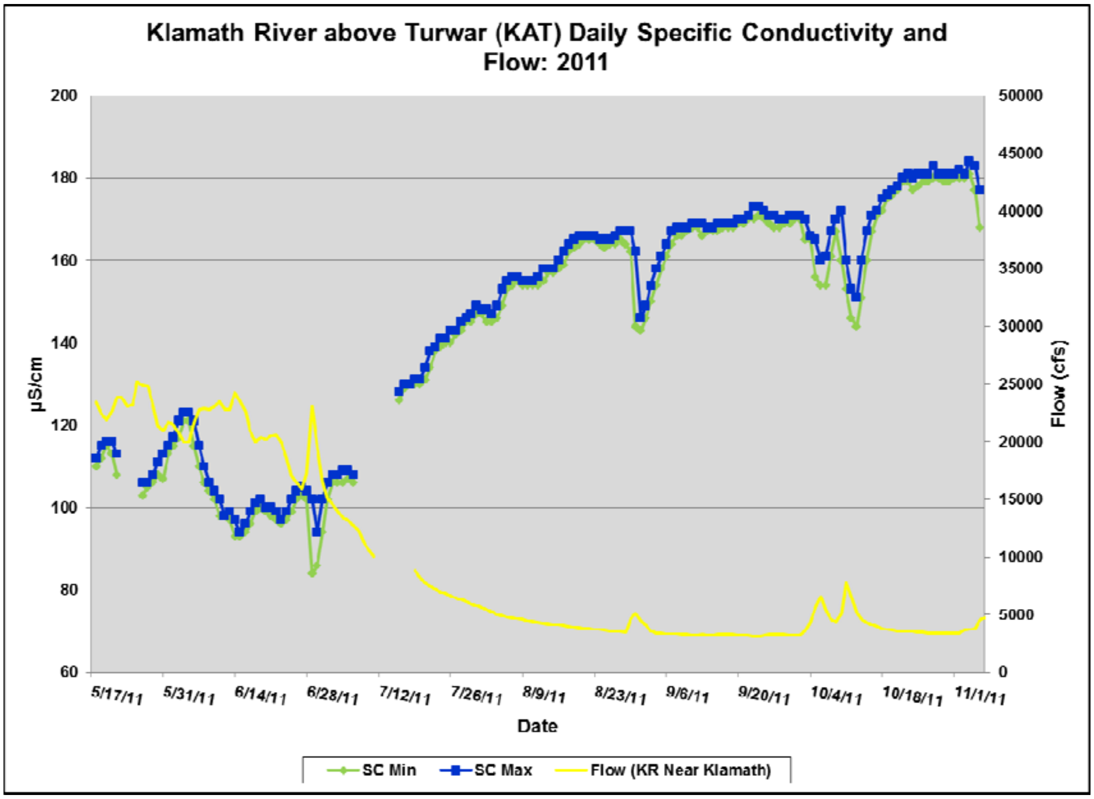

Figure 6-25. KAT Maximum/minimum Specific Conductivity and Flow: 2011

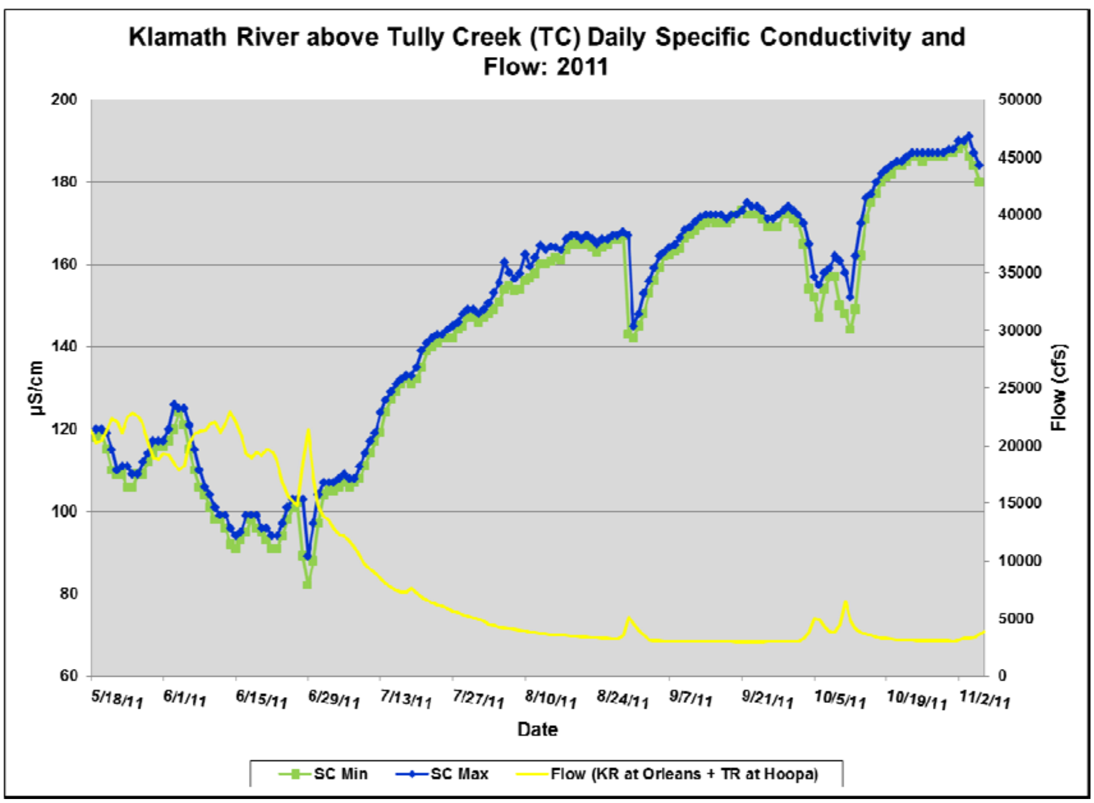

Figure 6-26. TC Maximum/minimum Specific Conductivity and Flow: 2011

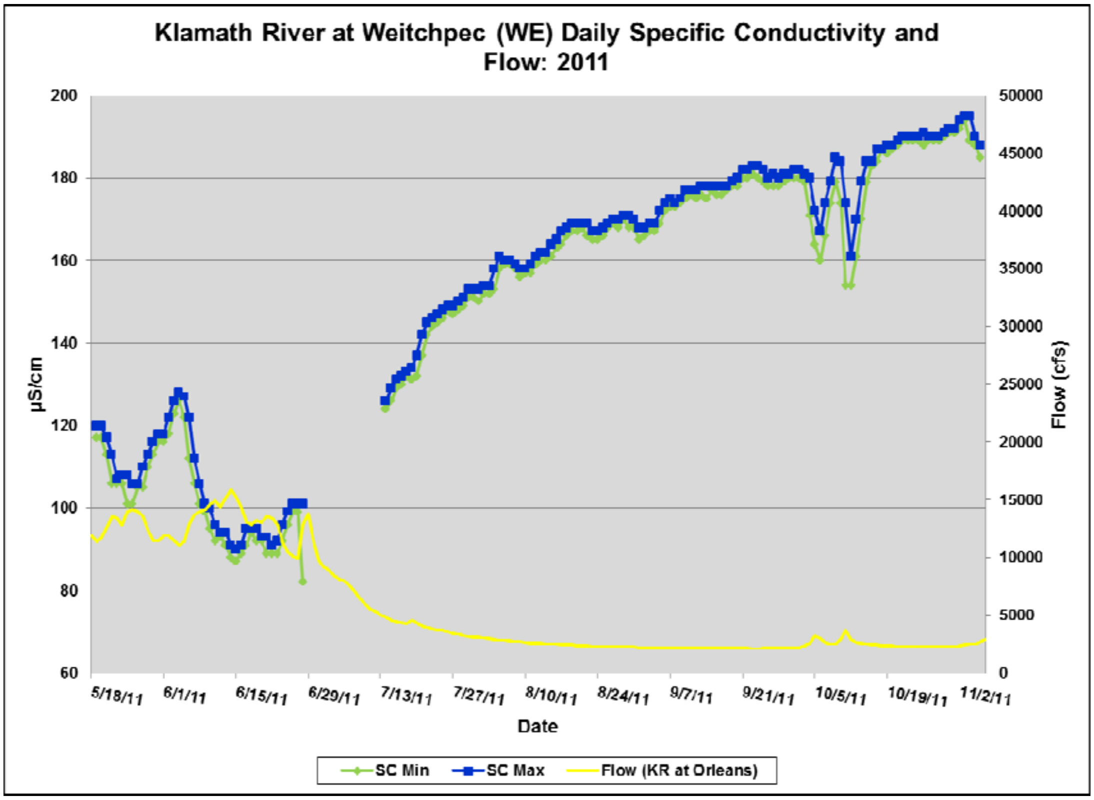

Figure 6-27. WE Maximum/minimum Specific Conductivity and Flow: 2011

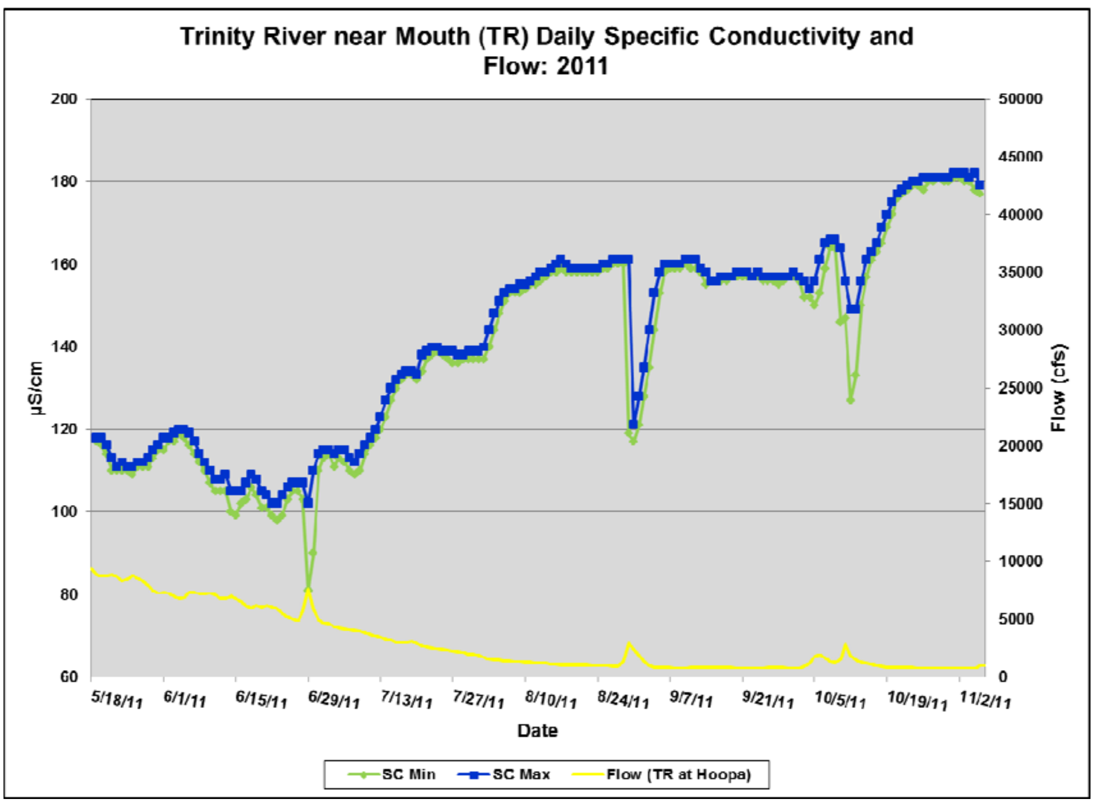

Figure 6-28. TR Maximum/minimum Specific Conductivity and Flow: 2011

VII. Discussion

Temperature

All Riverine Sites

From initial deployment in mid-May until late June, the highest daily maximum water temperatures tended to be recorded at TR (Figure 7-1). From late June to late September, the highest temperatures were recorded at WE. From late September into the beginning of October the highest temperatures were variable among sites, while from early October until extraction in early November, highest daily maximum temperatures tended to be recorded at KAT.

In the water temperature graphs shown in Section VI, 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 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 water temperature.

Klamath River above Turwar (KAT)

Rain events seem to have decreased maximum water temperature at KAT for short periods of time (Figures 6-1 and 6-2). During the period leading up to the rain event in late June, maximum water temperature was generally increasing. On June 30, however, maximum water temperature was 15.64°C, a reduction of 1.54°C from June 27. Prior to the rain event in early October, maximum water temperature was decreasing very slowly. On October 6, however, maximum water temperature was 14.82°C, a reduction of 3.88°C from October 2.

The pulse flow from Lewiston Dam on the Trinity River in late August also appears to have briefly influenced the maximum water temperature in the Lower Klamath River at KAT (Figures 6-1 and 6-2). Leading up to the pulse flow in late August, maximum water temperature was generally holding steady. On September 1, however, the maximum water temperature was 21.05°C, a reduction of 1.84°C from August 29.

Klamath River above Tully Creek (TC)

Rain events seem to have decreased maximum water temperature at TC for short periods of time (Figures 6-4 and 6-5). During the time leading up to the rain event in late June, maximum water temperature was slightly increasing. On June 29, however, maximum water temperature was 15.14°C, a reduction of 1.54°C from June 27. Prior to the rain event in early October, maximum water temperature was decreasing very slowly. On October 6, however, maximum water temperature was 13.87 °C, a reduction of 4.55°C from October 2.

The pulse flow from Lewiston Dam on the Trinity River in late August also appears to have briefly influenced the maximum water temperature in the Klamath River downstream of the confluence at TC (Figures 6-1 and 6-2). Leading up to the pulse flow in late August, maximum water temperature was generally holding steady. On September

1, however, maximum water temperature was 20.32°C, a reduction of 2.97°C from August 28.

Klamath River at Weitchpec (WE)

Rain events seem to have decreased maximum water temperature at WE for short periods of time (Figures 6-7 and 6-8). During the period leading up to the rain event in late June, maximum water temperature was slightly increasing. On June 29, however, maximum water temperature was 15.18°C, a reduction of 1.51°C from June 27. Prior to the rain event in early October, maximum water temperature was slowly decreasing. On October 6, however, maximum water temperature was 14.13°C, a reduction of 4.28°C from October 2.

Trinity River near Mouth (TR)

Rain events seem to have decreased maximum water temperature at TR for short periods of time (Figures 6-9 and 6-10). During the time leading up to the rain event in late June, maximum water temperature was holding steady. On June 29, however, maximum water temperature was 15.78 °C, a reduction of 1.02°C from June 27. Prior to the rain event in early October, maximum water temperature was decreasing very slowly. On October 6, however, maximum water temperature was 13.61°C, a reduction of 4.40°C from October 2.

The pulse flow from Lewiston Dam upstream on the Trinity River in late August also appears to have briefly influenced the maximum water temperature at TR (Figures 6-1 and 6-2). Leading up to the pulse flow in late August, maximum water temperature was slightly increasing. On September 1, however, maximum water temperature was 18.48°C, a reduction of 4.85°C from August 28.

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

During the 2011 monitoring season the Trinity River had a variable effect on water temperature in the Klamath River. From mid-May to late June, it appears that the Trinity River actually had a slight warming effect on the Klamath River, with daily maximum temperature at TC slightly higher than at WE (Figure 7-2). This warming effect was less than 0.5°C for most of this time period. From late June until late October it seems that the Trinity River had a slight cooling effect on the Klamath River, with the daily maximum temperature at TC was usually lower than at WE. Again, this cooling effect was less than 0.5°C for most of this time period. From late October until datasonde extraction in early November, the Trinity River again had a small warming 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 confluence with the Trinity River. 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). During this same period water temperature at WE decreased slightly, but the reduction was gradual over the course of nearly a week, while the reductions at KAT and TC happened over the course of 1-2 days.

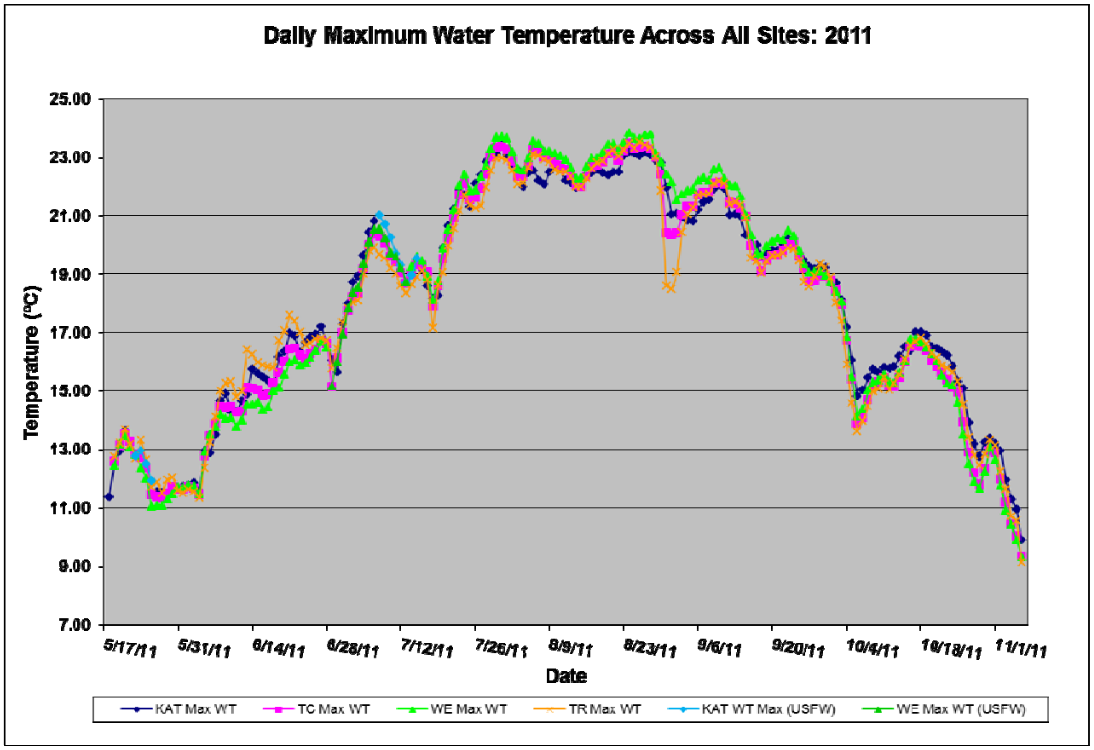

Figure 7-1.Daily Maximum Temperature Across All Sites: 2011

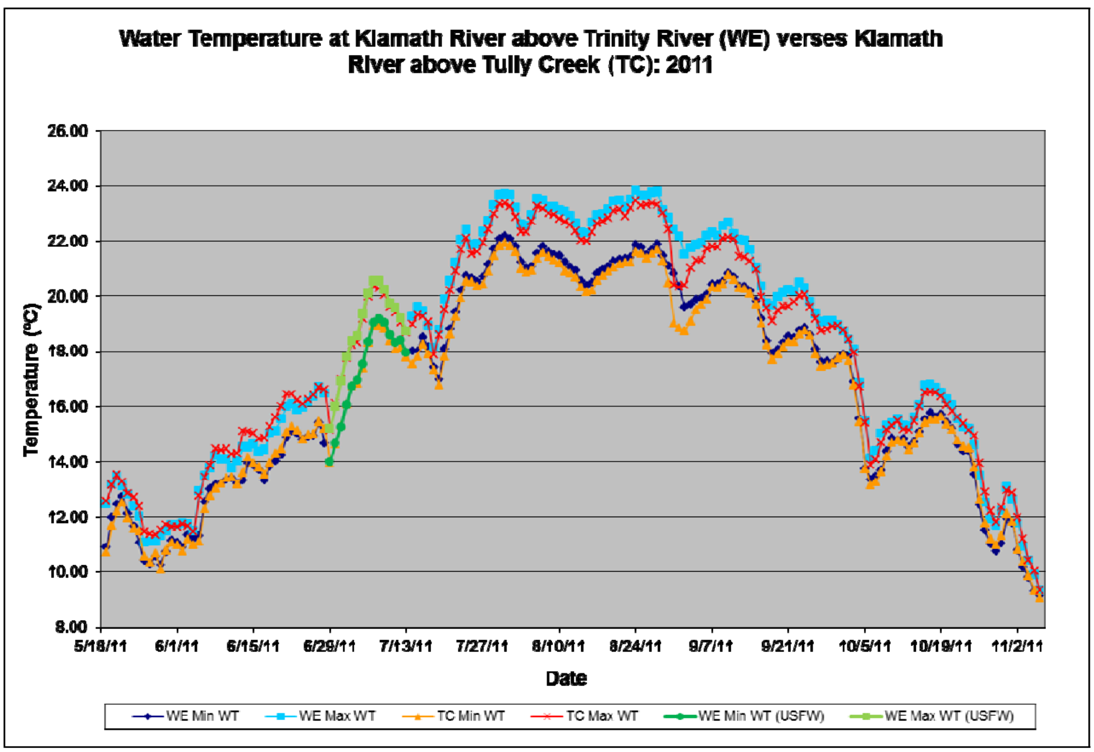

Figure 7-2.WE vs. TC Water Temperature: 2011

Dissolved Oxygen

All Riverine Sites

From mid-May to early June, daily minimum DO concentrations were usually highest at KAT (7-3). After early June, TR tended to have the highest daily minimum DO concentrations and after late October, WE tended to have the highest minimum DO concentrations.

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)

Rain events seem to have increased minimum DO concentrations at KAT for short periods of time (Figures 6-13 and 6-14). During the period leading up to the rain event in late June, minimum DO concentrations were generally decreasing. On June 30, however, minimum DO was 10.05 mg/L, an increase of 0.52 mg/L from June 28. Prior to the rain event in early October, minimum DO concentrations were decreasing slowly. On October 7, however, minimum DO was 9.84 mg/L, an increase of 1.51 mg/L from October 2.

The pulse flow from Lewiston Dam in late August also appears to have briefly influenced minimum DO concentrations at TC (Figures 6-13 and 6-14). Leading up to the pulse flow in late August, minimum DO was decreasing. On September 1, however, minimum DO was 8.46 mg/L, an increase of 0.50 mg/L from August 28.

Klamath River above Tully Creek (TC)

Rain events seem to have increased minimum DO concentrations at TC for short periods of time (Figures 6-15 and 6-16). During the time leading up to the rain event in late June, minimum DO concentrations were decreasing. On June 29, however, minimum DO was 10.25 mg/L, an increase of 0.45 mg/L from June 28. Prior to the rain event in early October, minimum DO concentrations were slightly decreasing. On October 7, however, minimum DO was 10.27 mg/L, an increase of 1.36 mg/L from October 2.

The pulse flow from Lewiston Dam in late August also appears to have briefly influenced minimum DO concentrations at TC (Figures 6-15 and 6-16). Leading up to the pulse flow in late August, minimum DO was generally holding steady. On September 1, however, minimum DO was 8.72 mg/L, an increase of 0.72 mg/L from August 28.

Klamath River at Weitchpec (WE)

Rain events seem to have increased minimum DO concentrations at WE for short periods of time (Figures 6-17 and 6-18). Prior to the rain event in early October, minimum DO concentrations were increasing slightly. On October 7, however, minimum DO was 10.20 mg/L, an increase of 1.22 mg/L from October 2.

Trinity River near Mouth (TR)

Rain events seem to have increased minimum DO concentrations at TR for short periods of time (Figures 6-19 and 6-20). During the time leading up to the rain event in late June, minimum DO concentrations were decreasing. On June 29, however, minimum DO was 9.94 mg/L, an increase of 0.20 mg/L from June 28. Prior to the rain event in early October, minimum DO concentrations were slightly increasing. On October 7, however, minimum DO was 10.55 mg/L, an increase of 1.20 mg/L from October 2.

The pulse flow from Lewiston Dam in late August also 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 slowly decreasing. On September 1, however, minimum DO was 9.36 mg/L, an increase of 1.02 mg/L from August 28.

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

During the 2011 monitoring season it appears that the Trinity River had little to no effect on DO concentrations in the Klamath River with both minimum and maximum DO concentrations at TC generally lower than minimum and maximum DO concentrations at WE (Figure 7-4). The pulse flow from Lewiston at the end of August/early September appeared to have increased DO concentrations at TC. Daily minimum and maximum DO concentrations showed a more dramatic increase at TC than the general upward trend that occurred at WE at the time the pulse flow reached TC (Figure 6-15 and 6-16).

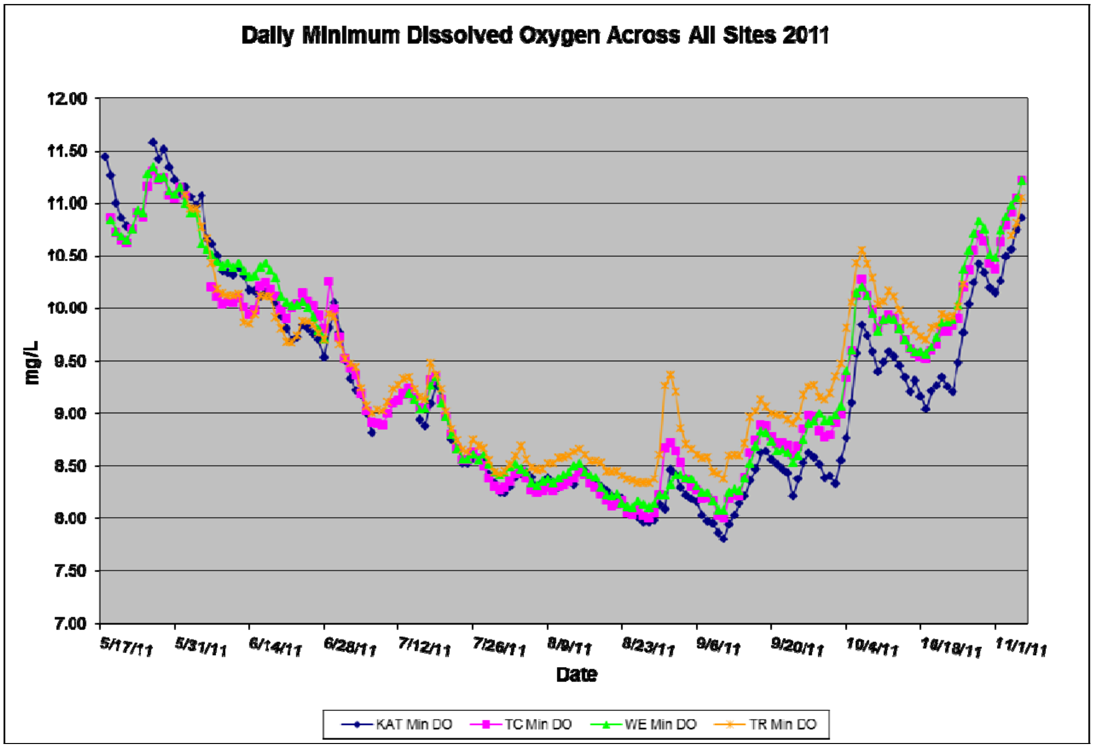

Figure 7-3.Daily Minimum Dissolved Oxygen Across All Sites: 2011

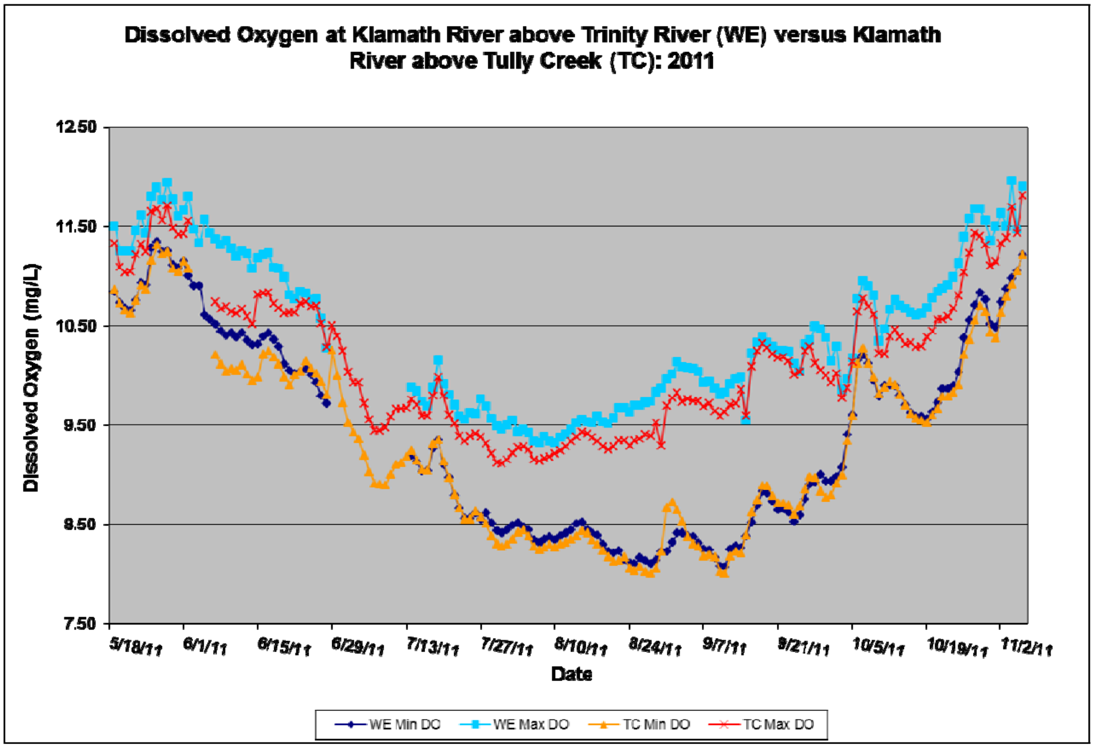

Figure 7-4.WE vs. TC Dissolved Oxygen: 2011

pH

All Riverine Sites

Throughout a majority of the 2011 monitoring season, WE had the highest maximum pH values of all sites (Figure 7-5). The exception to this was a period from late October to early November in which KAT had the highest maximum pH values.

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 time leading up to the rain event in late June, pH was slightly increasing. On June 30, however, maximum pH was 8.05, a decrease of 0.28 from June 27. As in June, pH values leading up to the rain event in late October were increasing. This rain event, which was actually two pulses of rain over the course of a week (Figure 6-21), reduced pH values twice. During the first pulse of water, maximum pH dropped to 8.20 on October 5, a decrease of 0.26 from October 1. During the second pulse, maximum pH dropped to 8.20 on October 11, a reduction of 0.23 from October 9.

The pulse flow from Lewiston Dam in late August appears to have influenced maximum pH at KAT very minimally, if at all (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 30, however, maximum pH was 8.02, a decrease of 0.29 from June 27. pH values leading up to the rain event in late October were generally holding steady. This rain event, which was actually two pulses of rain over the course of a week (Figure 6-22), reduced pH values twice. During the first pulse of water, maximum pH dropped to 8.07 on October 5, a decrease of 0.34 from October 2. During the second pulse, maximum pH dropped to 8.08 on October 12, a reduction of 0.22 from October 9.

The pulse flow from Lewiston Dam in late August also appears to have briefly influenced pH at TC (Figure 6-22). Leading up to the pulse flow in late August, maximum pH was slowly increasing. On August 30, however, maximum pH was 8.26, a reduction of 0.16 from August 29.

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 rain event in late June, pH was slightly increasing. On June 28, which is the last day data is available before an equipment malfunction, maximum pH was 8.23, a decrease of 0.27 from June 27. pH values leading up to the rain event in late October were slightly dropping. This rain event, which was actually two pulses of rain over the course of a week (Figure 6-23), reduced pH values twice. During the first pulse of water, maximum pH dropped to 8.28 on October 5, a decrease of 0.39 from October 2. During the second pulse, maximum pH dropped to 8.39 on October 11, a reduction of 0.18 from October 9. Both of these pulses of water reduced maximum pH values below the standard of 8.5 for short periods of time.

Trinity River near Mouth (TR)

Rain events seem to have decreased daily maximum pH at TR for short periods of time (Figure 6-24). pH values leading up to the rain event in late October were slightly increasing. This rain event, which was actually two pulses of rain over the course of a week (Figure 6-24), reduced pH values twice. During the first pulse of water, maximum pH dropped to 8.23 on October 5, a decrease of 0.18 from October 2. During the second pulse, maximum pH dropped to 8.18 on October 12, a reduction of 0.20 from October 9.

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 holding steady. On August 31, however, maximum pH was 8.25, a reduction of 0.19 from August 29.

Impacts of the Trinity River on pH in the Klamath River

During the 2011 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 entire monitoring season. During this time period, however, daily maximum pH at TR was not always lower than TC (late June to late August and late September to early November). 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.

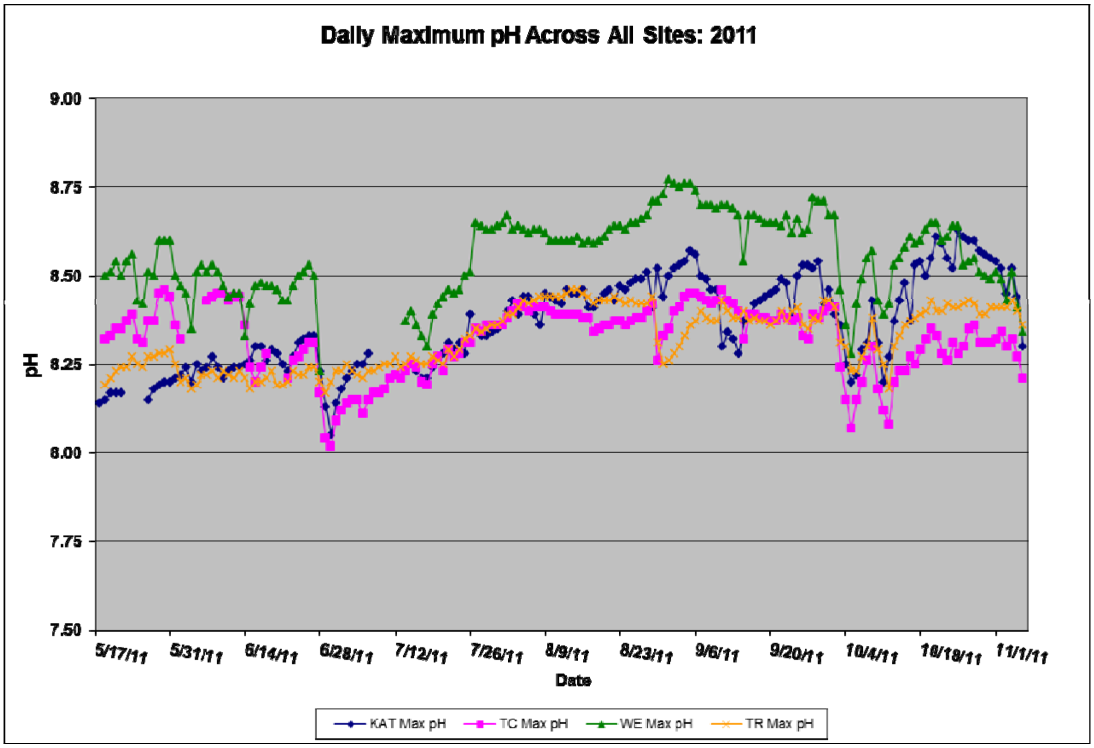

Figure 7-5. Daily Maximum pH Across All Sites: 2011

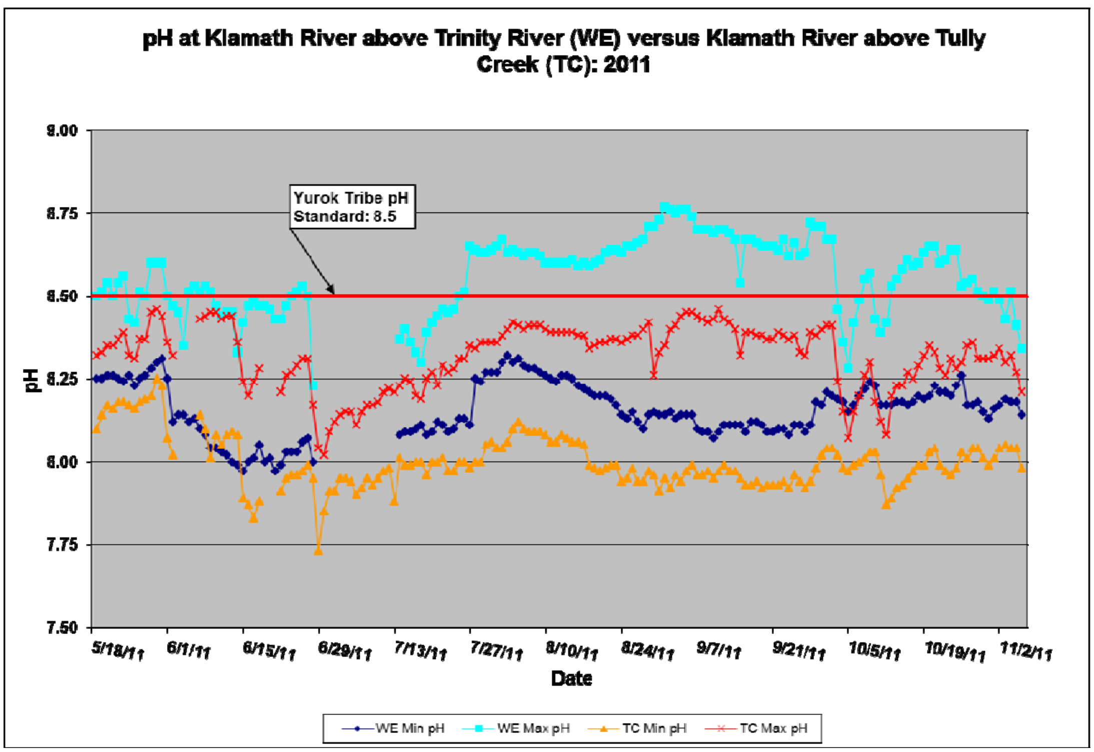

Figure 7-6. WE vs. TC pH: 2011

Specific Conductivity

All Riverine Sites

From mid-May to early June, the highest daily maximum specific conductivity was variable among sites (Figure 7-7). From early June to mid-July the highest readings were recorded at TR, while from mid-July to extraction in early November, the highest specific conductivity readings were recorded at WE.

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 rain event in late June, specific conductivity was slowly increasing. On June 29, however, maximum specific conductivity was 84 µS/cm, a decrease of 19 µS/cm from June 27. Specific conductivity values leading up to the rain event in late October were generally holding steady. This rain event, which was actually two pulses of rain over the course of a week (Figure 6-25), reduced specific conductivity values twice. During the first pulse of water, maximum specific conductivity dropped to 160 µS/cm on October 6, a decrease of 10 µS/cm from October 3. During the second pulse, maximum specific conductivity dropped to 151 µS/cm on October 13, a decrease of 21 µS/cm from October 10.

The pulse flow from Lewiston Dam in late August also appears to have briefly influenced specific conductivity at KAT (Figure 6-25). Leading up to the pulse flow in late August, maximum specific conductivity was generally holding steady. On September 1, however, maximum specific conductivity dropped to 146 µS/cm, a reduction of 21 µS/cm from August 30.

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 rain event in late June, specific conductivity was slowly increasing. On June 29, however, maximum specific conductivity was 89 µS/cm, a decrease of 14 µS/cm from June 28. Specific conductivity values leading up to the rain event in late October were generally holding steady. This rain event, which was actually two pulses of rain over the course of a week (Figure 6-26), reduced specific conductivity values twice. During the first pulse of water, maximum specific conductivity dropped to 155 µS/cm on October 6, a decrease of 17 µS/cm from October 2. During the second pulse, maximum specific conductivity dropped to 152 µS/cm on October 12, a decrease of 10 µS/cm from October 9.

The pulse flow from Lewiston Dam in late August also appears to have briefly influenced specific conductivity at TC (Figure 6-26). Leading up to the pulse flow in late August, maximum specific conductivity was generally holding steady. On August 31, however, maximum specific conductivity dropped to 145 μS/cm, a reduction of 23 μS/cm from August 29.

Klamath River at Weitchpec (WE)

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 rain event in late June, specific conductivity was increasing. Due to equipment malfunctions, data was not collected for most of this rain event and maximum specific conductivity data is not available. On June 28, however, minimum specific conductivity was 82 μS/cm, a decrease of 17 μS/cm from June 27. It can be assumed, based on other sites in the Klamath Basin during this time period, that maximum specific conductivity decreased by a similar amount during this period. Specific conductivity values leading up to the rain event in late October were generally holding steady. This rain event, which was actually two pulses of rain over the course of a week (Figure 6-27), reduced specific conductivity values twice. During the first pulse of water, maximum specific conductivity dropped to 167 μS/cm on October 6, a decrease of 15 μS/cm from October 2. During the second pulse, maximum specific conductivity dropped to 161 μS/cm on October 12, a decrease of 24 μS/cm from October 9.

Trinity River near Mouth (TR)

Rain events seem to have decreased daily maximum specific conductivity at TR for short periods of time (Figure 6-28). Specific conductivity values leading up to the rain event in late October were generally holding steady. This rain event, which was actually two pulses of rain over the course of a week (Figure 6-26), seems to have affected specific conductivity values in two different ways. During the first pulse of water, maximum specific conductivity increased to 166 μS/cm on October 8, an increase of 12 μS/cm from October 4. During the second pulse, maximum specific conductivity dropped to 149 μS/cm on October 12, a decrease of 17 μS/cm from October 9.

The pulse flow from Lewiston Dam in late August also appears to have briefly influenced specific conductivity at TR (Figure 6-28). Leading up to the pulse flow in late August, maximum specific conductivity was generally holding steady. On August 31, however, maximum specific conductivity dropped to 121 μS/cm, a reduction of 40 μS/cm from August 29.

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

From mid-May to mid-July the Trinity River tended to increase daily maximum specific conductivity in the Klamath River, with higher 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 higher than daily maximum specific conductivity at WE during this period. From mid-July to early November this trend was reversed with the Trinity River usually lowering daily maximum specific conductivity on the Klamath River. During this time daily maximum specific conductivity at TC tended to be lower than daily minimum specific conductivity at WE (Figure 7-8).

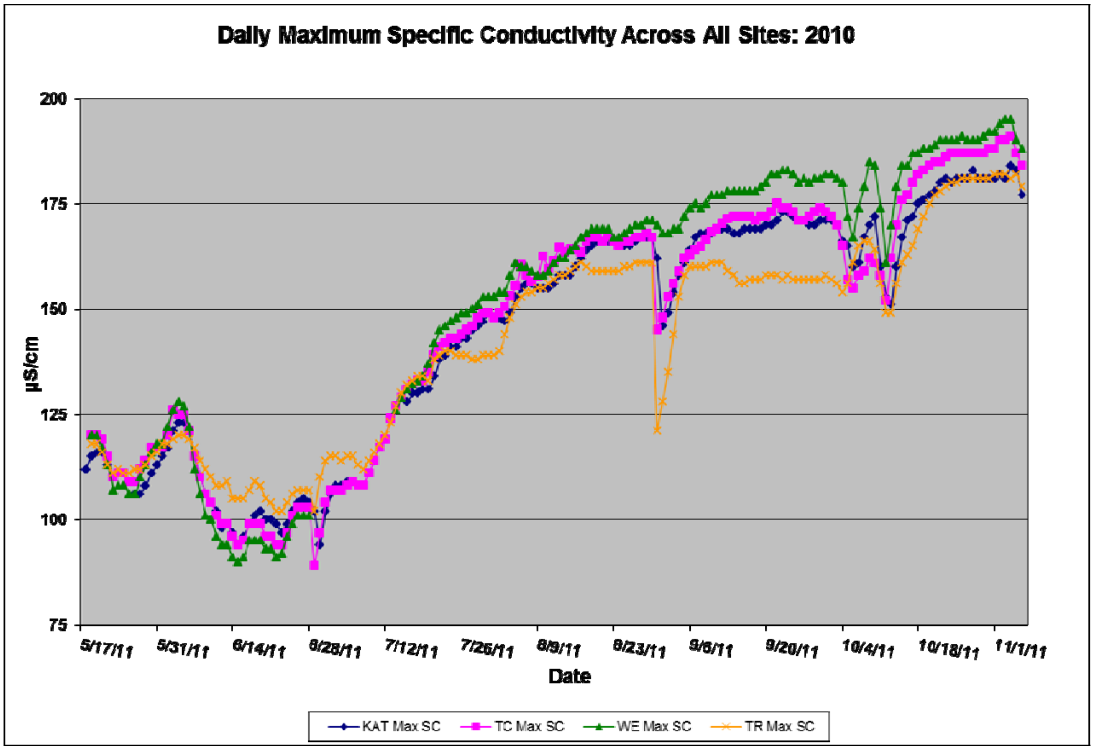

Figure 7-7. Daily Maximum Specific Conductivity Across All Site: 2011

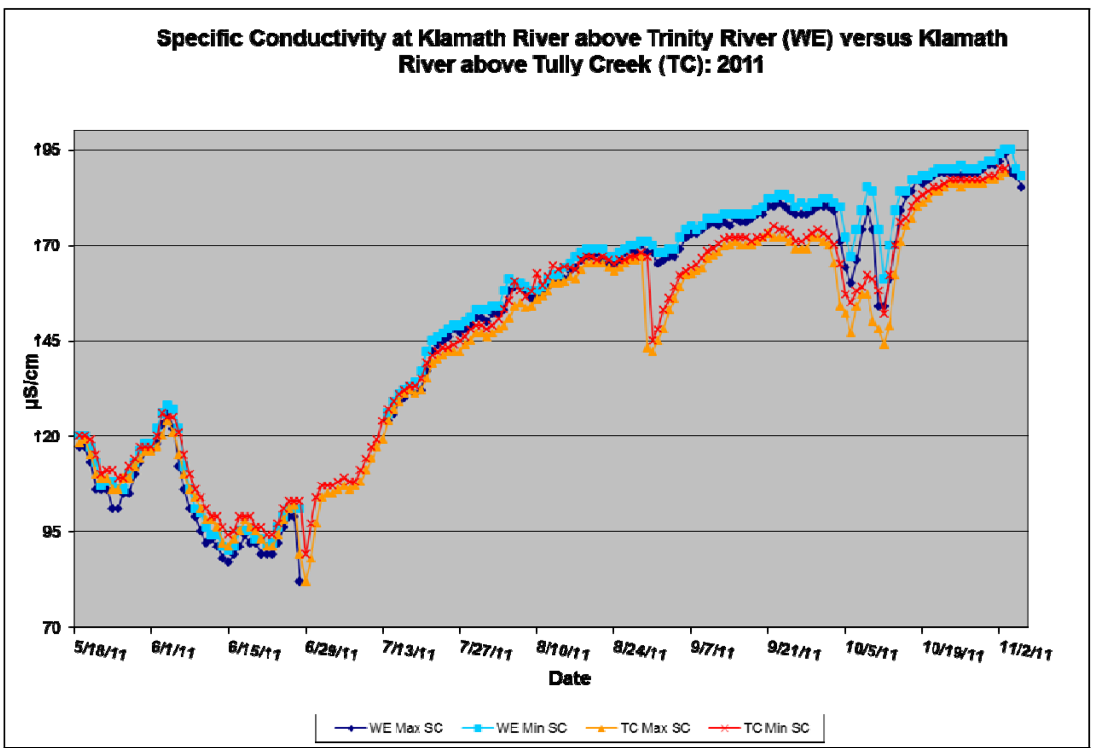

Figure 7-8. WE vs. TC Specific Conductivity: 2011

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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 al of the sondors 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 Weitchpecor 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 datalogger.**

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 sondeDO 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 datasondeto 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, highlightcalibrate 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,**Record 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 Sp Cond 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 Riverdo 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 datacable, 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 kim 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 sondesthat are not hooked up to a datalogger

Before postcalibrating 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.

During the 2011 monitoring year no grades of 'D' or poorer were generated (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: 2011

Table B-2. KAT Grades 2011				
Date	Water Temperature Grade	Specific Conductivity Grade	pH Grade	Dissolved Oxygen Grade
5/17/2011	A	A	B	B
5/31/2011	A	A	B	A
6/14/2011	A	A	A	A
6/30/2011	A	A	A	A
7/12/2011	A	A	A	A
7/26/2011	A	A	A	A
8/2/2011	A	A	A	A
8/17/2011	A	A	A	A
8/30/2011	A	A	A	A
9/13/2011	A	A	A	A
9/27/2011	A	A	A	A
10/11/2011	A	A	A	A
10/25/2011	A	A	A	A

Table B-3. TC Grades: 2011

Table B-3. TC Grades 2011				
Date	Water Temperature Grade	Specific Conductivity Grade	pH Grade	Dissolved Oxygen Grade
5/18/2011	A	A	B	A
6/1/2011	A	A	A	A
6/15/2011	A	A	A	A
6/29/2011	A	A	A	A
7/13/2011	A	A	A	A
7/27/2011	A	A	A	A
8/3/2011	A	A	A	A
8/18/2011	A	A	A	A
9/1/2011	A	A	A	A
9/14/2011	A	A	A	A
9/28/2011	A	A	A	A
10/12/2011	A	A	A	A
10/26/2011	A	A	A	A

Table B-4. WE Grades: 2011

Table B-4. WE Grades 2011				
Date	Water Temperature Grade	Specific Conductivity Grade	pH Grade	Dissolved Oxygen Grade
5/18/2011	A	A	A	A
6/1/2011	A	A	A	A
6/15/2011	A	A	A	A
7/13/2011	A	A	A	A
7/27/2011	A	A	A	A
8/3/2011	A	A	A	A
8/18/2011	A	A	A	A
9/1/2011	A	A	A	A
9/14/2011	A	A	A	A
9/28/2011	A	A	A	A
10/12/2011	A	A	B	A
10/26/2011	A	A	A	A

Table B-5. TR Grades: 2011

Table B-5. TR Grades 2011				
Date	Water Temperature Grade	Specific Conductivity Grade	pH Grade	Dissolved Oxygen Grade
5/18/2011	A	A	A	C
6/1/2011	A	A	A	B
6/15/2011	A	A	A	A
6/29/2011	A	A	A	A
7/13/2011	A	A	A	B
7/27/2011	A	A	A	B
8/3/2011	A	A	A	A
8/18/2011	A	A	A	A
9/1/2011	A	A	A	A
9/14/2011	A	A	A	A
9/28/2011	A	A	A	A
10/12/2011	A	A	A	A
10/26/2011	A	A	A	A