KHSA Interim Measure 15: Water Quality Monitoring Activities Monitoring Year 2013

1. Introduction and Overview

On February 18, 2010, the United States, the States of California and Oregon, PacifiCorp, Indian tribes, and a number of other stakeholders signed the Klamath Hydroelectric Settlement Agreement (KHSA). The KHSA lays out the process for additional studies, environmental review, and a determination by the Secretary of the Interior regarding whether removal of four dams owned by PacifiCorp on the Klamath River (i.e., Iron Gate, J.C. Boyle, Copco 1, and Copco 2 dams) will advance restoration of the salmonid fisheries of the Klamath Basin, and is in the public interest (which includes effects on local communities and tribes).

The KHSA includes provisions and detailed actions for the interim operation of the dams and mitigation activities prior to removal of the dams or the termination of KHSA. One of these measures titled: Interim Measure 15 - Water Quality Monitoring states that PacifiCorp shall fund ($500,000 per year) long-term baseline water quality monitoring to support water quality improvement activities, dam removal studies, permitting studies (as necessary), and form a long-term record to assess trends and other potential changes in the basin. This includes funding for blue-green algae (BGA) and BGA toxin monitoring, as necessary to protect public health. This plan addresses the fourth year of monitoring under Interim Measure 15 (hereafter referred to as IM 15). Since the goals and objectives of IM 15 remain the same and the sampling entities and locations are unchanged since monitoring began in 2009, this document provides any updates and/or changes to the sampling from previous plans (Note: In 2009, sampling was done under an interim settlement agreement). Detailed discussions on goals, objectives and the rationale for the parameters sampled can be found in the previous study plans, available on the Klamath Basin Monitoring Program (KBMP) website (http://www.kbmp.net under the Collaboration tab on the Home page). This website hosts all of the IM 15 study plans and results.

This document outlines the parameters to be sampled, their frequency and location by sampling entity for the monitoring period from February 2013 through December 2013 This monitoring includes monitoring of the Klamath River mainstem (including reservoirs) from Link River dam downstream through the estuary (Figure 1). The 24 monitoring sites have been sampled under this planning process since 2009.This plan is being conducted as one of numerous monitoring and/or study efforts in the Klamath River Basin, including annual monitoring of: tributaries above Upper Klamath Lake, Upper Klamath Lake, and tributaries to the Klamath River including the Lost River basin. These other efforts are being captured in a basin-wide framework developed by KBMP PacifiCorp and other parties to the KHSA agreed to a cooperative effort for the finalization of the 2013IM 15 monitoring schedule.

The work presented in this plan represents consensus amongst the following participants: PacifiCorp, California North Coast Regional Board, Oregon Department of Environmental Quality, the Karuk and Yurok Tribes, U.S. Bureau of Reclamation and the United States Environmental Protection Agency (Region 9). Modification to this plan beyond 2013 is anticipated as science and monitoring programs evolve. Any modifications will be done in consultation with the participants listed above.

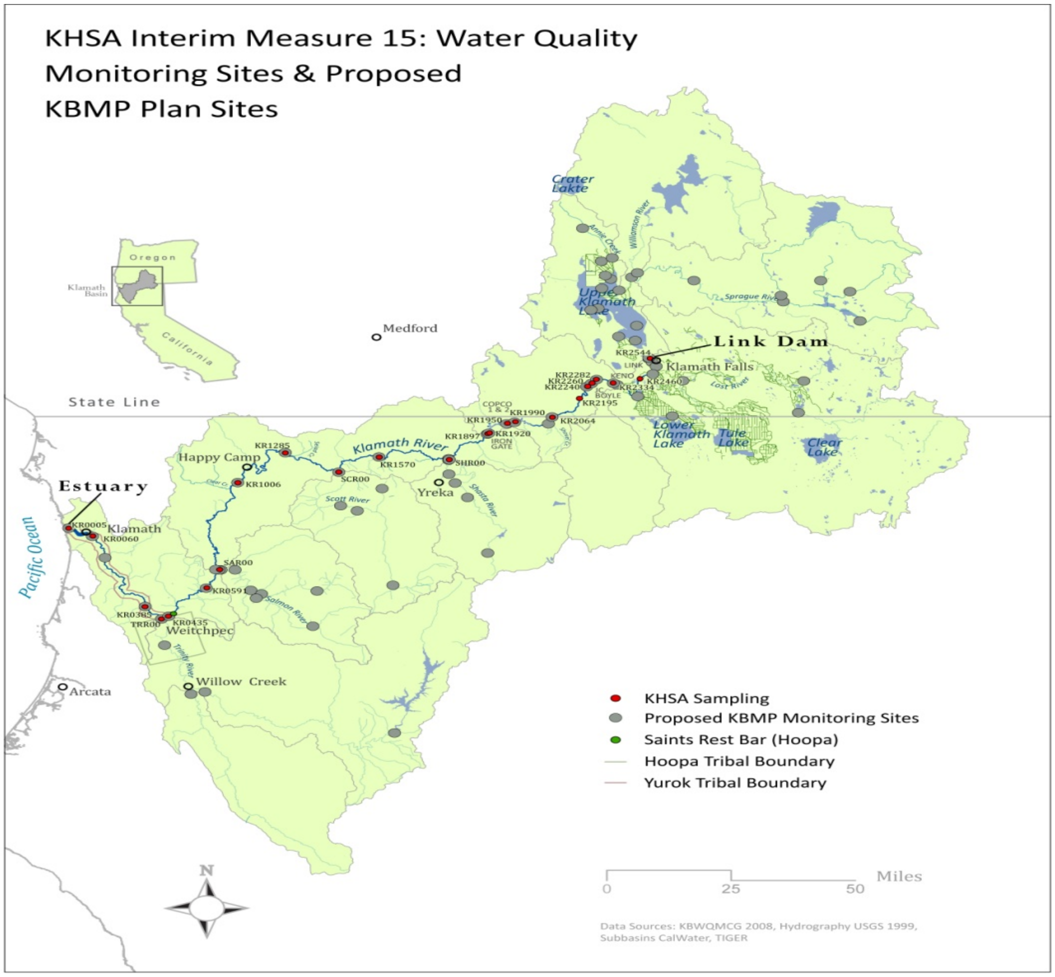

Figure 1Monitoring stations within the KBMP framework.

2. Objectives

The IM 15 monitoring objectives remain the same as previous years and include both public health monitoring for cyanobacteria and toxins, and baseline monitoring. These key objectives are:

- Provide data on cyanobacteria and related toxins in a timely manner to support public health decisions.
- Support the science in the dam removal framework.
- Improve the current understanding of seasonal, annual, and long-term variations in a wide range of water quality parameters for Klamath River from Link Dam to the estuary. A system wide approach is necessary because influences from upstream sources extend downstream.
- Form a long-term program that helps capture the effects of other activities in the system potentially affecting water quality in the Klamath River, including those related to: regulatory actions (e.g., Biological Opinions, TMDL implementation, adjudications, etc.), potential climate change, fires, and land use activities, as well as other factors.
- Provide a long-term baseline data set of water quality conditions that can be readily extended to assess impacts of management actions and restoration processes, including:
    - Clearly identifying current conditions for a wide range of hydrology, meteorology, and water quality conditions.
    - Identifying and quantifying potential water quality changes, impacts, and implementation measures.
    - Determining progress towards restoration of the river system and evaluation of possible mitigation measures to minimize long term impacts or promote/accelerate recovery
- Collect data under a consistent Quality Assurance (QA) framework
- Disseminate data in a timely fashion.

3. Monitoring Components

The 2013 IM 15 monitoring activities include the following two components.

3.1 Monitoring Component 1: Public health monitoring of Cyanobacteria and toxins

To assess potential risks to public health, due to exposure to cyanobacteria and their toxins occurring in the Klamath River, this monitoring component includes water column and shoreline water sampling within the Klamath River and reservoirs. A number of species of cyanobacteria have been documented in the Klamath River and reservoirs; the most abundant species include: *Aphanizomenon flos-aquae*, *Microcystis aeruginosa*, *Anabaena flos-aquae*, and *Oscillatoria sp*. Since 2004, Klamath River monitoring has documented elevated levels of toxin-producing cyanobacteria primarily *Microcystis aeruginosa* (MSAE) and the toxin microcystin. Microcystins are a class of toxic chemicals produced by some strains of cyanobacteria including MSAE, and are released into waters when cyanobacterial cells die or cell membranes degrade. MSAE blooms and microcystins at elevated levels can present risks to human health and to terrestrial and aquatic species, and result in impairments to a number of beneficial uses for the waterbody. Microcystin toxins are capable of inducing skin rashes, sore throat, oral blistering, nausea, gastroenteritis, fever, and liver toxicity (WHO 2003).

MSAE counts and microcystin concentrations found in Klamath River waters within Copco and Iron Gate Reservoirs and below Iron Gate dam have exceeded action levels defined by the World Health Organization (WHO), and the California Draft Voluntary Statewide Guidance for Blue-Green Algae Blooms (SWRCB, 2010). Since 2005, Copco and Iron Gate reservoirs have been posted with public health advisories as a result of summer blooms of MSAE; reaches of the Klamath River downstream of Iron Gate dam were posted in 2005, and 2008 through 2012.

Anabaena flos-aquae has been found in water samples collected from Upper Klamath Lake and in Iron Gate and Copco reservoirs. Since 2010, lab analysis has been done to see if anatoxin-a, an acute neurotoxin, is present in selected samples when *Anabaena* was found to exceed approximately 40,000 cell/mL. Results to date have been negative for anatoxin-a, but limited analysis will continue in 2013 to monitor if the toxin is present.

The locations, parameters, and frequency associated with Monitoring Component 1 (Public Health) are listed in Tables 1 and 2, respectively.

3.2 Monitoring Component 2: Baseline water quality monitoring of the Klamath River

This component is designed to characterize water quality conditions by monitoring for basic water quality parameters (temperature, dissolved oxygen (DO), pH, and conductance) as well as a suite of nutrients and other related indicators. Results from baseline monitoring will be used to support water quality improvement activities, dam removal studies, permitting studies (as necessary), and form a long-term record to assess trends and other potential changes in the basin. Monitoring is intended to establish current data trends for the evaluation of implementation activities, and management actions and remedies.

The locations, parameters, frequency and sampling entity associated with Monitoring Component 2 are listed in Appendix A.

4. Quality Assurance, Data Management, and Dissemination

4.1 KHSA Program Quality Assurance Strategy for 2013

The 2013 IM 15 monitoring entities are striving to use common sample collection methods, laboratories, and data management strategy These QA requirements have been evaluated, compared and documented. The *2010 Klamath River Baseline Sampling Program QA Comparison* (on the KBMP website, http://www.kbmp.net) compares participating entity's existing QA plans and standard operating procedures. Except where otherwise specified, it is the responsibility of each monitoring entity to individually contract the services of laboratories for the analysis of water quality samples. In contracts with the laboratories, each reach monitoring entity includes requirements for a minimum level of laboratory QA procedures.

Participants in the KHSA monitoring use common laboratories where possible and practical; however, there are instances where different labs are being used. The analysis of water quality samples by multiple labs requires additional QA procedures to enable comparisons of performance by participating laboratories. To support such a comparison, a number of nutrient samples (described in the QA requirements) are divided into splits and those splits sent to each of the laboratories doing nutrient analyses. The lab comparison memos prepared for 2009 through 2012 are available on the KBMP website. Triplicate samples will be collected by the Karuk Tribe, at the Klamath River site near Weitchpec three times over the sampling season (April, August and November 2013). The results from this effort will be summarized in a lab comparison memo and posted on the KBMP website.

Water samples for public health monitoring will be collected in accordance with the *Standard Operating Procedures, Environmental Sampling of Cyanobacteria for cell enumeration, identification and toxin analysis* (Cyanobacteria SOP, KBGAWG 2009).

This SOP, developed for the Klamath River by the Klamath BGA Workgroup, is posted on the KBMP website.

4.2 Data Management and Dissemination

In an effort to maintain continuity with the long-term basin wide water quality monitoring plan, KBMP in partnership with the California Environmental Data Exchange Network (CEDEN), has developed a searchable web-based database for the collection and dissemination of data characterizing the Klamath River Basin, available on the KBMP website. Blue-green algae public health monitoring data, posted following lab analysis, and an interactive map are also available on the website. Each monitoring entity is responsible for maintaining all data collected, in usable spreadsheets (e.g. Excel).

Public health monitoring of cyanobacteria and toxins requires prompt and effective communication of data to the local and state agencies to support management decisions regarding the need to post waterbodies with informational signage or issue health advisories. Thus, results from cyanobacteria cell count and toxin analyses are forwarded promptly to the appropriate local and state health agencies (e.g., ODEQ, California Regional Board and State Board, and County Health Departments). For public health cyanobacteria analyses (cell count and toxin levels), each sampling entity is responsible for producing a memorandum every two weeks with the most recent analytical results and distributing that memo to regulatory agencies and interested parties including KBMP (submitted in spreadsheet format). These public health memos, as well as annual summary reports for the baseline monitoring, are posted on the KBMP website.

5. Sampling Constituents and Frequency

This section describes the 2013 sampling locations, frequency and procedures. Table 1 describes the public health sampling locations. Table 2 and Appendix A provide a summary of public health and baseline monitoring locations, constituents, method, and frequency.

5.1 Monitoring Component 1: Public health monitoring of cyanobacteria and toxins

Risks to public health related to cyanobacteria and toxin exposure will be evaluated through toxin analysis, identification and enumeration of cyanobacteria,, and the identification of the presence of scums.

5.1.1 Locations

Public health monitoring for cyanobacteria and microcystin toxin in water samples will occur during 2013 at a total of 12 designated locations used for public access and recreation. These are listed in Table 1, and include:

- Four shoreline sites in coves on Copco (Mallard Cove and Copco Cove) and Iron Gate reservoirs (Camp Creek and Williams Boat Ramp). These cove sites provide public access, are known areas of likely accumulation during blooms, and have been monitored since 2005.
- Eight (8) river sites stretching from Iron Gate dam (RM 189.7) to Turwar (RM 6.0). Most of these sites have been monitored since 2005, and all represent areas of public access.

Table 1: 2013 Klamath River sampling sites for public health monitoring of cyanobacteria and cyanotoxins in surface water samples.

Location	Approx RM	Sampling Entity
Copco Reservoir and Mallard Cove	200.8	PacifiCorp
Copco Reservoir at Copco Cove	198.5	PacifiCorp
Iron Gate Reservoir at Camp Creek	192.8	PacifiCorp
Iron Gate Reservoir at Williams Boat Ramp	192.4	PacifiCorp
Klamath River below Iron Gate Dam (Hatchery Bridge)	189.7	PacifiCorp
Klamath River at I-5 Rest Area	176	Karuk
Klamath River at Brown Bear River Access	157.5	Karuk
Klamath River at Seiad Valley	128.5	Karuk
Klamath River at Happy Camp	108.4	Karuk
Klamath River at Orleans	59.1	Karuk
Klamath River at Weitchpec	43.5	Yurok
Klamath River at Turwar	6.0	Yurok

Table 2: Klamath River IM 15 Monitoring Program 2013 – Summary Table of Public Health monitoring locations, constituents, method, and frequency

Site ID	**Location**	**Phyto-plankton Species**	**Microcystin - EPA**	**LC/MS/MS water for cyanotoxins**	**Sampling Entity**
KR2008	Copco Reservoir at Mallard Cove	BM7-mod	BM7-mod	S	PacifiCorp
KR1985	Copco Reservoir at Copco Cove	BM7-mod	BM7-mod	S	PacifiCorp
KR1928	Iron Gate Reservoir at Camp Creek	BM7-mod	BM7-mod	S	PacifiCorp
KR1924	Iron Gate Reservoir at Williams Boat Ramp	BM7-mod	BM7-mod	S	PacifiCorp
KR1897	Klamath River below Iron Gate Dam (Hatchery Bridge)	BM/W	BM/W	-	PacifiCorp
KR1760	Klamath River at I-5 Rest Area	BM/W	BM/W	-	Karuk
KR1575	Klamath River at Brown Bear River Access	BM/W	BM/W	-	Karuk
KR1285	Klamath River at Seiad Valley	BM/W	BM/W	-	Karuk
KR1084	Klamath River at Happy Camp	BM/W	BM/W	-	Karuk
KR0591	Klamath River at Orleans	BM/W	BM/W	BM5	Karuk
KR0435	Klamath River at Weitchpec	BM/W	BM/W	-	Yurok
KR0060	Klamath River at Turwar	BM/W	BM/W	-	Yurok

Frequency	# of sample events	Sampling frequency description
BM7-mod	9	1x month in May and 2x month June, July, October, and November (omits August and September)
BM/W	16	Timing of public health monitoring will be at the discretion of the sampling entity and will follow the CA BGA posting guidelines
BM5	10	2x month June-October
S	4	Analysis for anatoxin-a will be tied to the temporal and density distribution of *Anabaena* in the reservoirs but 4 test analysis are budgeted.

5.1.2 Sampling Frequency

Sampling for public health monitoring under this plan will occur at each of the identified sites as listed in Table 2:

For Copco and Iron Gate Reservoirs:

Public health sampling in Copco and Iron Gate reservoirs will begin in May, and then continue until the reservoirs are posted with health advisories[1], which usually happens by the end of July. Once the reservoirs are posted, no public health sampling is planned during August and September since the reservoirs will have been posted and based on previous years sampling (2005-2012), MSAE cell counts and/or microcystin levels will remain elevated until cooler weather and shorter days terminate the blooms. Sampling will resume in October to provide the data needed to de-post the reservoirs.

Following the schedule in Table 2, samples will be collected and submitted for identification and enumeration of toxigenic phytoplankton species and analysis of total microcystins by ELISA. This data will then be provided to regulatory agencies (e.g., California's North Coast Regional Water Quality Control Board) to inform whether criteria have been met to warrant the posting of public health advisories and to provide the necessary information to lift the advisories.

Since 2010, an effort has been made to see if anatoxin-a is present when *Anabaena flos-aquae* is detected. Although the results for anatoxin-a have been non-detect for samples analyzed to date, additional sampling in 2013 will support further screening for the presence of anatoxin-a. Therefore, up to four reservoirs samples will be analyzed for anatoxin-a when elevated cell levels of *Anabaena* are present. These samples will be collected and frozen, and those samples having cell identification / enumeration results exceeding 40,000 *Anabaena* cells/mL will be submitted for anatoxin-a analysis.

For the Klamath River below Iron Gate dam:

A total of at least sixteen shoreline samples will be collected for toxigenic algae speciation and microcystin (ELISA) analysis to track cyanobacterial bloom conditions in the Klamath River below Iron Gate dam. Timing of public health monitoring will be at the discretion of the sampling entity to support posting in accordance with California's posting guidelines (SWRCB, 2010).

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[1] The California State Water Resources Control Board (SWRCB 2010) and Oregon Department of Health Services (ODHS 2005) provide guidelines for posting advisories in recreation waters. These guidelines were developed using information provided in WHO (2003). Both SWRCB (2010) and ODHS (2005) recommend posting advisories in recreation waters under three circumstances: (1) if "scum is present associated with toxigenic species"; (2) if scum is not present, but the density of *Microcystis* or *Planktothrix* is 40,000 cells/ml or greater; and (3) if scum is not present, but the density of all potentially toxigenic BGA is 100,000 cells/ml or greater. Based on WHO (2003) information, SWRCB (2010) and ODHS (2005) indicate that cell counts of 40,000 and 100,000 cells/ml equate to microcystin toxin concentrations of 8 μg/L and 20 μg/L, respectively.

To confirm ELISA results for microcystin, to see which microcystin congeners are present, and to test for the presence of anatoxin-a, a total of ten (10) water samples will be collected at one location (Orleans (Table 2)) for analysis by LC/MS/MS, on a bimonthly basis from June through October.

5.1.3. Sampling Procedures

Under the 2012 IM 15 monitoring program, water samples will be collected for phytoplankton species cell identification/enumeration to determine the presence and abundance of cyanobacterial species (e.g., *Anabaena sp.*, *Aphanizomenon sp.*, *Microcystis sp.*, etc). Depending on the severity (e.g., density and size) of the algal bloom and timing (e.g., pending decision to post a reach due to species and cell density) reach monitoring entities will specify whether a 48-hour rush or a 2-week turnaround will be requested for the phytoplankton sample analysis.

Water samples will also be collected for cyanotoxin analysis by one or two methods:

- Enzyme-Linked ImmunoSorbent Assay (ELISA) for total microcystins, analyzed by the U.S. EPA Region 9 laboratory, in accordance with the U.S. EPA Region 9 Laboratory Standard Operating Procedure (SOP 1305 for Microcystin analysis by ELISA), and

- Liquid Chromatography - tandem Mass Spectrometry (LC/MS/MS) for microcystin congeners and anatoxin-a analysis (per Mekebri et. al., 2009), at the California Department of Fish and Game laboratory in Rancho Cordova, CA.

All of the public health samples will be analyzed using ELISA; LC/MS/MS will be conducted at selected locations (see Table 2). Sample collection and preservation will be conducted in accordance with the Cyanobacteria SOP (KBGAWG 2009).

5.1.2. Public Health Data

Criteria to be used for purposes of protecting public health include those presented in California's Draft Voluntary Statewide Guidance for Cyanobacteria in California Recreational Water Bodies (SWRCB, 2010). Exceedances of criteria for the protection of human health and aquatic life (summarized below) may result in the posting of a waterbody by state or local health agencies:

- Surface scums are present containing toxigenic species[2];
- *Microcystis aeruginosa* or *Planktothrix* cell densities $\geq$ 40,000 cells/mL;

[2] When using the presence of scums to establish the need to post, staff should be trained in recognizing *Microcystis aeruginosa* scums, compile a photographic record in accordance with SWRCB 2009, as part of the monitoring program.

- Other potentially toxigenic cyanobacteria ≥100,000 cells/mL;
- Total microcystin concentrations ≥ 8 µg/L; and
- Other, as specified in the California State Water Board 2010 Guidance.

5.2 Monitoring Component 2: Comprehensive Baseline Water Quality Monitoring of the Klamath River

5.2.1 Locations

The baseline water quality monitoring locations, constituents, and sampling frequency are presented in Appendix A. Twenty mainstem sites including the Klamath River estuary, and the mouths of four major tributaries, are identified for baseline monitoring. Reservoir sites are being sampled at multiple depths. The exception to this is J.C. Boyle reservoir. Baseline sampling in this reservoir was eliminated in 2012; because the J.C. Boyle Reservoir is more riverine in nature, the sampling stations located above and below the reservoir were deemed adequate by the sampling entities to capture the nutrient composition in this section of the river. Only chlorophyll a, phytoplankton and microcystin are collected seasonally at this location.

5.2.2 Sampling Procedures

The Cyanobacteria SOP (KBGAWG 2009) is used for cyanobacterial water collection. Other sampling methods for baseline monitoring will follow each sampling entities QA plans.

5.2.3 Sampling Constituents and Frequency

Listed below are constituents sampled for the baseline monitoring plan. The baseline monitoring will begin in February 2013 and continue through December 2013.

Data Collection Using Sondes

For each of the following parameters, capturing sub-daily variability is important to understanding the dynamics present in the system. Continuous monitoring devices, with probes for the following parameters (at a minimum) will be deployed to address the period May to November.

- Temperature
- Dissolved Oxygen
- pH
- Conductance

Data Collection by Sampling

Table 3 outlines the sampling locations and frequency. The following parameters will be sampled during 2013 at least monthly, with a few exceptions.

- CBOD
- Inorganic/Organic Nitrogen (ammonia, nitrate, nitrite, organic N)Total Nitrogen
- Total Kjeldahl Nitrogen (TKN) (only at Upper Basin sites)
- Inorganic/Organic Phosphorus (orthophosphate, organic P)
- Particulate and Dissolved Carbon
- Total and Volatile Suspended Solids (TSS / VSS)
- Alkalinity
- Water Column Chlorophyll a/pheophytin
- Microcystin
- Phytoplankton
- Particulate and Dissolved Organic Carbon
- Particulate Nitrogen
- Particulate Phosphorous and Particulate Inorganic Phosphorus
- Dissolved Organic Nitrogen and Phosphorus

Most of the parameters listed above have been part of settlement agreement monitoring programs since 2009. Modifications to the sampling are anticipated as management actions change and science and monitoring program designs evolve.

Several modifications were made to the baseline sampling program in 2012. Particulate and dissolved organic carbon, particulate N and turbidity were added to the parameters sampled. Several changes were also made to the sampling frequency in 2012. The details and rationale for these changes can be found in the 2012 study plan located on the KBMP website.

6.0 SPECIAL STUDIES

In 2013, IM 15 will continue to fund a periphyton study in the Klamath River to characterize the periphyton community and develop sampling protocols that are unique to the river. The sampling plan details are in Appendix B. This study builds on the 2011 and 2012 periphyton studies.

References

Klamath Blue Green Algae Working Group (KBGAWG), 2009. Cyanobacteria Sampling SOP, Standard Operating Procedures Environmental Sampling of Cyanobacteria for Cell Enumeration, Identification and Toxin Analysis; Developed for the 2009 AIP Interim Measure 12, Water Quality Monitoring Activities, Klamath River, V6, June 24, 2009

SWRCB. 2010. Draft Voluntary Statewide Guidance for Blue-Green Alge Blooms. Cyanobacteria in California Recreational Water Bodies: Providing Voluntary Guidance about Harmful Algal Blooms, Their Monitoring, and Public Notification. Document by the Blue Green Algae Work Group of the State Water Resources Control Board (SWRCB), the California Department of Public Health (CDPH) and the Office of Environmental Health and Hazard Assessment (OEHHA). July 2010. http://www.cdph.ca.gov/HealthInfo/environhealth/water/Documents/BGA/BGAdraftvoluntarystatewideguidance-07-09-2010.pdf.

WHO. 2003. Cyanobacterial Toxins: Microcystin-LR in Drinking Water. Background document for the development of WHO Guidelines for Drinking-Water Quality. World Health Organization. Geneva.

APPENDIX B

2013 Klamath River Periphyton Study Plan

PURPOSE

The benthic community is often an important element of aquatic system condition, supporting a diverse flora and fauna that plays a role in the physical, chemical, and biological response in riverine systems (Naimen et al, 2009). An important element of the benthic community is the periphyton community. Although periphyton data in the Klamath River has been collected in the basin for several years, the record is spatially and temporally incomplete.

Benthic periphyton sampling is being proposed to a) form an initial baseline sampling program to define current conditions, and b) continue to identify potential a systematic approach for characterizing the periphytic algal community in the Klamath River by continuing to collect samples at the same sites as in 2011 and 2012 with comparable methods. Proposed sites extend from Iron Gate Dam to Turwar Gage. The proposed sampling would employ KHSA Interim Measure #15 funding in 2013. The Yurok and Karuk Tribes will complete baseline sampling as in previous years. No exploratory element will be included in this study. Effort will be made to look at the 2011 and 2012 results when summarizing the 2013 data set.

PROJECT HYPOTHESIS

Several hypotheses outlined for study in 2013 have been identified as part of previous studies:

- Periphyton species composition (spp. ID and enumeration) and algal biomass changes through time at individual sites during the principal growing season (July to November) in response to physical, chemical, and biological conditions.

The first hypothesis has been illustrated through at least three years of data (2004, 2011 and 2012), but additional years are desired to identify potential inter-annual variability and consistent trends.

STUDY DESIGN AND HYPOTHESES

Longitudinal Monitoring

The purpose of this sampling study is to compare periphyton species and algal biomass spatial and temporal trends in the Klamath River from July to November (approximately middle of month sampling time) utilizing a standard sampling method. Each sampling entity will be responsible for collecting samples consistent with the final sampling protocol (to be updated from the 2012 protocol) and proper sample handling to submit samples to the laboratory for analysis. The same laboratory will be selected to process the species identification and enumeration samples (Aquatic Analysts Inc.) and periphyton algal biomass (Aquatic Research Inc.)

Nine sites have been identified for sampling periphyton in 2013 (Table 1). These sites may change in location depending on access and local conditions (e.g., safety, adequately substrate, lack of disturbance, shade, or other factors). One site has been added below the confluence of the Scott River. This site has been added to identify the periphytic assemblage below a major tributary impaired by high sediment loads.

Table 1. Sampling sites on the Klamath River for the 2013 Periphyton Study

Location	Approximate River Mile	Agency
below Iron Gate Dam	189	Karuk
Interstate 5 Bridge	179.3	Karuk
below Beaver Creek(nr Quigley's store)	160.5	Karuk
Seiad Valley (Sluice Box river access)	130	Yurok
Happy Camp	103	Yurok
Orleans	60	Yurok
Weitchpec (ab Trinity)	43.5	Yurok
Turwar	6	Yurok

In addition to the five-rock composite samples, additional observations will be collected at each site to enhance the interpretation of the species identification and enumeration. Specifically, the following observations will be included in the data sheet and reported in an end of season data report:

- Depth and velocity measurements at the sampling location. As per existing protocols, substrate is to be sampled in 1 to 3 feet of water where velocities are 1 to 3 feet per second. In the field this information is estimated at the time of sampling, but specifically measuring and recording this information will be included in 2013. Mean profile velocities (e.g., 60% depth) will be recorded with a current meter.
- Photosynthetically available radiation (PAR) will be measured with a PAR meter at multiple depths at the sampling site (in a nearby, representative area in minimum of 3 feet of water). These data will be recorded and processed to estimate light extinction characteristics for each site during each visit.
- A qualitative description of the substrate will be included (e.g., previous year screen counting grid).

Species identification and enumeration metrics will be reported for each sampling site.

SAMPLING METHOD

As part of this study, the project team will expand on the sampling program developed in 2011 and 2012 and consider specific conditions within the Klamath River. Updated protocols will be discussed, future research areas identified, and the final set of working protocols included in final documentation.

DATA SUMMARY AND REPORTING

Each sampling entity will generate agreed upon metrics to summarize sampling results and compile the technical memoranda identified above.

REFERENCES

Naiman, R.J., H. Decamps, M.E. McClain. 2005. *Riparia: Ecology, Conservation, and Management of Streamside Communities*. Elsevier Academic Press. Boston. 430 pp.

Klamath River KHSA (Interim Measure 15) Monitoring Program 2013

Summary Table of Public Health monitoring locations, constituents, method, and frequency

Site ID	**Location**	**Phyto-plankton Species**	**Microcystin - EPA**	**LC/MS/MS**	**Sampling Entity**
KR2008	Copco Reservoir at Mallard Cove	BM-mod	BM-mod	S	PacifiCorp
KR1985	Copco Reservoir at Copco Cove	BM-mod	BM-mod	S	PacifiCorp
KR1928	Iron Gate Reservoir at Camp Creek	BM-mod	BM-mod	S	PacifiCorp
KR1924	Iron Gate Reservoir at Williams Boat Ramp	BM-mod	BM-mod	S	PacifiCorp
KR1897	Klamath River below Iron Gate Dam (Hatchery Bridge)	BM/W	BM/W	-	PacifiCorp
KR1760	Klamath River at I-5 Rest Area	BM/W	BM/W	BM5	Karuk
KR1575	Klamath River at Brown Bear River Access	BM/W	BM/W	-	Karuk
KR1285	Klamath River at Seiad Valley	BM/W	BM/W	-	Karuk
KR1084	Klamath River at Happy Camp	BM/W	BM/W	-	Karuk
KR0591	Klamath River at Orleans	BM/W	BM/W	-	Karuk
KR0435	Klamath River at Weitchpec	BM/W	BM/W	-	Yurok
KR0060	Klamath River at Turwar	BM/W	BM/W	-	Yurok

CODES

Frequency	Sampling frequency description	# of sample events
BM-mod	1x month in May and 2x month June, July, August, September, October, and November	13
BM/W	timing of public health monitoring will be at the discretion of the sampling entity and will follow the CA BGA posting guidelines	16
BM5	2x month June-October	10
S	Analysis for anatoxin-a will be tied to the temporal and density distribution of *Anabaena* in the reservoirs but 4 test analysis are budgeted.	4

Appendix A

2013 KHSA (Interim Measure 15) baseline water quality monitoring

Location	Temperature (oC)	Dissolved Oxygen (mg/l)	pH (log[H+])	Conductance (uS/cm)	Total N (mg/l)	Ammonia N (mg/l)	TKN (mg/l)	Nitrite+Nitrate (mg/l)	Total P (mg/L)	Ortho P (mg/L)	Particulate P & Particulate Inorganic P (mg/l)	Dissolved Organic N & P (mg/l)	Particulate and Dissolved C (mg/l)	Particulate N (mg/l)	TSS/VSS (mg/l)	Alkalinity (mg/l)	Water Column chl_a/Phe	Phytoplankton species	Microcystin (ug/l)	LCMS confirmation	CBOD, mg/l	turbidity, (NTU)	Sampling Entity
Sampling Method:	*T,P*	*P*	*P*	*P*	*G*	*G*	*G*	*G*	*G*	*G*	*G*	*G*	*G*	*G*	*G*	*G*	*G*	*G*	*G*	*G*	*G*	*G*	
Link Dam (RM - 254.4)	H	H	H	H		M/BM	M/BM	M/BM	M/BM	M/BM	M/BM	M/BM	M/BM	M/BM	M/BM	M/BM	M/BM	M/BM	BM/S		M2/BM2	M2/BM2**	USBR
Keno Reservoir at Miller Island (RM - 234.9)	H	H	H	H		M	M	M	M	M			M		M	M	M	M	M/S		M	M	USBR
KR below Keno Dam (RM -233.4) near a USGS gage	H	D	D	D		M2/BM2	M2/BM2	M2/BM2	M2/BM2	M2/BM2	M		M	M	M	M2/BM2**	M	M	M/S		M2/BM2	M2/BM2**	USBR
KR above J.C. Boyle Reservoir (RM-228.2)	H	D	D	D	M	M		M	M	M			M		M	M	M	M-					PacifiCorp
J.C. Boyle Reservoir[a] (RM-226.0)	VP	VP	VP	VP													M/S	M/S	M/S				PacifiCorp
KR below J.C. Boyle Dam (RM-224.0)	H	D	D	D	M	M		M	M	M			M		M	M	M	M-					PacifiCorp
KR below USGS Gage (RM-219.5)	H	D	D	D	M	M		M	M	M			M		M	M	M	M	M/S			M	PacifiCorp
KR near Stateline (RM-206.4)	H	D	D	D	M2/BM2	M2/BM2		M2/BM2	M2/BM2	M2/BM2	M		M	M	M	M	M	M	M/S		M2/BM2	M	PacifiCorp
Copco Reservoir[b] (RM-199.0)	VP	VP	VP	VP	M	M		M	M	M			M		M	M	M	M-	M/S				PacifiCorp
KR below Copco Dam (RM-195.0)	H	D	D	D	M	M		M	M	M			M		M	M	M	M-	M/S				PacifiCorp
Iron Gate Reservoir[c] (RM-192.0)	VP	VP	VP	VP	M	M		M	M	M			M		M	M	M	M-	M/S				PacifiCorp
KR below Iron Gate Dam (RM-189.7)	H	H	H	H	M/BM	M/BM		M/BM	M/BM	M/BM	M/BM		M/BM	M/BM	M/BM	M/BM	M/BM	M/BM	BM/S		M2/BM2	M/BM	PacifiCorp
KR at Walker Bridge (RM- 176.7)	H	D	D	D	M	M		M	M	M			M		M	*	M	M-	M/S	S2			Karuk
KR below Seiad (RM - 128.5)	H	H	H	H	M	M		M	M	M	M		M	M	M	*	M	M	M/S		M	M	Karuk
KR near Happy Camp (RM-93.5)	H	D	D	D	M	M		M	M	M			M		M	*	M	M-	M/S				Karuk
KR at Orleans (USGS) (RM-59.1)	H	H	H	H	M	M		M	M	M			M		M	M	M	M	M/S			M	Karuk
KR at Weitchpec (RM-43.5)	H	H	H	H	M	M		M	M	M			M		M	*	M	M-	M/S	S2			Yurok
KR below Trinity River (RM-38.5)	H	H	H	H	M	M		M	M	M			M		M	*	M	M-	M/S				Yurok
KR near Klamath (RM-6.0)	H	H	H	H	M	M		M	M	M	M		M	M	M	*	M	M	M/S			M	Yurok
KR Estuary^d (RM-0.5)	HP	D	D	D	M	M		M	M	M			M		M	*	M	M-	M/S				Yurok
Shasta River near mouth	H	H	H	H	M	M		M	M	M			M		M	*	M	*				M	Karuk
Scott River near mouth	H	H	H	H	M	M		M	M	M			M		M	*	M	*				M	Karuk
Salmon River near mouth	H	H	H	H	M	M		M	M	M			M		M	*	M	*				M	Karuk
Trinity River near mouth	H	H	H	H	M	M		M	M	M			M		M	*	M	*				M	Yurok

[a] Sampling at one depth in J.C. Boyle reservoir (0.5 m depth = surface)

[b] Sampling at 3 depth Intervals in Copco reservoir (0.5 m, thermocline and 0.5m from the

[c] Sampling at 3 depth intervals in Iron Gate reservoir (0.5, thermocline and 0.5m from the

[d] Hourly sampling in the estuary at 4 locations (two in lower estuary, one in mid estuary and one in upper estuary)at two depths (0.5m and bottom)

Key

Sampling Method
T – thermistor
P – probe or data sonde
G – grab sample
D – discrete sample

Sampling Frequency
VP – vertical profile at stated sampling frequency
H – hourly measurements by sondes (in some instances sub-hourly data may be desired)
M – monthly sampling, excluding January
M/S – monthly sampling, seasonally from May through October
M/BM – Bi-monthly sampling May - October and monthly sampling the remainder of the year
M2/BM2 – Bi-monthly sampling June-September and monthly the remainder of the year
BM/S –Bimonthly sampling July-Oct
S2 – monthly sampling July - Oct
* - Not sampled This parameter is covered M/S by Tribal WQ Workgroup
M- = Monthly Sampling with exception of December, January and February
M2/BM2 **– Bi-monthly sampling June-September and monthly the remainder of the year and consider adding May and October to go to M/BM
HP - Hourly measurements in a profile