

Blue-Green Algae (Cyanobacteria) and Microcystin Monitoring Results in the Vicinity of the Klamath Hydroelectric Project: August 25 to September 2, 2008

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Introduction

This technical memorandum summarizes the latest results of monitoring during 2008 of blue-green algae (BGA) species and the associated toxin microcystin above, below, and in the vicinity of PacifiCorp's Klamath Hydroelectric Project (Project). This monitoring is particularly focused on *Microcystis aeruginosa* (MSAE), a BGA species with a recent history of summertime blooms in Copco and Iron Gate reservoirs that is capable of producing microcystin. This monitoring also estimates the presence of other potentially-toxigenic BGA species, including *Anabaena spp.* (ANAB) and *Planktothrix (Oscillatoria) spp.* (PLKT). This monitoring is one of several water quality studies being conducted by PacifiCorp in the vicinity of the Project in 2008 in support of on-going assessment of water quality conditions and potential management actions (PacifiCorp 2008a and 2008b).

The results specifically addressed in this memorandum are for samples collected on August 25 to September 2, 2008. Earlier results from sampling in April, May, June, July, and August 2008 are discussed in previous memoranda (Carlson and Raymond 2008a, 2008b, 2008c, 2008d, 2008e). PacifiCorp plans to prepare subsequent memoranda such as this on a rolling basis to summarize the results to date of BGA species and microcystin sample analysis. PacifiCorp plans to prepare a final report of the results and interpretation of the complete set of collected data after the conclusion of the sampling effort in winter 2008-09.

Methods

Phytoplankton sampling for laboratory analysis of potentially-toxigenic BGA species, notably MSAE, and microcystin is occurring at 23 sites in the vicinity of the Project listed in Table 1, including:

- Eight river sites upstream, within, and downstream of the Project area that were sampled during PacifiCorp's 2008 water quality monitoring study (as further described in PacifiCorp 2008c and 2008d).

- Two open-water reservoir sites in the lower ends of Iron Gate and Copco reservoirs (near the log booms) that are associated with PacifiCorp's 2008 water quality monitoring study (as further described in PacifiCorp 2008c and 2008d).
- Four shoreline sites in coves in Copco and Iron Gate reservoir (i.e., two cove sites in each reservoir). These are similar to sites as monitored in previous years by the Karuk Tribe.
- Four shoreline sample locations in the lower basin of Upper Klamath Lake.
- Five open-water sample locations in the vicinity of solar-powered circulators deployed in the upper end of Copco reservoir during 2008 (in conjunction with PacifiCorp's testing of circulators in Copco reservoir).

Sampling is to occur at the river and open-water monitoring sites once per month in April, May, November, and December, and twice per month in June through October. Samples are to be taken at the shoreline locations in the reservoirs once per month in April, May, October, and November and twice per month in June through September. Samples from the four shoreline locations in UKL will be obtained once in June and twice per month in July through September. Samples at the sites in the vicinity of solar-powered circulators in Copco reservoir are to be obtained once in May and twice per month from June through October.

A total of 32 samples are obtained from the 23 sites in the vicinity of the Project. One sample is taken from each of the seven river sites as grab samples offshore in the current at approximately 0.5 meters (m) below the surface. One sample is taken from each of the four shallow reservoir shoreline sites (e.g., cove sites) and the four shoreline locations in UKL as a surface grab sample over the top 30 cm depth. Two samples are taken from each of the two open-water reservoir sites (i.e., near the log booms) as: (1) a surface grab sample over the top 30 cm depth; and (2) an integrated vertical sample from the surface to a depth of 8 m (approximately the depth of the reservoir's photic zone). Since the sampling on July 30, an additional phytoplankton sample has been taken from the two open-water reservoir sites (i.e., near the log booms) as a horizontal integrated sample (over a distance of about 150 ft) at a depth of 0.5 m below the surface. Two samples are taken from each of the five open-water sample locations in the vicinity of solar-powered circulators deployed in the upper end of Copco reservoir. These two samples include: (1) a surface grab sample over the top 30 cm depth; and (2) an integrated vertical sample from the surface to a depth of up to 8 m (depending on the total depth of the location).

Samples for phytoplankton speciation, density, and biovolume are preserved in Lugol's solution and sent to Aquatic Analysts in White Salmon, Washington for analysis. The laboratory analysis of phytoplankton speciation and density is done 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. BGA species are enumerated as individual cells. 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 taxa.

Table 1. Sites of Blue-Green Algae (Cyanobacteria) and Microcystin Monitoring in the Vicinity of the Klamath Hydroelectric Project During 2008.

Location	Approximate River Mile	River Sites	Reservoir Open Water Sites	Reservoir Shoreline Sites	UKL Shoreline Sites	Test Circulator Monitoring Sites
Upper Klamath Lake near Eagle Ridge ramp	UKL				X	
Upper Klamath Lake near Hagelstein Park	UKL				X	
Upper Klamath Lake at Wocus Bay	UKL				X	
Upper Klamath Lake at Pelican Bay ramp	UKL				X	
Link River below Upper Klamath Lake	253.1	X				
Klamath R. below Keno dam	233.4	X				
Klamath R. below J.C. Boyle powerhouse	220.0	X				
Klamath R. above Copco reservoir	206.4	X				
Copco reservoir upper end at Copco Village (SB 1)	204.0					X
Copco reservoir upper end near "narrows" (SB 2)	203.0					X
Copco reservoir middle above Mallard Cove (SB 3)	202.0					X
Copco reservoir at Mallard Cove ramp	201.5			X		
Copco reservoir middle below Mallard Cove (SB 4)	201.0					X
Copco reservoir middle near Copco Cove (SB 5)	200.0					X
Copco reservoir at Copco Cove ramp	200.0			X		
Copco reservoir lower end at log boom	198.6		X			
Iron Gate reservoir at Camp Creek area	192.8			X		
Iron Gate reservoir at Williams boat ramp	192.4			X		
Iron Gate reservoir lower end above log boom	190.2		X			
Iron Gate powerhouse tailwaters	190.1	X				
Klamath R. at Iron Gate Hatchery bridge	189.7	X				
Klamath R. at I-5 Rest Area	176.7	X				
Klamath R. at Walker Bridge Road	159.0	X				

Samples for determination of microcystin toxin are placed in a cooler on ice and shipped to CH2M HILL Applied Sciences Laboratory in Corvallis, Oregon. 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 0.16 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.

Results of Samples of August 25 to September 2, 2008

Microcystin

Microcystin was above the quantitation limit (i.e., greater than 0.16 µg/L) in 26 of 32 samples obtained during August 25 to September 2, 2008. Of the 26 samples above the quantitation limit, seven samples were above the SWRCB (2007) and ODHS (2005) guideline value of 8 µg/L¹ for posting advisories in recreation waters. The microcystin concentrations in these seven samples were 95, 23, 23, 22, 20, 19, and 9 µg/L taken from Copco reservoir at Copco Cove, Copco reservoir at the log boom (horizontal-integrated sample at 0.5 m depth), Copco reservoir at Mallard Cove, Iron Gate reservoir at the log boom (horizontal-integrated sample at 0.5 m depth), Copco reservoir near the “narrows” at site SB2 (surface grab sample), Copco reservoir at the log boom (surface grab sample), and Iron Gate reservoir at Mirror Cove, respectively.

Eight additional samples had a microcystin concentration above the WHO (2003) guideline value of 4 µg/L² for low health risk associated with recreational use of waters. The microcystin concentrations in these eight additional samples covered a range from 4.2 to 7.2 µg/L. These eight samples were taken from three of the open-water sample locations in the vicinity of solar-powered circulators deployed in the upper end of Copco reservoir (i.e., sites SB2, SB3, and SB4), Iron Gate reservoir at the log boom (surface grab sample), Iron Gate reservoir at Camp Creek, the Klamath River below Iron Gate dam, and the Klamath River at the I-5 Rest Area. Microcystin concentrations were less than 4 µg/L, and mostly less than 2 µg/L in the other 17 samples obtained during August 25 to September 2.

¹ The California State Water Resources Control Board (SWRCB 2007) 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 (2007) 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 (2007) 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.

² The World Health Organization (WHO) has recommended guidelines for safe recreational water environments based on a low, moderate, or high probability of adverse health effects from exposure to concentrations of BGA (cyanobacteria) cells and microcystin toxins in recreational waters (WHO 2003). The WHO guideline values for low and moderate probability of adverse health in recreational waters are 20,000 and 100,000 BGA (cyanobacteria) cells/mL, respectively. WHO equates these cell count values to microcystin toxin concentrations of 4 µg/L and 20 µg/L, respectively (WHO 2003). The WHO guideline for high probability of adverse health effects is a narrative; i.e., “Cyanobacterial scum formation in areas where whole-body contact and/or risk of ingestion/aspiration occur”. No specific BGA (cyanobacteria) cell or microcystin concentrations are provided by WHO for high probability of adverse health effects. The WHO (2003) guidance values were derived from calculations based on a 20 kg child that would swim for up to two hours (in a day) and would accidentally ingest 0.05 L of water per hour.

Phytoplankton Cell Densities

PacifiCorp did not order any expedited processing of phytoplankton samples taken during August 25-28, 2008. Due to the presence of visible algae accumulations on the surface of Iron Gate and Copco reservoirs, the California Regional Water Quality Control Board (North Coast Region) issued an advisory on July 29, 2008 urging caution by recreational users of the reservoirs. Because the advisory had already been issued, expedited processing of samples to assess phytoplankton counts for advisory purposes was not needed.

Results are available for two non-expedited samples taken on August 27 from Copco reservoir at the log boom (horizontal-integrated sample at 0.5 m depth) and Iron Gate reservoir at the log boom (horizontal-integrated sample at 0.5 m depth). MSAE and *Aphanizomenon flos-aquae* (APHA) cells were present in both samples. The total cell density of potentially toxigenic species (i.e., MSAE) in both samples were above the WHO (2003) guideline value¹ of 20,000 cells per milliliter (cells/ml) for low health risk associated with recreational use of waters, and also above the SWRCB (2007) and ODHS (2005) guideline value² of 40,000 cells/ml for posting advisories in recreation waters.

Results are not yet available for BGA speciation and cell count data for the other non-expedited samples. These results will be reported in future memoranda as the results become available from the analytical laboratory.

References

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Table 2. Blue-green algae cell count (cells/mL) and microcystin concentration (ug/L) in sites sampled to date during 2008 by PacifiCorp in Iron Gate, Copco, and J.C. Boyle reservoirs and other sites in the Klamath River.

Codes:

- R Regular grab sample (at surface)
- INT Integrated grab sample (from surface to 8 m)
- NA Results not available to date
- NT Sample not taken

Date	Location	River Mile	Depth (m)	Sample Type	Microcystin (ug/L)	<i>Microcystis</i> (cells/mL)	<i>Anabaena</i> (cells/mL)	<i>Planktothrix</i> (cells/mL)	<i>Aphanizomenon</i> (cells/mL)
NT	Upper Klamath Lake near Eagle Ridge ramp	UKL	0.3	R					
NT	Upper Klamath Lake near Hagelstein Park	UKL	0.3	R					
NT	Upper Klamath Lake at Wocus Bay	UKL	0.3	R					
NT	Upper Klamath Lake at Pelican Bay ramp	UKL	0.3	R					
24-May-08	Link River below Upper Klamath Lake	253.1	0.5	R	<0.16	NA	NA	NA	NA
24-May-08	Klamath R. below Keno dam	233.4	0.5	R	<0.16	NA	NA	NA	NA
24-May-08	Klamath R. below J.C. Boyle powerhouse	220.0	0.5	R	<0.16	NA	NA	NA	NA
23-May-08	Klamath R. above Copco reservoir	206.4	0.5	R	<0.16	NA	NA	NA	NA
22-May-08	Copco reservoir upper end at Copco Village (SB 1)	204.0	0.5	R	<0.16	NA	NA	NA	NA
22-May-08	Copco reservoir upper end at Copco Village (SB 1)	204.0	5.0	INT	<0.16	NA	NA	NA	NA
22-May-08	Copco reservoir upper end near "narrows" (SB 2)	203.0	0.5	R	<0.16	NA	NA	NA	NA
NT	Copco reservoir upper end near "narrows" (SB 2)	203.0	6.0	INT					
22-May-08	Copco reservoir middle above Mallard Cove (SB 3)	202.0	0.5	R	<0.16	NA	NA	NA	NA
22-May-08	Copco reservoir middle above Mallard Cove (SB 3)	202.0	8.0	INT	<0.16	NA	NA	NA	NA
22-May-08	Copco reservoir at Mallard Cove ramp	201.5	0.3	R	<0.16	NA	NA	NA	NA
22-May-08	Copco reservoir middle below Mallard Cove (SB 4)	201.0	0.5	R	<0.16	NA	NA	NA	NA
22-May-08	Copco reservoir middle below Mallard Cove (SB 4)	201.0	8.0	INT	<0.16	NA	NA	NA	NA
NT	Copco reservoir middle near Copco Cove (SB 5)	200.0	0.5	R					
NT	Copco reservoir middle near Copco Cove (SB 5)	200.0	8.0	INT					
22-May-08	Copco reservoir at Copco Cove ramp	200.0	0.3	R	<0.16	NA	NA	NA	NA
22-May-08	Copco reservoir lower end at log boom	198.6	0.3	R	<0.16	NA	NA	NA	NA
22-May-08	Copco reservoir lower end at log boom	198.6	8.0	INT	<0.16	NA	NA	NA	NA
23-May-08	Iron Gate reservoir at Camp Creek area	192.8	0.3	R	<0.16	NA	NA	NA	NA
23-May-08	Iron Gate reservoir at Williams boat ramp	192.4	0.3	R	<0.16	NA	NA	NA	NA
23-May-08	Iron Gate reservoir lower end above log boom	190.2	0.3	R	<0.16	NA	NA	NA	NA
23-May-08	Iron Gate reservoir lower end above log boom	190.2	8.0	INT	<0.16	NA	NA	NA	NA
24-May-08	Iron Gate powerhouse tailwaters	190.1	0.5	R	<0.16	NA	NA	NA	NA
23-May-08	Klamath R. at Iron Gate Hatchery bridge	189.7	0.5	R	<0.16	NA	NA	NA	NA
22-May-08	Klamath R. at I-5 Rest Area	176.7	0.5	R	<0.16	NA	NA	NA	NA
22-May-08	Klamath R. at Walker Bridge Road	159.0	0.5	R	<0.16	NA	NA	NA	NA

Table 2. Blue-green algae cell count (cells/mL) and microcystin concentration (ug/L) in sites sampled to date during 2008 by PacifiCorp in Iron Gate, Copco, and J.C. Boyle reservoirs and other sites in the Klamath River.

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Date	Location	River Mile	Depth (m)	Sample Type	Microcystin (ug/L)	<i>Microcystis</i> (cells/mL)	<i>Anabaena</i> (cells/mL)	<i>Planktothrix</i> (cells/mL)	<i>Aphanizomenon</i> (cells/mL)
NT	Upper Klamath Lake near Eagle Ridge ramp	UKL	0.3	R					
NT	Upper Klamath Lake near Hagelstein Park	UKL	0.3	R					
NT	Upper Klamath Lake at Wocus Bay	UKL	0.3	R					
NT	Upper Klamath Lake at Pelican Bay ramp	UKL	0.3	R					
3-Jun-08	Link River below Upper Klamath Lake	253.1	0.5	R	0.18	NA	NA	NA	NA
3-Jun-08	Klamath R. below Keno dam	233.4	0.5	R	<0.16	NA	NA	NA	NA
5-Jun-08	Klamath R. above Copco reservoir	206.4	0.5	R	0.17	NA	NA	NA	NA
NT	Copco reservoir upper end at Copco Village (SB 1)	204.0	0.5	R					
NT	Copco reservoir upper end at Copco Village (SB 1)	204.0	5.0	INT					
NT	Copco reservoir upper end near "narrows" (SB 2)	203.0	0.5	R					
NT	Copco reservoir upper end near "narrows" (SB 2)	203.0	6.0	INT					
NT	Copco reservoir middle above Mallard Cove (SB 3)	202.0	0.5	R					
NT	Copco reservoir middle above Mallard Cove (SB 3)	202.0	8.0	INT					
4-Jun-08	Copco reservoir at Mallard Cove ramp	201.5	0.3	R	0.19	NA	NA	NA	NA
4-Jun-08	Copco reservoir middle below Mallard Cove (SB 4)	201.0	0.5	R	0.19	NA	NA	NA	NA
4-Jun-08	Copco reservoir middle below Mallard Cove (SB 4)	201.0	8.0	INT	0.26	NA	NA	NA	NA
4-Jun-08	Copco reservoir middle near Copco Cove (SB 5)	200.0	0.5	R	0.19	NA	NA	NA	NA
4-Jun-08	Copco reservoir middle near Copco Cove (SB 5)	200.0	8.0	INT	0.20	NA	NA	NA	NA
4-Jun-08	Copco reservoir at Copco Cove ramp	200.0	0.3	R	<0.16	NA	NA	NA	NA
4-Jun-08	Copco reservoir lower end at log boom	198.6	0.3	R	0.19	NA	NA	NA	NA
4-Jun-08	Copco reservoir lower end at log boom	198.6	8.0	INT	0.19	NA	NA	NA	NA
3-Jun-08	Iron Gate reservoir at Camp Creek area	192.8	0.3	R	0.20	NA	NA	NA	NA
3-Jun-08	Iron Gate reservoir at Williams boat ramp	192.4	0.3	R	0.23	NA	NA	NA	NA
4-Jun-08	Iron Gate reservoir lower end above log boom	190.2	0.3	R	0.18	NA	NA	NA	NA
4-Jun-08	Iron Gate reservoir lower end above log boom	190.2	8.0	INT	<0.16	NA	NA	NA	NA
5-Jun-08	Iron Gate powerhouse tailwaters	190.1	0.5	R	0.19	NA	NA	NA	NA
5-Jun-08	Klamath R. at Iron Gate Hatchery bridge	189.7	0.5	R	0.21	NA	NA	NA	NA
3-Jun-08	Klamath R. at I-5 Rest Area	176.7	0.5	R	0.17	NA	NA	NA	NA
3-Jun-08	Klamath R. at Walker Bridge Road	159.0	0.5	R	<0.16	NA	NA	NA	NA

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Date	Location	River Mile	Depth (m)	Sample Type	Microcystin (ug/L)	<i>Microcystis</i> (cells/mL)	<i>Anabaena</i> (cells/mL)	<i>Planktothrix</i> (cells/mL)	<i>Aphanizomenon</i> (cells/mL)
19-Jun-08	Upper Klamath Lake near Eagle Ridge ramp	UKL	0.3	R	0.42	NA	NA	NA	NA
19-Jun-08	Upper Klamath Lake near Hagelstein Park	UKL	0.3	R	0.34	NA	NA	NA	NA
19-Jun-08	Upper Klamath Lake at Wocus Bay	UKL	0.3	R	0.22	NA	NA	NA	NA
NT	Upper Klamath Lake at Pelican Bay ramp	UKL	0.3	R					
19-Jun-08	Link River below Upper Klamath Lake	253.1	0.5	R	0.65	NA	NA	NA	NA
NT	Klamath R. below Keno dam	233.4	0.5	R					
17-Jun-08	Klamath R. above Copco reservoir	206.4	0.5	R	<0.16	NA	NA	NA	NA
24-Jun-08	Copco reservoir upper end at Copco Village (SB 1)	204.0	0.5	R	<0.16	NA	NA	NA	NA
24-Jun-08	Copco reservoir upper end at Copco Village (SB 1)	204.0	5.0	INT	<0.16	NA	NA	NA	NA
24-Jun-08	Copco reservoir upper end near "narrows" (SB 2)	203.0	0.5	R	<0.16	NA	NA	NA	NA
24-Jun-08	Copco reservoir upper end near "narrows" (SB 2)	203.0	6.0	INT	<0.16	NA	NA	NA	NA
24-Jun-08	Copco reservoir middle above Mallard Cove (SB 3)	202.0	0.5	R	<0.16	NA	NA	NA	NA
24-Jun-08	Copco reservoir middle above Mallard Cove (SB 3)	202.0	8.0	INT	<0.16	NA	NA	NA	NA
18-Jun-08	Copco reservoir at Mallard Cove ramp	201.5	0.3	R	0.45	0	0	0	0
24-Jun-08	Copco reservoir middle below Mallard Cove (SB 4)	201.0	0.5	R	<0.16	NA	NA	NA	NA
24-Jun-08	Copco reservoir middle below Mallard Cove (SB 4)	201.0	8.0	INT	<0.16	NA	NA	NA	NA
24-Jun-08	Copco reservoir middle near Copco Cove (SB 5)	200.0	0.5	R	<0.16	NA	NA	NA	NA
24-Jun-08	Copco reservoir middle near Copco Cove (SB 5)	200.0	8.0	INT	<0.16	NA	NA	NA	NA
18-Jun-08	Copco reservoir at Copco Cove ramp	200.0	0.3	R	0.46	0	0	0	0
18-Jun-08	Copco reservoir lower end at log boom	198.6	0.3	R	<0.16	0	0	0	0
18-Jun-08	Copco reservoir lower end at log boom	198.6	8.0	INT	<0.16	NA	NA	NA	NA
18-Jun-08	Iron Gate reservoir at Camp Creek area	192.8	0.3	R	0.42	0	0	0	271
18-Jun-08	Iron Gate reservoir at Williams boat ramp	192.4	0.3	R	0.32	0	0	0	0
18-Jun-08	Iron Gate reservoir lower end above log boom	190.2	0.3	R	<0.16	NA	NA	NA	NA
18-Jun-08	Iron Gate reservoir lower end above log boom	190.2	8.0	INT	<0.16	NA	NA	NA	NA
18-Jun-08	Iron Gate powerhouse tailwaters	190.1	0.5	R	<0.16	NA	NA	NA	NA
17-Jun-08	Klamath R. at Iron Gate Hatchery bridge	189.7	0.5	R	<0.16	0	0	0	0
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- NT Sample not taken

Date	Location	River Mile	Depth (m)	Sample Type	Microcystin (ug/L)	<i>Microcystis</i> (cells/mL)	<i>Anabaena</i> (cells/mL)	<i>Planktothrix</i> (cells/mL)	<i>Aphanizomenon</i> (cells/mL)
2-Jul-08	Upper Klamath Lake near Eagle Ridge ramp	UKL	0.3	R	0.20	NA	NA	NA	NA
2-Jul-08	Upper Klamath Lake near Hagelstein Park	UKL	0.3	R	<0.16	NA	NA	NA	NA
2-Jul-08	Upper Klamath Lake at Wocus Bay	UKL	0.3	R	1.30	NA	NA	NA	NA
2-Jul-08	Upper Klamath Lake at Pelican Bay ramp	UKL	0.3	R	<0.16	NA	NA	NA	NA
2-Jul-08	Link River below Upper Klamath Lake	253.1	0.5	R	<0.16	NA	NA	NA	NA
2-Jul-08	Klamath R. below Keno dam	233.4	0.5	R	<0.16	NA	NA	NA	NA
30-Jun-08	Klamath R. above Copco reservoir	206.4	0.5	R	<0.16	NA	NA	NA	NA
9-Jul-08	Copco reservoir upper end at Copco Village (SB 1)	204.0	0.5	R	0.22	NA	NA	NA	NA
9-Jul-08	Copco reservoir upper end at Copco Village (SB 1)	204.0	5.0	INT	0.20	NA	NA	NA	NA
9-Jul-08	Copco reservoir upper end near "narrows" (SB 2)	203.0	0.5	R	0.25	NA	NA	NA	NA
9-Jul-08	Copco reservoir upper end near "narrows" (SB 2)	203.0	6.0	INT	0.21	NA	NA	NA	NA
9-Jul-08	Copco reservoir middle above Mallard Cove (SB 3)	202.0	0.5	R	0.21	NA	NA	NA	NA
9-Jul-08	Copco reservoir middle above Mallard Cove (SB 3)	202.0	8.0	INT	0.23	NA	NA	NA	NA
30-Jun-08	Copco reservoir at Mallard Cove ramp	201.5	0.3	R	<0.16	0	0	0	2,064
9-Jul-08	Copco reservoir middle below Mallard Cove (SB 4)	201.0	0.5	R	0.23	NA	NA	NA	NA
9-Jul-08	Copco reservoir middle below Mallard Cove (SB 4)	201.0	8.0	INT	0.22	NA	NA	NA	NA
9-Jul-08	Copco reservoir middle near Copco Cove (SB 5)	200.0	0.5	R	0.31	NA	NA	NA	NA
9-Jul-08	Copco reservoir middle near Copco Cove (SB 5)	200.0	8.0	INT	0.24	NA	NA	NA	NA
30-Jun-08	Copco reservoir at Copco Cove ramp	200.0	0.3	R	0.46	861	964	0	516
1-Jul-08	Copco reservoir lower end at log boom	198.6	0.3	R	<0.16	0	0	0	1,293
1-Jul-08	Copco reservoir lower end at log boom	198.6	8.0	INT	<0.16	NA	NA	NA	NA
30-Jun-08	Iron Gate reservoir at Camp Creek area	192.8	0.3	R	<0.16	0	0	0	0
30-Jun-08	Iron Gate reservoir at Williams boat ramp	192.4	0.3	R	<0.16	0	0	0	0
1-Jul-08	Iron Gate reservoir lower end above log boom	190.2	0.3	R	<0.16	0	1,513	0	0
1-Jul-08	Iron Gate reservoir lower end above log boom	190.2	8.0	INT	<0.16	NA	NA	NA	NA
30-Jun-08	Iron Gate powerhouse tailwaters	190.1	0.5	R	<0.16	0	0	0	605
30-Jun-08	Klamath R. at Iron Gate Hatchery bridge	189.7	0.5	R	<0.16	0	0	0	0
30-Jun-08	Klamath R. at I-5 Rest Area	176.7	0.5	R	<0.16	NA	NA	NA	NA
30-Jun-08	Klamath R. at Walker Bridge Road	159.0	0.5	R	<0.16	0	0	0	0

Table 2. Blue-green algae cell count (cells/mL) and microcystin concentration (ug/L) in sites sampled to date during 2008 by PacifiCorp in Iron Gate, Copco, and J.C. Boyle reservoirs and other sites in the Klamath River.

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Date	Location	River Mile	Depth (m)	Sample Type	Microcystin (ug/L)	<i>Microcystis</i> (cells/mL)	<i>Anabaena</i> (cells/mL)	<i>Planktothrix</i> (cells/mL)	<i>Aphanizomenon</i> (cells/mL)
15-Jul-08	Upper Klamath Lake near Eagle Ridge ramp	UKL	0.3	R	1.57	NA	NA	NA	NA
15-Jul-08	Upper Klamath Lake near Hagelstein Park	UKL	0.3	R	<0.16	NA	NA	NA	NA
15-Jul-08	Upper Klamath Lake at Wocus Bay	UKL	0.3	R	1.31	NA	NA	NA	NA
15-Jul-08	Upper Klamath Lake at Pelican Bay ramp	UKL	0.3	R	<0.16	NA	NA	NA	NA
15-Jul-08	Link River below Upper Klamath Lake	253.1	0.5	R	0.33	NA	NA	NA	NA
15-Jul-08	Klamath R. below Keno dam	233.4	0.5	R	0.40	NA	NA	NA	NA
15-Jul-08	Klamath R. above Copco reservoir	206.4	0.5	R	<0.16	0	0	0	391
22-Jul-08	Copco reservoir upper end at Copco Village (SB 1)	204.0	0.5	R	0.31	NA	NA	NA	NA
22-Jul-08	Copco reservoir upper end at Copco Village (SB 1)	204.0	5.0	INT	<0.16	NA	NA	NA	NA
22-Jul-08	Copco reservoir upper end near "narrows" (SB 2)	203.0	0.5	R	0.83	NA	NA	NA	NA
22-Jul-08	Copco reservoir upper end near "narrows" (SB 2)	203.0	6.0	INT	0.51	NA	NA	NA	NA
22-Jul-08	Copco reservoir middle above Mallard Cove (SB 3)	202.0	0.5	R	0.62	NA	NA	NA	NA
22-Jul-08	Copco reservoir middle above Mallard Cove (SB 3)	202.0	8.0	INT	0.38	NA	NA	NA	NA
17-Jul-08	Copco reservoir at Mallard Cove ramp	201.5	0.3	R	0.20	3,191	0	0	0
22-Jul-08	Copco reservoir middle below Mallard Cove (SB 4)	201.0	0.5	R	2.00	NA	NA	NA	NA
22-Jul-08	Copco reservoir middle below Mallard Cove (SB 4)	201.0	8.0	INT	0.28	NA	NA	NA	NA
22-Jul-08	Copco reservoir middle near Copco Cove (SB 5)	200.0	0.5	R	0.66	NA	NA	NA	NA
22-Jul-08	Copco reservoir middle near Copco Cove (SB 5)	200.0	8.0	INT	1.11	NA	NA	NA	NA
17-Jul-08	Copco reservoir at Copco Cove ramp	200.0	0.3	R	0.45	3,806	0	0	3,654
16-Jul-08	Copco reservoir lower end at log boom	198.6	0.3	R	0.41	0	0	0	1,611
16-Jul-08	Copco reservoir lower end at log boom	198.6	8.0	INT	0.19	NA	NA	NA	NA
17-Jul-08	Iron Gate reservoir at Camp Creek area	192.8	0.3	R	1.11	0	0	0	0
17-Jul-08	Iron Gate reservoir at Williams boat ramp	192.4	0.3	R	0.73	8,607	0	0	0
16-Jul-08	Iron Gate reservoir lower end above log boom	190.2	0.3	R	0.92	11,664	0	0	369
16-Jul-08	Iron Gate reservoir lower end above log boom	190.2	8.0	INT	NA	NA	NA	NA	NA
17-Jul-08	Iron Gate powerhouse tailwaters	190.1	0.5	R	<0.16	NA	NA	NA	NA
17-Jul-08	Klamath R. at Iron Gate Hatchery bridge	189.7	0.5	R	0.26	0	0	0	0
17-Jul-08	Klamath R. at I-5 Rest Area	176.7	0.5	R	0.18	861	0	0	0
17-Jul-08	Klamath R. at Walker Bridge Road	159.0	0.5	R	<0.16	NA	NA	NA	NA

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Date	Location	River Mile	Depth (m)	Sample Type	Microcystin (ug/L)	<i>Microcystis</i> (cells/mL)	<i>Anabaena</i> (cells/mL)	<i>Planktothrix</i> (cells/mL)	<i>Aphanizomenon</i> (cells/mL)
29-Jul-08	Upper Klamath Lake near Eagle Ridge ramp	UKL	0.3	R	0.25	NA	NA	NA	NA
29-Jul-08	Upper Klamath Lake near Hagelstein Park	UKL	0.3	R	<0.16	NA	NA	NA	NA
29-Jul-08	Upper Klamath Lake at Wocus Bay	UKL	0.3	R	0.50	NA	NA	NA	NA
29-Jul-08	Upper Klamath Lake at Pelican Bay ramp	UKL	0.3	R	<0.16	NA	NA	NA	NA
28-Jul-08	Link River below Upper Klamath Lake	253.1	0.5	R	0.55	NA	NA	NA	NA
29-Jul-08	Klamath R. below Keno dam	233.4	0.5	R	<0.16	NA	NA	NA	NA
30-Jul-08	Klamath R. above Copco reservoir	206.4	0.5	R	<0.16	NA	NA	NA	NA
5-Aug-08	Copco reservoir upper end at Copco Village (SB 1)	204.0	0.5	R	0.21	NA	NA	NA	NA
5-Aug-08	Copco reservoir upper end at Copco Village (SB 1)	204.0	5.0	INT	<0.16	NA	NA	NA	NA
5-Aug-08	Copco reservoir upper end near "narrows" (SB 2)	203.0	0.5	R	21.00	NA	NA	NA	NA
5-Aug-08	Copco reservoir upper end near "narrows" (SB 2)	203.0	6.0	INT	8.00	NA	NA	NA	NA
5-Aug-08	Copco reservoir middle above Mallard Cove (SB 3)	202.0	0.5	R	21.00	NA	NA	NA	NA
5-Aug-08	Copco reservoir middle above Mallard Cove (SB 3)	202.0	8.0	INT	4.10	NA	NA	NA	NA
30-Jul-08	Copco reservoir at Mallard Cove ramp	201.5	0.3	R	4.20	NA	NA	NA	NA
5-Aug-08	Copco reservoir middle below Mallard Cove (SB 4)	201.0	0.5	R	13.00	NA	NA	NA	NA
5-Aug-08	Copco reservoir middle below Mallard Cove (SB 4)	201.0	8.0	INT	2.40	NA	NA	NA	NA
5-Aug-08	Copco reservoir middle near Copco Cove (SB 5)	200.0	0.5	R	3.20	NA	NA	NA	NA
5-Aug-08	Copco reservoir middle near Copco Cove (SB 5)	200.0	8.0	INT	2.90	NA	NA	NA	NA
30-Jul-08	Copco reservoir at Copco Cove ramp	200.0	0.3	R	3.50	NA	NA	NA	NA
30-Jul-08	Copco reservoir lower end at log boom	198.6	0.3	R	9.40	NA	NA	NA	NA
30-Jul-08	Copco reservoir lower end at log boom	198.6	0.5	INT	5.30	NA	NA	NA	NA
30-Jul-08	Copco reservoir lower end at log boom	198.6	8.0	INT	1.90	NA	NA	NA	NA
30-Jul-08	Iron Gate reservoir at Camp Creek area	192.8	0.3	R	22.00	NA	NA	NA	NA
30-Jul-08	Iron Gate reservoir at Williams boat ramp	192.4	0.3	R	17.00	NA	NA	NA	NA
30-Jul-08	Iron Gate reservoir lower end above log boom	190.2	0.3	R	13.00	NA	NA	NA	NA
30-Jul-08	Iron Gate reservoir lower end above log boom	190.2	0.5	INT	57.00	NA	NA	NA	NA
30-Jul-08	Iron Gate reservoir lower end above log boom	190.2	8.0	INT	1.50	NA	NA	NA	NA
30-Jul-08	Iron Gate powerhouse tailwaters	190.1	0.5	R	1.40	NA	NA	NA	NA
30-Jul-08	Klamath R. at Iron Gate Hatchery bridge	189.7	0.5	R	1.40	NA	NA	NA	NA
31-Jul-08	Klamath R. at I-5 Rest Area	176.7	0.5	R	1.60	NA	NA	NA	NA
31-Jul-08	Klamath R. at Walker Bridge Road	159.0	0.5	R	1.30	NA	NA	NA	NA

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12-Aug-08	Upper Klamath Lake near Eagle Ridge ramp	UKL	0.3	R	0.56	NA	NA	NA	NA
12-Aug-08	Upper Klamath Lake near Hagelstein Park	UKL	0.3	R	<0.16	NA	NA	NA	NA
12-Aug-08	Upper Klamath Lake at Wocus Bay	UKL	0.3	R	1.47	NA	NA	NA	NA
12-Aug-08	Upper Klamath Lake at Pelican Bay ramp	UKL	0.3	R	<0.16	NA	NA	NA	NA
11-Aug-08	Link River below Upper Klamath Lake	253.1	0.5	R	0.72	NA	NA	NA	NA
12-Aug-08	Klamath R. below Keno dam	233.4	0.5	R	<0.16	NA	NA	NA	NA
12-Aug-08	Klamath R. below J.C. Boyle powerhouse	220.0	0.5	R	<0.16	NA	NA	NA	NA
13-Aug-08	Klamath R. above Copco reservoir	206.4	0.5	R	<0.16	NA	NA	NA	NA
20-Aug-08	Copco reservoir upper end at Copco Village (SB 1)	204.0	0.5	R	0.29	NA	NA	NA	NA
20-Aug-08	Copco reservoir upper end at Copco Village (SB 1)	204.0	5.0	INT	<0.16	NA	NA	NA	NA
20-Aug-08	Copco reservoir upper end near "narrows" (SB 2)	203.0	0.5	R	19.80	NA	NA	NA	NA
20-Aug-08	Copco reservoir upper end near "narrows" (SB 2)	203.0	6.0	INT	20.40	NA	NA	NA	NA
20-Aug-08	Copco reservoir middle above Mallard Cove (SB 3)	202.0	0.5	R	11.50	NA	NA	NA	NA
20-Aug-08	Copco reservoir middle above Mallard Cove (SB 3)	202.0	8.0	INT	9.46	NA	NA	NA	NA
13-Aug-08	Copco reservoir at Mallard Cove ramp	201.5	0.3	R	58.00	NA	NA	NA	NA
20-Aug-08	Copco reservoir middle below Mallard Cove (SB 4)	201.0	0.5	R	1.94	NA	NA	NA	NA
20-Aug-08	Copco reservoir middle below Mallard Cove (SB 4)	201.0	8.0	INT	2.24	NA	NA	NA	NA
20-Aug-08	Copco reservoir middle near Copco Cove (SB 5)	200.0	0.5	R	2.01	NA	NA	NA	NA
20-Aug-08	Copco reservoir middle near Copco Cove (SB 5)	200.0	8.0	INT	1.26	NA	NA	NA	NA
13-Aug-08	Copco reservoir at Copco Cove ramp	200.0	0.3	R	48.00	NA	NA	NA	NA
13-Aug-08	Copco reservoir lower end at log boom	198.6	0.3	R	20.00	NA	NA	NA	NA
13-Aug-08	Copco reservoir lower end at log boom	198.6	0.5	INT	15.00	75,726	7,080	0	19,264
13-Aug-08	Copco reservoir lower end at log boom	198.6	8.0	INT	2.50	NA	NA	NA	NA
13-Aug-08	Iron Gate reservoir at Camp Creek area	192.8	0.3	R	11.00	NA	NA	NA	NA
13-Aug-08	Iron Gate reservoir at Williams boat ramp	192.4	0.3	R	3.50	NA	NA	NA	NA
13-Aug-08	Iron Gate reservoir lower end above log boom	190.2	0.3	R	4.90	NA	NA	NA	NA
13-Aug-08	Iron Gate reservoir lower end above log boom	190.2	0.5	INT	2.30	10,197	245	0	6,544
13-Aug-08	Iron Gate reservoir lower end above log boom	190.2	8.0	INT	2.40	NA	NA	NA	NA
13-Aug-08	Iron Gate powerhouse tailwaters	190.1	0.5	R	3.30	NA	NA	NA	NA
13-Aug-08	Klamath R. at Iron Gate Hatchery bridge	189.7	0.5	R	1.60	NA	NA	NA	NA
14-Aug-08	Klamath R. at I-5 Rest Area	176.7	0.5	R	2.50	NA	NA	NA	NA
14-Aug-08	Klamath R. at Walker Bridge Road	159.0	0.5	R	1.90	NA	NA	NA	NA

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26-Aug-08	Upper Klamath Lake near Eagle Ridge ramp	UKL	0.3	R	3.26	NA	NA	NA	NA
26-Aug-08	Upper Klamath Lake near Hagelstein Park	UKL	0.3	R	<0.16	NA	NA	NA	NA
26-Aug-08	Upper Klamath Lake at Wocus Bay	UKL	0.3	R	1.73	NA	NA	NA	NA
26-Aug-08	Upper Klamath Lake at Pelican Bay ramp	UKL	0.3	R	<0.16	NA	NA	NA	NA
25-Aug-08	Link River below Upper Klamath Lake	253.1	0.5	R	0.65	NA	NA	NA	NA
26-Aug-08	Klamath R. below Keno dam	233.4	0.5	R	<0.16	NA	NA	NA	NA
26-Aug-08	Klamath R. below J.C. Boyle powerhouse	220.0	0.5	R	<0.16	NA	NA	NA	NA
27-Aug-08	Klamath R. above Copco reservoir	206.4	0.5	R	<0.16	NA	NA	NA	NA
2-Sep-08	Copco reservoir upper end at Copco Village (SB 1)	204.0	0.5	R	0.40	NA	NA	NA	NA
2-Sep-08	Copco reservoir upper end at Copco Village (SB 1)	204.0	5.0	INT	<0.16	NA	NA	NA	NA
2-Sep-08	Copco reservoir upper end near "narrows" (SB 2)	203.0	0.5	R	20.10	NA	NA	NA	NA
2-Sep-08	Copco reservoir upper end near "narrows" (SB 2)	203.0	6.0	INT	6.12	NA	NA	NA	NA
2-Sep-08	Copco reservoir middle above Mallard Cove (SB 3)	202.0	0.5	R	7.21	NA	NA	NA	NA
2-Sep-08	Copco reservoir middle above Mallard Cove (SB 3)	202.0	8.0	INT	4.81	NA	NA	NA	NA
27-Aug-08	Copco reservoir at Mallard Cove ramp	201.5	0.3	R	22.80	NA	NA	NA	NA
2-Sep-08	Copco reservoir middle below Mallard Cove (SB 4)	201.0	0.5	R	4.20	NA	NA	NA	NA
2-Sep-08	Copco reservoir middle below Mallard Cove (SB 4)	201.0	8.0	INT	2.35	NA	NA	NA	NA
2-Sep-08	Copco reservoir middle near Copco Cove (SB 5)	200.0	0.5	R	1.23	NA	NA	NA	NA
2-Sep-08	Copco reservoir middle near Copco Cove (SB 5)	200.0	8.0	INT	1.06	NA	NA	NA	NA
27-Aug-08	Copco reservoir at Copco Cove ramp	200.0	0.3	R	95.30	NA	NA	NA	NA
27-Aug-08	Copco reservoir lower end at log boom	198.6	0.3	R	19.50	NA	NA	NA	NA
27-Aug-08	Copco reservoir lower end at log boom	198.6	0.5	INT	23.10	64,199	0	0	48,149
27-Aug-08	Copco reservoir lower end at log boom	198.6	8.0	INT	2.38	NA	NA	NA	NA
27-Aug-08	Iron Gate reservoir at Camp Creek area	192.8	0.3	R	4.19	NA	NA	NA	NA
27-Aug-08	Iron Gate reservoir at Williams boat ramp	192.4	0.3	R	9.28	NA	NA	NA	NA
27-Aug-08	Iron Gate reservoir lower end above log boom	190.2	0.3	R	5.39	NA	NA	NA	NA
27-Aug-08	Iron Gate reservoir lower end above log boom	190.2	0.5	INT	22.20	47,492	0	0	21,911
27-Aug-08	Iron Gate reservoir lower end above log boom	190.2	8.0	INT	1.20	NA	NA	NA	NA
27-Aug-08	Iron Gate powerhouse tailwaters	190.1	0.5	R	1.57	NA	NA	NA	NA
28-Aug-08	Klamath R. at Iron Gate Hatchery bridge	189.7	0.5	R	4.90	NA	NA	NA	NA
28-Aug-08	Klamath R. at I-5 Rest Area	176.7	0.5	R	6.19	NA	NA	NA	NA
28-Aug-08	Klamath R. at Walker Bridge Road	159.0	0.5	R	0.43	NA	NA	NA	NA