Final
2014 Klamath River Nutrient Summary Report

Yurok Tribe Environmental Program:
Water Division

July 2014

Prepared by: Matthew Hanington
and Rowyn Cooper-Carouseli

Acknowledgements

The Yurok Tribe Environmental Program (YTEP) would like to thank those that contributed to the data collection efforts that occurred during the 2014 monitoring season. AmeriCorps Watershed Stewards Project Members Kristin Braun and Sarah Stawasz 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.

Table of Contents

Table of Figures

Table of Tables

I. **Introduction**

This report summarizes the presence and concentration of commonly occurring nutrients and associated analytes on the Klamath and Trinity Rivers during the 2014 sampling season. The Yurok Tribe Environmental Program (YTEP) collected monthly water samples at several monitoring sites from Weitchpec to the Klamath River Estuary in mid-February through 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 and Trinity Rivers 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.

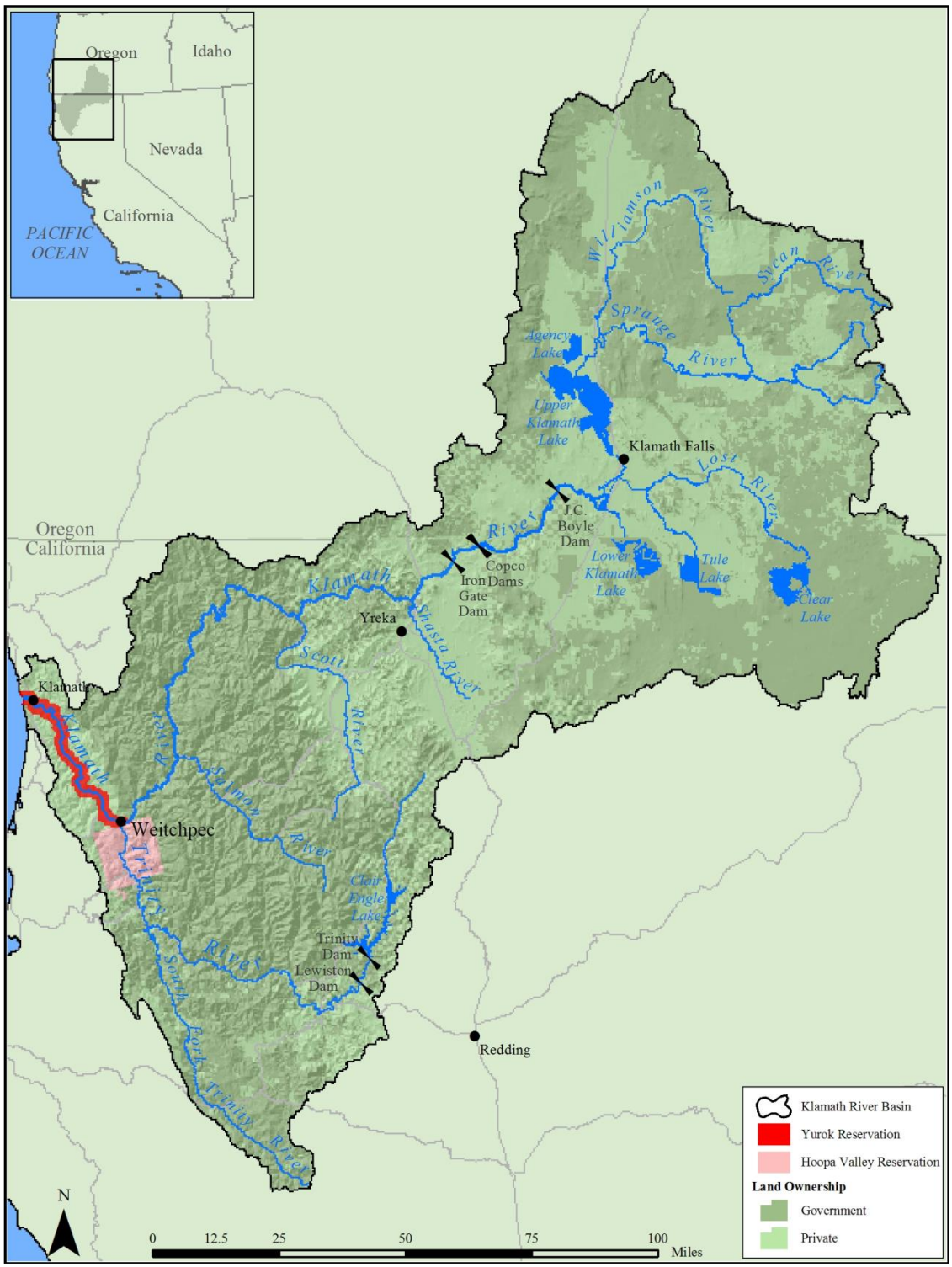


Figure 2-1. Klamath River Basin Map

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 North Coast Regional Water Quality Control Board (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.

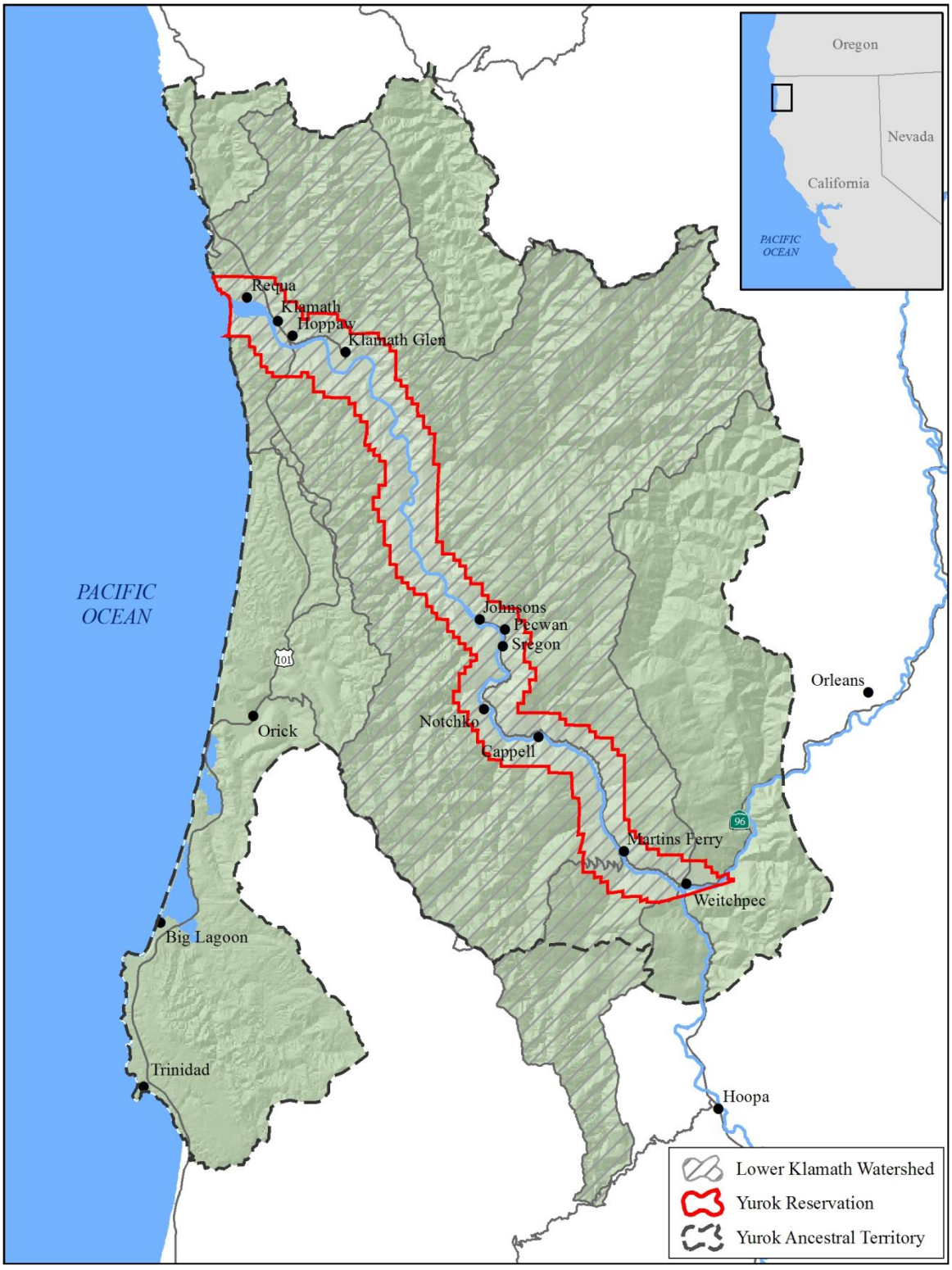


Figure 2-2. Yurok Indian Reservation and Yurok Ancestral Territory Map

III. Methods

The Yurok Tribe Environmental Program (YTEP) collected water samples at several monitoring sites from Weitchpec to the Klamath River Estuary monthly from February to 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 2014 season in an effort to maintain consistency in laboratory methods. All samples except particulate carbon and particulate nitrogen were delivered to Aquatic Research Inc. in Seattle, WA. Particulate carbon and nitrogen 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. The particulate carbon and nitrogen analyses required water samples to be filtered once the crew returned from the field. Once the samples were filtered the filters were frozen in tin foil wrapped in Whirl Pack bags and later shipped overnight to the lab for analysis.

Table 3- 1. Parameters sampled on the Klamath River during 2014

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 and Nitrogen

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 one May, and 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 samples collected 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 conductivity, 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)

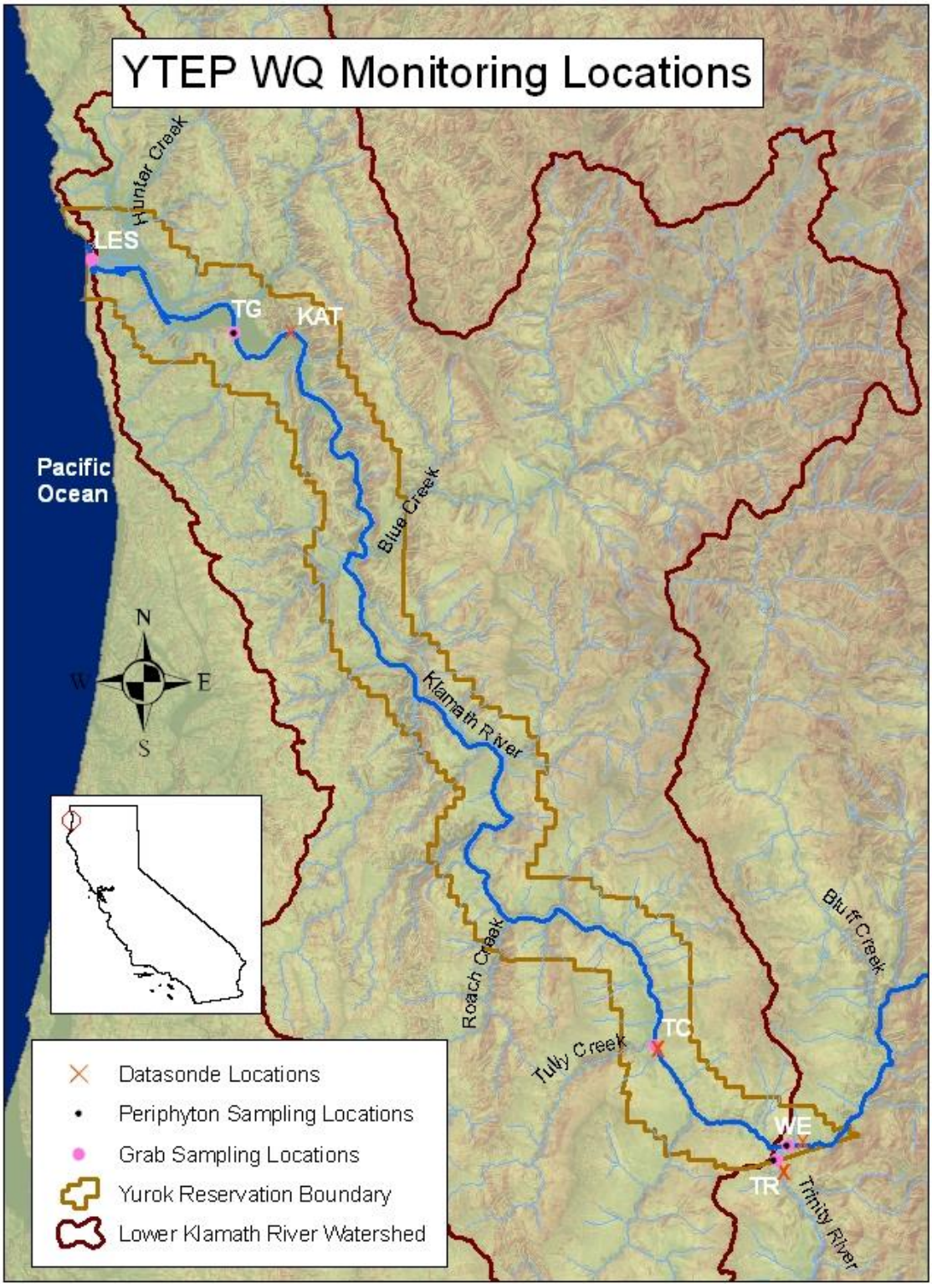


Figure 4-1. Nutrient "Grab" Sampling Sites for 2014 (as indicated by the pink dots)

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)* and was subsequently revised with minor changes and approved by USEPA in May of 2014. 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. A relative percent difference (RPD) of the initial and duplicate samples was 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 2014 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 2014 sampling season indicate that there is no significant issue with contamination of samples in the field or laboratory. Equipment blank samples were prepared in 2014 by rinsing the churn according to the cleaning protocol, pouring distilled water into the churn, and then filling the containers provided by the laboratory following the stirring protocol. As with true duplicates, blanks were sent with a different ID code so as not to alert lab staff that the samples were blanks.

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 is 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

Table 6-1. Nutrient Results, Yurok Reservation 2014

Total Phosphorous
mg/L; Report Limit: 0.002

Site	2/19/2014	3/19/2014	4/16/2014	5/7/2014	5/21/2014	6/11/2014	6/25/2014	7/9/2014	7/23/2014	8/6/2014	8/20/2014	9/10/2014	9/24/2014	10/8/2014	10/22/2014	11/19/2014	12/17/2014
LES	0.045	0.032	0.031	0.015	0.016	0.017	0.024	0.024	0.027	0.064	0.058	0.070	0.052	0.070	0.061	0.039	0.041
TG	0.029	0.026	0.077	0.018	0.017	0.026	0.021	0.023	0.024	0.064	0.071	0.067	0.057	0.077	0.059	0.030	0.043
TC	0.025	0.025	0.020	0.019	0.025	0.020	0.039	0.034	0.044	0.093	0.092	0.086	0.085	0.101	0.059	0.032	0.027
WE	0.031	0.032	0.025	0.026	0.035	0.044	0.052	0.049	0.057	0.128	0.126	0.145	0.128	0.132	0.077	0.053	0.034
TR	0.016	0.012	0.009	0.008	0.008	0.006	0.004	0.003	0.003	0.005	0.004	0.006	0.010	0.005	0.005	0.004	0.019

Soluble Reactive Phosphorous
mg/L; Report Limit: 0.001

Site	2/19/2014	3/19/2014	4/16/2014	5/7/2014	5/21/2014	6/11/2014	6/25/2014	7/9/2014	7/23/2014	8/6/2014	8/20/2014	9/10/2014	9/24/2014	10/8/2014	10/22/2014	11/19/2014	12/17/2014
LES	0.013	0.015	0.008	0.005	0.004	0.016	0.022	0.021	0.023	0.034	0.045	0.050	0.044	0.058	0.046	0.028	0.014
TG	0.013	0.015	0.007	0.005	0.004	0.012	0.015	0.018	0.020	0.032	0.044	0.039	0.046	0.063	0.035	0.021	0.017
TC	0.013	0.015	0.008	0.007	0.010	0.020	0.035	0.032	0.043	0.060	0.066	0.064	0.068	0.083	0.043	0.030	0.014
WE	0.015	0.019	0.011	0.012	0.019	0.029	0.048	0.045	0.057	0.085	0.090	0.094	0.107	0.111	0.060	0.040	0.020
TR	0.007	0.006	0.003	0.0005	0.002	0.003	0.003	0.0030	0.0005	0.0020	0.001	0.002	0.003	0.0005	0.0005	0.0030	0.0040

Ammonia Nitrogen
mg/L; Report Limit: 0.010

Site	2/19/2014	3/19/2014	4/16/2014	5/7/2014	5/21/2014	6/11/2014	6/25/2014	7/9/2014	7/23/2014	8/6/2014	8/20/2014	9/10/2014	9/24/2014	10/8/2014	10/22/2014	11/19/2014	12/17/2014
LES	0.01	0.005	0.01	0.005	0.005	0.015	0.011	0.005	0.017	0.005	0.017	0.02	0.033	0.018	0.041	0.029	0.012
TG	0.005	0.005	0.005	0.005	0.005	0.005	0.014	0.005	0.011	0.005	0.005	0.005	0.021	0.005	0.005	0.005	0.005
TC	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.016	0.005	0.005	0.005	0.005
WE	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.01	0.005	0.005	0.005	0.019	0.010	0.005	0.005	0.005
TR	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005

Nitrate +Nitrite
mg/L; Report Limit: 0.010

Site	2/19/2014	3/19/2014	4/16/2014	5/7/2014	5/21/2014	6/11/2014	6/25/2014	7/9/2014	7/23/2014	8/6/2014	8/20/2014	9/10/2014	9/24/2014	10/8/2014	10/22/2014	11/19/2014	12/17/2014
LES	0.216	0.110	0.034	0.022	0.005	0.045	0.019	0.017	0.030	0.005	0.015	0.010	0.094	0.014	0.114	0.126	0.127
TG	0.126	0.106	0.037	0.047	0.031	0.080	0.104	0.067	0.067	0.014	0.005	0.041	0.086	0.015	0.117	0.147	0.125
TC	0.08	0.080	0.014	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.011	0.005	0.044	0.074	0.063	0.071	0.105
WE	0.079	0.096	0.015	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.043	0.098	0.078	0.092	0.121
TR	0.041	0.040	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.015	0.031	0.005	0.005	0.005	0.073

Total Nitrogen
mg/L; Report Limit 0.050

Site	2/19/2014	3/19/2014	4/16/2014	5/7/2014	5/21/2014	6/11/2014	6/25/2014	7/9/2014	7/23/2014	8/6/2014	8/20/2014	9/10/2014	9/24/2014	10/8/2014	10/22/2014	11/19/2014	12/17/2014
LES	0.309	0.215	0.223	0.141	0.080	0.333	0.025	0.235	0.204	0.429	0.342	0.350	0.263	0.576	0.359	0.401	0.292
TG	0.23	0.193	0.286	0.194	0.154	0.188	0.122	0.219	0.193	0.429	0.300	0.334	0.261	0.307	0.337	0.371	0.318
TC	0.22	0.169	0.144	0.090	0.104	0.175	0.025	0.220	0.178	0.423	0.358	0.333	0.414	0.332	0.234	0.222	0.344
WE	0.179	0.240	0.196	0.169	0.134	0.214	0.025	0.263	0.263	0.515	0.439	0.553	0.460	0.679	0.283	0.333	0.352
TR	0.178	0.085	0.146	0.091	0.075	0.071	0.025	0.148	0.085	0.088	0.096	0.131	0.094	0.025	0.060	0.104	0.096

Table 6-2. Other Analytes Results, Yurok Reservation 2014

Chlorophyll a
µg/L; Report Limit: 0.1

Site	2/19/2014	3/19/2014	4/16/2014	5/7/2014	5/21/2014	6/11/2014	6/25/2014	7/9/2014	7/23/2014	8/6/2014	8/20/2014	9/10/2014	9/24/2014	10/8/2014	10/22/2014	11/19/2014	12/17/2014
LES	2.1	1.1	1.9	1.9	0.8	1.3	1.1	0.9	0.5	11.0	3.7	1.3	0.6	0.5	1.1	0.7	1.6
TG	2.1	0.5	6.1	1.3	1.6	0.5	1.9	0.5	0.05	9.1	8.0	5.1	1.5	6.7	5.6	1.4	2.1
TC	1.1	0.5	2.4	1.3	1.6	1.6	1.6	1.1	2.1	11.0	6.9	2.1	2.7	2.1	3.7	1.4	2.0
WE	2.1	0.3	1.2	2.1	1.9	1.9	1.6	0.5	2.1	11.0	9.10	2.7	3.3	2.9	4.0	1.6	1.5
TR	2.1	0.3	0.7	1.10	1.9	1.3	0.8	1.6	0.05	0.05	0.3	1.1	0.9	0.5	2.0	1.0	2.1

Pheophytin a
µg/L; Report Limit: 0.1

Site	2/19/2014	3/19/2014	4/16/2014	5/7/2014	5/21/2014	6/11/2014	6/25/2014	7/9/2014	7/23/2014	8/6/2014	8/20/2014	9/10/2014	9/24/2014	10/8/2014	10/22/2014	11/19/2014	12/17/2014
LES	2.7	1.2	1.9	0.7	1.8	0.3	0.2	0.9	1.7	2.6	1.9	1.8	1.5	1.3	2.3	1.4	1.0
TG	1.2	1.7	4.1	1.3	1.9	1.1	0.9	1.9	3.4	4.4	1.7	4.6	1.4	2.9	6.2	1.7	0.6
TC	2.3	1.5	1.1	1.7	1.4	0.60	0.8	1.2	0.9	3.90	1.70	1.4	1.9	2.7	1.3	0.6	0.05
WE	0.9	2.0	1.6	1.4	1.10	0.7	0.8	1.0	1.6	1.40	1.8	2.0	2.1	3.0	2.5	1.0	0.05
TR	0.5	1	1.8	0.8	0.4	0.20	0.05	0.6	1.1	0.7	0.5	0.3	0.4	0.3	0.05	0.05	0.40

Alkalinity
mg/L CaCO3; Report Limit: 1.0

Site	2/19/2014	3/19/2014	4/16/2014	5/7/2014	5/21/2014	6/11/2014	6/25/2014	7/9/2014	7/23/2014	8/6/2014	8/20/2014	9/10/2014	9/24/2014	10/8/2014	10/22/2014	11/19/2014	12/17/2014
LES	DNS	DNS	DNS	DNS	61.8	DNS	73.2	DNS	76.6	DNS	79.6	DNS	DNS	DNS	78.6	DNS	DNS
TG	DNS	DNS	DNS	DNS	66.5	DNS	78.6	DNS	76.0	DNS	79.4	DNS	DNS	DNS	85.2	DNS	DNS
TC	DNS	DNS	DNS	DNS	65.3	DNS	74.0	DNS	71.8	DNS	77.2	DNS	DNS	DNS	81.2	DNS	DNS
WE	DNS	DNS	DNS	DNS	66.4	DNS	75.2	DNS	74.8	DNS	79.6	DNS	DNS	DNS	81.2	DNS	DNS
TR	DNS	DNS	DNS	DNS	65.0	DNS	71.4	DNS	65.8	DNS	70.8	DNS	DNS	DNS	81.2	DNS	DNS

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

Site	2/19/2014	3/19/2014	4/16/2014	5/7/2014	5/21/2014	6/11/2014	6/25/2014	7/9/2014	7/23/2014	8/6/2014	8/20/2014	9/10/2014	9/24/2014	10/8/2014	10/22/2014	11/19/2014	12/17/2014
LES	1.45	1.030	0.924	1.24	1.47	1.48	1.46	1.71	0.97	1.66	2.45	2.62	2.11	2.49	2.38	1.660	1.69
TG	1.67	1.040	0.830	1.10	1.25	1.37	1.21	1.58	0.89	1.57	2.54	2.49	2.15	2.45	2.06	1.360	1.47
TC	2.61	1.180	1.150	1.35	1.54	1.46	1.82	1.81	1.38	2.02	2.97	3.02	2.91	3.14	2.56	1.830	1.80
WE	2.13	1.280	1.450	1.74	1.83	2.12	2.16	2.02	1.81	2.63	3.61	4.46	3.83	3.63	2.91	2.060	2.00
TR	3.63	0.813	0.882	1.070	1.11	0.998	0.970	1.040	0.715	0.726	1.490	1.250	1.68	0.875	1.186	1.110	1.620

Particulate Carbon (PC)
mg C/L

Site	2/19/2014	3/19/2014	4/16/2014	5/7/2014	5/21/2014	6/11/2014	6/25/2014	7/9/2014	7/23/2014	8/6/2014	8/20/2014	9/10/2014	9/24/2014	10/8/2014	10/22/2014	11/19/2014	12/17/2014
LES	0.858	0.3570	0.0370	0.2400	0.2440	0.2960	0.2960	0.275	0.324	1.420	0.9460	0.3260	0.3330	0.3100	0.6920	0.316	0.4500
TG	0.5900	0.1890	0.1790	0.3130	0.2900	0.2040	0.2940	1.340	0.361	1.680	1.3400	1.3200	0.8700	0.3940	0.6740	0.370	0.2880
TC	0.6030	0.2540	0.0267	0.2960	0.4420	0.3320	0.3410	0.227	0.362	1.860	1.3700	0.4870	0.5980	0.7930	0.6660	0.508	0.7920
WE	0.5660	0.1350	0.1660	0.3020	0.4040	0.4060	0.3340	2.750	0.490	2.400	1.5200	0.6860	1.4600	0.8610	0.5970	0.334	0.2320
TR	0.2820	0.2940	0.0323	0.1710	0.2580	0.1780	0.1380	0.147	0.226	0.129	0.2100	0.1920	0.2910	0.1510	0.3260	0.120	0.3620

DNS= Did Not Sample

Table 6-3. Other Analytes Results (contd), Yurok Reservation 2014

Particulate Nitrogen (PN) mg N/L	Site	2/19/2014	3/19/2014	4/16/2014	5/7/2014	5/21/2014	6/11/2014	6/25/2014	7/9/2014	7/23/2014	8/6/2014	8/20/2014	9/10/2014	9/24/2014	10/8/2014	10/22/2014	11/19/2014	12/17/2014
	LES	DNS	DNS	0.401	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	0.031	DNS
	TG	0.0391	0.0107	0.2500	0.0328	0.0372	0.0366	0.0450	0.1840	0.0490	0.2420	0.1800	0.208	0.0627	0.0504	0.0878	0.0215	0.0609
	TC	DNS	DNS	0.254	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	0.053	DNS
	WE	DNS	DNS	0.194	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	0.038	DNS
	TR	DNS	DNS	0.304	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	0.011	DNS

Particulate Phosphorus (PP) mg N/L	Site	2/19/2014	3/19/2014	4/16/2014	5/7/2014	5/21/2014	6/11/2014	6/25/2014	7/9/2014	7/23/2014	8/6/2014	8/21/2014	9/10/2014	9/24/2014	10/8/2014	10/22/2014	11/19/2014	12/17/2014
	LES	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS
	TG	0.012	0.0038	0.0389	0.0094	0.0086	0.0071	0.0081	0.0339	0.0085	0.2330	0.0201	0.0165	0.0096	0.0085	0.0145	0.0038	0.0190
	TC	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS
	WE	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS
	TR	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS

Particulate Inorganic Phosphorus (PIP) mg N/L	Site	2/19/2014	3/19/2014	4/16/2014	5/7/2014	5/21/2014	6/11/2014	6/25/2014	7/9/2014	7/23/2014	8/6/2014	8/21/2014	9/10/2014	9/24/2014	10/8/2014	10/22/2014	11/19/2014	12/17/2014
	LES	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS
	TG	0.009	0.0021	0.0366	0.0033	0.0021	0.0024	0.0021	0.0175	0.0020	0.0102	0.0094	0.0083	0.0024	0.0024	0.0075	0.0024	0.0120
	TC	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS
	WE	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS
	TR	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS

Total Organic Carbon (TOC) Add PC and DOC	Site	2/19/2014	3/19/2014	4/16/2014	5/7/2014	5/21/2014	6/11/2014	6/25/2014	7/9/2014	7/23/2014	8/6/2014	8/20/2014	9/10/2014	9/24/2014	10/8/2014	10/22/2014	11/19/2014	12/17/2014
	LES	2.308	1.39	0.96	1.48	1.71	1.78	2.06	1.99	1.29	3.08	3.40	2.95	2.44	2.80	3.08	1.98	2.14
	TG	2.260	1.229	1.009	1.413	1.540	1.574	1.507	2.900	1.255	3.250	3.880	3.81	3.02	2.84	2.73	1.73	1.76
	TC	3.213	1.434	1.177	1.646	1.982	1.792	2.161	2.037	1.742	3.880	4.340	3.51	3.51	3.93	3.22	2.34	2.59
	WE	2.696	1.415	1.616	2.042	2.234	2.524	2.494	4.770	2.300	5.030	5.130	5.15	5.29	4.50	3.51	2.39	2.23
	TR	3.912	1.107	0.914	1.241	1.368	1.256	1.108	1.187	0.941	0.855	1.700	1.44	1.97	1.03	1.51	1.23	1.98

DNS= Did Not Sample

Non-Filterable Residue (TSS) mg/L; Report Limit: 0.50	**Site**	2/19/2014	3/19/2014	4/16/2014	5/7/2014	5/21/2014	6/11/2014	6/25/2014	7/9/2014	7/23/2014	8/6/2014	8/20/2014	9/10/2014	9/24/2014	10/8/2014	10/22/2014	11/19/2014	12/17/2014
	LES	21	7.9	6.2	2	1.5	2.7	1.3	1.3	1.80	4.70	3.00	2.2	2.3	1.2	2.0	2.0	12.0
	TG	14	5.0	5.8	1.9	1.7	0.9	1.3	2.0	1.7	6.7	5.3	4.8	4.2	1.9	6.0	1.0	20.0
	TC	13	5.0	1.8	2.4	2.7	2.1	2.0	2.00	2.0	3.7	6.0	2.2	5.7	5.0	3.75	1	8.8
	WE	12	4.0	1.7	2.5	2.7	3.0	2.5	2.0	2.5	8.5	5.6	2.5	7.2	5.8	3.7	1	5.8
	TR	5.8	3.0	2.3	1.5	1.8	1.0	0.6	0.8	0.025	0.025	0.025	0.71	2.1	0.03	1.13	0.025	7.60

Volatile Suspended Solids (VSS) mg/L; Report Limit: 0.50	Site	2/19/2014	3/19/2014	4/16/2014	5/7/2014	5/21/2014	6/11/2014	6/25/2014	7/9/2014	7/23/2014	8/6/2014	8/20/2014	9/10/2014	9/24/2014	10/8/2014	10/22/2014	11/19/2014	12/17/2014
	LES	2.0	0.8	1.80	1.2	0.5	2.2	0.025	0.83	1.20	2.30	1.80	1.00	0.83	0.83	0.75	0.8	2.60
	TG	1.60	0.025	1.90	5.3	0.025	0.51	0.7	1.0	0.8	5.0	3.30	5.0	1.0	0.87	1.38	0.025	1.40
	TC	1.5	1.0	2.4	0.025	1.20	0.50	0.67	0.50	1.20	3.30	4.00	1.20	2.2	2.0	0.88	0.025	1.5
	WE	1.0	0.8	2.5	0.7	1.30	1.1	0.025	1.20	1.3	7.0	4.00	1.3	2.8	2.3	1.43	0.025	0.75
	TR	1.00	0.60	1.5	0.8	0.025	0.03	0.025	0.67	0.025	0.025	0.025	0.025	0.75	0.025	0.75	0.025	1.80

Turbidity NTU; Report Limit: 0.10	**Site**	2/19/2014	3/19/2014	4/16/2014	5/7/2014	5/21/2014	6/11/2014	6/25/2014	7/9/2014	7/23/2014	8/6/2014	8/20/2014	9/10/2014	9/24/2014	10/8/2014	10/22/2014	11/19/2014	12/17/2014
	LES	9.4	3.8	2.4	1.5	0.9	2.20	2.9	0.49	1.90	2.60	3.00	0.81	1.5	0.60	1.10	1.7	6.0
	TG	7.50	3.1	7.2	1.6	1.3	1.60	1.60	0.61	1.5	3.50	3.00	1.4	1.5	0.65	1.20	0.6	6.5
	TC	5.1	2.6	1.5	2.0	1.40	2.00	2.00	0.45	1.60	3.80	3.80	0.7	1.4	1.5	1.10	1.4	4.6
	WE	4.7	2.5	1.6	2.0	1.60	2.60	1.70	0.51	1.9	4.40	4.10	0.7	1.6	2.1	1.30	1.4	2.9
	TR	3.5	1.7	1.9	1.4	0.72	1.10	0.69	0.25	0.65	0.54	0.55	0.35	1.0	0.19	0.39	0.29	5.9

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.

Table 6-3. Discrete Datasonde Measurements, Yurok Reservation 2014

Temperature ºC	Site	2/19/2014	3/19/2014	4/16/2014	5/7/2014	5/21/2014	6/11/2014	6/25/2014	7/9/2014	7/23/2014	8/6/2014	8/20/2014	9/10/2014	9/24/2014	10/8/2014	10/22/2014	11/19/2014	12/17/2014
	LES	8.73	9.60	12.94	13.87	16.99	20.51	20.01	21.20	21.83	21.07	21.03	14.97	DNR	17.39	16.01	10.07	9.07
	TG	8.64	9.65	12.95	13.62	16.06	18.75	19.18	20.55	21.42	20.71	20.61	17.94	DNR	17.50	16.51	10.35	9.04
	TC	8.09	8.95	12.93	14.00	16.47	20.59	20.51	23.80	23.35	23.00	22.60	18.95	DNR	17.03	14.98	DNR	8.63
	WE	7.88	8.50	12.61	14.57	16.60	21.02	20.79	23.80	23.01	22.86	21.85	19.04	DNR	17.05	15.05	DNR	8.42
	TR	8.69	9.62	13.58	14.19	16.04	20.83	20.06	24.46	22.61	23.37	23.61	18.39	DNR	17.06	14.98	DNR	8.97

Dissolved Oxygen mg/L	Site	2/19/2014	3/19/2014	4/16/2014	5/7/2014	5/21/2014	6/11/2014	6/25/2014	7/9/2014	7/23/2014	8/6/2014	8/20/2014	9/10/2014	9/24/2014	10/8/2014	10/22/2014	11/19/2014	12/17/2014
	LES	11.51	10.81	10.10	9.60	9.04	7.93	8.49	7.96	7.42	7.16	7.36	8.99	DNR	9.34	8.74	10.86	11.25
	TG	11.41	10.86	10.10	9.56	9.10	8.12	6.90	7.07	6.65	6.95	7.01	7.75	DNR	8.62	7.95	9.91	11.27
	TC	11.96	11.45	10.57	10.17	9.70	8.88	8.68	8.26	7.92	8.35	8.37	9.02	DNR	9.41	9.84	DNR	11.65
	WE	12.15	11.67	10.84	10.27	9.94	9.16	8.94	9.09	8.62	9.52	9.01	9.78	DNR	9.45	10.02	DNR	11.75
	TR	11.65	11.24	10.55	10.49	9.96	8.98	9.19	8.70	8.61	8.74	8.54	9.65	DNR	10.09	10.11	DNR	11.52

Dissolved Oxygen %	Site	2/19/2014	3/19/2014	4/16/2014	5/7/2014	5/21/2014	6/11/2014	6/25/2014	7/9/2014	7/23/2014	8/6/2014	8/20/2014	9/10/2014	9/24/2014	10/8/2014	10/22/2014	11/19/2014	12/17/2014
	LES	99.00	94.9	95.7	92.9	93.5	88.6	92.9	91.1	86.0	81.9	83.5	105.0	DNR	97.7	88.7	98.5	97.5
	TG	97.9	95.5	95.8	92.0	92.0	87.2	74.8	78.6	75.2	77.5	78.2	81.7	DNR	90.1	79.7	88.8	97.6
	TC	101.2	99.0	100.1	98.7	99.3	98.8	96.5	97.8	93.0	97.4	96.8	97.1	DNR	97.5	97.6	DNR	100.0
	WE	102.3	99.8	102.0	101.2	102.1	102.9	99.9	107.7	100.6	110.6	102.8	105.6	DNR	97.9	99.5	DNR	100.3
	TR	100.0	98.7	101.4	102.3	101.0	100.5	101.2	104.3	99.7	102.6	100.7	102.8	DNR	104.6	100.5	DNR	99.6

Table 6-3 (contd.). Discrete Datasonde Measurements, Yurok Reservation 2014

Specific Conductivity µS/cm	Site	2/19/2014	3/19/2014	4/16/2014	5/7/2014	5/21/2014	6/11/2014	6/25/2014	7/9/2014	7/23/2014	8/6/2014	8/20/2014	9/10/2014	9/24/2014	10/8/2014	10/22/2014	11/19/2014	12/17/2014
	LES	117	139	136	139	172	162	2573	2752	5262	6041	4188	41436	DNR	999	629	691	11.5
	TG	105	131	138	137	143	160	168	168	171	170	171	160	DNR	183	177	167	138
	TC	111	136	138	135	137	152	161	167	165	165	166	151	DNR	177	170	DNR	146
	WE	107	132	133	132	143	163	164	171	171	170	171	168	DNR	183	171	DNR	138
	TR	127	150	151	137	129	135	149	155	150	147	149	123	DNR	153	169	DNR	161

pH	Site	2/19/2014	3/19/2014	4/16/2014	5/7/2014	5/21/2014	6/11/2014	6/25/2014	7/9/2014	7/23/2014	8/6/2014	8/20/2014	9/10/2014	9/24/2014	10/8/2014	10/22/2014	11/19/2014	12/17/2014
	LES	8.08	7.92	7.86	7.62	8.34	8.02	8.11	8.14	8.06	7.99	8.10	8.18	DNR	7.99	7.85	7.52	6.99
	TG	7.92	7.95	7.87	7.78	7.79	7.65	7.58	7.72	7.71	7.84	7.72	7.87	DNR	7.97	7.49	7.59	7.70
	TC	7.78	8.04	8	8.06	8.05	8.18	8.25	8.27	8.32	8.23	8.17	8.14	DNR	7.93	7.90	DNR	7.83
	WE	7.81	8.00	8.07	7.93	8.12	8	8.32	8.36	8.26	8.44	8.15	8.27	DNR	7.99	7.88	DNR	7.91
	TR	8.00	8.03	8.11	8.08	8.07	8.06	8.29	8.29	8.29	8.16	8.14	8.01	DNR	8.16	7.98	DNR	7.96

Blue-green Algae cells/mL	Site	2/19/2014	3/19/2014	4/16/2014	5/7/2014	5/21/2014	6/11/2014	6/25/2014	7/9/2014	7/23/2014	8/6/2014	8/20/2014	9/10/2014	9/24/2014	10/8/2014	10/22/2014	11/19/2014	12/17/2014
	LES	275	DNR	DNR	118	DNR	1000	1053	1165	1402.5	5025	3460	1550	DNR	1225	1290	987	DNR
	TG	317	DNR	DNR	198.5	-675	959.5	1275	1621.5	1410	6761.5	DNR	1985	DNR	1575	1600	1300.5	750
	TC	585	DNR	DNR	172	DNR	1000	1007.5	DNR	1584	8782.5	5500	1825	DNR	1775	1780	DNR	1117
	WE	496	DNR	DNR	1300	DNR	1522	1475	1036	1634.5	11801	6500	4500	DNR	1977.5	1767	DNR	950
	TR	DNR	DNR	DNR	2959	DNR	2140	847.5	467.5	613	820.00	2500	3500	DNR	DNR	DNR	DNR	1100

DNR= Did Not Record

Total Phosphorous

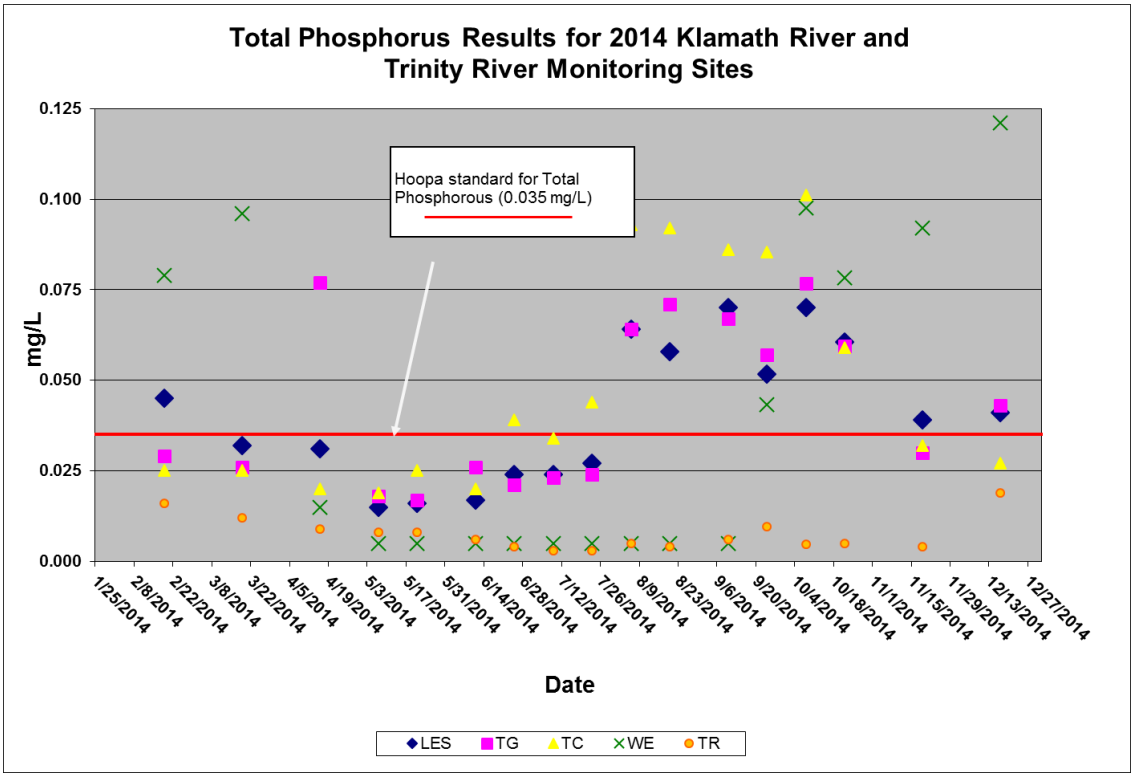


Figure 6-1. Total Phosphorus Results 2014

Soluble Reactive Phosphorous (SRP)

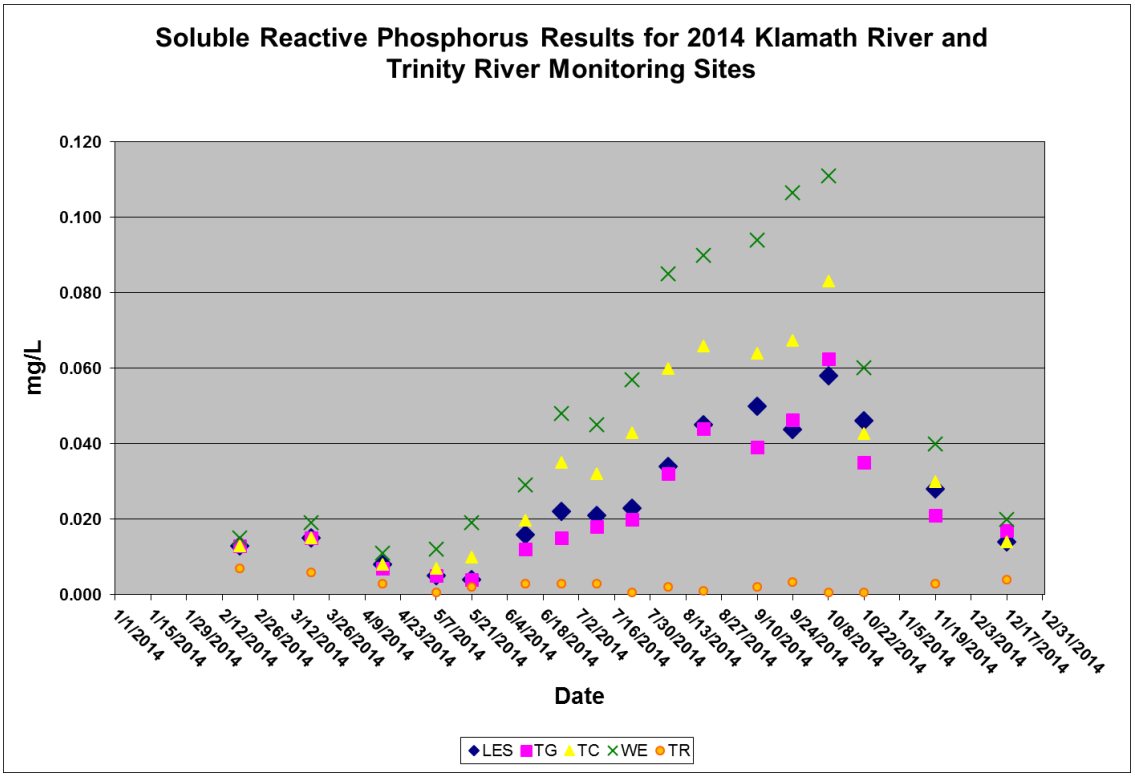


Figure 6-2. Soluble Reactive Phosphorus Results 2014

Ammonia

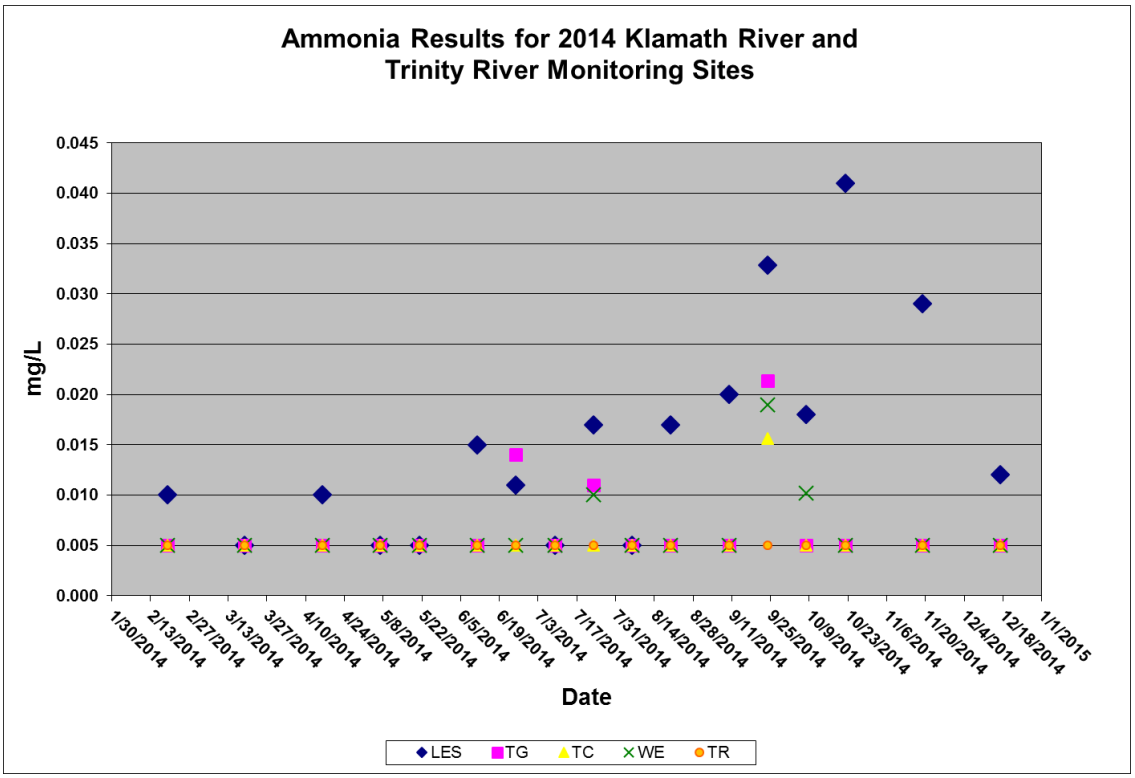


Figure 6-3. Ammonia Results 2014

Nitrite + Nitrate

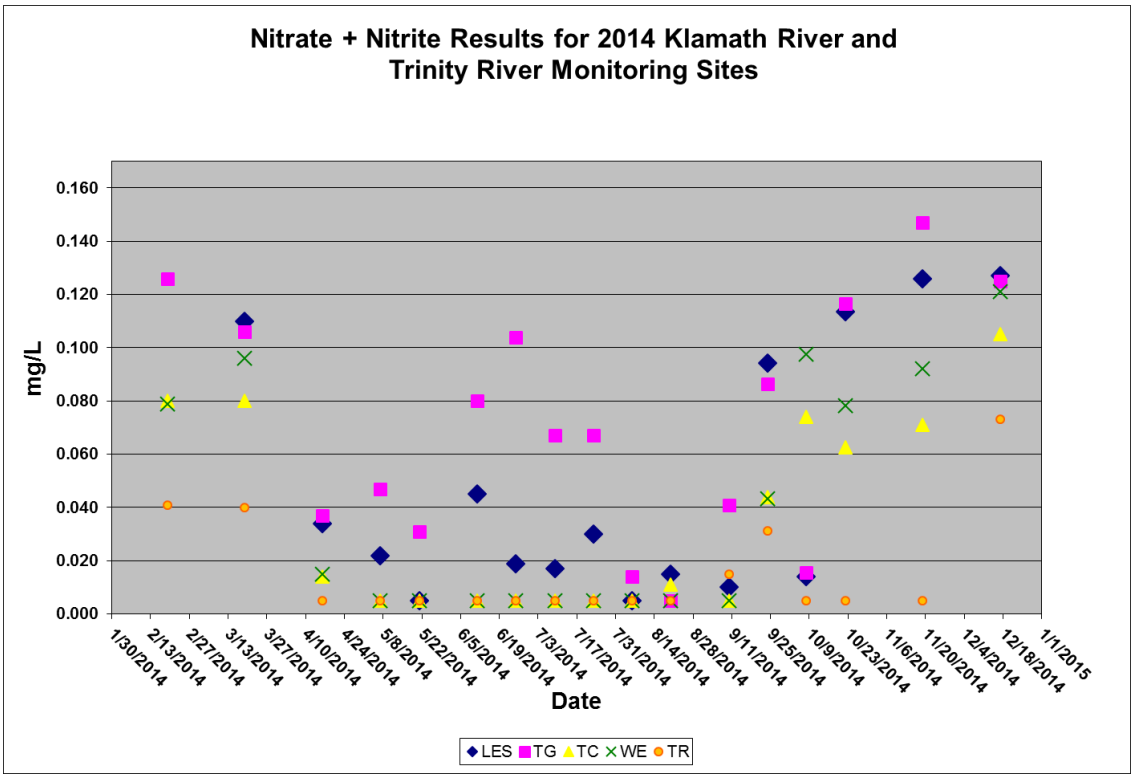


Figure 6-4. Nitrate + Nitrite Results 2014

Total Nitrogen

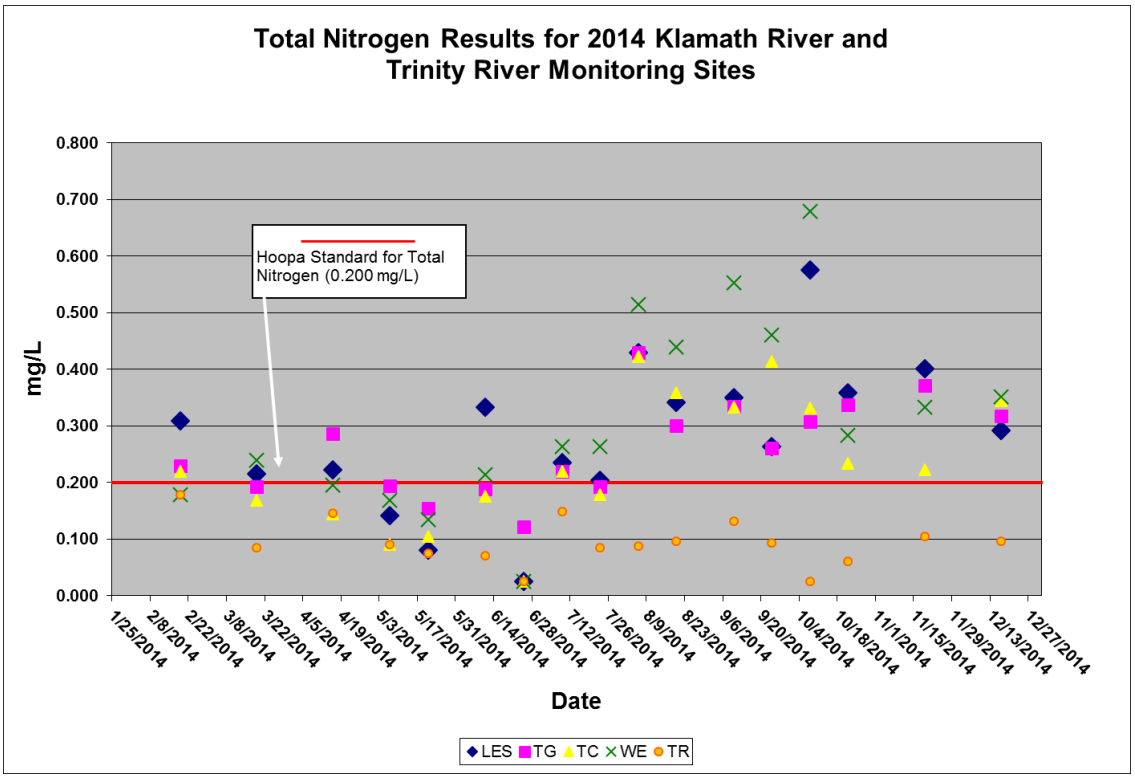


Figure 6-5. Total Nitrogen Results 2014

Chlorophyll-a

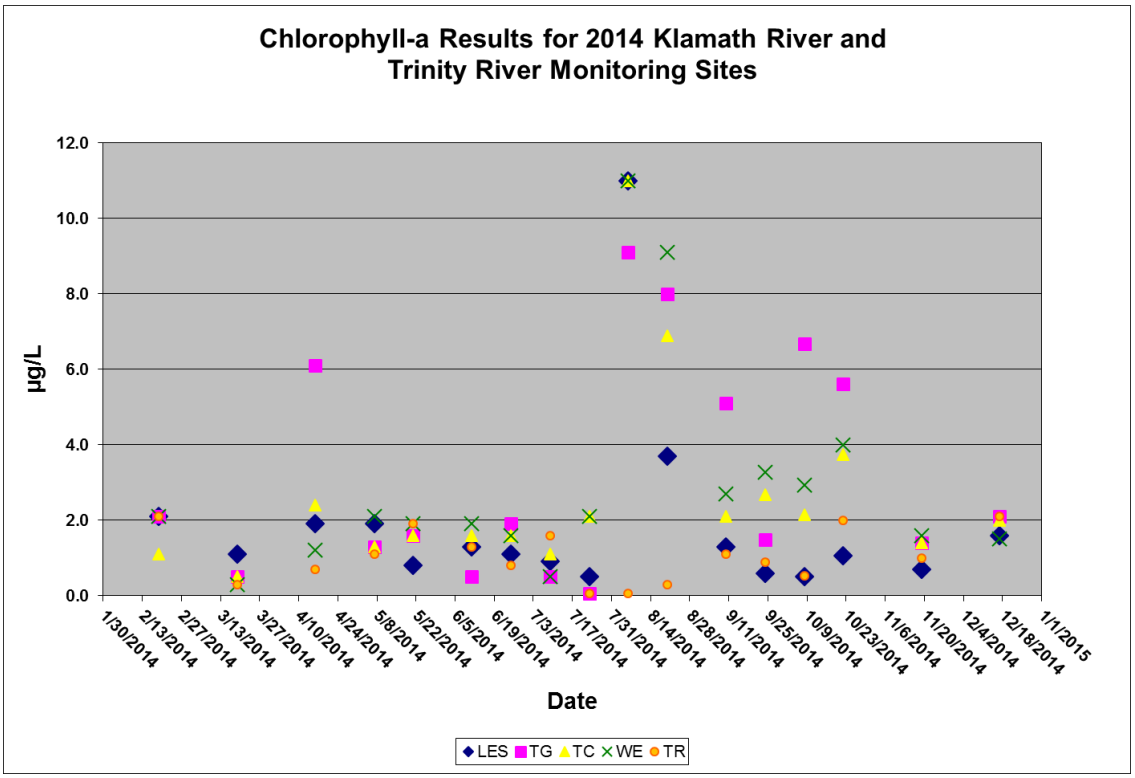


Figure 6-6. Chlorophyll-a Results 2014

Pheophytin-a

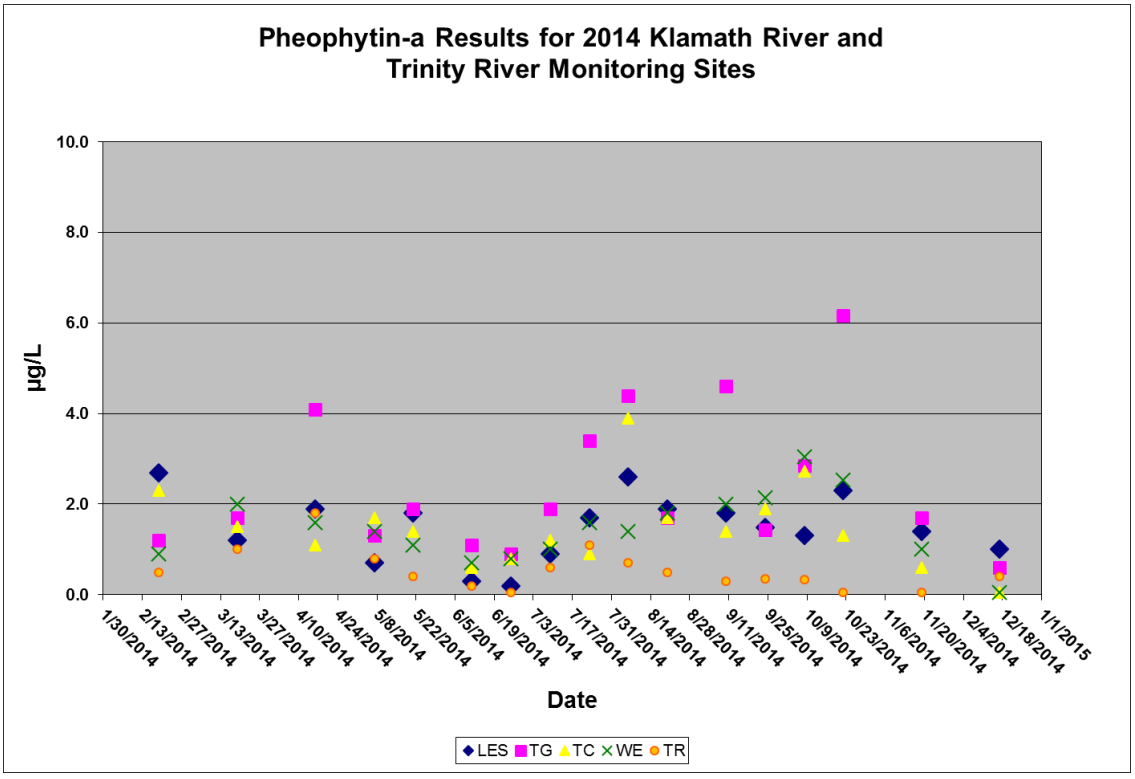


Figure 6-7. Pheophytin-a Results 2014

Alkalinity

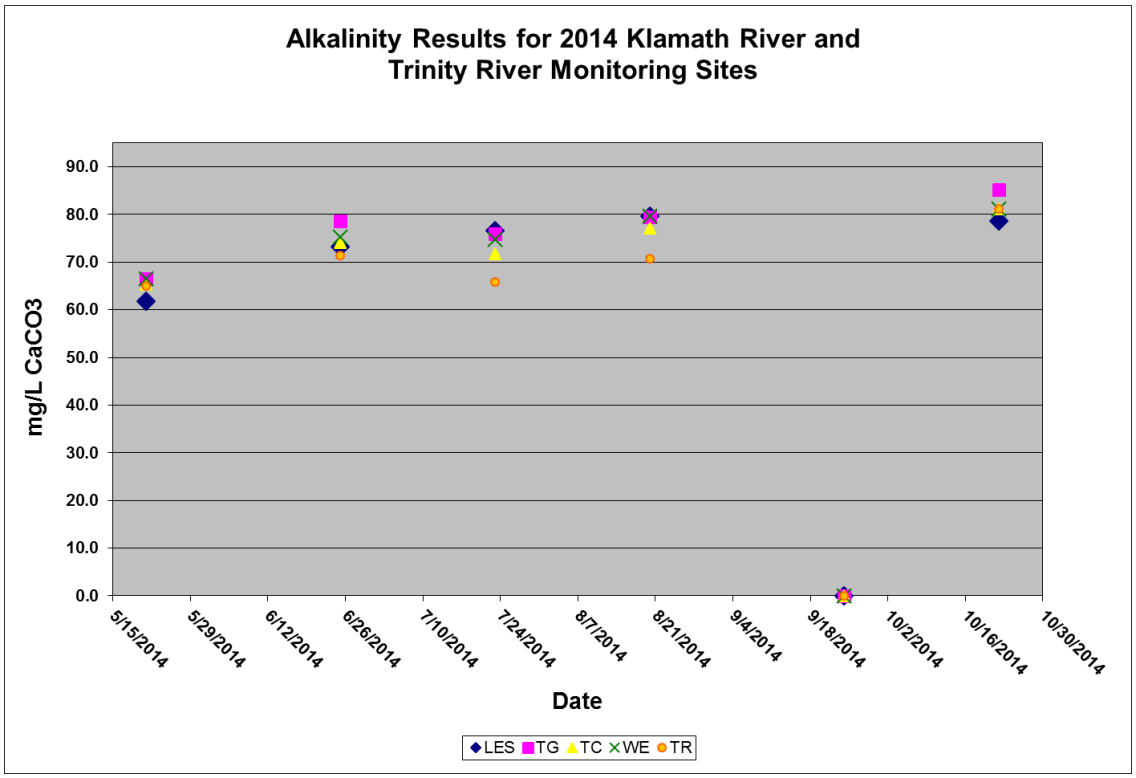


Figure 6-8. Alkalinity Results 2014

Particulate Carbon (PC)

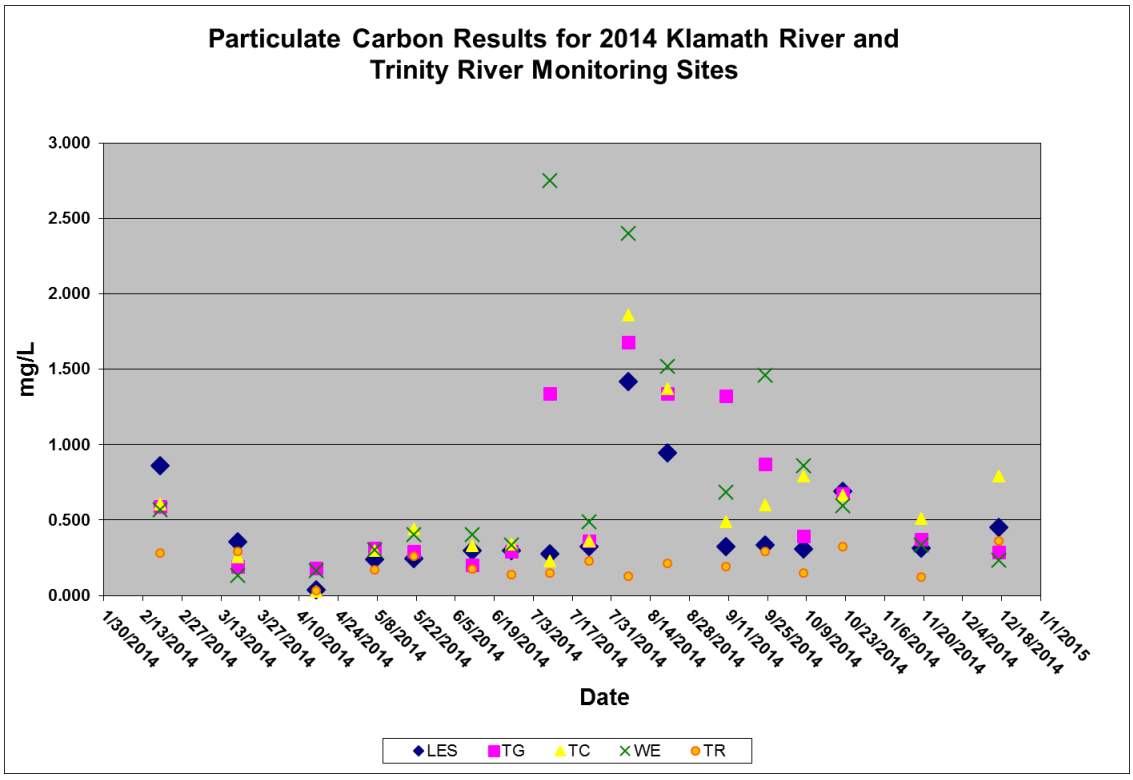


Figure 6-8. Particulate Carbon Results 2014

Dissolved Organic Carbon (DOC)

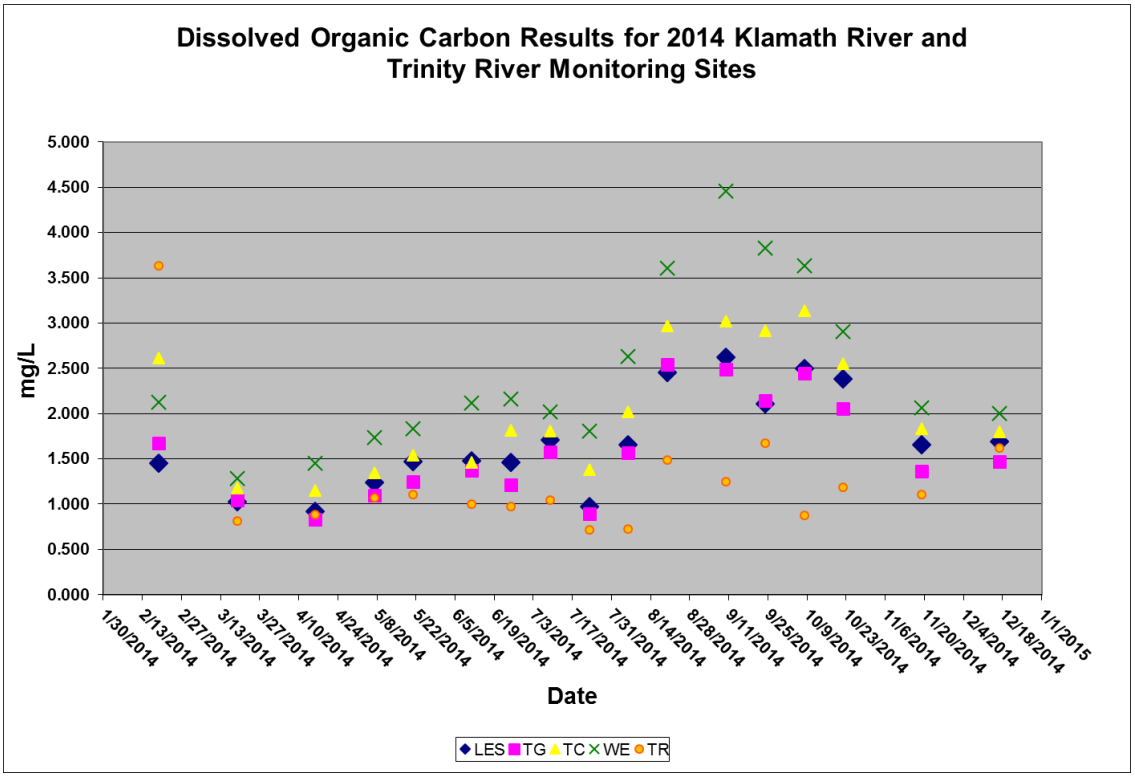


Figure 6-9. Dissolved Organic Carbon Results 2014

Particulate Nitrogen (PN)

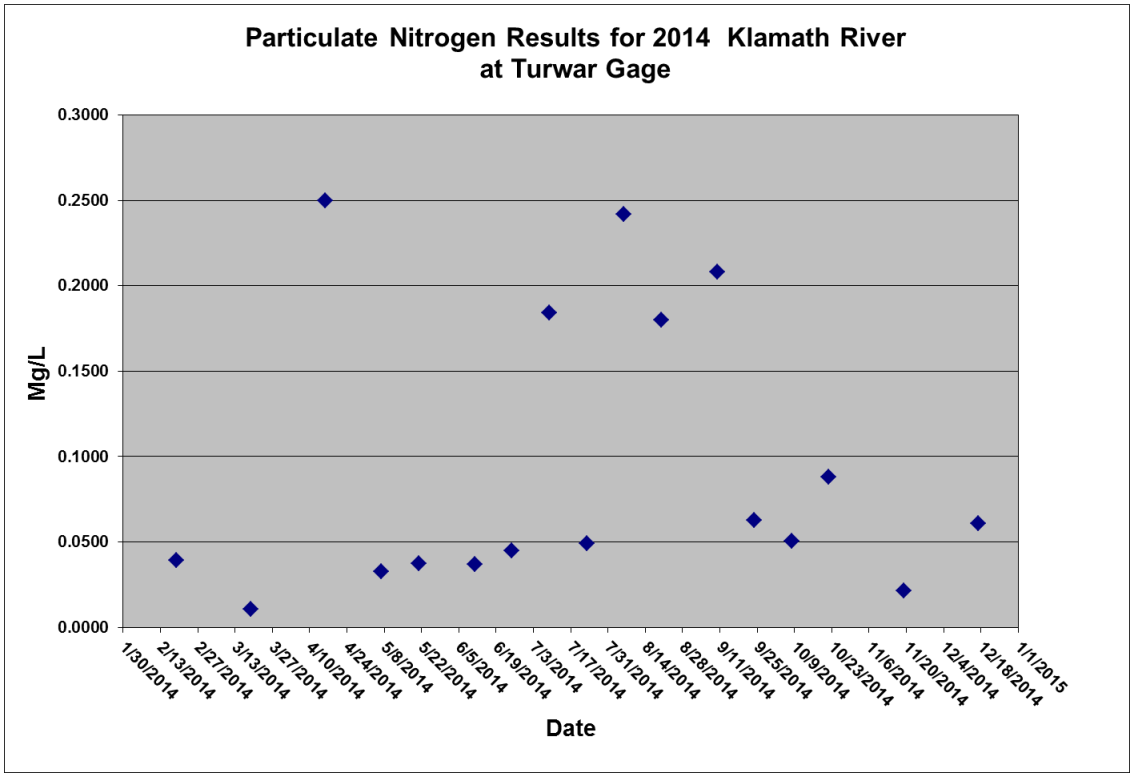


Figure 6-10. Particulate Nitrogen Results 2014

Non-Filterable Residue (TSS)

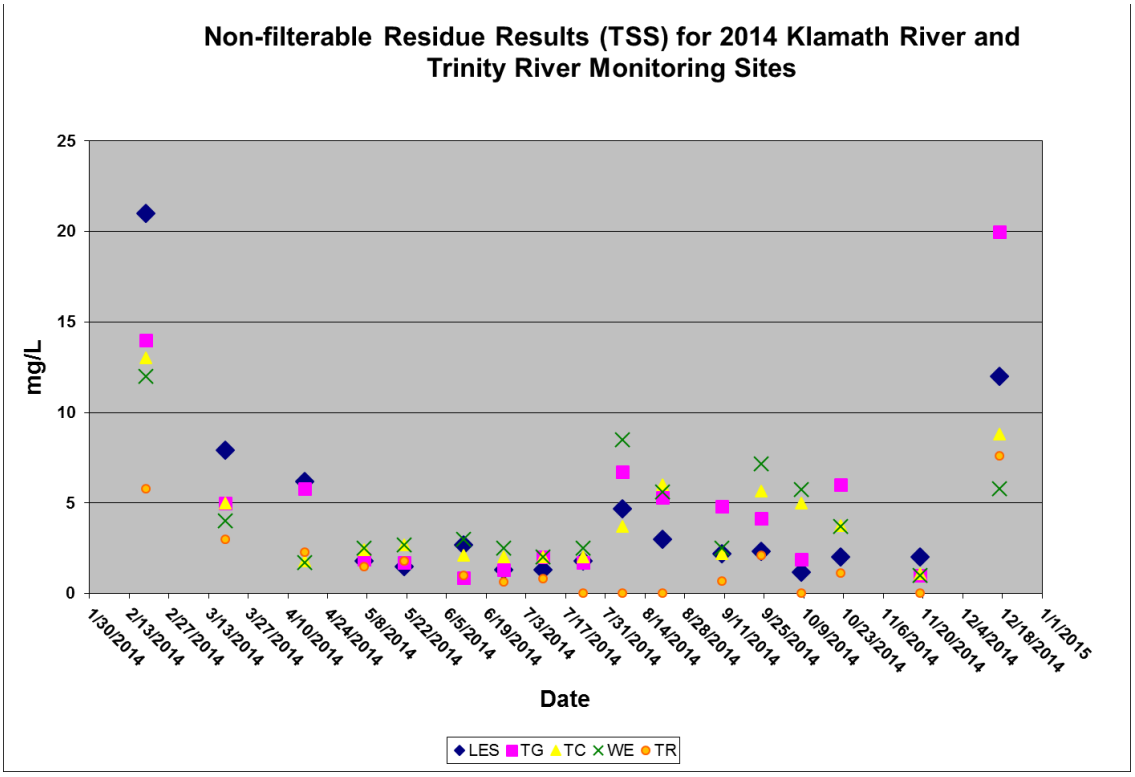


Figure 6-11. Non-filterable Residue Results 2014

Volatile Suspended Solids (VSS)

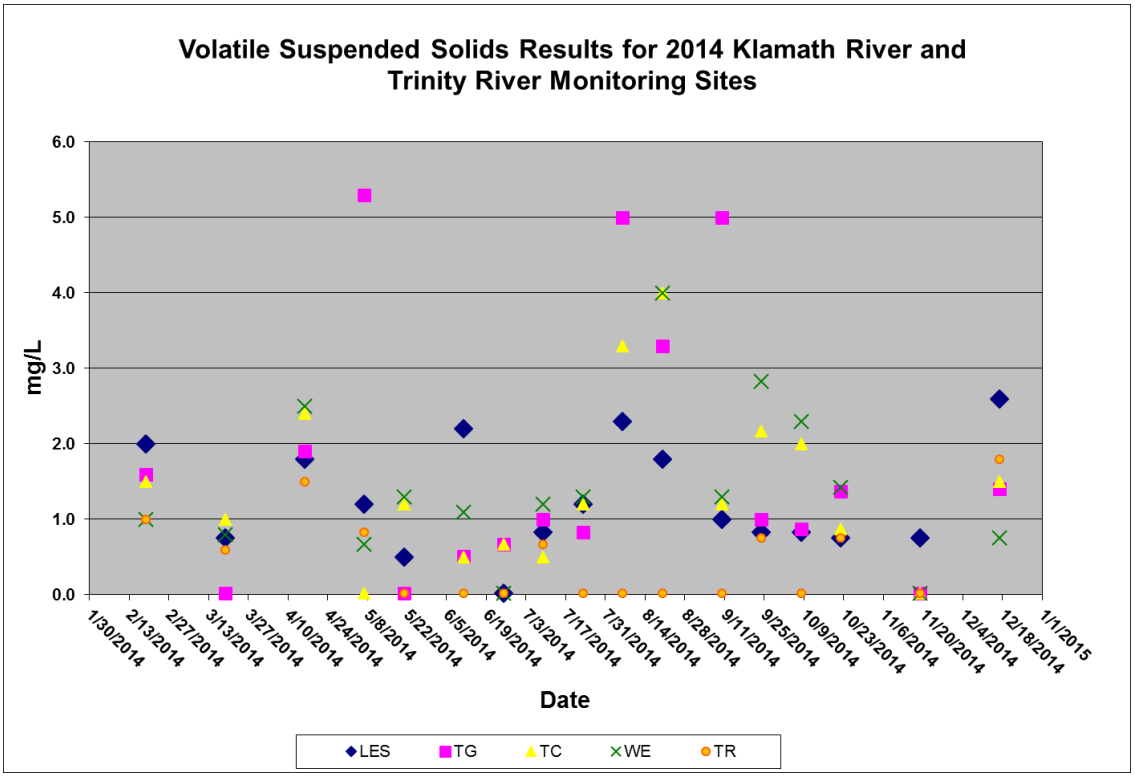


Figure 6-12. Volatile Suspended Solids Results 2014

Turbidity

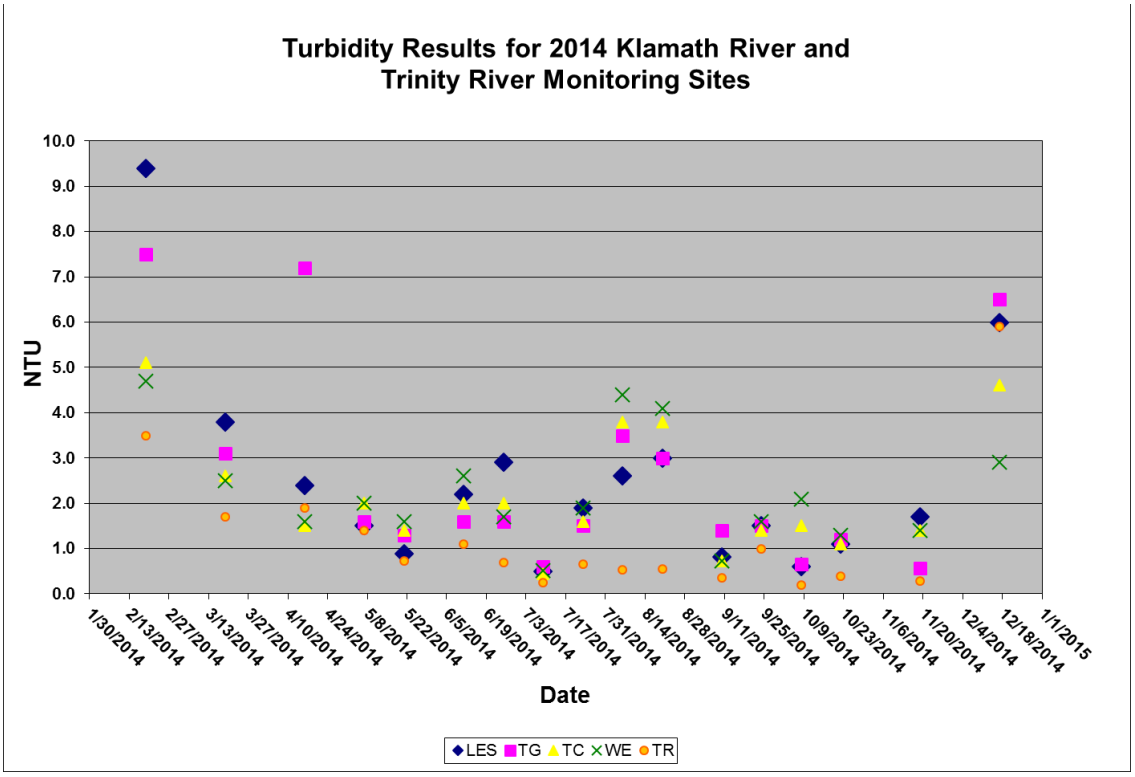


Figure 6-13. Turbidity Results 2014

Water Temperature

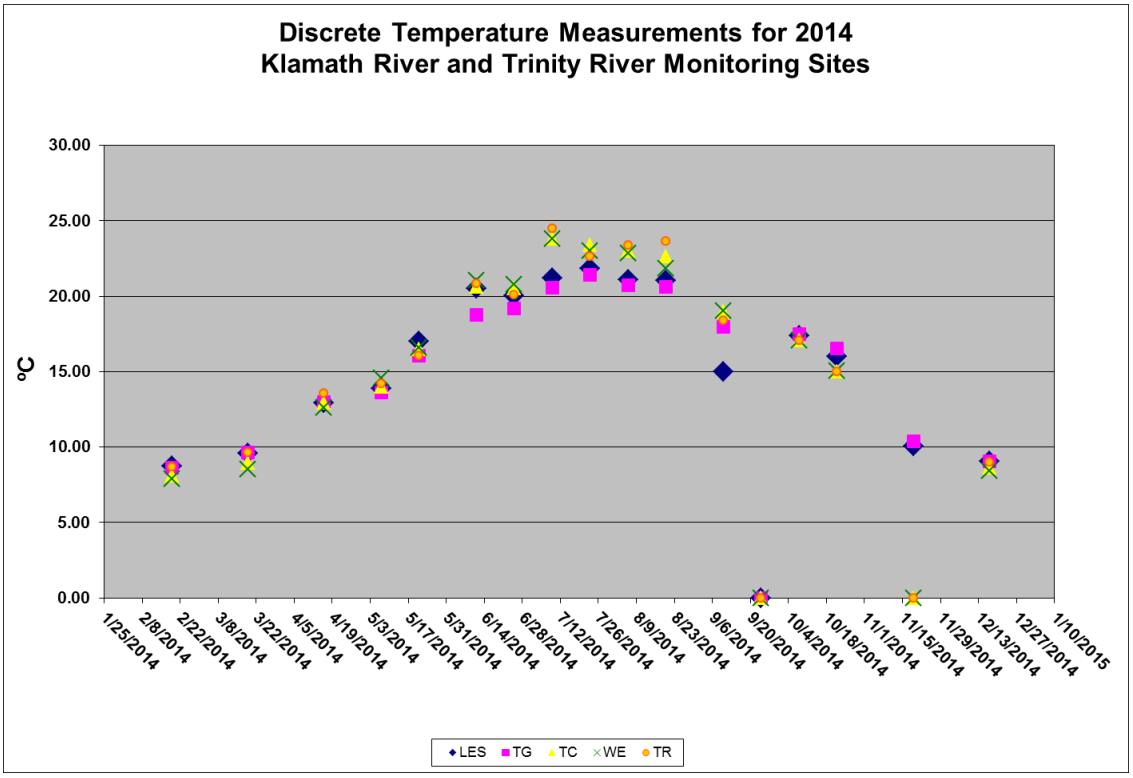


Figure 6-14. Discrete Water Temperature Measurements 2014

Dissolved Oxygen (mg/L)

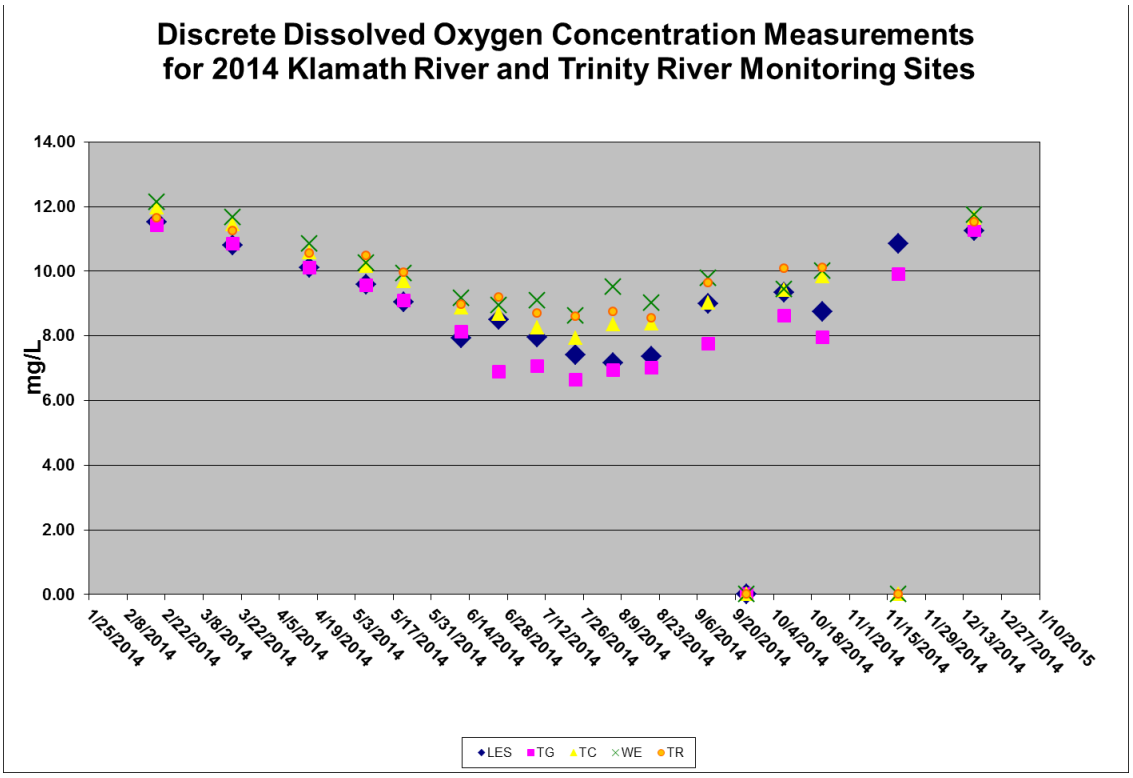


Figure 6-15. Discrete Dissolved Oxygen Concentration Measurements in mg/L 2014

Dissolved Oxygen (%)

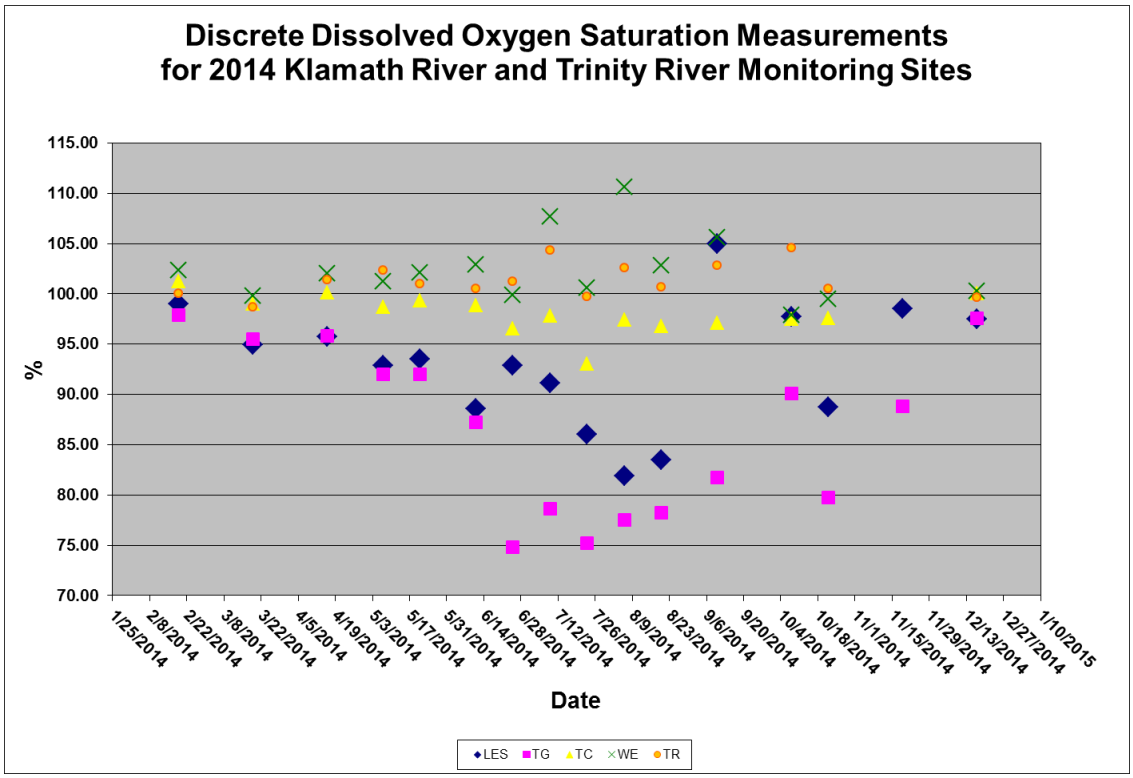


Figure 6-16. Discrete Dissolved Oxygen Saturation Measurements in Percent 2014

Specific Conductivity

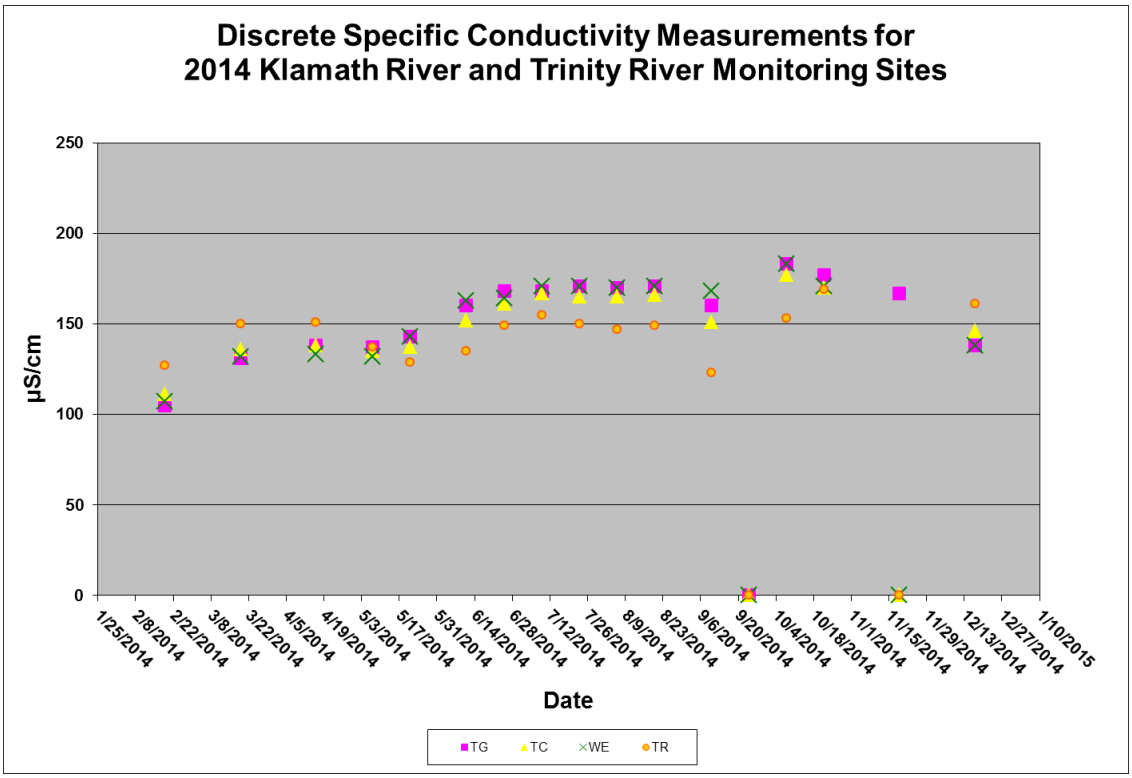


Figure 6-17. Discrete Specific Conductivity Measurements 2014

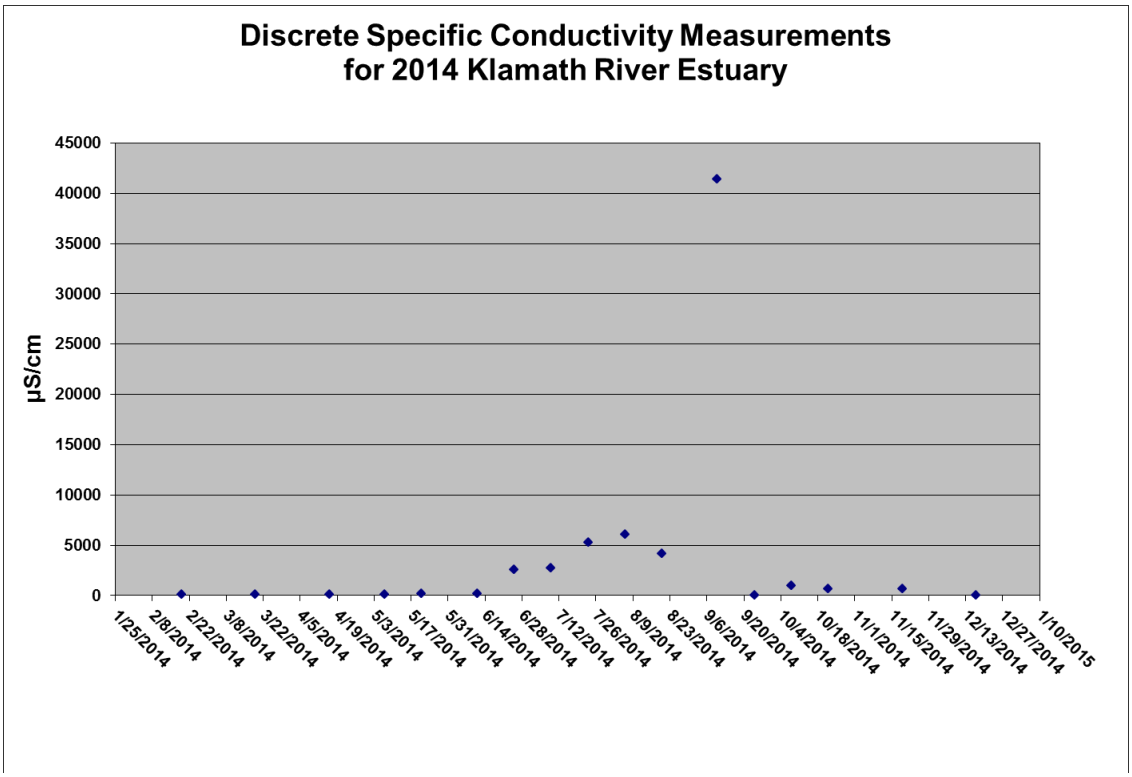


Figure 6-18. Discrete Specific Conductivity Measurements in the Klamath River Estuary 2014

pH

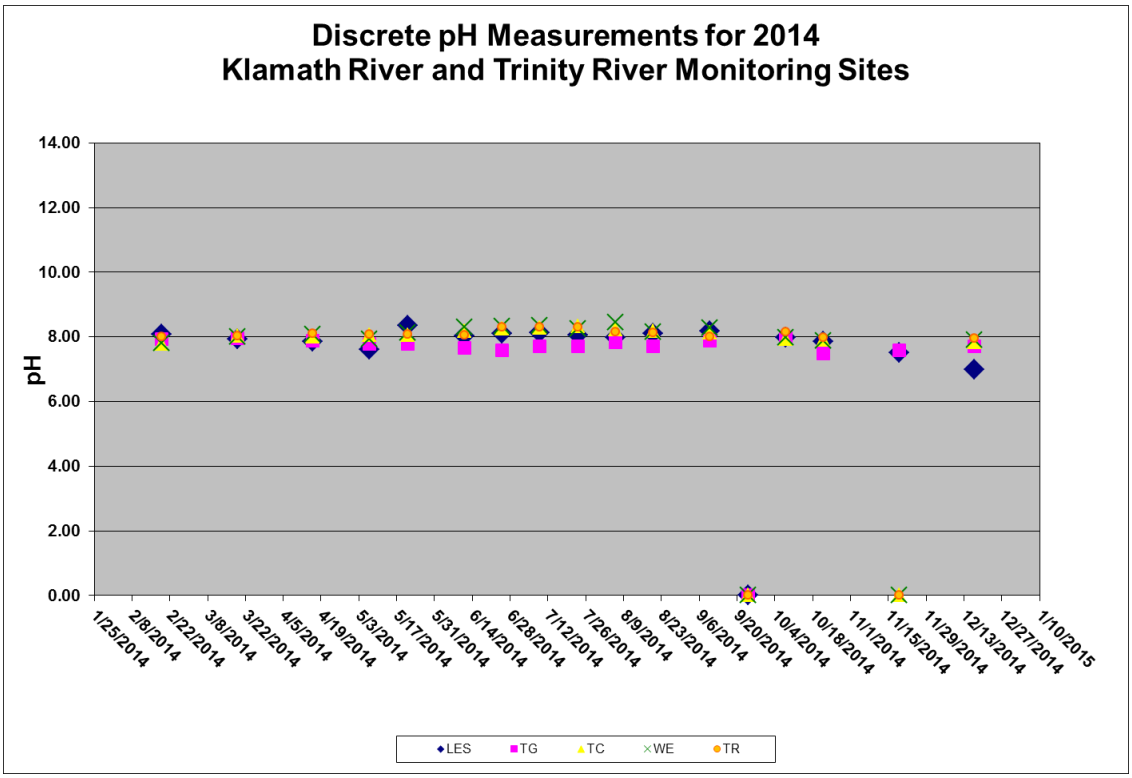


Figure 6-19. Discrete pH Measurements 2014

Blue-green Algae

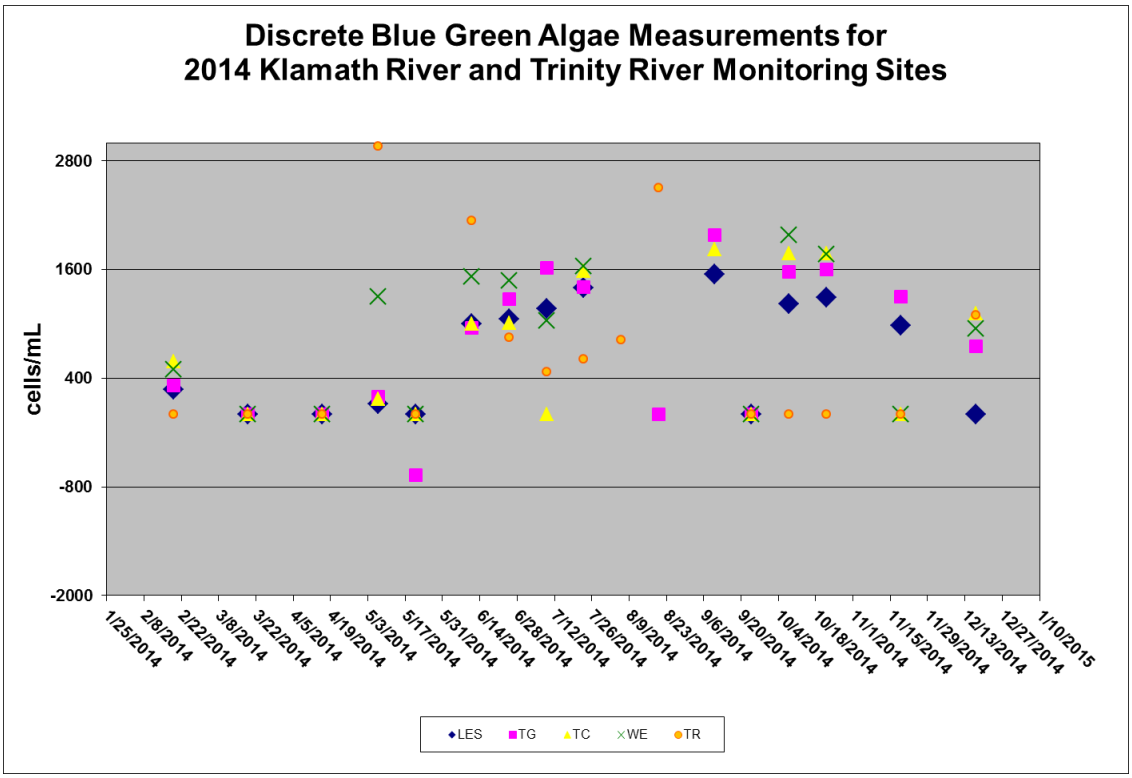


Figure 6-20. Discrete BGA Measurements 2014

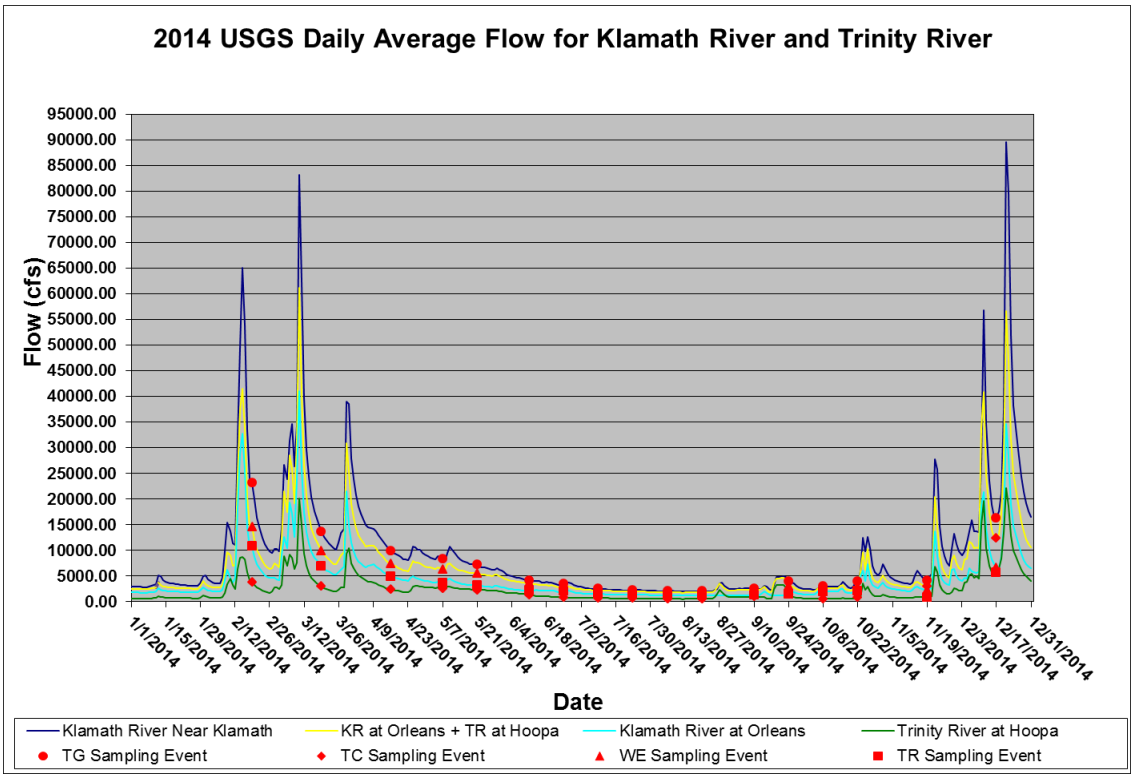


Figure 6-21. Daily Average Flow 2014 (From USGS) with sites superimposed onto flow on dates sampled

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. For the 2014 sampling year YTEP calculated total organic carbon (TOC) in house. 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.

Particulate Carbon peaks in early July, and is higher at WE and TG. It is undetermined why TG and WE have higher concentrations and it may be due to site specific hydraulics. However, DOC concentrations peaked at all sites in mid-September with a long gradual increase. Carbon concentrations decrease as carbon moves downriver in the Klamath River system.

Phosphorus

The EPA recommends phosphorus concentrations for riverine systems to stay below 0.1mg/L to avoid eutrophication, and exceeding this concentration can lead to a host of water quality associated problems. The Phosphorus recorded on the YIR is typically below this limit, with one result from 2014 exceeding it. This was the result at WE from the December 17th sampling event.

For the 2014 data we decided to calculate and distinguish between organic phosphorus and inorganic phosphorous.At TG YTEP collects TP, SRP, PIP, and POP. What we need is to calculate Dissolved Organic Phosphorous (DOP). We do this by subtracting the SRP from the TP. We can then add DOP and POP to obtain Total Organic Phosphorous. To obtain Total Inorganic Phosphorous (TIP) we simply must add SRP and PIP. The equation looks like this:

TP-SRP=DOP
DOP+POP=TOP
SRP+PIP=TIP

The Phosphorus in the Klamath System mostly comes in organic form, and it is generally an order of magnitude greater than inorganic phosphorus. This is untrue for 2014 when Inorganic Phosphorus Exceeds Organic phosphorus in August 2014, until November 2014. The trends for the two forms of Phosphorus vary greatly in October, as Organic Phosphorus drops while Inorganic Phosphorus reaches its maximum (Figure 7-5). Most of this is coming in the form of Soluble Reactive Phosphorus, or Orthophosphate (Figure 6-2).

Nitrogen

Nitrogen concentrations in the Klamath Basin are spatially distributed with concentrations decreasing downstream (Figure 6-5). This is evidence by the increase in Nitrogen-fixing periphyton as you look at the species assemblages as you go downriver (Gillett 2016). In 2014 there is a distinct difference in Total Nitrogen concentrations between the Klamath River and the Trinity River (Figure 6-5). From July to the end of December TR TN concentrations are roughly a third of the Klamath River sites, with sometimes being just a fifth of The Klamath River at WE or the Klamath River above the influence of the Trinity River.

It should be noted that the opposite spatial loading is true for Ammonia. The further downriver you are in the Klamath River System the higher concentration of Ammonia. At times the LES site is the only site with concentrations above the Lower Detection Limit of the analytical equipment and it will be present at 5x the LDL. Nitrate and Nitrite concentrations are highest in the lower river, at TG and at LES. The only time during the 2014 sampling season that one of these sites is not the highest concentration is during the October 9th sampling event, when consequently WE and TC concentrations began to rise, and continued to rise until the end of the sampling season. (Figure 6-3) Particulate Nitrogen data at TG seems to follow the same trend of Trend of Total Nitrogen at TG, which seems to be the opposite of Ammonia or Nitrate and Nitrite.

Chl-A & Pheophytin

Chlorophyll-a is largely used in water quality as an indicator for total algal biomass. Pehophytin-a is a natural degradation Product from chlorophyll (Algal Biomass Indicators 2007). It is a link between the chemical and biological interactions of water quality, and has been monitored intensively in the Klamath Basin for some time.

The most notable thing about Chlorophyll-a in 2014 is the spike in concentration during the 7/23 sampling event at the Klamath River monitoring sites (Figure 6-6). This spike does not occur on the trinity, which leads one to devise that it came from upriver. There was a spike in the hydrograph for the USGS Klamath River hydrographs, but not the Trinity River hydrograph which could account for this spike in the data a month later. It may not be a bad idea to add Ash Free Dry Weight to the monitoring procedure to then add to Chlorophyll-a and particulate carbon to calculate total algal biomass.

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 2014 sampling year.

For the Klamath River 2014 the ratio of VSS to TSS increases at all sites during the months of May through October. This holds true for TR, but it is a false ratio as both TSS and VSS are at the detection limit when the ratio is 100 percent. 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. Biomass in the winter time is more likely to be attributed to algal and organic matter already present in the river, compared to leaf and detritus organic matter that may be washed in by rain. When most VSS biomass is algal biomass there will not be a significant increase in TSS as we can see in low values for the summer months of the Klamath (Figure 6-12).

VSS peaks at TG on the 4/16/14 sampling event, however it is not the peak ratio, as a late march storm event brings the TSS to a peak as well. The peak VSS to TSS ratio occurs on the 8/6/14 sampling event, the same as the peak VSS numbers (Figure 7-4).

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 2014

ratio of PC to TOC	Site	2/19/2014	3/19/2014	4/16/2014	5/7/2014	5/21/2014	6/11/2014	6/25/2014	7/9/2014	7/23/2014	8/6/2014	8/20/2014	9/10/2014	9/24/2014	10/8/2014	10/22/2014	11/19/2014	12/17/2014
	LES	37.2	25.7	3.9	16.2	14.2	16.7	16.9	13.9	25.0	46.1	27.9	11.1	13.7	11.1	22.5	0.2	21.1
	TG	26.1	15.4	17.7	22.2	18.8	13.0	19.5	45.9	28.8	51.7	34.5	16.4	28.8	24.5	24.5	27.2	16.3
	TC	18.8	17.7	2.3	18.0	22.3	18.5	15.8	11.1	20.8	47.9	31.6	30.4	17.0	11.2	20.9	16.8	30.6
	WE	21.0	9.5	10.3	14.8	18.1	16.1	13.4	57.7	21.3	47.7	29.6	4.1	7.1	4.0	10.1	5.5	10.4
	TR	7.2	26.6	3.5	13.8	18.9	15.1	12.5	12.4	24.0	15.1	12.4	35.4	46.5	49.6	33.5	23.2	18.3

Table 7-2. Ratio of DOC to TOC, Yurok Reservation 2014

ratio of DOC to TOC	Site	2/19/2014	3/19/2014	4/16/2014	5/7/2014	5/21/2014	6/11/2014	6/25/2014	7/9/2014	7/23/2014	8/6/2014	8/20/2014	9/10/2014	9/24/2014	10/8/2014	10/22/2014	11/19/2014	12/17/2014
	LES	62.8	74.3	96.1	83.8	85.8	83.3	83.1	86.1	75.0	53.9	72.1	88.9	86.3	88.9	77.5	99.8	78.9
	TG	73.9	84.6	82.3	77.8	81.2	87.0	80.5	54.1	71.2	48.3	65.5	83.6	71.2	75.5	75.5	72.8	83.7
	TC	81.2	82.3	97.7	82.0	77.7	81.5	84.2	88.9	79.2	52.1	68.4	69.6	83.0	88.8	79.1	83.2	69.4
	WE	79.0	90.5	89.7	85.2	81.9	83.9	86.6	42.3	78.7	52.3	70.4	95.9	92.9	96.0	89.9	94.5	89.6
	TR	92.8	73.4	96.5	86.2	81.1	84.9	87.5	87.6	76.0	84.9	87.6	64.6	53.5	50.4	66.5	76.8	81.7

Table 7-3. Ratio of VSS to TSS, Yurok Reservation 2014

ratio of VSS to TSS	Site	2/19/2014	3/19/2014	4/16/2014	5/7/2014	5/21/2014	6/11/2014	6/25/2014	7/9/2014	7/23/2014	8/6/2014	8/20/2014	9/10/2014	9/24/2014	10/8/2014	10/22/2014	11/19/2014	12/17/2014
	LES	9.5	9.5	29.0	66.7	33.3	81.5	NA	63.8	66.7	48.9	60.0	45.5	35.7	71.4	37.5	37.5	21.3
	TG	11.4	NA	32.8	278.9	NA	57.3	51.5	50.0	48.8	74.6	62.3	104.2	24.0	46.7	22.9	NA	7.0
	TC	11.5	20.0	133.3	NA	44.4	23.8	33.5	25.0	60.0	89.2	66.7	54.5	38.2	40.0	23.3	NA	17.1
	WE	8.3	20.0	147.1	26.8	48.1	36.7	NA	60.0	52.0	82.4	71.4	52.0	39.5	39.1	38.5	NA	13.0
	TR	17.2	20.0	65.2	55.3	NA	NA	NA	80.7	NA	NA	NA	NA	35.3	NA	66.7	NA	23.7

NA = No Detection for one or both parameters

Table 7-4. Ratio of PN to TN, Yurok Reservation 2014

ratio of PN to TN	Site	2/19/2014	3/19/2014	4/16/2014	5/7/2014	5/21/2014	6/11/2014	6/25/2014	7/9/2014	7/23/2014	8/6/2014	8/20/2014	9/10/2014	9/24/2014	10/8/2014	10/22/2014	11/19/2014	12/17/2014
	LES	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS
	TG	17.0	5.5	87.4	16.9	24.2	19.4	36.9	84.0	25.4	56.4	60.0	62.3	24.1	16.4	26.0	23.7	19.1
	TC	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS
	WE	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS
	TR	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS	DNS

DNS= Did Not Sample

Figure 7-1. Ratio of PC to TOC 2014

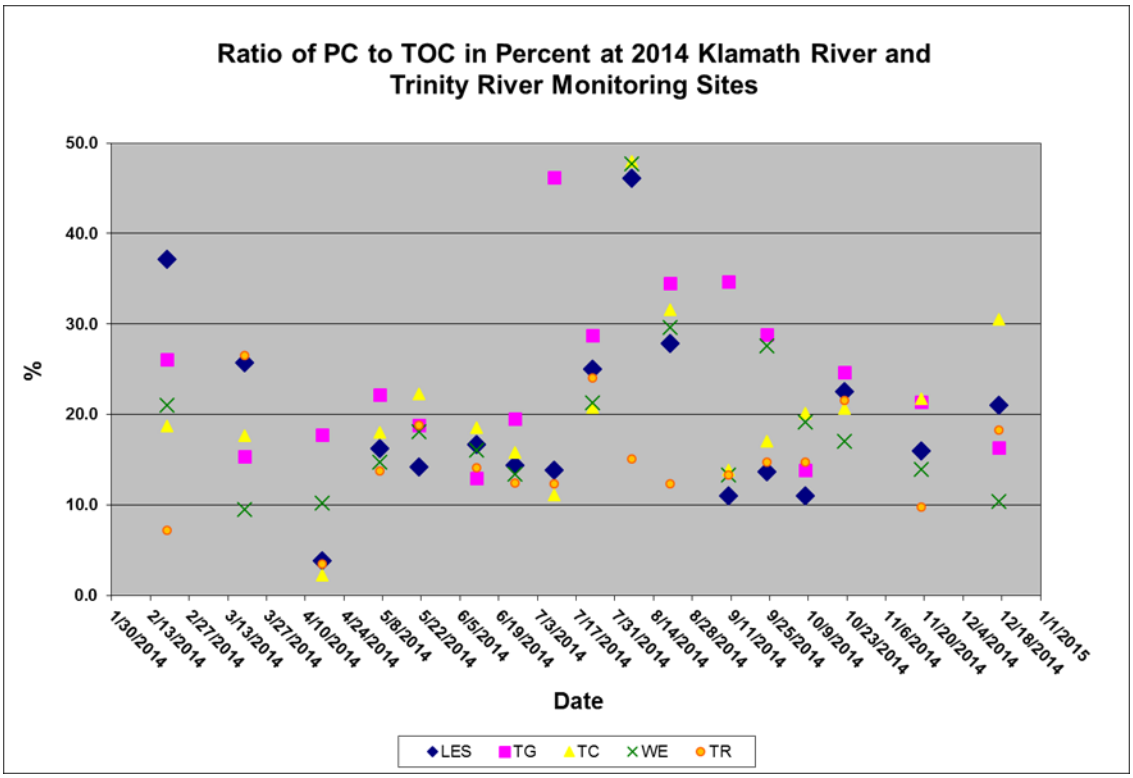


Figure 7-2. Ratio of DOC to TOC 2014

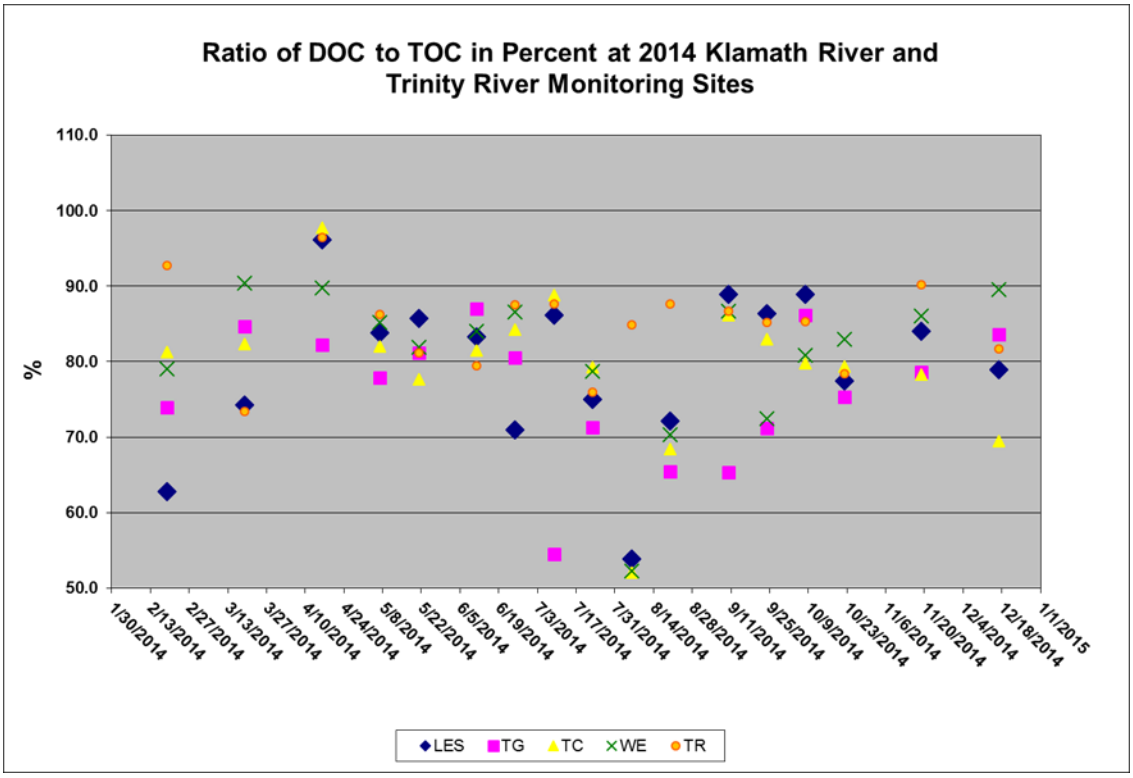


Figure 7-3. Ratio of VSS to TSS 2014

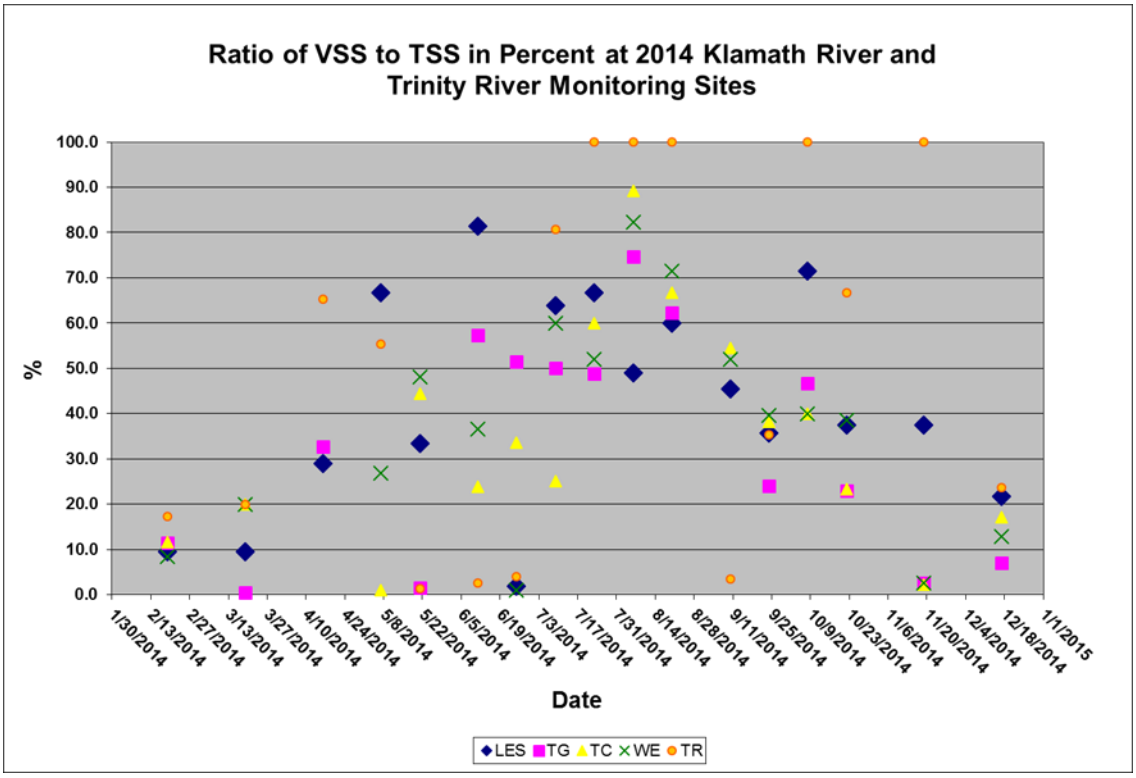


Figure 7-4. Ratio of PN to TN 2014

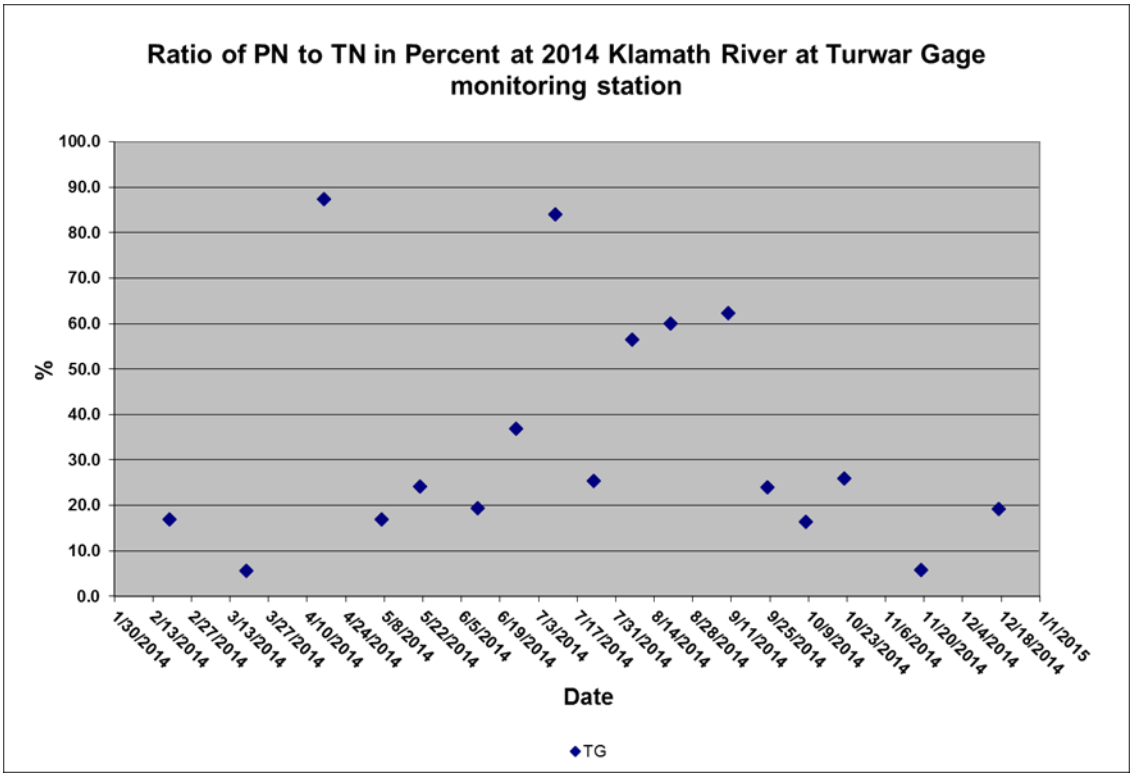
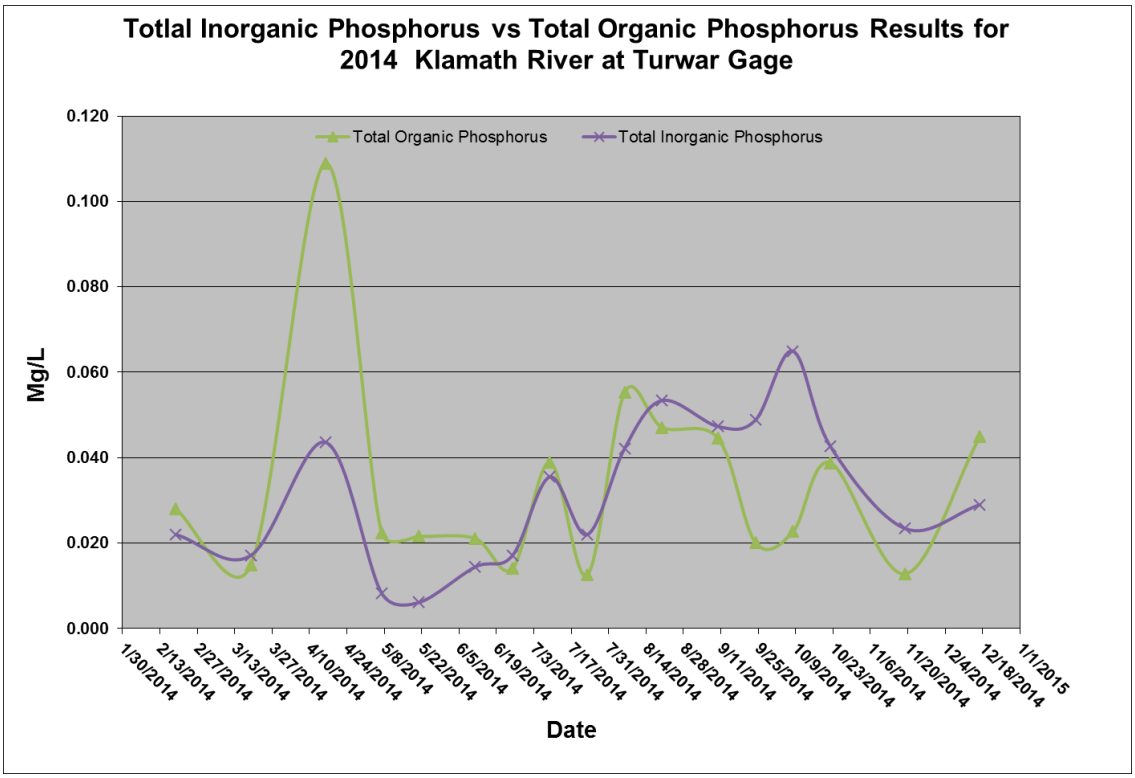


Figure 7-5. Total Inorganic and Total Organic Phosphorus 2014



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 dissolved oxygen over the course of the day as biochemical processes increase and decrease in accordance with the rise and fall of the sun. Periphyton growth can also cause a swing in pH by releasing carbon dioxide into the water column, which breaks down into carbonaceous acid. The water column is a buffer though and if the pH swings too low, the equilibrium rate will change, shifting back to basic.

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 stream flows, 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 2014 a few small rain events occurred in June and September (Figure 6-21). This doesn't seem to impact the nutrient concentrations or have a significant effect on river flow either.

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 6-14, 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 2014. 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 results exceeded the Hoopa standard of 0.2mg/L on 47 out of 85 samples. There were no exceedances at TR for 2014. If we just consider the Klamath River Samples than total nitrogen was exceeded 47/68 samples or 69.11 % of samples for 2016. Total Phosphorous sample results exceeded the 0.035 standard set by the Hoopa Valley Tribe 36 out of 68 samples or 52.9% of the time. Most of these exceedances occur in the late summer, and winter months.

Table 7-5. 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

Berkman, Julie A., Canova, Michael G. *Algal Biomass Indicators* USGS p 9-11

Gillett, N.D. et al 2016. *Spatial and Temporal variability of river periphyton below a hypereutrophic lake and a series of dams.* Science of the Total Environment.

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.

ND= No Detect
DNS= Did Not Sample
NS= No Sample for this date
OUT=Outlier