

TECHNICAL MEMORANDUM

Results of Cyanobacteria and Microcystin Monitoring in the Vicinity of the Klamath Hydroelectric Project: July 18th, 2011

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Introduction

This technical memorandum summarizes the latest results of public health monitoring during 2011 for cyanobacteria species and the associated toxin microcystin in Copco and Iron Gate reservoirs in PacifiCorp's Klamath Hydroelectric Project (Project) and at one monitoring station in the Klamath River below Iron Gate Dam. This monitoring is particularly focused on *Microcystis aeruginosa* (MSAE), a cyanobacterium that is known to produce microcystin, with a recent history of summertime blooms in Copco and Iron Gate reservoirs. This monitoring also estimates the presence of other potentially-toxicogenic cyanobacteria, including *Anabaena* spp. and *Planktothrix* (*Oscillatoria*) spp. This monitoring is being conducted pursuant to Interim Measure 15, Water Quality Monitoring Activities, contained in the Klamath Hydroelectric Settlement Agreement (KHSA) executed between the United States Department of Interior, the states of California and Oregon, PacifiCorp, and other parties.

The results addressed in this memorandum are specifically for samples collected on July 18th, 2011. Subsequent memoranda will be prepared approximately every two weeks to report the results of continued monitoring.

Methods

PacifiCorp is conducting phytoplankton sampling for laboratory analysis of potentially toxicogenic cyanobacteria, notably MSAE, and microcystin at four sites in Copco and Iron Gate reservoirs and one site below Iron Gate Dam (listed in Table 1), including:

- Four shoreline sites in coves in Copco and Iron Gate reservoirs (i.e., two cove sites in each reservoir).
- One Klamath River site below Iron Gate Dam near the hatchery bridge.

Samples will be taken at the shoreline locations in the reservoirs once in May and twice per month in June, July, October, and November. Samples for the river site below Iron Gate Dam are scheduled to be collected twice per month in June, July and October and weekly in August and September but may change due to river conditions. Sampling in the river would increase when the potential for blooms exists.

Phytoplankton samples from the river sites are taken as grab samples offshore according to the standard operating procedure (SOP) developed by the Klamath Blue Green Algae Working Group (<http://www.kbmp.net/collaboration/klamath-hydroelectric-settlement-agreement-monitoring>). Additional samples at open water sites in Copco and Iron Gate reservoirs, including a grab sample at 0.5 m depth and an integrated sample over 8 m depth, will be collected as part of the baseline water quality monitoring.

Samples for potentially toxic phytoplankton are preserved in Lugol's solution and sent to Aquatic Analysts in Friday Harbor, Washington for analysis. The laboratory analysis of phytoplankton speciation and abundance is performed on prepared microscope slides of filtered samples using phase contrast microscopy. Species are counted as algal units of cell, filament, or colony depending on the natural growth form of the species. Algal forms are identified to species or otherwise to the lowest practicable taxonomic level. Biovolumes are estimated by multiplying the cell counts by the average geometric dimensions of the cells for a given phytoplankton taxon. Results for cyanobacteria species are reported as individual cells per milliliter.

Samples for determination of microcystin toxin are placed in a cooler on ice and shipped to the EPA Region 9 Laboratory in Richmond, California. The samples are analyzed using the competitive Enzyme-Linked ImmunoSorbent Assay (ELISA) method based on the EnviroLogix QuantiPlate Kit for microcystins. The quantitation limit is 0.18 µg/L or parts per billion (ppb). This test method does not distinguish between the specific microcystin congeners, but detects their presence to differing degrees. That is, ELISA test results yield one value as the sum of all measurable microcystin variants.

Table 1. Sites of cyanobacteria and microcystin public health monitoring in Copco and Iron Gate reservoirs during 2011.		
Location	Approximate River Mile	Site ID
Copco Reservoir at Mallard Cove ramp	201.5	CRMC
Copco Reservoir at Copco Cove ramp	200.0	CRCC
Iron Gate Reservoir at Camp Creek ramp	192.8	IRCC
Iron Gate Reservoir at John Williams campground	192.4	IRJW
Klamath River below Iron Gate dam near hatchery bridge	189.7	KRBI

Results

Samples of July 18th, 2011

Five samples and four samples were collected for public health purposes on July 18th 2011, from shoreline stations in Copco and Iron Gate reservoirs and the Klamath River below Iron Gate dam. Aliquots were sent to the EPA Region 9 laboratory for analysis for Microcystin via ELISA, to Aquatic Analysts for cyanobacteria species identification and enumeration, and held for potential subsequent analysis for microcystin via LCMS.

Cell counts for cyanobacteria samples, as well as microcystin results collected on July 18, 2011, were below California's public health posting criteria (SWRCB 2010). The results of cyanobacteria species identification and enumeration are summarized in Table 2. The results of microcystin analysis are summarized in Table 3.

Table 2. Summary of cyanobacteria public health monitoring on July 18, 2011.

Date	Sample	Location	Species	Biovolume ($\mu\text{m}^3/\text{mL}$)	Cells/mL
07/18/11	KR11827	CRMC	Anabaena flos-aquae	131,944	1,969
07/18/11	KR11828	CRCC	Anabaena flos-aquae	3,082,134	46,002
07/18/11	KR11828	CRCC	Aphanizomenon flos-aquae	623,338	9,894
07/18/11	KR11829	IRCC	Anabaena flos-aquae	506,274	7,556
07/18/11	KR11829	IRCC	Aphanizomenon flos-aquae	18,170	288
07/18/11	KR11829	IRCC	Anabaena sp.	2,451	36
07/18/11	KR11829	IRCC	Microcystis aeruginosa	8,652	1,082
07/18/11	KR11830	IRJW	Aphanizomenon flos-aquae	1,186,477	8,762
07/18/11	KR11830	IRJW	Anabaena flos-aquae	587,073	18,833
07/18/11	KR11830	IRJW	Anabaena sp.	20,221	297
07/18/11	KR11833	KRBI	Aphanizomenon flos-aquae	6,899	110
07/18/11	KR11833	KRBI	Anabaena flos-aquae	3,252	49
07/18/11	KR11833	KRBI	Microcystis aeruginosa	498	62

Table 3. Summary of microcystin public health monitoring on July 18, 2011.

Date	Sample	Location	Result	Units
07/18/11	KR11827	CRMC	ND	$\mu\text{g/L}$
07/18/11	KR11828	CRCC	0.57	$\mu\text{g/L}$
07/18/11	KR11829	IRCC	0.36	$\mu\text{g/L}$
07/18/11	KR11830	IRJW	0.30	$\mu\text{g/L}$
07/18/11	KR11833	KRBI	ND	$\mu\text{g/L}$

References

SWRCB. 2010. Cyanobacteria in California Recreational Water Bodies: Providing Voluntary Guidance about Harmful Algal Blooms, Their Monitoring, and Public Notification. July 2010. Document provided as part of Blue-green Algae Work Group of State Water Resources Control Board (SWRCB) and Office of Environmental Health and Hazard Assessment (OEHHA).

Appendix 1

Cumulative Species data for 2011 Public Health Samples.

Date	Sample	Location	Species	Biovolume, $\mu\text{m}^3/\text{mL}$	Cells/mL
05/24/11	KR11800	CRMC	None	0	0
05/24/11	KR11801	CRCC	None	0	0
05/24/11	KR11802	IRCC	None	0	0
05/24/11	KR11803	IRJW	None	0	0
05/24/11	KR11804	CRCC	None	0	0
06/06/11	KR11806	CRMC	<i>Anabaena flos-aquae</i>	9,623	144
06/06/11	KR11807	CRCC	None	0	0
06/06/11	KR11808	IRCC	None	0	0
06/06/11	KR11809	IRJW	None	0	0
06/06/11	KR11812	KRBI	None	0	0
06/22/11	KR11813	CRMC	<i>Aphanizomenon flos-aquae</i>	49,869	792
06/22/11	KR11813	CRMC	<i>Microcystis aeruginosa</i>	1,277	160
06/22/11	KR11814	CRCC	<i>Anabaena flos-aquae</i>	378,226	5,645
06/22/11	KR11814	CRCC	<i>Aphanizomenon flos-aquae</i>	201,984	3,206
06/22/11	KR11815	IRCC	<i>Aphanizomenon flos-aquae</i>	23,588	374
06/22/11	KR11815	IRCC	<i>Anabaena sp.</i>	2,572	38
06/22/11	KR11815	IRCC	<i>Anabaena flos-aquae</i>	1,267	19
06/22/11	KR11815	IRCC	<i>Microcystis aeruginosa</i>	1,210	151
06/22/11	KR11816	IRJW	None	0	0
07/05/11	KR11820	CRMC	None	0	0
07/05/11	KR11821	CRCC	None	0	0
07/05/11	KR11822	IRCC	<i>Oscillatoria sp.</i>	1,268	20
07/05/11	KR11823	IRJW	<i>Aphanizomenon flos-aquae</i>	2,208	35
07/05/11	KR11823	IRJW	<i>Anabaena flos-aquae</i>	7,044	105
07/05/11	KR11824	KRBI	<i>Aphanizomenon flos-aquae</i>	13,708	218
07/18/11	KR11827	CRMC	<i>Anabaena flos-aquae</i>	131,944	1,969
07/18/11	KR11828	CRCC	<i>Anabaena flos-aquae</i>	3,082,134	46,002
07/18/11	KR11828	CRCC	<i>Aphanizomenon flos-aquae</i>	623,338	9,894
07/18/11	KR11829	IRCC	<i>Anabaena flos-aquae</i>	506,274	7,556
07/18/11	KR11829	IRCC	<i>Aphanizomenon flos-aquae</i>	18,170	288
07/18/11	KR11829	IRCC	<i>Anabaena sp.</i>	2,451	36
07/18/11	KR11829	IRCC	<i>Microcystis aeruginosa</i>	8,652	1,082
07/18/11	KR11830	IRJW	<i>Aphanizomenon flos-aquae</i>	1,186,477	8,762
07/18/11	KR11830	IRJW	<i>Anabaena flos-aquae</i>	587,073	18,833
07/18/11	KR11830	IRJW	<i>Anabaena sp.</i>	20,221	297
07/18/11	KR11833	KRBI	<i>Aphanizomenon flos-aquae</i>	6,899	110
07/18/11	KR11833	KRBI	<i>Anabaena flos-aquae</i>	3,252	49
07/18/11	KR11833	KRBI	<i>Microcystis aeruginosa</i>	498	62

Appendix 2

Laboratory Data Sheets for July 18, 2011 Public Health Samples.

Phytoplankton Sample Analysis					
Sample:		Klamath Basin			
Sample Site:		KR 11827			
Sample Depth:					
Sample Date:		18-Jul-11			
Total Density (#/mL):		42			
Total Biovolume (um ³ /mL):		131,944			
Trophic State Index:		35.3			
Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent	Group
1 Anabaena flos-aquae	42	100.0	131,944	100.0	bluegreen
Anabaena flos-aquae cells/mL =		1,969			
Note: Toxic Algae Only					
Aquatic Analysts			Sample ID: PM86		

Phytoplankton Sample Analysis					
Sample:		Klamath Basin			
Sample Site:		KR 11828			
Sample Depth:					
Sample Date:		18-Jul-11			
Total Density (#/mL):		1,138			
Total Biovolume (um ³ /mL):		3,705,472			
Trophic State Index:		59.3			
Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent	Group
1 Anabaena flos-aquae	708	62.2	3,082,134	83.2	bluegreen
2 Aphanizomenon flos-aquae	430	37.8	623,338	16.8	bluegreen
Aphanizomenon flos-aquae cells/mL =		9,894			
Anabaena flos-aquae cells/mL =		46,002			
Note: Toxic Algae Only					
Aquatic Analysts			Sample ID: PM87		

Phytoplankton Sample Analysis					
	Sample:	Klamath Basin			
	Sample Site:	KR 11829			
	Sample Depth:				
	Sample Date:	18-Jul-11			
	Total Density (#/mL):	83			
	Total Biovolume (um³/mL):	535,547			
	Trophic State Index:	45.3			
Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent	Group
1 Anabaena flos-aquae	58	69.6	506,274	94.5	bluegreen
2 Aphanizomenon flos-aquae	18	21.7	18,170	3.4	bluegreen
3 Anabaena sp.	4	4.3	2,451	0.5	bluegreen
4 Microcystis aeruginosa	4	4.3	8,652	1.6	bluegreen
	Anabaena flos-aquae cells/mL =	7,556			
	Aphanizomenon flos-aquae cells/mL =	288			
	Anabaena sp. cells/mL =	36			
	Microcystis aeruginosa cells/mL =	1,082			
	Note: Toxic Algae Only				
Aquatic Analysts			Sample ID:	PM88	

Phytoplankton Sample Analysis					
Sample:		Klamath Basin			
Sample Site:		KR 11833			
Sample Depth:					
Sample Date:		18-Jul-11			
Total Density (#/mL):		10			
Total Biovolume (um ³ /mL):		10,649			
Trophic State Index:		17.7			
Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent	Group
1 Aphanizomenon flos-aquae	5	50.0	6,899	64.8	bluegreen
2 Anabaena flos-aquae	4	37.5	3,252	30.5	bluegreen
3 Microcystis aeruginosa	1	12.5	498	4.7	bluegreen
Aphanizomenon flos-aquae cells/mL = 110					
Anabaena flos-aquae cells/mL = 49					
Microcystis aeruginosa cells/mL = 62					
Note: Toxic Algae Only					
Aquatic Analysts			Sample ID: PM91		