FINAL
2011 Klamath River Nutrient Summary Report

Yurok Tribe Environmental Program:
Water Division

March 2012

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Acknowledgements

The Yurok Tribe Environmental Program (YTEP) would like to thank those that contributed to the data collection efforts that occurred during the 2011 monitoring season. AmeriCorps Watershed Stewards Project Members Nick Pence and Tim Sandborn were instrumental in collecting samples and submitting them to the labs. The Klamath Basin Tribal Water Quality Workgroup utilized shared United States Environmental Protection Agency (USEPA) funding and PacifiCorp provided funding under the Klamath Hydroelectric Agreement Settlement Agreement to accomplish a portion of this monitoring. We would also like to thank Aquatic Research Inc. and Chesapeake Biological Laboratory for their lab services analyzing samples, assistance in providing sampling containers and filters in advance and providing prompt responses to any inquiries to the results.

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I. Introduction

This report summarizes the presence and concentration of commonly occurring nutrients and associated analytes on the Klamath River during the 2011 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.

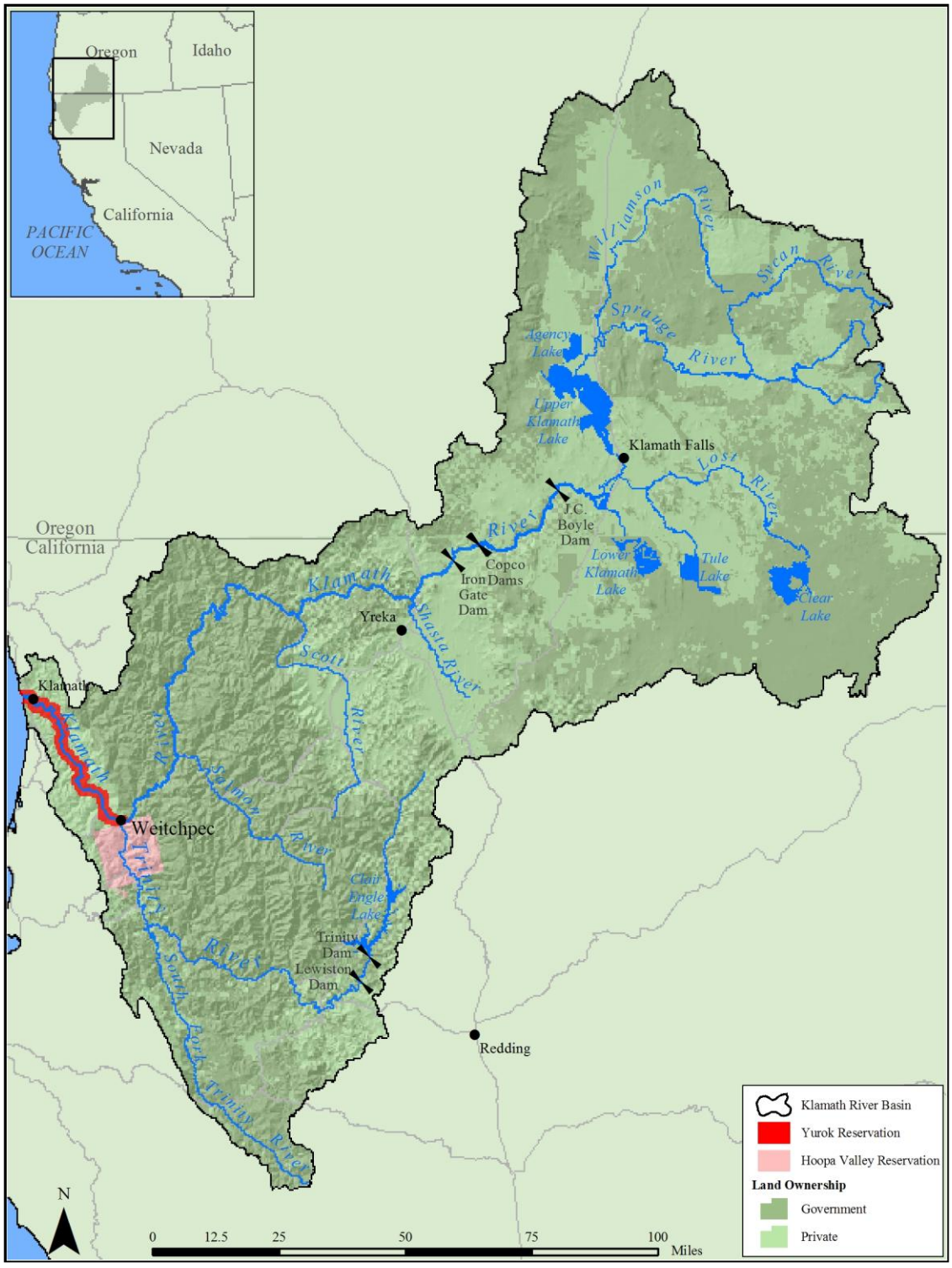

Figure 2-1. Klamath River Basin Map

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 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). 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.

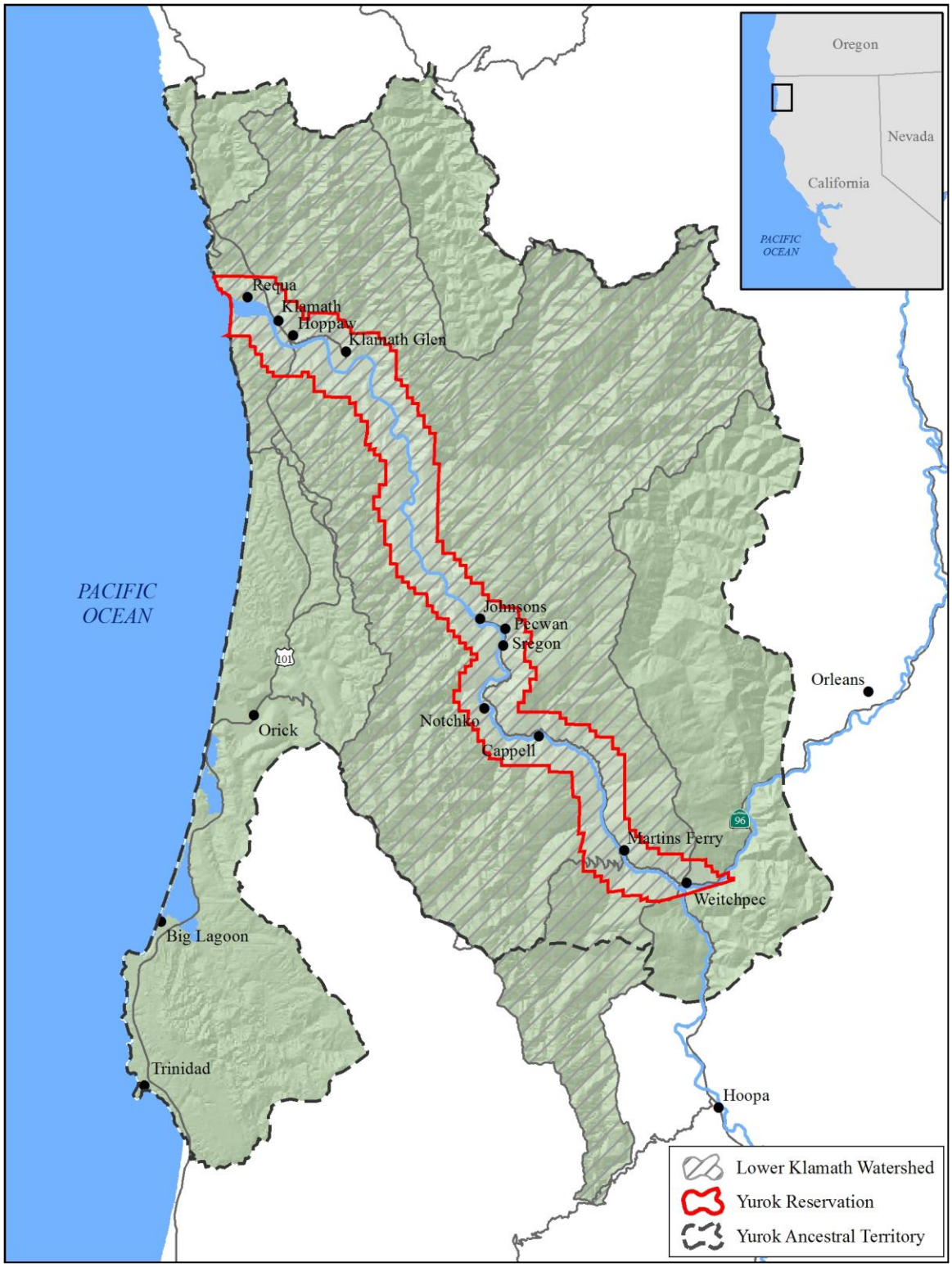

Figure 2-2. Yurok Indian Reservation and Yurok Ancestral Territory Map

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 2011 season in an effort to maintain consistency in laboratory methods. All samples except particulate carbon were delivered to Aquatic Research Inc. in Seattle, WA. Particulate carbon samples were delivered to Chesapeake Biological Laboratory in Solomons, MD. The parameters sampled are shown in Table 3-1.

Standard and consistent methods were utilized at each sampling site throughout the sampling season by following an established protocol, this protocol is available in Appendix A. 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. Ten complete cycles of stirring were completed before sample bottles were filled. 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 used were provided by the contract lab and were considered sterile prior to field usage. Sample bottles were rinsed with stream water from the churn three times before filling with sample water. Collected samples were placed immediately in coolers on wet ice for transport to the Fed Ex office in Arcata, CA and then mailed overnight to the contract lab for analysis.

Table 3- 1. Parameters sampled on the Klamath River during 2011

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

Chain-of-custody (COC) sheets were 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.

Additional quality control measures were included in the sampling. At one site during the March, May, July, August, September, and November sampling events duplicate split samples were sent to the laboratory blindly to assess laboratory precision and to gain improved confidence in the data. Additionally, during the August, September, and October sampling events, blank samples were sent to the laboratory blindly to assess contamination and analytical procedures at the laboratory. The blank sample in August was an "equipment blank," meaning the churn was rinsed according to protocol, filled with distilled water, then the sample bottles were filled following the stirring protocol described above. This was done as an additional quality check on the rinsing procedure performed by the field crew between sample sites. The blank samples collected in September and October were "true blanks," meaning the samples were collected by pouring distilled water directly from the container containing the distilled water into the sample bottles. The sample bottles were rinsed three times with distilled water before being filled with distilled water.

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.

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)

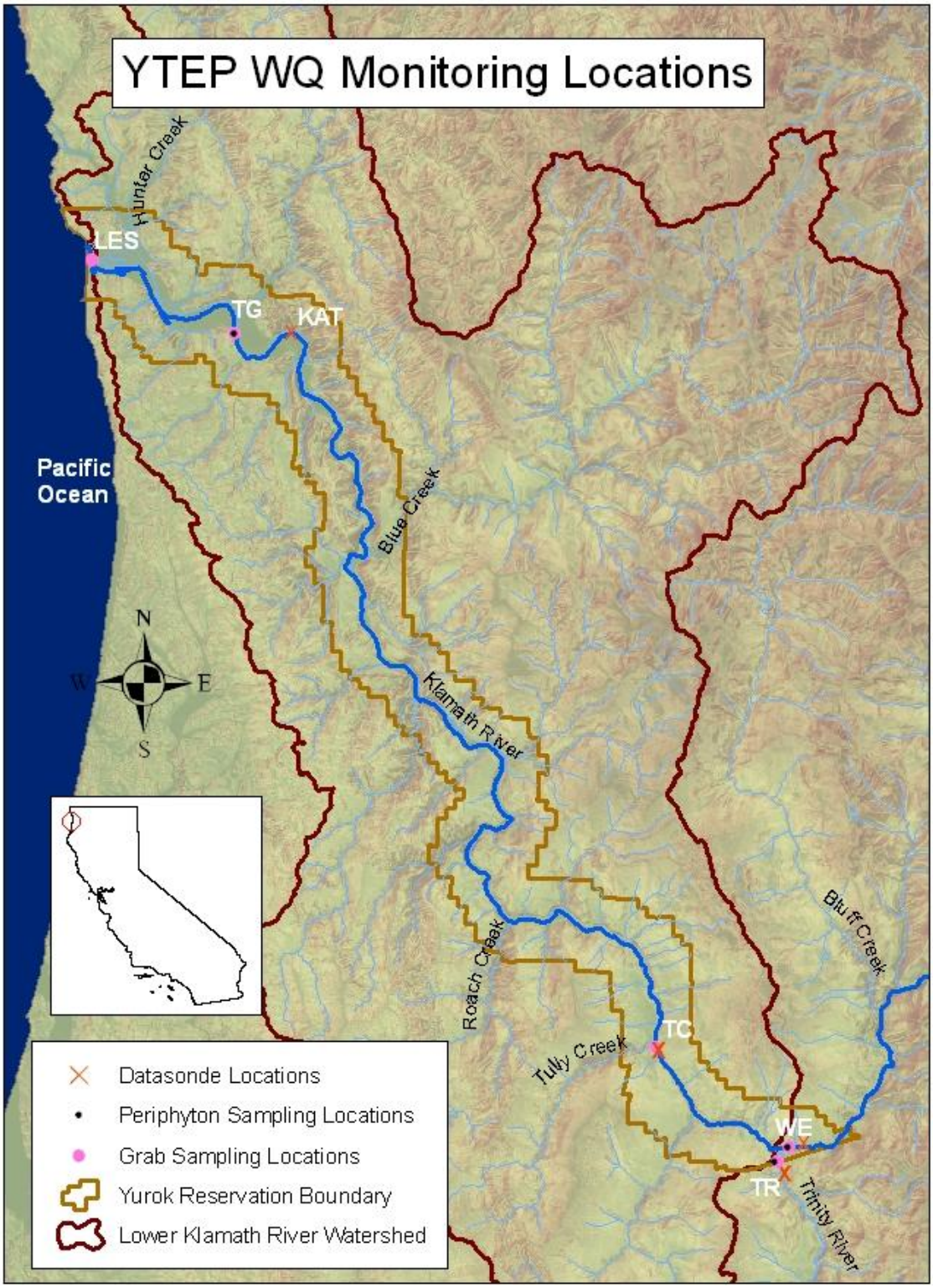

Figure 4-1. Nutrient "Grab" Sampling Sites for 2011 (as indicated by the pink dots)

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 Looking Downstream

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 duplicates were collected by splitting samples in the field using the churn splitter. One of the split samples was sent to the laboratory 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 +/- 20%.

True blank samples were prepared in 2011 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 2011 sampling season indicate that there is no significant issue with contamination of samples in the field or laboratory. Equipment blank samples were prepared in 2011 by rinsing the churn according to the cleaning protocol, pouring distilled water into the churn, then filling the containers provided by the laboratory following the stirring protocol. As with true blanks, equipment blanks were sent with a different ID code so as not to alert lab staff that the samples were blanks. Equipment blank sample results from the 2011 season indicate there is no significant issue with the cleaning protocol followed by the sample crew between sampling locations.

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 Water quality

Specialist 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 Water Quality Specialist 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 Water Quality Specialist maintains field datasheets and notebooks in the event that the, Program Manager and/or 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 2011 sampling season were similar for all sites, with elevated concentrations in February and March (Table 6-1, Figure 6-1). All sites returned their highest concentrations of the year during the March sampling event. After March, concentrations at all sites decreased dramatically, then tended to decline gradually until late July. After late July, results at LES, TG, TC, and WE slowly increased until early October, then generally held steady until December. Concentrations at TR hovered near the reporting limit until December, with a small spike in early October.

Total phosphorous concentrations at 2011 monitoring sites ranged from a low of 0.004 mg/L at TR on December 14, to high of 0.526 mg/L at TR on March 16. 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. From February through early May, TR returned some of the highest concentrations of all sites, subsequently yielding the lowest results for the rest of the sampling year. The highest concentrations of all sites were recorded in mid-March. 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 a decrease in concentrations from mid-February to mid-March, followed by generally stable results until early June (Table 6-1, Figure 6-2). In late June all sites except TR experienced a decrease in concentrations followed by increasing concentrations until mid-November. In mid-December all sites yielded a decrease

in results from mid-November. Concentrations at TR fluctuated very little throughout the sampling season. While results were higher from mid-February through early June all results were near or below the reporting limit of 0.001 mg/L.

SRP concentrations at the 2011 sites ranged from less than 0.001 mg/L to 0.053 mg/L. WE yielded the highest concentration during the 2011 season on November 16, with a result of 0.053 mg/L, while TR produced the lowest reportable concentration of 0.001 mg/L on November 16, 2011. Throughout the sampling year 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 nearly every sampling event throughout the year with concentrations hovering around the reporting limit of 0.001 mg/L for most of the season. The highest concentration at LES was recorded in late October, the highest concentration at TG was recorded in early October, while the highest concentrations at TC and WE were recorded in mid-November. The highest concentration at TR was recorded in early May. 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 year (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 reportable quantities of ammonia. However, results at LES fluctuated greatly throughout the sampling season, exhibiting no clear trend in ammonia concentrations. The greatest quantity of results above the reporting limit occurred during the February and March sampling events. Ammonia concentrations at the 2011 monitoring sites ranged from less than 0.010 mg/L to 0.055 mg/L. The highest concentration for the sampling season was 0.055 mg/L at TR on February 16, 2011. The lowest reportable concentration for the 2011 season was 0.011 mg/L on February 16 at LES and TG and on September 7 at LES.

Nitrite + Nitrate

Nitrite plus nitrate trends for all sites were generally similar for the 2011 sampling year (Table 6-1, Figure 6-4). Concentrations decreased from mid-February to early May, then results at all sites except TR fluctuated around 0.025 mg/L until early August. In late August and early September all sites decreased to levels near or below the reporting limit. After this dip, all sites except TR began increasing, with large spikes in early October and mid-December. Concentrations at TR were near or below the reporting limit from late May until late September, spiked in early October, then returned to levels below the reporting limit for the rest of the sampling year.

Nitrite plus nitrate concentrations at 2011 monitoring sites ranged from less than 0.010 mg/L to 0.252 mg/L. The lowest reportable concentration was 0.010 mg/L at TC on September 21. The site that yielded the highest concentration was the Klamath River at Weitchpec (WE) on December 14, with a result of 0.252 mg/L. Throughout much of the monitoring season, downriver sites (LES and TG) tended to have higher concentrations than upriver sites (WE and

TC). As with many parameters, the exception was TR, which consistently returned some of the lowest concentrations throughout the monitoring season. The highest concentrations at LES, TG and TR were recorded in mid-February and the highest results at TC and WE were recorded in mid-December. The reporting limit for nitrate plus nitrite was 0.010 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 (0.005 mg/L) was used when this occurred.

Total Nitrogen

All sites exhibited varying results for total nitrogen during 2011 (Table 6-1, Figure 6-5). At LES, concentrations fell from mid-February through early May, increased slightly in late May, then increased sharply in early June. In late June, concentration fell significantly, then increased steadily through early August. In late August concentrations fell again then increased through early October. In late October results dropped again, decreased slightly in mid-November, then increased in mid-December. At TG, concentrations dropped from mid-February through early May, increased slightly in late May, then increased sharply in early June. Results then decreased through late July, increased in early August, and decreased in late August. From late August through early October concentrations at TG increased, decreased through mid-November, then increased in mid-December. AT TC, concentrations increased from mid-February to mid-March, then decreased through late May. In early June results increased, then fell through late July. In early August concentrations rose then dropped again in late August. From early September to early October concentrations at TC increased, decreased through mid-November, then increased in mid-December. At WE, concentrations decreased from mid-February to late May, increased in early June, then decreased in late June. Results subsequently rose through early October, fell through mid-November, then increased in mid-December. At TR concentrations increased from mid-February to mid-March, decreased in mid-April, and increased in early May. Results then fell in late May, increased in early June, and decreased in late June. Concentrations at TR then rose through early August, fell in late August, then increased through early October. In late October results decreased through mid-November then increased in mid-December.

Total nitrogen concentrations at the 2011 monitoring sites ranged from less than 0.050 mg/L to 0.482 mg/L. The site with the lowest reportable concentration was the Trinity River above the mouth (TR) on September 7, with a result of 0.050 mg/L. The site with the highest concentration was the Lower Estuary Surface (LES) on October 5, with a result of 0.482 mg/L. The reporting limit for total nitrogen was 0.050 mg/L. The highest concentrations at LES, TC and WE were recorded on October 5. TG yielded its highest concentration on February 16, while TR yielded its highest result on March 16. TR consistently returned some of the lowest concentrations of all sites during the 2011 monitoring year. 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-March, a decrease in mid-April and another increase in early May (Table 6-2, Figure 6-6). In late May results fell, then increased through late June. In

early July concentrations decreased dramatically and continued to fall into late July. In early August concentrations began increasing and continued to increase into early September. In late September results decreased again, increased in early October and fell in late October. In mid-November concentrations rose again then fell in mid-December. At TR results increased from mid-February to mid-March then decreased into late May. In early June concentrations increased then fell into early July. In late July results increased again, fell in early August then increased slightly into early September. Concentrations at TR then fell in late September, increased significantly in early October, fell through mid-November, then increased in mid-December.

Chlorophyll-*a* concentrations for the 2011 sampling season ranged from 0.2 µg/L to 10 µg/L. WE produced the highest concentration of 10 µg/L on October 5, 2011, while TR yielded the lowest concentration of 0.2 µg/L on August 10, 2011. The highest concentrations at all sites except TC and TR were recorded during early October. The highest concentration at TC was recorded in mid-November, while TR yielded its highest concentration in mid-March. As with most parameters, TR consistently yielded the lowest results throughout the year. 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 2011 sampling year (Table 6-2, Figure 6-7). Concentrations at LES, TG and WE increased from mid-February to mid-March, while results at TC decreased. Concentrations at all sites then decreased to below the reporting limit in mid-April and remained at or very near this level in early May. All Klamath River sites except TG increased slightly in late May and early June, then decreased into early August. At TG concentrations rose in late May, dropped in early June, then remained generally stable until late July. In early August all sites except TG were below the reporting limit, while at TG concentrations increased. Results at all sites were near, or below, the reporting limit in late August, then increased in early September. Concentrations then increased into early October, dropped in late October, then increased again in mid-November and dropped in mid-December. Concentrations at TR increased from mid-February to mid-March, then dropped to below the reporting limit through late June. In early and late July results increased slightly, then fell to concentrations near or below the reporting limit until late October. In mid-November results at TR increased then fell back to near the reporting limit in mid-December.

Pheophytin-*a* concentrations for the 2011 sampling year ranged from less than 0.1 µg/L to 11µg/L. The lowest reportable concentration was 0.1 µg/L at WE on May 10, 2011, while the highest concentration of 12 µg/L was returned at WE on October 5, 2011. The highest concentrations for all Klamath River sites were recorded in early October, while the highest concentration recorded at TR was in mid-March. Except for during periods of rain, TR consistently yielded some of the lowest concentrations throughout the sampling year. 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 2011 monitoring year were very similar for all sites throughout the entire monitoring term, with concentrations decreasing from mid-February to mid-March, increasing in mid-April, then decreasing again in early May

(Table 6-2, Figure 6-8). From early May through early June, results generally held steady, then decreased in late June. From late June through early September concentrations gradually increased, then decreased into early October. Results subsequently increased into mid-November and decreased in mid-December.

Alkalinity concentrations at the 2011 sites ranged from a low of 45.7 mg/L $CaCO_3$ at WE on June 22, to a high of 100 mg/L $CaCO_3$ at WE on November16. The highest concentrations for all sites were recorded in mid-November. No sites produced results below the reporting limit of 1.0 mg/L $CaCO_3$ for this parameter during the 2011 sampling year.

Particulate Carbon (PC)

Particulate carbon concentrations varied among all sites during the 2011 sampling year (Table 6-2, Figure 6-9). Due to logistics PC was not analyzed until May for sites contained in this report. Concentrations at LES decreased slightly from early May to late May, then increased in early June. Results subsequently decreased into early August, increased into early September, then decreased in late September. In early October concentrations rose, fell in late October, increased in mid-November, then decreased in mid-December. Results at TG decreased from early May to early June, increased slightly in late June, then decreased into late July. In early August results increased, fell in late August, then increased in early September. In late September concentrations at TG fell again, increased in early October, then decreased through mid-December. At TC concentrations fell from early May to late May, increased in early June, then decreased into early August. Concentrations then increased from late August to early September, decreased in late September and rose in early October. Results then decreased from late October to mid-December. At WE concentrations increased from early May to late June, decreased to early August, then increased into early September. In late September results fell, increased in early October, then decreased from late October to mid-December. At TR concentrations fell from early May to early June, increased into early July, then decreased into late August. In early September results increased slightly, decreased in late September, then increased in early October. Concentrations at TR decreased from late October to mid-November, then increased slightly in mid-December.

PC concentrations at the 2011 sites ranged from a low of 0.142 mg/L at TR on August 24 to a high of 1.74 mg/L at TC on October 5, 2011. The highest concentrations for all sites except LES were recorded on October 5. The highest concentration at LES was recorded on June 8. TR consistently yielded some of the lowest results throughout the sampling year.

Dissolved Organic Carbon (DOC)

Dissolved organic carbon concentrations for all sites, including TR, exhibited similar trends throughout the sampling year (Table 6-2, Figure 6-10). Concentrations initially fell from mid-February to mid-March. Results at all Klamath River sites increased in mid-April, while results at TR decreased. Concentrations increased in early May, decreased in late May and early June, then increased in late June. Results decreased in early July, then increased in late July. The exception was TG, which held generally steady from early May to late June, increased in early July, then generally held steady until early August. In early August WE and LES increased, while TC decreased and TR held steady. In late August WE and TC increased, while LES, TG, and TR decreased. In early September concentrations at all sites increased, in late September results at all sites continued to increase, except at LES, which decreased. Concentrations at all

sites increased in early October, decreased in late October, then increased through mid-December.

DOC concentrations for the 2011 sampling season ranged from a low of 0.424 mg/L at TR on April 13, to a high of 2.84 mg/L at WE on October 5, 2011. Upriver sites tended to yield higher results then downriver sites, while TR consistently produced the lowest concentrations throughout the sampling year. The highest concentrations for all sites except TC were recorded in early October. The highest concentration at TC was recorded in mid-November. No sites produced concentrations below the reporting limit of 0.250 mg/L during the 2011 sampling year.

Non-Filterable Residue (TSS)

Non-filterable residue, also known as total suspended solids (TSS), trends for all sites were broadly similar for the 2011 sampling year (Table 6-2, Figure 6-11). Concentrations increased greatly from mid-February to mid-March, then decreased in mid-April. In early May results at all sites except WE increased slightly, then decreased in late May. From late May to mid-December, results stayed low and fluctuated very little, except for a slight increase in early October.

TSS concentrations for the 2011 sampling year ranged from less than 0.50 mg/L to 394 mg/L. The lowest reportable concentration for the sampling period was 0.62 mg/L at TR on September 21, 2011, while the highest concentration was 394 mg/L at TR on March 16, 2011. The highest concentrations for all sites were recorded in mid-March. 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 2011 sampling year were similar among all sites (Table 6-2, Figure 6-12). Concentrations increased dramatically from mid-February to mid-March, then decreased greatly in mid-Aril. In early May, results increased slightly, decreased somewhat in late May, then generally increased slightly into late June. Concentrations then gradually decreased into early August, held steady in late August, and increased in early September. In late September results held steady, increased in early October, then decreased in late October. Concentrations held steady in mid-November, then decreased slightly in mid-December.

Volatile suspended solids concentrations for the 2011 sampling year ranged from less than 0.50 mg/L to 24 mg/L. TR returned the highest concentration of 24 mg/L on March 16, 2011, while TC returned the lowest reportable concentration of 0.50 mg/L on August 24, 2011. The highest concentrations for all sights were recorded in mid-March. Except for periods of rain, TR tended to have the lowest concentrations for all sights. 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 were similar during the 2011 sampling year (Table 6-2, Figure 13). Concentrations at all sites increased from mid-February to mid-March, decreased in mid-April, and increased at all sites except WE in early May. Results at WE in early May

decreased slightly. Results at all sites then gradually decreased until late August, increased slightly in early September, then held steady in late September. In early October concentrations increased, decreased somewhat in late October, then generally held steady through mid-December.

Turbidity results for the 2011 sampling year ranged from 0.16 NTU to 160 NTU. TR returned the highest result of 160 NTU on March 16, 2011, while also yielding the lowest result of 0.16 NTU on August 24, 2011. The highest concentrations at all sites were recorded in mid-March. No sites produced concentrations below the reporting limit of 0.10 NTU during the 2011 sampling year.

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 2011 season displayed similar trends (Table 6-3, Figure 6-14). Measurements at all sites showed steadily increasing temperatures from mid-February to late August, with a small dip in late July. This was followed by generally decreasing temperatures until the end of the sampling year in mid-December. Water temperature at all sites was at its lowest in mid-December. Temperatures for the 2011 sampling season ranged from a low 3.13 ºC on December 14, to a high of 22.26 ºC on August 24, 2011. Both of these temperatures were recorded at WE.

Dissolved Oxygen (mg/L)

Dissolved oxygen (DO) measured in mg/L during the 2011 sampling season showed similar trends at all sites throughout the season (Table 6-3, Figure 6-15). DO at all sites generally decreased from mid-February to early July, leveling off in late July. In early August, DO decreased again, then steadily increased until the end of the sampling year in mid-December. The highest DO concentrations of the year were recorded in mid-December at all sites. Throughout the sampling season, upriver sites tended to return higher concentrations of DO than downriver sites. Concentrations of DO during the 2011 sampling season ranged from a low of 7.62 mg/L at LES on August 24, to a high of 13.44 mg/L at WE on December 14, 2011.

Dissolved Oxygen (%)

DO concentrations measured in percent for the 2011 sampling year exhibited similar trends for upriver sites, while downriver sites returned different patterns (Table 6-3, Figure 6-16). TC, WE, and TR all showed slightly increasing DO percentages from mid-February to mid-March, followed by generally steady percentages through late May. In early June DO percentages increased then slowly decreased through early August. DO percentages then increased through late September followed by declines in early October. In late October and mid-November percentages continually increased, then decreased in mid-December. At LES and TG DO percentages increased slightly from mid-February to mid-March then decreased in mid-April. DO percentages then climbed until late May, followed by steadily declining numbers through the beginning of August. In late August DO percentages at LES decreased, while at TG readings increased. DO percentages at LES increased in early September, decreased in late September, then increased steadily until mid-November. At TG, DO readings decreased in early

September, increased in late September, then declined through late October. DO percentages at TG then increased into mid-November. DO readings at both LES and TG declined in 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 2011 sampling year was 105.0% at WE on June 8, while the lowest DO percentage measured was 86.4% at LES on September 21, 2011.

Specific Conductivity

Specific conductivity at all sites except LES exhibited similar trends during the 2011 sampling year (Table 6-3, Figures 6-17 and 6-18). Specific conductivity readings at TG, TC, WE, and TR decreased from mid-February to mid-March, increased in mid-April and decreased in early May. From early May through early June values held steady or declined slightly, declined sharply in late June then increased steadily until early September. In late September TG, TC and WE continued to increase while TR decreased. In early October all sites except LES decreased, increased into mid-November then decreased in mid-December. Specific conductivity readings at LES generally fluctuated around 100 µS/cm from mid-February through late June then fluctuated greatly until mid-December with spikes in late July, early September and early October. The highest specific conductivity reading for all sites except LES was recorded in mid-November while the highest reading at LES was recorded in early September.

Measurements for specific conductivity, disregarding LES, for the 2011 sampling year ranged from a low of 90 microSiemens per centimeter (µS/cm) at TC on June 22, to a high of 192 µS/cm at WE on November 16, 2010. At LES specific conductivity measurements ranged from a low of 95µS/cm on June 22, to a high of 3,150 µS/cm on September 7, 2011.

pH

pH trends during the 2011 sampling year was generally similar among all sites (Table 6-3, Figure 6-19). pH decreased from mid-February to mid-March, increased in mid-April then decreased again in early May. In late May pH increased at all sites, subsequently decreasing at TC, WE and TR early June while increasing at LES and remaining steady at TG. In late June pH decreased at all sites and increased in early July. pH at TC and WE increased in late July, held steady at LES and TG and decreased at TR. In early August pH at all sites except TG increased then decreased in late August. pH at TG decreased in early August then increased in late August. pH at all sites increased in early September then continually decreased until early October. In late October pH at all sites except TG increased then decreased in mid-November. pH at TG decreased in late October then increased in mid-November. pH at all sites except TR decreased in mid-December while at TR pH increased. The highest pH reading for all sites was recorded in mid-February.

The lowest pH was measured during the 2011 sampling season was 7.74 at LES on December 14, while the highest pH measured was 8.84 at TR on February 16, 2011. As with many other parameters, upriver sites tended to return higher pH measurements than downriver sites.

Table 6-1. Nutrient Results, Yurok Reservation 2011

Nutrients

	Date																
Total Phosphorous	**Site**	2/16/2011	3/16/2011	4/13/2011	5/10/2011	5/25/2011	6/8/2011	6/22/2011	7/6/2011	7/20/2011	8/10/2011	8/24/2011	9/7/2011	9/21/2011	10/5/2011	10/19/2011	11/16/2011	12/14/2011
mg/L; Report Limit: 0.002	**LES**	0.039	0.172	0.041	0.045	0.024	0.032	0.025	0.020	0.022	0.034	0.027	0.034	0.038	0.053	0.041	0.038	0.031
	TG	0.057	0.159	0.047	0.046	0.028	0.027	0.025	0.021	0.020	0.031	0.028	0.035	0.041	0.057	0.039	0.037	0.032
	TC	0.104	0.274	0.036	0.059	0.032	0.032	0.026	0.025	0.023	0.025	0.035	0.040	0.047	0.068	0.052	0.055	0.041
	WE	0.036	0.213	0.036	0.027	0.028	0.035	0.032	0.029	0.034	0.037	0.051	0.059	0.058	0.085	0.068	0.069	0.053
	TR	0.160	0.526	0.039	0.061	0.018	0.023	0.014	0.010	0.009	0.008	0.009	0.008	0.008	0.022	0.006	0.008	0.004
Soluble Reactive Phosphorous	**Site**	2/16/2011	3/16/2011	4/13/2011	5/10/2011	5/25/2011	6/8/2011	6/22/2011	7/6/2011	7/20/2011	8/10/2011	8/24/2011	9/7/2011	9/21/2011	10/5/2011	10/19/2011	11/16/2011	12/14/2011
mg/L; Report Limit: 0.001	**LES**	0.014	0.007	0.009	0.008	0.008	0.008	0.005	0.006	0.011	0.017	0.015	0.014	0.021	0.027	0.029	0.027	0.021
	TG	0.014	0.007	0.009	0.009	0.008	0.009	0.005	0.007	0.011	0.010	0.016	0.015	0.020	0.030	0.028	0.027	0.023
	TC	0.012	0.008	0.009	OUT	0.010	0.008	0.004	0.010	0.012	0.017	0.019	0.023	0.026	0.032	0.036	0.039	0.028
	WE	0.018	0.008	0.011	0.011	0.013	0.013	0.007	0.019	0.020	0.025	0.030	0.032	0.037	0.045	0.049	0.053	0.037
	TR	0.007	0.007	0.006	0.008	0.003	0.006	0.002	0.007	0.003	0.003	0.003	0.004	0.003	0.004	0.003	0.001	ND
Ammonia Nitrogen	**Site**	2/16/2011	3/16/2011	4/13/2011	5/10/2011	5/25/2011	6/8/2011	6/22/2011	7/6/2011	7/20/2011	8/10/2011	8/24/2011	9/7/2011	9/21/2011	10/5/2011	10/19/2011	11/16/2011	12/14/2011
mg/L; Report Limit: 0.010	**LES**	0.011	ND	ND	ND	ND	ND	0.020	ND	ND	0.024	ND	0.011	ND	0.027	0.016	ND	ND
	TG	0.011	0.013	ND	ND	ND	0.034	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	TC	0.032	0.016	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	WE	ND	0.015	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	TR	0.055	0.030	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nitrate +Nitrite	**Site**	2/16/2011	3/16/2011	4/13/2011	5/10/2011	5/25/2011	6/8/2011	6/22/2011	7/6/2011	7/20/2011	8/10/2011	8/24/2011	9/7/2011	9/21/2011	10/5/2011	10/19/2011	11/16/2011	12/14/2011
mg/L; Report Limit: 0.010	**LES**	0.247	0.098	0.073	0.030	0.015	0.017	0.036	0.023	0.016	0.019	ND	0.011	0.019	OUT	0.032	0.023	0.167
	TG	0.190	0.079	0.088	0.044	0.036	0.047	0.023	0.026	0.037	0.031	0.012	ND	0.014	0.065	0.042	0.028	0.167
	TC	0.130	0.068	0.058	0.024	0.016	0.018	0.012	0.022	0.016	ND	ND	ND	0.010	0.070	0.022	0.046	0.172
	WE	0.181	0.069	0.074	0.019	0.017	0.019	0.011	0.031	0.024	ND	ND	ND	0.012	0.067	0.026	0.074	0.252
	TR	0.070	0.063	0.018	0.033	0.011	ND	ND	ND	ND	0.012	ND	ND	ND	0.032	ND	ND	ND
Total Nitrogen	**Site**	2/16/2011	3/16/2011	4/13/2011	5/10/2011	5/25/2011	6/8/2011	6/22/2011	7/6/2011	7/20/2011	8/10/2011	8/24/2011	9/7/2011	9/21/2011	10/5/2011	10/19/2011	11/16/2011	12/14/2011
mg/L; Report Limit 0.050	**LES**	0.307	0.263	0.163	0.109	0.124	0.309	0.082	0.117	0.117	0.279	0.122	0.225	0.235	0.482	0.207	0.198	0.364
	TG	0.301	0.223	0.174	0.120	0.136	0.242	0.180	0.117	0.110	0.223	0.147	0.207	0.258	0.300	0.199	0.175	0.285
	TC	0.235	0.337	0.156	0.119	0.115	0.335	0.126	0.110	0.099	0.178	0.136	0.211	0.269	0.381	0.228	0.222	0.344
	WE	0.310	0.265	0.213	0.160	0.140	0.304	0.127	0.163	0.165	0.206	0.223	0.299	0.400	0.465	0.317	0.298	0.437
	TR	0.200	0.448	0.068	0.088	ND	0.213	ND	0.054	0.064	0.121	ND	0.050	0.086	0.174	0.053	ND	ND

ND= No Detect
OUT= Outlier

Table 6-2. Other Analytes Results, Yurok Reservation 2011

Other Analytes

		Date																
Chlorophyll a	**Site**	2/16/2011	3/16/2011	4/13/2011	5/10/2011	5/25/2011	6/8/2011	6/22/2011	7/6/2011	7/20/2011	8/10/2011	8/24/2011	9/7/2011	9/21/2011	10/5/2011	10/19/2011	11/16/2011	12/14/2011
µg/L; Report Limit: 0.1	**LES**	2.6	3.2	2.6	3.8	1.6	2.7	2.9	1.1	0.9	1.3	1.4	3.7	1.1	4.5	1.1	2.7	0.9
	TG	3.2	3.2	3.4	4.1	2.7	2.4	3.2	1.6	0.7	3.7	1.4	6.4	2.3	6.9	2.1	5.3	1.4
	TC	3.7	4.3	2.6	4.3	3.2	4.3	3.7	1.6	0.9	0.9	1.5	4.0	2.8	8.0	3.7	8.3	2.4
	WE	1.5	4.8	4.1	5.9	4.8	5.3	5.6	1.3	0.7	0.9	2.1	6.7	3.6	10	5.3	5.6	1.6
	TR	4.8	6.0	2.2	1.5	0.7	1.1	0.9	0.3	1.2	0.2	0.5	0.7	0.5	3.2	1.3	0.5	1.3
Pheophytin a	**Site**	2/16/2011	3/16/2011	4/13/2011	5/10/2011	5/25/2011	6/8/2011	6/22/2011	7/6/2011	7/20/2011	8/10/2011	8/24/2011	9/7/2011	9/21/2011	10/5/2011	10/19/2011	11/16/2011	12/14/2011
µg/L; Report Limit: 0.1	**LES**	ND	0.9	ND	ND	0.3	0.9	0.4	0.8	0.5	ND	ND	1.3	1.1	3.1	2.3	2.6	0.2
	TG	0.2	0.9	ND	ND	1.8	0.4	0.7	0.5	0.5	3.0	0.4	1.6	1.8	7.6	5.2	3.6	0.6
	TC	2.6	1.7	ND	0.2	0.5	1.9	1.5	ND	0.7	ND	ND	2.3	2.6	8.4	3.7	6.9	1.3
	WE	ND	0.8	ND	0.1	1.5	2.5	1.5	1.3	ND	ND	0.9	2.5	4.4	12	4.6	7.5	1.9
	TR	3.4	7.1	ND	ND	ND	ND	ND	1.0	1.6	ND	ND	ND	ND	0.5	ND	1.1	0.2
Alkalinity	**Site**	2/16/2011	3/16/2011	4/13/2011	5/10/2011	5/25/2011	6/8/2011	6/22/2011	7/6/2011	7/20/2011	8/10/2011	8/24/2011	9/7/2011	9/21/2011	10/5/2011	10/19/2011	11/16/2011	12/14/2011
mg/L CaCO3; Report Limit: 1.0	**LES**	56.5	52.7	73.4	56.8	56.7	58.0	49.8	56.0	66.9	79.9	84.2	88.5	86.8	75.3	90.6	91.7	87.4
	TG	59.0	55.0	74.6	58.6	60.6	61.5	52.2	57.5	67.1	82.8	83.1	84.3	86.0	82.9	91.8	99.8	89.6
	TC	61.6	57.5	77.2	58.6	59.0	57.4	47.2	55.4	67.5	78.4	84.4	87.3	84.2	80.8	92.5	98.8	91.6
	WE	58.4	57.8	73.4	57.4	56.0	54.1	45.7	53.2	68.1	79.2	83.8	89.2	74.6	85.9	96.3	100	91.2
	TR	65.0	64.2	82.5	59.6	59.9	60.2	51.5	58.2	69.0	80.0	82.0	81.9	78.6	76.9	85.9	94.4	90.8
Dissolved Organic Carbon (DOC)	**Site**	2/16/2011	3/16/2011	4/13/2011	5/10/2011	5/25/2011	6/8/2011	6/22/2011	7/6/2011	7/20/2011	8/10/2011	8/24/2011	9/7/2011	9/21/2011	10/5/2011	10/19/2011	11/16/2011	12/14/2011
mg/L; Report Limit: 0.250	**LES**	1.16	0.97	1.31	1.29	1.12	1.08	1.29	0.864	1.02	1.40	1.11	1.87	1.56	2.36	1.39	1.83	1.98
	TG	1.22	0.898	1.06	1.34	1.10	1.15	1.08	1.33	1.32	1.26	1.16	1.53	1.66	2.34	1.53	1.89	2.04
	TC	1.73	1.12	1.25	1.51	1.49	1.10	1.49	1.08	1.61	1.22	1.39	1.70	1.91	2.25	1.70	2.31	2.12
	WE	1.56	1.05	1.80	2.14	1.84	1.58	1.71	1.33	1.77	2.06	2.09	2.19	2.55	2.84	2.04	2.50	2.54
	TR	1.36	1.26	0.424	0.850	0.81	0.582	0.929	0.601	0.825	0.829	0.561	0.586	0.868	1.39	0.690	0.689	1.15
Particulate Carbon (PC)	**Site**	2/16/2011	3/16/2011	4/13/2011	5/10/2011	5/25/2011	6/8/2011	6/22/2011	7/6/2011	7/20/2011	8/10/2011	8/24/2011	9/7/2011	9/21/2011	10/5/2011	10/19/2011	11/16/2011	12/14/2011
mg C/L	**LES**	DNS	DNS	DNS	0.561	0.401	0.715	0.540	0.421	0.218	0.203	0.267	0.615	0.414	0.695	0.545	0.666	0.338
	TG	DNS	DNS	DNS	0.516	0.466	0.420	0.472	0.453	0.351	0.471	0.345	0.805	0.569	1.07	NS	0.377	0.241
	TC	DNS	DNS	DNS	0.737	0.504	0.729	0.628	0.403	0.346	0.241	0.314	0.624	0.504	1.74	0.710	0.596	0.213
	WE	DNS	DNS	DNS	0.570	0.588	0.700	0.962	0.616	0.437	0.262	0.502	0.707	0.630	1.69	0.913	0.421	0.250
	TR	DNS	DNS	DNS	0.664	0.314	0.239	0.393	0.469	0.200	0.144	0.142	0.197	0.145	0.915	0.368	0.154	0.159

ND= No Detect
DNS= Did Not Sample
NS= No Sample for this site

Table 6-2 (contd.). Other Analytes Results, Yurok Reservation 2011

Non-Filterable Residue (TSS)	Site	2/16/2011	3/16/2011	4/13/2011	5/10/2011	5/25/2011	6/8/2011	6/22/2011	7/6/2011	7/20/2011	8/10/2011	8/24/2011	9/7/2011	9/21/2011	10/5/2011	10/19/2011	11/16/2011	12/14/2011
mg/L; Report Limit: 0.50	LES	19	136	18	35	9	11	8.6	5.0	3.4	1.9	1.1	1.8	2.0	4.0	3.8	1.8	0.75
	TG	34	126	16	31	11	9.3	7.4	5.5	2.1	10	1.6	3.0	3.0	8.0	2.4	1.8	0.87
	TC	98	191	18	34	10	11	9.6	6.5	2.9	0.75	1.5	2.6	2.9	16	2.9	2.6	2.0
	WE	7.8	160	16	8.8	7.3	8.8	9.9	6.6	2.1	0.87	3.3	3.3	3.6	16	3.5	2.5	1.3
	TR	154	394	19	53	11	7.4	5.6	3.4	2.0	1.1	ND	0.63	0.62	9.2	0.87	1.4	1.0

Volatile Suspended Solids (VSS)	Site	2/16/2011	3/16/2011	4/13/2011	5/10/2011	5/25/2011	6/8/2011	6/22/2011	7/6/2011	7/20/2011	8/10/2011	8/24/2011	9/7/2011	9/21/2011	10/5/2011	10/19/2011	11/16/2011	12/14/2011
mg/L; Report Limit: 0.50	LES	2.5	7.5	2.3	2.5	1.1	1.8	1.6	0.63	1.1	0.63	0.63	0.75	0.87	1.2	1.0	0.63	ND
	TG	3.5	11	1.3	1.8	0.75	1.3	1.1	0.75	ND	1.1	0.75	1.6	1.4	2.3	0.87	0.88	0.63
	TC	8.5	16	1.5	3.3	1.0	2.4	2.0	1.0	0.87	ND	0.50	1.1	1.1	4.2	1.3	1.0	0.88
	WE	1.4	15	1.5	1.5	1.3	1.0	2.1	1.5	0.75	ND	1.0	1.6	1.5	4.0	1.4	0.75	ND
	TR	8.0	24	1.5	3.0	1.8	ND	0.87	0.88	ND	ND	ND	ND	ND	2.3	ND	1.0	0.63

Turbidity	Site	2/16/2011	3/16/2011	4/13/2011	5/10/2011	5/25/2011	6/8/2011	6/22/2011	7/6/2011	7/20/2011	8/10/2011	8/24/2011	9/7/2011	9/21/2011	10/5/2011	10/19/2011	11/16/2011	12/14/2011
NTU; Report Limit: 0.10	LES	21	60	7.4	9.3	3.7	3.3	1.9	1.8	0.69	0.21	0.23	0.64	0.70	1.8	0.73	0.68	0.48
	TG	29	58	5.9	9.0	3.4	3.5	2.6	1.9	0.66	0.73	0.26	0.75	0.51	0.88	0.45	0.47	0.42
	TC	61	73	5.4	8.3	2.6	3.0	2.2	1.9	0.57	0.28	0.21	0.55	0.44	0.86	0.48	0.68	0.52
	WE	14	70	3.9	2.5	1.7	2.1	2.5	1.6	0.46	0.18	0.31	0.85	0.63	2.0	0.61	0.66	0.57
	TR	96	160	6.5	17	3.0	2.2	2.0	0.69	0.52	0.17	0.16	0.20	0.21	2.1	0.23	0.45	0.34

ND= No Detect

Table 6-3. Discrete Datasonde Measurements, Yurok Reservation 2011

Discrete Datasonde Results

Temperature
ºC

Site	2/16/2011	3/16/2011	4/13/2011	5/10/2011	5/25/2011	6/8/2011	6/22/2011	7/6/2011	7/20/2011	8/10/2011	8/24/2011	9/7/2011	9/21/2011	10/5/2011	10/19/2011	11/16/2011	12/14/2011
LES	7.18	8.09	9.32	10.59	12.38	13.45	15.95	18.21	17.31	20.90	22.01	18.85	18.54	14.54	16.48	10.15	5.07
TG	6.96	8.03	9.46	10.70	12.28	13.46	15.79	18.23	17.29	19.76	21.46	20.06	18.56	15.01	15.71	10.26	4.68
TC	6.55	7.64	9.03	10.22	11.69	13.06	15.26	18.35	17.87	21.31	21.67	20.34	18.43	14.32	15.62	9.96	3.62
WE	6.28	7.59	8.89	10.39	11.77	13.35	15.32	18.66	18.40	21.81	22.26	20.64	18.77	14.53	15.93	10.11	3.13
TR	6.66	7.98	9.14	10.51	11.45	13.05	15.48	18.23	17.14	21.20	21.50	19.84	17.81	13.51	15.35	9.86	4.47

Dissolved Oxygen
mg/L

Site	2/16/2011	3/16/2011	4/13/2011	5/10/2011	5/25/2011	6/8/2011	6/22/2011	7/6/2011	7/20/2011	8/10/2011	8/24/2011	9/7/2011	9/21/2011	10/5/2011	10/19/2011	11/16/2011	12/14/2011
LES	11.85	11.85	11.22	11.02	11.05	10.29	9.59	9.07	9.16	7.93	7.62	8.41	8.07	8.87	9.01	11.11	12.25
TG	11.98	11.92	10.94	10.89	10.85	10.16	9.42	9.07	9.08	7.96	8.17	8.11	8.57	9.13	8.62	10.61	12.07
TC	12.37	12.37	11.73	11.36	10.95	10.65	10.18	9.49	9.51	8.65	8.6	8.87	9.27	9.86	9.77	11.53	13.28
WE	12.57	12.43	11.92	11.56	11.08	10.98	10.47	9.64	9.65	8.77	8.83	9.11	9.27	9.91	10.04	11.77	13.44
TR	12.25	12.14	11.52	11.21	10.92	10.59	10.06	9.58	9.74	8.92	9.02	9.42	9.72	10.09	10.18	11.61	13.2

Percent Dissolved Oxygen

Site	2/16/2011	3/16/2011	4/13/2011	5/10/2011	5/25/2011	6/8/2011	6/22/2011	7/6/2011	7/20/2011	8/10/2011	8/24/2011	9/7/2011	9/21/2011	10/5/2011	10/19/2011	11/16/2011	12/14/2011
LES	98.2	100.2	97.9	99.0	103.5	98.6	97.2	96.3	95.4	89.0	87.2	91.4	86.4	87.3	92.3	98.9	96.2
TG	98.6	100.7	95.7	98.2	101.4	97.5	95.1	96.3	94.6	87.1	92.5	89.3	91.6	90.6	86.9	94.6	93.8
TC	100.8	103.5	101.5	101.1	100.9	101.2	101.5	100.9	100.2	97.6	97.7	98.3	98.8	96.4	98.2	102.0	100.3
WE	101.7	103.9	102.9	103.4	102.3	105.0	104.6	103.2	102.8	100.0	101.5	101.4	99.5	97.3	101.6	104.6	100.7
TR	100.1	102.4	100.1	100.5	100.1	100.7	100.9	101.7	101.1	100.5	102.2	103.4	102.4	97.0	101.7	102.6	102.0

Table 6-3 (contd.). Discrete Datasonde Measurements, Yurok Reservation 2011

Specific Conductivity
µS/cm

Site	2/16/2011	3/16/2011	4/13/2011	5/10/2011	5/25/2011	6/8/2011	6/22/2011	7/6/2011	7/20/2011	8/10/2011	8/24/2011	9/7/2011	9/21/2011	10/5/2011	10/19/2011	11/16/2011	12/14/2011
LES	123	102	140	109	110	110	95	108	135	740	282	3150	730	2250	348	528	294
TG	126	101	143	112	113	112	98	110	134	159	164	168	172	165	178	185	171
TC	128	106	144	111	109	106	90	107	133	156	163	170	173	163	182	189	175
WE	124	107	142	111	107	103	87	103	134	157	165	173	180	172	186	192	176
TR	138	114	147	112	112	112	99	113	131	155	160	161	158	152	172	183	176

pH

Site	2/16/2011	3/16/2011	4/13/2011	5/10/2011	5/25/2011	6/8/2011	6/22/2011	7/6/2011	7/20/2011	8/10/2011	8/24/2011	9/7/2011	9/21/2011	10/5/2011	10/19/2011	11/16/2011	12/14/2011
LES	8.62	7.88	8.11	8.01	8.23	8.31	8.12	8.15	8.13	8.19	8.13	8.21	8.13	7.97	8.37	8.25	7.74
TG	8.71	7.93	7.98	7.90	8.25	8.24	8.02	8.11	8.09	7.93	8.20	8.22	8.22	8.15	7.98	8.19	8.10
TC	8.78	8.03	8.12	8.04	8.36	8.28	8.06	8.04	8.25	8.33	8.25	8.28	8.28	8.23	8.38	8.44	8.22
WE	8.79	8.00	8.14	8.07	8.38	8.26	8.06	8.05	8.27	8.40	8.31	8.33	8.26	8.26	8.52	8.48	8.30
TR	8.81	8.13	8.15	8.04	8.41	8.25	8.08	8.13	7.82	8.29	8.19	8.27	8.24	8.12	8.40	8.44	8.47

Blue-green Algae
cells/mL

Site	2/16/2011	3/16/2011	4/13/2011	5/10/2011	5/25/2011	6/8/2011	6/22/2011	7/6/2011	7/20/2011	8/10/2011	8/24/2011	9/7/2011	9/21/2011	10/5/2011	10/19/2011	11/16/2011	12/14/2011
LES	200	DNR	DNR	DNR	-450	-650	-950	-800	-750	-250	-650	450	-350	1250	-400	-1100	-950
TG	200	DNR	DNR	DNR	-700	-850	-950	-500	-800	-750	-850	1050	-350	650	-550	-800	-1350
TC	625	DNR	DNR	DNR	-700	-200	-600	-550	-850	-750	-750	550	-200	-50	150	-800	-1150
WE	50	DNR	DNR	DNR	-450	150	-475	-350	-550	-800	-500	1450	300	750	550	-750	-1100
TR	500	DNR	DNR	DNR	-850	1450	850	-850	-1550	-900	-750	-750	-950	-950	-650	-1000	-1300

DNR= Did Not Record

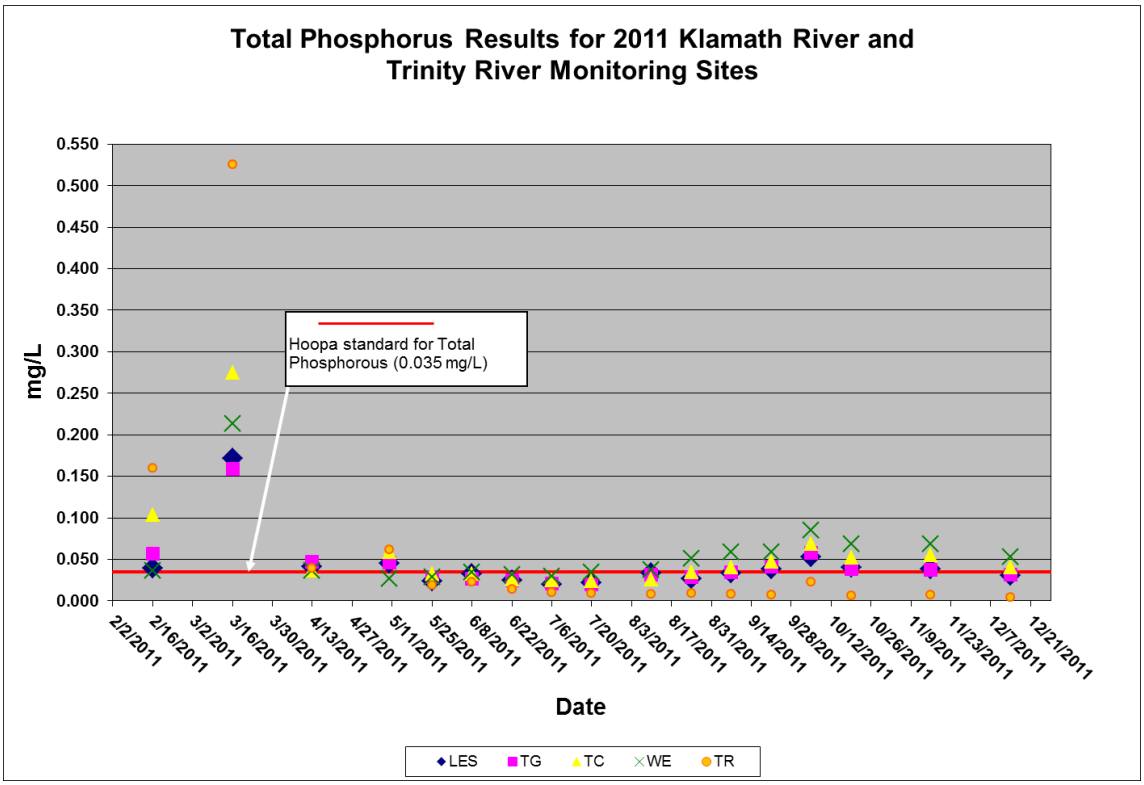

Figure 6-1. Total Phosphorus Results 2011

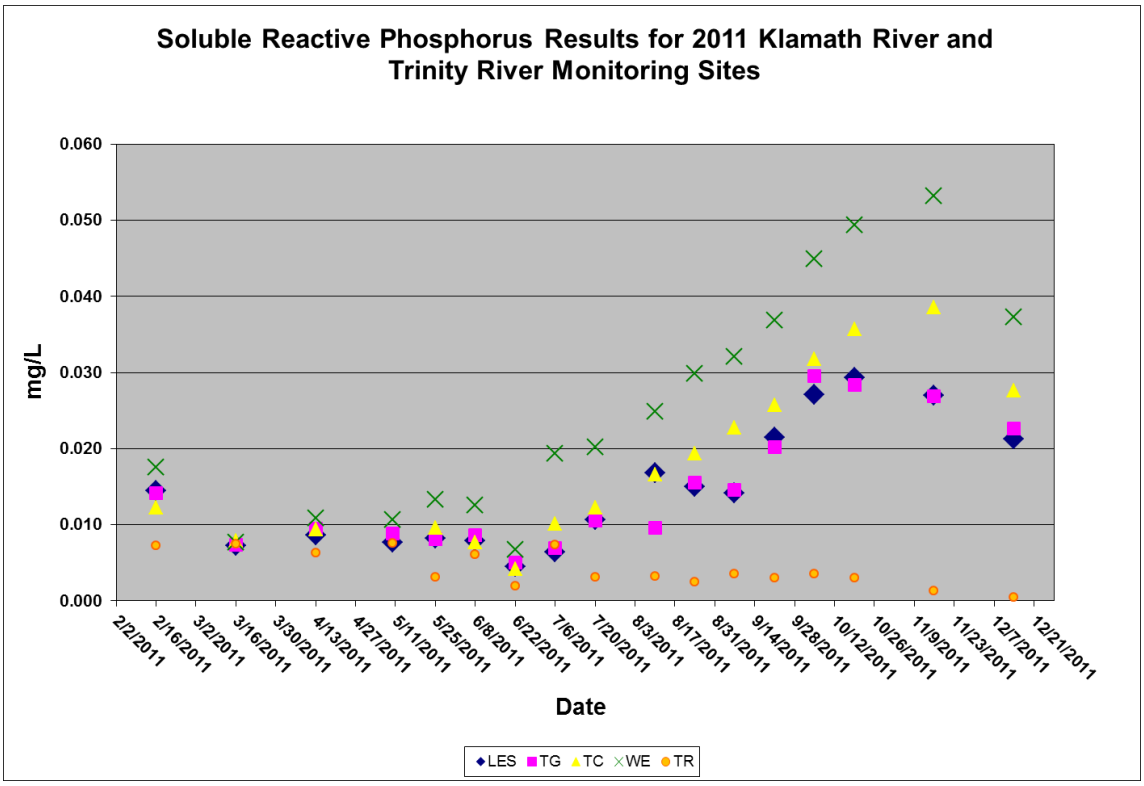

Figure 6-2. Soluble Reactive Phosphorus Results 2011

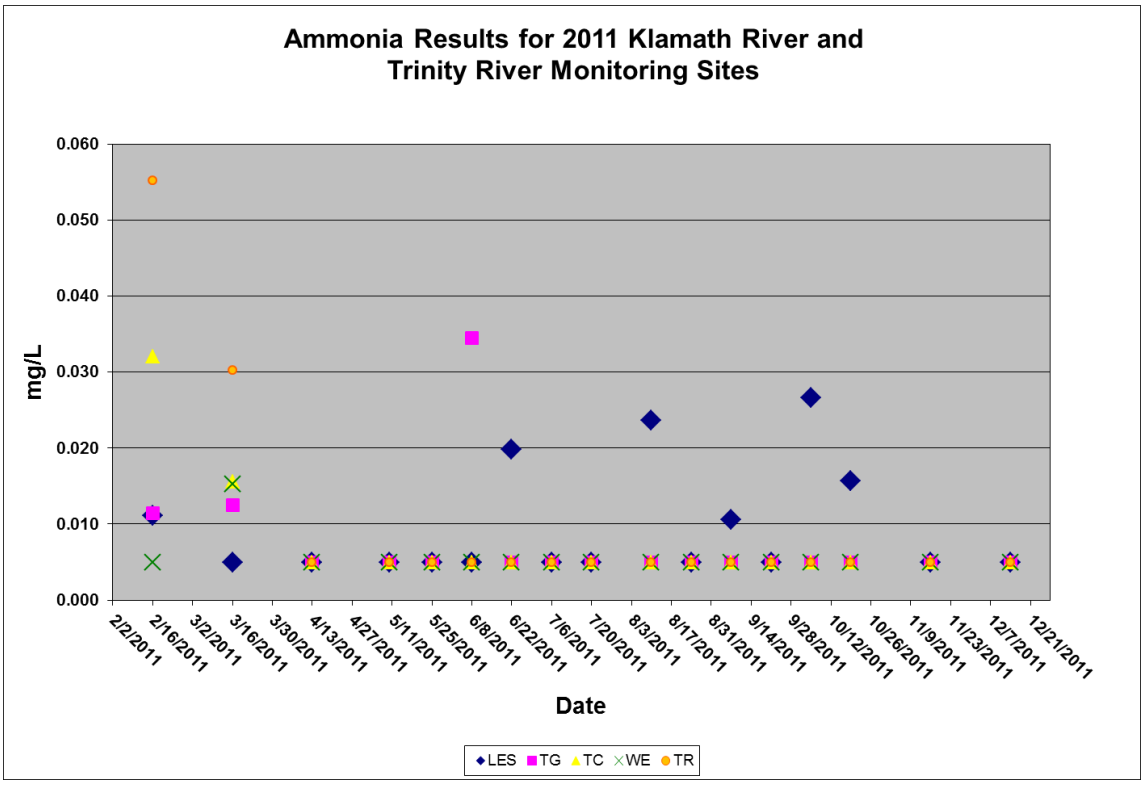

Figure 6-3. Ammonia Results 2011

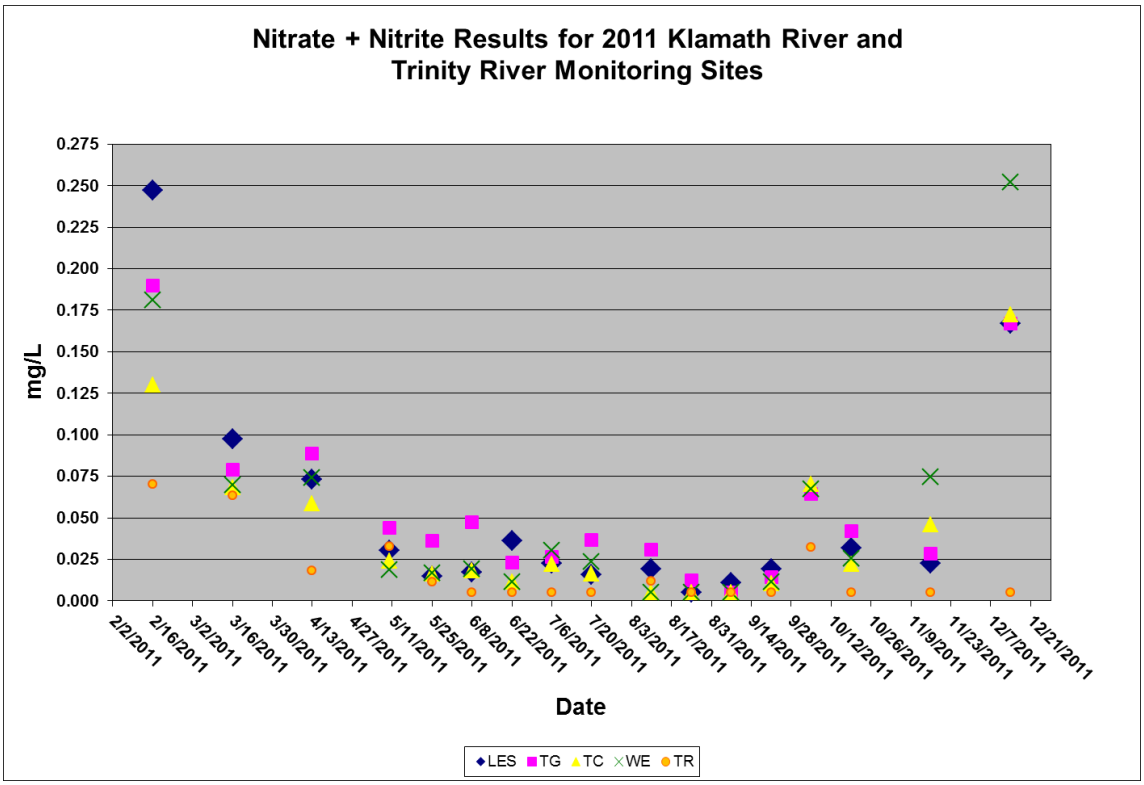

Figure 6-4. Nitrate + Nitrite Results 2011

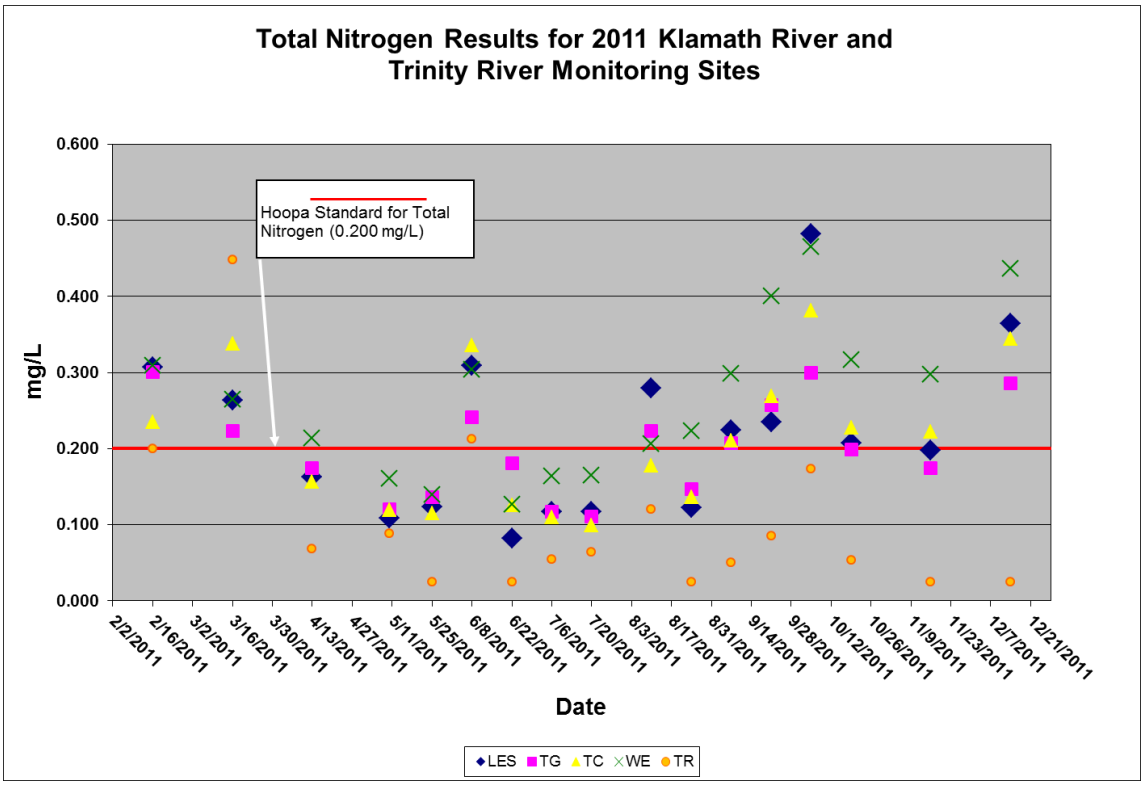

Figure 6-5. Total Nitrogen Results 2011

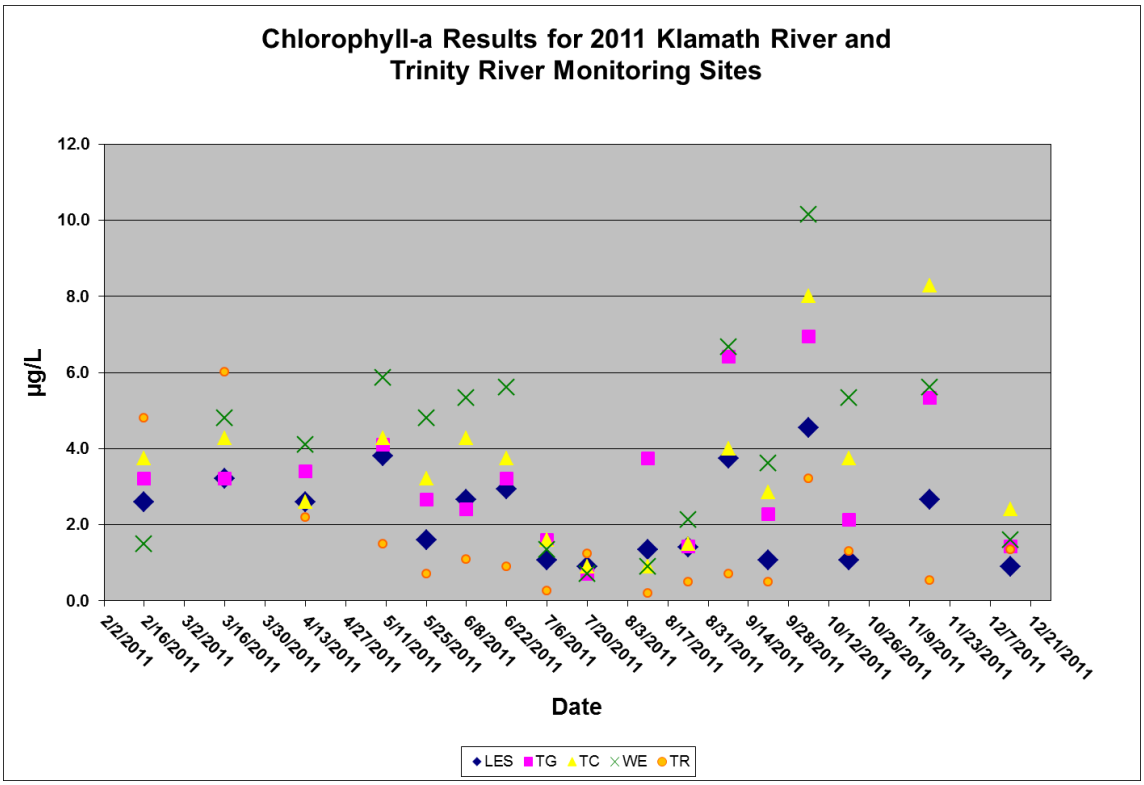

Figure 6-6. Chlorophyll-a Results 2011

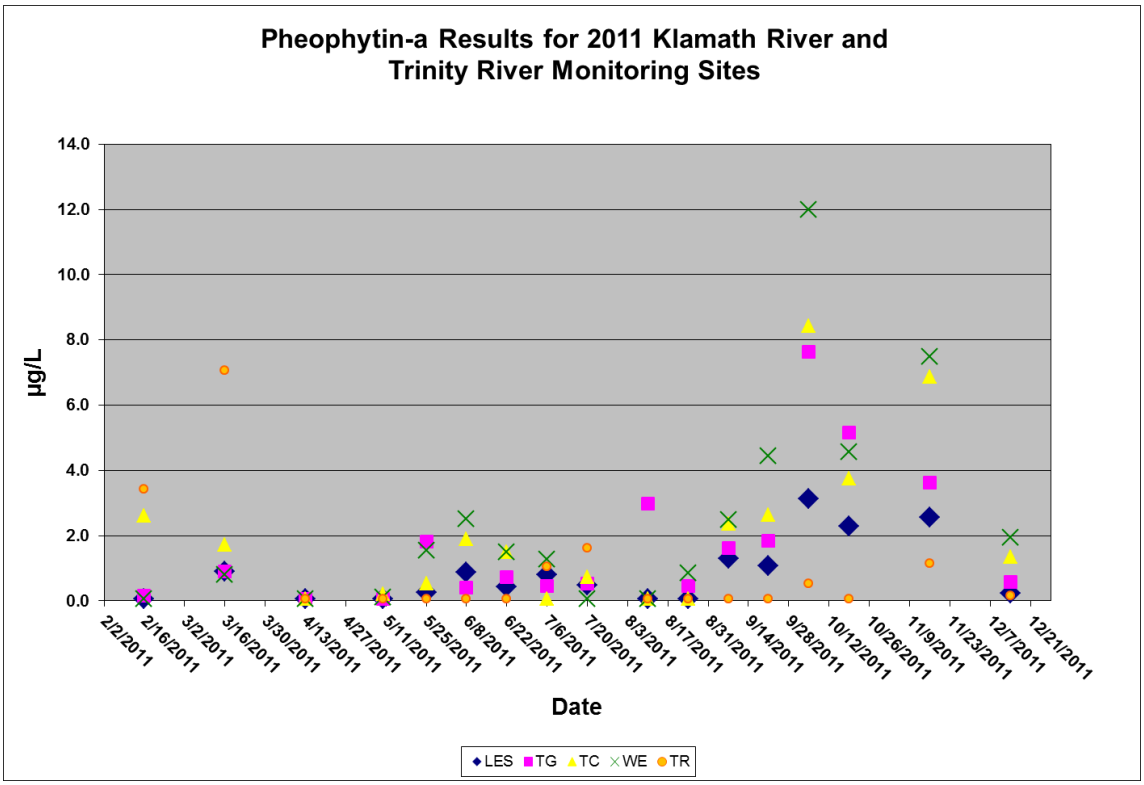

Figure 6-7. Pheophytin-a Results 2011

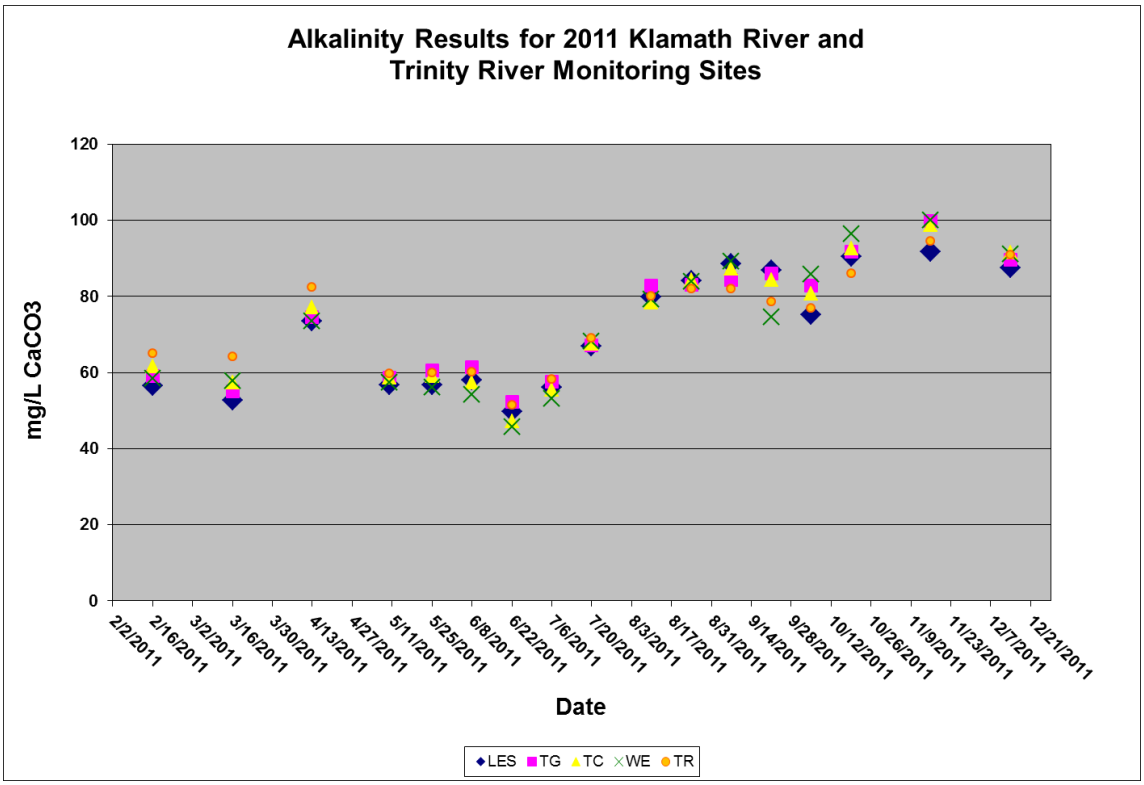

Figure 6-8. Alkalinity Results 2011

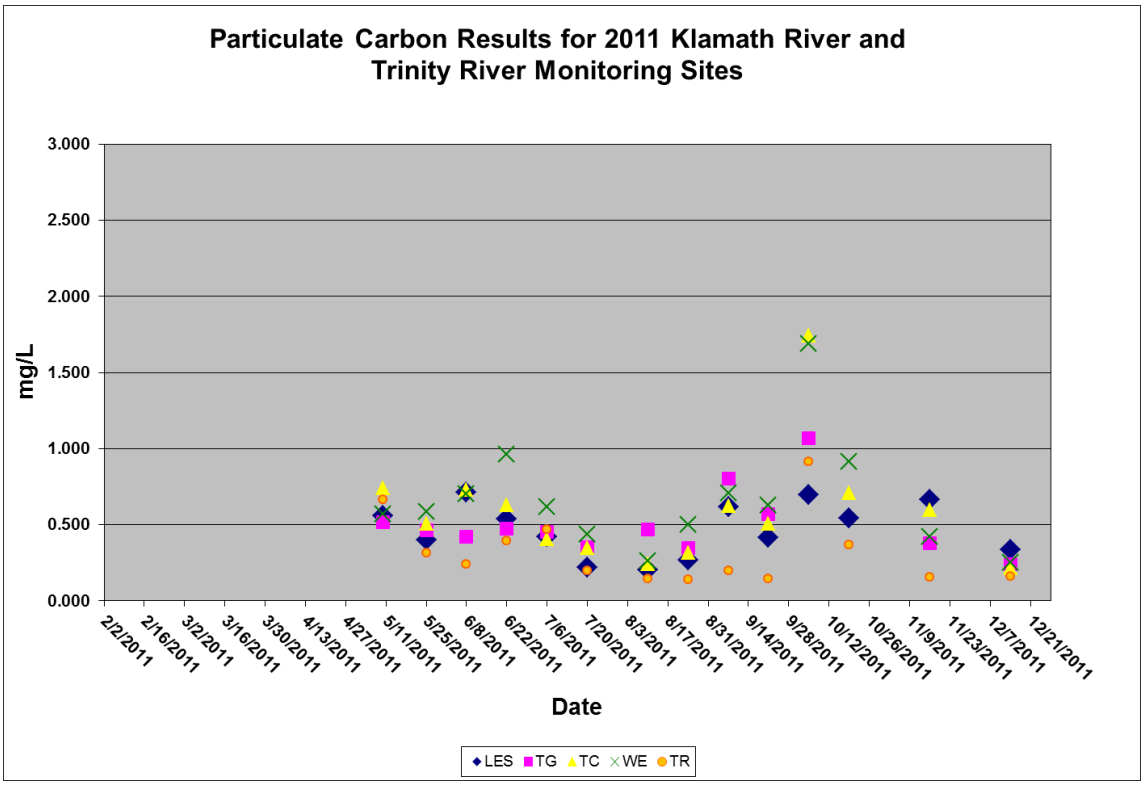

Figure 6-9. Particulate Carbon Results 2011

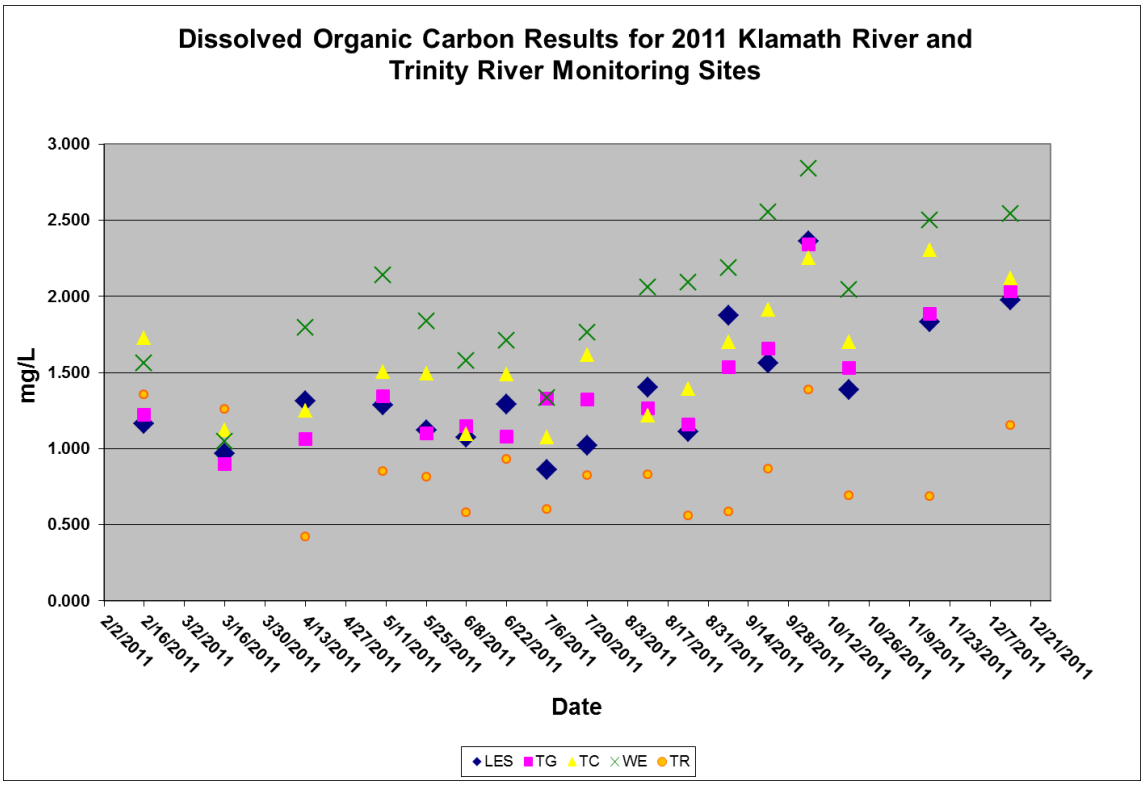

Figure 6-10. Dissolved Organic Carbon Results 2011

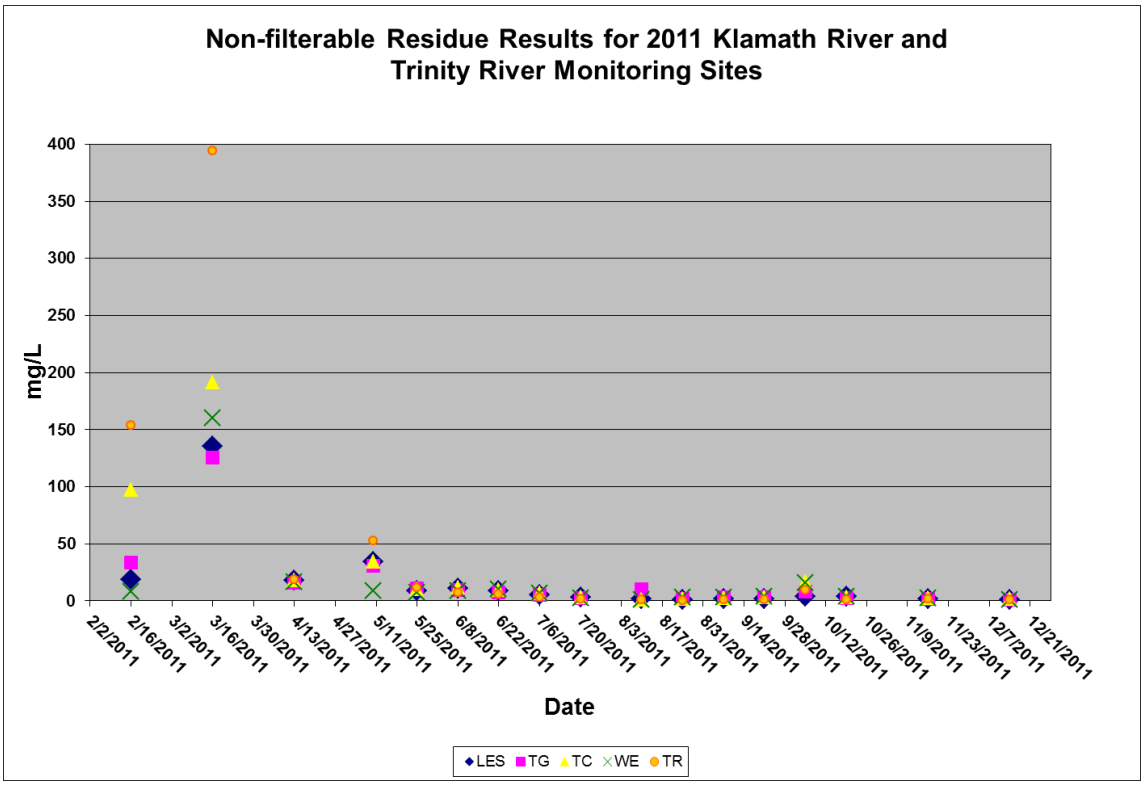

Figure 6-11. Non-filterable Residue Results 2011

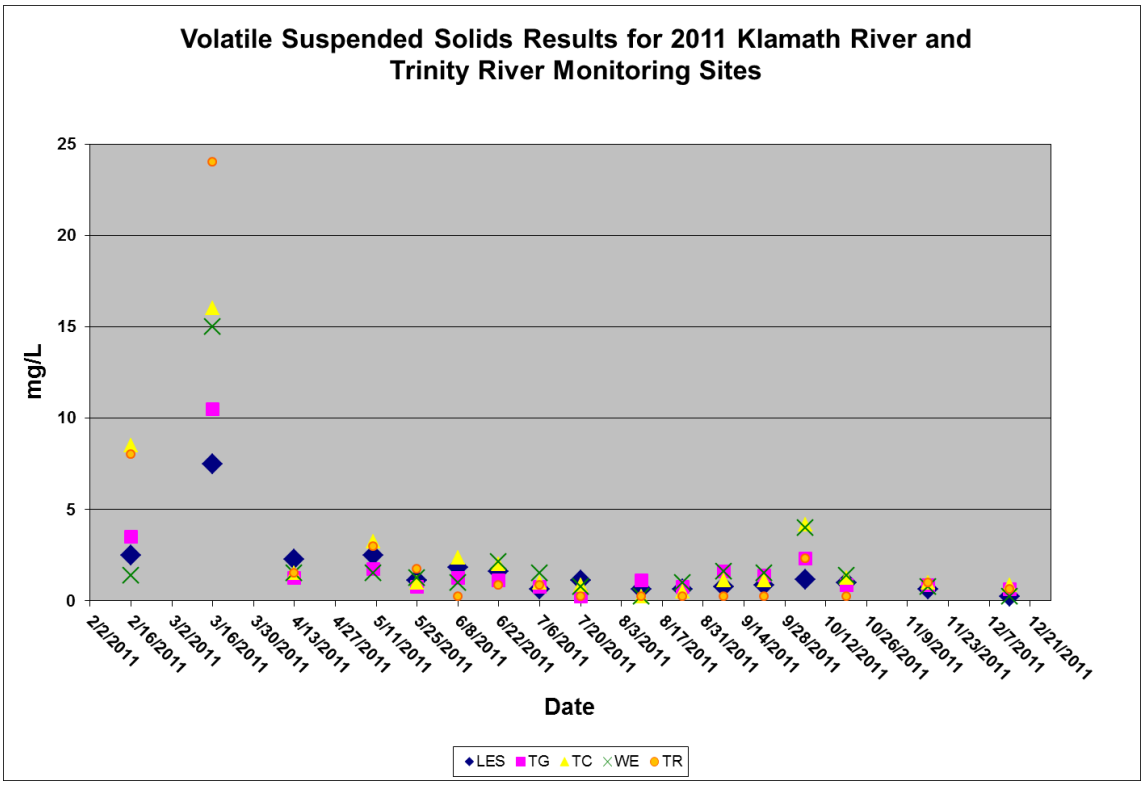

Figure 6-12. Volatile Suspended Solids Results 2011

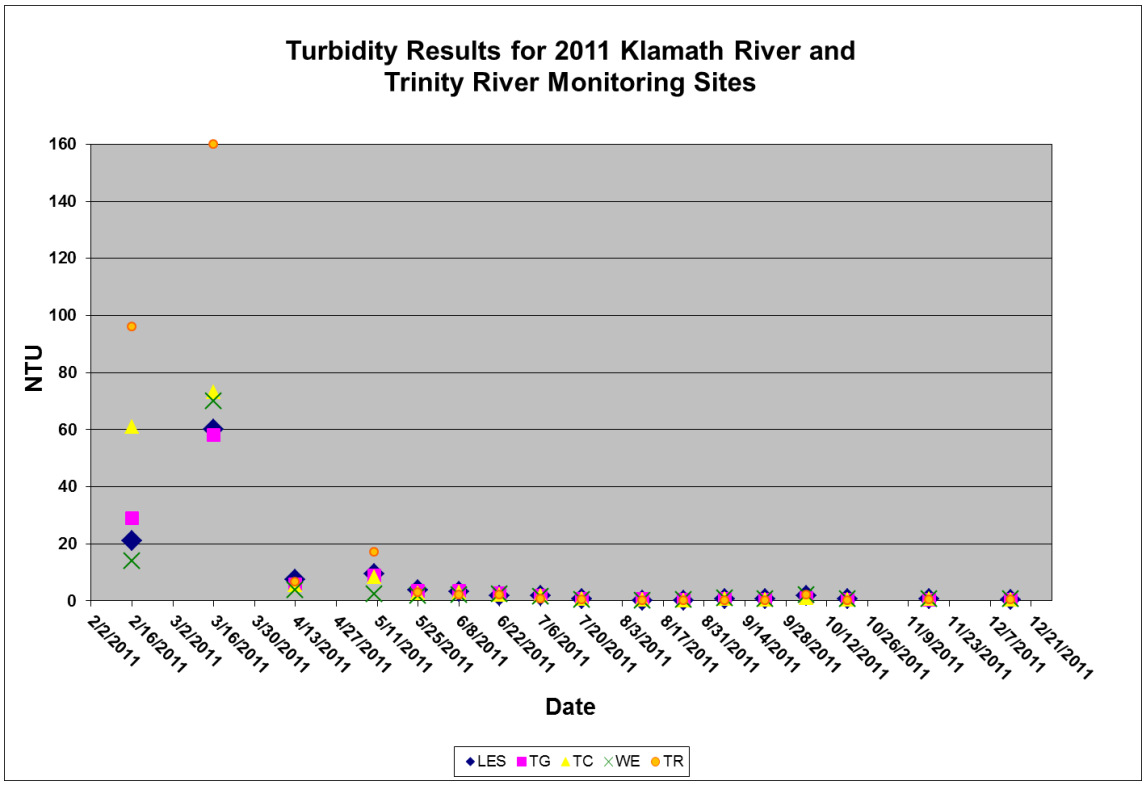

Figure 6-13. Turbidity Results 2011

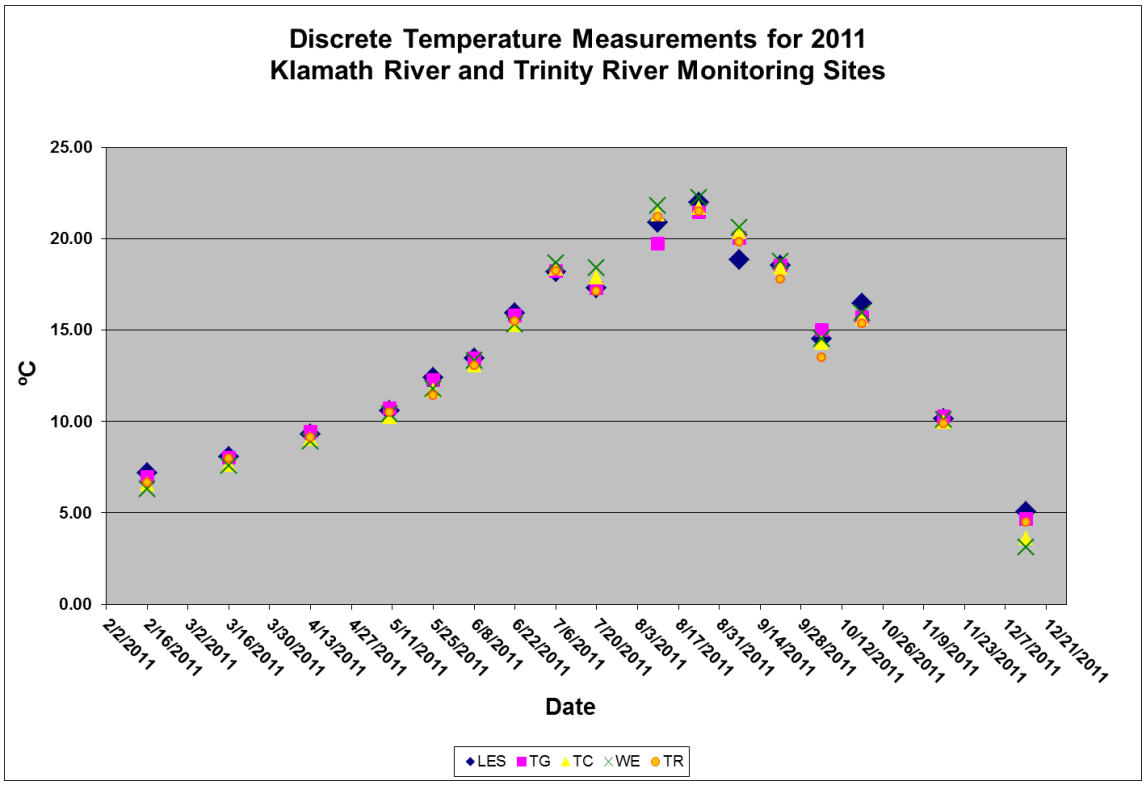

Figure 6-14. Discrete Water Temperature Measurements 2011

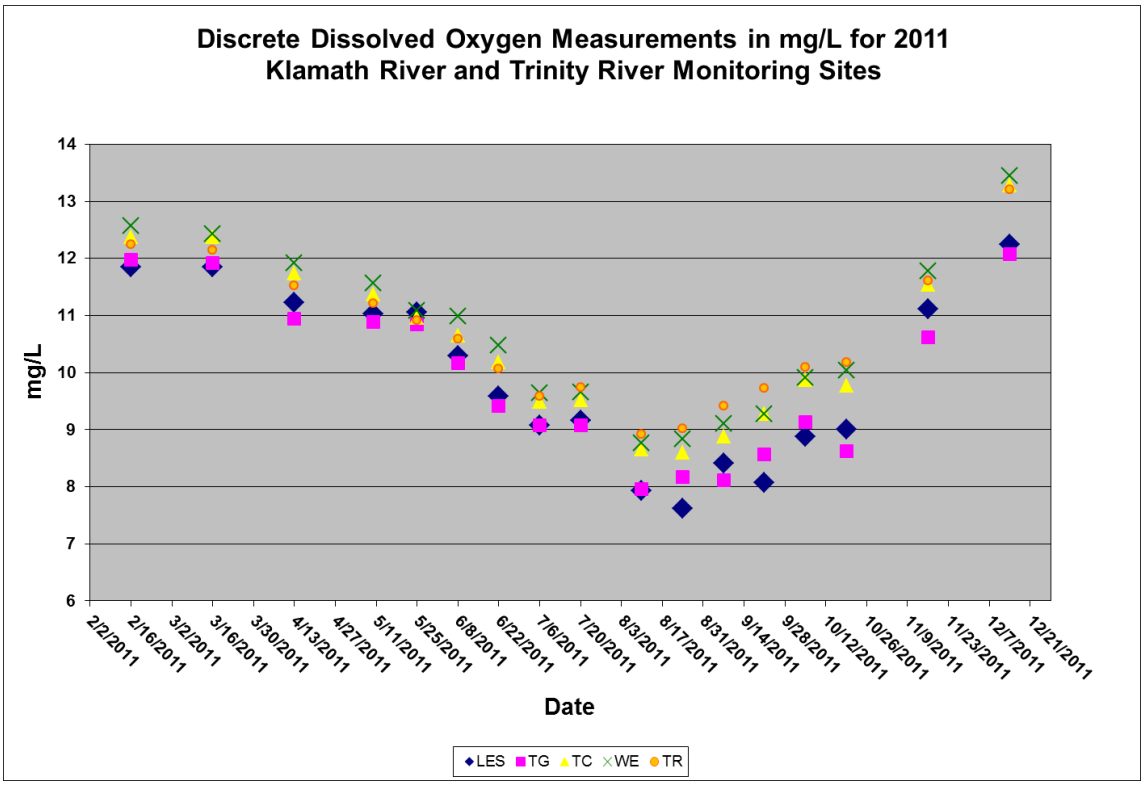

Figure 6-15. Discrete Dissolved Oxygen Measurements in mg/L 2011

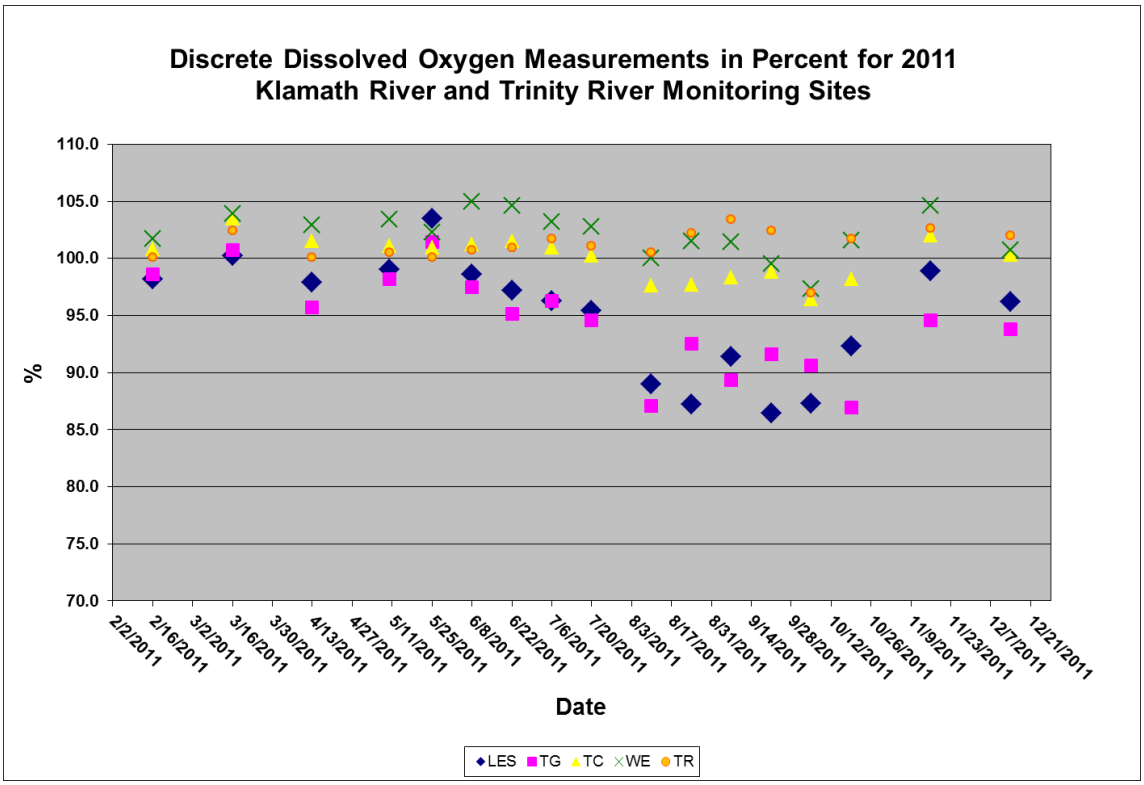

Figure 6-16. Discrete Dissolved Oxygen Measurements in Percent 2011

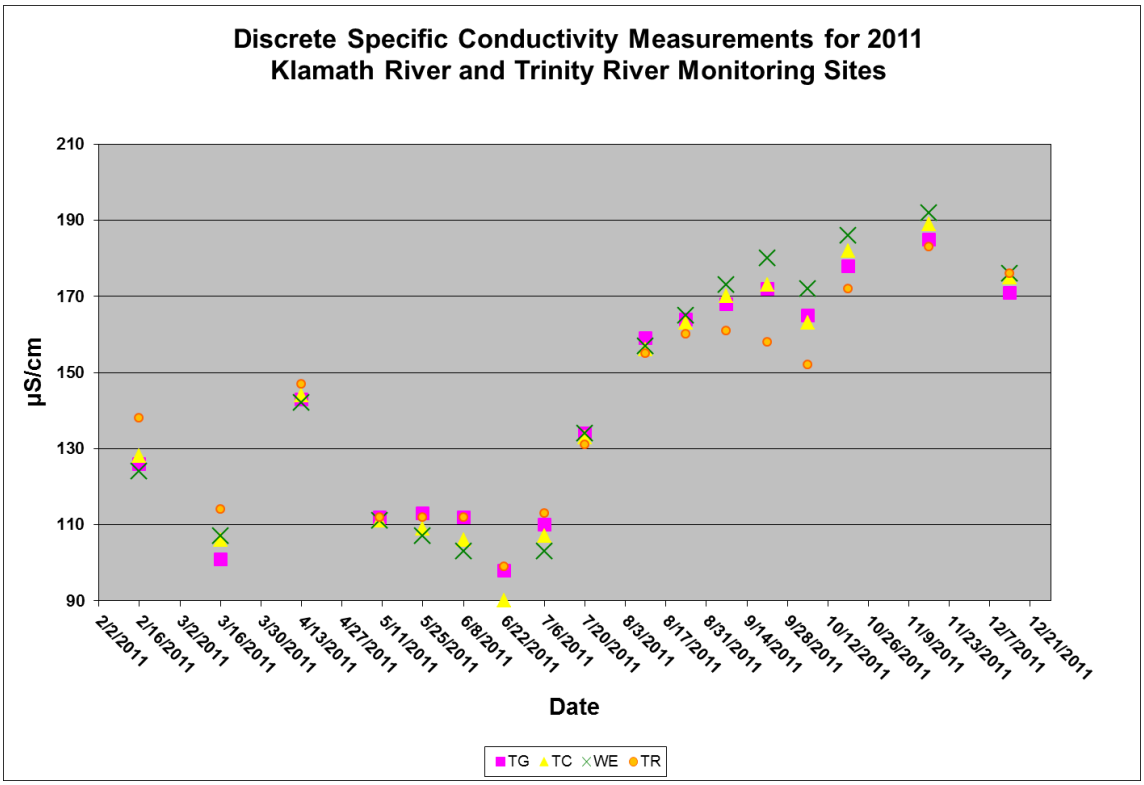

Figure 6-17. Discrete Specific Conductivity Measurements 2011

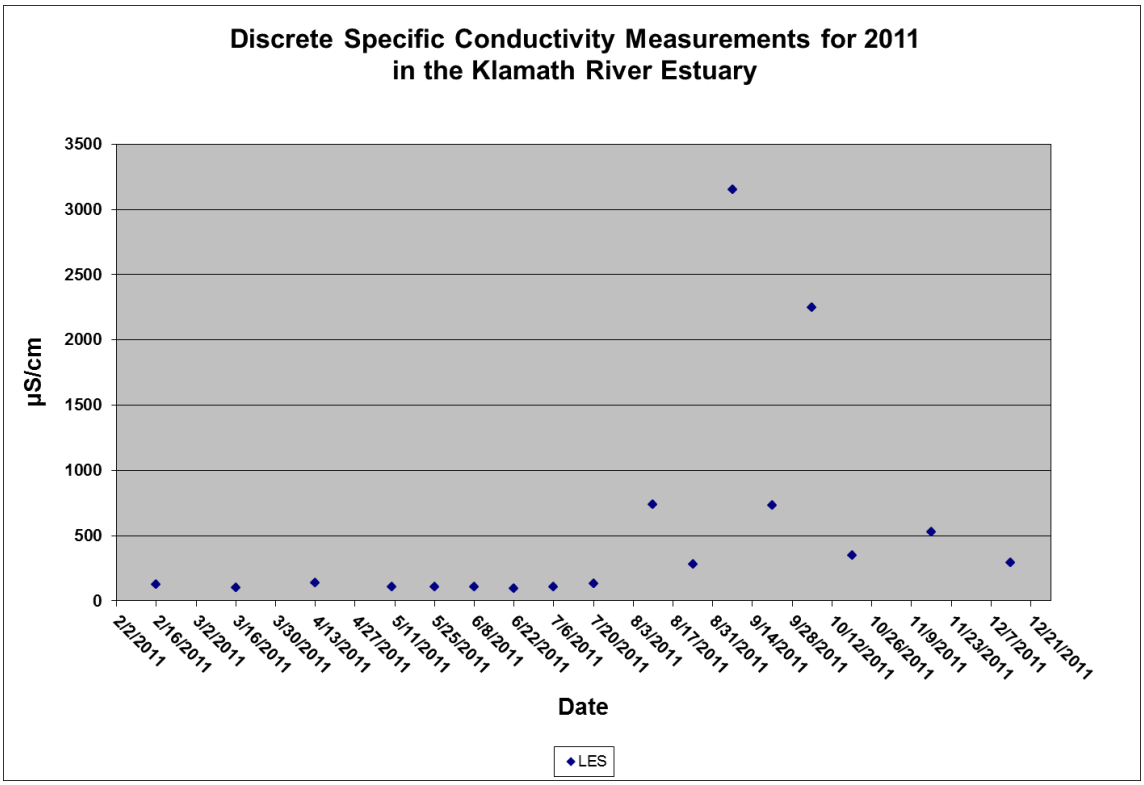

Figure 6-18. Discrete Specific Conductivity Measurements in the Klamath River Estuary 2011

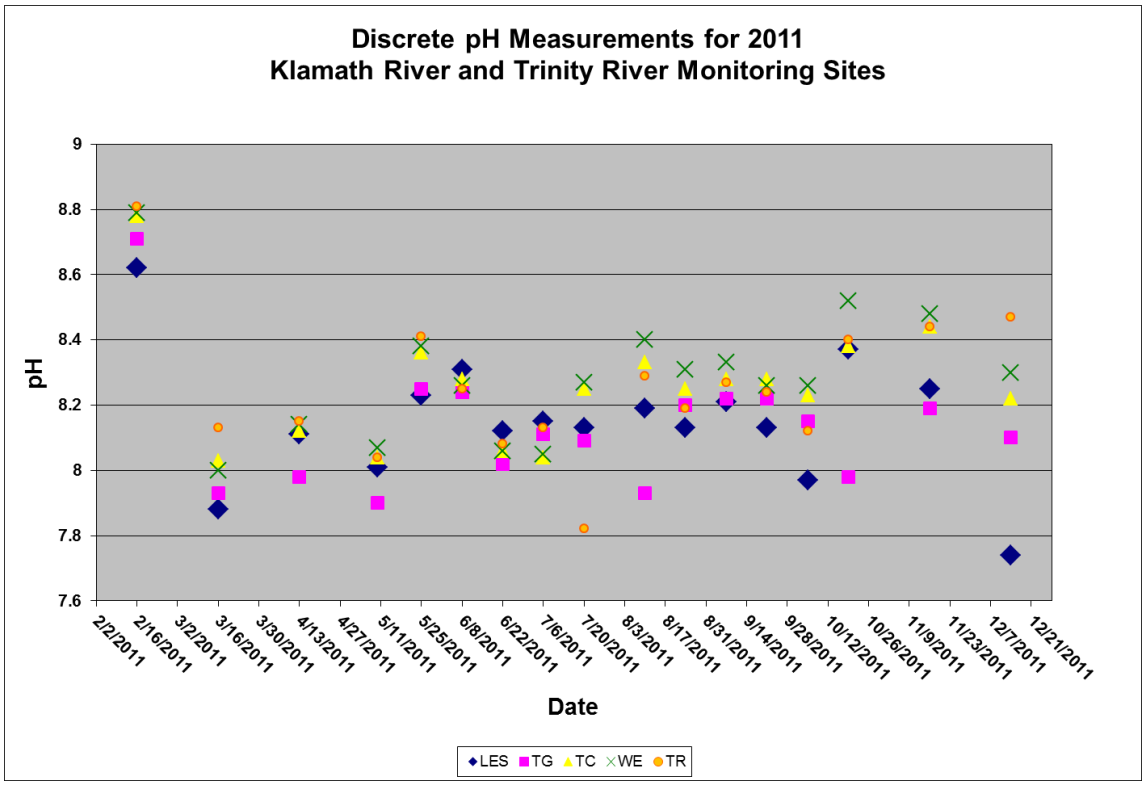

Figure 6-19. Discrete pH Measurements 2011

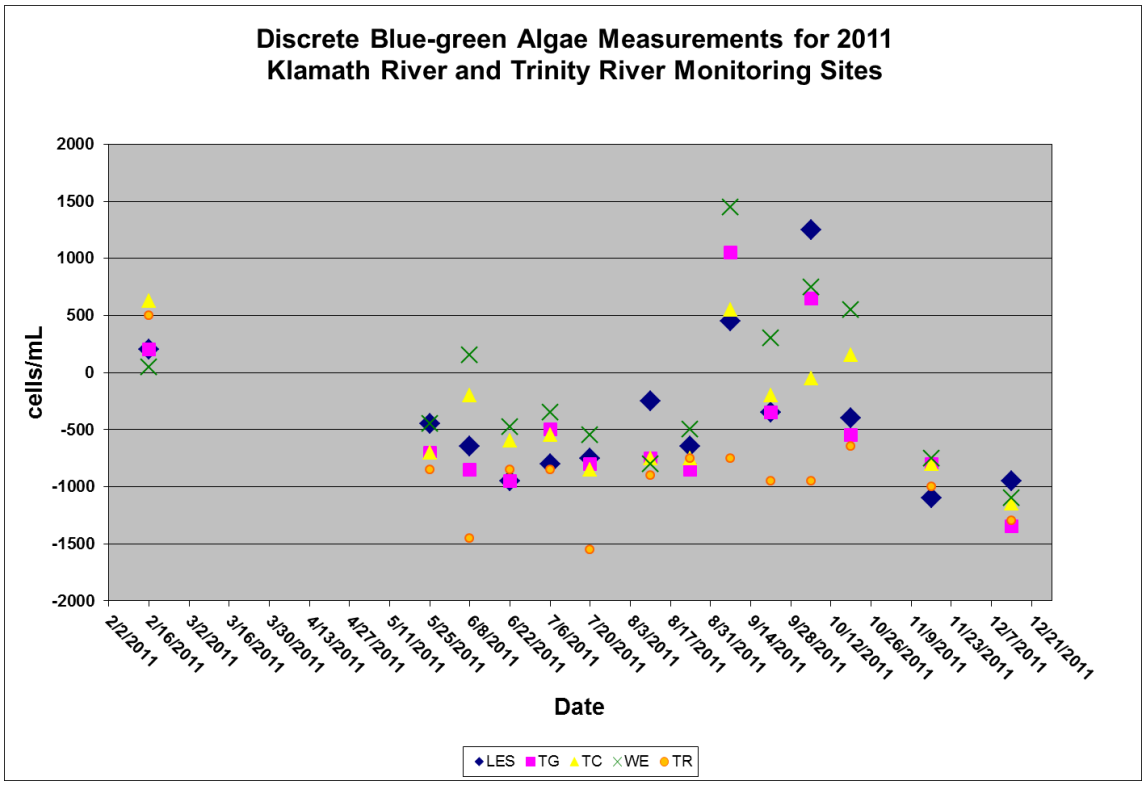

Figure 6-20. Discrete BGA Measurements 2011

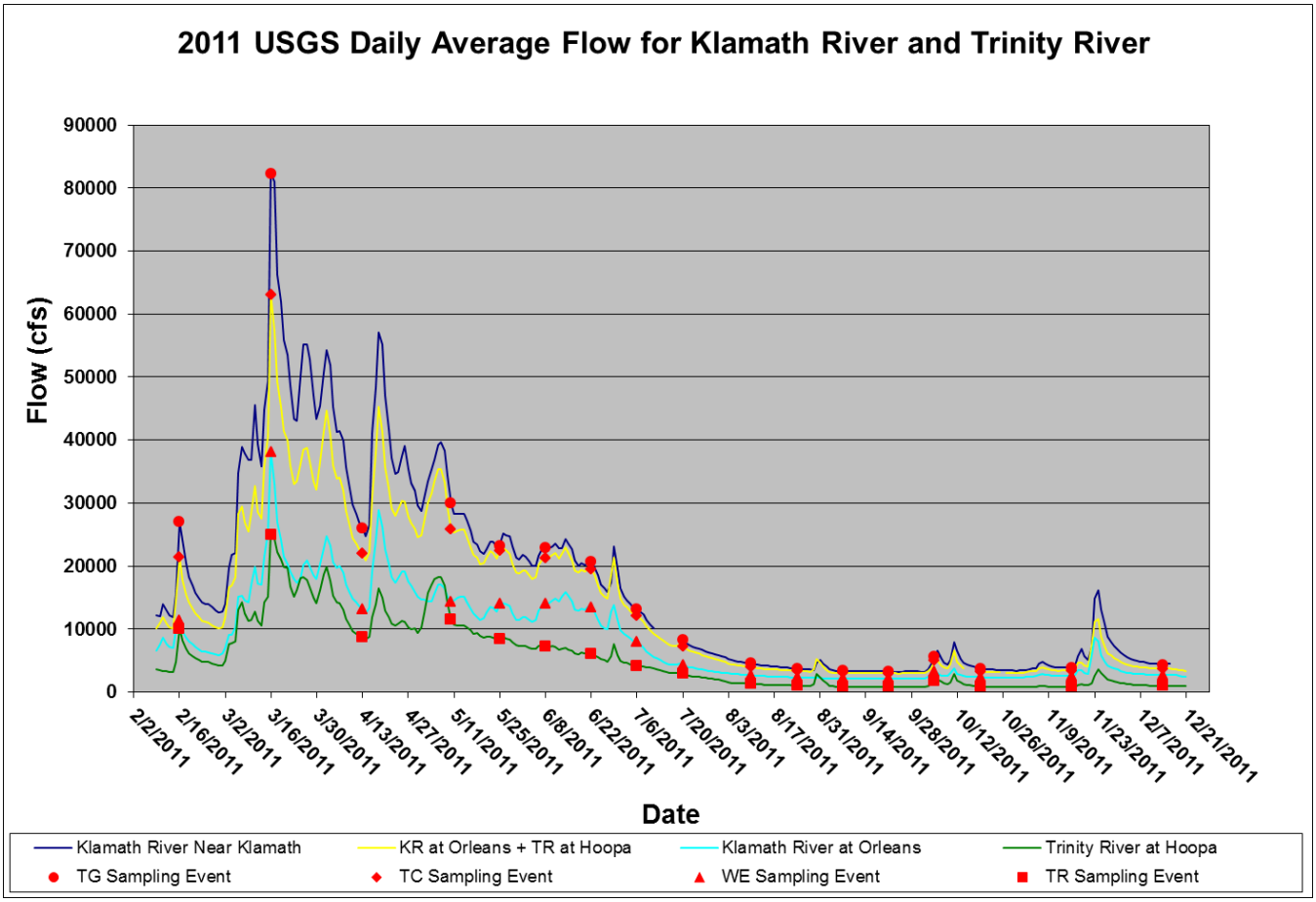

Figure 6-21. Daily Average Flow 2011 (From USGS) with sites superimposed onto flow on dates sampled

Blue-green Algae

Blue-green algae probe readings from the datasonde exhibited trends that were similar for all sites except TR for the 2011 sampling season (Table 6-3, Figure 6-20). Measurements at all sites were slightly elevated in mid-February due to the effects of turbidity during a high flow event while from mid-March to early May readings were not recorded due to the probe being sent in for yearly maintenance. From late May through late August readings at all sites were near or below zero. In early September readings at all sites except TR increased significantly, decreased in late September then increased again in early October. Readings then decreased gradually to levels below zero into mid-December. Blue-green algae measurements remained well below zero at TR from late May through mid-December.

The lowest reading for blue-green algae during the 2011 sampling season was -1550 cells/mL at TR on July 20, while the highest reading was 1,450 cells/mL at WE on September 7, 2011.

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. During the 2011 sampling year YTEP stopped requesting Aquatic Research to analyze water samples for total organic carbon (TOC). The change was made in collaboration with other entities in the Klamath Basin that YTEP coordinates sampling events with (Karuk Tribe, Watercourse Engineering, Inc., BOR, PacifiCorp). This decision was made due to the variation involved in analyzing for TOC, which was leading to results which the sampling entities could not be confident in, regardless of the laboratory that analyzed the samples. In YTEP's case, during certain sampling events, dissolved organic carbon (DOC) results were slightly higher than TOC results (see YTEP's 2009 and 2010 Nutrient Summary Report). While not only inaccurate, this prevented YTEP from determining the fraction of particulate organic carbon in the sample.

On May 10, 2011, YTEP began sampling for particulate carbon (PC), which was analyzed by Chesapeake Biological Laboratory in Solomons, MD, while Aquatic Research continued to analyze samples for DOC. Samples were collected in bottles following the standard grab sample protocol (Appendix A), stored on ice, then filtered following the PC filtration protocol (Appendix B) when all samples from all sites had been collected.

Dissolved organic carbon is organic carbon that can pass through a filter. Particulate carbon is carbon in particulate form that is too large to pass through a filter. Except in watersheds dominated by carbonate bedrock, nearly all particulate carbon has found to be organic. Results from samples in the Klamath River, a non-carbonate system, concur with this conclusion. PC was added to DOC to determine TOC for each sampling event in which both parameters were analyzed.

The ratio of PC to TOC fluctuated throughout the year (Table 7-1, Figure 7-1). From early May to early July ratios tended to fluctuated between 20-40%. After early July, ratios at all sites except TG dropped into early August. At TG the ratio of PC to TOC dropped in late July, then fluctuated around 30% until early October. From late August to early September ratios increased, decreased slightly in late September, then increased in early October. The ratio of PC to TOC at LES during this period tended to fluctuate at just above 20%. The ratio of PC to TOC declined from early October to mid-December. The highest ratio of PC to TOC was 43.9% at TR on May 10 while the lowest ratio was 9.0% at WE on December 16, 2011.

The ratio of DOC to TOC fluctuated throughout the year (Table 7-2, Figure 7-2). From early May to early July results tended to fluctuate around 70%. From late July to early August the ratio of DOC to TOC at all sites except TG increased. Ratios at TG fluctuated around 70% from early August to early October. Ratios decreased from late August to early September, increased in late September, then decreased in early October. The ratio at LES during this time period tended to hover at just under 80%. From early October to mid-December the ratio of DOC to TOC increased. The highest ratio of DOC to TOC was 91.0% at WE on December 16, while the lowest ratio of DOC to TOC was 56.1% on May 10, 2011.

Suspended Solids

Suspended solids refer 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. Both of these procedures were performed by Aquatic Research Inc. for the 2011 sampling year.

The ratio of VSS to TSS fluctuated throughout the year (Table 7-3, Figure 7-3). From mid-February to early May, ratios were low, fluctuating around 10%. Starting in early May the proportion of VSS began to increase, continuing to rise until late August/early September. During this period, VSS percentage topped out at 42.9-54.2%. After early September, the ratio decreased until early October, then increased until mid-December, except for LES and WE, which had a ratio of 0.0% due to lack of VSS in the sample. The except again was TR, which had some of the lowest ratios, often near or at zero, except for the mid-November and mid-December sampling events when it had some of the highest ratios.

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 of aquatic organisms and then decreases as the activity of those organisms decreases in the fall and winter. The rain events on March 16 and October 5 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, indicating that a smaller portion of the suspended solids in the system was coming from volatile suspended solids.

The highest ratio of VSS to TSS was 72.7% at TR on November 16, while the lowest ratio was 5.2% at TR on February 16, 2011. On several dates the ratio was 0%. On these dates, VSS returned results that were below the reporting limit of 0.50 mg/L. TR consistently returned the lowest results, often having a ratio of zero due to the high frequency of VSS not being detected throughout the year.

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 of low quality, full of organic matter that is live and dead, 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.

Table 7-1. Ratio of PC to TOC, Yurok Reservation 2011

Site	2/16/2011	3/16/2011	4/13/2011	5/10/2011	5/25/2011	6/8/2011	6/22/2011	7/6/2011	7/20/2011	8/10/2011	8/24/2011	9/7/2011	9/21/2011	10/5/2011	10/19/2011	11/16/2011	12/14/2011
LES	DNS	DNS	DNS	30.3	26.3	39.9	29.5	32.8	17.6	12.6	19.4	24.7	21.0	22.7	28.2	26.7	14.6
TG	DNS	DNS	DNS	27.7	29.8	26.8	30.4	25.4	21.0	27.2	23.0	34.4	25.5	31.4	NS	16.7	10.6
TC	DNS	DNS	DNS	32.9	25.3	39.9	29.7	27.3	17.7	16.5	18.4	26.9	20.9	43.6	29.5	20.5	9.1
WE	DNS	DNS	DNS	21.0	24.2	30.8	36.0	31.6	19.8	11.3	19.3	24.4	19.8	37.3	30.9	14.4	9.0
TR	DNS	DNS	DNS	43.9	27.8	29.1	29.7	43.8	19.5	14.8	20.2	25.2	14.3	39.7	34.8	18.3	12.1

DNS= Did Not Sample
NS = No Sample for this date

Table 7-2. Ratio of DOC to TOC, Yurok Reservation 2011

Site	2/16/2011	3/16/2011	4/13/2011	5/10/2011	5/25/2011	6/8/2011	6/22/2011	7/6/2011	7/20/2011	8/10/2011	8/24/2011	9/7/2011	9/21/2011	10/5/2011	10/19/2011	11/16/2011	12/14/2011
LES	DNS*	DNS*	DNS*	69.7	73.7	60.1	70.5	67.2	82.4	87.4	80.6	75.3	79.0	77.3	71.8	73.3	85.4
TG	DNS*	DNS*	DNS*	72.3	70.2	73.2	69.6	74.6	79.0	72.8	77.0	65.6	74.5	68.6	NS*	83.3	89.4
TC	DNS*	DNS*	DNS*	67.1	74.7	60.1	70.3	72.7	82.3	83.5	81.6	73.1	79.1	56.4	70.5	79.5	90.9
WE	DNS*	DNS*	DNS*	79.0	75.8	69.2	64.0	68.4	80.2	88.7	80.7	75.6	80.2	62.7	69.1	85.6	91.0
TR	DNS*	DNS*	DNS*	56.1	72.2	70.9	70.3	56.2	80.5	85.2	79.8	74.8	85.7	60.3	65.2	81.7	87.9

DNS*= Did Not Sample Particulate Carbon
NS* = No Sample for Particulate Carbon on this date

Table 7-3. Ratio of VSS to TSS, Yurok Reservation 2011

Site	2/16/2011	3/16/2011	4/13/2011	5/10/2011	5/25/2011	6/8/2011	6/22/2011	7/6/2011	7/20/2011	8/10/2011	8/24/2011	9/7/2011	9/21/2011	10/5/2011	10/19/2011	11/16/2011	12/14/2011
LES	13.5	5.5	12.7	7.2	12.7	17.2	18.8	12.5	33.3	33.3	55.6	42.9	43.8	29.2	26.7	35.7	0.0
TG	10.4	8.4	8.1	5.7	6.7	13.5	15.3	13.6	0.0	11.0	46.2	54.2	45.8	29.2	36.8	50.0	71.4
TC	8.7	8.4	8.3	9.6	9.6	21.1	20.8	15.4	30.4	0.0	33.3	42.9	39.1	25.5	43.5	38.1	43.8
WE	17.7	9.4	9.2	17.1	17.2	11.4	21.5	22.6	35.3	0.0	30.8	50.0	41.4	24.7	39.3	30.0	0.0
TR	5.2	6.1	7.9	5.7	15.6	0.0	15.6	25.9	0.0	0.0	0*	0.0	0.0	25.5	0.0	72.7	62.5

0*= No Detect for both parameters

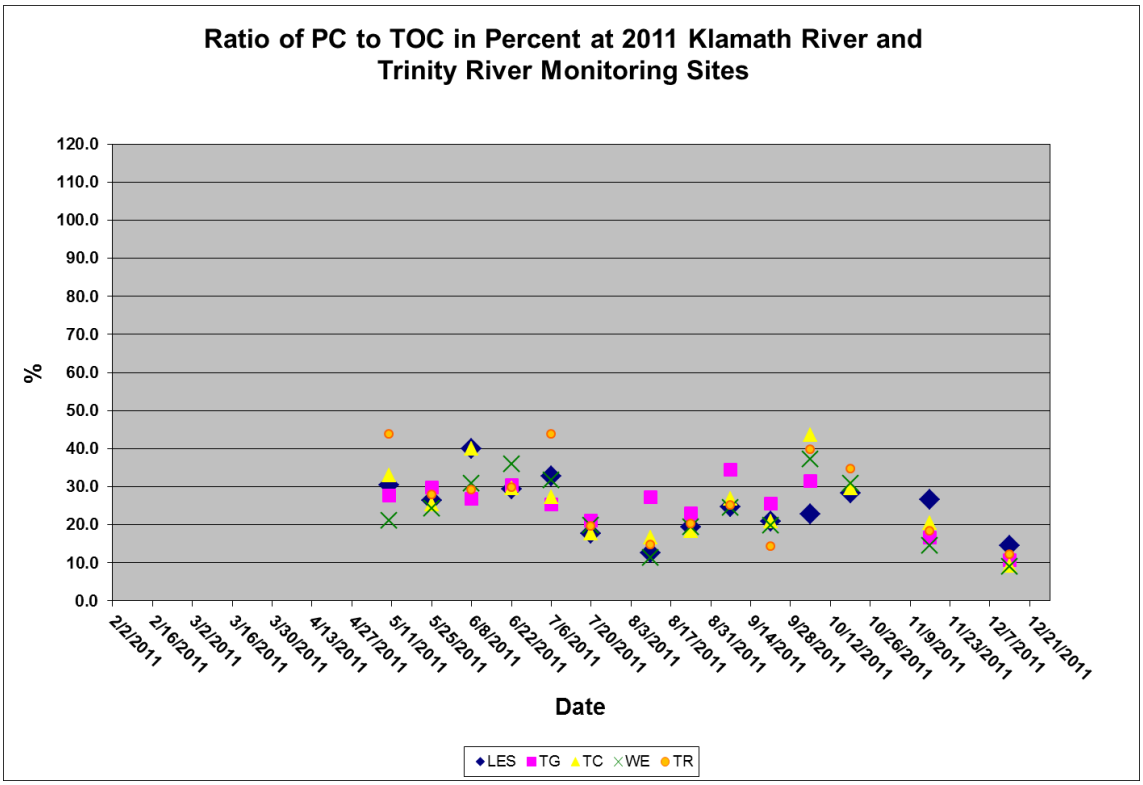

Figure 7-1. Ratio of PC to TOC 2011

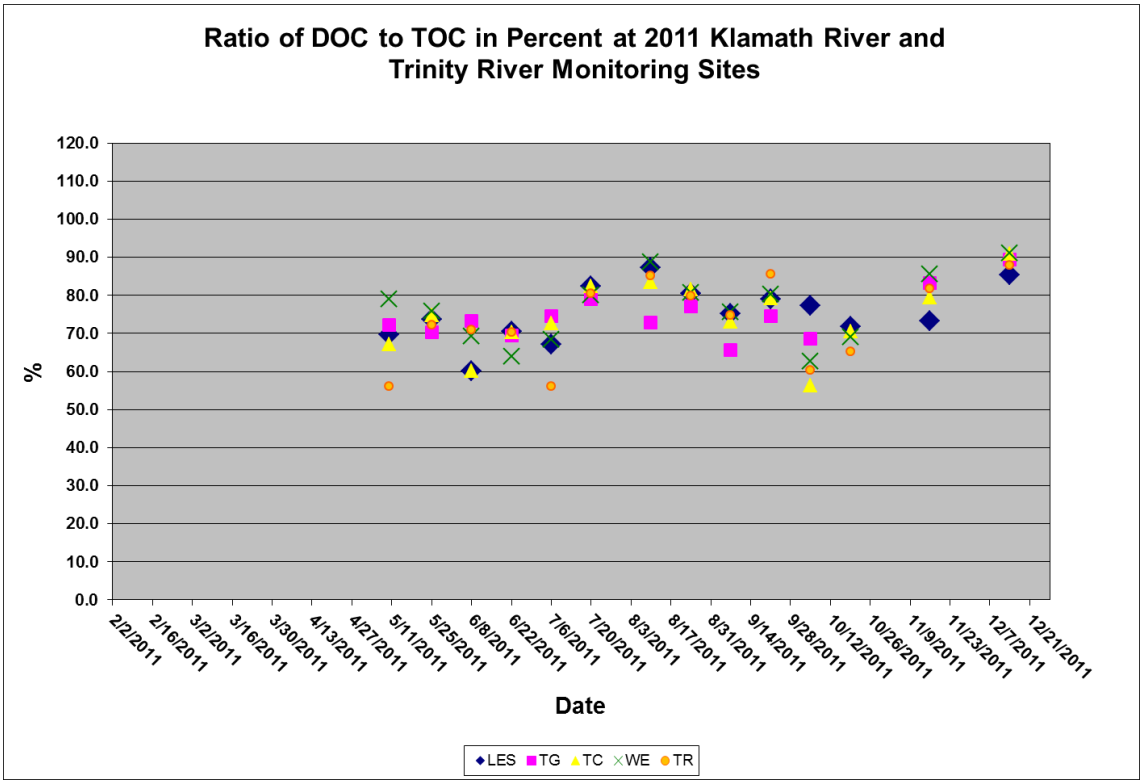

Figure 7-2. Ratio of DOC to TOC 2011

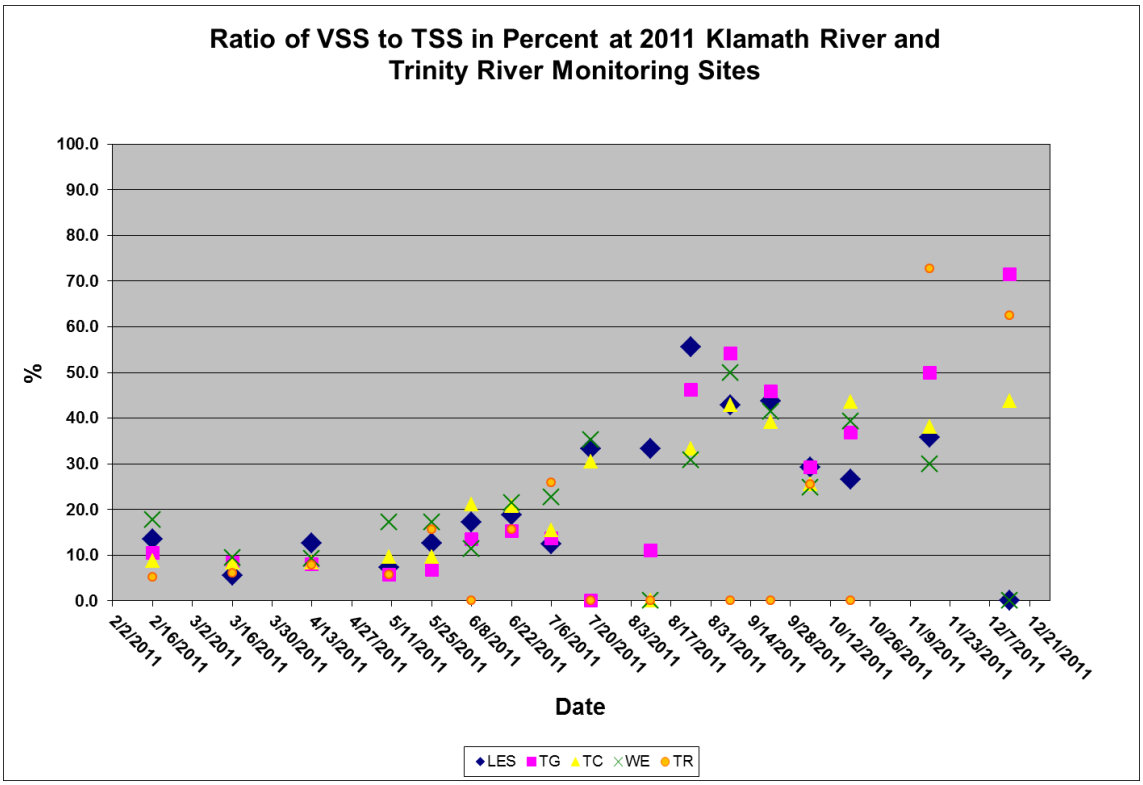

Figure 7-3. Ratio of VSS to TSS 2011

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.

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 2011 rain events occurred throughout May and June (Figure 6-21 and 6-22). As can be seen in Figures 6-1 through 6-12, concentrations of many parameters increased during the rain events on February 16, March 16 and October 5, 2011. The October 5 event, which was the first rain event of the wet season,

seems to have acted as a flushing event as parameters increased that did not respond during rain events at other times during the year.

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 are 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, except nitrate plus nitrite, 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 2011. 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 7-3, red line in Figure 6-5). As can be seen in Table 7-1 and Figure 6-5, total nitrogen concentrations exceeded 0.200 mg/L during the rain events in mid-February and mid-March. In mid-April all sites except WE dropped below the standard and remained below through late May. WE remained above the threshold in mid-April, dropping below 0.200 mg/L in early May and late May. In early June all sites rose above the standard, then dropped below again in late June. All sites continued to remain below 0.200 mg/L in early July and late July. WE exceeded the standard in early August and continued to stay above this level until mid-December. LES and TG exceed the standard in early August, all sites except TR exceeded from early September to early October, LES and TC exceeded in late October, TC exceeded in mid-November and all sites except TR exceeded the standard in mid-December. TR remained below the standard except during the rain events in mid-February, mid-March and early June.

Total Phosphorous

The Hoopa Valley Tribal EPA has set the proposed standard for total phosphorous at 0.035 mg/L (Table 7-3, 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 2011 sampling year. All sites exceeded standard during the sampling events in mid-February and mid-March, which occurred during rain events (Figure 6-21). All sites also exceed the threshold in mid-April and early May, except for WE, which did not surpass 0.035 mg/L in early May. All sites then dropped below the standard in late May and remained low through late July. In early August WE surpassed 0.035 mg/L and remained above throughout the rest of the sampling year. All other sites remained below the standard until early September, when TC rose above 0.035 mg/L, while LES and TG exceeded the threshold in late September. These three sites remained above the standard through mid-November. In mid-December LES and TG dropped below the threshold, while TC remained above 0.035 mg/L. In late May TR dropped below the standard and remained below for the rest of the sampling year.

Table 7-4. 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.

Works Cited

Kroeber, A.L. *Handbook of the Indians of California*. Bureau of American Ethnology, Smithsonian Institute. 1925

Lindenberg, M.K., Hoilman, Gene, and Wood, T.M., 2009, *Water Quality Conditions in Upper Klamath and Agency Lakes, Oregon, 2006*. U.S. Geological Survey Scientific Investigations Report 2008-5201, 54 p.

Mueller, David K., and Spahr, Norman E., 2006, *Nutrients in Streams and Rivers Across the Nation—1992–2001*. U.S. Geological Survey Scientific Investigations Report 2006–5107, 44 p.

Norton, Ken, Pliny McCovey Jr., Curtis Miller, Louisa McConnell, Mike Orcutt, Nolan Colgegrove, Mark Higley. *Water Quality Control Plan: Hoopa Valley Indian Reservation*. 2008

Sprague, L.A., Mueller, D.K., Schwarz, G.E., and Lorenz, D.L., 2009, *Nutrient Trends in Streams and Rivers of the United States, 1993–200.*U.S. Geological Survey Scientific Investigations Report 2008–5202, 196 p.

Appendix A

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.

Bibliography

Bel-Art Products. Churn Sample Splitter Instructions, 37805 Series. Pequannock, NJ, 1993.

Eaton, Andrew D., Lenore S. Clesceri, and Arnold E. Greenberg., ed. Standard Methods for the Examination of Water and Wastewater. 19th Edition. Washington D.C., 1995.

Lurry,D.L. and C.M. Kolbe. Interagency field manual for the collection of Water Quality Data. USGS Publication, Open File Report 00-213.

Appendix B

SOP for Particulate Carbon Filtration

1. Get out vacuum pump and flask (should be connected by tubing). Plug in pump.
2. Make sure stopper is placed in opening at top of flask.
3. Lay out sample bottles by site.
4. Get out Whirl-Pak bags, sharpie, sticky labels, and scissors.
5. Get out basin to collect waste water in, can also use sink as basin.
6. Get out waste HCl bottle and funnel to collect waste HCl in.
7. Put on latex gloves and splash apron.
8. Get out squirt bottles with dilute Liquinox, 10% HCl solution, and deionized water and graduated cylinder. Place next to basin/sink.
9. On a separate surface, lay down large sheet of aluminum foil to place filter holder, forceps, etc on.
10. Get out container holding 25 mm filters, place on aluminum foil square.
11. Tear off another, smaller piece of aluminum foil.
12. Using scissors cut out a 3 in. by 3 in. square of aluminum foil from sheet in Step 11.
13. With the dull side up, and without touching the center of the square, fold aluminum foil in half.
14. Fold over the sides that are perpendicular to the side that now has the crease. Fold twice on both sides. You should now have a small pouch that is open at one end.
15. Place pouch on large aluminum foil square.
16. Remove filter holder/funnel from box.
17. Rotate funnel counter-clockwise to disengage funnel from filter holder, being careful not to drop the plastic disc that sits at the top of the filter holder. Place near basin/sink.
18. Remove graduated cylinder from bubble wrap. Place near basin/sink.
19. Remove forceps from bag. Place near basin/sink.
20. Clean filter funnel, filter holder, graduated cylinder, and forceps by squirting with dilute Liquinox, then distilled water, followed by 10% HCl soluting, then dionized water.
21. Place filter funnel, filter holder, graduated cylinder and forceps on large aluminum foil square after they have been cleaned.
22. Using forceps, place one filter on filter holder, concave side up. If the filter is dropped while placing it on the holder, discard and select another filter
23. Being careful to keep filter centered on filter holder, put funnel and filter back together, twist clockwise to lock back into place.
24. Insert base of funnel into hole in stopper until base of filter holder presses against stopper.
25. Select sample bottle from one site and gently swirl to suspend particles.

26. Pour half of the sample into graduated cylinder, swirl again, pour half of remaining sample into graduated cylinder, swirl again, pour remaining sample into graduated cylinder. Tap the bottom of the sample bottle to get remaining drops.
27. Record the volume of sample that poured into the graduated cylinder on the data sheet.
28. Gently swirl the graduated cylinder to keep particles suspended, pour half of sample into filter funnel, swirl, pour half of remaining sample into filter funnel, swirl again, pour rest of sample into filter funnel.
29. While gently holding the filter funnel/holder tightly against the stopper, turn on vacuum pump.
30. Once all of the liquid has been pulled through the filter, allow the pump to keep running in order to slightly dry out filter.
31. Turn off vacuum pump.
32. If filter is light brown/tan color, proceed to Step 33. If not, return to Step 22 and follow procedure to filter another sample bottle.
33. Remove filter funnel/holder from stopper. Remove slowly to slowly release pressure.
34. Rotate funnel counter-clockwise to disengage funnel from filter holder.
35. Place filter funnel on large aluminum foil square.
36. Using forceps with pointed ends, loosen filter by gently putting one side of forceps under edge of the filter and running the forceps around circumference of filter.
37. Use forceps to fold filter in half, with the suspended material on the inside. Be careful not to remove material with the forceps. This works best with two people. One person carefully folds the filter in half with the pointed forceps. Once the filter is folded in half, the other person gently presses down the filter at the crease with the flat pair of forceps. The second person then pinches the filter together to keep the part with the suspended material on the inside. The first person then lets go.
38. Place filter in aluminum foil pouch.
39. We need two filters per site so repeat Steps 22-37 to get another filter.
40. Label filter pouch with Site ID, Date, and volume filtered per pad using labels.
41. Place aluminum foil pouch in Whirl-Pak bag and seal bag.
42. Place Whirl-Pak bag with filter in freezer.
43. Clean filter funnel and graduated cylinder by squirting with dilute Liquinox, making sure Liquinox is draining into waste basin.
44. Thoroughly rinse with distilled water, allowing water to drain into waste basin.
45. Wash filter funnel with 10% HCl solution, collecting waste into waste HCl bottle.
46. Thoroughly rinse filter funnel and holder with deionized water, collecting waste into waste HCl bottle.
47. Repeat Steps 22-46 for every site that was sampled for Particulate Carbon.
48. Once all sites have been sampled, place all of the Whirl-Pak bags into a ziplock bag.
49. If this is occurring on Wednesday or later in the week, store samples in freezer so they can be mailed at a later date.

50. If the samples will be sent off that day, fill small cooler with double-bagged ice and place the samples on top of the ice. Do not place ice on top of the samples.
51. Place a copy of the datasheet and COC in cooler, tape shut, and ship overnight to:

    Carl Zimmermann or Jerry Frank
    Chesapeake Biological Laboratory
    1 Williams Street
    Solomons, MD 20688

NOTES:
Bring the amber glass bottles back to the lab to be cleaned for the next sampling event.