Phytoplankton Species and Abundance Observed During 2009 in the Vicinity of the Klamath Hydroelectric Project

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Summary

Phytoplankton sampling during 2009 was a continuation of similar sampling conducted by PacifiCorp in 2001 through 2008[1] to characterize the phytoplankton community of the Project. A second component of the work was to provide information for public health agencies related to the presence of potentially toxic cyanobacteria. The results of the baseline monitoring are presented in this report. The results of the public health sampling were distributed in a series of biweekly memoranda during the sampling season and are located on PacifiCorp's Klamath Hydroelectric Project website (http://www.pacificorp.com/es/hydro/hl/kr.html). Phytoplankton samples were collected in association with water chemistry samples at nine sites in the Klamath River and reservoirs. An additional four shoreline locations, two each in Copco and Iron Gate reservoirs, were sampled for public health purposes without associated water chemistry samples.

Results were similar to those obtained on prior years. Cyanobacteria and diatoms are the two most abundant phytoplankton groups that have been observed in samples collected from 2001 through 2009. Cyanobacteria are dominant in the reservoirs, especially in late summer and fall, while diatoms are dominant in the Klamath River. The Klamath River and reservoirs were both dominated by diatoms early in the summer (May) followed by a period of relatively low abundance of phytoplankton in general. The two most abundant cyanobacteria in Copco and Iron Gate reservoirs are *Microcystis aeruginosa* and *Aphanizomenon flos-aquae*. *Aphanizomenon* is typically more abundant than *Microcystis*. Cyanobacteria reached levels leading to issuance of health advisories for water contact recreation in Copco and Iron Gate reservoir by mid-July. Cell counts of *Microcystis* were generally above the California guideline[2] at least one location in Copco or Iron Gate reservoir through October. *Microcystis* was first observed below Iron Gate dam on July 6 and was present for the rest of the summer. *Microcystis* cell counts exceeded the California guideline at the site below Iron Gate only once, on August 3. Comparison of the frequency of occurrence and biovolume of *Microcystis* in samples collected from 2001 through 2009 suggests the possibility that M*icrocystis* abundance has been increasing in recent years.

Introduction

This report presents the results of phytoplankton sampling conducted by PacifiCorp Energy (PacifiCorp) during 2009 in the vicinity of the Klamath Hydroelectric Project (Project), located along the upper Klamath River in Klamath County, south-central Oregon, and Siskiyou County,

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[1] Phyoplankton sampling was not conducted in 2006.

[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 cyanobacterial 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 cyanobacterial 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., "Cyanbacterial scum formation in areas where whole-body contact and/or risk of ingestion/aspiration occur". No specific cyanobacterial 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.

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 cells/mL and 100,000 cells/mL equate to microcystin toxin concentrations of 8 µg/L and 20 µg/L, respectively.

northern California. Phytoplankton sampling in 2009 was governed by the scope of work of the 2009 Agreement in Principal monitoring plan developed between the states of Oregon and California and the United States and other parties. The 2009 AIP plan is available on the California North Cast Regional Board's website (www.waterboards.ca.gov/northcoast/water_issues/programs/tmdls/klamath_river). There were two components to phytoplankton sampling in 2009; sampling for the purpose of protecting public health, and baseline sampling. The purpose of the baseline phytoplankton sampling is to characterize the phytoplankton community and to identify the typical seasonal succession of phytoplankton in the Klamath River system in the vicinity of the Project. The results of the baseline monitoring are presented in this report. The results of the public health sampling were distributed in a series of biweekly memoranda during the sampling season and are posted on PacifiCorp's Klamath Hydroelectric Project website (http://www.pacificorp.com/es/hydro/hl/kr.html).

The Project is located along the 100 miles of the Klamath River immediately downstream of Upper Klamath Lake. Upper Klamath Lake is highly enriched with nutrients and supports a large population of the cyanobacteria (blue-green algae) *Aphanizomenon flos-aquae* and a smaller population of *Microcystis aeruginosa*. As water from the lake flows into the Klamath River, the river carries a large load of nutrient and organic material in the form of algal cells and associated metabolic products. This organic and nutrient load, combined with the additional inputs to Lake Ewauna from various sources, provides the input that drives the growth, species composition, and abundance of phytoplankton in the vicinity of the Project.

The phytoplankton sampling during 2009 was a continuation of similar sampling conducted by PacifiCorp in 2001 through 2008[3] to characterize the phytoplankton community of the Project area. PacifiCorp began phytoplankton sampling in 2001, primarily in the Project reservoirs. The sampling was expanded in 2002 to include a number of river stations in the vicinity of the Project. Results of phytoplankton sampling in previous years are described in other documents (PacifiCorp 2004a, 2004b, 2006, 2007a, 2007b, Raymond 2008, 2009); these documents and the related data are available on PacifiCorp's website.

Phytoplankton are important water quality indicators because of their sensitivity to environmental change and short life span. Phytoplankton are also useful indicators of high nutrient concentration in water because of their propensity to multiply rapidly. Under the right conditions they can undergo rapid population growth, or "blooms". An understanding of the current conditions in the waters within the Project can be derived from measurement of phytoplankton indicators such as chlorophyll *a*, algal biomass, and algal community species composition.

Description of the Program

The 2009 sampling program included public health monitoring for blue-green algae and baseline monitoring. The objectives of Plan included the following:

[3] Phyoplankton sampling was not conducted in 2006.

- Provide data on cyanobacteria and related toxins in a timely manner to support public health decisions.
- Improve the current understanding of seasonal, annual, and long-term variations in a wide range of water quality parameters for Klamath River from Link Dam to the estuary. A system-wide approach is necessary because influences from upstream sources extend downstream.
- Form a long-term program that captures the effects of other activities in the system potentially affecting water quality in the Klamath River, regulatory actions (e.g., Biological Opinions, adjudications, etc.), potential climate change impacts, fires and land use activities, and other factors.
- Provide a long-term baseline data set of water quality conditions that can be readily extended to assess impacts of management actions and restoration processes, including water quality conditions.
- Collect data under a consistent Quality Assurance (QA) framework
- Disseminate data in a timely fashion.

Sites

Sampling for phytoplankton abundance and microcystin in 2009 was conducted by several organizations including the Bureau of Reclamation, PacifiCorp, the Karuk Tribes Natural Resources Department, and the Yurok Tribes Environmental Program. PacifiCorp collected samples at nine sites upstream, within, and downstream of the Project. Sampling locations are listed in Table 1 and depicted in Figure 1.

Phytoplankton samples were collected in association with water chemistry samples at nine sites in the Klamath River and reservoirs. An additional four shoreline locations, two each in Copco and Iron Gate reservoirs, were sampled for public health purposes without associated water chemistry samples. This report presents the results of phytoplankton and microcystin sampling. The results of the water chemistry sampling are presented in a separate report (Raymond 2010). The water quality and phytoplankton reports and additional data will be posted on PacifiCorp's Project website at http://www.pacificorp.com/es/hydro/hl/kr.html.

Table 1. 2009 baseline phytoplankton sampling locations in the vicinity of the Klamath Hydroelectric Project.

Location	Site ID	River Mile
Klamath River above J. C. Boyle reservoir	KR22822	228.2
J. C. Boyle Reservoir at the log boom	KR22478	224.8
Klamath River below J. C. Boyle dam	KR22460	224.6
Klamath River below J. C. Boyle powerhouse	KR22000	220.0
Klamath River above Shovel Creek	KR20642	206.4
Copco reservoir lower end at log boom	KR19874	198.7
Klamath River above Iron Gate reservoir	KR19645	196.4
Iron Gate reservoir lower end above log boom	KR19019	190.2
Klamath River at Iron Gate Hatchery bridge	KR18973	189.7

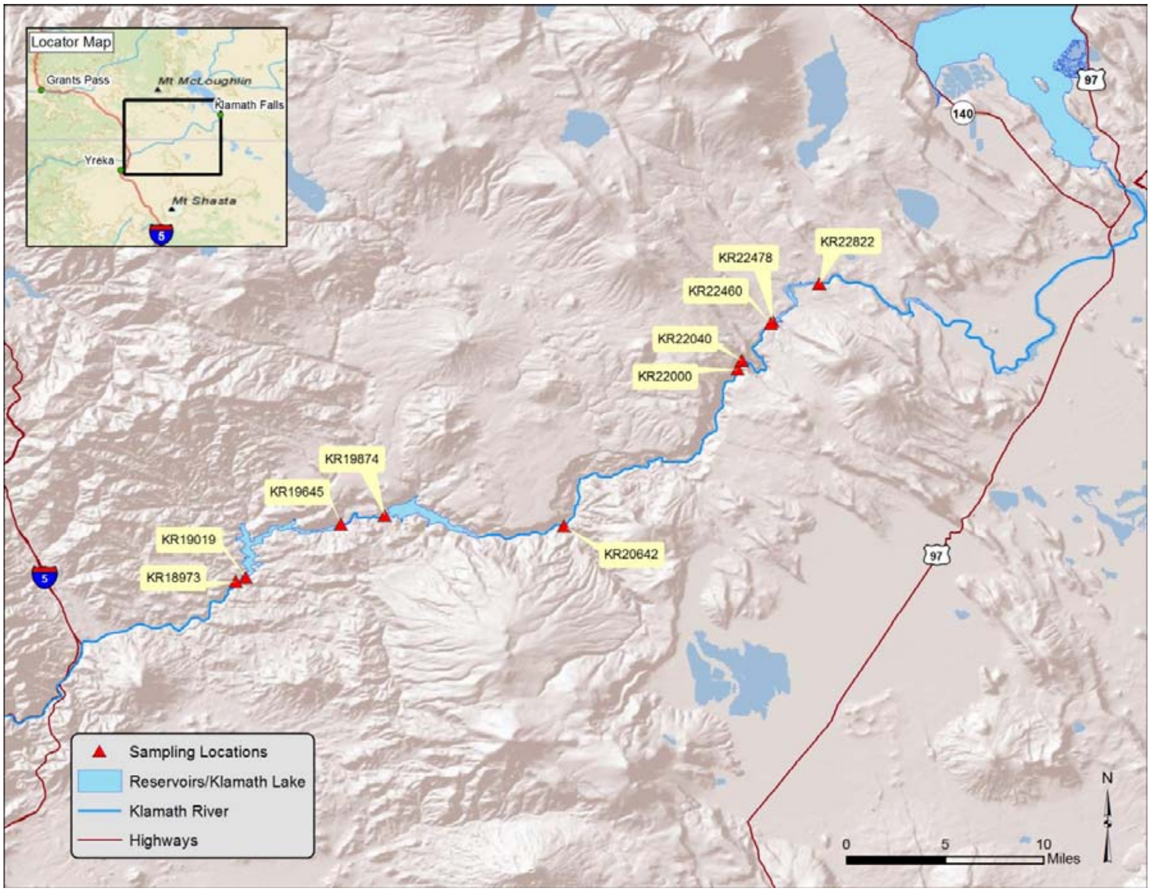

Figure 1. Location of phytoplankton collection sites in 2009.

Sampling Frequency

In 2009 baseline phytoplankton samples were collected once per month in January, and May through December. In addition, the site below Iron Gate dam was visited biweekly during June through October for a total of 14 sampling events.

Methods

Field Methods

Grab samples for phytoplankton community characterization were collected at sites by lowering a Kemmerer sampler from a boat or bridge, or throwing it from the shore, into the current. The sampler was retrieved, emptied into a churn splitter, and dispensed into sample containers supplied by the laboratory. Samples were collected from approximately 0.5 m depth in the current at the river sites and from 0.5 m depth in the reservoir sites. In addition, an integrated sample of the top 8 m of water in Copco and Iron Gate reservoirs was collected at the site near the dam in each reservoir. The integrated samples from Copco and Iron Gate reservoirs were collected by lowering a weighted tube to 8 m, clamping off the top, retrieving the tube and draining it into a churn splitter. The contents of the churn were mixed and dispensed into sample containers supplied by the laboratory. Public health samples were collected by grab samples in the upper 10 cm of the water column in areas of local maximum accumulation.

Approximately every 10th sample, but at least once for every sample set, a duplicate sample was collected for quality control purposes. Phytoplankton samples for speciation, abundance, and biovolume were preserved in the field with Lugol's solution and kept on ice in the dark until shipped to the laboratory for analysis. Chlorophyll *a* samples were kept in opaque bottles on ice in the dark until filtered through filters supplied by the laboratory. Filters were wrapped in aluminum foil, frozen, and shipped to the laboratory. Samples for determination of microcystin toxin were placed in a cooler on ice in the dark until they could be frozen and shipped to the laboratory.

Laboratory Methods

Sample analyses of phytoplankton speciation, density, and biovolume were performed by Aquatic Analysts of Friday Harbor, Washington. To determine phytoplankton species and abundance, prepared microscope slides of filtered samples were examined using phase contrast microscopy. Species were counted as algal units of cell, filament, or colony depending on the natural growth form of the species. Cyanobacteria were also counted as individual cells. Algal forms were identified to species or otherwise to the lowest practicable taxonomic level. Biovolume was estimated by multiplying the cell counts by the average geometric dimensions of the cells for a given phytoplankton taxon.

Chlorophyll *a* was measured fluorometrically by Chesapeake Biological Laboratory of Solomons, Maryland. Samples were filtered and pigment extracted by macerating the filters in a tissue grinder in the presence of a mixture of 90 parts acetone and 10 parts saturated magnesium carbonate solution. Chlorophyll *a* was determined by measuring fluorescence at 663 nm. Chlorophyll *a* measurements were corrected for the presence of phaeophytin by measuring fluorescence on samples before and after acidification.

Determination of microcystin toxin was performed by EPA Region 9 Laboratory in Richmond, California. The samples were analyzed using the competitive Enzyme-Linked ImmunoSorbent Assay (ELISA) method based on the EnviroLogix QuantiPlate Kit for microcystins. The quantitation limit was 0.18 μg/L. This test method does not distinguish between the specific microcystin congeners, but yields one value as the sum of all measurable microcystin variants, reported as microcystin LR.

Statistical Methods

Phytoplankton data gathered in 2009 were examined using several graphical and numerical methods. Graphical methods included boxplots, scatterplots, and bar graphs. Numerical methods included calculation of summary statistics, comparison of confidence intervals, linear and non-linear regression. Graphical and numerical methods were carried out using a variety of statistical software including Minitab®, Statistix9®, XLStat®, and SigmaPlot®.

Quality Assurance

The PacifiCorp baseline water quality activities follow a defined quality control program (PacifiCorp 2008d) that includes internal quality control by the laboratories, external quality control by field crews, and functional quality control by administrative oversight. For the phytoplankton and microcystin sampling, quality assurance was verified by replication of approximately every 10th sample, but at least one sample in every sample batch.

Results

This section describes the results obtained during the 2009 baseline water quality monitoring program or phytoplankton sample analysis for algal abundance and biovolume, species identification, and chlorophyll *a* concentration. There were 106 samples collected for phytoplankton analysis in the baseline monitoring program in 2009 during 14 sampling events. Most sites were visited monthly in January and May through December. The site below Iron Gate dam (KR19019) was also visited biweekly during June through October. The measures of overall phytoplankton conditions exhibited a wide range of values (Table 2). The distribution of values for the variables was typically skewed, with many high outlier values (Figure 2).

Table 2. Summary statistics for three measurements of algal conditions at the sites samples in 2009.

Statistic	Number of Species	Abundance (algal units)	Biovolume (μm^3/mL)	Chlorophyll *a* (µg/L)
No. of observations	106	106	106	167
Minimum	5	96	36,229	0.4
Maximum	31	48,732	51,663,311	62.1
1st Quartile	13	537	153,277	0.6
Median	20	1,246	419,889	1.6
3rd Quartile	25	2,857	982,146	5.7
Mean	19	2,605	1,528,058	6.8

Algal Community

Species

The major groups of phytoplankton observed in 2009 in the waters associated with the Project included:

- diatoms (kingdom Plantae, phylum Bacillariophyta)
- golden-brown algae (kingdom Chromista, phylum Ochrophyta)
- green algae (kingdom Plantae, phylum Chlorophyta)
- dinoflagellates (kingdom Protozoa, phylum Dinophyta)
- cryptomonads (kingdom Chromista, phylum Cryptophyta)
- microflagellates (kingdom Protozoa, phylum Euglenozoa)
- blue-green bacteria (kingdom Bacteria, phylum Cyanobacteria)

Cyanobacteria (57.1 percent), diatoms (38.2 percent), cryptomonads (3.0 percent), and green algae (1.5 percent) accounted for more than 99 percent of the total biovolume measured in 2009.

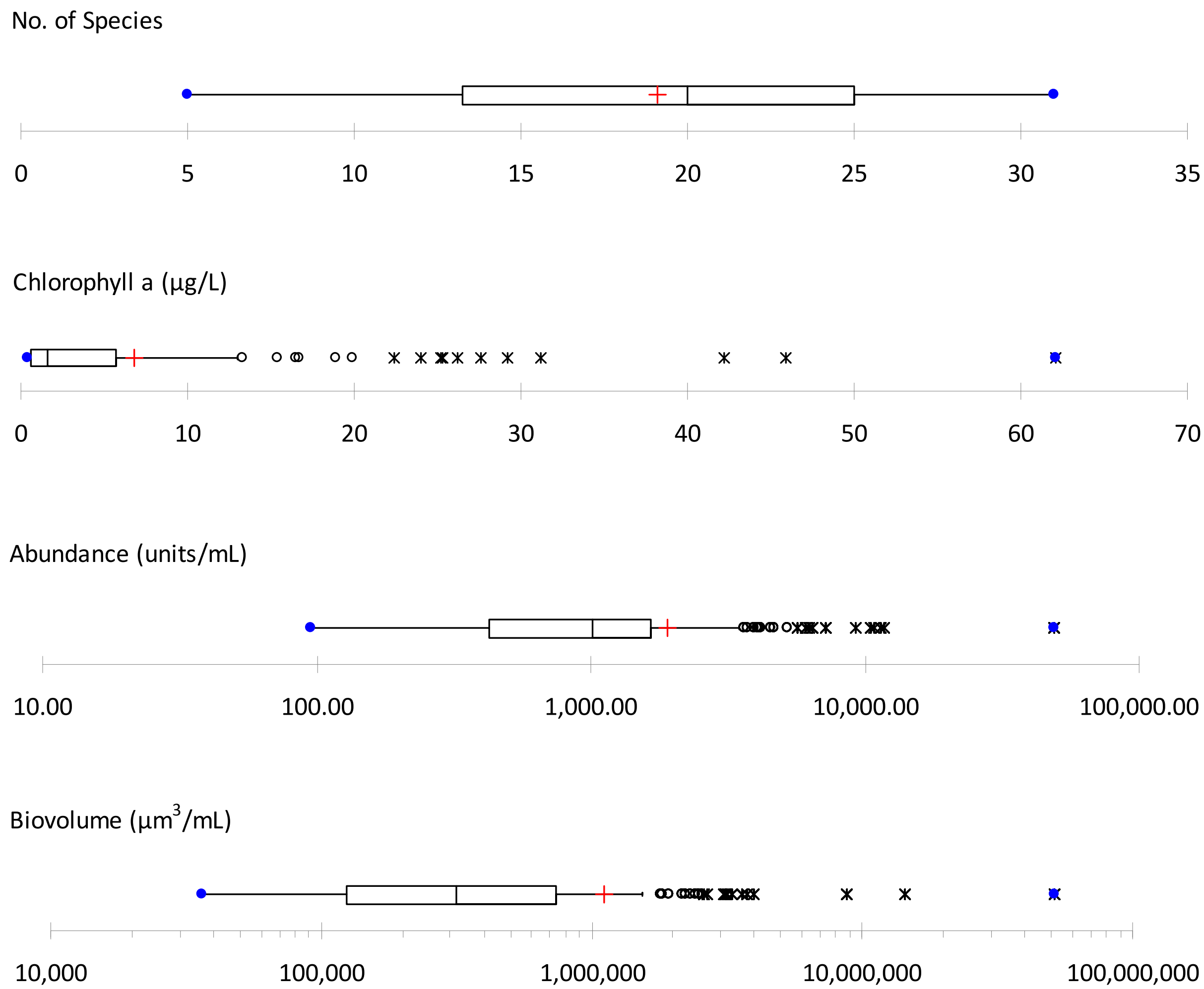

Figure 2. **Box plots[4] showing the distribution of values for number of species per sample, chlorophyll *a*, algal abundance, and biovolume for samples collected in the Klamath River in 2009.**

The number of species observed varied among the sites. The average number of species observed among all sites was 11. Typically, more species were observed at river sites than at reservoir sites. The highest species diversity was observed at sites in the Klamath River between J. C. Boyle dam (RM 226.4) and Shovel Creek above Copco reservoir (RM 206.4). The average number of species present at each site is shown in Figure 3.

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[4] A box plot illustrates the characteristics of a set of data. The box represents the middle 50% of the measured values from the 25th to the 75th percentile. The vertical line within the box indicates the median (middle) value. The lines extending out from the box extend to the highest or lowest value that is within 1.5 times the interquartile range. Outliers are values greater than 1.5 times the interquartile distance from the limits of the box and are respresented by individual symbols . Extreme outliers more than 3 times the interquartile distance from the box may be represented by a different symbol. The mean may be represented by a red cross.

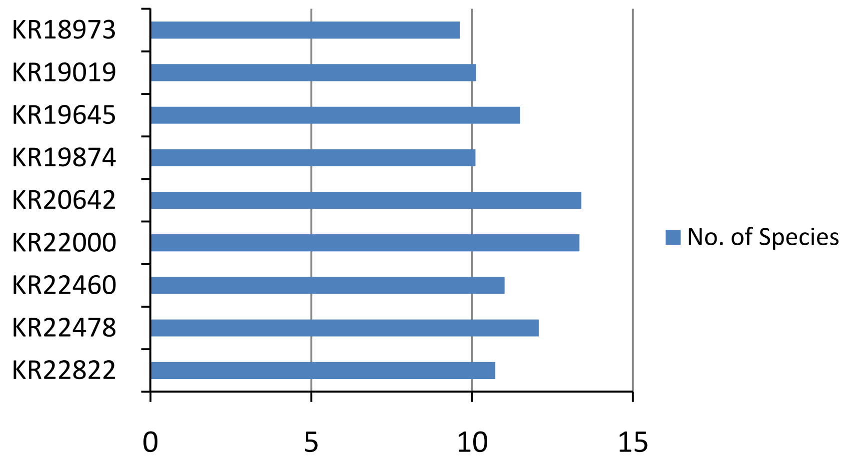

Figure 3. The average number of species observed at various sample locations in the Klamath river in 2009.

A total of 131 species was observed in the samples that were analyzed for this report. Of those species 23 occurred in only one sample, 86 occurred in more than 2 samples, and 46 comprised more than 5 percent of any one sample. There were 55 species that occurred in more than 5 percent of samples. Species that comprised at least 5 percent of biovolume in any one sample are listed in Table 3. A complete list of species observed in 2009 is included as Appendix 1.

Table 3. The most commonly observed phytoplankton species in 2009 in the Klamath River in the vicinity of the Klamath Hydroelectric Project.

Taxon	Frequency of Occurrence	Percent Frequency of Occurrence	Maximum Percent Biovolume	Average Percent Biovolume	Percent of Total Biovolume
Cryptomonas erosa	94	71.8	58.7	10.7	2.5
Asterionella formosa	80	61.1	95.4	20.2	17.0
Cocconeis placentula	75	57.3	23.8	5.3	1.4
Nitzschia palea	75	57.3	21.7	3.1	1.7
Nitzschia frustulum	70	53.4	11.3	2.5	0.4
Stephanodiscus hantzschii	67	51.1	68.2	6.1	1.0
Fragilaria construens venter	64	48.9	6.4	0.8	0.1
Aphanizomenon flos-aquae	60	45.8	97.7	34.1	26.4
Chlamydomonas sp.	58	44.3	26.7	2.9	0.9
Stephanodiscus astraea minutula	57	43.5	15.4	2.8	0.3
Rhoicosphenia curvata	55	42.0	6.1	1.1	0.2
Nitzschia dissipata	53	40.5	32.3	4.3	0.3
Aulacoseira granulata	51	38.9	91.3	16.5	3.5
Cyclotella meneghiniana	51	38.9	16.4	3.3	0.4
Gomphonema angustatum	51	38.9	5.0	1.3	0.1
Fragilaria construens	49	37.4	11.5	1.8	1.4
Fragilaria vaucheriae	42	32.1	30.0	2.3	1.1

Taxon	Frequency of Occurrence	Percent Frequency of Occurrence	Maximum Percent Biovolume	Average Percent Biovolume	Percent of Total Biovolume
Scenedesmus quadricauda	37	28.2	16.0	3.4	0.3
Fragilaria capucina mesolepta	32	24.4	15.4	3.6	0.8
Gomphonema subclavatum	32	24.4	11.7	2.6	0.1
Microcystis aeruginosa	23	17.6	72.5	28.7	30.4
Cryptomonas ovata	21	16.0	39.7	12.4	0.3
Diatoma vulgare	16	12.2	14.9	6.8	0.6
Glenodinium sp.	15	11.5	7.7	3.0	0.1
Navicula tripunctata	14	10.7	15.8	6.4	0.1
Synedra ulna	13	9.9	22.2	9.8	0.2
Chromulina sp.	10	7.6	14.1	2.4	0.1
Anabaena flos-aquae	10	7.6	8.5	3.0	0.2
Fragilaria crotonensis	9	6.9	94.9	32.4	3.8
Synedra cyclopum	8	6.1	20.2	5.8	0.0
Aulacoseira ambigua	8	6.1	8.2	3.2	0.1
Cymbella affinis	6	4.6	20.9	12.7	0.2
Aulacoseira varians	6	4.6	14.3	4.4	0.0
Gomphoneis herculeana	6	4.6	14.1	10.0	1.8
Gomphonema ventricosum	6	4.6	8.4	2.9	0.1
Nitzschia linearis	3	2.3	6.3	5.8	0.0
Actinastrum hantzschii	3	2.3	5.6	3.3	0.1
Epithemia sorex	2	1.5	44.2	30.8	0.3
Gomphonema acuminatum	2	1.5	10.7	8.3	0.0
Cymbella tumida	2	1.5	8.6	5.9	0.0
Trachelomonas volvocina	2	1.5	5.2	4.6	0.0
Cymatopleura solea	1	0.8	32.3	32.3	0.1
Anabaena sp.	1	0.8	10.2	10.2	0.0
Epithemia turgida	1	0.8	8.5	8.5	0.0
Cyclotella comta	1	0.8	5.5	5.5	0.0

Abundance and Biovolume

Five species accounted for more than 80 percent of the total biovolume measured in 2009 (Table 4). *Microcystis aeruginosa* comprised 30.4 percent of total biovolume, the result of two samples from Copco Reservoir that were heavily dominated by *Microcystis*. *Aphanizomenon flos-aquae* accounted 26.4 percent and *Asterionella formosa* (a diatom) accounted for 17.0 percent. Other species that individually accounted for more than 2 percent of total biovolume included *Fragilaria crotonensis* (diatom), *Aulacoseira granulata* (diatom), and *Cryptomonas erosa* (cryptophyte).

Table 4. The most common species observed in 2009 based on maximum biovolume (μm^3/mL) in a single sample and on percent of total biovolume of all samples.

Species	Maximum Biovolume	Species	Percent of Total Biovolume
Microcystis aeruginosa	37,431,991	*Microcystis aeruginosa*	30.4
Aphanizomenon flos-aquae	8,557,725	*Aphanizomenon flos-aquae*	26.4
Fragilaria crotonensis	3,782,128	*Asterionella formosa*	17.0
Asterionella formosa	3,434,538	*Fragilaria crotonensis*	3.8
Gomphoneis herculeana	2,724,161	*Aulacoseira granulata*	3.5
Fragilaria construens	1,695,034	*Cryptomonas erosa*	2.5
Aulacoseira granulata	1,664,475	*Gomphoneis herculeana*	1.8
Cocconeis placentula	1,392,349	*Nitzschia palea*	1.7
Nitzschia palea	1,271,275	*Cocconeis placentula*	1.4
Fragilaria vaucheriae	1,074,528	*Fragilaria construens*	1.4

The average and median algal biovolume for both the baseline and public health monitoring are shown in Figure 4. The relatively large difference between the mean and median, especially in Copco (KR19874) and Iron Gate (KR19019) reservoirs, is a consequence of the variability of values, with occasional extreme high values at those locations. Note that the values for the public health samples are approximately two orders of magnitude larger than for the baseline samples; a consequence of the different sampling techniques used[5]. Although biovolume measurements include all species, late summer phytoplankton in Copco and Iron Gate reservoirs are dominated by cyanobacteria Results of the public health sampling suggest that surface scums are more concentrated at the shoreline sites – Copco Cove (CRCC), Mallard Cove (CRMC), Camp Creek (IRCC), and Jay Williams Camp(IRJW) – than at the open reservoir locations (CR01, IR01).

Chlorophyll

Chlorophyll *a* concentration varied seasonally and spatially in 2009. Summary statistics for chlorophyll *a* values are provided in Table 5. The values are illustrated in Figure 5.

The highest mean chlorophyll *a* value (15.6 µg/L) occurred in Copco reservoir (KR19874) while the lowest mean chlorophyll value (3.9 µg/L) – among sites sampled more than once – occurred in the Klamath River above Shovel Creek (KR20642). The highest median chlorophyll *a* value (7.0 µg/L) occurred below Iron Gate dam (KR18973), while the lowest (0.97 µg/L) occurred in Iron Gate reservoir (KR19019). Both mean and median values for chlorophyll *a* tended to decrease with distance downstream, with the exception of mean values in Copco and Iron Gate reservoirs which were influenced by occasional high values in near-surface samples.

Chlorophyll concentration was low in January, and increased at all sites in May. After May, the sites diverged with chlorophyll decreasing at most sites in August while increasing in August and September in Copco and Iron Gate reservoirs and below Iron Gate reservoir. By November, chlorophyll concentration was low at all locations.

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[5] Baseline samples were collected as discrete grabs at 0.5 m depth, public health samples were collected by grab samples in the upper f 10 cm of the water column at the point of local maximum accumulation.

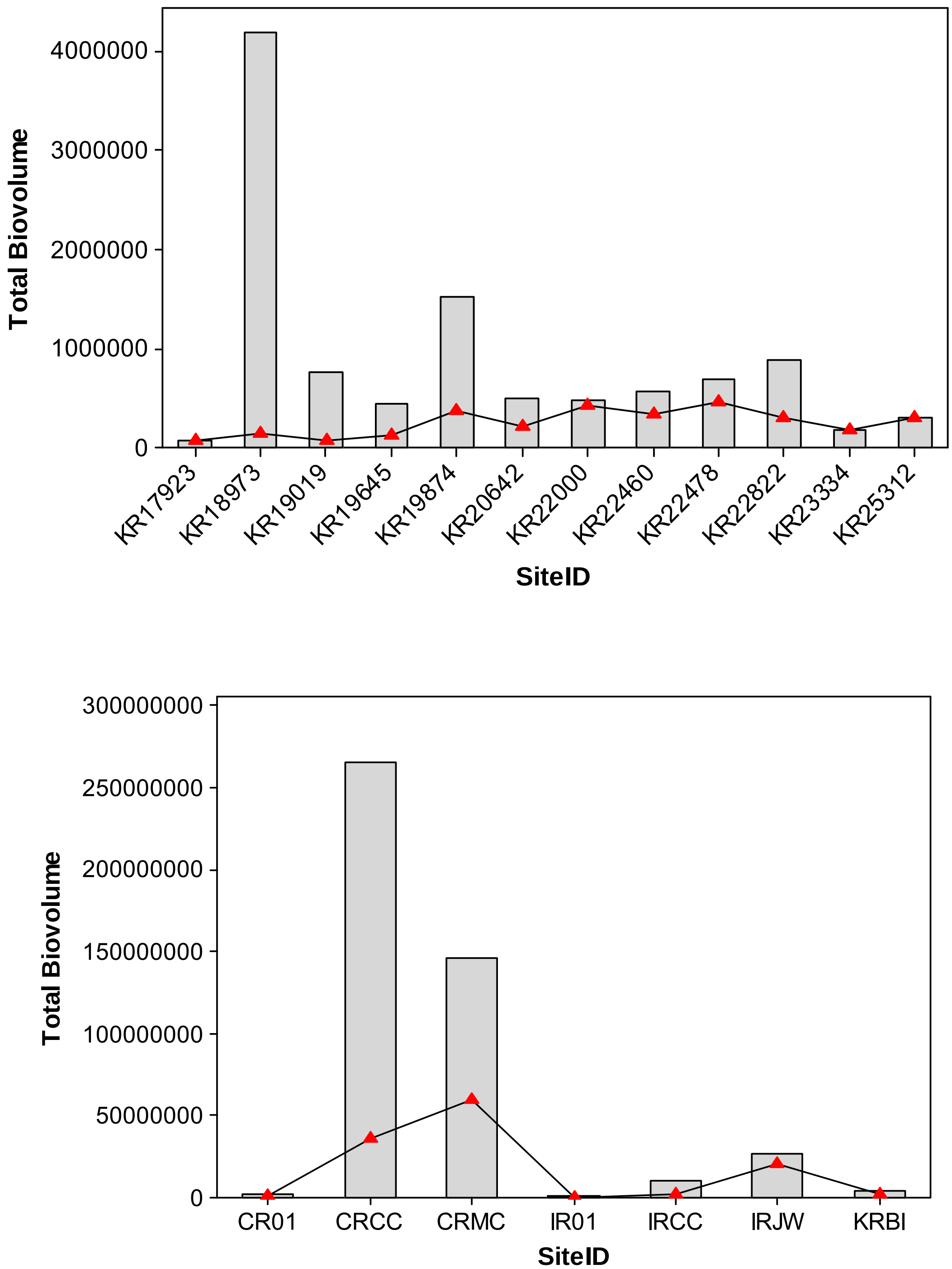
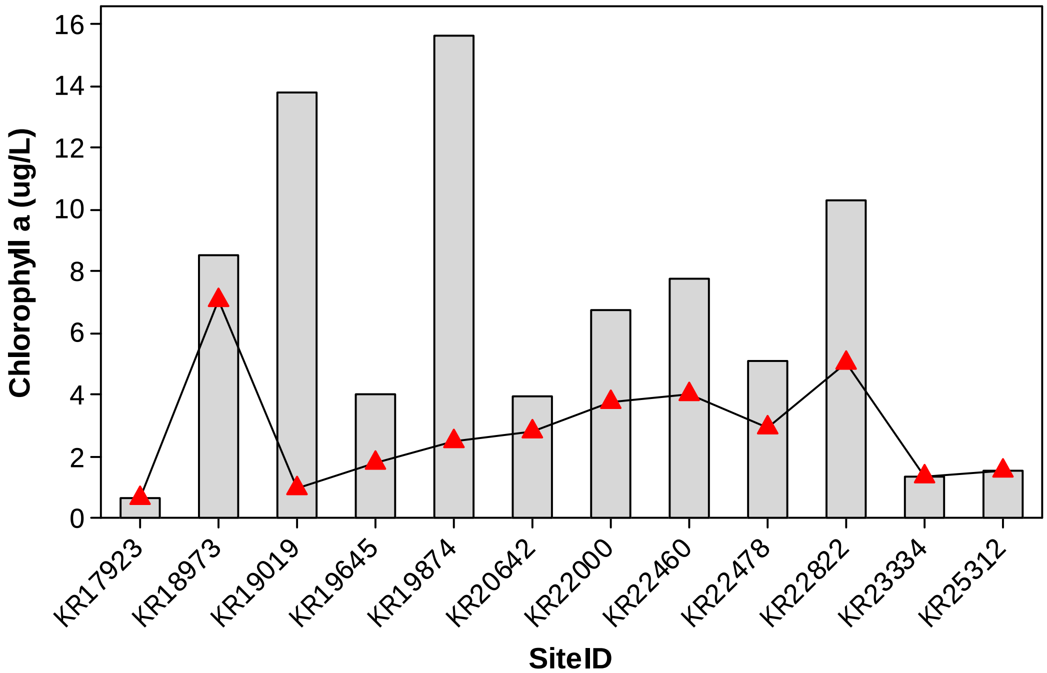


Figure 4. Average (bars) and median (triangles) biovolume measured at various locations in the vicinity of the Klamath Hydroelectric Project in 2009. The upper graph shows sites sampled for the baseline monitoring program, the lower graph shows sites sampled for the public health monitoring program. Sampling methods were different for the two programs.



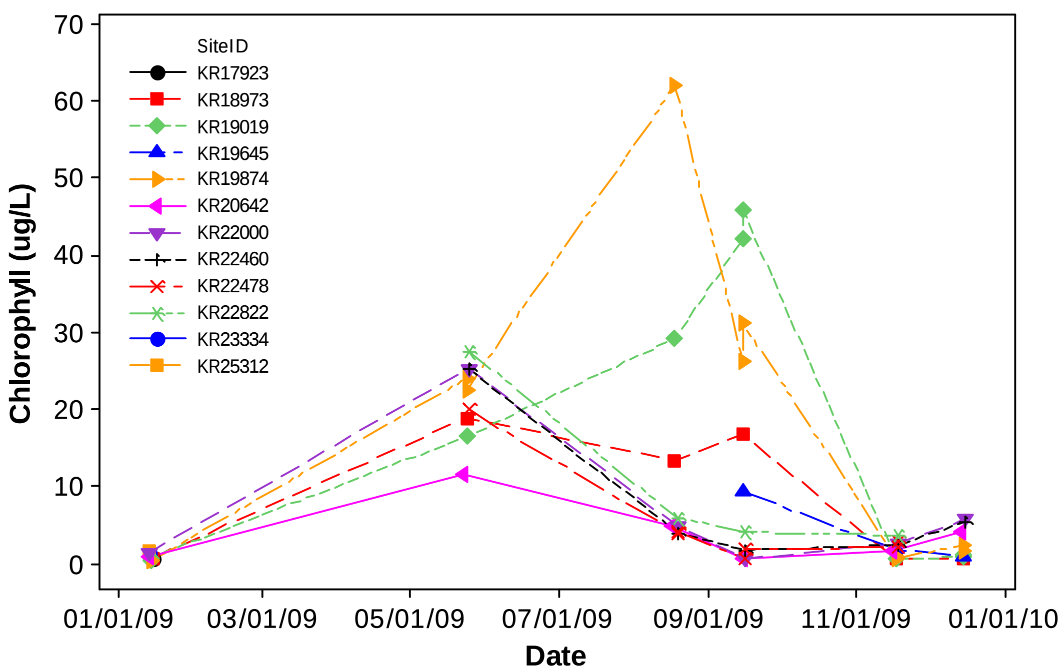


Figure 5. **Top: Mean (bars) and median (triangles) chlorophyll *a* values measured at various locations in 2009 in the vicinity of the Klamath Hydroelectric Project. Bottom: Seasonal change of chlorophyll *a* values measured in 2009.**

Table 5. Summary statistics for chlorophyll *a* values measured in 2009 in the vicinity of the Klamath Hydroelectric Project.

Site ID	Location	N	Mean	Minimum	Median	Maximum
KR17923	Walker Bridge	1	--	0.66	--	0.66
KR18973	Hatchery Bridge	6	8.48	0.56	7.04	18.90
KR19019	Iron Gate reservoir near dam	10	13.80	0.41	0.97	45.89
KR19645	Above Iron Gate reservoir	3	3.99	0.88	1.78	9.33
KR19874	Copco reservoir near dam	11	15.65	0.36	2.46	62.07
KR20642	Above Shovel Creek	6	3.91	0.54	2.81	11.58
KR22000	Spring Island landing	6	6.72	0.57	3.73	25.27
KR22460	Below J.C. Boyle dam	5	7.75	1.72	3.99	25.19
KR22478	J. C. Boyle reservoir	7	5.09	0.62	2.95	19.93
KR22822	Above J. C. Boyle reservoir	4	10.32	3.67	5.01	27.58
KR23334	Below Keno Dam	1	--	1.31	--	1.31
KR25312	Link River	1	--	1.52	--	1.52

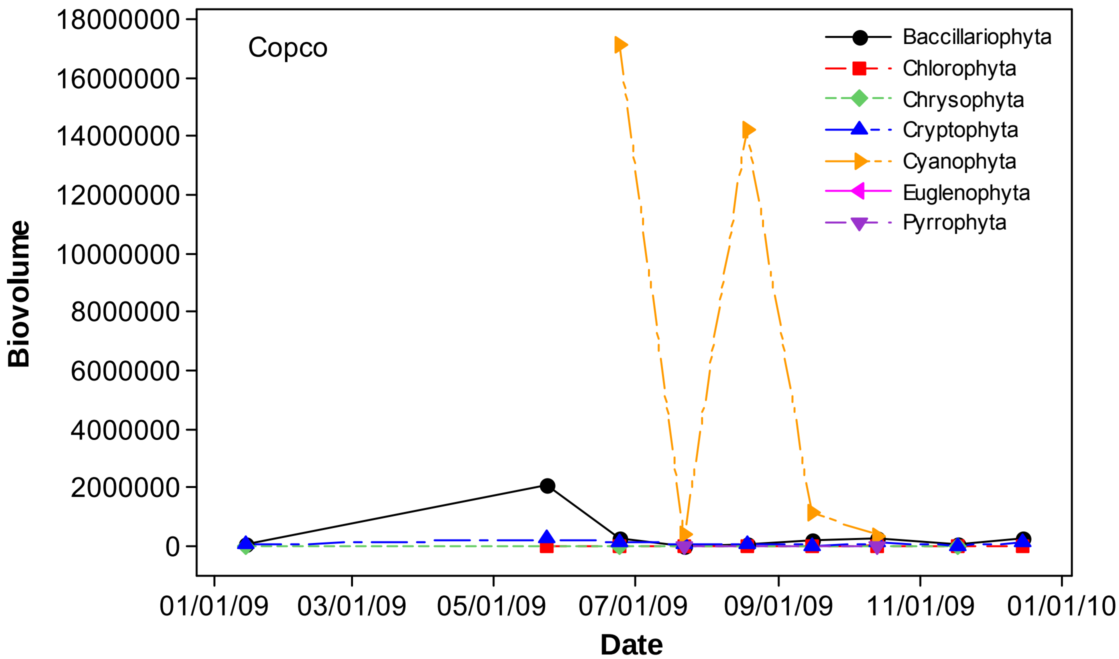
Seasonal Succession

Seasonal succession is a term used to describe the periodicity in the biomass of phytoplankton generally observed in temperate climate lakes. From low abundance during the winter, phytoplankton biomass increases to a maximum, typically composed primarily of diatoms, in the early spring. Zooplankton also tend to increase during this period, grazing on the algae and leading to a period of relatively low phytoplankton biomass in early summer. The growth of other species, including cyanobacteria, leads to another peak in biomass later in the summer or early fall. This general pattern has been observed in Copco and Iron Gate reservoirs in previous years (PacifiCorp 2004b, PacifiCorp 2006, PacifiCorp 2007b, PacifiCorp 2008c, Raymond 2008, Raymond 2009).

Succession of Algal Phyla

The succession of algal groups differed somewhat in Copco and Iron Gate reservoir in 2009. The seasonal changes are illustrated in Figure 6.

Phytoplankton abundance was low in both reservoirs in January, and both reservoirs were dominated by Baccillariophyta (diatoms) in May. Phytoplankton abundance was again low in June, likely the result of grazing by zooplankton. In June and August Copco reservoir was dominated by cyanobacteria, but phytoplankton numbers were low in July. This may reflect actual changes in the population, or may be the result of the patchy distribution of cyanobacteria in the reservoir or the rapid changes in concentration near the surface that occur because of vertical migration. A similar low value of chlorophyll *a* was not observed in August in Copco reservoir. In Iron Gate reservoir the May diatom peak was larger, but the cyanobacteria peak was much smaller, and occurred later in the summer. Cyanobacteria abundance in Iron Gate reservoir was increasing in July, but did not reach a maximum until September, and declined quickly.



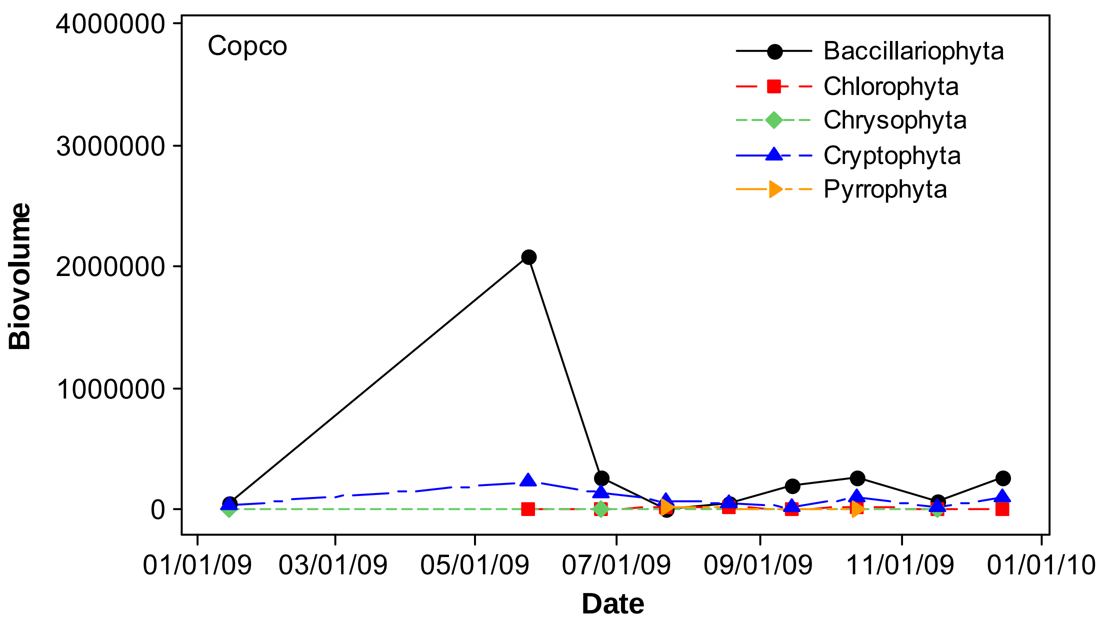
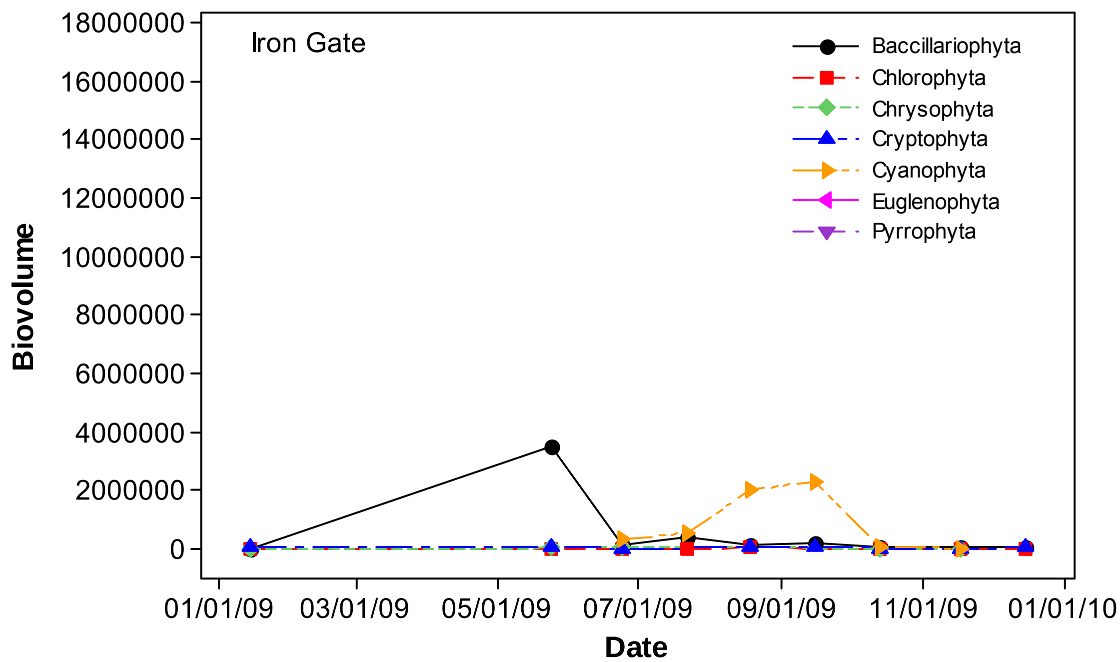


Figure 6. Seasonal changes in biovolume (µm3/mL) of various algal groups in Copco and Iron Gate reservoirs in 2009.



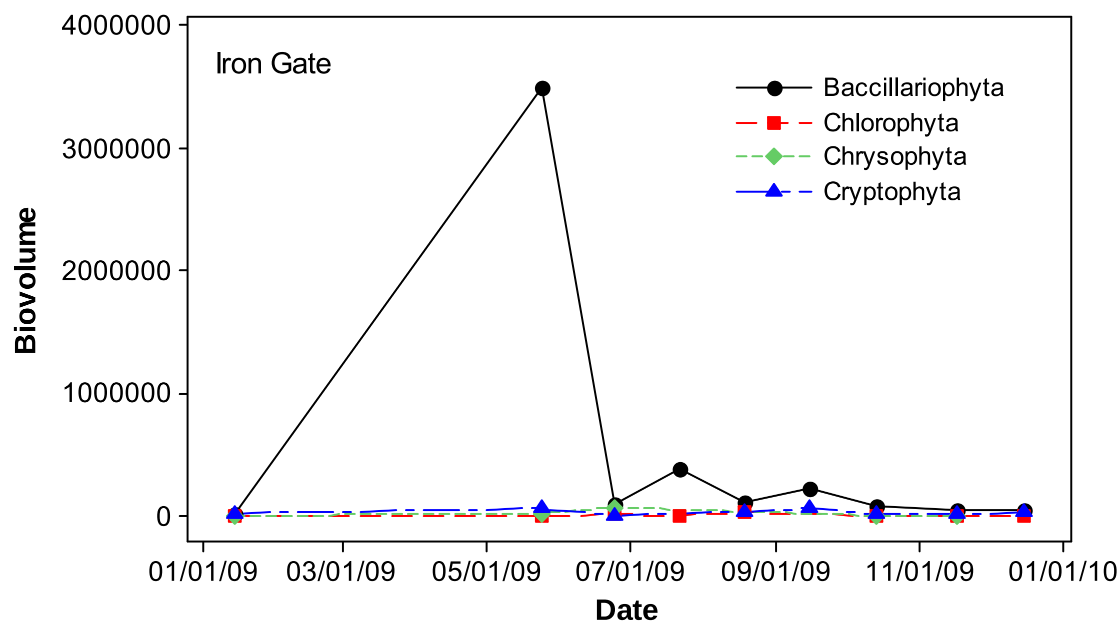


Figure 6. Continued.

More detail of the seasonal changes in phytoplankton groups other than cyanobacteria can be seen in the lower panels of Figure 6. In Copco reservoir, diatoms (primarily *Asterionella formosa*) decreased from the May peak to a minimum value in July and then rebounded, reaching a second, lower, peak in October. Cryptophytes (primarily *Cryptomonas erosa* and *Rhodomonas minuta*), although much less abundant, followed a similar pattern, reaching a peak in May, declining through September, and rebounding slightly in October. Diatoms (*Stephanodiscus hantzschii* and *Aulacoseira granulata*) and Cryptophytes (*Cryptomonas erosa*) both increased in December.

Diatoms (*Asterionella Formosa* and *Fragilaria vaucheriae*) were more abundant in Iron Gate reservoir in May than in Copco reservoir, decreased to a lower level in June, but reached a second, considerably lower peak in July, in contrast to the continued decline that occurred in Copco. Diatoms in Iron Gate reservoir did not show an increase in abundance in October or December as occurred in Copco reservoir.

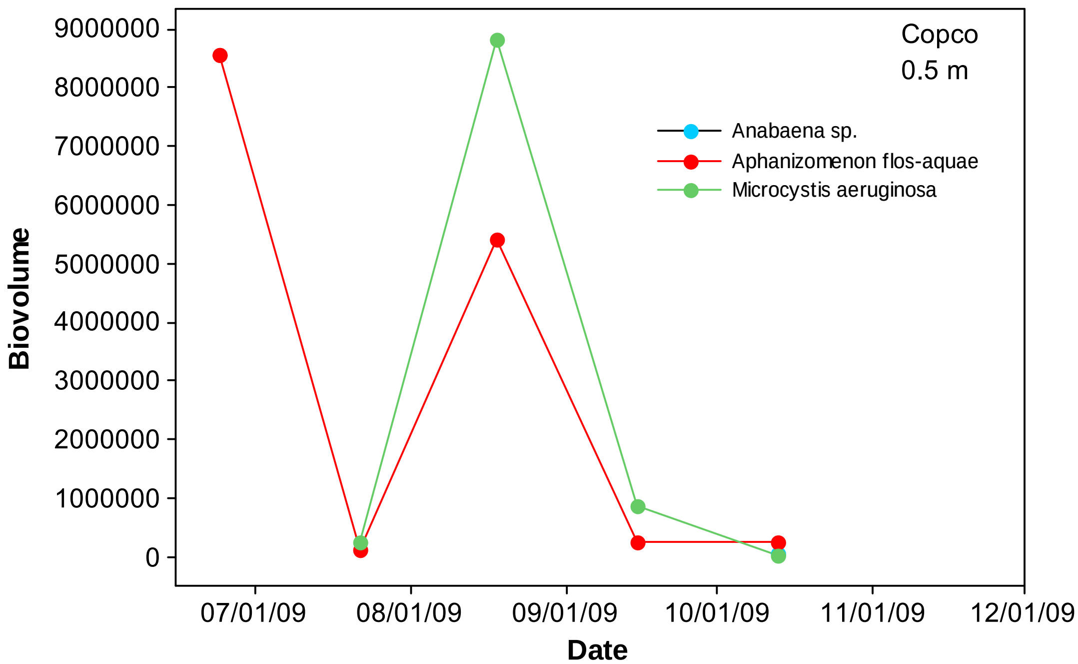
Succession of Cyanobacteria

Cyanobacteria are the dominant phytoplankton group in Copco and Iron Gate reservoirs in the late summer. They are of particular interest because of the presence of some species capable of producing toxins that may present a public health risk at high concentration. Seven species of cyanobacteria were observed in the samples collected in 2009:

- *Anabaena flos-aquae*
- *Anabaena sp.*
- *Aphanizomenon flos-aquae*
- *Microcystis aeruginosa*
- *Gloeotrichia echinulata*
- *Oscillatoria limnetica*
- *Oscillatoria* sp.

Anabaena flos-aquae was observed in the Klamath River above J. C. Boyle, in Copco and Iron Gate reservoirs, and in the Klamath River below Iron Gate dam in both baseline open water grab samples, and in public health samples collected from near shore surface accumulations (scums). *Aphanizomenon flos-aquae* was observed at all sites sampled in both open water and shoreline samples. *Gloeotrichia echinulata* was observed at only one shoreline site in Copco reservoir. *Microcystis aeruginosa* was observed in the Klamath River below the J. C. Boyle powerhouse, in Copco and Iron Gate reservoirs at both shoreline and open water sites, and in the Klamath River below Iron Gate dam. *Oscillatoria* species were observed rarely in shoreline sites in Copco reservoir.

In Copco and Iron Gate reservoirs samples were collected near the dams in approximately the deepest point in the reservoir. Two samples were collected during each event, one discrete grab sample at 0.5 m depth, and one depth-integrated sample from 0 to 8 m depth. Cyanobacteria can change their depth in the photic zone by changing their buoyancy, and typically rise to the surface during daylight hours. Near-surface abundance of cyanobacteria can change substantially in a period of several minutes. Samples taken near the surface may therefore have unusually high or low numbers of cyanobacteria depending on the time they are collected. Samples integrated



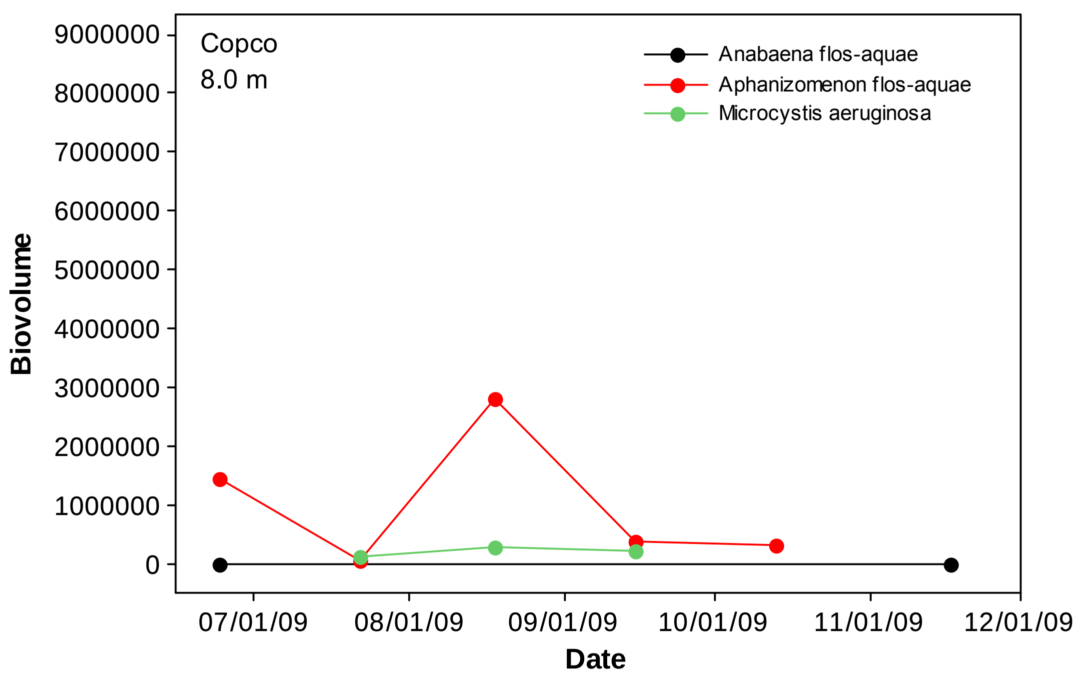
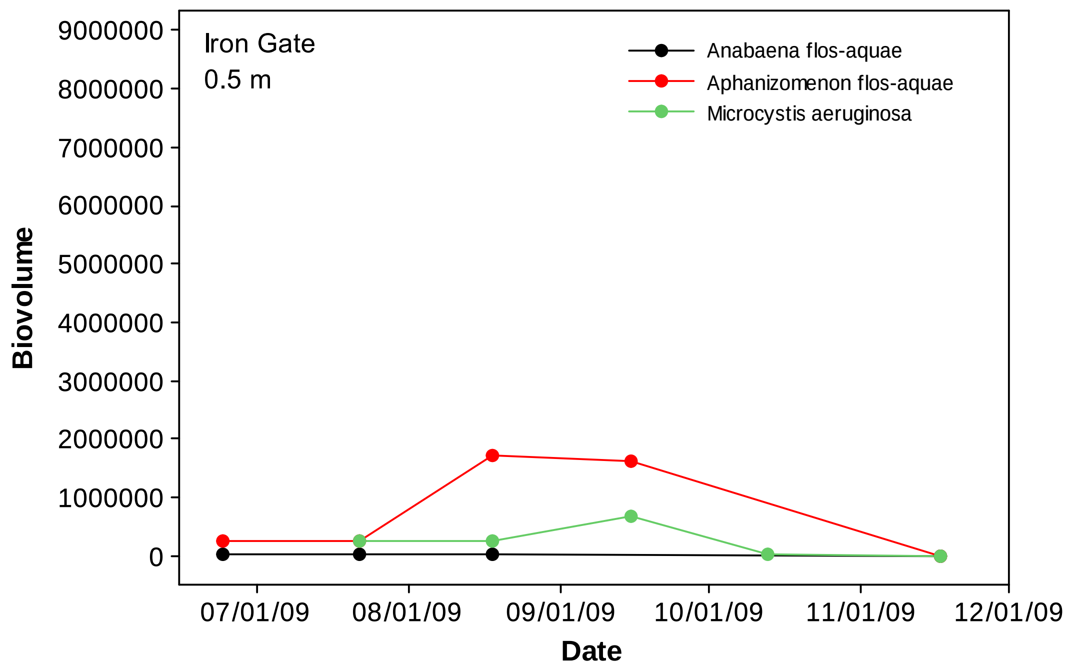


Figure 7. Seasonal changes in cyanobacteria biovolume (µm3/mL) in Copco and Iron Gate reservoir in 2009.



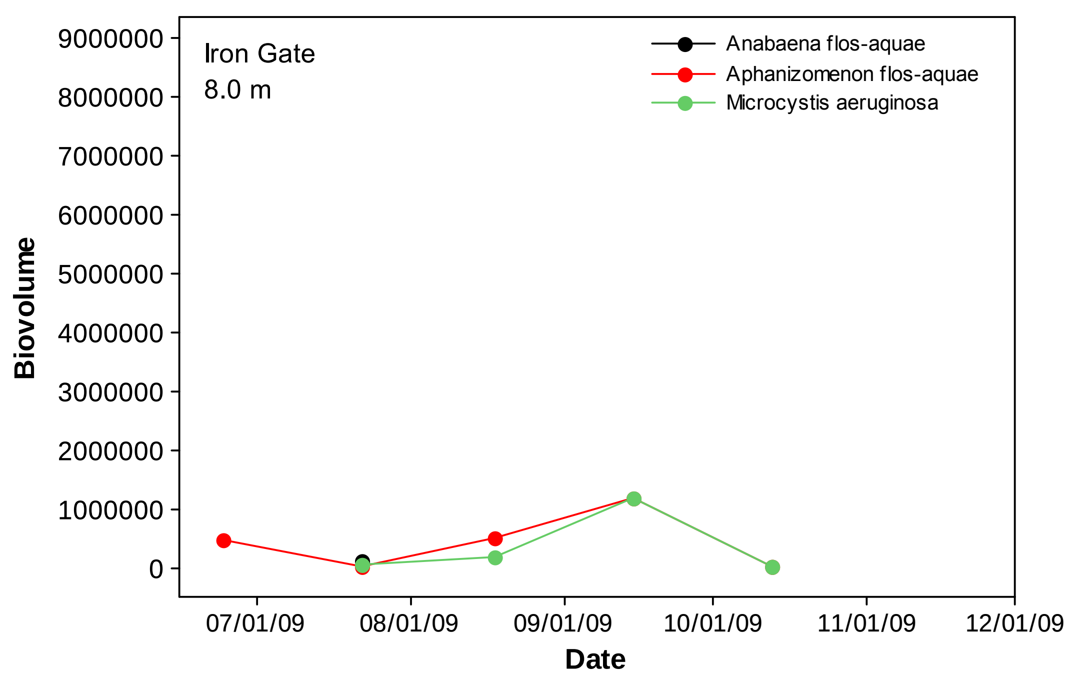


Figure 7. Continued.

over the photic zone (approximately 8 m in Copco and Iron Gate reservoirs) are less subject to this short-term variation, and may be a more reliable estimate of the overall abundance of cyanobacteria in the reservoir. Samples collected from surface accumulations for public health purposes are intended to estimate the maximum risk of exposure, and are representative only of short-term, localized surface concentrations.

Aphanizomenon flos-aquae was the dominant cyanobacterium in Copco reservoir in 2009 in both abundance and duration, based on the depth-integrated samples. From high values in June, in both the surface and integrated samples, *Aphanizomenon* decreased to a minimum in July and then reached a maximum in August before declining in September and October. *Microcystis* was not observed prior to July, was present at the surface in high abundance in August and then declined.

In Iron Gate reservoir *Microcystis* and *Aphanizomenon* were more equally present in the integrated samples, and *Microcystis* was more abundant than in Copco reservoir. However, *Microcystis* never showed the peak abundance in Iron Gate near-surface samples that was evident in Copco reservoir, where *Aphanizomenon* was clearly the most abundant through the summer. Both *Aphanizomenon* and *Microcystis* persisted into November at low levels near the surface in Iron Gate reservoir, possibly a consequence of the longer duration of thermal stratification in Iron Gate reservoir.

Other cyanobacteria genera (*Anabaena*, *Oscillatoria*, *Gloeotrichia*) were minor components of the population, appearing only rarely at low abundance in the baseline samples or only in samples collected from shoreline surface accumulations.

Public Health Sampling

Sampling for public health purposes for cyanobacteria, primarily *Microcystis*, and microcystin, the toxin produced by *Microcystis*, was conducted by PacifiCorp in 2009 at seven locations: two open-water reservoir sites near the dams in Copco and Iron Gate reservoirs, and five shoreline sites – two each in Copco and Iron Gate reservoirs and one along the Klamath River below Iron Gate dam.

Table 6. Sites sampled by PacifiCorp in 2009 for cyanobacteria and microcystin specifically for public health purposes. Cyanobacteria and microcystin were also measured at baseline sites sampled for water chemistry.

Location	Site ID	River Mile
Copco reservoir at Mallard Cove ramp	CRMC	201.5
Copco reservoir at Copco Cove ramp	CRCC	200.0
Copco reservoir lower end at log boom	CR01	198.7
Iron Gate reservoir at Camp Creek area	IRCC	192.8
Iron Gate reservoir at Williams boat ramp	IRJW	192.4
Iron Gate reservoir lower end above log boom	IR01	190.2
Klamath River at Iron Gate Hatchery bridge	KRBI	189.7

Results of the public health samples were distributed in a series of technical memoranda during the sampling season. The final data table from the series of memoranda is included in Appendix 2. The results of analysis of water samples from the vicinity of the Project for cyanobacteria in 2009 are summarized in Appendix 3.

Cyanobacteria

The first occurrence of a potentially toxigenic cyanobacterium in 2009 was *Anabaena flos-aquae* in the Klamath River above J. C. Boyle reservoir on May 25. *Anabaena* exceeded the Californiacyanobacteria guideline (of 100,000 cells per mL) once at two locations in 2009, on June 8 in a surface scum in Mallard Cove in Copco reservoir and in a surface scum near Jay Williams camp in Iron Gate reservoir. *Anabaena* was observed sporadically in Copco and Iron Gate reservoirs in July, but did not rise to abundances that exceeded the California guideline (also 100,000 cells per mL).

In 2009, *Microcystis aeruginosa* first appeared on July 6 in shoreline samples from Copco and Iron Gate reservoir, and exceeded the California guideline at Copco Cove in Copco reservoir and Jay Williams camp in Iron Gate reservoir on that date. *Microcystis* was generally above the guideline at least one location in Copco or Iron Gate reservoir through October. *Microcystis* was first observed below Iron Gate dam, on July 6 and was present for the rest of the summer. *Microcystis* exceeded the guideline below Iron Gate dam only once, on August 3.

Microcystin

The results of analysis for microcystin of water samples collected by PacifiCorp in 2009 from the vicinity of the Project are provided in Appendix 4. The first instance in 2009 that microcystin exceeded the method reporting limit (0.18 µg/L) was in surface shoreline samples from Copco Cove in Copco reservoir (0.18 µg/L) and Jay Williams camp in Iron Gate reservoir (0.84 µg/L) on June 8. The first instance that microcystin exceeded the California guideline value of 8 µg/L[6]. was on July 6 at Copco Cove (50 µg/L). Microcystin concentration greater than 8.0 µg/L was observed in at least one sample on every sample date from July 12 through October 26. The highest microcystin concentrations were observed in September with a maximum of 73,000 µg/L measured on a surface shoreline sample from Mallard Cove in Copco reservoir on September 24.

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[6] 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 cyanobacterial 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 cyanobacterial 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., "Cyanbacterial scum formation in areas where whole-body contact and/or risk of ingestion/aspiration occur". No specific cyanobacterial 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.

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 cells/mL and 100,000 cells/mL equate to microcystin toxin concentrations of 8 µg/L and 20 µg/L, respectively.

As can be seen in Figure 8, there was a generally positive relationship between microcystin and the abundance, in cells/mL, of *Microcystis aeruginosa*[7]. However, there were ten instances when microcystin occurred at concentrations greater than the method reporting limit in the absence of *Microcystis*, including one occasion when microcystin exceeded 8.0 µ/L. There were 5 instances when *Microcystis* exceeded 40,000 cells/mL but microcystin was less than 8.0 µ/L, including two instances when *Microcystis* exceeded 300,000 and 70,000 cells/mL respectively but microcystin was not detected above the method reporting limit (0.18 µg/L).

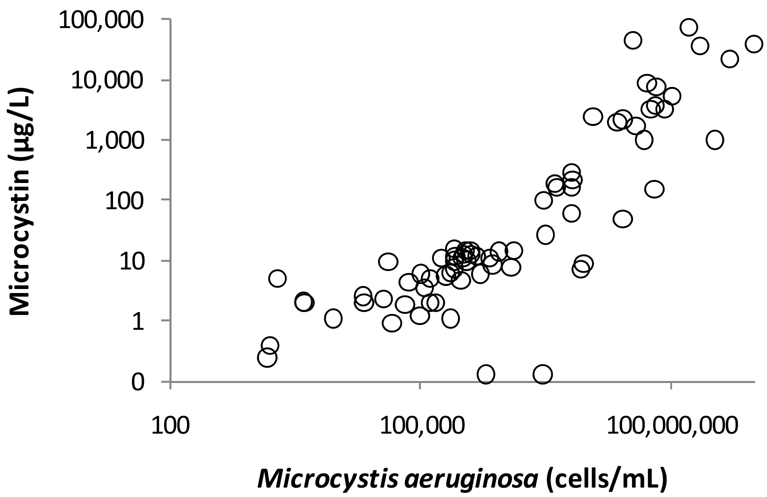

Figure 8. The relationship between the abundance of *Microcystis aeruginosa* and the concentration of microcystin measured in samples collected in the vicinity of the Klamath Hydroelectric project in 2009.

Comparison with Other Years

Comparison of phytoplankton data collected since 2001 can provide some insight into patterns of growth that occur in the Klamath River in the vicinity of the Klamath Hydropower Project. In Figure 9 average biovolume for the period 2001 through 2009 is plotted for each location sampled during that time. The very high productivity of Upper Klamath Lake (KR25479) and the large amount of algae transported downstream through Link River are apparent in the top panel. Average algal biomass is relatively low, with small increases in Copco (KR19874) and Iron Gate (KR19019) reservoirs, and increases below Iron Gate dam, as seen at the I-5 freeway sampling location (KR17923).

Diatoms (Bacillariophyta) and cyanobacteria (Cyanophyta) are the dominant groups present in the phytoplankton, but they are not equally distributed. Cyanobacteria are most abundant in Upper Klamath Lake, in the Klamath River above Keno dam, and in Copco and Iron Gate reservoirs. Cyanobacteria are present in relatively low abundance in the Klamath River between J. C. Boyle reservoir and Copco reservoir. Diatom abundance peaks in the faster flowing riverine

[7] Small numbers (1 for cells/mL, and 0.01 for µg/L) were used to replace zeros in the data set to avoid the problem of taking the logarithm of zero.

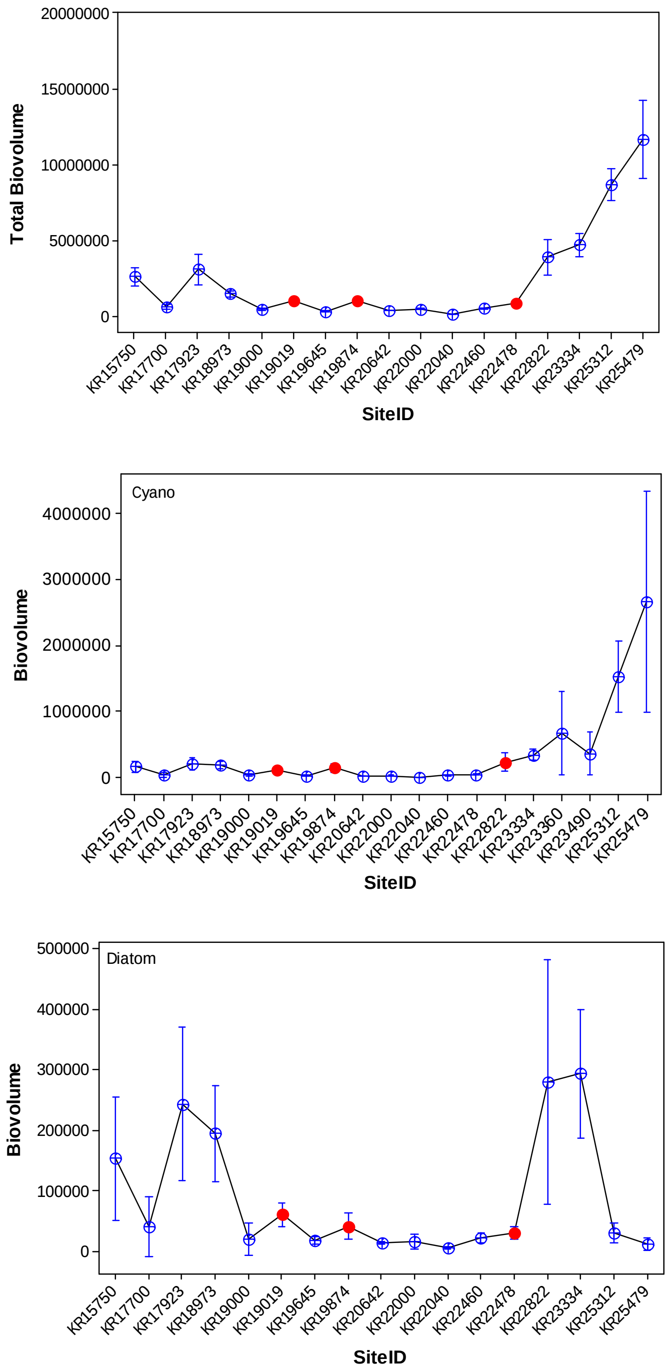

Figure 9. Average total biovolume (μm^3/mL) measured at various locations in the Vicinity of the Klamath Hydropower Project in 2001 through 2009. Top panel shows total biovolume, middle panel shows cyanobacterial biovolume, bottom panel shown diatom biovolume. Sites are arranged from upstream to downstream with Upper Klamath Lake on the left. Project reservoirs are noted by red symbols.

reaches between Keno dam and J. C. Boyle reservoir and between Iron Gate dam and the I-5 freeway (Figure 9). A comparison of cyanobacteria and diatom abundance between years (Figure 10) shows that while overall diatom abundance is relatively stable among years, cyanobacteria abundance tends to be more variable.

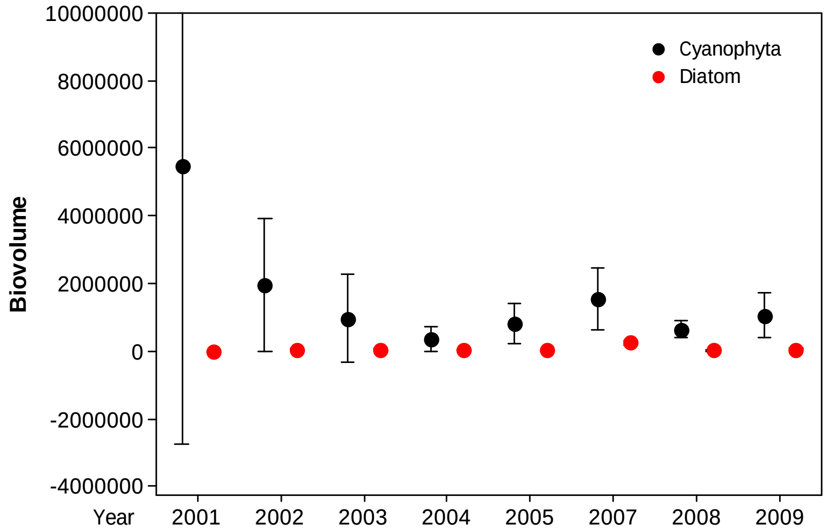

Figure 10. Comparison of the average biovolume (μm^3/mL) of cyanobacteria versus diatoms for all sites sampled in the vicinity of the Klamath Hydropower Project in 2001 through 2009.

The two most abundant cyanobacteria in Copco and Iron Gate reservoirs are *Microcystis aeruginosa* and *Aphanizomenon flos-aquae*. *Aphanizomenon* is typically more abundant than *Microcystis*, but its numbers fluctuate quite a bit from year to year and occasionally, as in 2003 and 2009 are similar to *Microcystis* (Figure11). Within each reservoir, the picture is somewhat more complex. In Iron Gate reservoir numbers of both *Aphanizomenon* and *Microcystis* are relatively uniform both within years and between years. Notable exceptions were in 2005 when *Microcystis* was more highly variable, and in 2002 and 2007 when *Aphanizomenon* numbers were both unusually high and unusually variable. The average biovolume of both *Aphanizomenon* and *Microcystis* is more variable in Copco reservoir than in Iron Gate reservoir. *Aphanizomenon* is typically more abundant, but there are exceptions as in 2003 and 2007. Because both *Aphanizomenon* and *Microcystis* can adjust buoyancy, local abundance at the sampling point can change rapidly. This is a source of variation that may influence the comparisons between years even when samples have been collected using a uniform protocol as has been the case with other PacifiCorp baseline monitoring.

Microcystis aeruginosa has been a concern because it has been found in Copco and Iron Gate reservoirs, and in the Klamath River below the Project, in numbers that exceed relevant public health guidelines. Figure12 shows all the instances when *Microcystis* was observed in Copco or Iron Gate reservoir in samples taken at 0.5 m depth near the dam. All samples were collected by a uniform protocol comparable between years. Despite some differences in sampling frequency, it seems that *Microcystis* abundance may have increased in recent years.

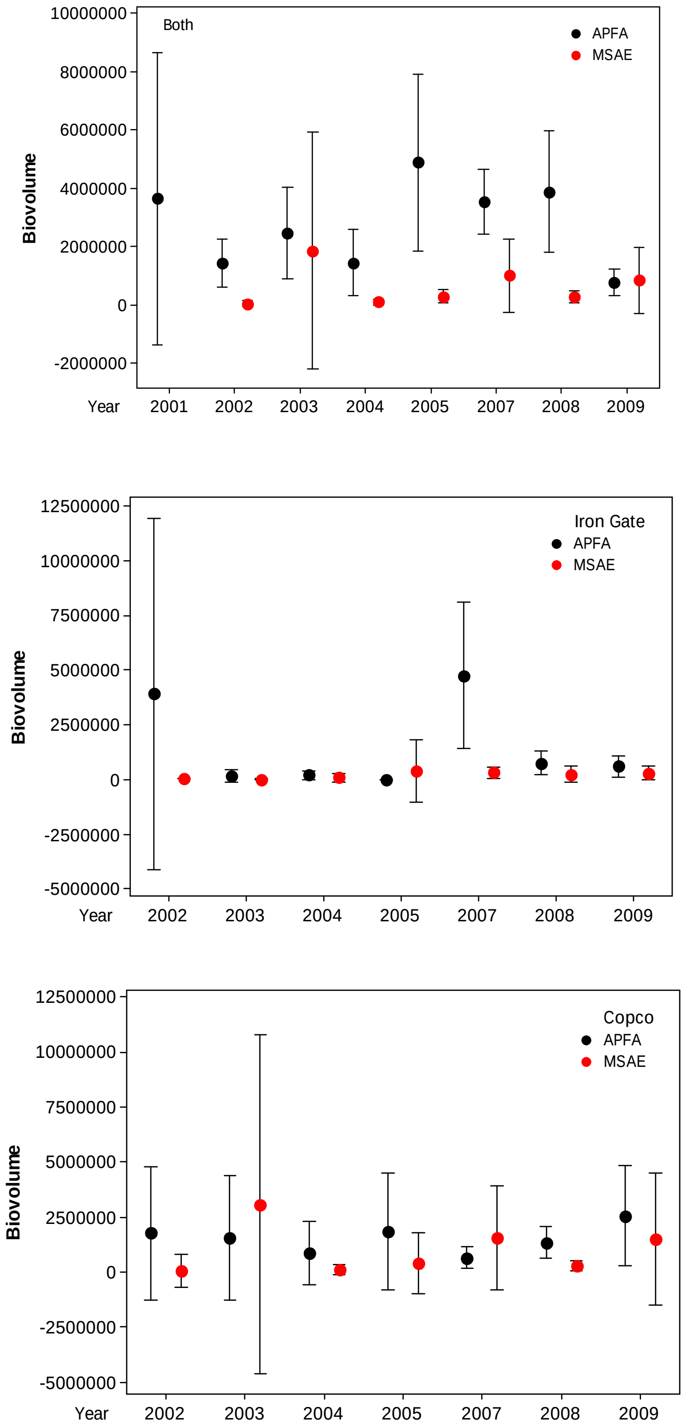

Figure 11. Average biovolume (µm^3/mL) of *Aphanizomenon flos-aquae* (APFA) and *Microcystis aeruginosa* (MSAE) measured in Copco and Iron Gate reservoirs in 2001 through 2009. Top panel shows total biovolume, middle panel shows the species in Iron Gate reservoir, bottom panel shows the species in Copco reservoir.

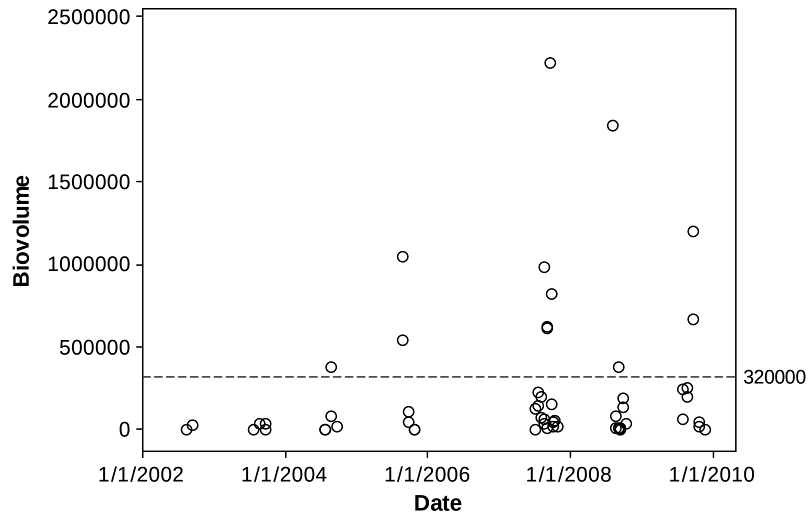

Figure 12. ***Microcystis aeruginosa*** **biovolume (µm³/mL) measured on all samples collected in Copco and Iron Gate reservoirs during 2001 through 2009 plotted against sample data. Two very high values, 18,040,000 µm³/mL in 2004 and 27,598,826 µm³/mL in 2007 have been left off the graph to improve readability. The dashed line at 320,000 µm³/mL represents the approximate biovolume equal to the guideline value of 40,000 cells/mL.**

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Appendix 1
List of phytoplankton species observed in 2009 in the vicinity of the Klamath Hydroelectric Project

Taxon	Frequency of Occurrence	Percent Frequency of Occurrence	Maximum Percent Biovolume	Average Percent Biovolume	Percent of Total Biovolume
Cryptomonas erosa	94	88.7	58.7	10.7	9.41
Rhodomonas minuta	90	84.9	3.2	0.4	0.35
Asterionella formosa	80	75.5	95.4	20.2	15.08
Cocconeis placentula	75	70.8	23.8	5.3	3.71
Nitzschia palea	75	70.8	21.7	3.1	2.15
Nitzschia frustulum	70	66.0	11.3	2.5	1.61
Nitzschia amphibia	68	64.2	3.4	0.9	0.58
Ankistrodesmus falcatus	68	64.2	3.2	0.3	0.20
Stephanodiscus hantzschii	67	63.2	68.2	6.1	3.84
Fragilaria construens venter	64	60.4	6.4	0.8	0.48
Aphanizomenon flos-aquae	60	56.6	97.7	34.1	19.14
Chlamydomonas sp.	58	54.7	26.7	2.9	1.57
Stephanodiscus astraea minutula	57	53.8	15.4	2.8	1.50
Rhoicosphenia curvata	55	51.9	6.1	1.1	0.54
Navicula cryptocephala veneta	55	51.9	4.9	1.0	0.53
Nitzschia dissipata	53	50.0	32.3	4.3	2.14
Aulacoseira granulata	51	48.1	91.3	16.5	7.88
Cyclotella meneghiniana	51	48.1	16.4	3.3	1.57
Gomphonema angustatum	51	48.1	5.0	1.3	0.62
Fragilaria construens	49	46.2	11.5	1.8	0.84
Fragilaria vaucheriae	42	39.6	30.0	2.3	0.90
Scenedesmus quadricauda	37	34.9	16.0	3.4	1.16
Achnanthes lanceolata	33	31.1	4.0	1.0	0.30
Fragilaria capucina mesolepta	32	30.2	15.4	3.6	1.09
Gomphonema subclavatum	32	30.2	11.7	2.6	0.77
Kephyrion sp.	31	29.2	3.0	0.5	0.16
Microcystis aeruginosa	23	21.7	72.5	28.7	6.16
Cryptomonas ovata	21	19.8	39.7	12.4	2.43
Navicula pupula	21	19.8	2.4	0.9	0.18
Achnanthes minutissima	19	17.9	1.4	0.3	0.05
Selenastrum minutum	18	17.0	1.3	0.3	0.04
Diatoma vulgare	16	15.1	14.9	6.8	1.02
Nitzschia paleacea	16	15.1	1.8	0.5	0.07

Glenodinium sp.	15	14.2	7.7	3.0	0.41
Navicula tripunctata	14	13.2	15.8	6.4	0.84
Synedra ulna	13	12.3	22.2	9.8	1.19
Diatoma tenue	13	12.3	3.2	1.4	0.16
Navicula sp.	12	11.3	1.1	0.6	0.07
Fragilaria virescens	11	10.4	1.5	0.9	0.09
Anabaena flos-aquae	10	9.4	8.5	3.0	0.28
Chromulina sp.	10	9.4	14.1	2.4	0.23
Scenedesmus acuminatus	10	9.4	3.8	1.4	0.13
Chrysococcus rufescens	10	9.4	1.1	0.5	0.05
Fragilaria crotonensis	9	8.5	94.9	32.4	2.73
Nitzschia capitellata	9	8.5	3.1	1.5	0.13
Nitzschia acicularis	9	8.5	1.8	1.1	0.09
Amphora perpusilla	9	8.5	2.4	0.7	0.06
Fragilaria pinnata	9	8.5	0.3	0.2	0.02
Synedra cyclopum	8	7.5	20.2	5.8	0.44
Aulacoseira ambigua	8	7.5	8.2	3.2	0.24
Cymbella minuta	8	7.5	1.8	1.2	0.09
Synedra parasitica	8	7.5	0.9	0.5	0.04
Navicula minima	8	7.5	0.8	0.3	0.02
Caloneis ventricosa	7	6.6	1.7	0.9	0.06
Scenedesmus denticulatus	7	6.6	2.2	0.9	0.06
Cymbella affinis	6	5.7	20.9	12.7	0.71
Gomphoneis herculeana	6	5.7	14.1	10.0	0.56
Aulacoseira varians	6	5.7	14.3	4.4	0.25
Gomphonema ventricosum	6	5.7	8.4	2.9	0.16
Navicula cryptocephala	6	5.7	0.7	0.6	0.03
Synedra rumpens	6	5.7	0.5	0.4	0.02
Nitzschia microcephala	6	5.7	0.3	0.3	0.01
Cyclotella stelligera	6	5.7	0.3	0.1	0.01
Amphora ovalis	5	4.7	3.6	2.2	0.10
Amphora coffeiformes	5	4.7	0.4	0.3	0.01
Coelastrum microporum	4	3.8	4.5	3.1	0.12
Navicula capitata	4	3.8	2.3	1.6	0.06
Achnanthes hauckiana	4	3.8	0.3	0.2	0.01
Nitzschia linearis	3	2.8	6.3	5.8	0.16
Actinastrum hantzschii	3	2.8	5.6	3.3	0.09
Synedra socia	3	2.8	3.2	1.9	0.05
Synedra radians	3	2.8	1.7	1.1	0.03
Navicula viridula	3	2.8	1.5	0.9	0.02
Mallomonas sp.	3	2.8	1.2	0.7	0.02
Gomphonema olivaceum	3	2.8	0.8	0.6	0.02
Achnanthes linearis	3	2.8	1.0	0.6	0.02

Sphaerocystis schroeteri	3	2.8	0.8	0.6	0.02
Navicula gregaria	3	2.8	0.6	0.6	0.02
Nitzschia volcanica	3	2.8	0.8	0.6	0.02
Fragilaria sp.	3	2.8	0.6	0.5	0.01
Nitzschia sp.	3	2.8	0.7	0.4	0.01
Cymbella sinuata	3	2.8	0.5	0.4	0.01
Nitzschia communis	3	2.8	0.5	0.3	0.01
Navicula mutica	3	2.8	0.2	0.2	0.01
Navicula minuscula	3	2.8	0.3	0.2	0.01
Schroderia sp.	3	2.8	0.3	0.1	0.00
Epithemia sorex	2	1.9	44.2	30.8	0.58
Gomphonema acuminatum	2	1.9	10.7	8.3	0.16
Cymbella tumida	2	1.9	8.6	5.9	0.11
Trachelomonas volvocina	2	1.9	5.2	4.6	0.09
Pediastrum boryanum	2	1.9	4.9	3.2	0.06
Aulacoseira granulata angustissima	2	1.9	4.8	2.7	0.05
Pinnularia sp.	2	1.9	1.5	1.3	0.02
Surirella ovata	2	1.9	1.4	1.2	0.02
Navicula rhynchocephala	2	1.9	1.2	1.2	0.02
Tetraedron minimum	2	1.9	1.1	1.1	0.02
Gomphonema sp.	2	1.9	1.1	0.8	0.01
Cocconeis klamathensis	2	1.9	0.8	0.7	0.01
Synedra tenera	2	1.9	1.2	0.6	0.01
Oocystis pusilla	2	1.9	0.6	0.5	0.01
Navicula decussis	2	1.9	0.5	0.4	0.01
Achnanthes clevei	2	1.9	0.5	0.4	0.01
Crucigenia quadrata	2	1.9	0.6	0.3	0.01
Synedra mazamaensis	2	1.9	0.4	0.3	0.01
Dinobryon sertularia	2	1.9	0.1	0.1	0.00
Cymatopleura solea	1	0.9	32.3	32.3	0.30
Anabaena sp.	1	0.9	10.2	10.2	0.10
Epithemia turgida	1	0.9	8.5	8.5	0.08
Cyclotella comta	1	0.9	5.5	5.5	0.05
Gomphonema truncatum	1	0.9	4.7	4.7	0.04
Dictyosphaerium ehrenbergianum	1	0.9	2.1	2.1	0.02
Caloneis ventricosa minuta	1	0.9	1.3	1.3	0.01
Pediastrum duplex	1	0.9	1.2	1.2	0.01
Gloeocystis ampla	1	0.9	1.1	1.1	0.01
Hantzschia amphioxys	1	0.9	1.0	1.0	0.01
Stauroneis sp.	1	0.9	0.8	0.8	0.01
Staurastrum gracile	1	0.9	0.7	0.7	0.01
Cymbellonitzschia diluviana	1	0.9	0.6	0.6	0.01

Gomphonema tenellum	1	0.9	0.5	0.5	0.01
Scenedesmus abundans	1	0.9	0.4	0.4	0.00
Cyclotella ocellata	1	0.9	0.3	0.3	0.00
Gomphonema clevei	1	0.9	0.3	0.3	0.00
Navicula seminulum hustedtii	1	0.9	0.3	0.3	0.00
Pediastrum simplex	1	0.9	0.3	0.3	0.00
Nitzschia innominata	1	0.9	0.2	0.2	0.00
Cymbella sp.	1	0.9	0.2	0.2	0.00
Chodatella wratislawiensis	1	0.9	0.2	0.2	0.00
Unidentified flagellate	1	0.9	0.0	0.0	0.00

Appendix 2
Summary data table from the series of technical memoranda distributed by PacifiCorp in 2008 presenting the results of microcystin sampling in the vicinity of the Klamath Hydroelectric Project.

Date	Sample	Location[1]	Species	Biovolume, µm3/mL	Rank[2]	Cells/mL
08/18/09	KR9150	CR01	*Aphanizomenon flos-aquae*	7,629,417	2	121,102
09/15/09	KR9189	CR01	*Aphanizomenon flos-aquae*	1,216,899	2	19,316
10/13/09	KR9227	CR01	*Aphanizomenon flos-aquae*	274,332	3	4,354
08/18/09	KR9150	CR01	*Microcystis aeruginosa*	3,006,667	1	375,833
09/15/09	KR9189	CR01	*Microcystis aeruginosa*	1,312,647	1	164,081
10/13/09	KR9227	CR01	*Microcystis aeruginosa*	97,976	1	12,247
06/08/09	KR9060	CRCC	*Anabaena flos-aquae*	1,019,824	2	15,221
06/22/09	KR9065	CRCC	*Anabaena flos-aquae*	61,364	4	916
10/26/09	KR9242	CRCC	*Anabaena sp.*	13,339,785	2	196,173
06/08/09	KR9060	CRCC	*Aphanizomenon flos-aquae*	9,471	26	150
06/22/09	KR9065	CRCC	*Aphanizomenon flos-aquae*	1,262,193	1	20,035
07/06/09	KR9096	CRCC	*Aphanizomenon flos-aquae*	422,813	8	6,711
07/20/09	KR9100	CRCC	*Aphanizomenon flos-aquae*	799,116	11	12,684
08/03/09	KR9134	CRCC	*Aphanizomenon flos-aquae*	1,183,875	11	18,792
08/17/09	KR9178	CRCC	*Aphanizomenon flos-aquae*	15,452,684	2	245,281
08/31/09	KR9168	CRCC	*Aphanizomenon flos-aquae*	10,332,000	3	164,000
09/14/09	KR9173	CRCC	*Aphanizomenon flos-aquae*	19,984,606	3	317,216
10/12/09	KR 9211	CRCC	*Aphanizomenon flos-aquae*	2,768,446,154	1	43,943,590
10/26/09	KR9242	CRCC	*Aphanizomenon flos-aquae*	34,448,922	1	546,808
08/03/09	KR9134	CRCC	*Gloeotrichia echinulata*	76,670,000	8	1,127,500
07/06/09	KR9096	CRCC	*Microcystis aeruginosa*	25,950,397	1	3,243,800
07/20/09	KR9100	CRCC	*Microcystis aeruginosa*	50,589,145	1	6,323,643
08/03/09	KR9134	CRCC	*Microcystis aeruginosa*	64,893,889	2	8,111,736
08/17/09	KR9178	CRCC	*Microcystis aeruginosa*	6,370,968	1	796,371
08/31/09	KR9168	CRCC	*Microcystis aeruginosa*	498,560,000	1	62,320,000
09/14/09	KR9173	CRCC	*Microcystis aeruginosa*	35,018,824	2	4,377,353
09/28/09	KR9206	CRCC	*Microcystis aeruginosa*	93,669	2	27,164,077
10/12/09	KR 9211	CRCC	*Microcystis aeruginosa*	56,479,077	2	7,059,885
10/26/09	KR9242	CRCC	*Microcystis aeruginosa*	3,127,556	3	390,945
07/20/09	KR9100	CRCC	*Oscillatoria sp.*	229,951	20	3,709
06/08/09	KR9059	CRMC	*Anabaena flos-aquae*	271,627,386	1	4,054,140
10/12/09	KR 9210	CRMC	*Anabaena sp.*	224,674	11	3,304
10/26/09	KR9241	CRMC	*Anabaena sp.*	5,606,494	2	82,448
06/22/09	KR9064	CRMC	*Aphanizomenon flos-aquae*	826,007	1	13,111
07/06/09	KR9095	CRMC	*Aphanizomenon flos-aquae*	7,941	13	126
07/20/09	KR9101	CRMC	*Aphanizomenon flos-aquae*	191,548	8	3,040
08/17/09	KR9177	CRMC	*Aphanizomenon flos-aquae*	3,790,167	5	60,161
08/31/09	KR9167	CRMC	*Aphanizomenon flos-aquae*	1,732,500	6	27,500
09/14/09	KR9172	CRMC	*Aphanizomenon flos-aquae*	31,254,300	3	496,100
09/28/09	KR9205	CRMC	*Aphanizomenon flos-aquae*	928	8	9,280
10/12/09	KR 9210	CRMC	*Aphanizomenon flos-aquae*	208,154	6	3,304
10/26/09	KR9241	CRMC	*Aphanizomenon flos-aquae*	10,654,875	1	169,125
07/06/09	KR9095	CRMC	*Microcystis aeruginosa*	1,471	26	184
07/20/09	KR9101	CRMC	*Microcystis aeruginosa*	26,147,865	1	3,268,483
08/03/09	KR9133	CRMC	*Microcystis aeruginosa*	65,031,611	2	8,128,951
08/17/09	KR9177	CRMC	*Microcystis aeruginosa*	22,253,821	1	2,781,728
08/31/09	KR9167	CRMC	*Microcystis aeruginosa*	326,106,000	1	40,763,250

09/14/09	KR9172	CRMC	*Microcystis aeruginosa*	978,706,080	1	122,338,260
09/28/09	KR9205	CRMC	*Microcystis aeruginosa*	77,951	1	20,267,160
10/12/09	KR 9210	CRMC	*Microcystis aeruginosa*	6,290,872	1	786,359
10/26/09	KR9241	CRMC	*Microcystis aeruginosa*	9,020	9	1,128
08/31/09	KR9167	CRMC	*Oscillatoria limnetica*	618,750	4	13,750
08/18/09	KR9141	IR01	*Aphanizomenon flos-aquae*	1,961,665	2	31,138
09/15/09	KR9180	IR01	*Aphanizomenon flos-aquae*	1,791,254	2	28,433
08/18/09	KR9141	IR01	*Microcystis aeruginosa*	257,008	1	32,126
09/15/09	KR9180	IR01	*Microcystis aeruginosa*	392,174	1	49,022
10/13/09	KR9218	IR01	*Microcystis aeruginosa*	1,577	7	197
06/08/09	KR9062	IRCC	*Anabaena flos-aquae*	83,936	2	1,253
06/22/09	KR9067	IRCC	*Anabaena flos-aquae*	1,303,884	1	19,461
07/06/09	KR9098	IRCC	*Anabaena sp.*	36,222	8	533
08/17/09	KR9180	IRCC	*Anabaena sp.*	982,949	17	14,455
06/22/09	KR9067	IRCC	*Aphanizomenon flos-aquae*	406,734	2	6,456
08/03/09	KR9136	IRCC	*Aphanizomenon flos-aquae*	617,248	3	9,798
08/17/09	KR9180	IRCC	*Aphanizomenon flos-aquae*	127,494	23	2,024
09/14/09	KR9174	IRCC	*Aphanizomenon flos-aquae*	119,284	3	1,893
10/12/09	KR 9212	IRCC	*Aphanizomenon flos-aquae*	161,700	4	2,567
07/06/09	KR9098	IRCC	*Microcystis aeruginosa*	227,276	2	28,409
07/20/09	KR9103	IRCC	*Microcystis aeruginosa*	320,366	1	40,046
08/03/09	KR9136	IRCC	*Microcystis aeruginosa*	352,506	1	44,063
08/17/09	KR9180	IRCC	*Microcystis aeruginosa*	346,923	20	43,365
08/31/09	KR1970	IRCC	*Microcystis aeruginosa*	62,456,198	1	7,807,025
09/14/09	KR9174	IRCC	*Microcystis aeruginosa*	515,233	1	64,404
09/28/09	KR9207	IRCC	*Microcystis aeruginosa*	41,781	1	501,371
10/12/09	KR 9212	IRCC	*Microcystis aeruginosa*	469,333	1	58,667
10/26/09	KR9243	IRCC	*Microcystis aeruginosa*	324,950	1	40,619
07/20/09	KR9102	IRJW	*Anabaena flos-aquae*	112,414	12	1,678
06/08/09	KR9061	IRJW	*Anabaena flos-aquae*	18,829,827	1	281,042
06/22/09	KR9066	IRJW	*Anabaena flos-aquae*	22,136	12	330
06/22/09	KR9066	IRJW	*Aphanizomenon flos-aquae*	272,567	3	4,326
07/06/09	KR9097	IRJW	*Aphanizomenon flos-aquae*	417,838	13	6,632
07/20/09	KR9102	IRJW	*Aphanizomenon flos-aquae*	42,281	13	671
09/14/09	KR9175	IRJW	*Aphanizomenon flos-aquae*	6,016,871	4	95,506
09/28/09	KR9208	IRJW	*Aphanizomenon flos-aquae*	221	3	5,969
07/06/09	KR9097	IRJW	*Microcystis aeruginosa*	8,312,549	1	1,039,069
07/20/09	KR9102	IRJW	*Microcystis aeruginosa*	6,550,238	1	818,780
08/03/09	KR9135	IRJW	*Microcystis aeruginosa*	46,612,848	1	5,826,606
08/17/09	KR9179	IRJW	*Microcystis aeruginosa*	6,402,431	1	800,304
08/31/09	KR1969	IRJW	*Microcystis aeruginosa*	2,890,393	1	361,299
09/14/09	KR9175	IRJW	*Microcystis aeruginosa*	100,514,635	1	12,564,329
09/28/09	KR9208	IRJW	*Microcystis aeruginosa*	43,405	1	520,861
10/12/09	KR 9213	IRJW	*Microcystis aeruginosa*	82,360,060	1	10,295,008
10/26/09	KR9244	IRJW	*Microcystis aeruginosa*	11,465,975	1	1,433,247
07/20/09	KR9102	IRJW	*Oscillatoria sp.*	24,966	14	403
06/08/09	KR9063	KRBI	*Anabaena flos-aquae*	9,306	27	139
06/22/09	KR9068	KRBI	*Anabaena flos-aquae*	14,238	10	213
08/17/09	KR9181	KRBI	*Anabaena sp.*	1,572,790	1	23,129
08/24/09	KR9165	KRBI	*Anabaena sp.*	1,211,687	9	17,819

06/08/09	KR9063	KRBI	*Aphanizomenon flos-aquae*	12,353	26	196
06/22/09	KR9068	KRBI	*Aphanizomenon flos-aquae*	83,305	2	1,322
07/06/09	KR9099	KRBI	*Aphanizomenon flos-aquae*	10,005	20	159
08/03/09	KR9132	KRBI	*Aphanizomenon flos-aquae*	3,381,592	4	53,676
08/10/09	KR9137	KRBI	*Aphanizomenon flos-aquae*	179,165	4	2,844
08/31/09	KR9166	KRBI	*Aphanizomenon flos-aquae*	495,936	1	7,872
09/07/09	KR9171	KRBI	*Aphanizomenon flos-aquae*	968,625	6	15,375
09/14/09	KR9176	KRBI	*Aphanizomenon flos-aquae*	198,692	7	3,154
09/21/09	KR9204	KRBI	*Aphanizomenon flos-aquae*	214,977	6	3,412
07/06/09	KR9099	KRBI	*Microcystis aeruginosa*	4,065	21	508
07/20/09	KR9104	KRBI	*Microcystis aeruginosa*	406,316	1	50,790
08/03/09	KR9132	KRBI	*Microcystis aeruginosa*	37,431,991	1	4,678,999
08/10/09	KR9137	KRBI	*Microcystis aeruginosa*	129,268	7	16,158
08/17/09	KR9181	KRBI	*Microcystis aeruginosa*	20,964	11	2,620
08/31/09	KR9166	KRBI	*Microcystis aeruginosa*	611,501	3	76,438
09/07/09	KR9171	KRBI	*Microcystis aeruginosa*	50,738	19	6,342
09/14/09	KR9176	KRBI	*Microcystis aeruginosa*	72,160	6	9,020
09/21/09	KR9204	KRBI	*Microcystis aeruginosa*	40,757	14	5,095
09/28/09	KR9209	KRBI	*Microcystis aeruginosa*	179	4	22,371
10/12/09	KR9214	KRBI	*Microcystis aeruginosa*	4,045	6	506

[1]CRMC = Copco reservoir at Mallard Cove ramp, CRCC = Copco reservoir at Copco Cove ramp, IRCC = Iron Gate reservoir at Camp Creek ramp, IRJW = Iron Gate reservoir at Williams campground, KRBI = Klamath R. at Iron Gate Hatchery bridge, IR01=Iron Gate reservoir at log boom, CR01 = Copco reservoir at cable line

[2]Rank = The rank of the species in the sample based on the count of algal units.

Appendix 3
Cyanobacteria data from samples collected in the vicinity of the Klamath Hydroelectric Project in 2009.

Sample ID	SiteID	Date	Time	Depth	Type	Taxon	Rank	Density	% Density	Biovolume	% Biov	Total Density	Total Biovolume
KR9010	KR20642	01/13/09	15:20	0.5	G	Aphanizomenon flos-aquae	18	4	0.9	5,056	4.1	425	123,046
KR9052	KR22000	05/25/09	10:00	0.5	G	Aphanizomenon flos-aquae	8	43	0.8	54,640	1.4	5,681	3,779,553
KR9054	KR22478	05/25/09	11:35	8.0	8G	Aphanizomenon flos-aquae	14	33	0.7	41,784	1.6	4,510	2,600,745
KR9055	KR22822	05/25/09	13:00	0.5	G	Anabaena flos-aquae	10	45	0.7	60,434	1.8	6,449	3,304,567
KR9060	CRCC	06/08/09	13:30	0.1	S	Anabaena flos-aquae	2	188	10.7	1,019,824	52.7	1,757	1,934,798
KR9060	CRCC	06/08/09	13:30	0.1	S	Aphanizomenon flos-aquae	26	6	0.3	9,471	0.5	1,757	1,934,798
KR9059	CRMC	06/08/09	12:40	0.1	S	Anabaena flos-aquae	1	47,141	93.3	271,627,386	99.3	50,543	273,469,779
KR9062	IRCC	06/08/09	14:10	0.1	S	Anabaena flos-aquae	2	50	16.2	83,936	31.7	310	264,604
KR9061	IRJW	06/08/09	14:20	0.1	S	Anabaena flos-aquae	1	6,855	79.9	18,829,827	89.9	8,584	20,934,843
KR9058	KR18973	06/08/09	14:59	0.5	G	Anabaena flos-aquae	9	20	1.8	19,750	1.1	1,081	1,823,720
KR9058	KR18973	06/08/09	14:59	0.5	G	Aphanizomenon flos-aquae	11	10	0.9	6,190	0.3	1,081	1,823,720
KR9063	KRBI	06/08/09	15:00	0.1	S	Anabaena flos-aquae	27	8	0.5	9,306	0.5	1,659	1,801,949
KR9063	KRBI	06/08/09	15:00	0.1	S	Aphanizomenon flos-aquae	26	16	1.0	12,353	0.7	1,659	1,801,949
KR9065	CRCC	06/22/09	11:35	0.1	S	Anabaena flos-aquae	4	83	4.1	61,364	3.4	2,043	1,815,813
KR9065	CRCC	06/22/09	11:35	0.1	S	Aphanizomenon flos-aquae	1	1,336	65.4	1,262,193	69.5	2,043	1,815,813
KR9064	CRMC	06/22/09	10:56	0.1	S	Aphanizomenon flos-aquae	1	596	33.9	826,007	40.3	1,756	2,050,729
KR9067	IRCC	06/22/09	12:20	0.1	S	Anabaena flos-aquae	1	649	39.6	1,303,884	54.8	1,637	2,377,851
KR9067	IRCC	06/22/09	12:20	0.1	S	Aphanizomenon flos-aquae	2	340	20.8	406,734	17.1	1,637	2,377,851
KR9066	IRJW	06/22/09	12:54	0.1	S	Anabaena flos-aquae	12	18	1.2	22,136	1.1	1,539	2,068,875
KR9066	IRJW	06/22/09	12:54	0.1	S	Aphanizomenon flos-aquae	3	144	9.4	272,567	13.2	1,539	2,068,875
KR9068	KRBI	06/22/09	13:18	0.1	S	Anabaena flos-aquae	10	9	2.0	14,238	2.8	434	500,364
KR9068	KRBI	06/22/09	13:18	0.1	S	Aphanizomenon flos-aquae	2	66	15.3	83,305	16.6	434	500,364
KR9076	KR20642	06/23/09	15:05	0.5	G	Aphanizomenon flos-aquae	2	145	10.7	118,803	17.6	1,358	676,149
KR9075	KR22000	06/23/09	15:52	0.5	G	Aphanizomenon flos-aquae	1	380	29.8	310,855	47.0	1,273	661,318
KR9069	KR22460	06/23/09	17:40	0.5	G	Aphanizomenon flos-aquae	1	395	31.9	423,084	48.2	1,240	878,177
KR9071	KR22478	06/23/09	20:30	0.5	G	Aphanizomenon flos-aquae	1	618	44.7	662,206	67.8	1,382	976,112
KR9072	KR22478	06/23/09	20:15	8.0	8G	Aphanizomenon flos-aquae	2	219	20.0	220,990	38.4	1,096	575,610
KR9070	KR22822	06/23/09	21:20	0.5	G	Aphanizomenon flos-aquae	1	153	27.2	135,169	46.2	564	292,438
KR9078	KR18973	06/24/09	20:30	0.5	G	Anabaena flos-aquae	13	13	0.9	8,584	1.3	1,409	640,510
KR9078	KR18973	06/24/09	20:30	0.5	G	Aphanizomenon flos-aquae	2	205	14.5	219,555	34.3	1,409	640,510
KR9086	KR19019	06/24/09	14:15	0.5	G	Anabaena flos-aquae	6	22	0.5	29,625	6.3	4,090	470,366
KR9085	KR19019	06/24/09	14:20	8.0	INT	Aphanizomenon flos-aquae	2	376	9.2	473,550	56.8	4,107	833,410

Sample ID	SiteID	Date	Time	Depth	Type	Taxon	Rank	Density	% Density	Biovolume	% Biov	Total Density	Total Biovolume
KR9086	KR19019	06/24/09	14:15	0.5	G	Aphanizomenon flos-aquae	3	243	5.9	260,453	55.4	4,090	470,366
KR9084	KR19645	06/24/09	16:40	0.5	G	Aphanizomenon flos-aquae	1	757	58.4	858,269	55.9	1,296	1,536,168
KR9079	KR19874	06/24/09	12:30	8.0	INT	Anabaena flos-aquae	7	12	0.7	8,167	0.4	1,682	1,821,760
KR9079	KR19874	06/24/09	12:30	8.0	INT	Aphanizomenon flos-aquae	1	1,280	76.1	1,451,367	79.7	1,682	1,821,760
KR9080	KR19874	06/24/09	12:25	0.5	G	Aphanizomenon flos-aquae	1	6,174	86.1	8,557,725	97.7	7,168	8,760,809
KR9080	KR19874	06/24/09	12:25	0.5	G	Aphanizomenon flos-aquae	1	6,174	86.1	8,557,725	97.7	7,168	8,760,809
KR9096	CRCC	07/06/09	11:40	0.1	S	Aphanizomenon flos-aquae	8	447	0.7	422,813	1.2	60,625	36,107,964
KR9096	CRCC	07/06/09	11:40	0.1	S	Microcystis aeruginosa	1	32,438	53.5	25,950,397	71.9	60,625	36,107,964
KR9095	CRMC	07/06/09	10:40	0.1	S	Aphanizomenon flos-aquae	13	8	1.2	7,941	3.2	636	245,592
KR9095	CRMC	07/06/09	10:40	0.1	S	Microcystis aeruginosa	26	5	0.7	1,471	0.6	636	245,592
KR9098	IRCC	07/06/09	13:05	0.1	S	Anabaena sp.	8	36	0.8	36,222	2.2	4,457	1,610,372
KR9098	IRCC	07/06/09	13:05	0.1	S	Microcystis aeruginosa	2	284	6.4	227,276	14.1	4,457	1,610,372
KR9097	IRJW	07/06/09	13:45	0.1	S	Aphanizomenon flos-aquae	13	442	1.0	417,838	1.6	45,321	26,450,575
KR9097	IRJW	07/06/09	13:45	0.1	S	Microcystis aeruginosa	1	10,391	22.9	8,312,549	31.4	45,321	26,450,575
KR9094	KR18973	07/06/09	14:30	0.5	G	Aphanizomenon flos-aquae	5	29	4.7	18,571	10.8	625	171,928
KR9099	KRBI	07/06/09	14:20	0.1	S	Aphanizomenon flos-aquae	20	16	0.5	10,005	0.3	3,325	2,895,909
KR9099	KRBI	07/06/09	14:20	0.1	S	Microcystis aeruginosa	21	6	0.2	4,065	0.1	3,325	2,895,909
KR9101	CRCC	07/20/09	11:30	0.1	S	Aphanizomenon flos-aquae	8	101	0.3	191,548	0.6	30,168	30,298,754
KR9101	CRCC	07/20/09	11:30	0.1	S	Microcystis aeruginosa	1	15,202	50.4	26,147,865	86.3	30,168	30,298,754
KR9100	CRMC	07/20/09	10:40	0.1	S	Aphanizomenon flos-aquae	11	668	1.8	799,116	1.3	36,087	59,629,766
KR9100	CRMC	07/20/09	10:40	0.1	S	Microcystis aeruginosa	1	20,399	56.5	50,589,145	84.8	36,087	59,629,766
KR9100	CRMC	07/20/09	10:40	0.1	S	Oscillatoria sp.	20	185	0.5	229,951	0.4	36,087	59,629,766
KR9103	IRCC	07/20/09	12:15	0.1	S	Microcystis aeruginosa	1	2,670	88.8	320,366	12.3	3,007	2,598,123
KR9102	IRJW	07/20/09	12:40	0.1	S	Anabaena flos-aquae	12	34	0.3	112,414	1.4	10,691	7,754,932
KR9102	IRJW	07/20/09	12:40	0.1	S	Aphanizomenon flos-aquae	13	34	0.3	42,281	0.5	10,691	7,754,932
KR9102	IRJW	07/20/09	12:40	0.1	S	Microcystis aeruginosa	1	8,188	76.6	6,550,238	84.5	10,691	7,754,932
KR9102	IRJW	07/20/09	12:40	0.1	S	Oscillatoria sp.	14	20	0.2	24,966	0.3	10,691	7,754,932
KR9105	KR20642	07/20/09	20:25	0.5	G	Aphanizomenon flos-aquae	9	29	3.4	20,428	9.8	865	208,659
KR9104	KRBI	07/20/09	17:00	0.1	S	Microcystis aeruginosa	1	4,232	54.0	406,316	14.5	7,840	2,808,828
KR9106	KR18973	07/21/09	17:00	0.5	G	Aphanizomenon flos-aquae	3	84	7.1	111,112	4.5	1,186	2,476,469
KR9106	KR18973	07/21/09	17:00	0.5	G	Microcystis aeruginosa	1	819	69.0	65,508	2.6	1,186	2,476,469
KR9124	KR22000	07/21/09	12:50	0.5	G	Aphanizomenon flos-aquae	1	266	35.6	285,249	66.3	747	430,026
KR9125	KR22460	07/21/09	11:40	0.5	G	Aphanizomenon flos-aquae	1	150	30.3	141,818	51.7	496	274,058
KR9128	KR22478	07/21/09	10:40	0.5	G	Aphanizomenon flos-aquae	1	480	47.6	574,305	74.1	1,008	774,655
KR9129	KR22478	07/21/09	11:00	8.0	8G	Aphanizomenon flos-aquae	2	77	13.1	77,355	39.1	584	198,035
KR9130	KR22822	07/21/09	13:50	0.5	G	Aphanizomenon flos-aquae	1	941	69.0	888,856	90.3	1,363	984,157
KR9108	IRJW	07/22/09	12:10	0.1	S	Microcystis aeruginosa	1	50,225	82.7	40,180,000	93.1	60,731	43,135,741

Sample ID	SiteID	Date	Time	Depth	Type	Taxon	Rank	Density	% Density	Biovolume	% Biov	Total Density	Total Biovolume
KR9107	KR19019	07/22/09	10:10	8.0	INT	Anabaena flos-aquae	4	25	1.5	108,394	2.7	1,692	3,984,331
KR9109	KR19019	07/22/09	10:00	0.5	G	Anabaena flos-aquae	7	13	0.4	44,332	4.8	3,454	921,943
KR9107	KR19019	07/22/09	10:10	8.0	INT	Aphanizomenon flos-aquae	9	12	0.7	9,408	0.2	1,692	3,984,331
KR9109	KR19019	07/22/09	10:00	0.5	G	Aphanizomenon flos-aquae	2	185	5.4	245,112	26.6	3,454	921,943
KR9107	KR19019	07/22/09	10:10	8.0	INT	Microcystis aeruginosa	1	859	50.7	68,695	1.7	1,692	3,984,331
KR9109	KR19019	07/22/09	10:00	0.5	G	Microcystis aeruginosa	1	3,136	90.8	250,908	27.2	3,454	921,943
KR9122	KR19645	07/22/09	16:00	0.5	G	Aphanizomenon flos-aquae	6	60	3.1	60,712	19.2	1,951	316,471
KR9122	KR19645	07/22/09	16:00	0.5	G	Microcystis aeruginosa	1	1,253	64.2	100,222	31.7	1,951	316,471
KR9116	KR19874	07/22/09	14:00	8.0	INT	Aphanizomenon flos-aquae	7	47	2.5	50,667	21.9	1,877	231,382
KR9118	KR19874	07/22/09	14:10	0.5	G	Aphanizomenon flos-aquae	4	101	2.5	114,159	24.6	4,027	463,231
KR9116	KR19874	07/22/09	14:00	8.0	INT	Microcystis aeruginosa	1	1,403	74.8	112,277	48.5	1,877	231,382
KR9118	KR19874	07/22/09	14:10	0.5	G	Microcystis aeruginosa	1	3,138	77.9	251,003	54.2	4,027	463,231
KR9134	CRCC	08/03/09	11:25	0.1	S	Aphanizomenon flos-aquae	11	626	1.0	1,183,875	0.8	65,771	157,501,101
KR9134	CRCC	08/03/09	11:25	0.1	S	Gloeotrichia echinulata	8	626	1.0	76,670,000	48.7	65,771	157,501,101
KR9134	CRCC	08/03/09	11:25	0.1	S	Microcystis aeruginosa	2	21,924	33.3	64,893,889	41.2	65,771	157,501,101
KR9133	CRMC	08/03/09	10:50	0.1	S	Microcystis aeruginosa	2	22,898	21.3	65,031,611	79.4	107,523	81,921,711
KR9136	IRCC	08/03/09	12:15	0.1	S	Aphanizomenon flos-aquae	3	467	5.3	617,248	11.4	8,826	5,411,844
KR9136	IRCC	08/03/09	12:15	0.1	S	Microcystis aeruginosa	1	4,406	49.9	352,506	6.5	8,826	5,411,844
KR9135	IRJW	08/03/09	12:40	0.1	S	Microcystis aeruginosa	1	50,666	70.3	46,612,848	91.0	72,074	51,237,025
KR9132	KR18973	08/03/09	13:10	0.5	G	Aphanizomenon flos-aquae	4	3,834	7.9	3,381,592	6.5	48,732	51,663,311
KR9132	KR18973	08/03/09	13:10	0.5	G	Microcystis aeruginosa	1	17,657	36.2	37,431,991	72.5	48,732	51,663,311
KR9137	KRBI	08/10/09	10:15	0.1	S	Aphanizomenon flos-aquae	4	129	9.9	179,165	23.7	1,300	757,134
KR9137	KRBI	08/10/09	10:15	0.1	S	Microcystis aeruginosa	7	36	2.8	129,268	17.1	1,300	757,134
KR9178A	CRCC	08/17/09	13:10	0.1	S	Aphanizomenon flos-aquae	2	12,264	29.5	15,452,684	67.1	41,539	23,035,418
KR9178A	CRCC	08/17/09	13:10	0.1	S	Microcystis aeruginosa	1	24,132	58.1	6,370,968	27.7	41,539	23,035,418
KR9177A	CRMC	08/17/09	16:50	0.1	S	Aphanizomenon flos-aquae	5	4,628	5.0	3,790,167	5.3	92,135	72,119,191
KR9177A	CRMC	08/17/09	16:50	0.1	S	Microcystis aeruginosa	1	48,802	53.0	22,253,821	30.9	92,135	72,119,191
KR9180A	IRCC	08/17/09	11:30	0.1	S	Anabaena sp.	17	578	1.9	982,949	2.4	30,124	40,969,245
KR9180A	IRCC	08/17/09	11:30	0.1	S	Aphanizomenon flos-aquae	23	202	0.7	127,494	0.3	30,124	40,969,245
KR9180A	IRCC	08/17/09	11:30	0.1	S	Microcystis aeruginosa	20	434	1.4	346,923	0.8	30,124	40,969,245
KR9179A	IRJW	08/17/09	11:20	0.1	S	Microcystis aeruginosa	1	80,030	86.2	6,402,431	59.2	92,853	10,817,545
KR9138	KR20642	08/17/09	19:00	0.5	G	Aphanizomenon flos-aquae	12	26	3.0	14,261	6.5	859	219,823
KR9181A	KRBI	08/17/09	11:40	0.1	S	Anabaena sp.	1	1,779	20.7	1,572,790	23.1	8,592	6,811,424
KR9181A	KRBI	08/17/09	11:40	0.1	S	Microcystis aeruginosa	11	262	3.0	20,964	0.3	8,592	6,811,424
KR9150	CR01	08/18/09	14:25	0.1	S	Aphanizomenon flos-aquae	2	6,055	12.8	7,629,417	60.5	47,188	12,620,066
KR9150	CR01	08/18/09	14:25	0.1	S	Microcystis aeruginosa	1	37,583	79.6	3,006,667	23.8	47,188	12,620,066
KR9141	IR01	08/18/09	12:35	0.1	S	Aphanizomenon flos-aquae	2	1,297	25.1	1,961,665	80.6	5,159	2,433,516

Sample ID	SiteID	Date	Time	Depth	Type	Taxon	Rank	Density	% Density	Biovolume	% Biov	Total Density	Total Biovolume
KR9141	IR01	08/18/09	12:35	0.1	S	Microcystis aeruginosa	1	3,213	62.3	257,008	10.6	5,159	2,433,516
KR9139	KR18973	08/18/09	12:00	0.5	G	Aphanizomenon flos-aquae	3	264	9.2	333,118	42.3	2,877	787,928
KR9139	KR18973	08/18/09	12:00	0.5	G	Microcystis aeruginosa	1	1,882	65.4	150,541	19.1	2,877	787,928
KR9142	KR19019	08/18/09	17:05	0.5	G	Anabaena flos-aquae	6	30	0.6	23,856	1.1	5,252	2,165,067
KR9140	KR19019	08/18/09	12:20	8.0	INT	Aphanizomenon flos-aquae	3	399	10.9	502,250	56.7	3,644	885,505
KR9142	KR19019	08/18/09	17:05	0.5	G	Aphanizomenon flos-aquae	2	1,365	26.0	1,719,734	79.4	5,252	2,165,067
KR9140	KR19019	08/18/09	12:20	8.0	INT	Microcystis aeruginosa	1	2,506	68.8	200,444	22.6	3,644	885,505
KR9142	KR19019	08/18/09	17:05	0.5	G	Microcystis aeruginosa	1	3,234	61.6	258,732	12.0	5,252	2,165,067
KR9149	KR19874	08/18/09	15:25	8.0	INT	Aphanizomenon flos-aquae	2	2,232	35.8	2,812,307	88.4	6,236	3,182,426
KR9151	KR19874	08/18/09	17:00	0.5	G	Aphanizomenon flos-aquae	2	4,295	37.4	5,412,000	37.7	11,490	14,357,639
KR9149	KR19874	08/18/09	15:25	8.0	INT	Microcystis aeruginosa	1	3,751	60.1	300,053	9.4	6,236	3,182,426
KR9151	KR19874	08/18/09	17:00	0.5	G	Microcystis aeruginosa	1	6,765	58.9	8,821,560	61.4	11,490	14,357,639
KR9158	KR22000	08/19/09	11:20	0.5	G	Aphanizomenon flos-aquae	12	30	2.2	37,386	8.5	1,335	437,470
KR9157	KR22460	08/19/09	12:40	0.5	G	Aphanizomenon flos-aquae	15	29	2.5	36,427	11.1	1,156	327,394
KR9161	KR22478	08/19/09	12:30	0.5	G	Aphanizomenon flos-aquae	15	29	2.4	18,074	7.8	1,176	232,592
KR9163	KR22822	08/19/09	11:20	0.5	G	Aphanizomenon flos-aquae	1	705	35.5	577,139	66.3	1,988	870,650
KR9165	KRBI	08/24/09	12:00	0.1	S	Anabaena sp.	9	1,371	2.9	1,211,687	4.2	46,471	28,696,246
KR9168	CRCC	08/31/09	13:00	0.1	S	Aphanizomenon flos-aquae	3	10,250	4.1	10,332,000	1.9	252,589	542,030,250
KR9168	CRCC	08/31/09	13:00	0.1	S	Microcystis aeruginosa	1	205,000	81.2	498,560,000	92.0	252,589	542,030,250
KR9167	CRMC	08/31/09	11:40	0.1	S	Aphanizomenon flos-aquae	6	1,375	0.8	1,732,500	0.5	179,438	330,581,350
KR9167	CRMC	08/31/09	11:40	0.1	S	Microcystis aeruginosa	1	167,750	93.5	326,106,000	98.6	179,438	330,581,350
KR9167	CRMC	08/31/09	11:40	0.1	S	Oscillatoria limnetica	4	1,375	0.8	618,750	0.2	179,438	330,581,350
KR9170	IRCC	08/31/09	13:40	0.1	S	Microcystis aeruginosa	1	54,979	92.6	62,456,198	96.7	59,382	64,585,777
KR9169	IRJW	08/31/09	14:30	0.1	S	Microcystis aeruginosa	1	3,142	68.6	2,890,393	83.8	4,580	3,450,884
KR9166	KRBI	08/31/09	14:50	0.1	S	Aphanizomenon flos-aquae	1	492	34.0	495,936	31.4	1,449	1,577,994
KR9166	KRBI	08/31/09	14:50	0.1	S	Microcystis aeruginosa	3	232	16.0	611,501	38.8	1,449	1,577,994
KR9173	CRCC	09/14/09	10:35	0.1	S	Aphanizomenon flos-aquae	3	17,623	10.3	19,984,606	26.3	171,115	75,937,030
KR9173	CRCC	09/14/09	10:35	0.1	S	Microcystis aeruginosa	2	41,689	24.4	35,018,824	46.1	171,115	75,937,030
KR9172	CRMC	09/14/09	9:45	0.1	S	Aphanizomenon flos-aquae	3	33,073	5.9	31,254,300	2.9	565,253	1,081,338,647
KR9172	CRMC	09/14/09	9:45	0.1	S	Microcystis aeruginosa	1	411,913	72.9	978,706,080	90.5	565,253	1,081,338,647
KR9174	IRCC	09/14/09	11:00	0.1	S	Aphanizomenon flos-aquae	3	100	1.6	119,284	14.0	6,292	853,070
KR9174	IRCC	09/14/09	11:00	0.1	S	Microcystis aeruginosa	1	5,367	85.3	515,233	60.4	6,292	853,070
KR9175	IRJW	09/14/09	11:20	0.1	S	Aphanizomenon flos-aquae	4	5,306	2.7	6,016,871	4.8	193,665	124,783,741
KR9175	IRJW	09/14/09	11:20	0.1	S	Microcystis aeruginosa	1	98,159	50.7	100,514,635	80.6	193,665	124,783,741
KR9176	KRBI	09/14/09	11:30	0.1	S	Aphanizomenon flos-aquae	7	158	4.3	198,692	10.5	3,643	1,891,708
KR9176	KRBI	09/14/09	11:30	0.1	S	Microcystis aeruginosa	6	205	5.6	72,160	3.8	3,643	1,891,708
KR9189	CR01	09/15/09	10:05	0.1	S	Aphanizomenon flos-aquae	2	920	5.1	1,216,899	45.5	18,129	2,675,201

Sample ID	SiteID	Date	Time	Depth	Type	Taxon	Rank	Density	% Density	Biovolume	% Biov	Total Density	Total Biovolume
KR9189	CR01	09/15/09	10:05	0.1	S	Microcystis aeruginosa	1	16,408	90.5	1,312,647	49.1	18,129	2,675,201
KR9180	IR01	09/15/09	13:00	0.1	S	Aphanizomenon flos-aquae	2	1,422	18.6	1,791,254	71.5	7,647	2,504,913
KR9180	IR01	09/15/09	13:00	0.1	S	Microcystis aeruginosa	1	4,902	64.1	392,174	15.7	7,647	2,504,913
KR9178	KR18973	09/15/09	14:50	0.5	G	Aphanizomenon flos-aquae	3	752	8.2	899,745	50.1	9,216	1,795,209
KR9178	KR18973	09/15/09	14:50	0.5	G	Microcystis aeruginosa	1	7,517	81.6	721,600	40.2	9,216	1,795,209
KR9179	KR19019	09/15/09	13:00	8.0	INT	Aphanizomenon flos-aquae	3	940	8.0	1,183,875	44.3	11,745	2,673,953
KR9181	KR19019	09/15/09	12:55	0.5	G	Aphanizomenon flos-aquae	2	1,128	10.5	1,633,748	63.4	10,749	2,577,465
KR9179	KR19019	09/15/09	13:00	8.0	INT	Microcystis aeruginosa	1	9,396	80.0	1,202,667	45.0	11,745	2,673,953
KR9181	KR19019	09/15/09	12:55	0.5	G	Microcystis aeruginosa	1	8,344	77.6	667,480	25.9	10,749	2,577,465
KR9194	KR19645	09/15/09	9:00	0.5	G	Aphanizomenon flos-aquae	3	103	4.2	109,778	21.8	2,460	502,514
KR9194	KR19645	09/15/09	9:00	0.5	G	Microcystis aeruginosa	1	1,611	65.5	128,857	25.6	2,460	502,514
KR9188	KR19874	09/15/09	10:00	8.0	INT	Aphanizomenon flos-aquae	3	286	7.3	396,510	49.0	3,938	809,696
KR9190	KR19874	09/15/09	10:10	0.5	G	Aphanizomenon flos-aquae	3	226	2.2	269,924	20.1	10,429	1,344,797
KR9188	KR19874	09/15/09	10:00	8.0	INT	Microcystis aeruginosa	1	2,827	71.8	226,173	27.9	3,938	809,696
KR9190	KR19874	09/15/09	10:10	0.5	G	Microcystis aeruginosa	1	9,020	86.5	865,920	64.4	10,429	1,344,797
KR9197	KR22000	09/16/09	10:10	0.5	G	Aphanizomenon flos-aquae	10	10	2.6	15,375	12.5	371	122,780
KR9197	KR22000	09/16/09	10:10	0.5	G	Microcystis aeruginosa	22	5	1.3	11,714	9.5	371	122,780
KR9202	KR22822	09/16/09	12:45	0.5	G	Aphanizomenon flos-aquae	22	14	1.1	18,097	7.0	1,250	257,271
KR9204	KRBI	09/21/09	11:10	0.1	S	Aphanizomenon flos-aquae	6	262	1.4	214,977	2.8	18,481	7,717,636
KR9204	KRBI	09/21/09	11:10	0.1	S	Microcystis aeruginosa	14	84	0.5	40,757	0.5	18,481	7,717,636
KR9206	CRCC	09/28/09	12:15	0.1	S	Microcystis aeruginosa	2	93,669	36.5	217,312,615	87.2	256,723	249,231,273
KR9205	CRMC	09/28/09	11:20	0.1	S	Aphanizomenon flos-aquae	8	928	0.9	584,630	0.3	101,150	169,161,191
KR9205	CRMC	09/28/09	11:20	0.1	S	Microcystis aeruginosa	1	77,951	77.1	162,137,284	95.8	101,150	169,161,191
KR9207	IRCC	09/28/09	NS	0.1	S	Microcystis aeruginosa	1	41,781	94.2	4,010,971	87.4	44,368	4,586,631
KR9208	IRJW	09/28/09	13:10	0.1	S	Aphanizomenon flos-aquae	3	221	0.5	376,054	7.3	46,648	5,126,809
KR9208	IRJW	09/28/09	13:10	0.1	S	Microcystis aeruginosa	1	43,405	93.0	4,166,886	81.3	46,648	5,126,809
KR9209	KRBI	09/28/09	13:30	0.1	S	Microcystis aeruginosa	4	179	3.9	178,968	6.8	4,608	2,648,193
KR9211	CRCC	10/12/09	11:40	0.1	S	Aphanizomenon flos-aquae	1	2,312,821	90.7	2,768,446,154	97.5	2,549,885	2,839,790,885
KR9211	CRCC	10/12/09	11:40	0.1	S	Microcystis aeruginosa	2	190,808	7.5	56,479,077	2.0	2,549,885	2,839,790,885
KR9210	CRMC	10/12/09	11:00	0.1	S	Anabaena sp.	11	165	0.3	224,674	2.4	56,664	9,389,721
KR9210	CRMC	10/12/09	11:00	0.1	S	Aphanizomenon flos-aquae	6	330	0.6	208,154	2.2	56,664	9,389,721
KR9210	CRMC	10/12/09	11:00	0.1	S	Microcystis aeruginosa	1	46,256	81.6	6,290,872	67.0	56,664	9,389,721
KR9212	IRCC	10/12/09	12:12	0.1	S	Aphanizomenon flos-aquae	4	183	2.3	161,700	19.2	7,805	840,950
KR9212	IRCC	10/12/09	12:12	0.1	S	Microcystis aeruginosa	1	5,867	75.2	469,333	55.8	7,805	840,950
KR9213	IRJW	10/12/09	12:30	0.1	S	Microcystis aeruginosa	1	171,583	95.8	82,360,060	97.8	179,044	84,229,845

Sample ID	SiteID	Date	Time	Depth	Type	Taxon	Rank	Density	% Density	Biovolume	% Biov	Total Density	Total Biovolume
KR9214	KRBI	10/12/09	12:40	0.1	S	Microcystis aeruginosa	6	30	5.2	4,045	2.4	570	170,997
KR9227	CR01	10/13/09	11:10	0.1	S	Aphanizomenon flos-aquae	3	207	10.7	274,332	40.5	1,937	677,453
KR9227	CR01	10/13/09	11:10	0.1	S	Microcystis aeruginosa	1	875	45.2	97,976	14.5	1,937	677,453
KR9218	IR01	10/13/09	15:05	0.1	S	Microcystis aeruginosa	7	11	3.5	1,577	1.7	316	93,489
KR9215	KR18973	10/13/09	16:50	0.5	G	Aphanizomenon flos-aquae	14	5	2.6	3,075	6.9	185	44,447
KR9217	KR19019	10/13/09	15:10	8.0	INT	Aphanizomenon flos-aquae	5	21	7.1	19,595	16.7	290	117,581
KR9217	KR19019	10/13/09	15:10	8.0	INT	Microcystis aeruginosa	7	16	5.4	20,279	17.2	290	117,581
KR9219	KR19019	10/13/09	14:40	0.5	G	Microcystis aeruginosa	6	12	3.9	45,415	31.9	300	142,447
KR9228	KR19874	10/13/09	10:50	0.5	G	Anabaena sp.	7	29	2.4	75,674	10.2	1,223	742,561
KR9226	KR19874	10/13/09	11:15	8.0	INT	Aphanizomenon flos-aquae	2	207	20.6	312,543	52.4	1,005	596,278
KR9228	KR19874	10/13/09	10:50	0.5	G	Aphanizomenon flos-aquae	3	154	12.6	242,156	32.6	1,223	742,561
KR9228	KR19874	10/13/09	10:50	0.5	G	Microcystis aeruginosa	1	454	37.1	36,314	4.9	1,223	742,561
KR9216	KR20642	10/13/09	18:25	0.5	G	Aphanizomenon flos-aquae	3	110	10.8	96,805	23.4	1,018	413,134
KR9235	KR22000	10/14/09	14:00	0.5	G	Aphanizomenon flos-aquae	3	59	5.9	48,389	11.3	1,004	426,644
KR9238	KR22478	10/14/09	10:35	0.5	G	Aphanizomenon flos-aquae	8	35	2.8	28,268	7.7	1,243	368,301
KR9242	CRCC	10/26/09	12:00	0.1	S	Anabaena sp.	2	8,529	20.8	13,339,785	26.1	41,011	51,147,606
KR9242	CRCC	10/26/09	12:00	0.1	S	Aphanizomenon flos-aquae	1	30,378	74.1	34,448,922	67.4	41,011	51,147,606
KR9242	CRCC	10/26/09	12:00	0.1	S	Microcystis aeruginosa	3	1,636	4.0	3,127,556	6.1	41,011	51,147,606
KR9241	CRMC	10/26/09	11:00	0.1	S	Anabaena sp.	2	3,298	27.1	5,606,494	34.3	12,149	16,346,805
KR9241	CRMC	10/26/09	11:00	0.1	S	Aphanizomenon flos-aquae	1	8,456	69.6	10,654,875	65.2	12,149	16,346,805
KR9241	CRMC	10/26/09	11:00	0.1	S	Microcystis aeruginosa	9	28	0.2	9,020	0.1	12,149	16,346,805
KR9243	IRCC	10/26/09	12:30	0.1	S	Microcystis aeruginosa	1	2,901	52.1	324,950	28.6	5,573	1,135,957
KR9244	IRJW	10/26/09	12:50	0.1	S	Microcystis aeruginosa	1	119,437	83.5	11,465,975	59.3	143,076	19,341,493
KR9246	KR20642	11/16/09	16:20	0.5	G	Aphanizomenon flos-aquae	24	7	1.0	4,532	2.4	748	185,651
KR9247	KR18973	11/17/09	8:30	0.5	G	Aphanizomenon flos-aquae	10	5	3.7	4,899	11.9	140	41,261
KR9250	KR19019	11/17/09	14:00	0.5	G	Anabaena flos-aquae	19	2	1.8	4,842	8.5	137	57,110
KR9250	KR19019	11/17/09	14:00	0.5	G	Aphanizomenon flos-aquae	16	2	1.8	3,036	5.3	137	57,110
KR9250	KR19019	11/17/09	14:00	0.5	G	Microcystis aeruginosa	9	5	3.5	1,927	3.4	137	57,110
KR9257	KR19874	11/17/09	11:25	8.0	INT	Anabaena flos-aquae	21	3	1.1	2,166	1.9	301	117,076
KR9266	KR22000	11/18/09	9:45	0.5	G	Aphanizomenon flos-aquae	6	28	4.8	24,554	8.8	579	278,961

Site ID	Location
CR01	Surface public health sample, Copco Reservoir near dam
CRCC	Surface public health sample, Copco Reservoir, Copco Cove
CRMC	Surface public health sample, Copco Reservoir, Mallard Cove
IR01	Surface public health sample, Iron Gate Reservoir at log boom
IRCC	Surface public health sample, Iron Gate Reservoir, Camp Creek Camp

Sample ID	SiteID	Date	Time	Depth	Type	Taxon	Rank	Density	% Density	Biovolume	% Biov	Total Density	Total Biovolume

IRJW	Surface public health sample, Iron Gate Reservoir, Jay Williams Camp
KRBI	Surface public health sample, Klamath River near hatchery bridge
KR18973	Klamath River near Hatchery Bridge
KR19019	Iron Gate Reservoir at log boom
KR19645	Klamath River below Copco 2 Powerhouse
KR19874	Copco Reservoir near dam
KR20642	Klamath River above Shovel Creek
KR22000	Klamath River below JC Boyle Powerhouse (Spring Island)
KR22460	Klamath River below JC Boyle Dam
KR22478	JC Boyle reservoir at log boom
KR22822	Klamath River above JC Boyle Reservoir

Four-character alpha site ID codes indicate samples collected for public health monitoring purposes.
Seven-character alphanumeric codes indicate samples collected for baseline water quality.
Public health samples were collected at the surface, including the top 10 cm, at locations of local maximum abundance.
Baeline samples were collected at 0.5 m depth. Additional 8 m depth integrated samples were collected at KR19010 and KR19874.

Appendix 4
Microcystin data from samples collected in the vicinity of the Klamath Hydroelectric Project in 2009.

EPA Sample ID	True SampleID	SiteID	DATE	VALUE	MDL	MRL	UNITS
KR9033	KR9033	CR01	05/23/09	0.14	0.09	0.18	ug/L
KR9040	KR9040	IR01	05/23/09	0.15	0.09	0.18	ug/L
KR9045	KR9045	KR18973	05/23/09	0.11	0.09	0.18	ug/L
KR9031	KR9031	KR18973	05/23/09	0.12	0.09	0.18	ug/L
KR9044	KR9044	KR18973	05/23/09	0.17	0.09	0.18	ug/L
KR9042	KR9042	KR19019	05/23/09	0.13	0.09	0.18	ug/L
KR9041	KR9041	KR19019	05/23/09	0.14	0.09	0.18	ug/L
KR9034	KR9034	KR19874	05/23/09	0.13	0.09	0.18	ug/L
KR9035	KR9035	KR19874	05/23/09	0.15	0.09	0.18	ug/L
KR9052	KR9052	KR22000	05/23/09	0.12	0.09	0.18	ug/L
KR9053	KR9053	KR22478	05/23/09	0.11	0.09	0.18	ug/L
KR9054	KR9054	KR22478	05/24/09	0.14	0.09	0.18	ug/L
KR9055	KR9055	KR22822	05/24/09	0.14	0.09	0.18	ug/L
KR9059	KR9059	CRMC	06/08/09	1.5	0.09	0.18	ug/L
KR9060	KR9060	CRCC	06/08/09	0.18	0.09	0.18	ug/L
KR9062	KR9062	IRCC	06/08/09	0.14	0.09	0.18	ug/L
KR9061	KR9061	IRJW	06/08/09	0.84	0.09	0.18	ug/L
KR9063	KR9063	KRBI	06/08/09	0.14	0.09	0.18	ug/L
KR9058	KR9058	KR18973	06/08/09	0.12	0.09	0.18	ug/L
KR9064	KR9064	CRMC	06/22/09	ND	0.09	0.18	ug/L
KR9065	KR9065	CRCC	06/22/09	0.23	0.09	0.18	ug/L
KR9067	KR9067	IRCC	06/22/09	2.5	0.09	0.18	ug/L
KR9066	KR9066	IRJW	06/22/09	0.12	0.09	0.18	ug/L
KR9068	KR9068	KRBI	06/22/09	0.09	0.09	0.18	ug/L
KR9075	KR9075	KR22000	06/23/09	0.09	0.09	0.18	ug/L
KR9072	KR9072	KR22478	06/23/09	ND	0.09	0.18	ug/L
KR9071	KR9071	KR22478	06/23/09	ND	0.09	0.18	ug/L
KR9080	KR9080	KR19874	06/24/09	0.19	0.09	0.18	ug/L
KR9079	KR9079	KR19874	06/24/09	ND	0.09	0.18	ug/L
KR9086	KR9086	KR19019	06/24/09	0.14	0.09	0.18	ug/L
KR9085	KR9085	KR19019	06/24/09	0.11	0.09	0.18	ug/L
KR9076	KR9076	KR20642	06/24/09	ND	0.09	0.18	ug/L
KR9084	KR9084	KR19645	06/24/09	ND	0.09	0.18	ug/L
KR9078	KR9078	KR18973	06/24/09	0.1	0.09	0.18	ug/L
KR9093	KR9093	KR18973	06/24/09	0.1	0.09	0.18	ug/L
KR9088	KR9088	KR18973	06/24/09	ND	0.09	0.18	ug/L
KR9095	KR9095	CRMC	07/06/09	0.25	0.09	0.18	ug/L
KR9096	KR9096	CRCC	07/06/09	50	9.1	18	ug/L
KR9098	KR9098	IRCC	07/06/09	1.1	0.91	1.8	ug/L
KR9097	KR9097	IRJW	07/06/09	7.2	0.91	1.8	ug/L
KR9099	KR9099	KRBI	07/06/09	2	0.09	0.18	ug/L
KR9094	KR9094	KR18973	07/06/09	0.45	0.09	0.18	ug/L
KR9100	KR9100	CRMC	07/20/09	8700	910	1800	ug/L
KR9101	KR9101	CRCC	07/20/09	2200	910	1800	ug/L
KR9103	KR9103	IRCC	07/20/09	11	0.91	1.8	ug/L
KR9102	KR9102	IRJW	07/20/09	220	91	180	ug/L

KR9104	KR9104	KRBI	07/20/09	13	0.91	1.8	ug/L
KR9025	KR9115	KR18973	07/21/09	ND	0.09	0.18	ug/L
KR9026	KR9116	KR19874	07/21/09	3.5	0.91	1.8	ug/L
KR9019	KR9107	KR19019	07/21/09	10	0.91	1.8	ug/L
KR9027	KR9117	CR01	07/21/09	24	9.1	18	ug/L
KR9028	KR9118	KR19874	07/21/09	16	0.91	1.8	ug/L
KR9032	KR9122	KR19645	07/21/09	6	0.91	1.8	ug/L
KR9016	KR9106	KR18973	07/21/09	1.9	0.09	0.18	ug/L
KR9033	KR9123	KR18973	07/21/09	4.4	0.91	1.8	ug/L
KR9038	KR9128	KR22478	07/22/09	0.11	0.09	0.18	ug/L
KR9039	KR9129	KR22478	07/22/09	0.09	0.09	0.18	ug/L
KR9034	KR9124	KR22000	07/22/09	ND	0.09	0.18	ug/L
KR9132	KR9132	KR18973	08/03/09	1700	910	1800	ug/L
KR9133	KR9133	CRMC	08/03/09	7500	910	1800	ug/L
KR9135	KR9135	IRJW	08/03/09	1000	91	180	ug/L
KR9134	KR9134	CRCC	08/03/09	3800	910	1800	ug/L
KR9136	KR9136	IRCC	08/03/09	10	0.91	1.8	ug/L
KR9177	KR9177	CRMC	08/17/09	2000	91	180	ug/L
KR9178	KR9178	CRCC	08/17/09	62	9.1	18	ug/L
KR9180	KR9180	IRCC	08/17/09	15	0.91	1.8	ug/L
KR9179	KR9179	IRJW	08/17/09	160	9.1	18	ug/L
KR9181	KR9181	KRBI	08/17/09	2	0.09	0.18	ug/L
KR9138	KR9138	KR20642	08/17/09	0.17	0.09	0.18	ug/L
KR9141	KR9141	IR01	08/18/09	7.4	0.91	1.8	ug/L
KR9142	KR9142	KR19019	08/18/09	12	0.91	1.8	ug/L
KR9140	KR9140	KR19019	08/18/09	5.6	0.91	1.8	ug/L
KR9150	KR9150	CR01	08/18/09	100	9.1	18	ug/L
KR9151	KR9151	KR19874	08/18/09	8.9	0.91	1.8	ug/L
KR9149	KR9149	KR19874	08/18/09	4.7	0.91	1.8	ug/L
KR9139	KR9139	KR18973	08/18/09	2	0.09	0.18	ug/L
KR9148	KR9148	KR18973	08/18/09	ND	0.09	0.18	ug/L
KR9156	KR9156	KR18973	08/18/09	1.3	0.09	0.18	ug/L
KR9162	KR9162	KR22478	08/19/09	0.24	0.09	0.18	ug/L
KR9161	KR9161	KR22478	08/19/09	0.37	0.09	0.18	ug/L
KR9158	KR9158	KR22000	08/19/09	0.26	0.09	0.18	ug/L
KR9171	KR9171	KRBI	09/08/09	9.7	0.91	1.8	ug/L
KR9172	KR9172	CRMC	09/14/09	38000	9100	18000	ug/L
KR9173	KR9173	CRCC	09/14/09	44000	9100	18000	ug/L
KR9174	KR9174	IRCC	09/14/09	6	0.91	1.8	ug/L
KR9175	KR9175	IRJW	09/14/09	5300	910	1800	ug/L
KR9176	KR9176	KRBI	09/14/09	4.4	0.91	1.8	ug/L
KR9194	KR9194	KR19645	09/15/09	2	0.09	0.18	ug/L
KR9188	KR9188	KR19874	09/15/09	6.2	0.91	1.8	ug/L
KR9189	KR9189	CR01	09/15/09	15	0.91	1.8	ug/L
KR9190	KR9190	KR19874	09/15/09	14	0.91	1.8	ug/L
KR9181	KR9181	KR19019	09/15/09	11	0.91	1.8	ug/L
KR9180	KR9180	IR01	09/15/09	13	0.91	1.8	ug/L
KR9179	KR9179	KR19019	09/15/09	7.6	0.91	1.8	ug/L
KR9178	KR9178	KR18973	09/15/09	8.7	0.91	1.8	ug/L
KR9195	KR9195	KR18973	09/15/09	11	0.91	1.8	ug/L
KR9187	KR9187	KR18973	09/15/09	ND	0.09	0.18	ug/L
KR9177	KR9177	KR20642	09/15/09	ND	0.09	0.18	ug/L

KR9200	KR9200	KR22478	09/16/09	ND	0.09	0.18	ug/L
KR9201	KR9201	KR22478	09/16/09	0.09	0.09	0.18	ug/L
KR9197	KR9197	KR22000	09/16/09	ND	0.09	0.18	ug/L
KR9205	KR9205	CRMC	09/24/09	73000	9100	18000	ug/L
KR9206	KR9206	CRCC	09/24/09	36000	9100	18000	ug/L
KR9207	KR9207	IRCC	09/24/09	190	9.1	18	ug/L
KR9208	KR9208	IRJW	09/24/09	160	9.1	18	ug/L
KR9209	KR9209	KRBI	09/24/09	11	0.91	1.8	ug/L
KR9210	KR9210	CRMC	10/12/09	290	9.1	18	ug/L
KR9211	KR9211	CRCC	10/12/09	3200	910	1800	ug/L
KR9212	KR9212	IRCC	10/12/09	12	0.91	1.8	ug/L
KR9213	KR9213	IRJW	10/12/09	3200	910	1800	ug/L
KR9214	KR9214	KRBI	10/12/09	2.1	0.09	0.18	ug/L
KR9228	KR9228	KR19874	10/13/09	2.3	0.09	0.18	ug/L
KR9227	KR9227	CR01	10/13/09	1.2	0.09	0.18	ug/L
KR9226	KR9226	KR19874	10/13/09	0.69	0.09	0.18	ug/L
KR9232	KR9232	KR19645	10/13/09	1.8	0.09	0.18	ug/L
KR9219	KR9219	KR19019	10/13/09	0.93	0.09	0.18	ug/L
KR9218	KR9218	IR01	10/13/09	0.39	0.09	0.18	ug/L
KR9217	KR9217	KR19019	10/13/09	2.6	0.09	0.18	ug/L
KR9215	KR9215	KR18973	10/13/09	0.52	0.09	0.18	ug/L
KR9225	KR9225	KR18973	10/13/09	0.1	0.09	0.18	ug/L
KR9216	KR9216	KR20642	10/13/09	0.16	0.09	0.18	ug/L
KR9238	KR9238	KR22478	10/14/09	0.19	0.09	0.18	ug/L
KR9239	KR9239	KR22478	10/14/09	0.2	0.09	0.18	ug/L
KR9235	KR9235	KR22000	10/14/09	0.24	0.09	0.18	ug/L
KR9233	KR9233	KR18973	10/14/09	0.6	0.09	0.18	ug/L
KR9241	KR9241A	CRMC	10/26/09	1.1	0.09	0.18	ug/L
KR9242	KR9242A	CRCC	10/26/09	27	0.91	1.8	ug/L
KR9243	KR9243A	IRCC	10/26/09	13	0.91	1.8	ug/L
KR9244	KR9244A	IRJW	10/26/09	2400	91	180	ug/L
KR9245	KR9245A	KRBI	10/26/09	5.1	0.91	1.8	ug/L
KR9246	KR9246	KR20642	11/16/09	0.09	0.09	0.18	ug/L
KR9258	KR9258	CR01	11/17/09	0.1	0.09	0.18	ug/L
KR9249	KR9249	IR01	11/17/09	0.15	0.09	0.18	ug/L
KR9247	KR9247	KR18973	11/17/09	0.15	0.09	0.18	ug/L
KR9264	KR9264	KR18973	11/17/09	0.15	0.09	0.18	ug/L
KR9256	KR9256	KR18973	11/17/09	ND	0.09	0.18	ug/L
KR9250	KR9250	KR19019	11/17/09	0.12	0.09	0.18	ug/L
KR9248	KR9248	KR19019	11/17/09	0.21	0.09	0.18	ug/L
KR9263	KR9263	KR19645	11/17/09	0.15	0.09	0.18	ug/L
KR9257	KR9257	KR19874	11/17/09	0.11	0.09	0.18	ug/L
KR9259	KR9259	KR19874	11/17/09	0.12	0.09	0.18	ug/L
KR9266	KR9266	KR22000	11/18/09	0.18	0.09	0.18	ug/L
KR9268	KR9268	KR22460	11/18/09	ND	0.09	0.18	ug/L
KR9270	KR9270	KR22478	11/18/09	0.14	0.09	0.18	ug/L
KR9269	KR9269	KR22478	11/18/09	0.15	0.09	0.18	ug/L
KR9273	KR9273	KR20642	12/14/09	0.15	0.09	0.18	ug/L
KR9290	KR9290	KR19645	12/15/09	0.15	0.09	0.18	ug/L
KR9286	KR9286	KR19874	12/15/09	0.16	0.09	0.18	ug/L
KR9284	KR9284	KR19874	12/15/09	0.14	0.09	0.18	ug/L
KR9274	KR9274	KR18973	12/15/09	0.14	0.09	0.18	ug/L

KR9277	KR9277	KR19019	12/15/09	0.14	0.09	0.18	ug/L
KR9275	KR9275	KR19019	12/15/09	0.13	0.09	0.18	ug/L
KR9291	KR9291	KR18973	12/15/09	0.17	0.09	0.18	ug/L
KR9283	KR9283	KR18973	12/15/09	0.1	0.09	0.18	ug/L
KR9292	KR9292	KR22460	12/16/09	0.14	0.09	0.18	ug/L
KR9299	KR9299	KR22460	12/16/09	0.16	0.09	0.18	ug/L
KR9295	KR9295	KR22460	12/16/09	0.12	0.09	0.18	ug/L
KR9293	KR9293	KR22000	12/16/09	0.16	0.09	0.18	ug/L