FINAL
2010 Klamath River Nutrient Summary Report

Yurok Tribe Environmental Program:
Water Division

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Acknowledgements

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I. **Introduction**

This report summarizes the presence and concentration of commonly occurring nutrients on the Klamath River during the 2010 sampling season. The Yurok Tribe Environmental Program (YTEP) collected water samples at several monitoring sites from Weitchpec to the Klamath River Estuary in mid-February and mid-April, moved to a bi-weekly interval starting in mid-May and ending in mid-October, followed by monthly sampling in November and December. This sampling 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' nutrient data as part of an endeavor to build a multi-year database on the Lower Klamath River. This nutrient 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. Sample events were coordinated with the Karuk and Hoopa Tribes, PacifiCorp, and the Bureau of Reclamation to collect samples during the same day and with comparable methods to expand our understanding of the nutrient 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 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.

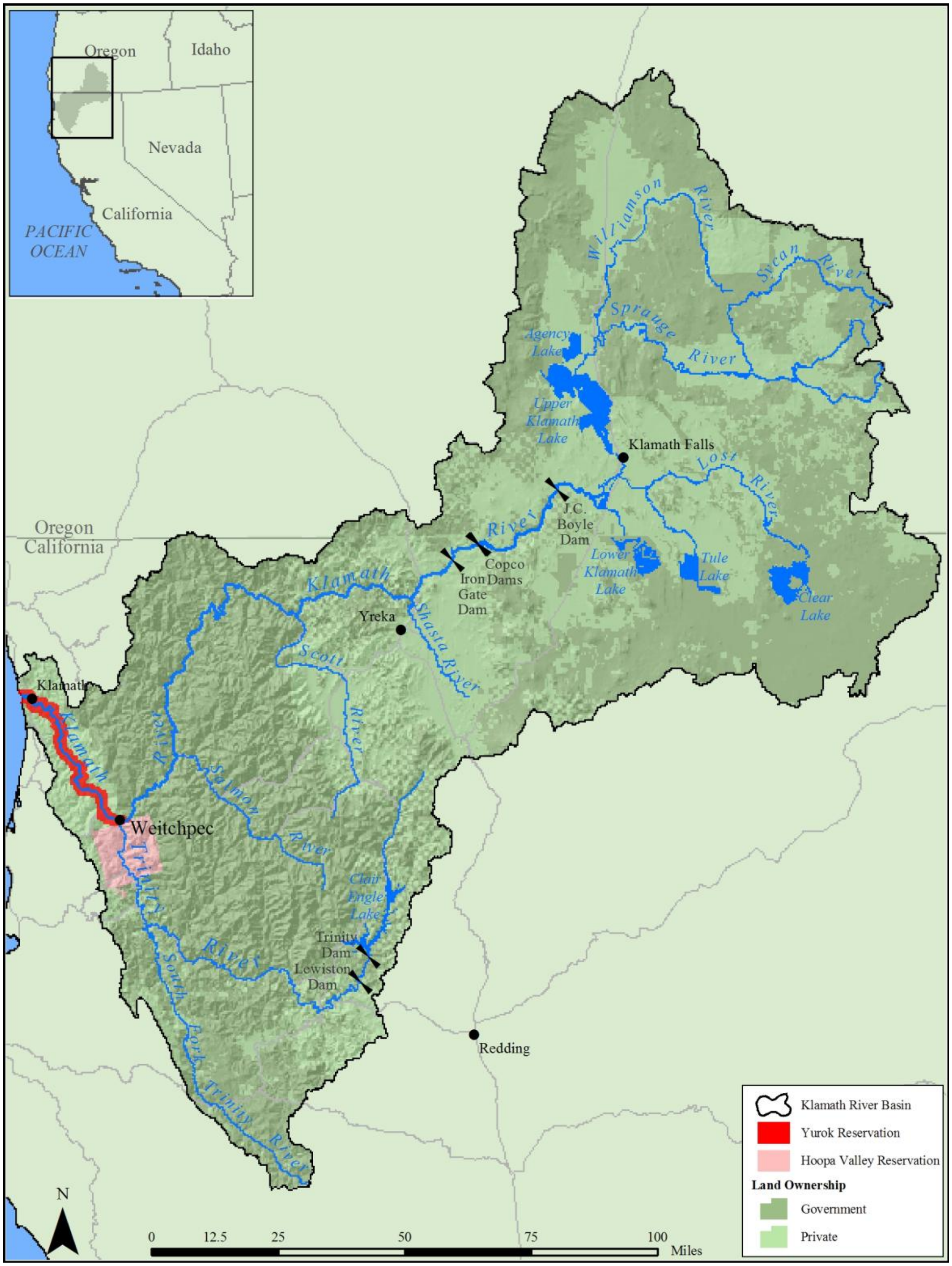

Figure 2-1. Klamath River Basin Map

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 covers about 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 59,000-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). A USEPA General Assistance Program (GAP) Grant and funding allocated under the Clean Water Act Section 106 and funding from PacifiCorp primarily fund YTEP’s water monitoring activities.

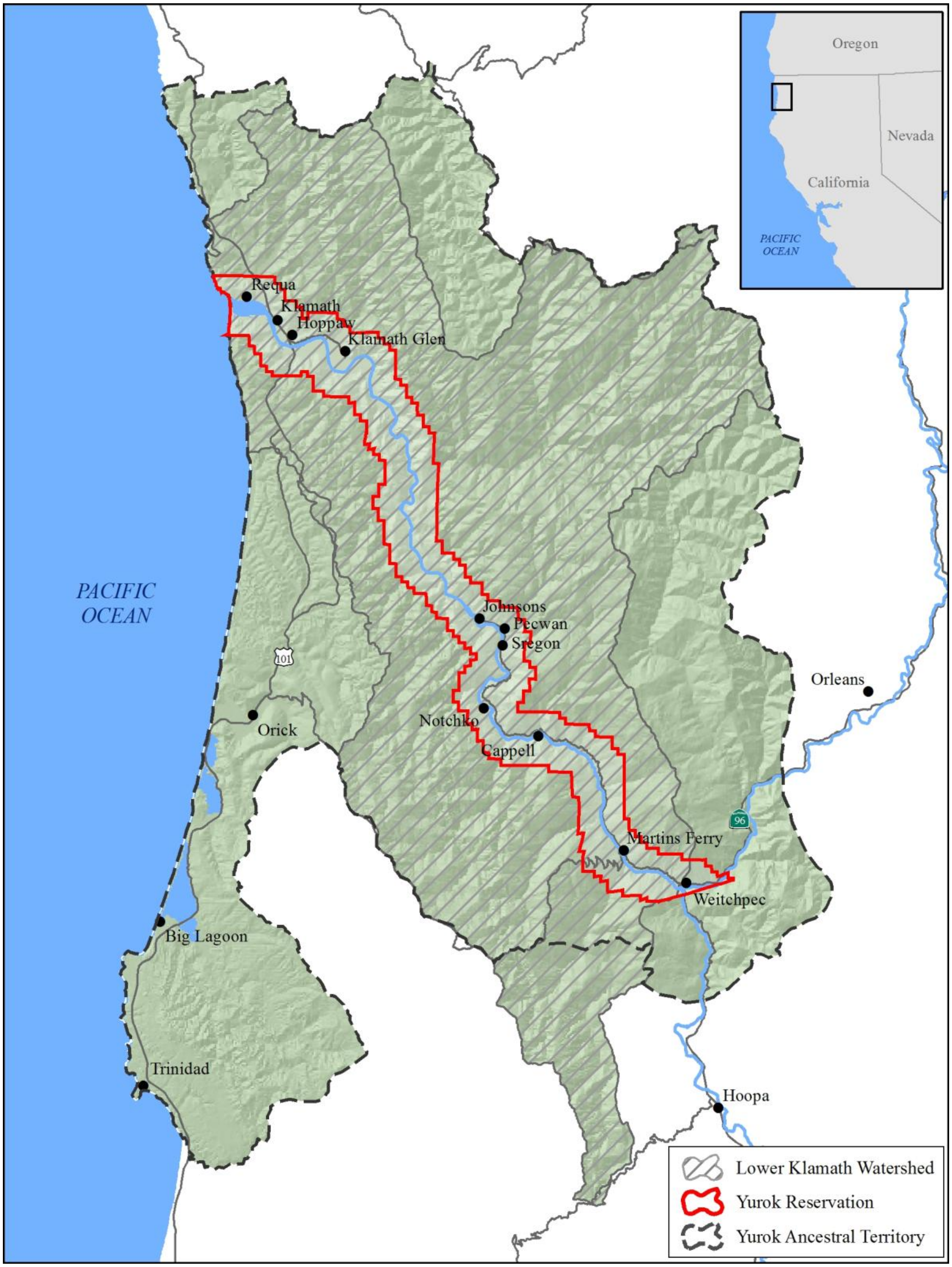

Figure 2-2. Yurok Indian Reservation and Yurok Ancestral Territory Map

III. Methods

The Yurok Tribe Environmental Program (YTEP) collected water samples at several monitoring sites from Weitchpec to the Klamath River Estuary in mid-February and mid-April, moved to a bi-weekly interval starting in mid-May and ending in mid-October, followed by monthly sampling in November and December. Samples were delivered to the same lab during the 2010 season in an effort to maintain consistency in laboratory methods. Samples were delivered to Aquatic Research Inc. in Seattle, WA. The parameters sampled are shown in Table 3-1.

Upon arrival at each site, a sampling churn was rinsed three times with distilled water. After rinsing with distilled water, the churn was rinsed three times with stream water. The churn was then fully submerged into the stream and filled to the lid with sample water. Completely filling the churn allowed for all samples to be filled from one churn; thereby minimizing differences in water properties and quality between samples.

Proper use of the churn guaranteed the water was well mixed before the sample was collected. The churn was stirred at a uniform rate by raising or lowering the splitter at approximately 9 inches per second. This mixing continued while the bottles were being filled. If filling had stopped for some reason, the stirring rate was resumed before the next sample was drawn from the churn.

The sample bottles and chemical preservatives used were provided by the contract lab and were considered sterile prior to field usage. Sample bottles without chemical preservatives were rinsed with stream water from the churn once before filling with sample water. In the case of bottles that contained chemical preservatives, bottles were not rinsed before sample collection and care was taken to avoid over-spillage that would result in chemical preservative loss. Collected samples were placed in coolers on wet ice for transport to the contract lab for analysis.

Table 3- 1. Parameters sampled on the Klamath River during 2010

Analytes
Nitrate + Nitrite
Total Nitrogen
Ammonia
Total Phosphorus
Soluble Reactive Phosphorous
Total Alkalinity
Chlorophyll-a
Pheophytin-a
Non-Filterable Residue
Volatile Suspended Solids
Dissolved Organic Carbon
Total Organic Carbon
Turbidity

Additional quality control measures were included in the sampling. At one site during the May and August sampling events duplicate split samples were sent to the laboratory blindly to assess laboratory precision and to gain improved confidence in the data.

Discrete environmental information was also recorded at the time water samples were collected. This information was collected using YSI 6600EDS multiparameter sondes equipped with specific conductivity/temperature, pH, ROX and phycocyanin probes. ROX probes detect concentrations of dissolved oxygen in bodies of water, while phycocyanin probes are designed to detect the presence of an accessory pigment known to occur in *Microcystis aeurginosa*. The data included water temperature, pH, specific conductance, dissolved oxygen and blue-green algae, as well as other observational notes. Chain-of-custody (COC) sheets were also filled out to document the handling of the samples from the time of collection to the time of laboratory analysis. This is a standard procedure for handling samples.

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 water samples for nutrient analysis May through December.

YTEP collected water samples for nutrient analysis at the following mainstem Klamath River locations (Figure 4-1) (river miles are approximate):

- **LES - Lower Estuary Surface – RM 0.5**
  (Figures 4-2 and 4-3)
- **TG - Klamath River at Turwar Boat Ramp – RM 6**
  (Figures 4-4 and 4-5)
- **TC - Klamath River above Tully Creek – RM 38.5**
  (Figures 4-6 and 4-7)
- **WE - Klamath River at Weitchpec (upstream of Trinity River) – RM 43.5**
  (Figures 4-8 and 4-9)

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**
  (Figures 4-10 and 4-11)

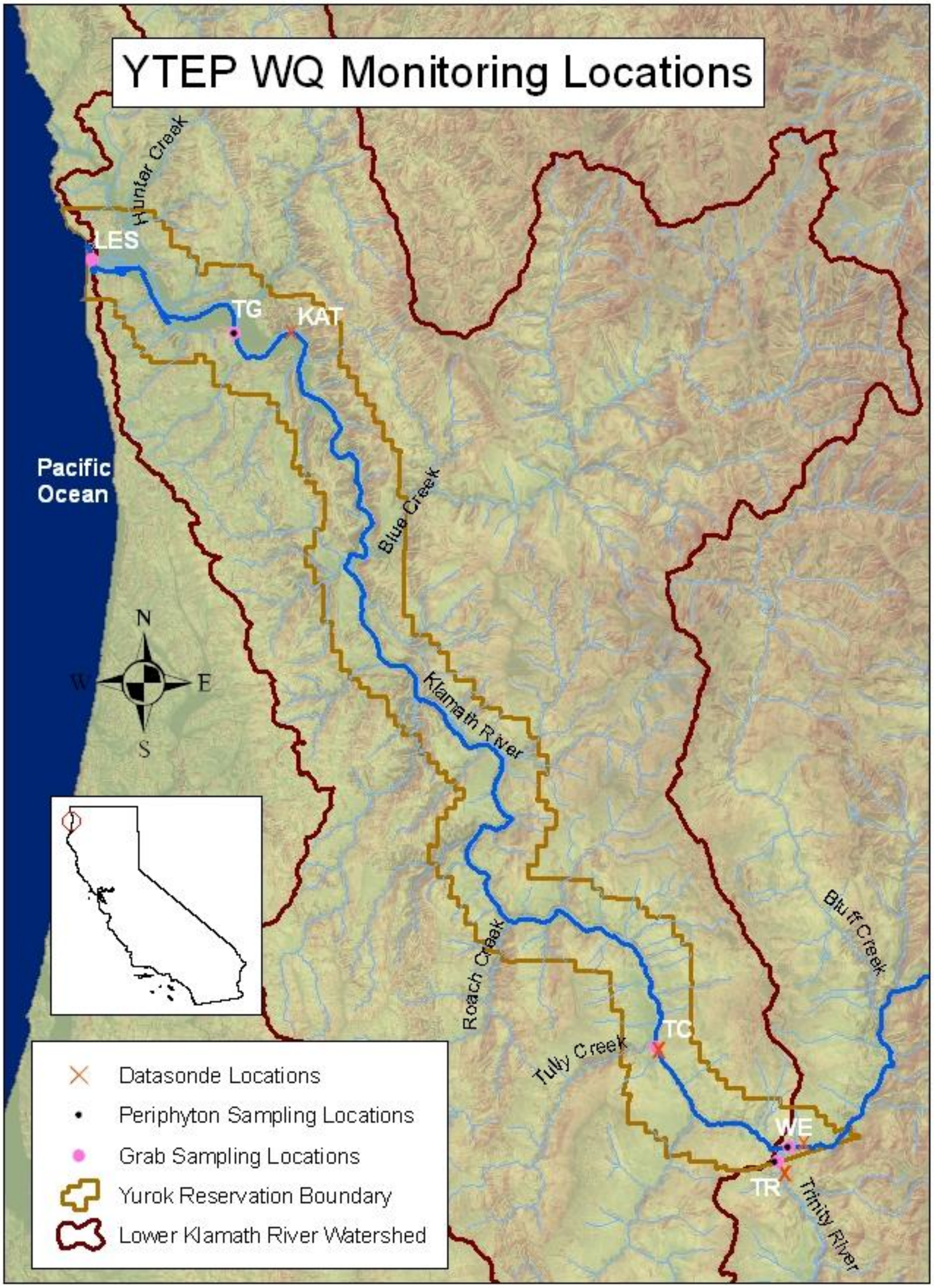

Figure 4-1. Nutrient "Grab" Sampling Sites for 2010(as indicated by the pink dots)

Figure 4-2. LES Looking Downstream

Figure 4-3. LES Looking Upstream

Figure 4-4. TG Looking Downstream

Figure 4-5. TG Looking Upstream

Figure 4-6. TC From Across River

Figure 4-7. TC Looking Upstream

Figure 4-8. WE Looking Downstream

Figure 4-9. WE Looking Upstream

Figure 4-10. TR Looking Downstream

Figure 4-11. TR Looking Upstream

V. Quality Assurance

During this study, many quality assurance and quality control (QA/QC) measures were undertaken to ensure the grab sample data that was collected was of the highest quality. YTEP performs all surface water quality monitoring activities consistent with its Quality Assurance Program Plan that was approved by the USEPA in April 2001. In June of 2008 USEPA approved YTEP's *Lower Klamath River Nutrient, Periphyton, Phytoplankton and Algal Toxin Sampling and Analysis Plan (SAP).* This document characterizes the quality control of the collection, preparation and analysis of water samples for presence of nutrients and related analytes. QA/QC was achieved by following a standard water sample collection protocol using a churn sampler and submitting samples to labs that follow strict protocol that have QA/QC measures.

All field personnel that were involved in collection of water samples 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 label samples appropriately in the field. Sampling is always conducted by at least two staff for safety reasons and to maintain consistency. Field crews collecting samples ensured representativeness of samples by selecting sites that have free-flowing water from established sampling locations and using a churn splitter to mix sample water once collected. All samples were transported to the appropriate laboratories following chain of custody procedures to ensure proper handling of the samples.

Field duplicate samples were collected by either the Yurok, Karuk, or Hoopa tribes on a rotating basis every month to evaluate crew performance. Field duplicates were collected by splitting samples in the field using the churn splitter. One of the split samples was sent with its associated split with a different ID code for analysis of both nutrients and related analytes so as to not alert lab staff of the fact that the samples were duplicates. Relative percent difference (RPD) of the initial and duplicate samples were calculated to determine the acceptability of the results. The lab was asked to reanalyze if the RPD or the difference was not within the criteria. Criteria used to evaluate acceptable nutrient duplicate samples is defined as if the initial or duplicate value >5x reporting limit (RL) then RPD should be within ± 20% or if the initial or duplicate value ≤5x RL then the difference of the two should be within ± RL. Duplicate sample results indicate the lab's precision is within the stated goals of this sampling project with 90% of samples meeting the relative percent difference of + or – 20%.

True blank samples were prepared in 2010 by pouring distilled water into sample containers provided by the laboratory and sent with a different ID code for analysis of both nutrients and related analytes so as to not alert lab staff of the fact that the samples were a true blank. True blank sample results from the 2010 sampling season indicate that there is no significant issue with contamination of samples in the field or laboratory.

Data is thoroughly reviewed once received from the laboratory. YTEP is the primary organization responsible for data review, although the professional laboratories analyzing water quality samples will also note potential problems with outliers or other anomalies in sample results. Information regarding QA/QC procedures for the laboratory is available upon request. One hundred percent of laboratory-generated data was checked on receipt by the Project Manager for consistency and acceptability, including whether duplicates are within specified targets and meet data quality objectives. Data is reviewed and finalized once data are merged or entered into a database, The data manager will visually inspect all entered data sets to check for inconsistencies with original field or laboratory 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, shipping handling and laboratory handling and testing 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. Water temperature, conductivity, pH and dissolved oxygen are measured in the field when samples are collected and values of these hand-held measurements can be used to check field conditions at the time of sampling.

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). Nutrient data covered in this report have been entered in YEDSS, and will be uploaded to USEPA's WQX database. The metadata associated with each data type are also stored within the system and can be easily accessed when questions arise.

VI. Results

Sampling Results

Total Phosphorous

Total phosphorous trends for the 2010 sampling season were similar for WE, TC, TG, and LES, with concentrations fluctuating somewhat, but generally holding steady from mid-February to late May (Table 6-1, Figure 6-1). In early June concentrations spiked sharply, then returned to previous levels in late June. After late June, concentrations at WE and TC increased until mid-October, at which time WE returned its highest results of the season, then declined in mid-November. Concentrations at TG and LES during this time increased until early September, then declined until mid-November. Concentrations at these four sites then sharply increased in mid-December, with LES, TC, and TG returning their highest results of the season during this sampling event. Trinity River above the mouth (TR) yielded results that were similar to other sites in mid-February, increased in mid-April, then decreased into late May. In early June there was a small spike in concentrations, after which concentrations fell to levels near the reporting limit of 0.002 mg/L until mid-November. In mid-December, concentrations increased sharply, with TR returning its highest results of the season during this sampling event.

Total phosphorous concentrations at 2010 monitoring sites ranged from a low of 0.005 mg/L at TR on August 25, to high of 0.097 mg/L at LES on December 15. Upriver sites tended to yield higher concentrations than downriver sites, especially during the summer months, with WE exhibiting the highest concentrations and LES or TG the lowest concentrations. The anomaly in this pattern occurred at TR, which, other than the sampling event on April 15 and the final sampling event on December 15, consistently yielded some of the lowest results. No sites produced results below the reporting limit of 0.002 mg/L for this parameter.

Soluble Reactive Phosphorous (SRP)

SRP for all sites except TR exhibited comparable trends with decreasing concentrations from mid-February to mid-May, a small spike in early June, then increasing concentrations until early to mid-September (Table 6-1, Figure 6-2). LES and TG returned peak concentrations in early September, while WE and TC returned peak results in mid-September. After mid-September all sites except TR decreased until mid-October, increased in mid-November, then sharply decreased in mid-December. Concentrations at TR fluctuated very little throughout the sampling season, with results near or below the reporting limit of 0.001 mg/L.

SRP concentrations at the 2010 sites ranged from less than 0.001 mg/L to 0.045 mg/L. WE yielded the highest concentration during the 2010 season on September 22, with a result of 0.045 mg/L, while TR produced the lowest reportable concentration of 0.001 mg/L on August 25, 2010.Throughout the sampling season upriver sites generally yielded higher SRP concentrations than downriver sites, with WE yielding the highest concentrations, and LES or TG the lowest. As with most parameters the exception was TR, which returned the lowest results at every sampling event throughout the season with concentrations hovering around the reporting limit of 0.001 mg/L for most of the season. If a site generated a result below the reporting limit, ND (No Detect) was entered into the database for this date and parameter, indicating that the results were below the minimum reporting value. For graphing purposes, ½ of the reporting limit (0.0005 mg/L) was used when this occurred.

Ammonia

Ammonia results for all sites exhibited concentrations below the reporting limit of 0.010 mg/L for the majority of the season (Table 6-1, Figure 6-3). If a site generated a result below the reporting limit, ND (No Detect) was entered into the database for this date and parameter, indicating that the results were below the reporting limit. For graphing purposes, ½ of the reporting limit (0.005 mg/L) was used when this occurred. LES was the site that most commonly produced measurable quantities of ammonia. However, LES fluctuated greatly throughout the sampling season, exhibiting no clear trend in ammonia concentrations. The other anomalies were TR on April 15 and TG on October 6. On the December 15, all sites returned concentrations above the reporting limit. Ammonia concentrations at the 2010 monitoring sites ranged from less than 0.010 mg/L to 0.030 mg/L. The highest concentration for the sampling season was 0.030 mg/L at TC on December 15, 2010. The lowest reportable concentration for the 2010 season was 0.010 mg/L on April 15 at LES.

Nitrite + Nitrate

Nitrite plus nitrate levels for all sites were generally similar for the 2010 sampling season (Table 6-1, Figure 6-4). Concentrations decreased from mid-February to late May, then spiked in early June. After the spike in early June, results decreased and concentrations were consistently near the reporting limit of 0.010 mg/L until mid-October. The exceptions were spikes at LES in early September and October, and a spike at WE, TC, and TG in mid-September. Concentrations at all sites except TR increased sharply in mid-November, then decreased in mid-December. Concentrations at TR remained at, or below, the reporting limit from late June through mid-November, then increased in mid-December.

Nitrite plus nitrate concentrations at the 2010 monitoring sites ranged from less than 0.010 mg/L to 0.188 mg/L. The lowest reportable concentration was 0.010 mg/L at TC and TR on October 6. The site that yielded the highest concentration was the Klamath River at

Weitchpec (WE) on November 17, 2010, with a result of 0.188 mg/L. The reporting limit for nitrate plus nitrite was 0.010 mg/L. Throughout most of the monitoring season, downriver sites (LES and TG) tended to have higher concentrations than upriver site (WE and TC). As with many parameters, the exception was TR, which consistently returned some of the lowest concentrations throughout the monitoring season. If a site generated a result below this number, ND (No Detect) was entered into the database for this date and parameter, indicating that the results were below the reporting limit. For graphing purposes, ½ of the reporting limit (0.005 mg/L) was used when this occurred.

Total Nitrogen

All sites except TR exhibited similar trends for total nitrogen during the 2010 sampling season (Table 6-1, Figure 6-5). Concentrations generally decreased from mid-February to mid-July, with a small peak in early June. After mid-July, concentrations increased until early September, then generally decreased until mid-November. In mid-December concentrations increased, with LES, TG, and TC returning their highest results of the season during this sampling event. TR concentrations fluctuated very little throughout most of the season, but did experience the same peak as all other sites in early June, followed by a drop to results near the reporting limit through mid-November, followed again by an increase in total nitrogen concentrations in mid-December. As with LES, TG, and TC; TR returned its highest results of the season in mid-December. TR consistently returned some of the lowest concentrations of all sites during the 2010 monitoring season.

Total nitrogen concentrations at the 2010 monitoring sites ranged from less than 0.050 mg/L to 0.592 mg/L. The site with the lowest reportable concentration was the Trinity River above the mouth (TR) on July 21, with a result of 0.055 mg/L. The site with the highest concentration was the Klamath River at Weitchpec (WE) on September 8, with a result of 0.592 mg/L. The reporting limit for total nitrogen was 0.050 mg/L. If a site generated a result below the reporting limit, ND (No Detect) was entered into the database for this date and parameter, indicating that the results were below the minimum reporting value. For graphing purposes, ½ of the reporting limit (0.025 mg/L) was used when this occurred.

Chlorophyll-a

Chlorophyll-*a* trends were broadly similar for all sites except TR, with an increase in concentrations from mid-February to mid-April, followed by decreasing concentrations until early July (Table 6-2, Figure 6-6). After early July, concentrations increased slightly until late August, then increased sharply in early September. Concentrations then generally decreased until early October, then increased again in mid-October. In mid-November, concentrations sharply decreased, then increased in mid-December. As with most parameters, the anomaly for chlorophyll-*a* was TR, which tended to follow the same pattern as the other sites until late August, then fluctuated very little until early October, at which time concentrations increased until mid-December.

Chlorophyll-*a* concentrations for the 2010 sampling season ranged from 0.4 µg/L to 14 µg/L. WE produced the highest concentration of 14 µg/L on October 20, 2010, while TR yielded the lowest concentration of 0.4 µg/L on August 25, 2010. No sites produced results below the reporting limit of 0.1 µg/L for this parameter.

Pheophytin-a

Pheophytin-*a* results and trends were broadly similar for all sites except TR during the 2010 sampling season (Table 6-2, Figure 6-7). Concentrations fluctuated, but generally held steady until early June, then decreased in late June. After late June concentrations generally increased until mid-September, then generally decreased until mid-November. Concentrations then increased in mid-December. The exception to this pattern was WE in mid-October, which exhibited a sharp spike in concentrations that returned to levels similar to other sites in mid-November. TR exhibited a similar pattern as other sites, yet consistently returned some of the lowest concentrations during the 2010 sampling season

Pheophytin-*a* concentrations for the 2010 sampling season ranged from less than 0.1 µg/L to 11µg/L. The lowest reportable concentration was 0.2µg/L at TR on July 7 and November 17, 2010, while the highest concentration of 11µg/L was returned at WE on October 20, 2010. The reporting limit for pheophytin-*a* was 0.1 µg/L. If a site generated a result below the reporting limit, ND (No Detect) was entered into the database for this date and parameter, indicating that the results were below the minimum reporting value. For graphing purposes, ½ of the reporting limit (0.05 µg /L) was used when this occurred.

Alkalinity

Trends and results for alkalinity concentrations during the 2010 monitoring season were very similar for all sites throughout the entire monitoring term, with concentrations gradually decreasing from mid-February to early June, followed by increasing concentrations until early September. After early September all sites experienced a slight decrease in mid-September, followed by increasing concentrations in late October, after which results at all sites decreased until mid-December. (Table 6-2, Figure 6-8). Alkalinity concentrations at the 2010 sites ranged from a low of 44.2 mg/L $CaCO_3$ at WE on June 9, to a high of 99.5 mg/L $CaCO_3$ at TC on October 20. No sites produced results below the reporting limit of 1.0 mg/L $CaCO_3$ for this parameter.

Total Organic Carbon (TOC)

TOC trends were broadly similar for all sites except TR throughout the sampling period (Table 6-2, Figure 6-9). Results remained constant in mid-February and mid-April, then spiked slightly in mid-May and early June. After early June, concentrations decreased until early July, then generally increased as the summer progressed. LES returned its highest concentrations of the sampling season in mid-September, TG and TC in early October, and WE in mid-October. LES, TG, and TC decreased into mid-November and increased in mid-December, while WE decreased into mid-December. As with most parameters, TR consistently produced some of the lowest concentrations throughout the sampling season. From mid-February to early July TR had similar TOC concentrations as the Klamath River sites, but after early July concentrations fluctuated very little, increasing slightly into mid-October, decreasing in mid-November, and increasing in mid-December.

TOC concentrations for the 2010 sampling season ranged from a low of 0.648 mg/L at TR on August 11, to a high of 2.76 mg/L on October 20, 2010 at WE. No sites produced concentrations below the reporting limit of 0.250 mg/L during the 2010 sampling season.

Dissolved Organic Carbon (DOC)

Dissolved organic carbon concentrations for all sites exhibited very similar trends to TOC throughout the sampling season (Table 6-2, Figure 6-10). Results generally remained constant from mid-February to mid-May, decreased in late May, then spiked slightly in early June. After early June, concentrations decreased until early July, then generally increased as the summer progressed. LES returned its highest concentrations of the sampling season in mid-September, while TG, TC, and WE peaked in early October, LES and TG decreased into mid-November and increased in mid-December, while TC and WE decreased into mid-December. As with most parameters, TR consistently produced some of the lowest concentrations throughout the sampling season. From mid-February to early July TR had similar DOC concentrations as the Klamath River sites, but after early July concentrations fluctuated very little, generally increasing into mid-December.

DOC concentrations for the 2010 sampling season ranged from a low of 0.600 mg/L at TR on July 21, to a high of 2.59 mg/L at LES on September 22, 2010. No sites produced concentrations below the reporting limit of 0.250 mg/L during the 2010 sampling season.

Non-Filterable Residue (TSS)

Non-filterable residue, also known as total suspended solids (TSS), trends for all sites were broadly similar for the 2010 sampling season (Table 6-2, Figure 6-11). LES increased slightly from mid-February to mid-May, TG and WE held steady during this time, while TC and TR increased from mid-February to mid-April, then decreased in mid- May. All sites decreased in late May, spiked in early June, then decreased in late June. After late June all sites fluctuated very little until mid-November. WE spiked slightly in mid-October, then decreased in mid-November. All sites then increased sharply in mid-December, returning their highest results of the 2010 sampling season during this sampling event.

TSS concentrations for the 2010 sampling season ranged from less than 0.50 mg/L to 70 mg/L. The lowest reportable concentration for the sampling period was 0.63 mg/L at TR on August 25, 2010, while the highest concentration was 70 mg/L at TR on December 15, 2010. The reporting limit for TSS was 0.50 mg/L. If a site generated a result below this number, ND (No Detect) was entered into the database for this date and parameter, indicating that the results were below the reporting limit. For graphing purposes, ½ of the reporting limit (0.25 mg/L) was used when this occurred.

Volatile Suspended Solids (VSS)

Trends and results for volatile suspended solids concentrations during the 2010sampling season were similar among LES, TG, and TC, while WE and TR exhibited unique results (Table 6-2, Figure 6-12). LES, TG, and TC increased from mid-February to mid-May, decreased in late May, then increased again in early June. Concentrations decreased again in late June, increased into late July, then held steady until late August. In early September, concentrations at LES, TG, and TC spiked, decreased into mid-November, then increased in mid-December, yielding their highest results of the sampling season. Concentrations at WE generally increased from mid-February into early June, then decreased in late June. Concentrations then generally increased into mid-September, and decreased in early October. Results increased sharply at WE in mid-October, decreased in mid-November, then increased in mid-December, yielding its highest results of the season. Concentrations at TR were very similar to LES, TG, and TC until early July, after which results fluctuated very little, hovering at, or below the reporting limit through mid-November. In mid-December, concentrations at TR increased, returning its highest results of the 2010 sampling season.

Volatile suspended solids concentrations for the 2010 sampling season ranged from less than 0.50 mg/L to 6.5 mg/L. TC returned the highest concentration of 6.5 mg/L on December 15, 2010, while LES returned the lowest reportable concentration of 0.50 mg/L on June 23, 2010, and TR yielded the same result on November 17 and December 15, 2010. If a site generated a result below the reporting limit, ND (No Detect) was entered into the database for this date and parameter, indicating that the results were below the minimum reporting value. For graphing purposes, ½ of the reporting limit (0.25 mg/L) was used when this occurred.

Turbidity

Trends for turbidity among all sites except TR were similar during the 2010 sampling season (Table 6-2, Figure 13). All sites except TR decreased from mid-April to mid-May, then increased into early June. After early June results decreased into early July, then fluctuated very little until late August. From early September to mid-November, results increased slightly, but still fluctuated very little, then increased sharply in mid-December. Turbidity results at TR decreased from mid-April to early July, then were consistently near the reporting limit until mid-November. In mid-December, results at TR increased sharply. All sites yielded their highest results of the season during the mid-December sampling event.

Turbidity results for the 2010 sampling season ranged from 0.17 NTU to 27 NTU. TR and LES returned the highest results of 27 NTU on December 17, 2010, while TR returned the lowest result of 0.17 NTU on September 8 and October 20, 2010. No sites produced concentrations below the reporting limit of 0.10 NTU during the 2010 sampling season.

Discrete Sonde Measurements

Below is a summary of the discrete sonde measurements that were taken at the sampling sites when surface water samples were collected.

Water Temperature

Water temperature at all sites during the 2010 season displayed similar trends (Table 6-3, Figure 6-14). Measurements at all sites showed steady to slightly increasing temperatures from mid-February to mid-April. This was followed by increasing temperatures from mid-May to mid-August, with temperatures peaking at WE in late July, LES and TR in mid-August, and TG and TC in late August. After this peak, all sites returned decreasing temperatures throughout the rest of the sampling period. Temperatures for the 2010 sampling season ranged from a low 7.62°C on December 15, to a high of 21.15°C on July 21, 2010. Both of these temperatures were recorded at the WE sampling site.

Dissolved Oxygen (mg/L)

Dissolved oxygen (DO) measured in mg/L during the 2010 sampling season showed similar trends at all sites throughout the season (Table 6-3, Figure 6-15). DO at all sites remained steady or increased slightly from mid-February to mid-May, then dropped from mid-May to late August. After late August, results at all sites generally increased until sampling was suspended in mid-December, at which time LES, TC, WE, and TR yielded their highest concentrations of the season. TG, however, yielded its highest result in mid-April. Throughout the sampling season upriver sites tended to return higher concentrations of DO than downriver sites, with WE and TR yielding the highest results and LES or TG yielding the lowest results. Concentrations of DO during the 2010 sampling season ranged from a low of 7.70 mg/L at LES on August 25, to a high of 12.44 mg/L at WE on December 15, 2010.

Dissolved Oxygen (%)

DO concentrations measured in percent for the 2010 sampling season exhibited similar trends for upriver sites, while downriver sites returned different patterns (Table 6-3, Figure 6-16). TC, WE, and TR all showed steady to slightly increasing DO percentages from mid-February to mid-April, then generally remained constant throughout the rest of the sampling season. DO at LES and TG increased slightly from mid-February to mid-April, dropped slightly in late May, then held steady until early July. After early July DO at TG dropped slightly again, held steady until mid-October, then increased into mid-December. DO at LES dropped from early July to early September, then generally increased into mid-December. Throughout the sampling season, upriver sites tended to return higher percentages of DO than downriver sites, with WE and TR returning the highest results and LES and TG the lowest. The highest percentage of DO measured during the 2010 sampling season was 105.1% at WE on August 11, while the lowest DO percentage measured was 83.1% at LES on September 8, 2010.

Specific Conductivity

Specific conductivity at all sites except LES exhibited similar trends during the 2010 sampling season (Table 6-3, Figures 6-17 and 6-18). Specific conductivity was generally consistent from mid-February to mid-April, then decreased until early June. After early June specific conductivity increased until early September, fell slightly in late September, then increased until mid-October. After mid-October results fell until sampling was suspended in mid-December Specific conductivity readings at LES fell from mid-February to early June, then increased until late August. After late August results decreased until mid-December, with a large spike in early October. Measurements for specific conductivity, disregarding LES, for the 2010 sampling season ranged from a low of 91 microSiemens per centimeter (μS/cm) at WE on June 9, to a high of 190 μS/cm at WE on October 6, 2010. At LES specific conductivity measurements ranged from a low of 91μS/cm on December 15, to a high of 8,025 μS/cm on October 6, 2010.

pH

pH trends during the 2010 sampling season was generally similar among all sites, with an overall trend of increasing pH throughout the sampling season (Table 6-3, Figure 6-19). pH increased from mid-February to mid-April, dropped in mid-May, and increased into late June. Early July saw a decrease in pH at all sites, followed by an increase in mid-July. pH subsequently dropped until late August, then generally increased until sampling was suspended in mid-December. As with many other parameters, upriver sites tended to return higher pH measurements than downriver sites. The lowest pH was measured during the 2010 sampling season was 7.56 at TC on May 12, while the highest pH measured was 8.65 at TR on November 17, 2010.

Table 6-1. Nutrient Results, Yurok Reservation 2010

Nutrients

Total Phosphorous
mg/L; Report Limit: 0.002

Site	2/18/2010	4/15/2010	5/12/2010	5/26/2010	6/9/2010	6/23/2010	7/7/2010	7/21/2010	8/11/2010	8/25/2010	9/8/2010	9/22/2010	10/6/2010	10/20/2010	11/17/2010	12/15/2010
LES	0.028	0.041	0.034	0.021	0.052	0.020	0.019	0.017	0.028	0.027	0.052	0.048	0.043	0.042	0.032	0.097
TG	0.032	0.027	0.037	0.031	0.056	0.019	0.016	0.016	0.027	0.030	0.051	0.051	0.043	0.036	0.031	0.063
TC	0.023	0.034	0.027	0.023	0.058	0.020	0.020	0.019	0.031	0.033	0.053	0.053	0.050	0.059	0.038	0.071
WE	0.021	0.019	0.019	0.019	0.045	0.022	0.025	0.027	0.048	0.049	0.075	0.073	0.070	0.092	0.051	0.066
TR	0.024	0.063	0.034	0.022	0.031	0.012	0.010	0.007	0.007	0.005	0.007	0.007	0.007	0.007	0.007	0.087

Soluble Reactive Phosphorous
mg/L; Report Limit: 0.001

Site	2/18/2010	4/15/2010	5/12/2010	5/26/2010	6/9/2010	6/23/2010	7/7/2010	7/21/2010	8/11/2010	8/25/2010	9/8/2010	9/22/2010	10/6/2010	10/20/2010	11/17/2010	12/15/2010
LES	0.010	0.007	0.006	0.007	0.013	0.007	0.008	0.010	0.017	0.019	0.026	0.022	0.024	0.018	0.024	0.010
TG	0.010	0.007	0.006	0.006	0.009	0.006	0.007	0.009	0.016	0.019	0.026	0.021	0.020	0.014	0.023	0.011
TC	0.010	0.007	0.006	0.006	0.008	0.008	0.009	0.013	0.020	0.023	0.028	0.030	0.026	0.027	0.029	0.010
WE	0.014	0.007	0.006	0.009	0.010	0.010	0.014	0.019	0.030	0.037	0.042	0.045	0.041	0.036	0.042	0.012
TR	0.006	0.006	0.004	0.003	0.003	0.002	0.002	0.004	0.002	0.001	ND	0.002	ND	ND	0.002	0.007

Ammonia Nitrogen
mg/L; Report Limit: 0.010

Site	2/18/2010	4/15/2010	5/12/2010	5/26/2010	6/9/2010	6/23/2010	7/7/2010	7/21/2010	8/11/2010	8/25/2010	9/8/2010	9/22/2010	10/6/2010	10/20/2010	11/17/2010	12/15/2010
LES	ND	0.010	ND	ND	ND	ND	ND	ND	0.012	0.017	0.012	0.014	0.019	ND	0.015	0.015
TG	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.013	ND	ND	0.011
TC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.030
WE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.015
TR	ND	0.022	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.017

Nitrate +Nitrite
mg/L; Report Limit: 0.010

Site	2/18/2010	4/15/2010	5/12/2010	5/26/2010	6/9/2010	6/23/2010	7/7/2010	7/21/2010	8/11/2010	8/25/2010	9/8/2010	9/22/2010	10/6/2010	10/20/2010	11/17/2010	12/15/2010
LES	0.148	0.078	0.045	0.037	0.058	ND	ND	ND	0.016	0.012	0.027	ND	0.040	ND	0.127	0.102
TG	0.130	0.064	0.050	0.039	0.063	0.021	ND	ND	0.013	0.012	0.012	0.043	ND	0.018	0.135	0.080
TC	0.112	0.047	0.018	0.013	0.037	ND	ND	ND	ND	ND	ND	0.046	0.010	ND	0.125	0.075
WE	0.156	0.048	0.011	ND	0.043	ND	ND	ND	ND	ND	ND	0.034	ND	ND	0.188	0.093
TR	0.059	0.047	0.038	0.013	0.032	ND	ND	ND	ND	ND	ND	ND	0.010	ND	ND	0.060

Total Nitrogen
mg/L; Report Limit 0.050

Site	2/18/2010	4/15/2010	5/12/2010	5/26/2010	6/9/2010	6/23/2010	7/7/2010	7/21/2010	8/11/2010	8/25/2010	9/8/2010	9/22/2010	10/6/2010	10/20/2010	11/17/2010	12/15/2010
LES	0.231	0.175	0.141	0.129	0.249	0.110	0.099	0.092	0.136	0.218	0.400	0.316	0.358	0.299	0.243	0.433
TG	0.232	0.124	0.131	0.175	0.174	0.134	0.088	0.109	0.136	0.173	0.339	0.289	0.307	0.305	0.223	0.358
TC	0.169	0.117	0.106	0.174	0.129	0.106	0.128	0.101	0.121	0.174	0.316	0.305	0.309	0.287	0.265	0.403
WE	0.230	0.122	0.128	0.148	0.147	0.121	0.142	0.121	0.213	0.233	0.592	0.420	0.420	0.492	0.386	0.444
TR	0.102	0.093	0.128	0.104	0.144	0.085	0.109	0.055	0.056	0.060	0.093	0.062	0.074	0.080	<0.050	0.283

ND= No Detect

Table6-2. Other Analytes Results, Yurok Reservation 2010

Other Analytes

Date

Chlorophyll a
µg/L; Report Limit: 0.1

Site	2/18/2010	4/15/2010	5/12/2010	5/26/2010	6/9/2010	6/23/2010	7/7/2010	7/21/2010	8/11/2010	8/25/2010	9/8/2010	9/22/2010	10/6/2010	10/20/2010	11/17/2010	12/15/2010
LES	2.7	4.0	3.2	2.1	1.6	1.3	1.2	1.9	1.1	1.6	7.2	8.0	4.5	5.0	1.2	3.2
TG	2.7	4.0	2.1	1.6	1.6	1.1	1.6	2.9	2.4	2.1	9.3	8.8	5.6	6.4	1.6	5.3
TC	2.7	4.8	1.6	1.9	1.6	1.1	1.4	1.3	2.1	1.9	6.7	6.4	5.9	7.2	2.4	4.3
WE	2.1	1.6	3.2	2.4	1.6	0.8	1.1	2.1	1.9	2.1	11	8.8	7.2	14	2.4	5.9
TR	1.9	4.8	1.6	1.8	2.1	0.8	1.4	1.1	1.5	0.4	0.9	1.6	0.7	1.2	2.9	5.3

Pheophytin a
µg/L; Report Limit: 0.1

Site	2/18/2010	4/15/2010	5/12/2010	5/26/2010	6/9/2010	6/23/2010	7/7/2010	7/21/2010	8/11/2010	8/25/2010	9/8/2010	9/22/2010	10/6/2010	10/20/2010	11/17/2010	12/15/2010
LES	1.6	2.2	1.7	1.2	2.5	0.5	1.1	2.6	2.5	1.9	3.4	4.0	3.1	2.4	1.0	4.6
TG	1.6	2.0	2.3	1.8	2.5	1.0	0.9	1.5	2.1	2.3	2.8	3.3	2.6	3.2	1.4	4.0
TC	1.3	1.7	2.9	1.7	2.1	1.0	0.6	2.0	1.4	1.9	2.5	3.1	2.5	3.4	1.9	4.7
WE	1.8	1.8	2.0	1.1	2.1	1.1	0.8	1.4	1.9	2.2	3.3	3.9	3.1	11	2.3	5.7
TR	1.5	1.2	2.1	1.3	0.9	0.7	0.2	0.8	ND	1.1	0.4	1.2	0.6	0.3	0.2	4.4

Alkalinity
mg/L CaCO3; Report Limit: 1.0

Site	2/18/2010	4/15/2010	5/12/2010	5/26/2010	6/9/2010	6/23/2010	7/7/2010	7/21/2010	8/11/2010	8/25/2010	9/8/2010	9/22/2010	10/6/2010	10/20/2010	11/17/2010	12/15/2010
LES	63.9	66.1	64.0	57.7	46.5	59.1	65.0	73.6	83.3	87.5	93.9	86.6	94.2	96.6	72.7	45.0
TG	68.6	69.4	67.2	60.5	51.5	62.8	64.9	74.8	80.0	82.4	90.0	87.8	90.2	96.9	74.9	44.5
TC	68.6	71.2	66.2	60.3	48.3	59.0	65.5	72.9	80.3	84.1	91.3	88.4	92.6	99.5	75.9	52.0
WE	63.2	66.2	64.9	59.5	44.2	56.8	65.5	74.3	78.6	84.3	91.4	88.5	95.2	99.0	75.1	48.0
TR	79.0	77.0	71.2	65.3	55.5	65.4	66.2	73.3	79.2	81.0	89.0	85.0	84.8	91.5	78.7	59.4

Total Organic Carbon (TOC)
mg/L; Report Limit: 0.250

Site	2/18/2010	4/15/2010	5/12/2010	5/26/2010	6/9/2010	6/23/2010	7/7/2010	7/21/2010	8/11/2010	8/25/2010	9/8/2010	9/22/2010	10/6/2010	10/20/2010	11/17/2010	12/15/2010
LES	1.24	1.03	1.09	1.02	1.68	1.05	0.839	0.904	1.07	1.18	1.62	2.52	1.91	1.88	1.35	1.61
TG	0.921	0.911	1.19	0.803	1.05	1.07	0.847	0.933	1.17	1.19	1.50	1.64	2.21	1.48	1.28	1.62
TC	0.987	1.06	1.32	0.871	1.19	1.14	0.907	1.04	1.50	1.79	1.95	1.91	2.08	1.44	1.45	1.66
WE	1.13	1.17	1.41	1.02	1.25	1.29	1.12	1.23	1.51	2.16	2.12	2.21	2.54	2.76	1.83	1.71
TR	0.973	1.08	1.13	0.717	1.20	0.906	0.681	0.696	0.648	0.682	0.676	0.781	0.876	1.03	0.765	1.58

Dissolved Organic Carbon (DOC)
mg/L; Report Limit: 0.250

Site	2/18/2010	4/15/2010	5/12/2010	5/26/2010	6/9/2010	6/23/2010	7/7/2010	7/21/2010	8/11/2010	8/25/2010	9/8/2010	9/22/2010	10/6/2010	10/20/2010	11/17/2010	12/15/2010
LES	0.894	0.844	1.19	0.739	1.43	1.25	0.838	0.959	1.00	1.32	1.56	2.59	1.82	1.43	1.21	1.51
TG	0.806	1.05	1.00	0.790	1.19	1.06	0.869	1.17	1.16	1.27	1.33	1.73	2.34	1.34	1.17	1.43
TC	1.04	1.26	1.31	0.907	1.24	1.22	1.01	0.814	1.38	1.50	1.64	1.83	1.95	1.64	1.58	1.57
WE	1.12	1.18	1.26	1.03	1.43	0.950	1.23	0.912	1.63	1.89	2.14	2.10	2.32	2.10	2.03	1.70
TR	0.907	1.05	1.10	0.641	1.02	0.927	0.711	0.600	0.707	0.687	0.820	0.678	0.770	0.753	0.898	1.30

ND= No Detect

Table 6-2 (contd.). Other Analytes Results, Yurok Reservation 2010

Non-Filterable Residue (TSS)	Site	2/18/2010	4/15/2010	5/12/2010	5/26/2010	6/9/2010	6/23/2010	7/7/2010	7/21/2010	8/11/2010	8/25/2010	9/8/2010	9/22/2010	10/6/2010	10/20/2010	11/17/2010	12/15/2010
mg/L; Report Limit: 0.50	LES	12	19	19	8.9	21	5.0	2.8	2.5	2.6	2.1	5.8	4.7	4.2	1.6	1.6	68
	TG	18	16	18	12	23	4.3	2.0	2.6	2.0	2.3	4.5	4.3	1.7	1.8	1.4	40
	TC	8.2	20	16	8.1	17	4.8	2.4	2.1	1.6	2.0	3.3	3.0	1.8	2.5	2.1	58
	WE	3.5	4.0	3.7	3.6	16	3.6	2.0	1.3	2.0	2.1	3.5	3.7	2.3	12	2.0	38
	TR	12	33	22	10	21	3.8	2.5	0.87	ND	0.63	ND	0.87	ND	ND	0.88	70

Volatile Suspended Solids (VSS)	Site	2/18/2010	4/15/2010	5/12/2010	5/26/2010	6/9/2010	6/23/2010	7/7/2010	7/21/2010	8/11/2010	8/25/2010	9/8/2010	9/22/2010	10/6/2010	10/20/2010	11/17/2010	12/15/2010
mg/L; Report Limit: 0.50	LES	ND	2.0	2.3	ND	1.8	0.50	0.63	1.1	0.87	ND	3.3	2.3	1.5	1.1	0.63	5.0
	TG	1.5	1.5	2.0	0.75	1.8	ND	0.63	0.87	0.75	1.0	2.7	1.5	1.0	1.0	0.62	3.5
	TC	0.67	2.7	3.5	1.3	1.5	0.88	0.63	1.0	0.87	0.87	1.7	1.7	1.7	1.5	1.0	6.5
	WE	ND	1.5	1.2	1.4	2.0	ND	0.87	ND	0.87	0.88	1.5	2.0	1.2	4.5	1.0	5.0
	TR	ND	1.6	1.8	1.1	1.5	ND	0.75	ND	ND	ND	ND	0.63	ND	ND	0.50	5.0

Turbidity	Site	2/18/2010	4/15/2010	5/12/2010	5/26/2010	6/9/2010	6/23/2010	7/7/2010	7/21/2010	8/11/2010	8/25/2010	9/8/2010	9/22/2010	10/6/2010	10/20/2010	11/17/2010	12/15/2010
NTU; Report Limit: 0.10	LES	DNS	7.9	4.1	4.7	14	2.1	0.53	0.38	0.53	0.61	1.4	1.8	0.92	0.72	0.61	27
	TG	DNS	6.3	4.4	5.2	12	1.6	0.66	0.42	0.43	0.52	2.0	1.7	1.6	0.67	0.45	20
	TC	DNS	6.9	3.4	3.8	5.8	1.4	0.51	0.29	0.37	0.47	1.8	1.4	0.92	0.78	0.50	19
	WE	DNS	2.2	0.66	1.7	5.5	0.72	0.51	0.34	0.38	0.42	2.5	1.7	2.2	2.7	0.42	13
	TR	DNS	17	5.5	5.7	4.4	1.3	0.60	0.27	0.24	0.23	0.17	0.18	0.23	0.17	0.33	27

ND= No Detect
DNS= Did Not Sample

Table 6-3. Discrete Datasonde Measurements, Yurok Reservation 2010

Discrete Datasonde Results

Water Temperature

°C

Site	2/18/2010	4/15/2010	5/12/2010	5/26/2010	6/9/2010	6/23/2010	7/7/2010	7/21/2010	8/11/2010	8/25/2010	9/8/2010	9/22/2010	10/6/2010	10/20/2010	11/17/2010	12/15/2010
LES	9.01	9.21	10.62	10.66	13.10	15.26	18.00	19.99	20.44	20.33	17.96	16.92	15.58	14.15	10.13	8.69
TG	9.11	9.40	10.94	10.90	13.20	15.33	17.99	19.79	20.37	20.62	18.85	16.86	16.71	13.79	10.11	8.62
TC	8.44	8.88	10.36	10.39	12.72	14.98	18.56	20.59	20.64	20.72	18.52	16.65	15.90	13.55	10.08	8.04
WE	8.21	8.89	10.45	10.64	12.27	14.84	19.01	21.15	20.93	20.78	18.52	16.83	15.99	13.32	9.77	7.62
TR	8.73	9.02	10.67	10.40	13.71	15.22	18.24	20.03	21.02	20.92	18.63	16.60	15.31	13.38	10.25	8.57

Dissolved Oxygen

mg/L

Site	2/18/2010	4/15/2010	5/12/2010	5/26/2010	6/9/2010	6/23/2010	7/7/2010	7/21/2010	8/11/2010	8/25/2010	9/8/2010	9/22/2010	10/6/2010	10/20/2010	11/17/2010	12/15/2010
LES	11.25	11.63	DNR	10.77	10.25	9.79	8.91	7.97	7.77	7.7	7.72	8.57	8.79	10.01	10.69	11.64
TG	11.09	11.72	DNR	10.64	10.01	9.80	9.09	8.34	8.29	8.27	8.62	9.01	8.89	9.13	10.65	11.43
TC	11.23	11.28	DNR	11.16	10.66	10.16	9.32	9.03	9.13	9.01	9.23	9.58	9.69	10.42	11.29	12.15
WE	11.44	11.54	DNR	11.33	10.88	10.26	9.45	9.31	9.38	9.14	9.6	9.80	9.87	10.42	11.55	12.44
TR	11.13	10.98	DNR	11.18	10.39	10.27	9.48	9.22	9.22	9.16	9.46	9.74	10.03	10.64	11.29	11.78

Percent Dissolved Oxygen

Site	2/18/2010	4/15/2010	5/12/2010	5/26/2010	6/9/2010	6/23/2010	7/7/2010	7/21/2010	8/11/2010	8/25/2010	9/8/2010	9/22/2010	10/6/2010	10/20/2010	11/17/2010	12/15/2010
LES	97.4	101.1	DNR	96.9	97.5	97.6	94.1	87.9	86.7	86.7	83.1	88.9	90.7	97.7	95.1	100.0
TG	96.3	102.4	DNR	96.3	95.5	97.9	96.0	91.4	91.7	92.2	92.8	93.0	91.5	88.2	94.7	98.0
TC	95.9	97.3	DNR	99.8	100.5	100.8	99.6	100.5	101.8	100.6	98.6	98.4	98.0	100.2	100.3	102.7
WE	97.1	99.5	DNR	101.9	101.6	101.4	101.9	104.8	105.1	102.2	102.6	101.1	100.0	99.6	101.8	104.1
TR	95.7	95.6	DNR	100.0	100.2	102.3	100.7	101.5	103.5	102.3	101.2	100.0	100.2	101.8	100.7	100.8

DNR= Did Not Record

Table 6-3 (contd.). Discrete Datasonde Measurements, Yurok Reservation 2010

Specific Conductivity μS/cm	Site	2/18/2010	4/15/2010	5/12/2010	5/26/2010	6/9/2010	6/23/2010	7/7/2010	7/21/2010	8/11/2010	8/25/2010	9/8/2010	9/22/2010	10/6/2010	10/20/2010	11/17/2010	12/15/2010
	LES	142	137	126	121	97	123	136	301	2367	5000	4900	1,545	8025	898	180	91
	TG	136	134	127	121	101	120	129	143	164	167	170	164	177	182	151	94
	TC	137	138	126	119	98	115	127	144	165	170	172	167	182	184	152	100
	WE	128	131	125	117	91	122	127	147	166	173	174	170	190	189	151	94
	TR	151	148	128	124	111	111	127	141	164	164	165	163	164	169	159	115

pH	Site	2/18/2010	4/15/2010	5/12/2010	5/26/2010	6/9/2010	6/23/2010	7/7/2010	7/21/2010	8/11/2010	8/25/2010	9/8/2010	9/22/2010	10/6/2010	10/20/2010	11/17/2010	12/15/2010
	LES	7.68	7.86	7.8	7.81	8.01	8.19	7.95	8.13	8.04	8.12	7.98	8.11	8.18	8.44	8.25	8.34
	TG	7.66	8.00	7.88	7.84	7.83	8.10	8.01	8.26	8.15	8.19	8.25	8.20	8.38	8.08	8.39	8.39
	TC	8.06	8.08	7.56	7.88	8.04	8.17	7.97	8.40	8.31	8.02	8.3	8.24	8.36	8.44	8.44	8.56
	WE	7.88	8.13	7.83	7.91	7.97	8.09	8	8.53	8.28	8.09	8.38	8.29	8.43	8.42	8.55	8.42
	TR	8.02	8.03	7.89	7.96	8.34	8.14	7.89	8.30	8.17	8.1	8.33	8.23	8.2	8.3	8.65	8.62

Blue-green Algae cells/mL	Site	2/18/2010	4/15/2010	5/12/2010	5/26/2010	6/9/2010	6/23/2010	7/7/2010	7/21/2010	8/11/2010	8/25/2010	9/8/2010	9/22/2010	10/6/2010	10/20/2010	11/17/2010	12/15/2010
	LES	DNR	DNR	DNR	-125	-125	-400	-650	-545	-450	-50	4250	4150	2550	2450	-650	-250
	TG	DNR	DNR	0	-450	-75	-450	-750	-305	-450	-400	4750	3550	3850	2750	-850	-650
	TC	DNR	DNR	-75	-100	0	-275	-450	-580	-450	-450	3650	2450	3750	3450	-450	-350
	WE	DNR	DNR	0	-175	50	-600	-200	-510	0	0	3750	3650	4750	6950	-450	50
	TR	DNR	DNR	-350	-325	450	-50	-300	-275	-100	-200	-550	-550	-350	250	-750	-350

DNR= Did Not Record

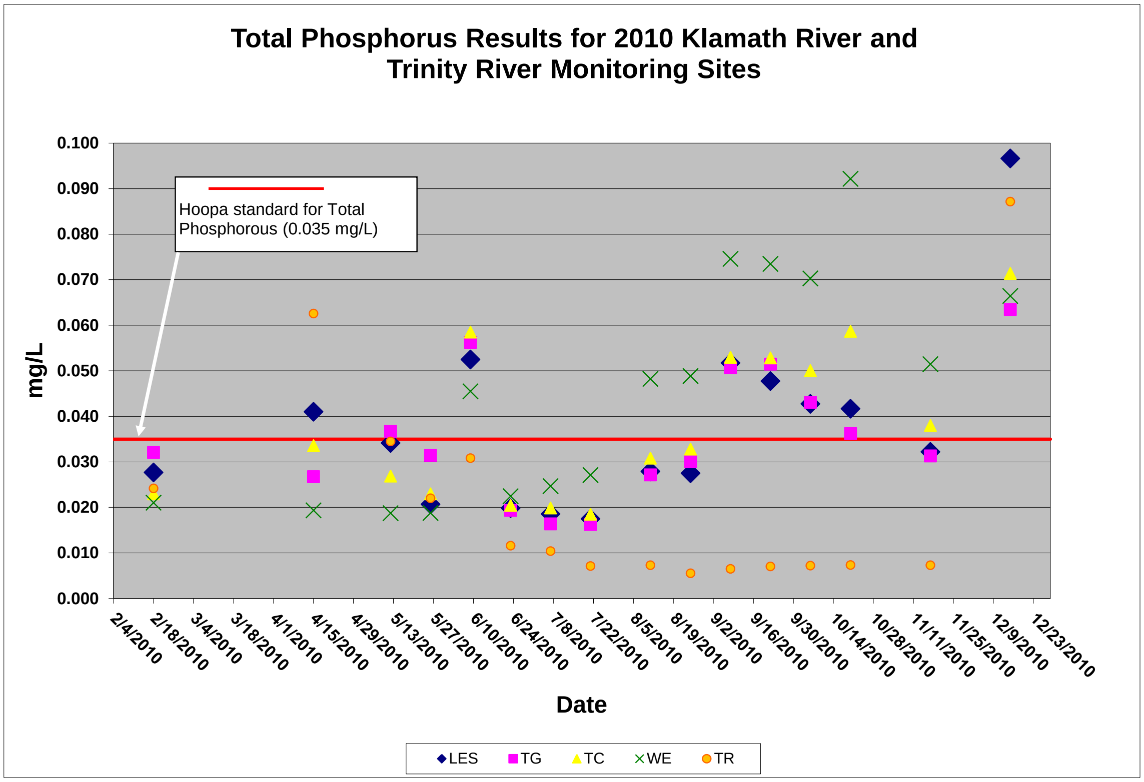

Figure 6-1. Total Phosphorus Results 2010

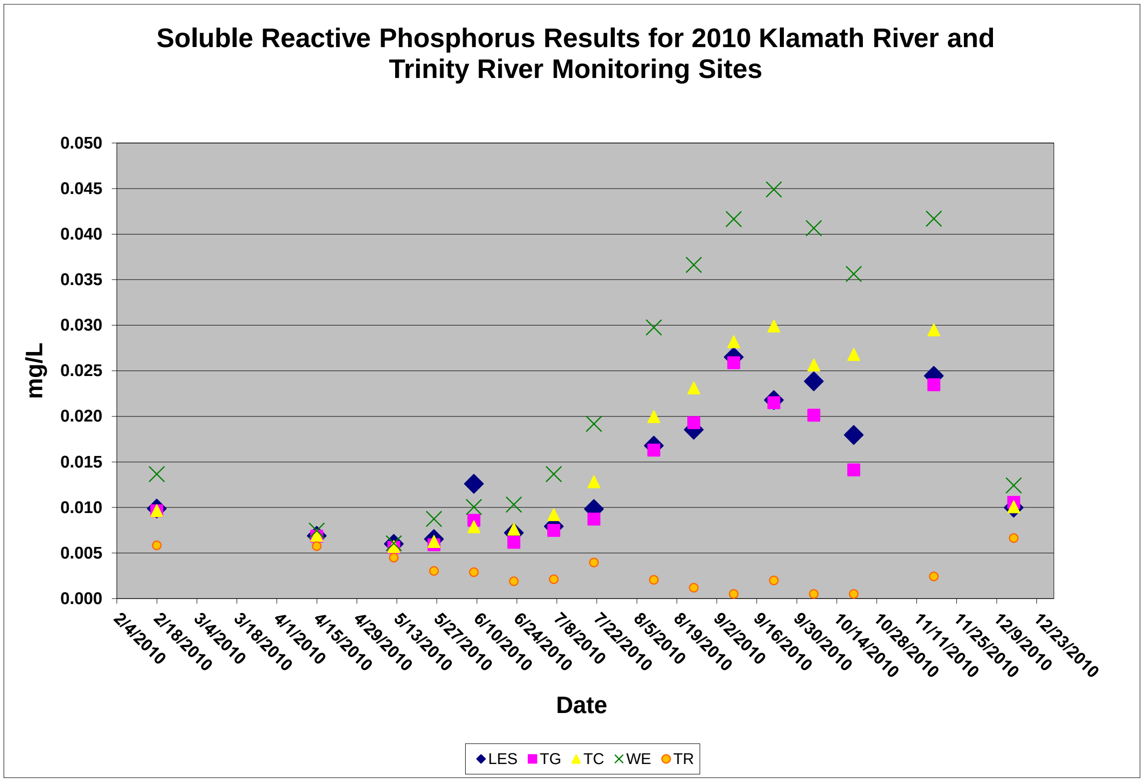

Figure 6-2. Soluble Reactive Phosphorus Results 2010

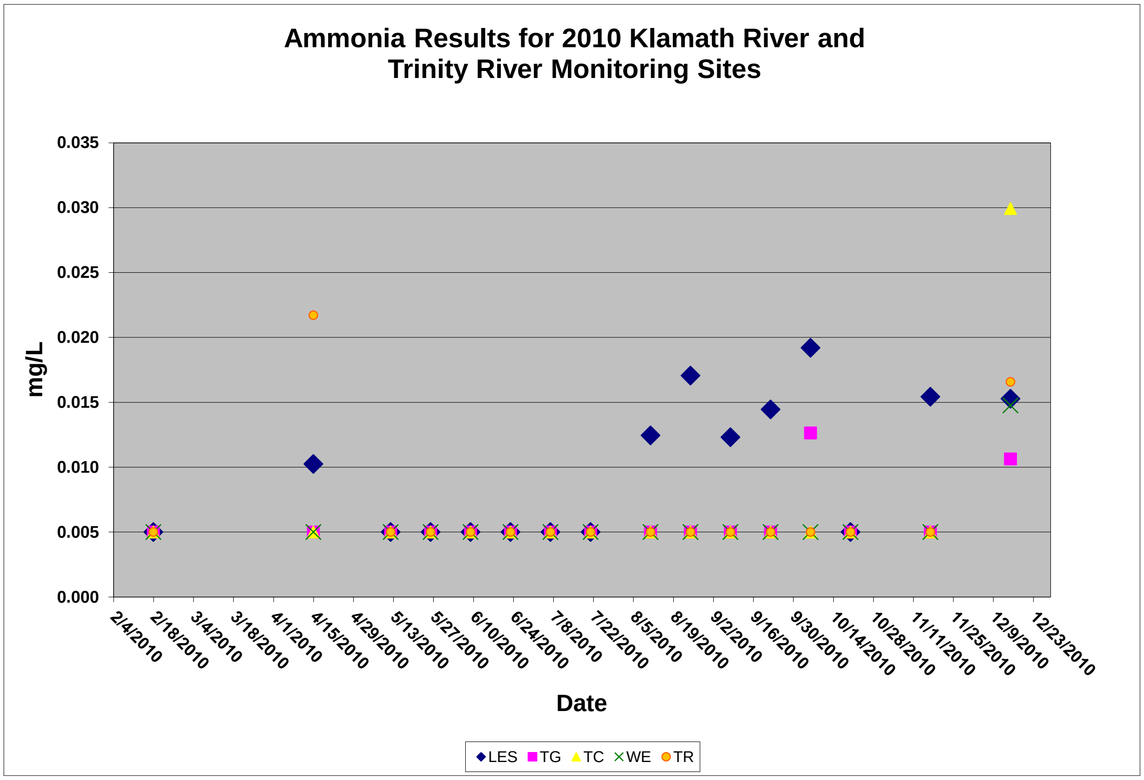

Figure 6-3. Ammonia Results 2010

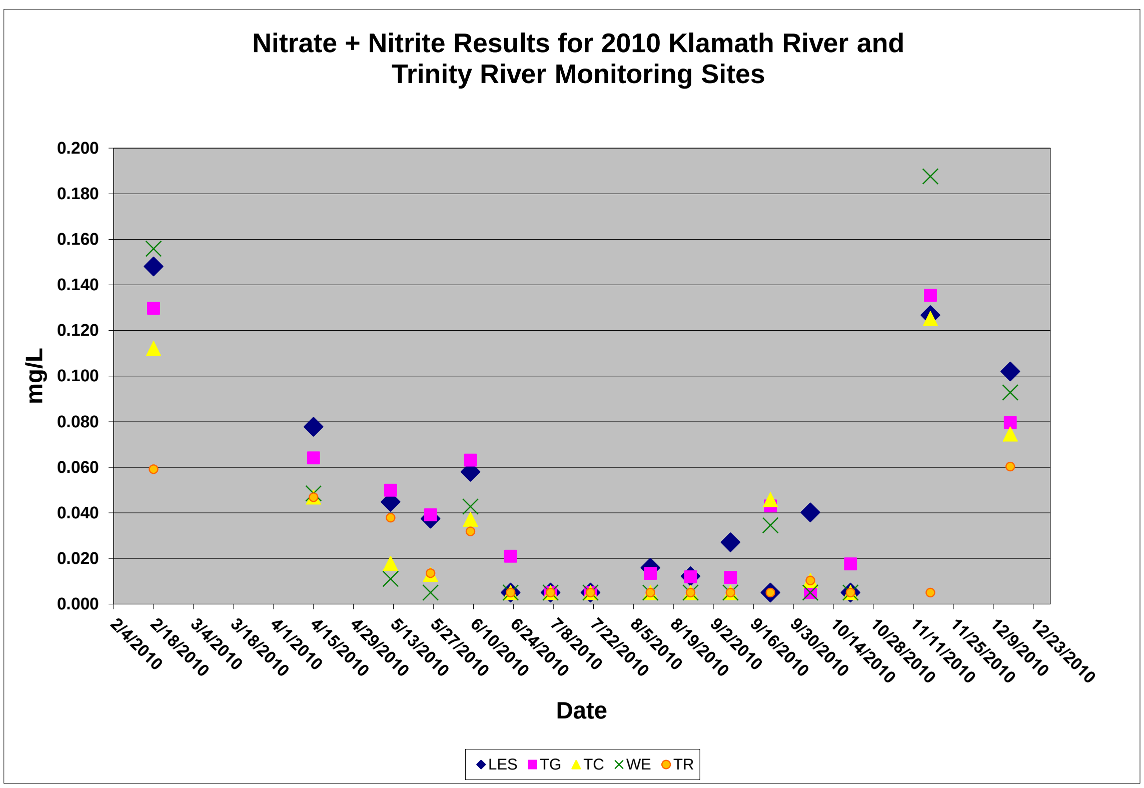

Figure 6-4. Nitrate + Nitrite Results 2010

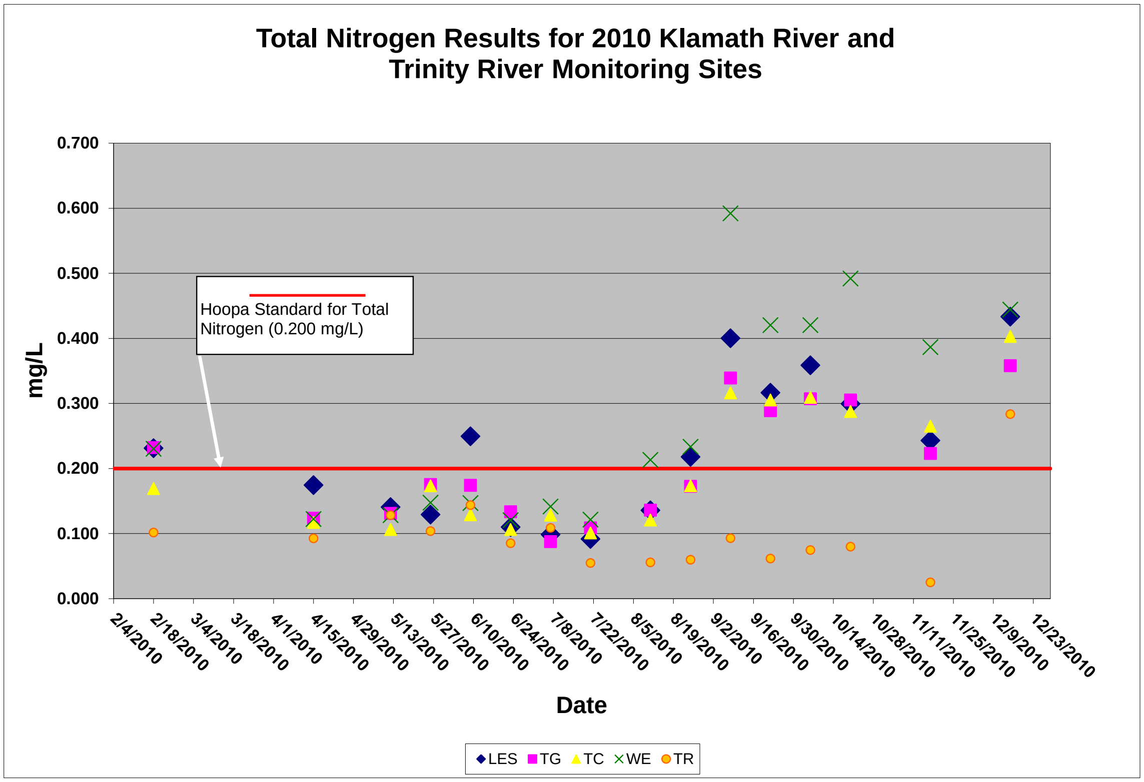

Figure 6-5. Total Nitrogen Results 2010

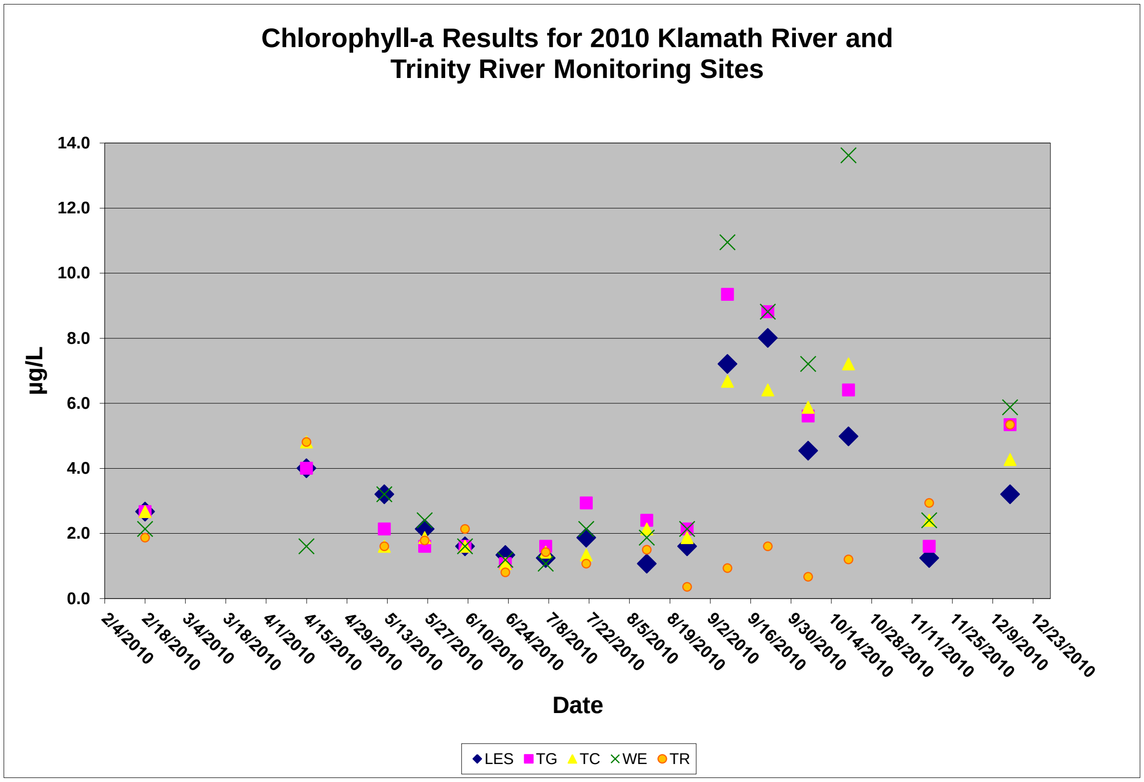

Figure 6-6. Chlorophyll-a Results 2010

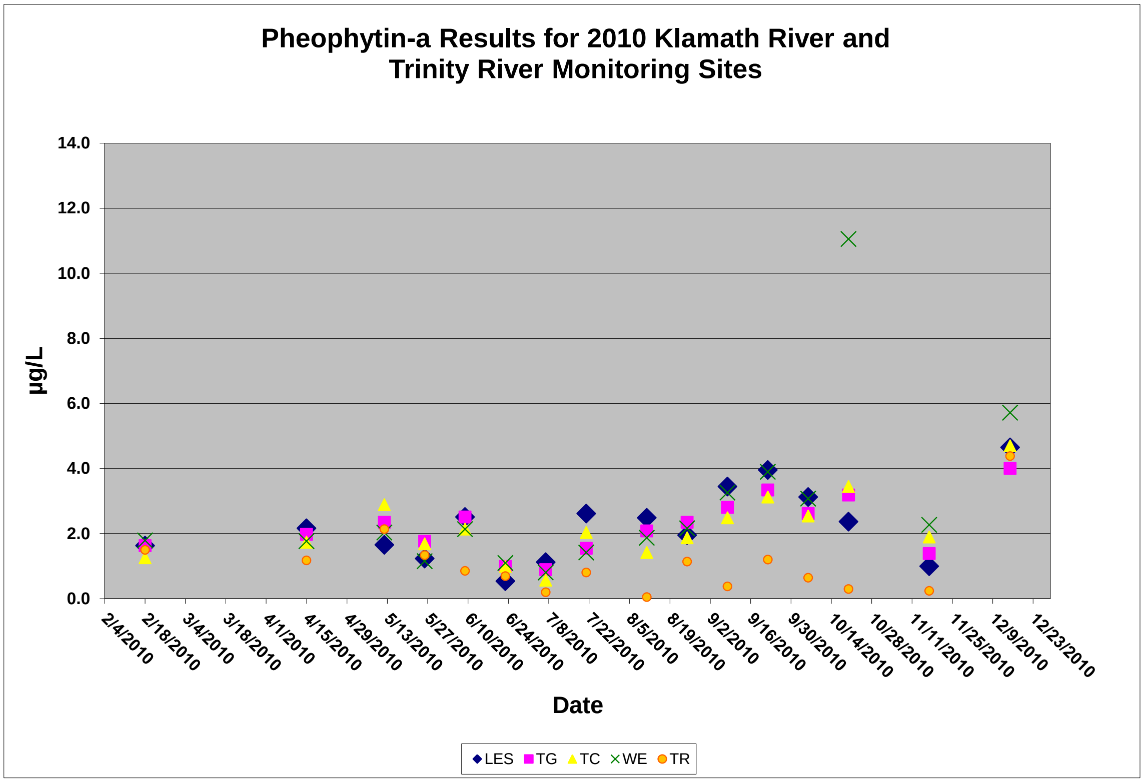

Figure 6-7. Pheophytin-a Results 2010

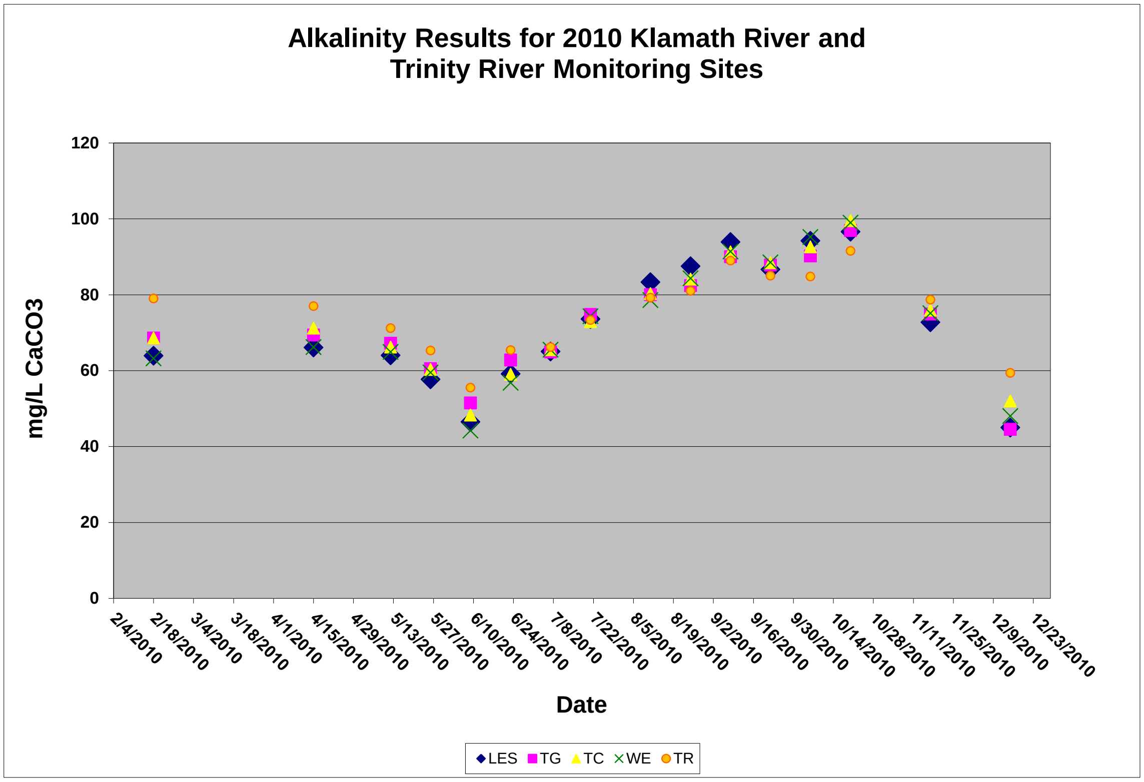

Figure 6-8. Alkalinity Results 2010

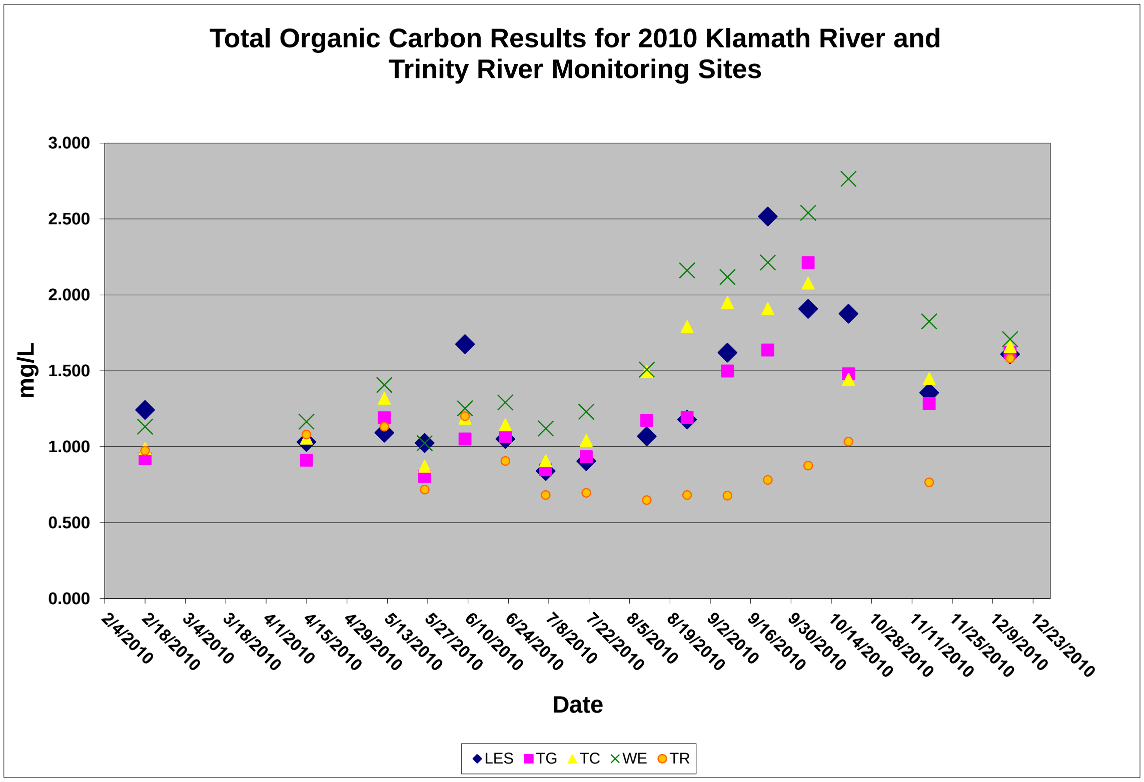

Figure 6-9. Total Organic Carbon Results 2010

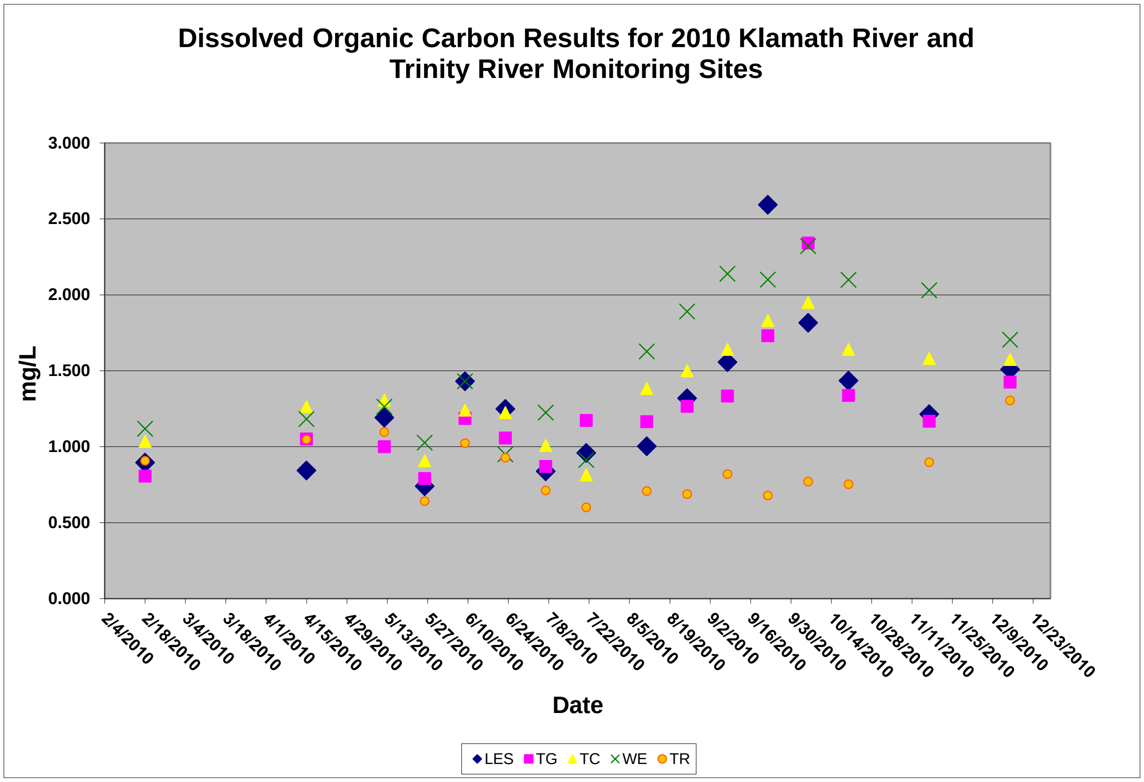

Figure 6-10. Dissolved Organic Carbon Results 2010

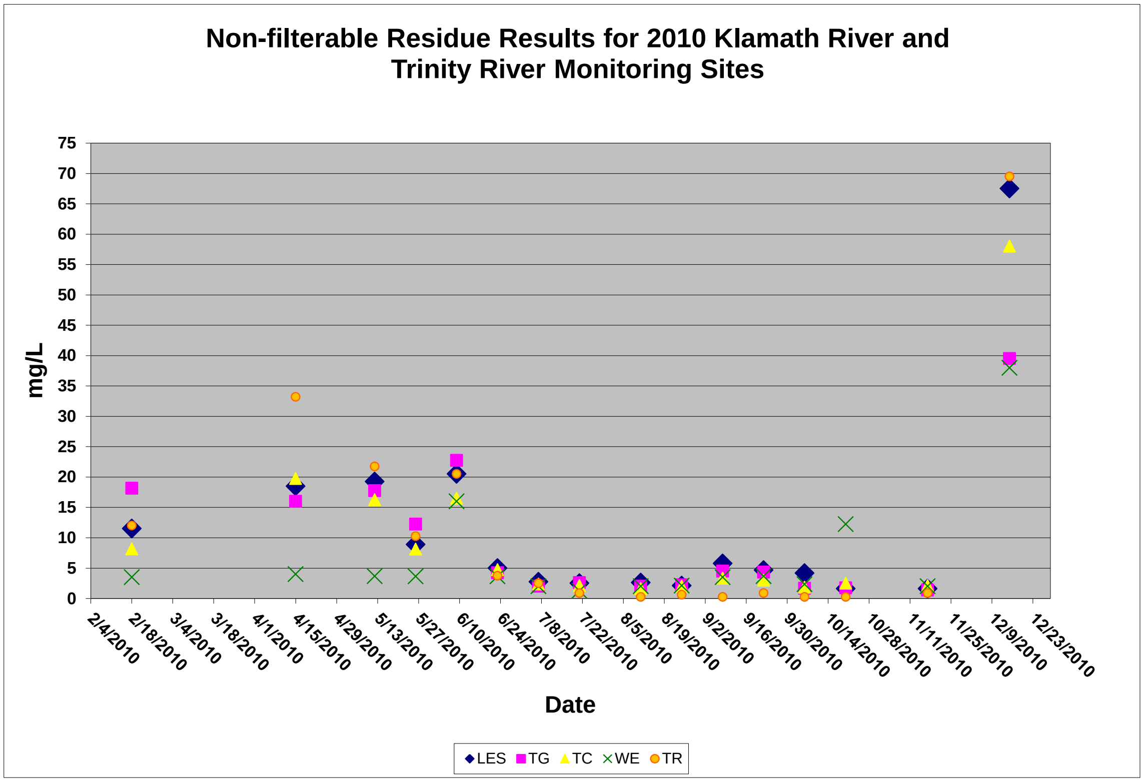

Figure 6-11. Non-filterable Residue Results 2010

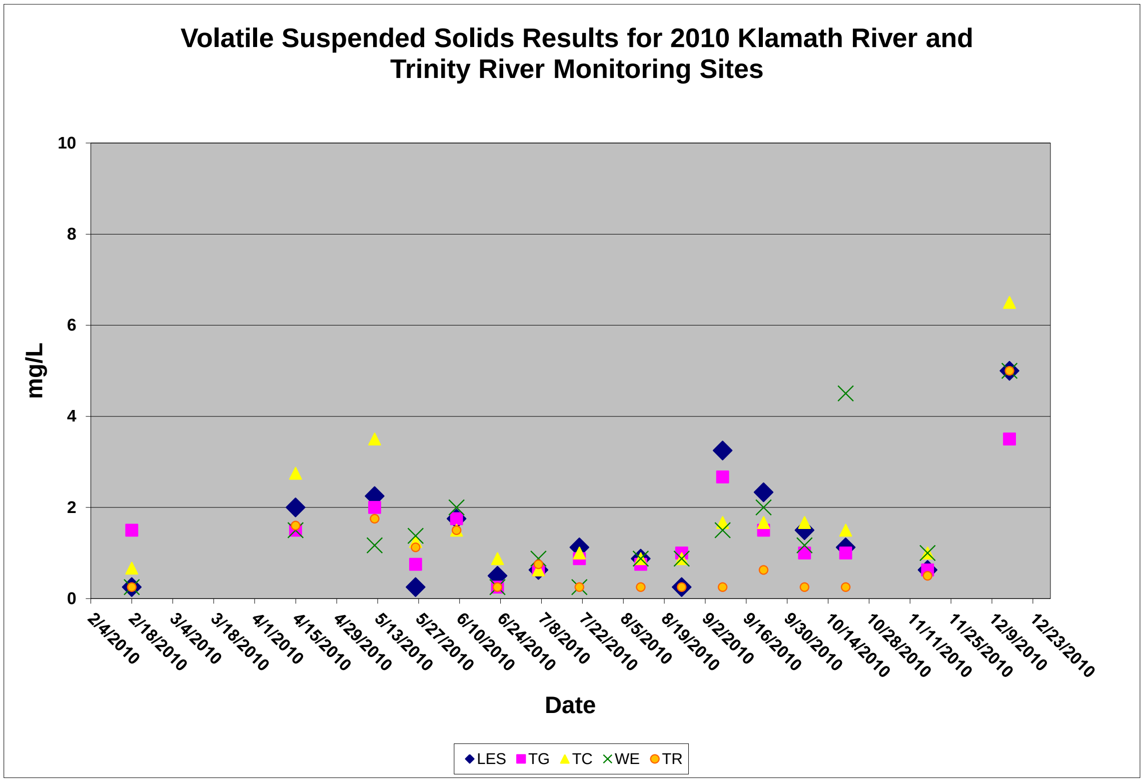

Figure 6-12. Volatile Suspended Solids Results 2010

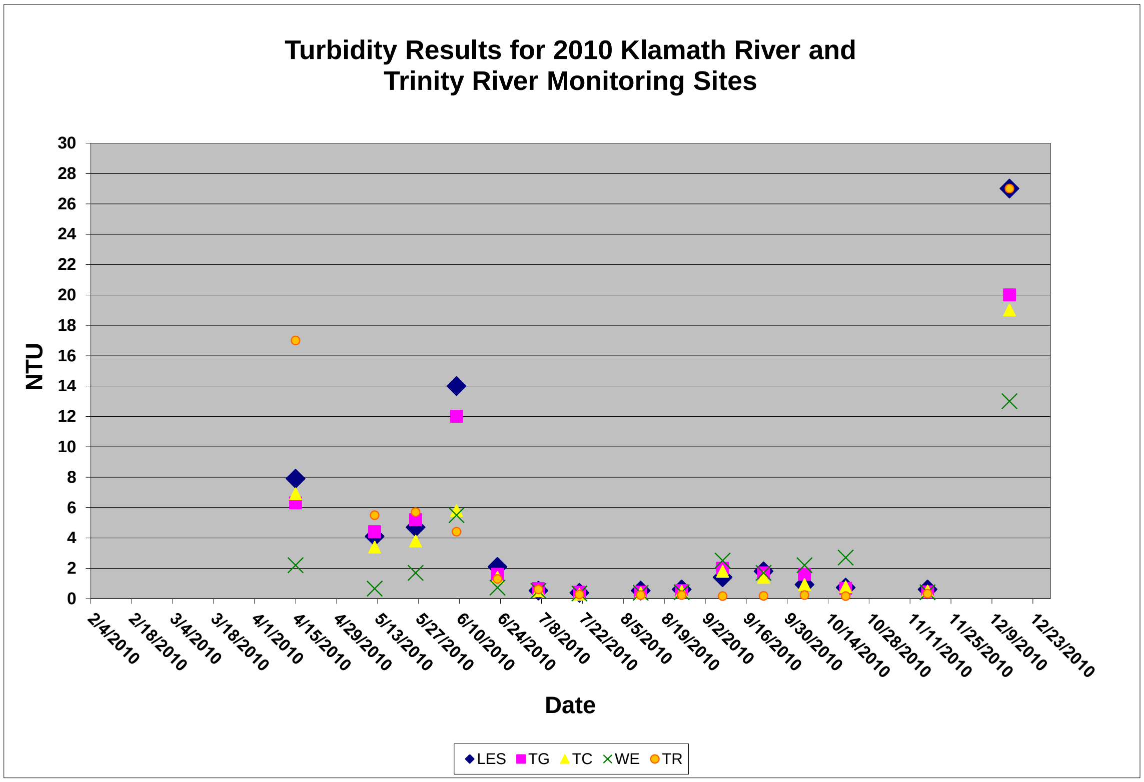

Figure 6-13. Turbidity Results 2010

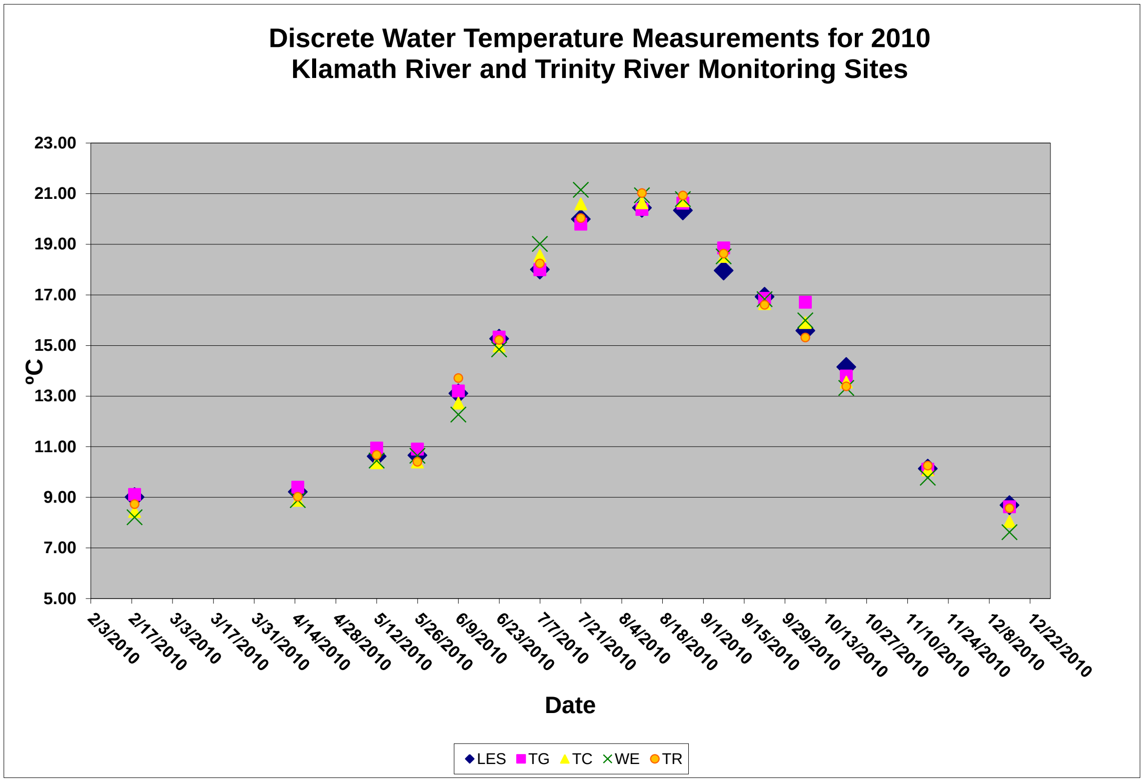

Figure 6-14. Discrete Water Temperature Measurements 2010

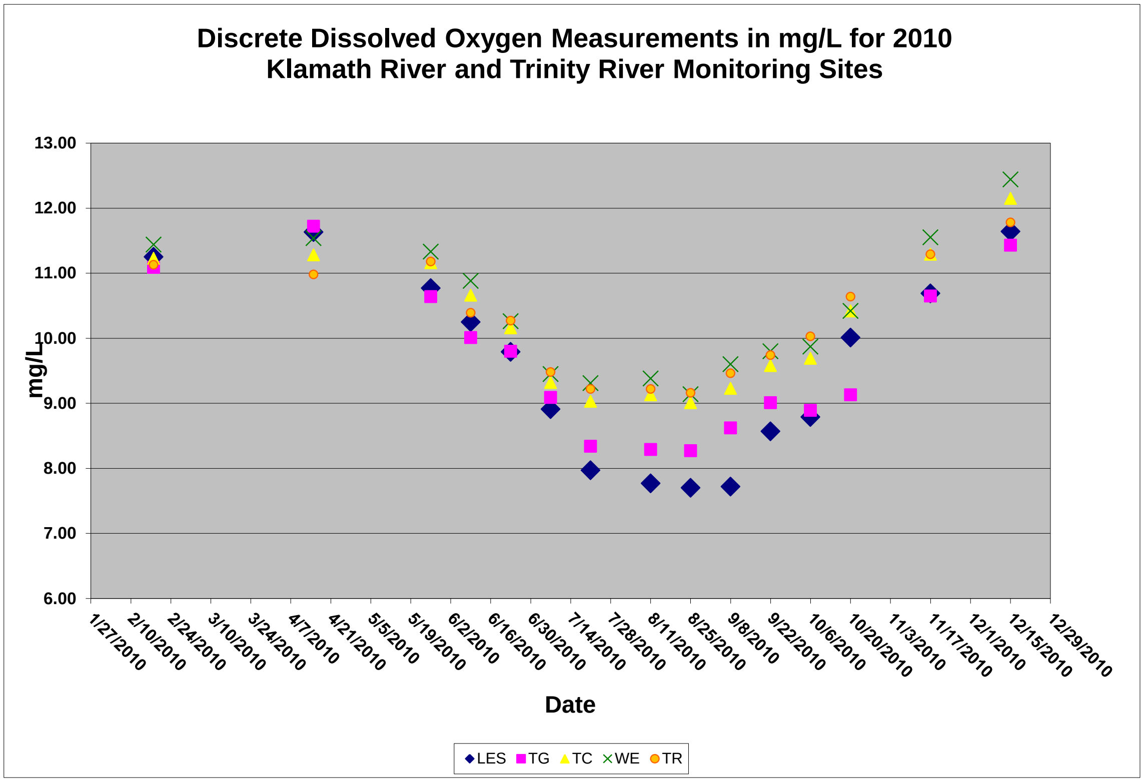

Figure 6-15. Discrete Dissolved Oxygen Measurements in mg/L 2010

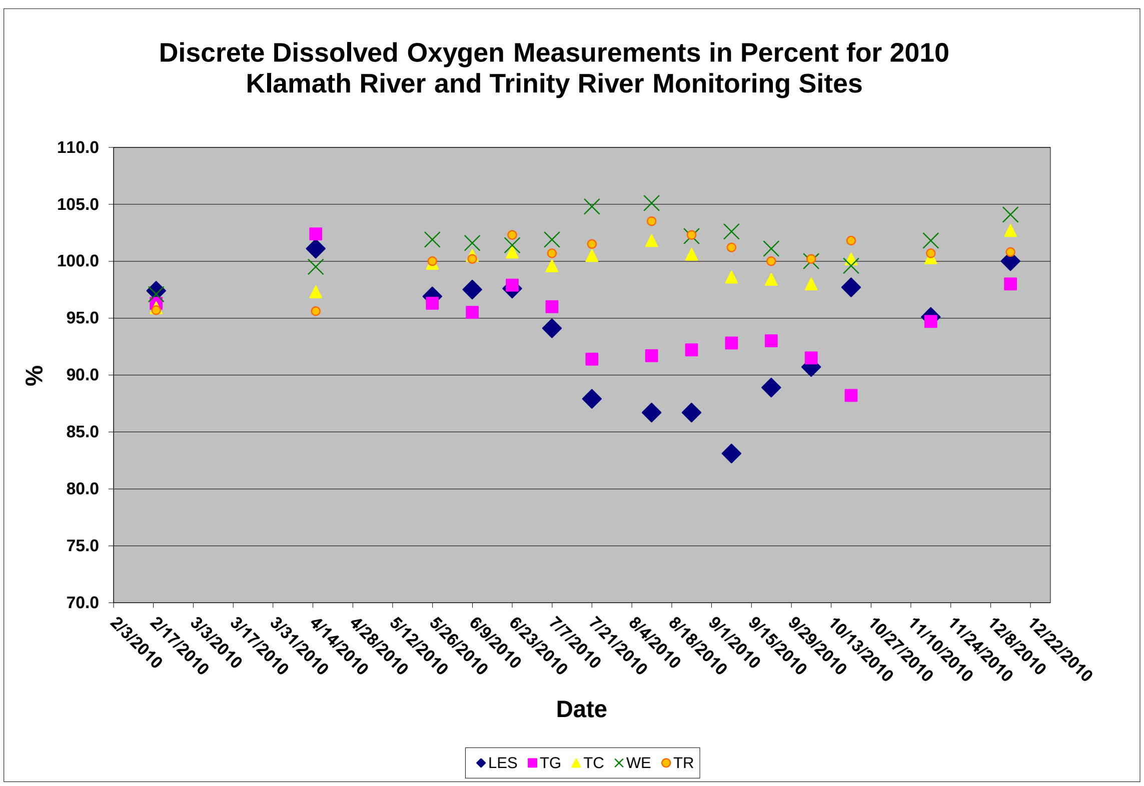

Figure 6-16. Discrete Dissolved Oxygen Measurements in Percent 2010

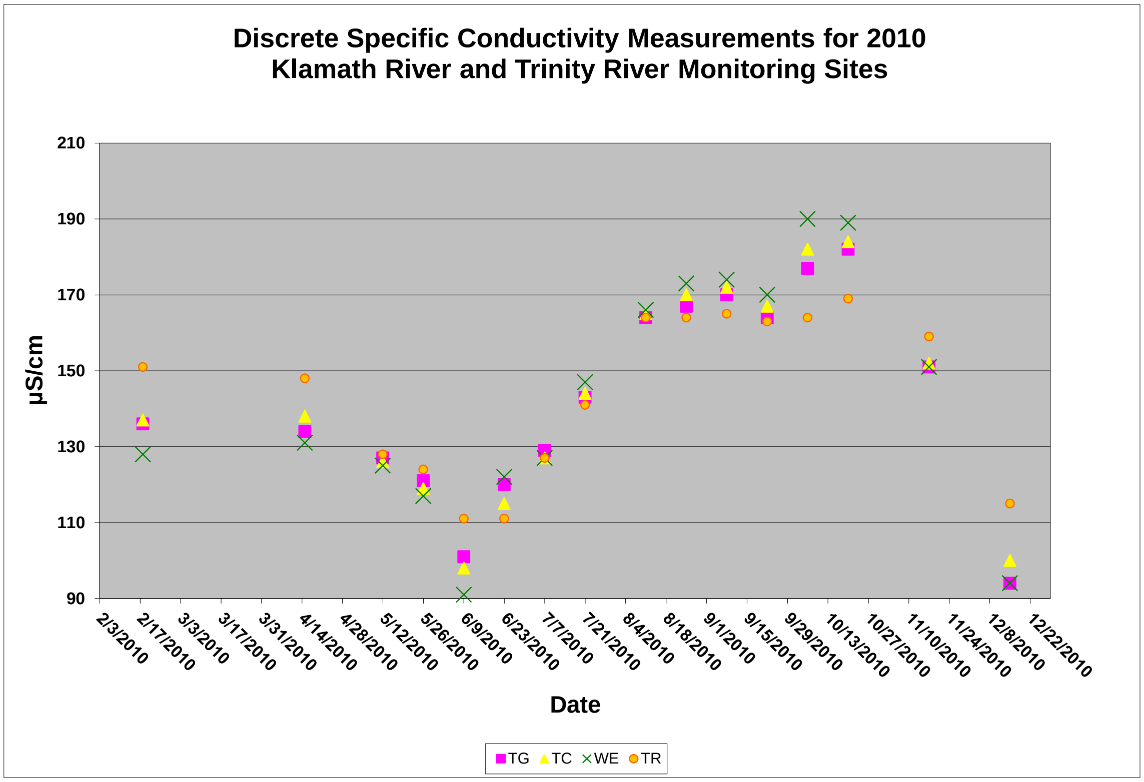

Figure 6-17. Discrete Specific Conductivity Measurements 2010

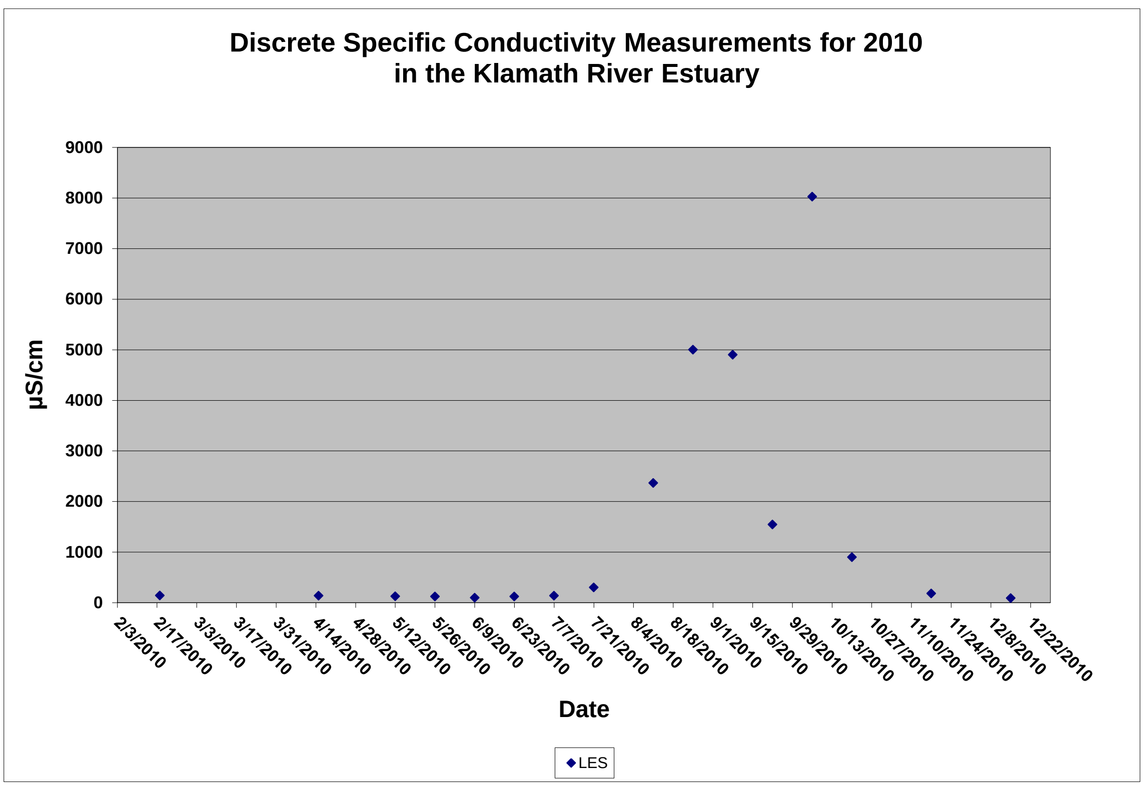

Figure 6-18. Discrete Specific Conductivity Measurements in the Klamath River Estuary 2010

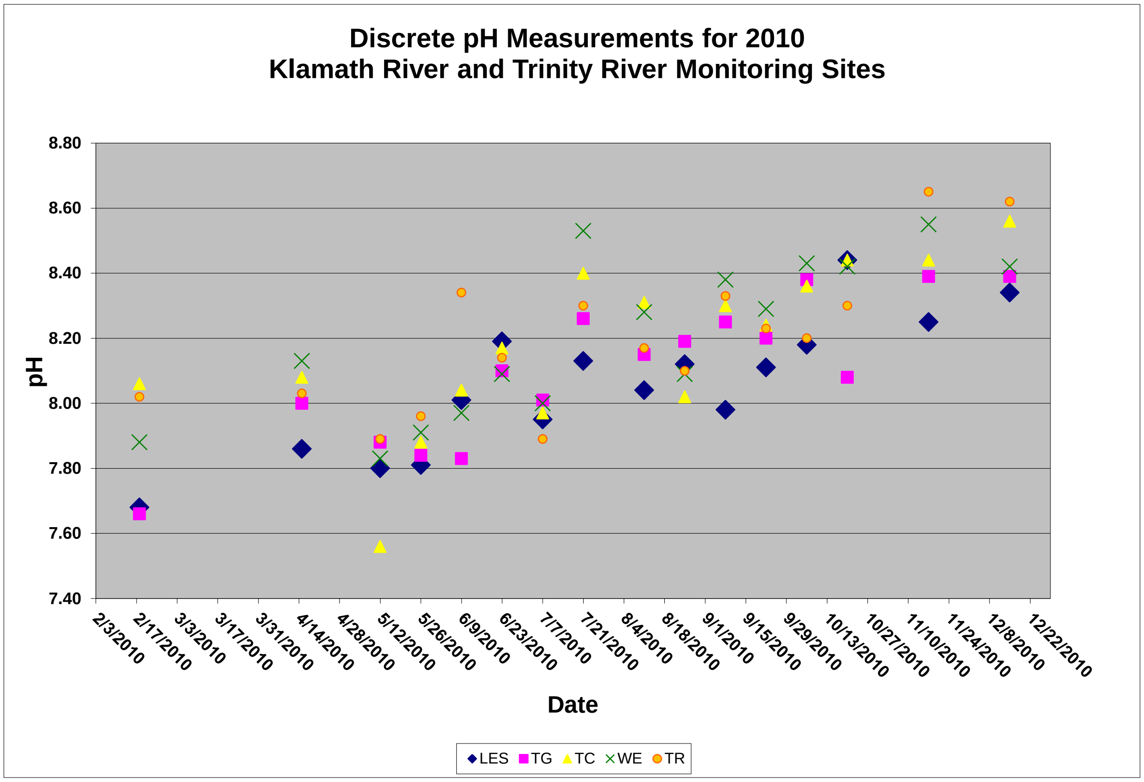

Figure 6-19. Discrete pH Measurements 2010

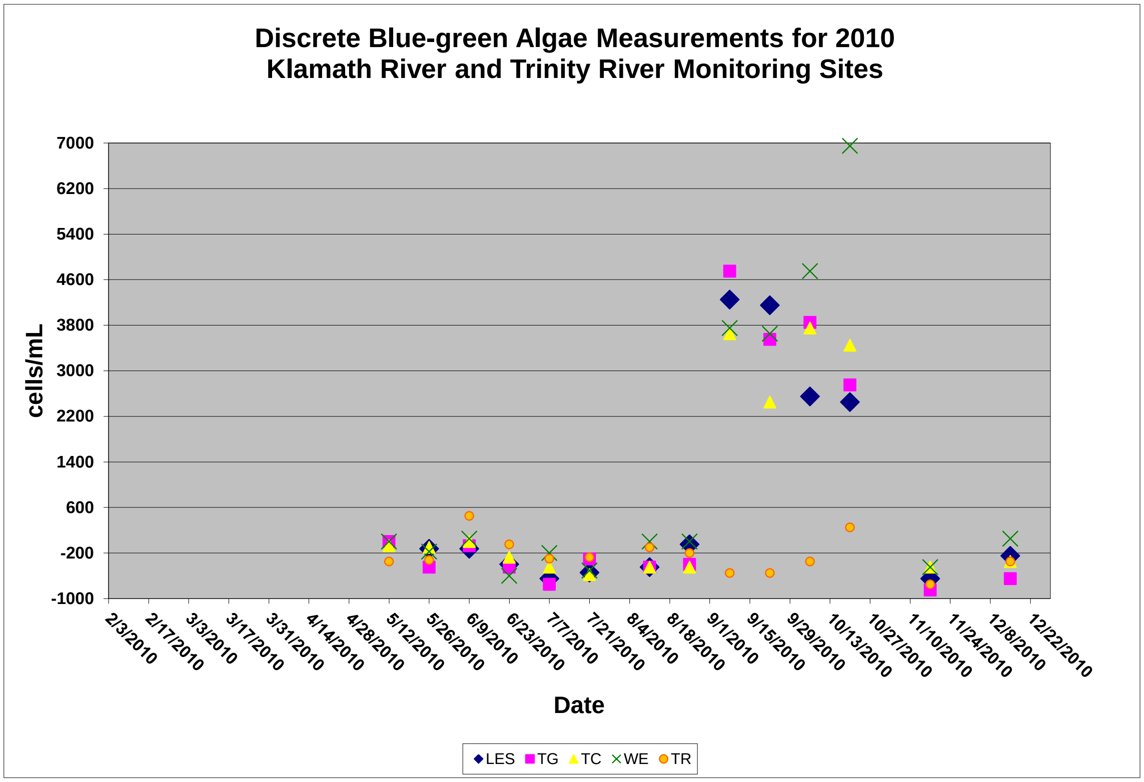

Figure 6-20. Discrete BGA Measurements 2010

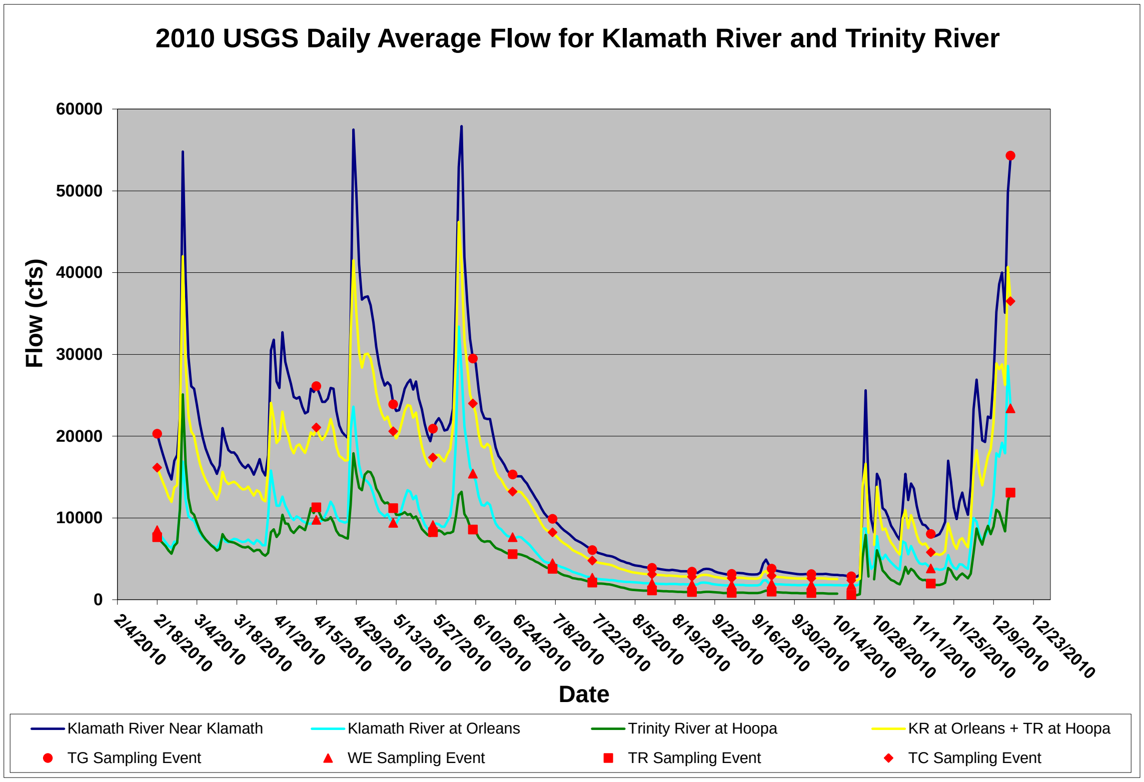

Figure 6-21. Daily Average Flow 2010 (From USGS) with sites superimposed onto flow on dates sampled

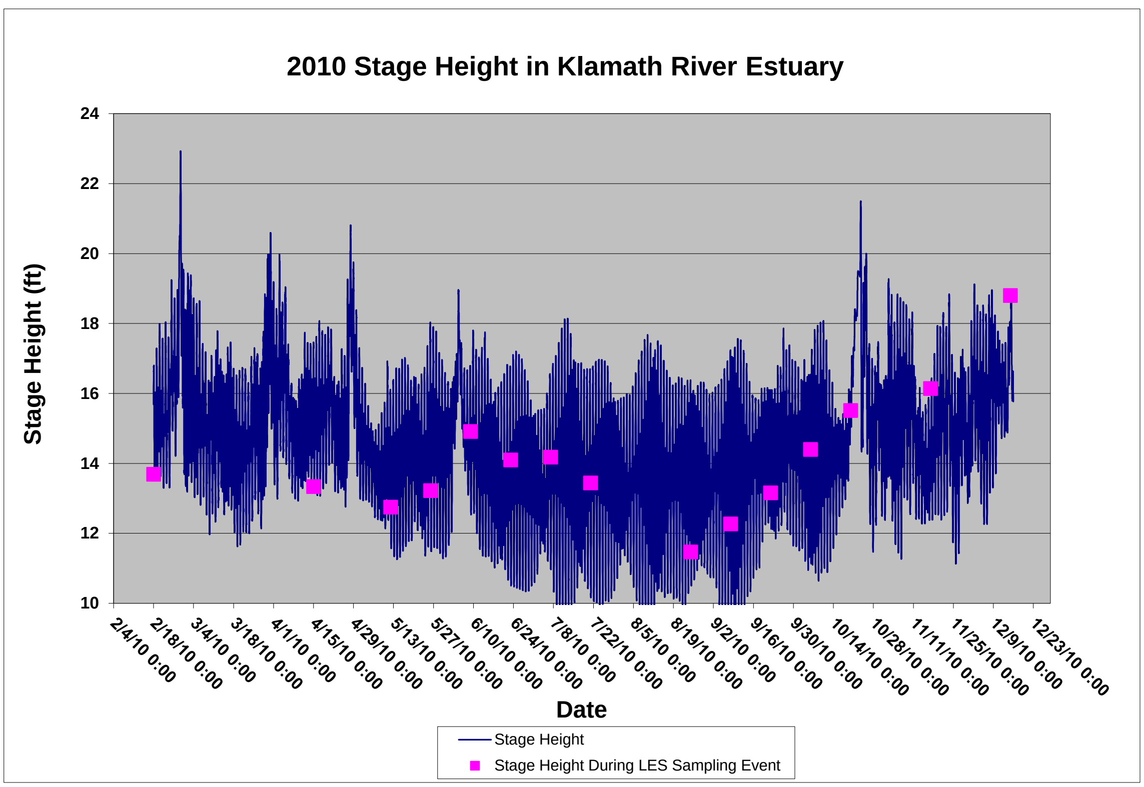

Figure 6-20. Klamath River Estuary Stage Height 2010 with sampling dates superimposed onto height

Blue-green Algae

Blue-green algae trends were similar for all sites except TR for the 2010 sampling season (Table 6-3, Figure 6-20). Measurements at all sites were near or below zero from mid-May to early September, increasing sharply at LES, TG, TC, and WE in early September. After early September, BGA measurements remained high at these sites, dropping slightly at LES, TG, and TC into mid-October. At WE, BGA levels increased into mid-October. BGA levels at these four sites returned at or below zero in mid-November and mid-December. BGA levels remained at, or below zero at TR throughout the sampling season. The lowest reading for blue-green algae during the 2010 sampling season was -850 cells/mL at TG on November 17, while the highest reading was 6,950 cells/mL at WE on October 20, 2010.

VII. Discussion

Organic Carbon

Organic matter plays a major role in aquatic systems. It affects biogeochemical processes, nutrient cycling, biological availability, and chemical transport and interactions. Organic matter content is typically measured as total organic carbon (TOC) and dissolved organic carbon (DOC), which are essential components of the carbon cycle. Dissolved organic carbon is the fraction of the total organic carbon that can pass through a filter. During certain sampling events, DOC results were slightly higher than TOC results (Table 6-2, Figures 6-9 and 6-10). This occurs because at the low levels of carbon that are being detected in the samples throughout the sampling season, most of the organic carbon in the system is in the dissolved form, causing TOC and DOC results to be essentially equal. This characteristic of the water being sampled, combined with the possibility of variation during DOC filtration, can sometimes lead to results in which DOC is slightly higher than TOC.

Throughout the sampling season the ratio of DOC to TOC fluctuated very little, with ratios at most sites near 100% for most sampling events (Table 7-1, Figure 7-1). This ratio held up even on December 15, when significant rainfall had occurred. Seven samples from the 2010 sampling season returned ratios less than 80%. They were LES on February 18, May 26, and October 20; WE on June 23, July 21, and October 20; and TR on October 20. It should be noted that three of these results occurred on October 20, when the lowest flows of the 2010 season were occurring. No site yielded a ratio of less than 70% during the 2010 sampling season. As discussed in the previous paragraph, ratios of more than 100% are possible because on certain dates and at certain sites, DOC results were higher than TOC results. These results indicate that throughout the sampling season, DOC constitutes almost all of the TOC found at the sampling sites.

Suspended Solids

Suspended solids refers to small solid particles which remain in suspension in water due to the motion of the water. Total suspended solids (TSS) are the amount of filterable solids in a water sample. Samples are run through a filter, which is then dried and weighed to determine the amount of total suspended solids in mg/l of sample. Volatile suspended solids (VSS) are those suspended solids lost on ignition (heating to 550 degrees C). They give an indication of the amount of organic matter present in the solid, suspended fraction of water.

The ratio of VSS to TSS fluctuated throughout the year (Table 7-2, Figure 7-2). At the beginning of the sampling season, ratios ranged from below reporting limits at LES, WE, and TR to 8.3% at TG. The ratio of VSS to TSS steadily increased until early October, at which time ratios ranged from 36% at LES to 91% at TC. Subsequently ratios generally decreased until sampling was suspended in mid-December, at which time ratios ranged from 7.2% at TR to 13.2% at WE. This temporal pattern is to be expected as the quantity of organic matter in suspended solids increases in the summer due to increased biological activity in aquatic organisms and then decreases as the activity of those organisms decreases in the fall and winter. TR consistently returned the lowest results, often having a ratio of zero due to the high frequency of TSS and VSS not being detected throughout the season. The rain events on June 9 and December 15 had considerable impacts on the ratio of VSS to TSS. While the total amount of both VSS and TSS in the water increased, the ratio decreased significantly, indicating that a smaller portion of the suspended solids in the system was from organic matter.

The highest ratio of VSS to TSS was 90.9% at TC on October 6, while the lowest ratio was 4.8% at TR on April 15, 2010. On several dates the ratio was 0%. On these dates, VSS returned results that were below the reporting limit of 0.50 mg/L.

Spatial Patterns

In a large watershed such as the Klamath Basin, in which water coming out of Upper Klamath Lake and that being released from upriver dams in the summer is very low quality, full of algae, and high in nutrients; nutrient concentrations decline as the river flows downstream. This decline in nutrient concentration occurs for three reasons: dilution, periphyton growth, and denitrification.

Dilution

This process has the largest effect on the concentration of nutrients in the Klamath River. In general, nutrient concentrations decline as the river flows downstream due to an influx of cleaner, cooler, higher-quality water from tributaries downstream of Iron Gate Dam.

Periphyton Growth

Periphyton, also known as benthic or attached algae, removes nutrients dissolved in water to facilitate biochemical processes involved in cellular growth. Periphyton can improve water quality by removing nutrients from the water and can also contribute to water quality degradation by re-releasing the nutrients into the river system during decomposition (Water Quality Control Plan: Hoopa Valley Reservation, 2008). Luxuriant periphyton growth also causes large swings in pH and dissolved oxygen over the course of the day as biochemical processes increase and decrease in accordance with the rise and fall of the sun.

Table 7-1. Ratio of DOC to TOC, Yurok Reservation 2010

Site	2/18/2010	4/15/2010	5/12/2010	5/26/2010	6/9/2010	6/23/2010	7/7/2010	7/21/2010	8/11/2010	8/25/2010	9/8/2010	9/22/2010	10/6/2010	10/20/2010	11/17/2010	12/15/2010
LES	72.1	81.8	109.2	72.2	85.4	118.8	99.9	106.1	93.9	112.0	96.1	103.1	95.2	76.4	89.7	93.8
TG	87.5	115.4	84.0	98.4	113.0	99.2	102.6	125.7	99.3	106.2	89.1	105.7	105.9	90.3	91.0	87.9
TC	104.9	119.6	98.9	104.1	104.5	107.1	111.2	78.2	92.4	83.8	84.1	95.9	93.8	113.7	109.1	94.9
WE	98.9	101.5	89.8	100.4	114.2	73.6	109.5	74.1	107.9	87.5	101.0	94.9	91.3	75.9	111.2	99.8
TR	93.2	97.1	96.8	89.5	85.3	102.3	104.4	86.2	109.1	100.9	121.2	86.9	87.9	72.9	117.4	82.4

Table 7-2. Ratio of VSS to TSS, Yurok Reservation 2010

Site	2/18/2010	4/15/2010	5/12/2010	5/26/2010	6/9/2010	6/23/2010	7/7/2010	7/21/2010	8/11/2010	8/25/2010	9/8/2010	9/22/2010	10/6/2010	10/20/2010	11/17/2010	12/15/2010
LES	0.0	10.8	11.7	0.0	8.5	10.0	22.7	45.0	33.3	0.0	56.5	50.0	36.0	69.2	38.5	7.4
TG	8.3	9.4	11.3	6.1	7.7	0.0	31.3	33.3	37.5	44.4	59.3	34.6	60.0	57.1	45.5	8.9
TC	8.2	13.9	21.5	15.4	9.1	18.4	26.3	47.1	53.8	43.8	50.0	55.6	90.9	60.0	47.1	11.2
WE	0.0	37.5	31.8	37.9	12.5	0.0	43.8	0.0	43.8	41.2	42.9	54.5	50.0	36.7	50.0	13.2
TR	0.0	4.8	8.0	11.0	7.3	0.0	30.0	0.0	0.0	0.0	0.0	71.4	0.0	0.0	57.1	7.2

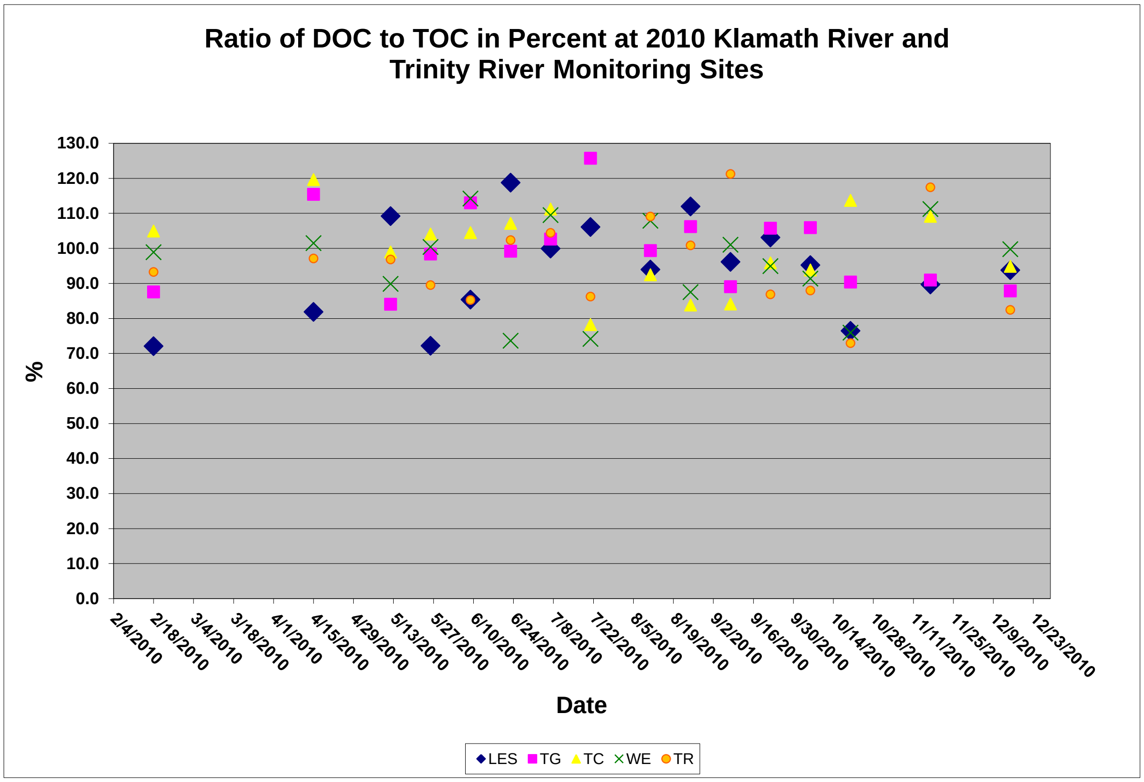

Figure 7-1. Ratio of DOC to TOC 2010

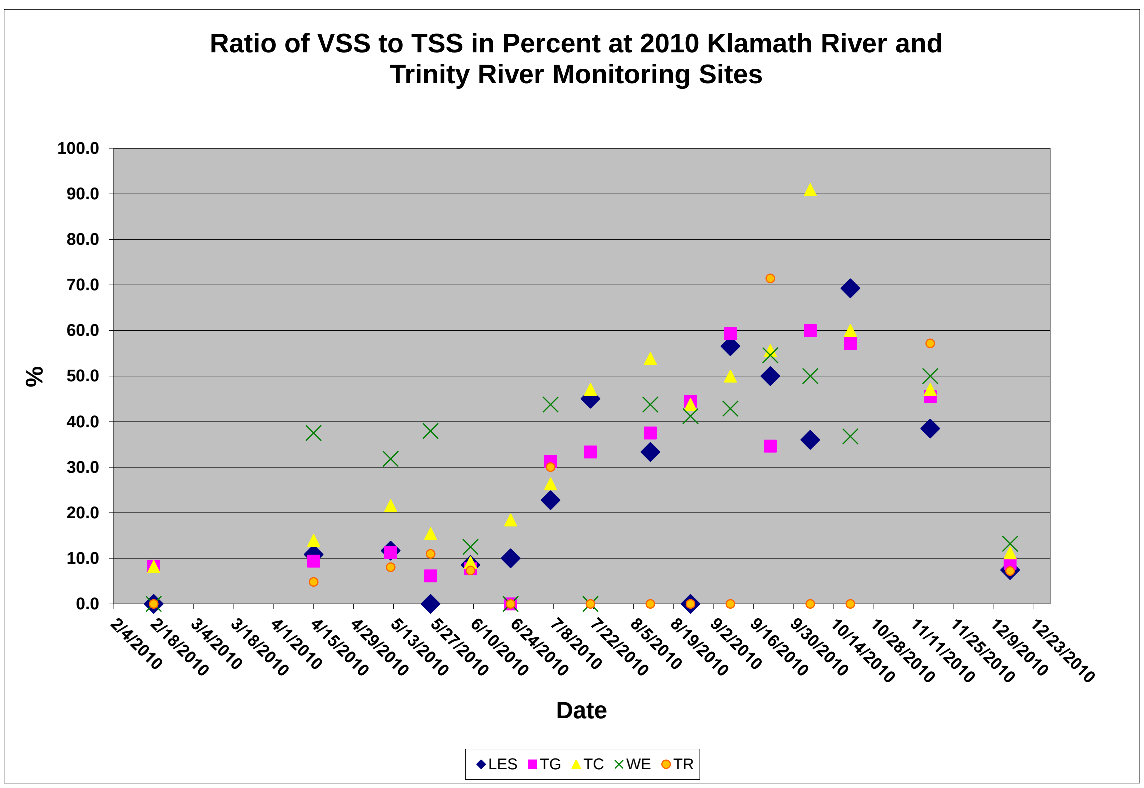

Figure 7-2. Ratio of VSS to TSS 2010

Temporal Patterns

The Klamath River's nutrient concentrations also vary over time. In the Klamath Basin, the principal source of nutrient loading in rivers and streams during months with large quantities of rainfall is from runoff originating from agricultural land. In this type of system, an increase in precipitation initiates an increase in runoff and associated streamflows, which subsequently leads to an increase in nutrient concentrations (Mueller et al., 2006; Sprague et al., 2008). The Klamath Basin receives most of its rain from November to April; however, in 2010 rain events occurred throughout May, with one of the largest rain events of the year occurring in early June (Figure 6-21 and 6-22). As can be seen in Figures 6-1 through 6-12, concentrations of all parameters except ammonia, alkalinity, and chlorophyll-a in the Klamath River increased in early June. During this event ammonia and alkalinity concentrations decreased. In mid-December there was another large rain event in which all parameters except SRP and alkalinity dramatically increased. During this event SRP and alkalinity decreased. During months with little rainfall, however, the principal source of nutrient loading in the Klamath River is from Upper Klamath Lake. In Upper Klamath Lake the source of nutrients during the spring and summer is largely due to internal loading from lake sediments (Lindenberg et al. 2008). Therefore, a drop in water levels does not correspond with a drop in nutrient levels. As can be seen in Figures 6-1 through 6-12, this corresponds to increasing levels of nutrients in the Klamath River as the summer progresses and river levels drop.

Nutrient Criteria

In this report, Hoopa Valley Tribal EPA nutrient criteria standards are applied to the information collected in 2010. The Hoopa Valley Tribe has not set standards for all nutrients analyzed by YTEP, therefore, nutrient standards to be discussed will be limited to total nitrogen and total phosphorous.

Total Nitrogen

The Hoopa Valley Tribal EPA has set the water quality standard for total nitrogen at 0.200 mg/L (Table 7-1, red line in Figure 6-5). As can be seen in Table 7-1 and Figure 6-5, total nitrogen concentrations stayed below this level at most sites from mid-February to late August. Exceptions to this pattern are LES on February 18 and June 9, and TG and WE on February 18. WE exceeded 0.200 mg/L again on August 11 and stayed above this level for the rest of the season, while LES surpassed it again on August 25. During the September 8 sampling event, all sites except TR exceeded this threshold and continued to be above this standard until sampling was suspended in mid-December. TR exceeded this threshold once during the December 15 sampling event. LES, TG, TC, and TR all returned their highest concentrations of the sampling season during the December 15 sampling event, which occurred during a significant rain event (Figures 6-21 and 6-22).

Total Phosphorous

The Hoopa Valley Tribal EPA has set the proposed standard for total phosphorous at 0.035 mg/L (Table 7-1, red line in Figure 6-1). As can be seen in Table 7-1 and Figure 6-1 this threshold was surpassed often during the 2010 sampling season. LES and TR both exceeded this standard on April 15, while TG exceeded it on May 12. All sites except TR exceeded 0.035 mg/L during the rain event in early June, then dropped below this level in late June. WE surpassed this threshold on August 11 and continued to exceed the standard until sampling was suspended in mid-December. LES, TG, and TC exceeded 0.035 mg/L on September 8. TC stayed above the standard until sampling was suspended, while LES and TG stayed above this level except for the sampling event on November 17. TR exceeded the threshold on two sampling events; April 15 and December 15. All sites returned elevated levels, with LES, TG, TC, and TR returning the highest concentrations of the season, during the sampling event on December 15, which occurred during a major rain event (Figures 6-21 and 6-22).

Table 7-3. Nutrient Standards for the Klamath River (based on data from Hoopa Valley Indian Reservation)

Parameter	Proposed Standard (mg/L)
Total Nitrogen	0.200
Total Phosphorous	0.035

The results from total nitrogen and total phosphorous indicate that nutrient levels in the Lower Klamath River often exceed water quality standards recognized as acceptable levels to meet beneficial uses.

Multi-year Comparisons

Consistently sampling multiple parameters at sites over many years throughout the Klamath River Basin aids in understanding baseline water quality conditions and contributes to a development of a water quality model of the system. A firm knowledge of baseline conditions can aid monitors in perceiving how conditions are fluctuating due to changes to the system such as shifting climate, altered land and water use practices, or the long-term effects of restoration projects.

In this report, parameters that have been collected by YTEP following similar protocols and analyzed at the same lab from 2006-2010 will be discussed. They are: total phosphorus, soluble reactive phosphorus, total nitrogen, ammonia, nitrate plus nitrite, alkalinity, chlorophyll-a, pheophytin-a, non-filterable residue, and total organic carbon. Samples have been collected at LES, TG, WE, and TR since 2006. Prior to September of 2007, samples collected just below the confluence were collected at KBW. In September of 2007 this site was moved slightly downstream due to access issues and renamed TC. These sites are close enough spatially, with no major tributary inputs, to be considered analogous in their results.

In May of 2009, year-round monitoring of nutrients began taking place. This increased temporal monitoring will increase our knowledge of when and where nutrients are moving through the Klamath River watershed. To obtain nutrient results from 2006-2009, please see the Nutrient Summary Report for the appropriate year, available at: http://www.yuroktribe.org/departments/ytep/ytepreports.htm.

Total Phosphorous

Patterns of total phosphorus from 2006-2010 were similar for each year with increasing concentrations as the summer progressed, usually reaching their peak in early September to mid-October (Figure 7-3). This peak was followed by decreasing concentrations into the late autumn. Upriver sites tended to have higher concentrations than downriver sites, except for TR, which consistently had some of the lowest concentrations of all sites. The highest peak concentrations for each site occurred in 2009, while the lowest peak concentrations tended to occur in 2008. All sites except TR usually passed the standard of 0.035 mg/L for total phosphorus by mid to late June. The exception to this pattern occurred in early June of 2010 in which a large rain event lowered concentrations to below the standard until early August (Figures 7-3 and 7-13).

Soluble Reactive Phosphorous

Patterns of soluble reactive phosphorus from 2006-2010 were similar for each year with increasing concentrations as the summer progressed, with the highest concentrations occurring in mid-September to late October (Figure 7-4). Concentrations then dropped after late October. Upriver sites tended to have higher concentrations than downriver sites, except for TR, which consistently had some of the lowest concentrations of all sites. Peak concentrations at each site were very similar for 2006-2009, while peak concentrations during 2010 were the lowest of the 5 years.

Total Nitrogen

Total nitrogen patterns from 2006-2010 were similar for each year with increasing concentrations as the summer progressed, usually reaching their peak in mid-September to late October (Figure 7-5). After peaking, concentrations decreased as Autumn progressed. WE tended to have the highest concentrations of all sites, while TR usually had the lowest. The highest peak concentrations for each site occurred in 2009, while the lowest peak concentrations occurred in 2006. All sites except TR passed the standard of 0.200 mg/L for total nitrogen by late May to late June. The exception to this occurred in early spring of 2010 in which a wet spring kept total nitrogen concentrations to below the standard until mid-August to early September (Figures 7-5, and 7-13).

Ammonia

Patterns of ammonia from 2006-2010 were similar for each year with most sites and most sampling events showing up as non-detects (Figure 7-6). LES was the exception, with many more detectable concentrations than any other site. The largest number of detectable concentrations occurred in 2009, while the lowest number of detectable concentrations occurred in 2007.

Nitrate + Nitrite

Nitrate + nitrite patterns from 2006-2010 were similar for each year with slightly decreasing concentrations as the summer progressed, with results hovering around the reporting limit of 0.010 mg/L for most of the summer (Figure 7-7). In contrast to other parameters, concentrations then increased with the first rain events of the fall, and subsequently fell throughout the winter and into the spring and summer. During the summer, downriver sites tended to have higher concentrations than upriver sites, while during the fall and winter, WE tended to have the highest concentrations. TR consistently had some of the lowest results of all sites.

Alkalinity

Patterns of alkalinity from 2006-2010 were similar for each year with increasing concentrations as the summer progressed, with the highest concentrations being detected in mid to late October (Figure 7-8). Concentrations then dropped after late October. The anomaly again occurs in early spring of 2010 in which large quantities of spring rain and snowmelt seems to have contributed to a decrease in concentrations until the final rain event in early June (Figures 7-8 and 7-13). Another interesting pattern is a decrease in concentrations at TR from early August to mid-September during 2006-2009, followed by increasing concentrations. The highest peak concentrations for each site were detected in 2010, while the lowest peak concentrations were detected in 2007. During the periods of lower flows, TR tended to have the lowest concentrations, while during periods of higher flows it had some of the highest results. During periods of higher flows WE had some of the lowest concentrations of all sites.

Chlorophyll-a

Chlorophyll-a patterns from 2006-2010 were similar for each year with increasing concentrations as the summer progressed, usually reaching their peak in early September to mid-October (Figure 7-9). After peaking, concentrations decreased as autumn progressed. As with other parameters, the wet spring of 2010 seems to have kept concentrations lower than the previous four years until early September (Figures 7-9 and 7-13). TR consistently had some of the lowest results of all sites. The highest peak concentrations at each site were detected in 2009, while the lowest peak concentrations at each site were detected in 2008.

Pheophytin-a

Patterns of pheophytin-a from 2006-2010 were similar for each year with increasing concentrations as the summer progressed, with the highest concentrations being detected in mid-September to mid-October (Figure 7-10). Concentrations tended to decrease after late October. TR consistently had the lowest results of all sites.

Non-filterable Residue (TSS)

Non-filterable residue, or total suspended solids (TSS), patterns from 2006-2010 were similar for each year with decreasing concentrations from spring throughout the summer, then increasing concentrations as flows increased in the fall and winter (Figures 7-11 and 7-13). TR tended to have the lowest concentrations during periods of lower flows and the highest concentrations during periods of higher flows.

Total Organic Carbon (TOC)

Patterns of total organic carbon from 2006-2010 were similar for each year with increasing concentrations as the summer progressed, with the highest concentrations being detected in mid-September to mid-October (Figure 7-12). After mid-October, concentrations decreased throughout the autumn and into winter. The wet spring of 201 seems to have kept concentrations of TOC low for longer in the year than the previous four years (Figures 7-12 and 7-13). Upriver sites tended to have higher concentrations than downriver sites, with the exception of TR, which consistently produced some of the lowest concentrations throughout the entire year.

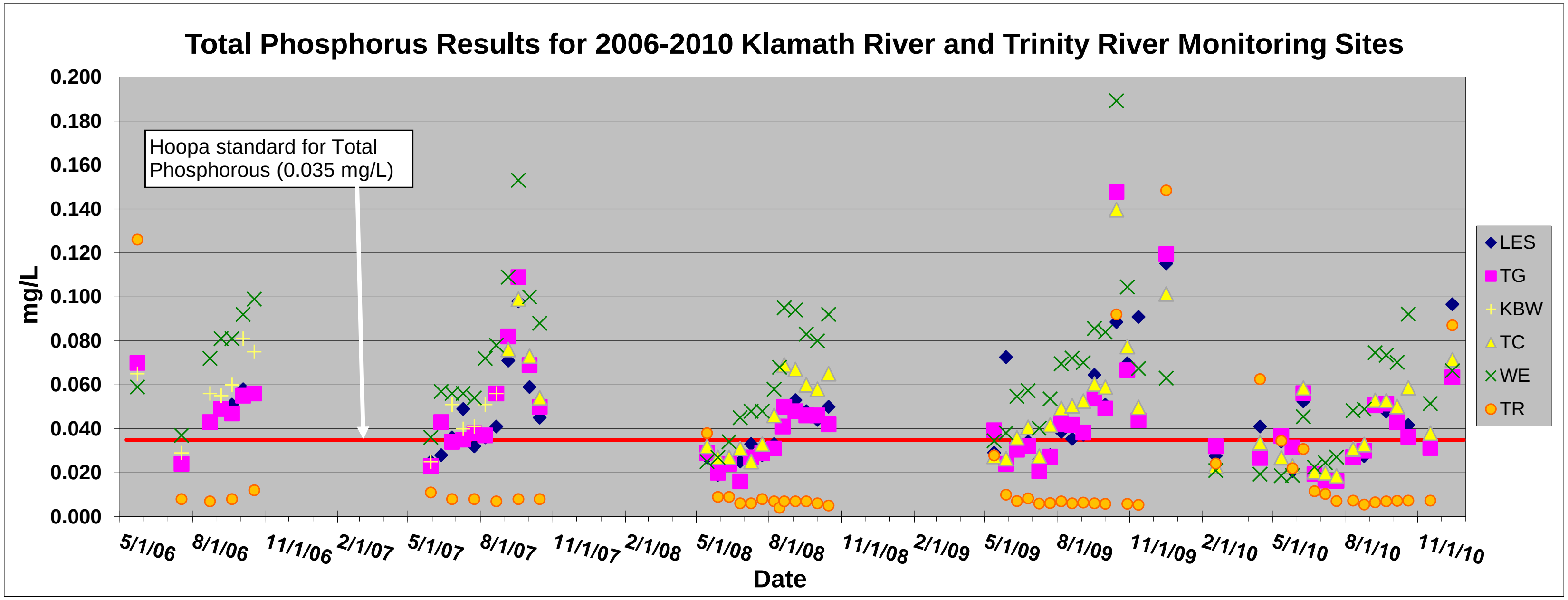

Figure 7-3. Total Phosphorus Results 2006-2010

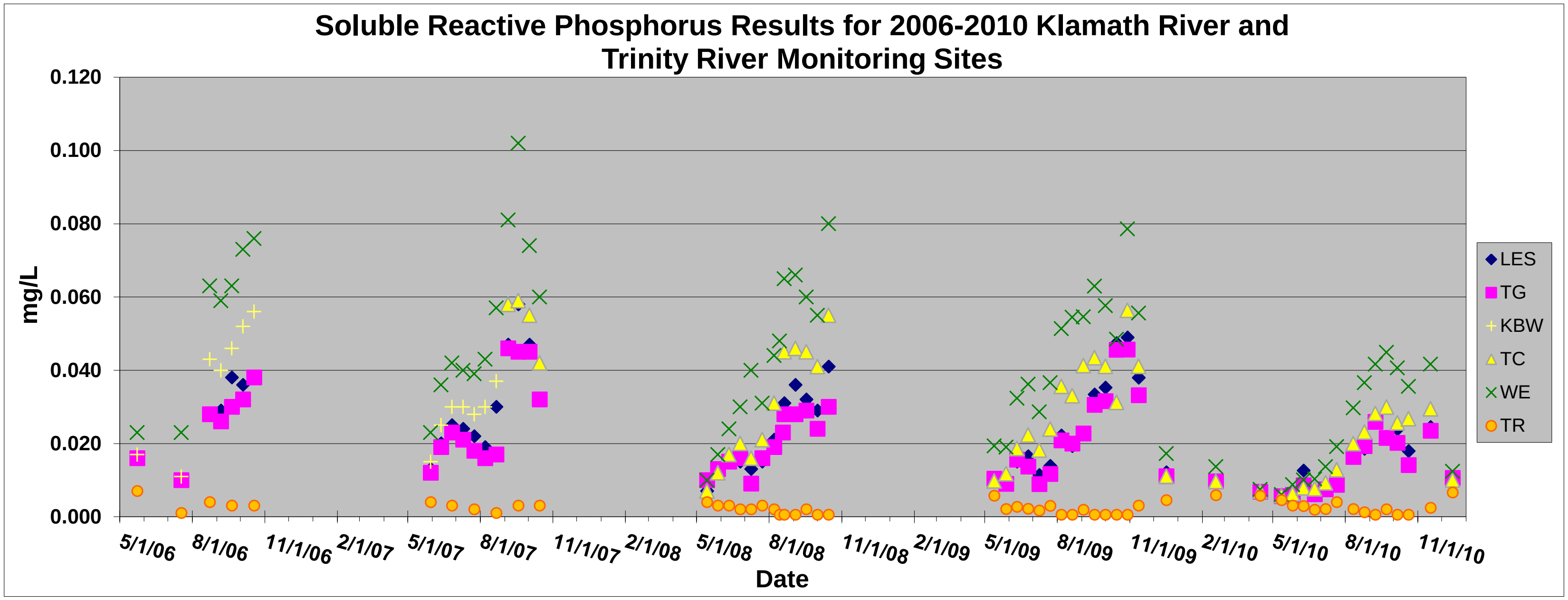

Figure 7-4. Soluble Reactive Phosphorus Results 2006-2010

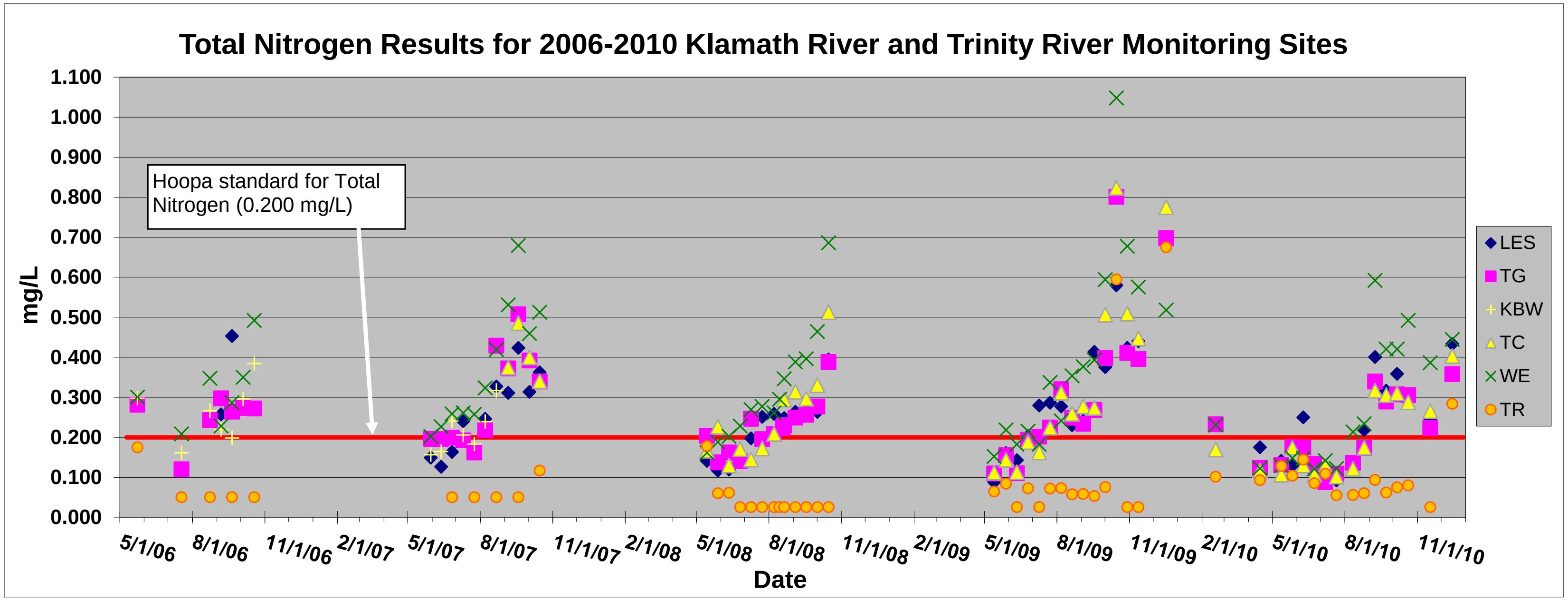

Figure 7-5. Total Nitrogen Results 2006-2010

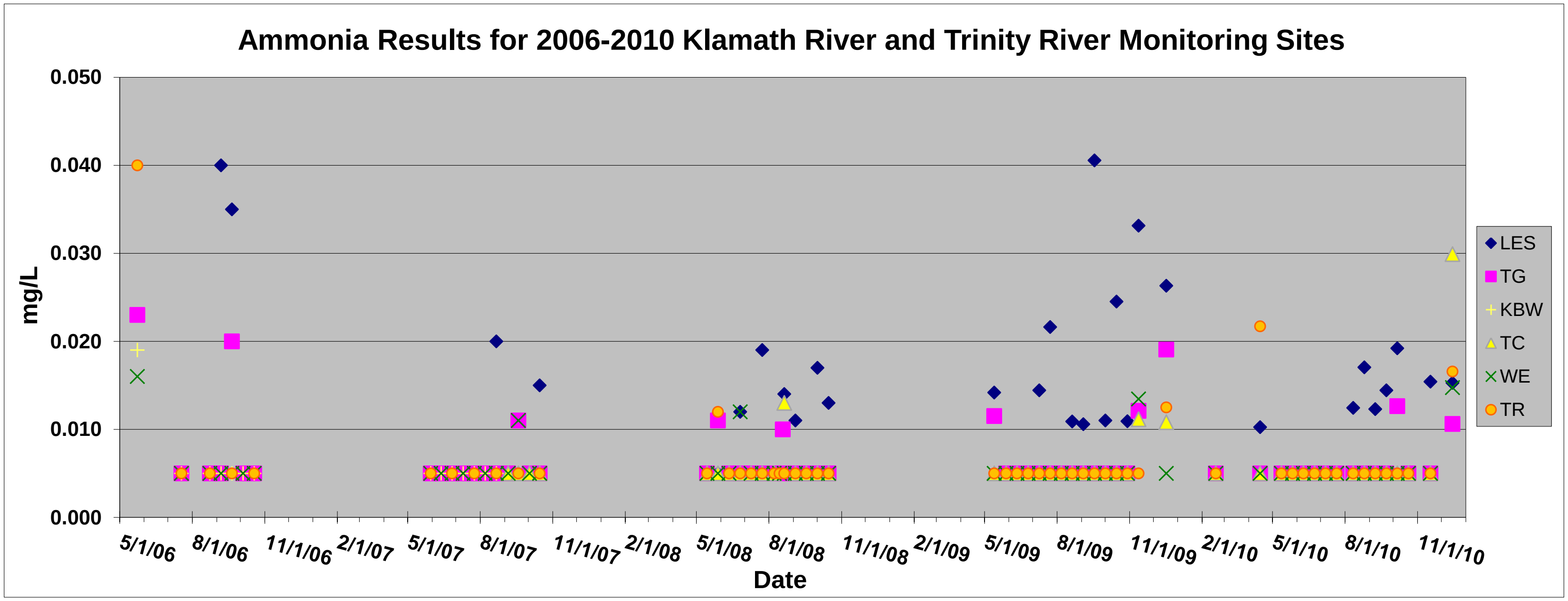

Figure 7-6. Ammonia Results 2006-2010

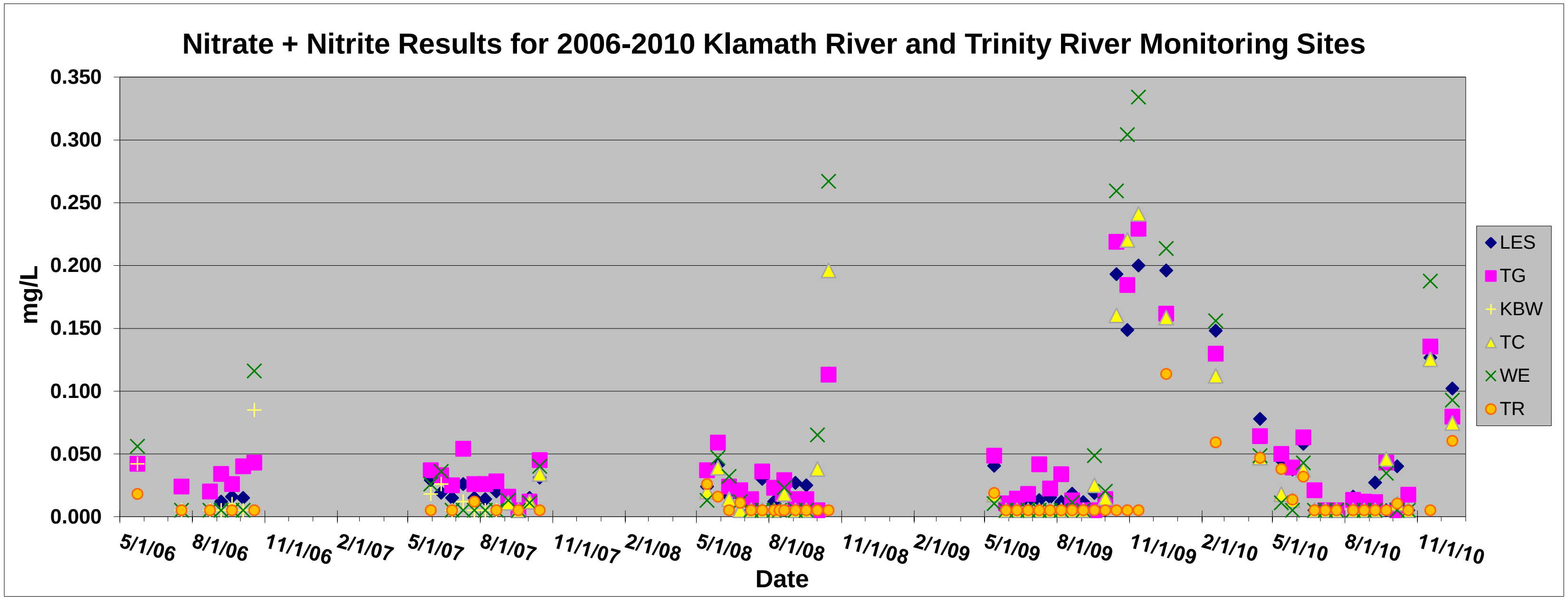

Figure 7-7. Nitrate + Nitrite Results 2006-2010

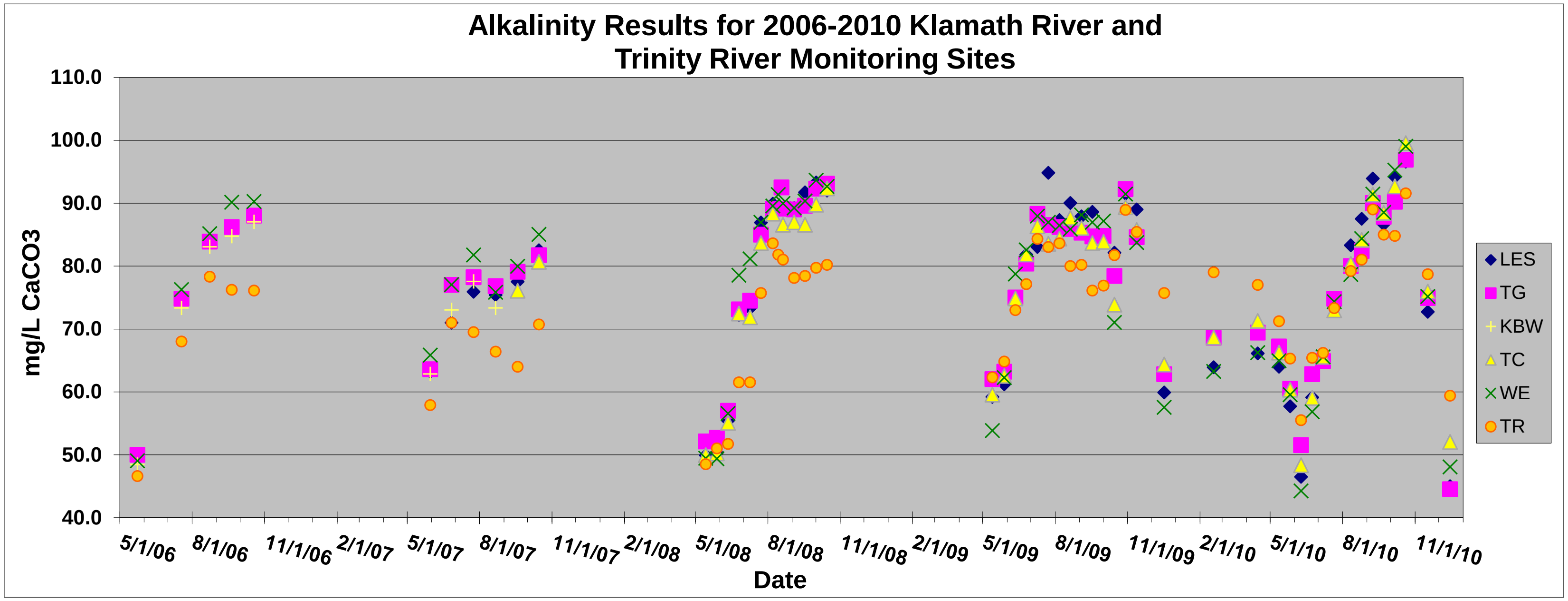

Figure 7-8. Alkalinity Results 2006-2010

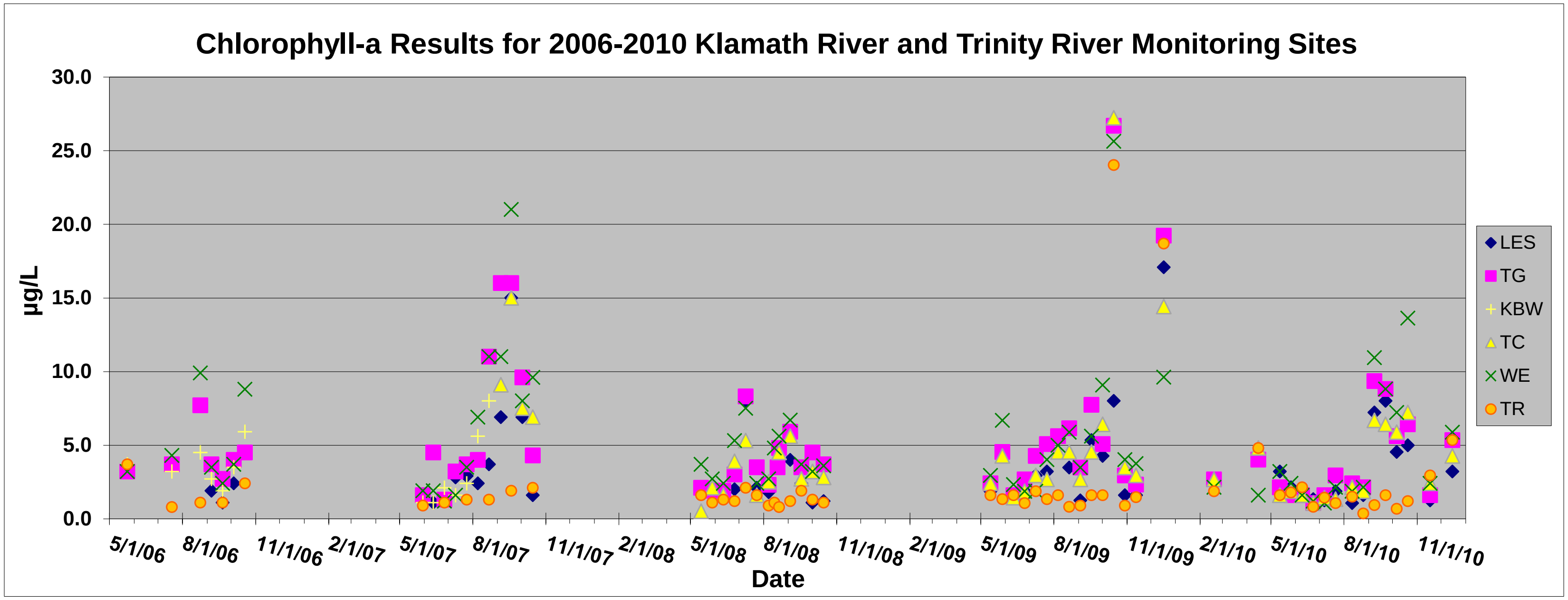

Figure 7-9. Chlorophyll-a Results 2006-2010

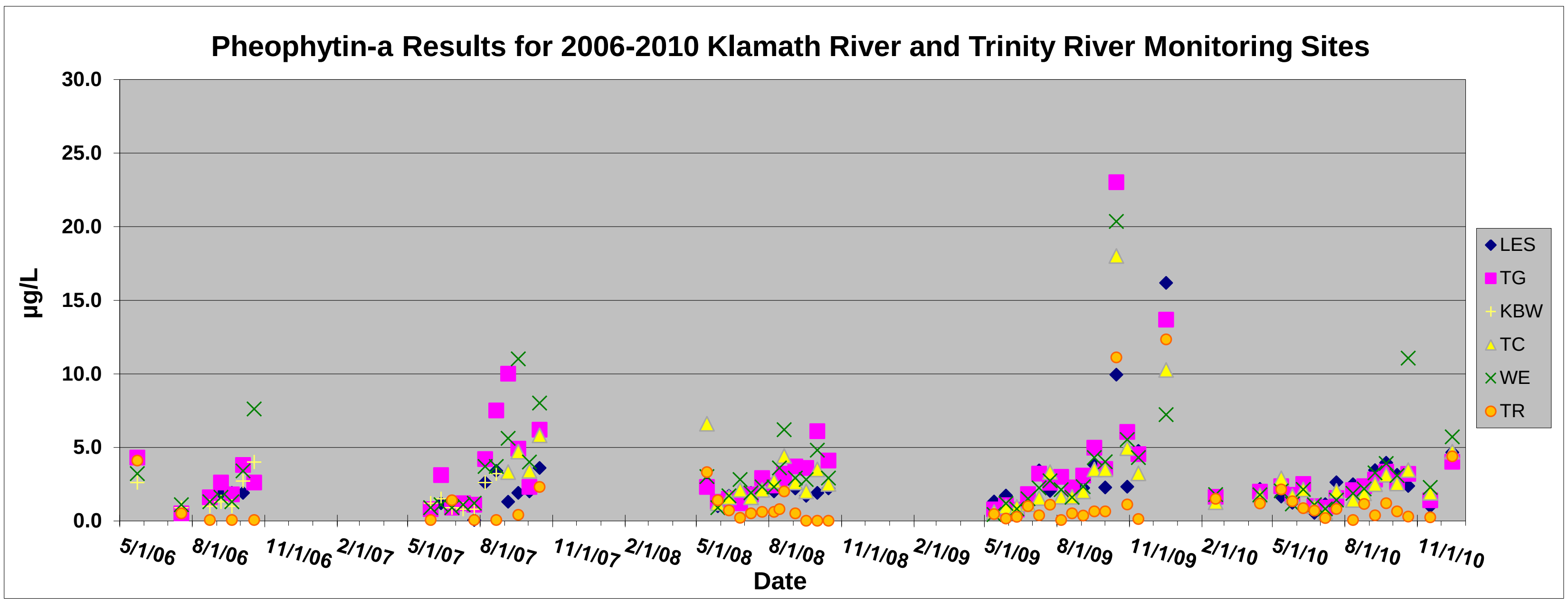

Figure 7-10. Pheophytin-a Results 2006-2010

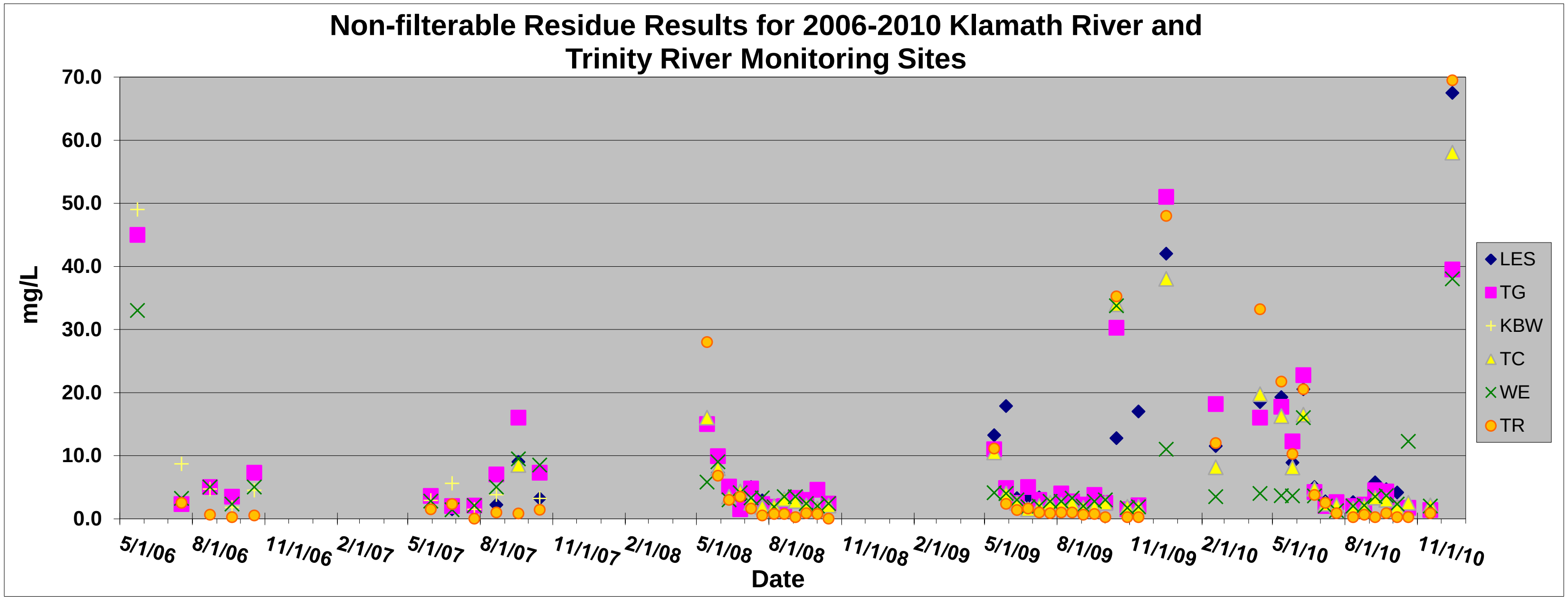

Figure 7-11. Non-filterable Residue Results 2006-2010

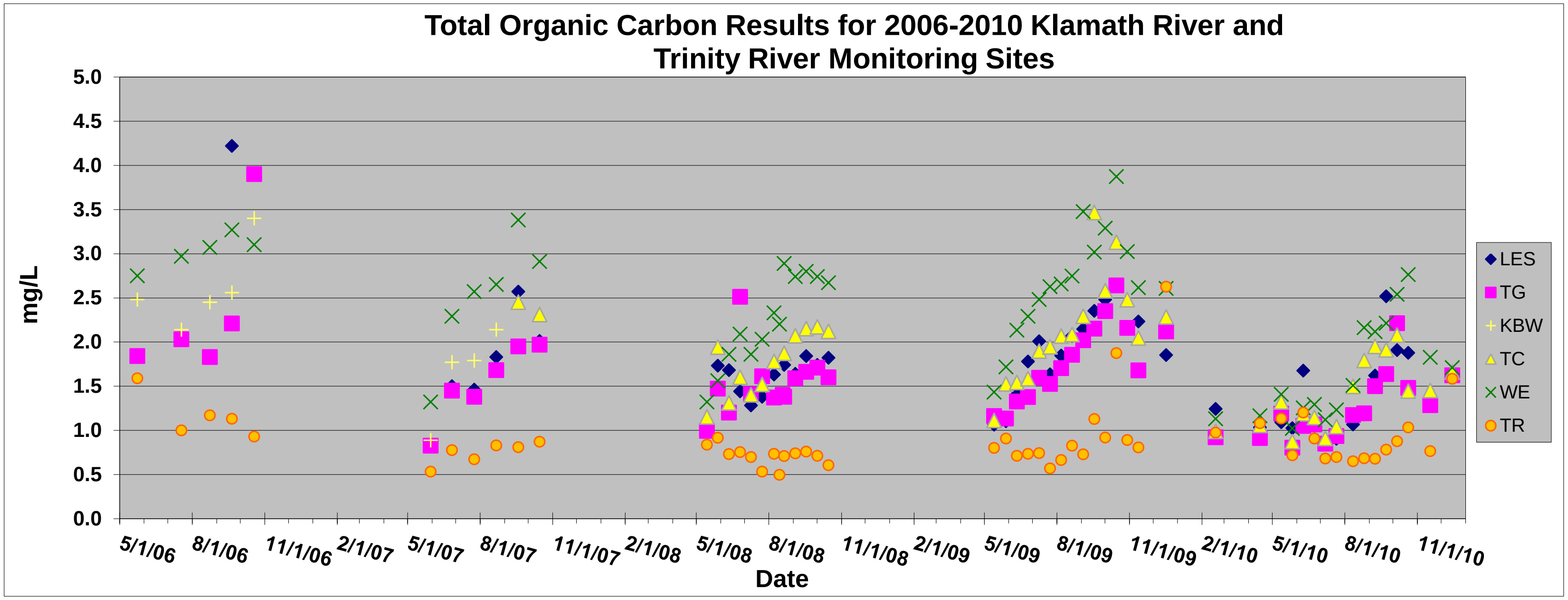

Figure 7-12. Total Organic Carbon Results 2006-2010

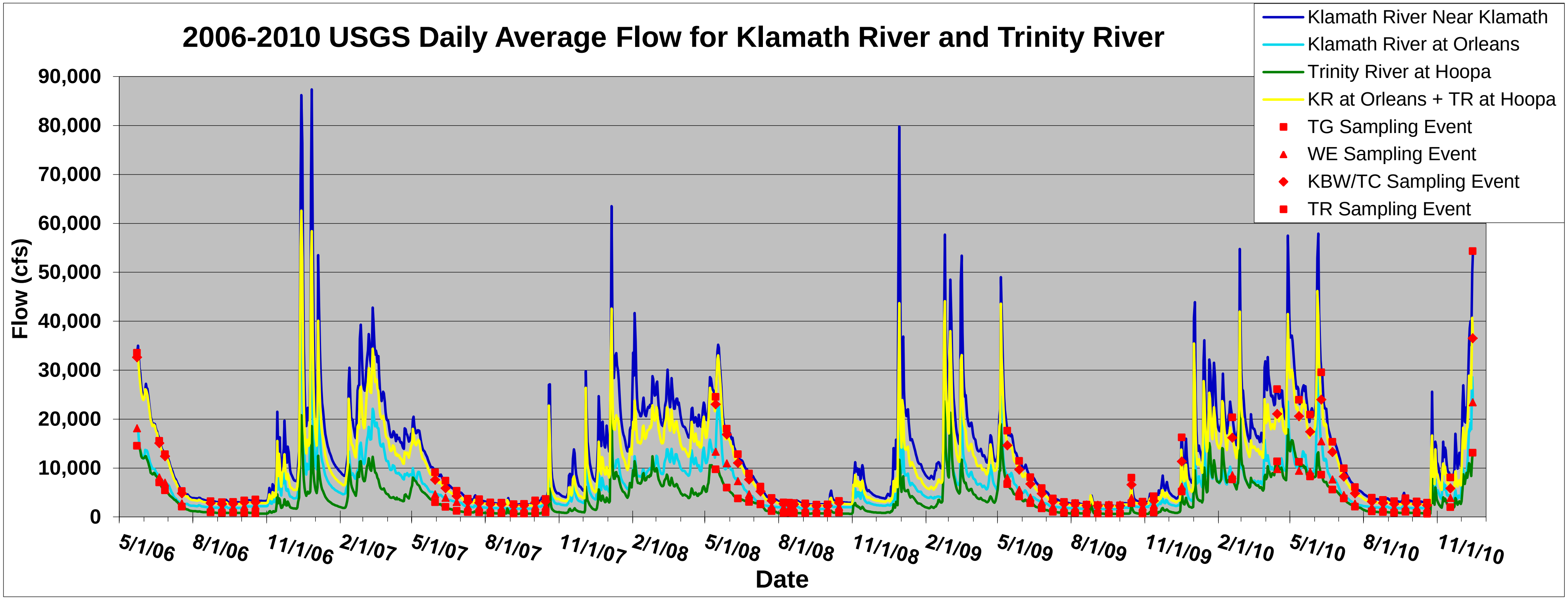

Figure 7-13. Daily Average Flow 2006-2010 (From USGS) with sites superimposed onto flow on dates sampled

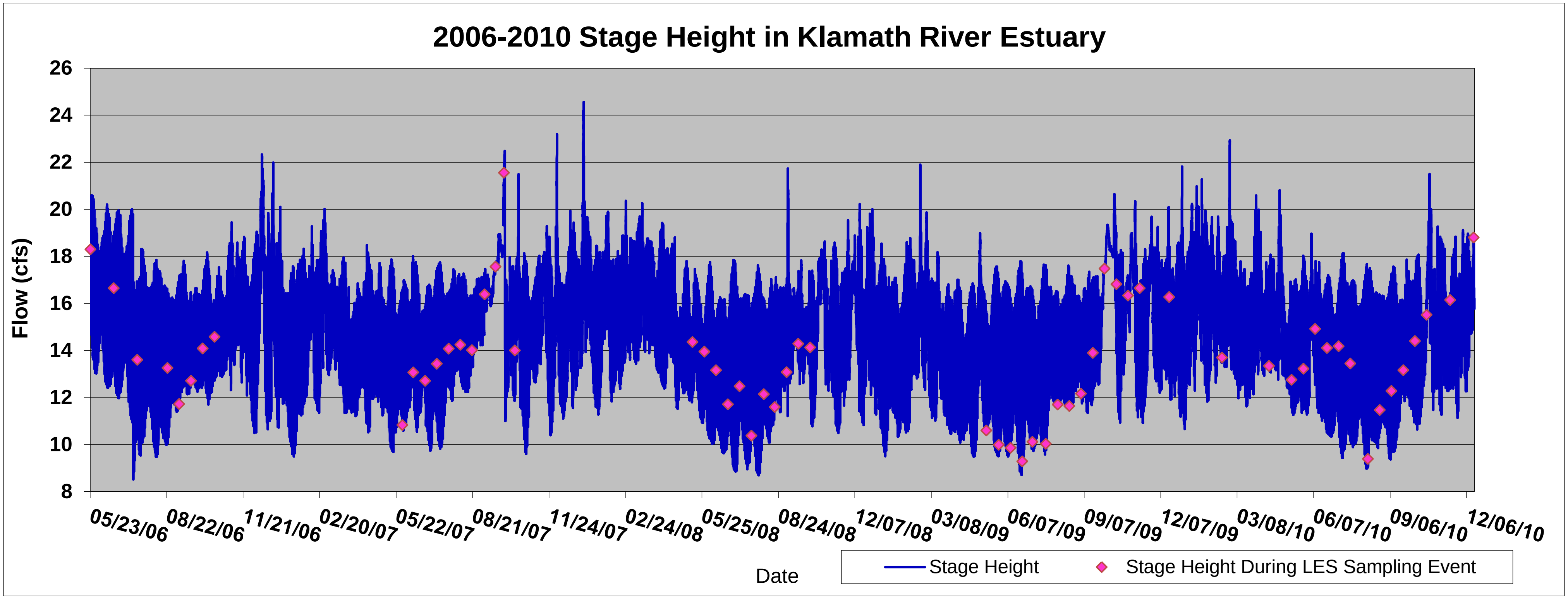

Figure 7-14. 2006-2010 Klamath River Estuary Stage Height with sampling date superimposed onto height

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Appendix

Grab Sample Protocol

'Grab sampling' refers to water samples obtained by dipping a collection container into the upper layer of a body of water and collecting a water sample (USGS File Report -00213). For quality assurance/quality control (QA/QC) purposes replicate, and blank bottle sets will be prepared and collected for one site each sampling period. These additional bottle sets will be handled, prepared and filled following the same protocol used for regular bottle sets and samples. General water quality parameters will also be measured with a freshly calibrated portable multi-probe water quality instrument during grab samples and recorded onto data sheets.

Upon arrival at each site, the sampling churn will be rinsed three times with distilled water. The goal of rinsing is 'equipment decontamination – the removal from equipment, residues from construction and machining and the removal of substances adhering to equipment from previous exposure to environmental and other media' (USGS Open File Report 00213). After rinsing with D.I. water, the churn will be rinsed three times with stream water. The churn is then fully submerged into the stream and filled to the lid with sample water. Completely filling the churn allows for all samples to be filled from one churn; thereby minimizing differences in water properties and quality between samples.

Proper use of the churn guarantees the water is well mixed before the sample is collected. The churn should be stirred at a uniform rate by raising or lowering the splitter at approximately 9 inches per second (Bel-Art Products, 1993). This mixing must continue while the bottles are being filled. If filling is stopped for some reason, the stirring rate must be resumed before the next sample is drawn from the churn. As the volume of water in the churn decreases, the round trip frequency increases as the velocity of the churn splitter remains the same. Care must be taken to avoid breaking the surface of the water as the splitter rises toward the top of the water in the churn.

Sample bottles and chemical preservatives used were provided by associated laboratories and were considered sterile prior to field usage. Sample bottles without chemical preservatives were rinsed with stream water from the churn 2-3 times before filling with sample water. In the case of bottles that contained chemical preservatives, bottles were not rinsed before sample collection and care was taken to avoid over-spillage that would result in chemical preservative loss. Collected samples will be placed in coolers on ice or dry ice for transport to contracted laboratories for analysis.

QA/QC – Duplicate, Blank and QA Reference Standard Bottle Sets

To ensure laboratory and sampling accuracy, one site every sampling period was randomly selected to receive two additional QA/QC bottle sets. These bottle sets contains duplicate and blank water samples. Duplicate samples are obtained using the same process as regular samples. This information is used to assure the laboratory maintains precision within results. True blank samples were collected by pouring distilled water straight into the sample bottles. These are disguised so the lab does not know which samples are blank samples. All bottle sets are then placed on ice and are transported to the associated laboratories by mailing a cooler via Fed Ex. All grab samples were processed within 24 hours or within known laboratory holding periods.

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