

TECHNICAL MEMORANDUM

Results of Cyanobacteria and Microcystin Monitoring in the Vicinity of the Klamath Hydroelectric Project: June 6th, 2013

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Introduction

This technical memorandum summarizes the results for the public health monitoring conducted June 6th, 2013 for cyanobacteria species and the associated toxin, microcystin, in Copco and Iron Gate reservoirs within PacifiCorp's Klamath Hydroelectric Project (Project) and at one monitoring station in the Klamath River below Iron Gate Dam. The public health monitoring is particularly focused on *Microcystis aeruginosa* (MSAE), a cyanobacterium with a recent history of summertime blooms in Copco and Iron Gate reservoirs and that is known to produce microcystin. but also estimates the presence of other potentially-toxic cyanobacteria, including *Anabaena* spp., *Planktothrix (Oscillatoria)* spp. and others. 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.

Methods

PacifiCorp is conducting public health sampling at 5 sites (Table 1) for laboratory analysis of potentially toxigenic cyanobacteria, notably MSAE, and microcystin at:

- 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 are planned to be taken at shoreline locations in the reservoirs once in May; and twice per month in June, July, August, September, October, and November. Samples to be collected from the river site below Iron Gate Dam are scheduled to be collected according to the discretion of the sampling entity (PacifiCorp) and will follow the California public health posting guidelines¹.

Public health 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 (BGA) Working Group (<http://www.kbmp.net/collaboration/klamath-hydroelectric-settlement-agreement-monitoring>). Additional samples, collected 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.

¹ The California State Water Resources Control Board provides guidelines for posting advisories in recreation water (SWRCB 2010). SWRCB recommends 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

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. 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 measurable microcystin variants.

Table 1. Sites of cyanobacteria and microcystin public health monitoring in Copco and Iron Gate reservoirs and the Klamath River during 2013.		
Location	Approximate River Mile	Site ID
Copco Reservoir at Mallard Cove	201.5	CRMC
Copco Reservoir at Copco Cove	200.0	CRCC
Iron Gate Reservoir at Camp Creek	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

Laboratory data sheets for the June 6th sampling are provided in Appendix 2. A summary of these result sheets is contained within Table 2. Because the cell counts for *Anabaena* were above the California posting guidelines for Copco Reservoir, public access areas in this reservoir were posted with public health advisory signs on June 18, 2013.

Table 2. Summary of public health monitoring (June 6th, 2013).

Date	Time	Location	RM	Sample ID	Depth	MSAE ⁽¹⁾	AFA ⁽²⁾	ANA ⁽³⁾	Other ^{(6), (7), (8), or (9)}	Microcystin (µg/L)
6/6/2013	14:15	CRMC	201.5	KR13805	SG	9,429	0	379,340	0	*
6/6/2013	16:00	CRCC	200.0	KR13806	SG	12,403	0	88,088	0	*
6/6/2013	15:30	IRCC	192.8	KR13807	SG	839	0	5,264	0	*
6/6/2013	15:15	IRJW	192.4	KR13808	SG	23	0	615	0	*
6/6/2013	15:20	IRJWdup	201.5	KR13809	SG	18	0	483	0	*

¹MSAE = *Microcystis aeruginosa* (cells/mL)

²AFA = *Aphanizomenon flos-aquae* (cells/mL)

³ANA = *Anabaena flos-aquae* (cells/mL)

Other = either ⁵*Planktothrix (Oscillatoria) sp.* or ⁶*Gloeotrichia echinulata* or ⁷*Anabaena sp.* or

⁸*Lyngbya sp.* (cells/mL) or ⁹*Anabaena circinalis* (cells/mL)

“0” value indicates non-detect by analytical laboratory

“*” value indicates results were not available upon the date this memo was submitted and will be included in subsequent memos as availability allows

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 Cyanobacteria Species data for 2013 Public Health Samples

Table 3. Summary of public health monitoring: 2013

Date	Time	Location	RM	Sample ID	Depth	MSAE ⁽¹⁾	AFA ⁽²⁾	ANA ⁽³⁾	Other ^{(6), (7), (8), or (9)}	Microcystin (µg/L)
5/20/2013	9:40	CRMC	201.5	KR13800	SG	0	0	0	0	ND
5/20/2013	11:15	CRCC	200.0	KR13801	SG	0	0	90	0	ND
5/20/2013	10:45	IRCC	192.8	KR13802	SG	0	0	0	0	ND
5/20/2013	10:30	IRJW	192.4	KR13803	SG	0	0	0	0	ND
5/20/2013	11:20	CRCC _{dup}	201.5	KR13804	SG	0	0	0	0	ND
6/06/2013	14:15	CRMC	201.5	KR13805	SG	9,429	0	379,340	0	*
6/06/2013	16:00	CRCC	200.0	KR13806	SG	12,403	0	88,088	0	*
6/06/2013	15:30	IRCC	192.8	KR13807	SG	839	0	5,264	0	*
6/06/2013	15:15	IRJW	192.4	KR13808	SG	23	0	615	0	*
6/06/2013	15:20	IRJW _{dup}	201.5	KR13809	SG	18	0	483	0	*

¹MSAE = *Microcystis aeruginosa* (cells/mL)

²AFA = *Aphanizomenon flos-aquae* (cells/mL)

³ANA = *Anabaena flos-aquae* (cells/mL)

Other = either ⁵*Planktothrix (Oscillatoria) sp.* or ⁶*Gloeotrichia echinulata* or ⁷*Anabaena sp.* or

⁸*Lyngbya sp.* (cells/mL) or ⁹*Anabaena circinalis* (cells/mL)

“0” value indicates non-detect by analytical laboratory

“*” value indicates results were not available upon the date this memo was submitted and will be included in subsequent memos as availability allows

Appendix 2

Laboratory Data Sheets June 6th, 2013 Public Health Sampling

Phytoplankton Sample Analysis					
Sample:		Klamath Basin			
Sample Site:		KR 13805			
Sample Depth:					
Sample Date:		6-Jun-13			
Total Density (#/mL):		11,335			
Total Biovolume (um ³ /mL):		25,491,227			
Trophic State Index:		73.2			
Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent	Group
1 Anabaena flos-aquae	10,838	95.6	25,415,795	99.7	bluegreen
2 Microcystis aeruginosa	496	4.4	75,431	0.3	bluegreen
Anabaena flos-aquae cells/mL =		379,340			
Microcystis aeruginosa cells/mL =		9,429			
Note: Toxic Algae Only					
Aquatic Analysts			Sample ID: RE47		
Phytoplankton Sample Analysis					
Sample:		Klamath Basin			
Sample Site:		KR 13806			
Sample Depth:					
Sample Date:		6-Jun-13			
Total Density (#/mL):		3,176			
Total Biovolume (um ³ /mL):		6,001,111			
Trophic State Index:		62.8			
Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent	Group
1 Anabaena flos-aquae	2,049	64.5	5,901,891	98.3	bluegreen
2 Microcystis aeruginosa	1,128	35.5	99,220	1.7	bluegreen
Anabaena flos-aquae cells/mL =		88,088			
Microcystis aeruginosa cells/mL =		12,403			
Note: Toxic Algae Only					
Aquatic Analysts			Sample ID: RE48		

Phytoplankton Sample Analysis					
Sample:		Klamath Basin			
Sample Site:		KR 13807			
Sample Depth:					
Sample Date:		6-Jun-13			
Total Density (#/mL):		305			
Total Biovolume (um ³ /mL):		359,435			
Trophic State Index:		42.5			
Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent	Group
1 Anabaena flos-aquae	229	75.0	352,721	98.1	bluegreen
2 Microcystis aeruginosa	76	25.0	6,714	1.9	bluegreen
Microcystis aeruginosa cells/mL =		839			
Anabaena flos-aquae cells/mL =		5,264			
Note: Toxic Algae Only					
Aquatic Analysts			Sample ID: RE49		
Phytoplankton Sample Analysis					
Sample:		Klamath Basin			
Sample Site:		KR 13808			
Sample Depth:					
Sample Date:		6-Jun-13			
Total Density (#/mL):		35			
Total Biovolume (um ³ /mL):		41,404			
Trophic State Index:		27.0			
Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent	Group
1 Anabaena flos-aquae	32	93.3	41,219	99.6	bluegreen
2 Microcystis aeruginosa	2	6.7	185	0.4	bluegreen
Anabaena flos-aquae cells/mL =		615			
Microcystis aeruginosa cells/mL =		23			
Note: Toxic Algae Only					
Aquatic Analysts			Sample ID: RE50		

Phytoplankton Sample Analysis						
	Sample:	Klamath Basin				
	Sample Site:	KR 13809				
	Sample Depth:					
	Sample Date:	6-Jun-13				
	Total Density (#/mL):	20				
	Total Biovolume (um ³ /mL):	32,519				
	Trophic State Index:	25.3				
		Density	Density	Biovolume	Biovolume	
	Species	#/mL	Percent	um ³ /mL	Percent	
					Group	
1	Anabaena flos-aquae	18	90.9	32,375	99.6	bluegreen
2	Microcystis aeruginosa	2	9.1	143	0.4	bluegreen
	Anabaena flos-aquae cells/mL =	483				
	Microcystis aeruginosa cells/mL =	18				
	Note: Toxic Algae Only					
	Aquatic Analysts			Sample ID:	RE51	