

TECHNICAL MEMORANDUM

Results of Cyanobacteria and Microcystin Monitoring in the Vicinity of the Klamath Hydroelectric Project:

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Introduction

This technical memorandum summarizes the results for the public health monitoring conducted during 2014 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. This monitoring is particularly focused on *Microcystis aeruginosa* (MSAE), which is known to produce microcystin. This monitoring 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.

Results from the public health sampling are used to determine if public health advisories are warranted¹. In addition to PacifiCorp's website (www.pacificorp.com/es/hydro/hl/kr.html#), these memos are also posted on the Klamath Basin Monitoring Program's (KBMP) website (www.kbmp.net) and inform the Blue Green Algae tracker on the KBMP website

The data summarized in this memorandum include results 2014 public health sampling events (see Appendix 1).

Methods

PacifiCorp is conducting public health sampling at 5 sites (Table 1) for laboratory analysis of potentially toxic 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) based on river conditions.

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 toxic 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 toxic BGA is 100,000 cells/ml or greater

Public health samples are taken as grab samples offshore according to the standard operating procedure (SOP) developed by the Klamath Blue Green Algae Working Group (www.kbmp.net/collaboration/klamath-hydroelectric-settlement-agreement-monitoring). Samples for potentially toxic phytoplankton are preserved in Lugol's solution and sent to Aquatic Analysts in Friday Harbor, Washington for analysis. 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.

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

Date	Time	Location	RM	Sample ID	Depth	MSAE ⁽¹⁾	AFA ⁽²⁾	ANA ⁽³⁾	Other ^{(5), (6), (7), (8), (9), or (10)}	Microcystin (µg/L)
5/20/2014	9:40	CRMC	201.5	KR13800	SG	0	0	0	0	ND
5/20/2014	11:15	CRCC	200.0	KR13801	SG	0	0	90	0	ND
5/20/2014	10:45	IRCC	192.8	KR13802	SG	0	0	0	0	ND
5/20/2014	10:30	IRJW	192.4	KR13803	SG	0	0	0	0	ND
6/10/2014	11:35	CRMC	201.5	KR13806	SG	0	0	253	0	0.23
6/09/2014	12:00	CRCC	200.0	KR13807	SG	0	0	256,920	0	ND
6/09/2014	11:20	IRCC	192.8	KR13808	SG	0	0	1,756	165	ND
6/09/2014	10:50	IRJW	192.4	KR13809	SG	0	0	433	0	ND
6/09/2014	15:45	KRBI	189.7	KR13810	SG	0	0	0	0	ND

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) or ¹⁰*Anabaena planctonica* (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

The June 9 sampling results from Copco Cove (CRCC) exceeded the California public health posting guidelines for *Anabaena* spp. (see Table 2), and all public access points on Copco reservoir were posted with health advisory signs on June 20, 2014.

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 2014 Public Health Samples

Table 3. Summary of public health monitoring: 2014

Date	Time	Location	RM	Sample ID	Depth	MSAE ⁽¹⁾	AFA ⁽²⁾	ANA ⁽³⁾	Other ^{(6), (7), (8), (9), or (10)}	Microcystin (µg/L)
5/20/2014	9:40	CRMC	201.5	KR13800	SG	0	0	0	0	ND
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6/09/2014	12:00	CRCC	200.0	KR13807	SG	0	0	256,920	0	ND
6/09/2014	11:20	IRCC	192.8	KR13808	SG	0	0	1,756	165	ND
6/09/2014	10:50	IRJW	192.4	KR13809	SG	0	0	433	0	ND
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¹MSAE = *Microcystis aeruginosa* (cells/mL)

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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) or ¹⁰*Anabaena planctonica*

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Appendix 2

Laboratory Data Sheets: May 20th, June 9th and 10th, 2014

Phytoplankton Sample Analysis					
Sample:	Klamath Basin				
Sample Site:	KR 14800				
Sample Depth:					
Sample Date:	20-May-14				
Total Density (#/mL):	<7				
Total Biovolume (um ³ /mL):					
Trophic State Index:					
	Density	Density	Biovolume	Biovolume	
Species	#/mL	Percent	um ³ /mL	Percent	Group

1 No Toxic Algae Present	<7				
Note: Toxic Algae Only					
Aquatic Analysts	Sample ID: SC40				

Phytoplankton Sample Analysis					
Sample:	Klamath Basin				
Sample Site:	KR 14801				
Sample Depth:					
Sample Date:	20-May-14				
Total Density (#/mL):	<3				
Total Biovolume (um ³ /mL):					
Trophic State Index:					
	Density	Density	Biovolume	Biovolume	
Species	#/mL	Percent	um ³ /mL	Percent	Group

1 No Toxic Algae Present	<3				
Note: Toxic Algae Only					
Aquatic Analysts	Sample ID: SC41				

Phytoplankton Sample Analysis					
Sample:		Klamath Basin			
Sample Site:		KR 14802			
Sample Depth:					
Sample Date:		20-May-14			
Total Density (#/mL):		<5			
Total Biovolume (um ³ /mL):					
Trophic State Index:					
Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent	Group

1 No Toxic Algae Present	<5				
Note: Toxic Algae Only					
Aquatic Analysts			Sample ID: SC42		
Phytoplankton Sample Analysis					
Sample:		Klamath Basin			
Sample Site:		KR 14803			
Sample Depth:					
Sample Date:		20-May-14			
Total Density (#/mL):		7			
Total Biovolume (um ³ /mL):		5,377			
Trophic State Index:		13.4			
Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent	Group

1 Oscillatoria limosa	7	100.0	5,377	100.0	bluegreen
Oscillatoria limosa cells/mL =		87			
Note: Toxic Algae Only					
Aquatic Analysts			Sample ID: SC43		

Phytoplankton Sample Analysis					
Sample:		Klamath Basin			
Sample Site:		KR 14806			
Sample Depth:					
Sample Date:		10-Jun-14			
Total Density (#/mL):		10			
Total Biovolume (um ³ /mL):		15,695			
Trophic State Index:		20.3			
Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent	Group

1 Oscillatoria sp.	10	100.0	15,695	100.0	bluegreen
Oscillatoria sp. cells/mL =		253			
Note: Toxic Algae Only					
Aquatic Analysts			Sample ID: SC52		

Phytoplankton Sample Analysis					
Sample:		Klamath Basin			
Sample Site:		KR 14807			
Sample Depth:					
Sample Date:		9-Jun-14			
Total Density (#/mL):		8,288			
Total Biovolume (um ³ /mL):		17,213,631			
Trophic State Index:		70.4			
Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent	Group
1 Anabaena flos-aquae	8,288	100.0	17,213,631	100.0	bluegreen
Anabaena flos-aquae cells/mL =		256,920			
Note: Toxic Algae Only					
Aquatic Analysts			Sample ID: SC53		

Phytoplankton Sample Analysis					
Sample:		Klamath Basin			
Sample Site:		KR 14808			
Sample Depth:					
Sample Date:		9-Jun-14			
Total Density (#/mL):		60			
Total Biovolume (um ³ /mL):		127,838			
Trophic State Index:		35.1			
Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent	Group
1 Anabaena flos-aquae	55	90.9	117,633	92.0	bluegreen
2 Oscillatoria sp.	5	9.1	10,205	8.0	bluegreen
Anabaena flos-aquae cells/mL =		1,756			
Oscillatoria sp. cells/mL =		165			
Note: Toxic Algae Only					
Aquatic Analysts			Sample ID: SC54		

Phytoplankton Sample Analysis					
Sample:		Klamath Basin			
Sample Site:		KR 14809			
Sample Depth:					
Sample Date:		9-Jun-14			
Total Density (#/mL):		22			
Total Biovolume (um ³ /mL):		28,985			
Trophic State Index:		24.5			
Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent	Group
1 Anabaena flos-aquae	22	100.0	28,985	100.0	bluegreen
Anabaena flos-aquae cells/mL =		433			
Note: Toxic Algae Only					
Aquatic Analysts			Sample ID: SC55		

Phytoplankton Sample Analysis					
Sample:		Klamath Basin			
Sample Site:		KR 14810			
Sample Depth:					
Sample Date:		9-Jun-14			
Total Density (#/mL):		<3			
Total Biovolume (um ³ /mL):					
Trophic State Index:					
Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent	Group
1 No Toxic Algae Present	<3				
Note: Toxic Algae Only					
Aquatic Analysts			Sample ID: SC56		