

TECHNICAL MEMORANDUM

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

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Date: July 11, 2018



Introduction

This technical memorandum summarizes the results for the 2018 public health monitoring for cyanobacteria species and an associated toxin, microcystin, from Upper Klamath Lake and within PacifiCorp's Klamath Hydroelectric Project (Project) from Keno reservoir to the Klamath River downstream Iron Gate Dam. Microcystin results from 2018 baseline monitoring are also included in the results summaries below. This monitoring is particularly focused on *Microcystis aeruginosa* (MSAE) which is known to produce microcystin. This monitoring also assesses the presence of other potentially-toxic cyanobacteria, including *Dolichospermum* sp., and others. 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 baseline and public health sampling are used in coordination with the appropriate public health authority to determine if public health advisories are warranted^{1,2}. 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 in Appendix 1 and Appendix 2 summarize results from all of the 2018 public health sampling events to date and microcystin results from the 2018 baseline sampling events.

¹ The California State Water Resources Control Board (SWRCB) provides guidelines for posting advisories in recreation water (California SWRCB 2016) for Project waters in California. SWRCB recommends posting advisories in recreation waters at three levels based on laboratory testing for microcystin. The posting levels are Caution, Warning, and Danger at microcystin concentrations of 0.8, 6, and 20 µg/L respectively. Toxin producing cells at concentrations of over 4,000 cells/mL or blooms, scums, or mats would result in posting at the Caution level.

² Postings of Project waters in Oregon are coordinated with the Oregon Health Authority (OHA). The health advisory guideline in Oregon waters is microcystin concentrations of 4 µg/L (OHA 2018) or more, over 100,000 cells/mL of all toxicogenic species combined, or over 40,000 cells/mL of *Microcystis* spp. or *Planktothrix* spp. (OHA 2016).

Methods

PacifiCorp and the Oregon Department of Environmental Quality (ODEQ) are conducting public health sampling at ten sites (Table 1). Samples are collected and sent for laboratory analysis of potentially toxigenic cyanobacteria, notably MSAE and microcystin, from:

- Three shoreline sites in Upper Klamath Lake, Oregon
- One shoreline site in Keno Reservoir, Oregon
- One shoreline site in J.C. Boyle Reservoir, Oregon
- Four shoreline sites in coves in Copco and Iron Gate reservoirs (i.e., two cove sites in each reservoir), California
- One Klamath River site below Iron Gate Dam near the hatchery bridge, California

Table 1. Sites of cyanobacteria and microcystin public health monitoring in Upper Klamath Lake, Keno Reservoir, J.C Boyle Reservoir, Copco Reservoir, Iron Gate Reservoir, and the Klamath River during 2018.			
Location	Approximate River Mile	Sampling Entity	Site ID
Upper Klamath Lake at Eagle Ridge County Park	N/A	ODEQ	UKEP
Upper Klamath Lake at Howard's Bay Park	N/A	ODEQ	UKHP
Upper Klamath Lake at Moore Park	N/A	ODEQ	UKMP
Keno Reservoir at Keno Park	234.0	ODEQ	KEKP
J.C. Boyle Reservoir at Topsy Campground	225.0	ODEQ	BRTC
Copco Reservoir at Mallard Cove	201.5	PacifiCorp	CRMC
Copco Reservoir at Copco Cove	200.0	PacifiCorp	CRCC
Iron Gate Reservoir at Camp Creek	192.8	PacifiCorp	IRCC
Iron Gate Reservoir at John Williams Campground	192.4	PacifiCorp	IRJW
Klamath River below Iron Gate dam near Hatchery Bridge	189.7	PacifiCorp	KRBI

Samples are planned to be taken once in May, November and December and twice per month in June, July, August, September, and October.

In addition to public health sampling, monthly and bi-monthly baseline sampling for microcystin is conducted by PacifiCorp and the U.S. Bureau of Reclamation (BOR) from May through October at 12 locations extending from Link Dam to the Klamath River downstream of Iron Gate Reservoir (Table 2).

Table 2. Sites of microcystin baseline monitoring from Link Dam to the Klamath River downstream of Iron Gate reservoir during 2018.				
Site Description	Approximate River Mile	Depth (m)	Sampling Entity	Site ID
Link Dam	254.4	0.5	BOR	KR254.4
Keno Reservoir at Miller Island	246.0	0.5	BOR	KR246.0
Klamath River below Keno Dam near a USGS Gage	231.8	0.5	BOR	KBK
Klamath River below JC Boyle Reservoir	224.6	0.5	PacifiCorp	KR22460
Klamath River at USGS Gage	219.5	0.5	PacifiCorp	KR21950
Klamath River above Shovel Creek	206.4	0.5	PacifiCorp	KR20642
Copco Reservoir at Buoy Line (surface)	198.7	0.5	PacifiCorp	KR19874
Copco Reservoir at Buoy Line (integrated)	198.7	0-8	PacifiCorp	KR19874
Klamath River below Copco 2 Reservoir	196.5	0.5	PacifiCorp	KR19645
Iron Gate Reservoir at Log Boom (surface)	190.2	0.5	PacifiCorp	KR19019
Iron Gate Reservoir at Log Boom (integrated)	190.2	0-8	PacifiCorp	KR19019
Klamath River below Hatchery Bridge	189.7	0.5	PacifiCorp	KR18973

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 collected for potentially toxic phytoplankton are preserved in Lugol’s solution and sent to Aquatic Analysts in Friday Harbor, Washington for analysis. The samples are labeled “Rush” for timely analysis and only potentially toxic cyanobacteria are identified and enumerated. 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 U.S. Environmental Protection Agency (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 with a detection limit of 0.10 µg/L and a quantification limit of 0.15 µg/L. 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.

Results

All public health samples (Table 3) and baseline microcystin samples (Tables 4 and 5) were collected as planned. Appendix 3 includes the raw phytoplankton results for the samples reported in Table 3.

Table 3. Summary of available public health laboratory algal identification and enumeration and microcystin results from sampling May and June 2018.

Date	Time	Site ID	RM	Sampling Entity	Sample ID	Depth	MSAE ⁽¹⁾	AFA ⁽²⁾	DKFA ⁽³⁾	Other ^{(4),(5), (6), (7), (8), (9), (10), or (11)}	Microcystin (µg/L)
5/30/2018	11:15	UKEP	N/A	ODEQ	UKEP18001	SG	27,561	76,069	9,822	0	0.16 ^{J, A2}
5/30/2018	11:31	UKHP	N/A	ODEQ	UKHP18001	SG	126	11,569	471	0	0.41 ^{J, A2}
5/30/2018	11:46	UKMP	N/A	ODEQ	UKMP18001	SG	0	9,577	4,672	0	0.11 ^{J, A2}
5/30/2018	10:31	KEKP	234	ODEQ	KEKP18001	SG	867	93,886	23,678	0	1.0 ^{J, A2}
5/30/2018	10:15	BRTC	225	ODEQ	BRTC18001	SG	0	546	0	0	ND ^{J, A2}
5/29/2018	13:00	CRMC	201.5	PacifiCorp	KR18800	SG	0	0	0	0	ND
5/29/2018	12:30	CRCC	200.0	PacifiCorp	KR18801	SG	0	0	65	0	ND
5/29/2018	11:40	IRCC	192.8	PacifiCorp	KR18802	SG	0	0	0	0	ND
5/29/2018	11:30	IRJW	192.4	PacifiCorp	KR18803	SG	0	76	0	0	ND
5/29/2018	10:30	KRBI	189.7	PacifiCorp	KR18804	SG	0	0	0	0	ND
6/20/2018	12:05	UKEP	N/A	ODEQ	UKEP18002	SG	0	5,683,065	0	0	4.0
6/20/2018	12:22	UKHP	N/A	ODEQ	UKHP18002	SG	152,881	6,206,983	3,363,390	5,136,814 ⁽⁵⁾	33
6/20/2018	12:38	UKMP	N/A	ODEQ	UKMP18002	SG	0	14,093,750	0	0	1.2
6/20/2018	11:24	KEKP	234	ODEQ	KEKP18002	SG	0	2,596,132	0	0	1.6
6/20/2018	11:08	BRTC	225	ODEQ	BRTC18002	SG	0	12,659	112	0	ND
6/9/2018	17:30	CRMC	201.5	PacifiCorp	KR18805	SG	0	0	0	401 ⁽¹⁰⁾	ND
6/9/2018	15:45	CRCC	200.0	PacifiCorp	KR18806	SG	0	0	161	0	ND
6/9/2018	12:20	IRCC	192.8	PacifiCorp	KR18807	SG	0	173	885	0	ND
6/9/2018	12:00	IRJW	192.4	PacifiCorp	KR18808	SG	0	85	466	254 ⁽¹⁰⁾	0.13 ^{C1, J}
6/9/2018	19:40	KRBI	189.7	PacifiCorp	KR18809	SG	0	43	35	0	ND
6/26/2018	13:41	UKEP	N/A	ODEQ	UKEP18003	SG	0	1,270,693	0	0	0.18
6/26/2018	13:57	UKHP	N/A	ODEQ	UKHP18003	SG	0	1,529,172	0	873,813 ⁽⁵⁾	9.1
6/26/2018	14:15	UKMP	N/A	ODEQ	UKMP18003	SG	0	155,011	0	0	ND
6/26/2018	13:00	KEKP	234	ODEQ	KEKP18003	SG	0	1,322,607	0	0	0.21
6/26/2018	12:43	BRTC	225	ODEQ	BRTC18003	SG	0	136,397	0	609 ⁽¹⁰⁾	ND
6/25/2018	14:30	CRMC	201.5	PacifiCorp	KR18810	SG	0	2,349	0	17,681 ⁽¹⁰⁾	ND
6/25/2018	13:05	CRCC	200.0	PacifiCorp	KR18811	SG	0	922	44	6 ⁽¹⁰⁾	ND
6/25/2018	12:30	IRCC	192.8	PacifiCorp	KR18812	SG	4,883	178	3,924	133 ⁽¹⁰⁾	0.59
6/25/2018	12:15	IRJW	192.4	PacifiCorp	KR18813	SG	1,179	0	2,587	0	0.10 ^{C1, J}
6/25/2018	11:45	KRBI	189.7	PacifiCorp	KR18814	SG	0	0	0	0	ND

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

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

³DKFA = *Dolichospermum flos-aquae* (cells/mL)

Other = Cells/mL of either ⁴*Planktothrix (Oscillatoria) sp.*, ⁵*Gloeotrichia echinulata*, ⁶*Dolichospermum sp.*, ⁷*Lyngbya sp.*,

⁸*Dolichospermum circinalis*, ⁹*Dolichospermum planctonica*, ¹⁰*Planktothrix (Oscillatoria) limosa*, or ¹¹*Pseudanabaena spp.*

“ND” value indicates a result less than the laboratory analytical detection limit (0.1 µg/L)

“A2” indicates the sample was received above the recommended temperature range.

“C1” indicates the reported concentration for this analyte is below the quantitation limit.

“J” indicates the reported result for this analyte should be considered an estimated value.

“0” value indicates non-detect by analytical laboratory

“*” value indicates no result available

Table 4. Summary of May and June 2018 baseline laboratory microcystin results for samples collected in Oregon.

Date	Time	Site ID	RM	Sampling Entity	Sample ID	Depth (m)	Microcystin (µg/L)
5/8/2018	10:50	KR246.0	246.0	BOR	2018KHSA-22	0.5	ND
5/8/2018	08:45	KBK	231.8	BOR	2018KHSA-23	0.5	ND
5/13/2018	17:30	KR22460	224.6	PacifiCorp	KR18047	0.5	ND
5/13/2018	17:00	KR21950	219.5	PacifiCorp	KR18048	0.5	ND
6/4/2018	11:00	KR246.0	246.0	BOR	2018KHSA-32	0.5	ND
6/4/2018	8:40	KBK	231.8	BOR	2018KHSA-33	0.5	0.10 ^{C1, J}
6/10/2018	8:30	KR22460	224.6	PacifiCorp	KR18064	0.5	ND
6/10/2018	9:30	KR21950	219.5	PacifiCorp	KR18065	0.5	ND

"ND" value indicates a result less than the laboratory analytical detection limit (0.1 µg/L)

"C1" indicates the reported concentration for this analyte is below the quantitation limit.

"J" indicates the reported result for this analyte should be considered an estimated value.

Table 5. Summary of May and June 2018 baseline laboratory microcystin results for samples collected in California.

Date	Time	Site ID	RM	Sampling Entity	Sample ID	Depth (m)	Microcystin (µg/L)
5/12/2018	16:10	KR20642	206.4	PacifiCorp	KR18043	0.5	ND
5/13/2018	11:00	KR19874	198.7	PacifiCorp	KR18039	0.5	ND
5/13/2018	11:10	KR19874	198.7	PacifiCorp	KR18040	0-8	ND
5/12/2018	14:15	KR19645	196.5	PacifiCorp	KR18038	0.5	ND
5/12/2018	11:50	KR19019	190.2	PacifiCorp	KR18034	0.5	ND
5/12/2018	12:00	KR19019	190.2	PacifiCorp	KR18035	0-8	ND
6/9/2018	16:50	KR20642	206.4	PacifiCorp	KR18060	0.5	ND
6/9/2018	14:20	KR19874	198.7	PacifiCorp	KR18056	0.5	ND
6/9/2018	14:30	KR19874	198.7	PacifiCorp	KR18057	0-8	ND
6/9/2018	13:00	KR19645	196.5	PacifiCorp	KR18055	0.5	ND
6/9/2018	9:30	KR19019	190.2	PacifiCorp	KR18051	0.5	ND

"ND" value indicates a result less than the laboratory analytical detection limit (0.1 µg/L)

References

California SWRCB 2016. Draft Statewide Voluntary Guidance on CyanoHABs in Recreational Waters. Available online at:

http://www.mywaterquality.ca.gov/monitoring_council/cyanohab_network/docs/triggers.pdf

Oregon Health Authority. 2016. Oregon Harmful Algal Bloom Surveillance (HABS) Program – Public Health Advisory Guidelines, Harmful Algae Blooms in Freshwater Bodies. 27 pp.

https://public.health.oregon.gov/HealthyEnvironments/Recreation/HarmfulAlgaeBlooms/Pages/resources_for_samplers.aspx

Oregon Health Authority. 2018. Oregon Public Health Division – Blue-green Algae Advisory. Electronic mail advising changes to guideline values. Distributed May 17, 2019 1648.

Appendix 1

Cyanobacteria Species and Microcystin Data for 2018 Public Health Samples

Table A1. Summary of 2018 public health laboratory algal identification and enumeration microcystin results.											
Date	Time	Site ID	RM	Sampling Entity	Sample ID	Depth	MSAE ⁽¹⁾	AFA ⁽²⁾	DKFA ⁽³⁾	Other ^{(4),(5), (6), (7), (8), (9), (10), or (11)}	Microcystin (µg/L)
5/30/2018	11:15	UKEP	N/A	ODEQ	UKEP18001	SG	27,561	76,069	9,822	0	0.16 ^{J, A2}
5/30/2018	11:31	UKHP	N/A	ODEQ	UKHP18001	SG	126	11,569	471	0	0.41 ^{J, A2}
5/30/2018	11:46	UKMP	N/A	ODEQ	UKMP18001	SG	0	9,577	4,672	0	0.11 ^{J, A2}
5/30/2018	10:31	KEKP	234	ODEQ	KEKP18001	SG	867	93,886	23,678	0	1.0 ^{J, A2}
5/30/2018	10:15	BRTC	225	ODEQ	BRTC18001	SG	0	546	0	0	ND ^{J, A2}
5/29/2018	13:00	CRMC	201.5	PacifiCorp	KR18800	SG	0	0	0	0	ND
5/29/2018	12:30	CRCC	200.0	PacifiCorp	KR18801	SG	0	0	65	0	ND
5/29/2018	11:40	IRCC	192.8	PacifiCorp	KR18802	SG	0	0	0	0	ND
5/29/2018	11:30	IRJW	192.4	PacifiCorp	KR18803	SG	0	76	0	0	ND
5/29/2018	10:30	KRBI	189.7	PacifiCorp	KR18804	SG	0	0	0	0	ND
6/20/2018	12:05	UKEP	N/A	ODEQ	UKEP18002	SG	0	5,683,065	0	0	4.0
6/20/2018	12:22	UKHP	N/A	ODEQ	UKHP18002	SG	152,881	6,206,983	3,363,390	5,136,814 ⁽⁵⁾	33
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6/20/2018	11:24	KEKP	234	ODEQ	KEKP18002	SG	0	2,596,132	0	0	1.6
6/20/2018	11:08	BRTC	225	ODEQ	BRTC18002	SG	0	12,659	112	0	ND
6/9/2018	17:30	CRMC	201.5	PacifiCorp	KR18805	SG	0	0	0	401 ⁽¹⁰⁾	ND
6/9/2018	15:45	CRCC	200.0	PacifiCorp	KR18806	SG	0	0	161	0	ND
6/9/2018	12:20	IRCC	192.8	PacifiCorp	KR18807	SG	0	173	885	0	ND
6/9/2018	12:00	IRJW	192.4	PacifiCorp	KR18808	SG	0	85	466	254 ⁽¹⁰⁾	0.13 ^{C1, J}
6/9/2018	19:40	KRBI	189.7	PacifiCorp	KR18809	SG	0	43	35	0	ND
6/26/2018	13:41	UKEP	N/A	ODEQ	UKEP18003	SG	0	1,270,693	0	0	0.18
6/26/2018	13:57	UKHP	N/A	ODEQ	UKHP18003	SG	0	1,529,172	0	873,813 ⁽⁵⁾	9.1
6/26/2018	14:15	UKMP	N/A	ODEQ	UKMP18003	SG	0	155,011	0	0	ND
6/26/2018	13:00	KEKP	234	ODEQ	KEKP18003	SG	0	1,322,607	0	0	0.21
6/26/2018	12:43	BRTC	225	ODEQ	BRTC18003	SG	0	136,397	0	609 ⁽¹⁰⁾	ND
6/25/2018	14:30	CRMC	201.5	PacifiCorp	KR18810	SG	0	2,349	0	17,681 ⁽¹⁰⁾	ND
6/25/2018	13:05	CRCC	200.0	PacifiCorp	KR18811	SG	0	922	44	6 ⁽¹⁰⁾	ND
6/25/2018	12:30	IRCC	192.8	PacifiCorp	KR18812	SG	4,883	178	3,924	133 ⁽¹⁰⁾	0.59
6/25/2018	12:15	IRJW	192.4	PacifiCorp	KR18813	SG	1,179	0	2,587	0	0.10 ^{C1, J}
6/25/2018	11:45	KRBI	189.7	PacifiCorp	KR18814	SG	0	0	0	0	ND

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

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

³DKFA = *Dolichospermum flos-aquae* (cells/mL)

Other = Cells/mL of either ⁴*Planktothrix (Oscillatoria)* sp., ⁵*Gloeotrichia echinulata*, ⁶*Dolichospermum* sp., ⁷*Lyngbya* sp., ⁸*Dolichospermum circinalis*, ⁹*Dolichospermum planctonica*, ¹⁰*Planktothrix (Oscillatoria) limosa*, or ¹¹*Pseudanabaena* spp.

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"**" value indicates no result available

Appendix 2

Microcystin Data for 2018 Baseline Samples

Table A2-1. Summary of 2018 baseline laboratory microcystin results for samples collected in Oregon.							
Date	Time	Site ID	RM	Sampling Entity	Sample ID	Depth (m)	Microcystin (µg/L)
5/8/2018	10:50	KR246.0	246.0	BOR	2018KHSA-22	0.5	ND
5/8/2018	08:45	KBK	231.8	BOR	2018KHSA-23	0.5	ND
5/13/2018	17:30	KR22460	224.6	PacifiCorp	KR18047	0.5	ND
5/13/2018	17:00	KR21950	219.5	PacifiCorp	KR18048	0.5	ND
6/4/2018	11:00	KR246.0	246.0	BOR	2018KHSA-32	0.5	ND
6/4/2018	8:40	KBK	231.8	BOR	2018KHSA-33	0.5	0.10 ^{C1, J}
6/10/2018	8:30	KR22460	224.6	PacifiCorp	KR18064	0.5	ND
6/10/2018	9:30	KR21950	219.5	PacifiCorp	KR18065	0.5	ND

"ND" value indicates a result less than the laboratory analytical detection limit (0.1 µg/L)

Table A2-2. Summary of 2018 baseline laboratory microcystin results for samples collected in California.							
Date	Time	Site ID	RM	Sampling Entity	Sample ID	Depth (m)	Microcystin (µg/L)
5/12/2018	16:10	KR20642	206.4	PacifiCorp	KR18043	0.5	ND
5/13/2018	11:00	KR19874	198.7	PacifiCorp	KR18039	0.5	ND
5/13/2018	11:10	KR19874	198.7	PacifiCorp	KR18040	0-8	ND
5/12/2018	14:15	KR19645	196.5	PacifiCorp	KR18038	0.5	ND
5/12/2018	11:50	KR19019	190.2	PacifiCorp	KR18034	0.5	ND
5/12/2018	12:00	KR19019	190.2	PacifiCorp	KR18035	0-8	ND
6/9/2018	16:50	KR20642	206.4	PacifiCorp	KR18060	0.5	ND
6/9/2018	14:20	KR19874	198.7	PacifiCorp	KR18056	0.5	ND
6/9/2018	14:30	KR19874	198.7	PacifiCorp	KR18057	0-8	ND
6/9/2018	13:00	KR19645	196.5	PacifiCorp	KR18055	0.5	ND
6/9/2018	9:30	KR19019	190.2	PacifiCorp	KR18051	0.5	ND

"ND" value indicates a result less than the laboratory analytical detection limit (0.1 µg/L)

"C1" indicates the reported concentration for this analyte is below the quantitation limit.

"J" indicates the reported result for this analyte should be considered an estimated value.

Appendix 3 Laboratory Phytoplankton Results

Phytoplankton Sample Analysis

Klamath
Sample: Basin
Sample ID: KR18800
Sample Depth:
Sample Date: 29-May-18 1300

Total Density (#/mL): <4
Total Biovolume (um³/mL):
Trophic State Index:

Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent
-	-	-	-	-
1 No Toxic Algae Present	<4			

Note: Toxic Algae Only

Phytoplankton Sample Analysis

Sample: Klamath Basin
Sample ID: KR18801
Sample Depth:
Sample Date: 29-May-18 1230

Total Density (#/mL): 8
Total Biovolume (um³/mL): 4,348
Trophic State Index: 12.1

Species	Density #/mL	Density Percent	Biovolume um³/mL	Biovolume Percent
1 Anabaena flos-aquae	8	100.0	4,348	100.0

Anabaena flos-aquae cells/mL = 65

Note: Toxic Algae Only

Phytoplankton Sample Analysis

Sample: Klamath Basin
Sample ID: KR18802
Sample Depth:
Sample Date: 29-May-18 1140

Total Density (#/mL): <8
Total Biovolume (um³/mL):
Trophic State Index:

Species	Density #/mL	Density Percent	Biovolume um³/mL	Biovolume Percent
-	-	-	-	-
1 No Toxic Algae Present	<8			

Note: Toxic Algae Only

Phytoplankton Sample Analysis

Klamath
Sample: Basin
Sample ID: KR18803
Sample Depth:
Sample Date: 29-May-18 1130

Total Density (#/mL): 4
Total Biovolume (um³/mL): 4,807
Trophic State Index: 12.7

Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent
1 Aphanizomenon flos-aquae	4	100.0	4,807	100.0

Aphanizomenon flos-aquae cells/mL = 76

Note: Toxic Algae Only

Phytoplankton Sample Analysis

Sample: Klamath Basin
Sample ID: KR18804
Sample Depth:
Sample Date: 29-May-18 1030

Total Density (#/mL): <6
Total Biovolume (um³/mL):
Trophic State Index:

Species	Density #/mL	Density Percent	Biovolume um³/mL	Biovolume Percent
-	-	-	-	-
1 No Toxic Algae Present	<6			

Note: Toxic Algae Only

Phytoplankton Sample Analysis

Klamath
Sample: Basin
Sample Site: BRTC18001
Sample Depth:
Sample Date: 30-May-18 1015

Total Density (#/mL): 39
Total Biovolume (um³/mL): 34,376
Trophic State Index: 25.7

Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent
1 Aphanizomenon flos-aquae	39	100.0	34,376	100.0

Aphanizomenon flos-aquae cells/mL = 546

Note: Toxic Algae Only

Phytoplankton Sample Analysis

Sample: Klamath Basin
Sample Site: KEKP18001
Sample Depth:
Sample Date: 30-May-18 1031

Total Density (#/mL): 4,449
Total Biovolume (um³/mL): 7,508,153
Trophic State Index: 64.4

Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent
1 Aphanizomenon flos-aquae	3,755	84.4	5,914,822	78.8
2 Dolichospermum flos-aquae	607	13.6	1,586,393	21.1
3 Microcystis aeruginosa	87	1.9	6,938	0.1

Aphanizomenon flos-aquae cells/mL = 93,886

Dolichospermum flos-aquae cells/mL = 23,678

Microcystis aeruginosa cells/mL = 867

Note: Toxic Algae Only

Phytoplankton Sample Analysis

Sample: Klamath Basin
Sample Site: UKEP18001
Sample Depth:
Sample Date: 30-May-18 1115

Total Density (#/mL): 5,557
Total Biovolume (um³/mL): 5,670,874
Trophic State Index: 62.4

Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent
1 Aphanizomenon flos-aquae	2,817	50.7	4,792,326	84.5
2 Microcystis aeruginosa	2,506	45.1	220,489	3.9
3 Dolichospermum flos-aquae	234	4.2	658,059	11.6

Aphanizomenon flos-aquae cells/mL = 76,069

Dolichospermum flos-aquae cells/mL = 9,822

Microcystis aeruginosa cells/mL = 27,561

Note: Toxic Algae Only

Phytoplankton Sample Analysis

Sample: Klamath Basin
Sample Site: UKHP18001
Sample Depth:
Sample Date: 30-May-18 1131

Total Density (#/mL): 509
Total Biovolume (um³/mL): 761,458
Trophic State Index: 47.9

Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent
1 Aphanizomenon flos-aquae	463	90.9	728,878	95.7
2 Dolichospermum flos-aquae	34	6.6	31,570	4.1
3 Microcystis aeruginosa	13	2.5	1,010	0.1

Dolichospermum flos-aquae cells/mL = 471

Microcystis aeruginosa cells/mL = 126

Aphanizomenon flos-aquae cells/mL = 11,569

Note: Toxic Algae Only

Phytoplankton Sample Analysis

Sample: Klamath Basin
Sample Site: UKMP18001
Sample Depth:
Sample Date: 30-May-18 1146

Total Density (#/mL): 546
Total Biovolume (um³/mL): 916,390
Trophic State Index: 49.2

Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent
1 Aphanizomenon flos-aquae	416	76.2	603,350	65.8
2 Dolichospermum flos-aquae	130	23.8	313,039	34.2

Aphanizomenon flos-aquae cells/mL = 9,577

Dolichospermum flos-aquae cells/mL = 4,672

Note: Toxic Algae Only

Phytoplankton Sample Analysis

Sample: Klamath Basin
Sample ID: KR18805
Sample Depth:
Sample Date: 9-Jun-18 1730

Total Density (#/mL): 20
Total Biovolume (um³/mL): 24,855
Trophic State Index: 23.5

Species	Density #/mL	Density Percent	Biovolume um³/mL	Biovolume Percent
1 Oscillatoria limosa	20	100.0	24,855	100.0

Oscillatoria limosa cells/mL = 401

Note: Toxic Algae Only

Phytoplankton Sample Analysis

Sample: Klamath Basin
 Sample ID: KR18806
 Sample Depth:
 Sample Date: 9-Jun-18 1545

Total Density (#/mL): 4
 Total Biovolume (um³/mL): 10,792
 Trophic State Index: 17.8

Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent
1 Dolichospermum flos-aquae	4	100.0	10,792	100.0

Dolichospermum flos-aquae cells/mL = 161

Note: Toxic Algae Only

Phytoplankton Sample Analysis

Sample: Klamath Basin
Sample ID: KR18807
Sample Depth:
Sample Date: 9-Jun-18 1220

Total Density (#/mL): 35
Total Biovolume (um³/mL): 70,200
Trophic State Index: 30.8

Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent
1 Dolichospermum flos-aquae	26	75.0	59,272	84.4
2 Aphanizomenon flos-aquae	9	25.0	10,928	15.6

Dolichospermum flos-aquae cells/mL = 885

Aphanizomenon flos-aquae cells/mL = 173

Phytoplankton Sample Analysis

Sample: Klamath Basin
 Sample ID: KR18808
 Sample Depth:
 Sample Date: 9-Jun-18 1200

Total Density (#/mL): 21
 Total Biovolume (um³/mL): 52,348
 Trophic State Index: 28.7

Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent
1 Dolichospermum flos-aquae	8	40.0	31,239	59.7
2 Oscillatoria sp.	8	40.0	15,768	30.1
3 Aphanizomenon flos-aquae	4	20.0	5,341	10.2

Dolichospermum flos-aquae cells/mL = 466

Aphanizomenon flos-aquae cells/mL = 85

Oscillatoria sp. cells/mL = 254

Note: Toxic Algae Only

Phytoplankton Sample Analysis

Sample: Klamath Basin
Sample ID: KR18809
Sample Depth:
Sample Date: 9-Jun-18 1940

Total Density (#/mL): 9
Total Biovolume (um³/mL): 5,056
Trophic State Index: 13.0

Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent
1 Dolichospermum flos-aquae	4	50.0	2,324	46.0
2 Aphanizomenon flos-aquae	4	50.0	2,732	54.0

Dolichospermum flos-aquae cells/mL = 35

Aphanizomenon flos-aquae cells/mL = 43

Note: Toxic Algae Only

Phytoplankton Sample Analysis

Klamath
Sample: Basin
Sample ID: KR18810
Sample Depth:
Sample Date: 25-Jun-18 1430

Total Density (#/mL): 598
Total Biovolume (um³/mL): 1,244,222
Trophic State Index: 51.4

Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent
1 Oscillatoria limosa	491	82.1	1,096,238	88.1
2 Aphanizomenon flos-aquae	107	17.9	147,984	11.9

Oscillatoria limosa cells/mL = 17,681

Aphanizomenon flos-aquae cells/mL = 2,349

Note: Toxic Algae Only

Phytoplankton Sample Analysis

Sample: Klamath Basin
 Sample ID: KR18811
 Sample Depth:
 Sample Date: 25-Jun-18 1305

Total Density (#/mL): 40
 Total Biovolume (um³/mL): 61,401
 Trophic State Index: 29.8

Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent
1 Aphanizomenon flos-aquae	37	92.6	58,071	94.6
2 Dolichospermum flos-aquae	2	5.6	2,964	4.8
3 Oscillatoria limosa	1	1.9	366	0.6

Aphanizomenon flos-aquae cells/mL = 922

Dolichospermum flos-aquae cells/mL = 44

Oscillatoria limosa cells/mL = 6

Note: Toxic Algae Only

Phytoplankton Sample Analysis

Sample: Klamath Basin
 Sample ID: KR18812
 Sample Depth:
 Sample Date: 25-Jun-18 1230

Total Density (#/mL): 653
 Total Biovolume (um³/mL): 321,417
 Trophic State Index: 41.7

Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent
1 Microcystis aeruginosa	488	74.8	39,063	12.2
2 Dolichospermum flos-aquae	151	23.1	262,912	81.8
3 Aphanizomenon flos-aquae	9	1.4	11,186	3.5
4 Oscillatoria limosa	4	0.7	8,256	2.6

Microcystis aeruginosa cells/mL = 4,883
 Dolichospermum flos-aquae cells/mL = 3,924
 Aphanizomenon flos-aquae cells/mL = 178
 Oscillatoria limosa cells/mL = 133

Note: Toxic Algae Only

Phytoplankton Sample Analysis

Sample: Klamath Basin
 Sample ID: KR18813
 Sample Depth:
 Sample Date: 25-Jun-18 1215

Total Density (#/mL): 184
 Total Biovolume (um³/mL): 182,736
 Trophic State Index: 37.6

Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent
1 Microcystis aeruginosa	118	64.0	9,433	5.2
2 Dolichospermum flos-aquae	66	36.0	173,303	94.8

Microcystis aeruginosa cells/mL = 1,179

Dolichospermum flos-aquae cells/mL = 2,587

Note: Toxic Algae Only

Phytoplankton Sample Analysis

Sample: Klamath Basin
Sample ID: KR18814
Sample Depth:
Sample Date: 25-Jun-18 1145

Total Density (#/mL): <10
Total Biovolume (um³/mL):
Trophic State Index:

Species	Density #/mL	Density Percent	Biovolume um³/mL	Biovolume Percent
-	-	-	-	-
1 No Toxic Algae Present	<10			

Note: Toxic Algae Only

Phytoplankton Sample Analysis

Sample: Klamath Basin
Sample Site: BRTC18002
Sample Depth:
Sample Date: 20-Jun-18 1108

Total Density (#/mL): 915
Total Biovolume (um³/mL): 805,013
Trophic State Index: 48.3

Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent
1 Aphanizomenon flos-aquae	904	98.8	797,533	99.1
2 Dolichospermum flos-aquae	11	1.2	7,479	0.9

Aphanizomenon flos-aquae cells/mL = 12,659

Dolichospermum flos-aquae cells/mL = 112

Note: Toxic Algae Only

Phytoplankton Sample Analysis

Sample: Klamath Basin
Sample Site: KEKP18002
Sample Depth:
Sample Date: 20-Jun-18 1124

Total Density (#/mL): 108,172
Total Biovolume (um³/mL): 163,556,337
Trophic State Index: 86.6

Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent
1 Aphanizomenon flos-aquae	108,172	100.0	163,556,337	100.0

Aphanizomenon flos-aquae cells/mL = 2,596,132

Note: Toxic Algae Only

Phytoplankton Sample Analysis

Sample: Klamath Basin
Sample Site: UKEP18002
Sample Depth:
Sample Date: 20-Jun-18 1205

Total Density (#/mL): 247,090
Total Biovolume (um³/mL): 358,033,072
Trophic State Index: 92.3

Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent
1 Aphanizomenon flos-aquae	247,090	100.0	358,033,072	100.0

Aphanizomenon flos-aquae cells/mL = 5,683,065

Note: Toxic Algae Only

Phytoplankton Sample Analysis

Sample: Klamath Basin
Sample Site: UKHP18002
Sample Depth:
Sample Date: 20-Jun-18 1222

Total Density (#/mL): 366,915
Total Biovolume (um³/mL): 966,913,424
Trophic State Index: 99.4

Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent
1 Aphanizomenon flos-aquae	214,034	58.3	391,039,932	40.4
2 Gloeotrichia echinulata	107,017	29.2	349,303,322	36.1
3 Dolichospermum flos-aquae	30,576	8.3	225,347,119	23.3
4 Microcystis aeruginosa	15,288	4.2	1,223,051	0.1

Microcystis aeruginosa cells/mL = 152,881
 Gloeotrichia echinulata cells/mL = 5,136,814
 Dolichospermum flos-aquae cells/mL = 3,363,390
 Aphanizomenon flos-aquae cells/mL = 6,206,983

Note: Toxic Algae Only

Phytoplankton Sample Analysis

Sample: Klamath Basin
Sample Site: UKMP18002
Sample Depth:
Sample Date: 20-Jun-18 1238

Total Density (#/mL): 563,750
Total Biovolume (um³/mL): 887,906,250
Trophic State Index: 98.8

Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent
1 Aphanizomenon flos-aquae	563,750	100.0	887,906,250	100.0

Aphanizomenon flos-aquae cells/mL = 14,093,750

Note: Toxic Algae Only

Phytoplankton Sample Analysis

Sample: Klamath Basin
Sample Site: BRTC18003
Sample Depth:
Sample Date: 26-Jun-18 1243

Total Density (#/mL): 7,598
Total Biovolume (um³/mL): 8,630,799
Trophic State Index: 65.4

Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent
1 Aphanizomenon flos-aquae	7,578	99.7	8,593,013	99.6
2 Oscillatoria limosa	20	0.3	37,786	0.4

Aphanizomenon flos-aquae cells/mL = 136,397

Oscillatoria limosa cells/mL = 609

Note: Toxic Algae Only

Phytoplankton Sample Analysis

Sample: Klamath Basin
Sample Site: KEKP18003
Sample Depth:
Sample Date: 26-Jun-18 1300

Total Density (#/mL): 69,611
Total Biovolume (um³/mL): 83,324,211
Trophic State Index: 81.7

Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent
1 Aphanizomenon flos-aquae	69,611	100.0	83,324,211	100.0

Aphanizomenon flos-aquae cells/mL = 1,322,607

Note: Toxic Algae Only

Phytoplankton Sample Analysis

Sample: Klamath Basin
Sample Site: UKEP18003
Sample Depth:
Sample Date: 26-Jun-18 1341

Total Density (#/mL): 60,509
Total Biovolume (um³/mL): 80,053,628
Trophic State Index: 81.5

Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent
1 Aphanizomenon flos-aquae	60,509	100.0	80,053,628	100.0

Aphanizomenon flos-aquae cells/mL = 1,270,693

Note: Toxic Algae Only

Phytoplankton Sample Analysis

Sample: Klamath Basin
Sample Site: UKHP18003
Sample Depth:
Sample Date: 26-Jun-18 1357

Total Density (#/mL): 77,868
Total Biovolume (um³/mL): 155,757,078
Trophic State Index: 86.3

Species	Density #/mL	Density Percent	Biovolume um ³ /mL
1 Aphanizomenon flos-aquae	76,459	98.2	96,337,828
2 Gloeotrichia echinulata	1,409	1.8	59,419,250

Aphanizomenon flos-aquae cells/mL = 1,529,172

Gloeotrichia echinulata cells/mL = 873,813

Note: Toxic Algae Only

Phytoplankton Sample Analysis

Sample: Klamath Basin
Sample Site: UKMP18003
Sample Depth:
Sample Date: 26-Jun-18 1415

Total Density (#/mL): 7,381
Total Biovolume (um³/mL): 9,765,691
Trophic State Index: 66.3

Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent
1 Aphanizomenon flos-aquae	7,381	100.0	9,765,691	100.0

Aphanizomenon flos-aquae cells/mL = 155,011

Note: Toxic Algae Only