

# Middle Klamath River Toxic Cyanobacteria Trends, 2009



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## INTRODUCTION

As outlined previously (e.g., Kann 2007; Kann and Corum 2009; Jacoby and Kann 2007) Copco and Iron Gate Reservoirs (the lowermost projects of PacifiCorp's Klamath Hydropower Project--KHP) experienced extensive blooms of toxigenic *Microcystis aeruginosa* (MSAE) from 2004-2008. These blooms were associated with high levels of microcystin, a potent hepatotoxin capable of causing chronic liver damage and acting as a tumor promoter (Carmichael 1995; Chorus et al. 1999; Chorus 2001).

The results of the 2005-2008 sampling program demonstrated widespread and high abundance of toxigenic MSAE blooms in Copco and Iron Gate reservoirs and in the Klamath River downstream, exceeding World Health Organization Moderate Probability of Adverse Health Effect Levels (WHO MPHAEL) for both cell density and toxin by 10 to over 1000 times. Although both cell density and toxin data indicated that MSAE cells and microcystin were either not detectable or detected at very low levels in the Klamath River directly above the reservoirs, levels of both parameters increased directly below the reservoirs in all years. In addition, bioaccumulation studies undertaken in 2007 and 2008 showed accumulation of microcystin toxin in muscle and/or liver tissues of yellow perch, hatchery salmon, and freshwater mussels (Mekebri et al. 2009; Kann 2008; Kanz 2008). Microcystin levels in biota exceeded public health threshold values for safe consumption (Kann 2008; OEHHA 2008).

Similar to previous years, a toxic algal monitoring program was undertaken by the Karuk Tribe during May-November, 2009. However, in 2009 the Karuk Tribe monitored only the river stations below the reservoirs, while PacifiCorp provided monitoring results for Copco and Iron Gate Reservoirs. The following report summarizes 2009 toxigenic MSAE trends in the Klamath River below the reservoir complex, as well as provides a comparison to upstream reservoir concentrations to provide consistency with previous years monitoring trends.

## METHODS

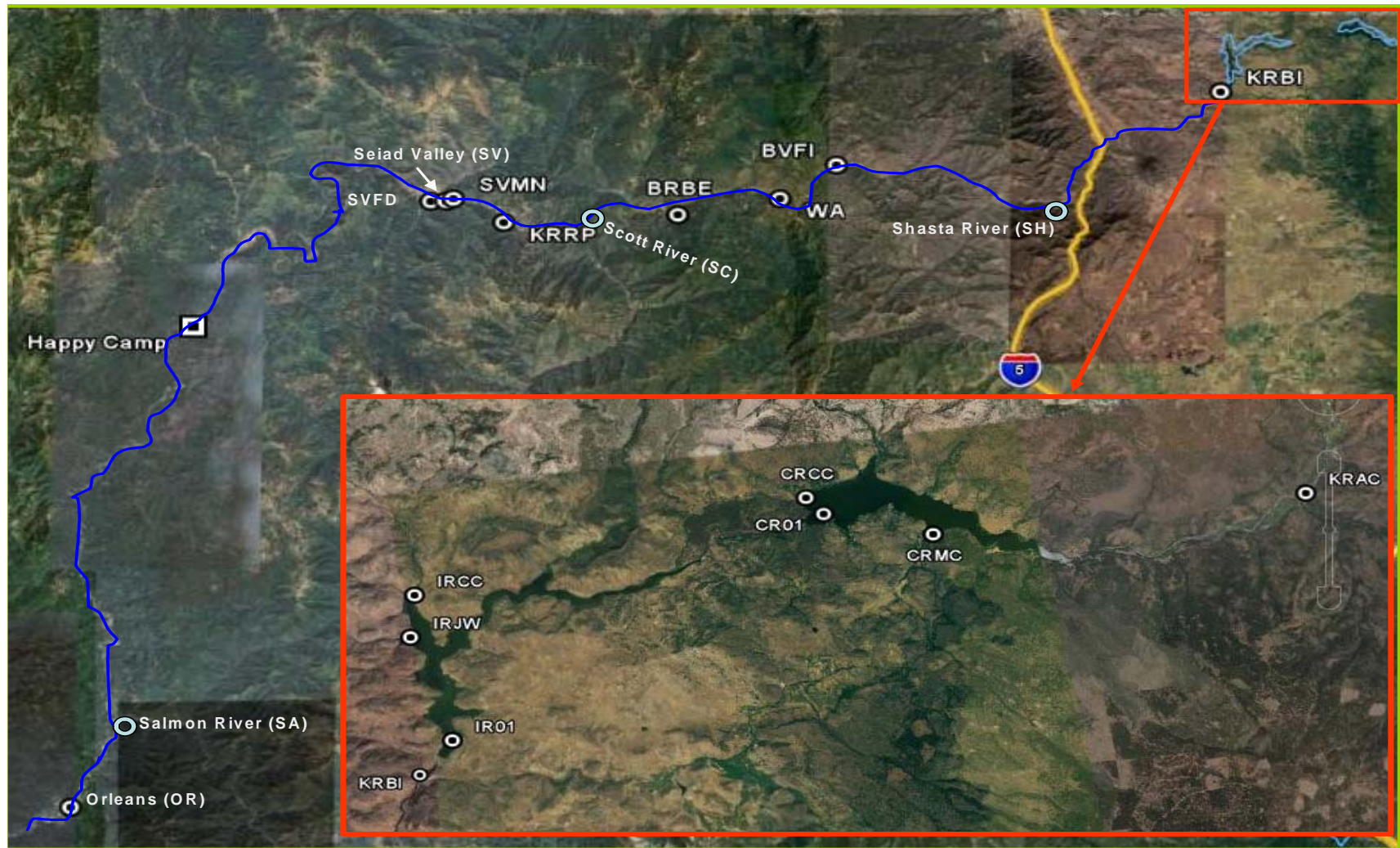
### *Station Location*

During the 2009 sampling season, MSAE cell density, cell biovolume, and microcystin toxin samples were collected from standard river stations KRBI (also recorded as IG), IB (I-5 Bridge), WA (Walker Bridge), BB (Brown Bear also recorded as BRBE), SV (Seiad Valley), HC (Happy camp) and OR (Orleans) located below Iron Gate Reservoir. In addition, tributary mouths for the Shasta River (SH), the Scott River (SC), and the Salmon River (SA) were also sampled (Table 1; Figure 1). Reservoir and river stations monitored by PacifiCorp consisted of CR01, CRCC, CRMC, IR01, IRCC, IRJW, and KRBI (Raymond 2009).

**Table 1. Phytoplankton/microcystin sampling locations in Copco and Iron Gate Reservoirs and Klamath River stations, 2009.**

STATION NAME	STATION LAT/LON	Station Description	Shoreline (SL) or Open Water (OW)
CR01	N41 58.932 W122 19.694	Copco Res. Near Dam	OW
CRCC	N41 59.035 W122 19.802	Copco Res. Copco Cove Boat Ramp/Recreation Area	SL
CRMC	N41 58.441 W122 17.869	Copco Res. Mallard Cove Boat Ramp/Recreation Area	SL
IR01	N41 56.330 W122 25.930	Iron Gate Res. Near Dam	OW
IRCC	N41 58.368 W122 26.114	Iron Gate Res. Camp Creek Boat Ramp/Recreation Area	SL
IRJW	N41 57.721 W122 26.425	Iron Gate Res. Jay Williams Boat Ramp/Recreation Area	SL
KRAC	N41 58.345 W122 12.101	Klamath River Above Copco Reservoir	River-OW
KRBI	N41 55.865 W122 26.532	Klamath River Below Iron Gate Reservoir (Sample Name IG in 2009)	River-OW
IB	N 41 51.417 W 122 34.233	I-5 Bridge	River-OW/SL
WA	N41 50.252 W122 51.811	Located downstream of the town of Klamath River. Samples were collected off of Walker Bridge.	River-OW
BB	N41 49.399 W122 57.650	Brown Bear River Access just east of Horse Creek (Sample name BRBE in 2008)	River-OW/SL
SV	N41 50.561 W 123 13.132	Seiad Valley at Sluice Box River Access	River-OW/SL
HC	N 41 43.780 W 123 25.775	Happy Camp	River-OW/SL
OR	N41 18.336 W 123 31.895	Orleans just north of Orleans Bridge	River-OW/SL
SA	N 41 22.617 W 123 28.633	Mouth of Salmon River	River-OW
SC	N 41 46.100 W 123 01.567	Mouth of Scott River	River-OW
SH	N 41 49.390 W 122 35.700	Mouth of Shasta River	River-OW

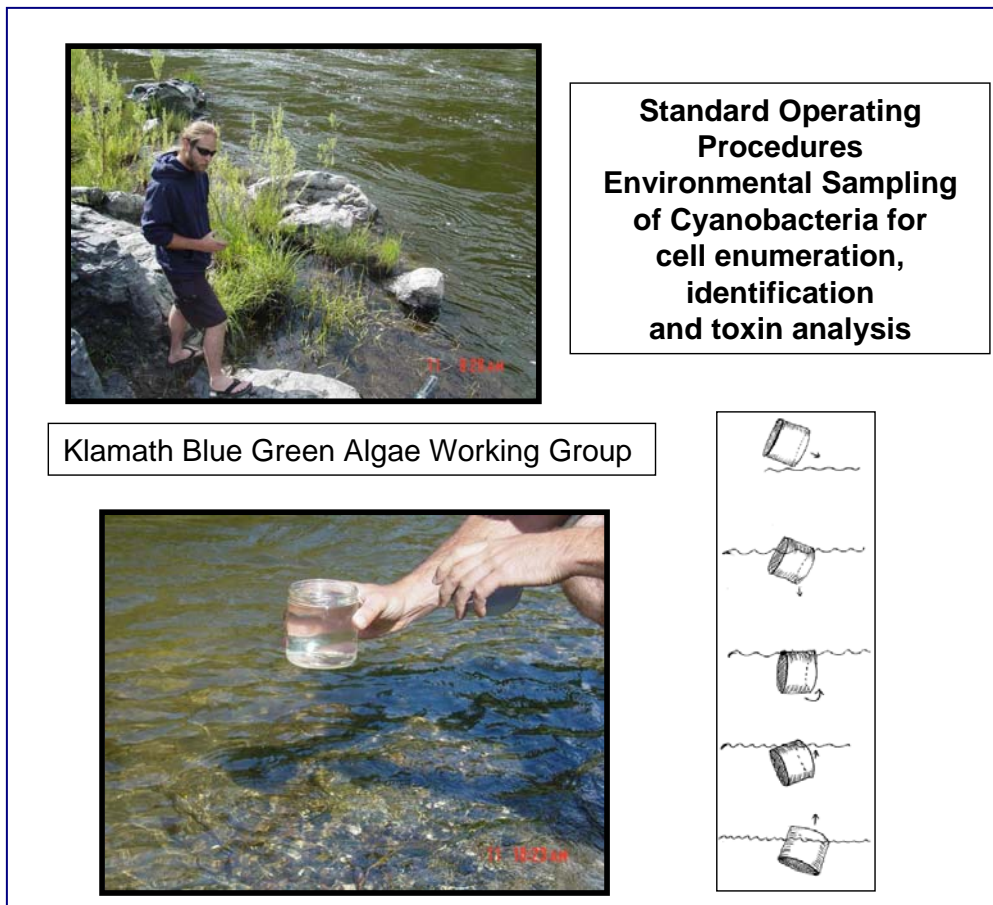




**Figure 1. Location of Copco and Iron Gate Reservoirs and Klamath River toxic cyanobacteria sampling stations, 2009. Note that stations BVFI, SVFD, and SVMN were only sampled in 2008. In 2009 station BRBE is renamed as BB.**

### *Sample Collection and Lab Analysis*

Samples of surface algal material taken from shoreline or river-edge areas (denoted SG in the depth column of Appendix I below) utilized the standard operating procedure (SOP) developed by the Klamath Blue-Green Algae Working Group, and is depicted in (Figure 2). River open-water samples were composited in a churn splitter by wading towards the center of the channel (in mixed areas of noticeable velocity), and then submersing and filling the churn prior to distributing to appropriate sample bottles. Samples for microscopic determination of phytoplankton density and biovolume were preserved in Lugol's Iodine and sent to Aquatic Analysts in White Salmon, WA where enumeration and biovolume measurements were determined according to APHA Standard Methods (1992).



**Figure 2. Klamath Blue Green Algae Working Group grab sample collection method. Klamath River 2009.**



Because previous work showed higher variability among split samples when MSAE levels were in the lower range (e.g. 0-30,000 cells/ml), toxigenic species in samples from the Klamath River stations were enumerated at an increased counting resolution that included cell counts of potentially toxigenic blue-green algae in an area 4x that of the usual 100 algal unit count performed by the laboratory. This provided an effective algal unit count of 400 for potentially toxigenic species.

Samples for microcystin toxin were collected in glass vials, which were frozen at Karuk Tribal facilities, and subsequently placed in a cooler with gel-ice and shipped overnight air to the USEPA Region 9 Laboratory in Richmond, CA for analysis of microcystin toxin using ELISA methodology. See Fetcho (2007) for a comprehensive description of laboratory methods and detection limits.

A set of “blind duplicate” quality assurance samples were collected for cell density and microcystin toxin. Quality assurance (QA) sampling was performed by splitting samples in the field using a churn splitter. One of the pair of split samples was disguised and sent with its associated split for analysis of both cell density and microcystin toxin.

### ***Comparison to Public Health Threshold Values***

Cell density and toxin concentration were compared to California State Water Resources Control Board (SWRCB) and Office of Environmental Health and Hazard Assessment (OEHHA) public health guideline levels that are similar to those used by the state of Oregon (Stone and Bress (2007)). These levels are 40,000 cells/ml of MSAE and 8 µg/L of microcystin and are also consistent with recent Australian analysis of health risk threshold values (NHMRC 2005).

The SWRCB/OEHHA levels are specific for MSAE and microcystin, whereas previously used World Health Organization (WHO) threshold values for Moderate Probability of Adverse Health Effects (MPAHEL as published in documents for the WHO and EPA: e.g., Falconer et al. 1999 and Chorus and Cavalieri 2000) are general levels for a variety of toxigenic cyanobacteria. These WHO guidelines indicated 4 µg/L of microcystin constituted a low probability of adverse health effects and 20 µg/L constituted a moderate probability of adverse health effects.

Microcystin concentration was also compared to the tolerable daily intake level (TDI: 0.04 µg microcystin per kg of body weight/day as described in WHO 1998) computed for a 20kg child ingesting 100 mls of reservoir water. The TDI as computed here for a 20kg child is equivalent to the exceedance of the 8µg/L public health guideline value described by SWRCB/OEHHA ([www.waterboards.ca.gov/water\\_issues/programs/bluegreen\\_algae/docs/bga\\_volguidance.pdf](http://www.waterboards.ca.gov/water_issues/programs/bluegreen_algae/docs/bga_volguidance.pdf)). The WHO (Falconer et al. 1999) also lists cyanobacterial scums in swimming areas as having a high probability of adverse health effects (i.e., the potential to cause acute poisoning) and recommends immediate action to prevent contact with scums. As noted above, public health threshold values were also evaluated by relating microcystin concentration to MSAE cell density.

## RESULTS/DISCUSSION

### *Quality Assurance Samples*

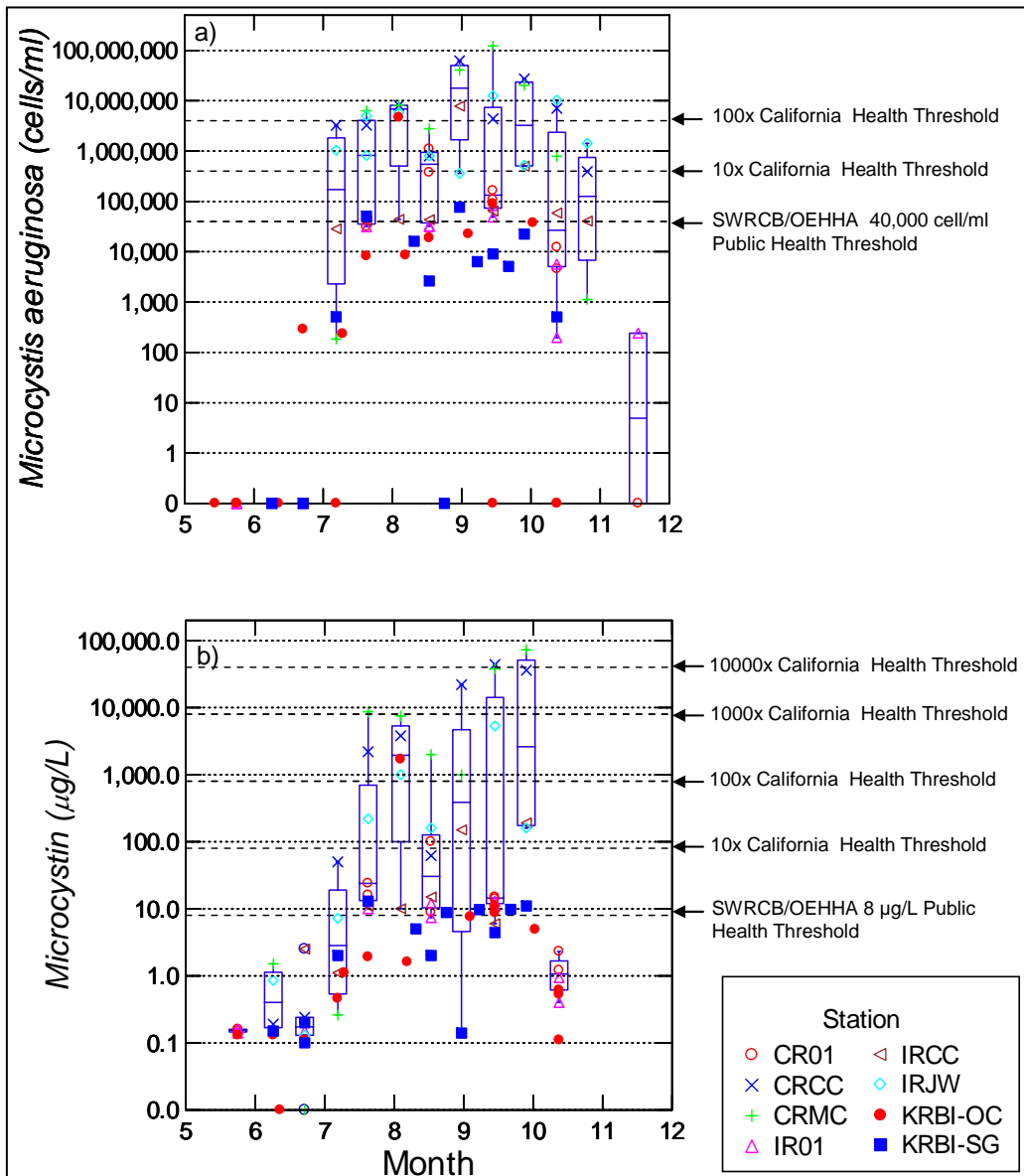
Microcystin analyses showed less variability than MSAE cell counts with very good agreement between paired microcystin samples and duplicates (Table 2). With respect to public health threshold values there were no instances when management based on the 8 µg/L microcystin or the 40,000 cells/ml MSAE threshold would have differed. Overall, the utilized phytoplankton and toxin methodology had adequate sensitivity relative to public health threshold values. However, on one occasion (9/24/2009) cell density varied by more than 10,000 cells/ml.

**Table 2. Field duplicate samples for MSAE cell density and microcystin concentration. ND denotes non-detect and blank means data were not available.**

Date	Station Name	Station Description	Depth	<i>Microcystis aeruginosa</i> (cells/ml)	<i>Planktothrix (Oscillatoria) sp.</i> (cells/ml)	<i>Anabaena sp.</i> (cells/ml)	Microcystin Total (µg/L)
6/11/09	SV	Seaid Valley	OC	0	0	0	nd
6/11/09	SD	Seaid Valley Dup	OC	0	0	0	nd
6/25/09	SV	Seaid Valley	SG	0	0	0	nd
6/25/09	SD	Seaid Valley Dup	SG	0	0	0	nd
6/25/09	SV	Seaid Valley	OC	0	30	0	nd
6/25/09	SD	Seaid Valley Dup	OC	0	0	0	nd
7/23/09	SV	Seaid Valley	SG	0	0	0	0.56
7/23/09	SD	Seaid Valley Dup	SG	0	0	0	0.31
7/23/09	SV	Seaid Valley	OC	1,374	0	0	0.18
7/23/09	SD	Seaid Valley Dup	OC	1,516	0	0	0.15
8/13/09	SV	Seaid Valley	SG	11,054	0	0	
8/13/09	SD	Seaid Valley Dup	SG	10,022	0	0	2.20
8/20/09	SV	Seaid Valley	OC	6,663	0	0	0.85
8/20/09	SD	Seaid Valley Dup	OC	11,275	0	0	0.51
8/27/09	SV	Seaid Valley	SG	5,875	0	0	1.70
8/27/09	SD	Seaid Valley Dup	SG	5,074	0	0	1.40
9/3/09	SV	Seaid Valley	SG	8,443	0	0	1.10
9/3/09	SD	Seaid Valley Dup	SG	5,785	0	0	0.96
9/3/09	SV	Seaid Valley	OC	6,500	0	0	1.10
9/3/09	SD	Seaid Valley Dup	OC	4,997	0	0	0.73
9/10/09	SV	Seaid Valley	SG	14,734	0	0	5.10
9/10/09	SD	Seaid Valley Dup	SG	15,869	0	0	2.20
9/17/09	SV	Seaid Valley	OC	26,581	0	0	7.20
9/17/09	SD	Seaid Valley Dup	OC	21,476	301	0	6.50
9/24/09	SV	Seaid Valley	SG	18,488	0	0	4.30
9/24/09	SD	Seaid Valley Dup	SG	8,032	0	0	4.70
10/15/09	SV	Seaid Valley	OC	0	0	0	0.42
10/15/09	SD	Seaid Valley Dup	OC	1,720	0	0	0.88

**2009 Temporal/Spatial Trends**

Although all of the standard reservoir sampling stations had low levels of microcystin concentration throughout May and June, the Reservoirs were first posted for *Anabaena* in June. The first detection of MSAE did not occur until 6/25 at station KRBI (Figure 3), and MSAE first exceeded the 40,000 cell/ml public health threshold on 7/6 at both CRCC and IRJW, when microcystin concentrations were 50 µg/L (exceeding the public health TDI by 6.3x) and 7.2 µg/L, respectively. During the 7/20 sample date the standard sampling stations (CRMC, CRCC, IRCC, IRJW, and KRBI) exceeded 40,000 cells/ml and stations (CRMC, CRCC, CR01, IR01, IRCC, IRJW, and KRBI-SG) exceeded 8 µg/L (Figure 3).



**Figure 3. Time-series of MSAE cell density (a) and microcystin toxin concentration (b) for Copco and Iron Gate Reservoir stations, 2009. The box plot (blue box) is for standard reservoir stations CR01, CRCC, CRMC, IR01, IRCC, IRJW only; the river station KRBI is shown independently. All data for reservoir and KRBI-SG stations were provided by PacifiCorp ([www.pacificorp.com/es/hydro/hl/kr.html](http://www.pacificorp.com/es/hydro/hl/kr.html)).**

Overall MSAE and microcystin levels increased from July through September with a decline occurring in mid August (Figure 3). On 9/28 CRCC had a microcystin concentration of 36,000 µg/L and CRMC had a microcystin concentration of 73,000 µg/L, both exceeding the public health TDI by 10,000x (Figure 3). The 73,000 µg/L microcystin level is the highest observed for these systems to date, and represents maximum world-wide observations. Levels of microcystin dropped significantly in October to levels below the public health threshold for all stations, while MASE levels remained relatively high at some stations throughout October (Figure 3). An evaluation of the ratio of toxin produced per unit MSAE indicates that unlike some previous years, 2009 ratios did not show a sharp decline in September or October (Figure 4a). An increased ratio occurred in Copco Reservoir relative to Iron Gate Reservoir in 2009 (Figure 4b). Of the five years, the ratio of toxin produced per unit MSAE in 2009 ranked among the highest for July, September and October (Figure 4).

A comparison of station distributions for 2009 shows a trend of moderate to high levels for microcystin and MSAE at CR01, CRCC and CRMC, lower levels at IR01, and moderate to high levels at IRCC and IRJW (Figure 5). Despite the IRJW station showing similar MSAE levels to CRCC and CRMC, microcystin values were noticeably lower. Relative to Copco Reservoir, microcystin levels in Iron Gate Reservoir were lower overall in 2009 (Figure 5).

Continuing downstream to KRBI and below to Orleans (OR), levels of both MSAE and microcystin toxin were lower relative to the reservoir stations; however, on numerous occasions river samples taken in the mixed portion of the channel exceeded the threshold guideline values of 40,000 cells/ml MSAE or 8 µg/L microcystin (Figure 5; Appendix I). Similar to 2008, samples taken in areas of low velocity in Klamath River edge habitat showed that for these samples MSAE cell density and microcystin concentration were often higher than the open water samples, and more frequently exceeded the 40,000 cells/ml MSAE and 8 µg/L microcystin public health guideline values (Figure 6). The edge-water concentrations typically observed are illustrated in Figure 7. Public health exceedances were typically highest at station BB, but a microcystin value of 1700 µg/L was observed at KRBI on 8/3/2009 (Figure 6; Appendix 1). As in 2008, from a public health perspective these data illustrate that low MSAE or toxin values in open-water (collected in mixed areas of higher velocity) Klamath River samples often translates to values exceeding public health thresholds in river-edge areas.

Because the jar method (as outlined above) of collecting surface algal material does not allow for easy sampling of scum material, areas of high algal concentration adjacent to some of the samples above are likely to exceed posting guideline levels in some cases. For example, stations IB and SV showed MSAE levels of 12,695 and 11,054 cells/ml, respectively on August 13<sup>th</sup>; yet photos of algal mats near these stations (Figure 7) indicate MSAE cells to be more highly concentrated than the cell counts would indicate. River users should be aware to avoid such areas (especially if they have pets).

With the exception of two instances of low MSAE cell density (451 cells/ml and 9 cells/ml) detected at the mouth of the Scott River (SC) on 10/15 and 12/10, MSAE was not detected in any other tributary samples during 2009 (Appendix I). Low levels of microcystin (less than 1 µg/L) were detected at SC, SA and SH throughout the sampling period. The cause of and or source of the low levels is unknown, but given the low level and infrequent detection, is not of general concern at this time.

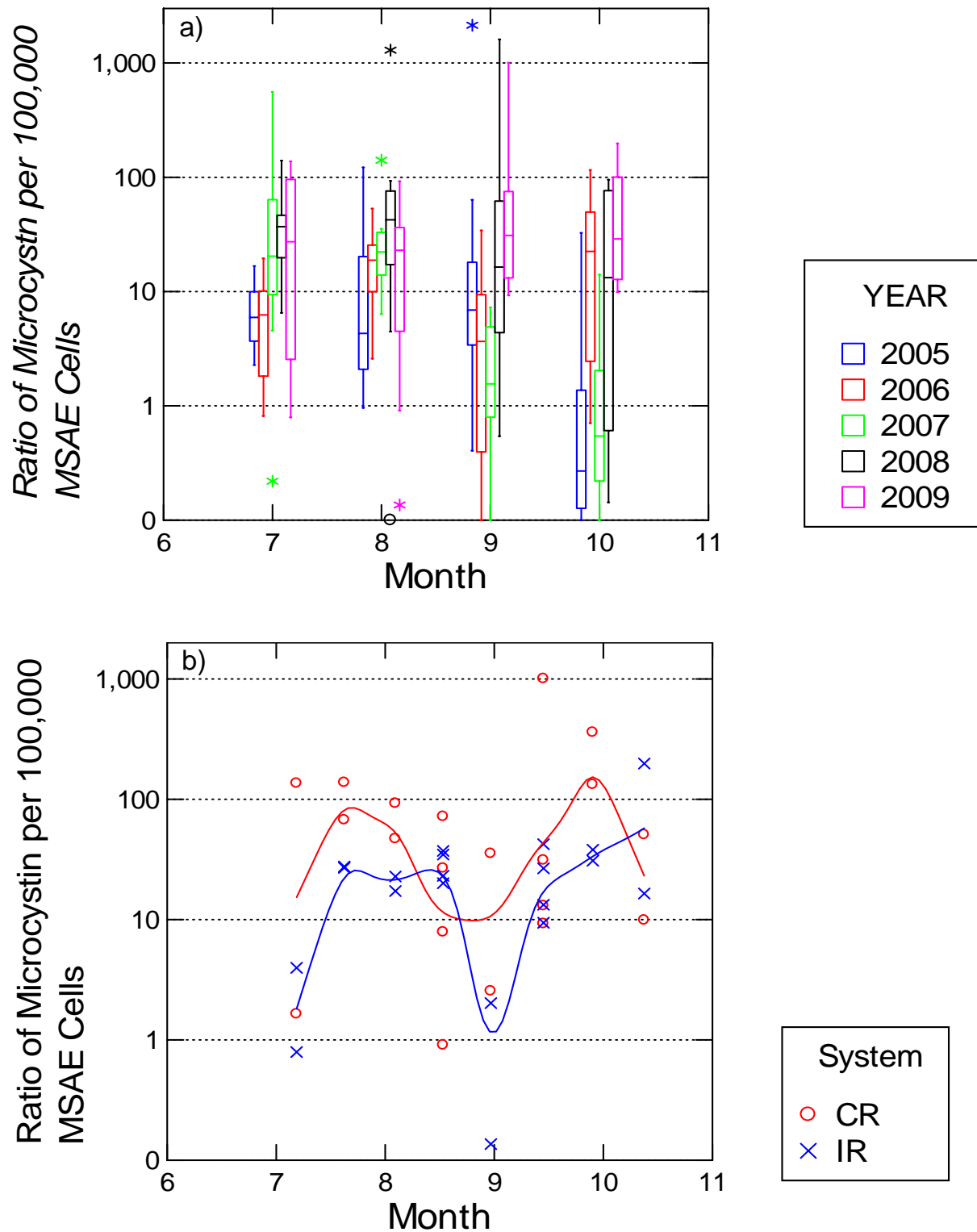


Figure 4. Box plot of the ratio of microcystin concentration per 100,000 MSAE cells at standard stations in Copco and Iron Gate Reservoirs, July through October 2005-2009 (a) and the Ratio of microcystin concentration per 100,000 MSAE cells compared between Copco and Iron Gate Reservoirs for 2009 (b). Trend line is the distance weighted least squares smoother; red Copco, blue Iron Gate. All data for reservoir and KRBI-SG stations were provided by PacifiCorp ([www.pacificorp.com/es/hydro/hl/kr.html](http://www.pacificorp.com/es/hydro/hl/kr.html)).

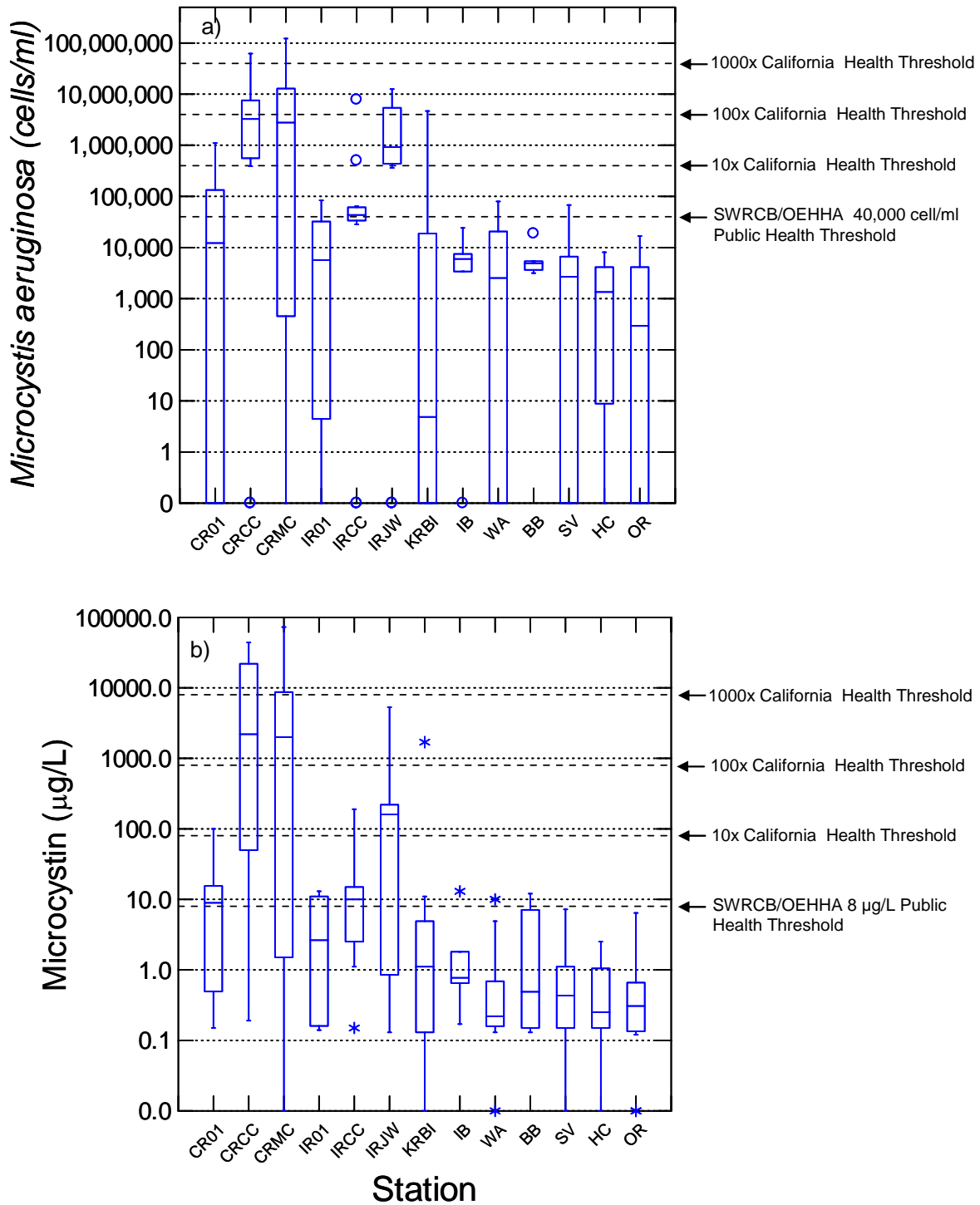
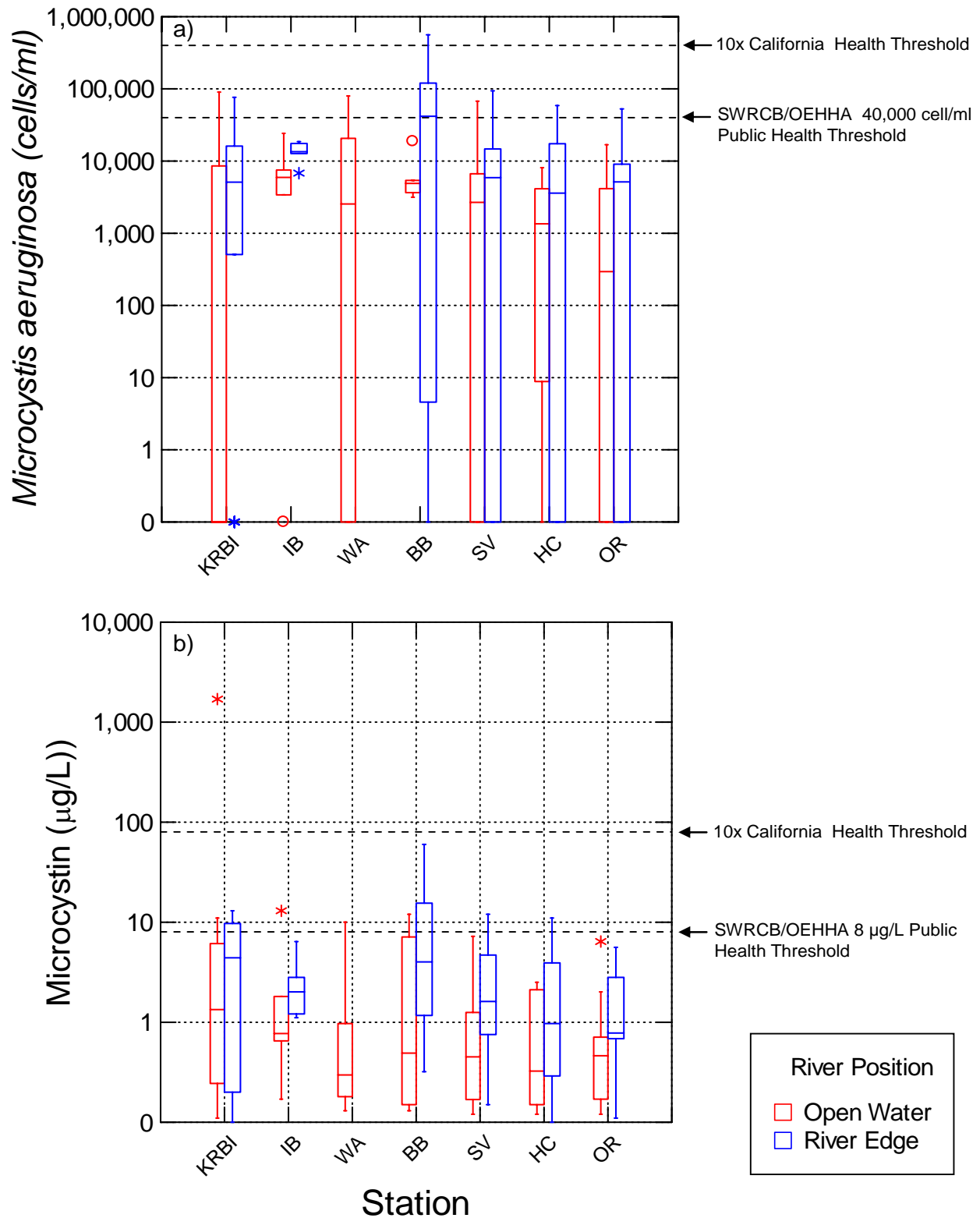
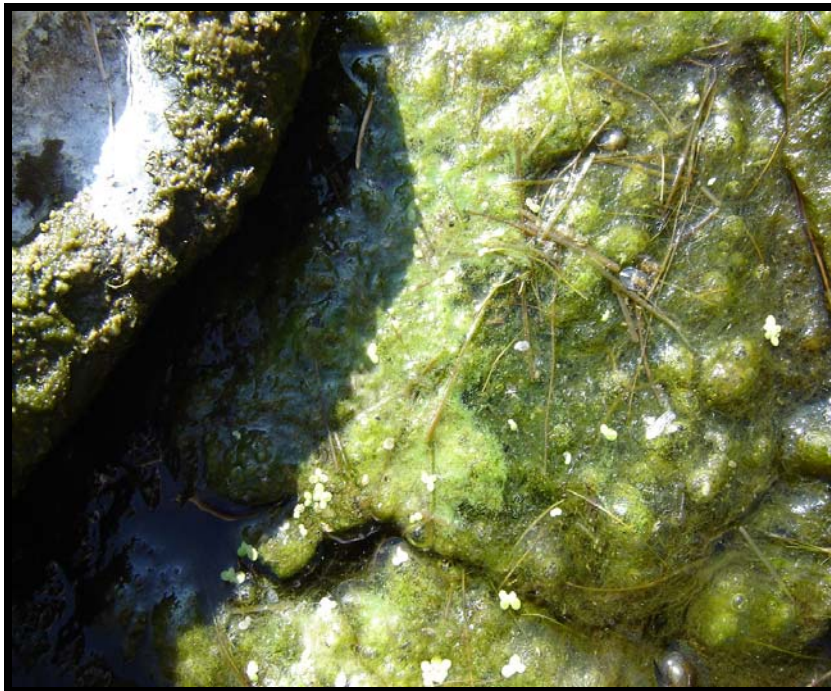


Figure 5. Station comparison of MSAE cell density (a) and microcystin toxin concentration (b) for Klamath River and Reservoir locations, 2009. Stations ordered longitudinally left (upstream) to right (downstream). All data for reservoir and KRBI-SG stations were provided by PacifiCorp ([www.pacificorp.com/es/hydro/hl/kr.html](http://www.pacificorp.com/es/hydro/hl/kr.html)). Reservoir stations include OC and SG depths, river stations include only OC depths.





**Figure 6.** MSAE cell density (a) and microcystin toxin concentration (b) for standard Klamath River stations sampled in areas of open water (OC) and low velocity at the river's edge (SG) May-November, 2009. Data for KRBI-SG stations were provided by PacifiCorp ([www.pacificorp.com/es/hydro/hl/kr.html](http://www.pacificorp.com/es/hydro/hl/kr.html)).



**Figure 7. Photos of algal mats with apparent accumulation of *Microcystis* near the I5 Bridge (a) and Seiad Valley (b), Klamath River, August 13, 2009.**

### ***Inter-annual Comparisons***

A comparison of combined 2009 reservoir data for Copco and Iron Gate reservoirs with 2005-2008 data showed both the median MSAE density and overall distribution to be higher than the previous two years, but similar to 2005 and 2006 (Figure 6a). Further breakdown shows that this trend is not only true for the reservoirs as a whole, but for Copco and Iron Gate individually, with the upper quartile values for both reservoirs notably higher in 2009 than 2008 (Figure 6b). Of the 5 year period of record, 2008 showed the lowest MSAE distribution both on a combined basis and for reservoirs individually. Aside from 2005 when Copco and Iron Gate showed similar MSAE levels, Iron Gate reservoir had lower overall MSAE densities than Copco Reservoir (Figure 6b).

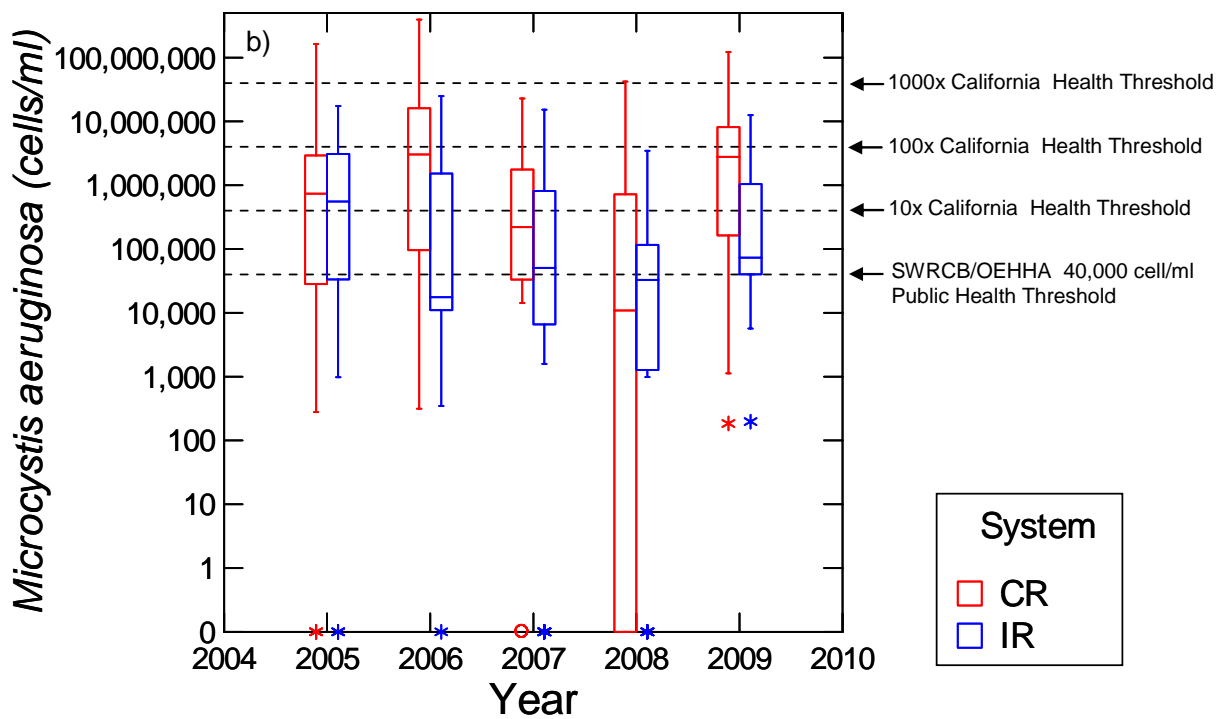
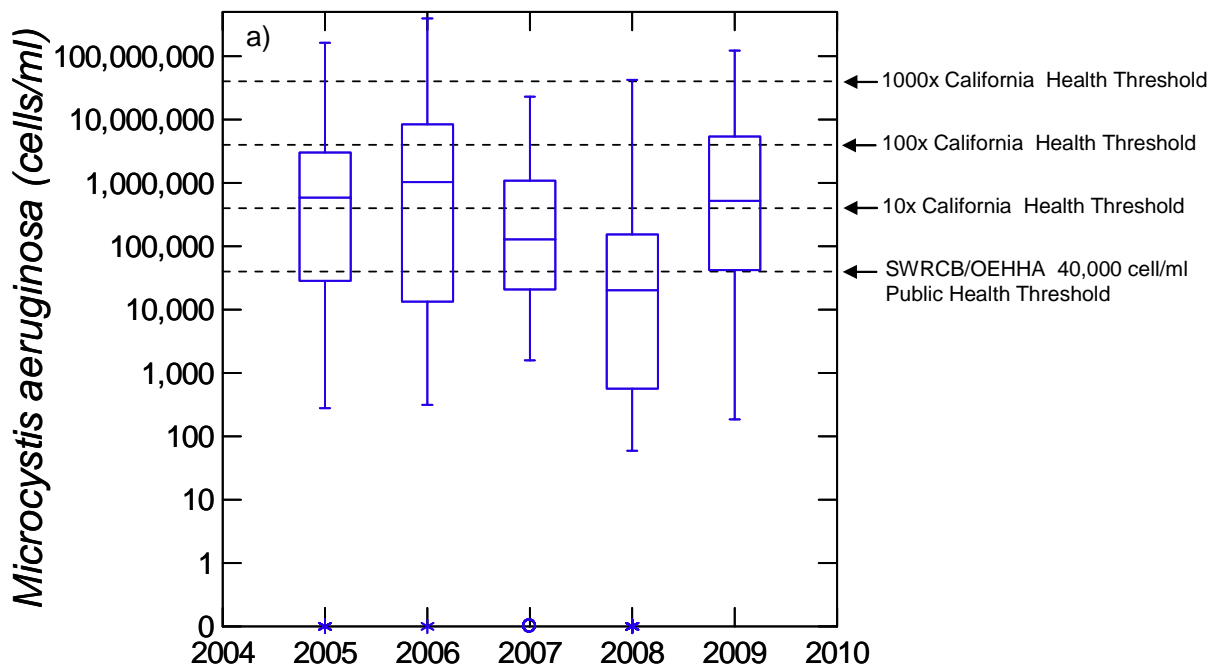
The overall microcystin distribution of both reservoirs combined (Figure 9.b) was also consistently higher than the previous two years (Figure 9a), and although the median was lower than 2005 and 2006, the upper quartile (top line of the box or 75<sup>th</sup> percentile in Figure 9a) was the highest of the 5 years (Figure 9.). Microcystin distribution in 2009 for the reservoirs individually also showed higher values than the previous two years, and although Copco was higher overall than 2005 and 2006, Iron Gate was more similar to those years. The overall distribution of microcystin toxin concentration tended to be lower in Iron Gate Reservoir than in Copco Reservoir in all years (Figure 9.b).

### ***MSAE Cell Density-Microcystin Concentration Relationships***

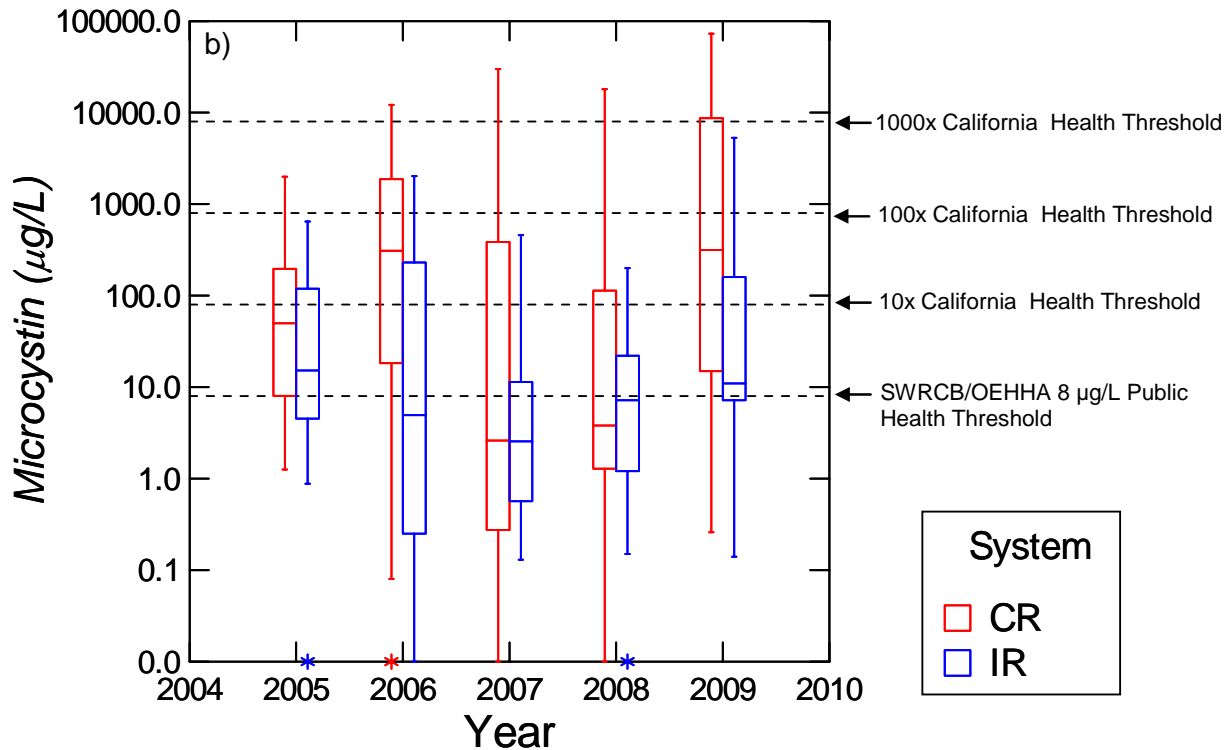
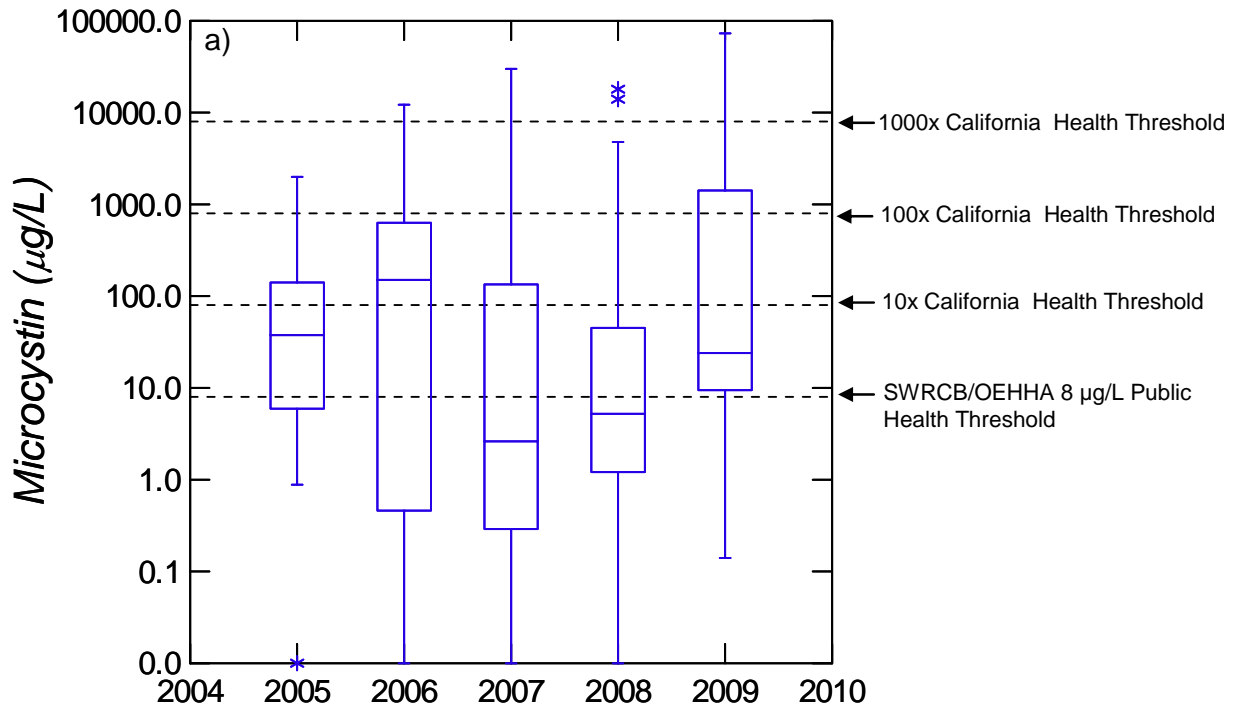
As noted previously, the relationship between MSAE cell density and microcystin toxin is variable, particularly when low or zero levels of MSAE are associated with high microcystin levels or with changing microcystin to cell ratios noted above. However, despite this variability and similar to plots produced for past years (Kann and Corum 2009) a scatter plot of 2009 data fitted with a distance weighted least squares smoother (DWLS) shows a general increasing trend of toxin concentration with cell density (Figure 10). As noted above, data points along the y-axis depict instances of microcystin detection when MSAE cells were not detected. As expected based on ratios of microcystin per unit cell density that did not decline during the fall months of 2009, these months fit the general trend (Figure 10; solid red circles).

The 2009 relationship of MSAE cell density vs. microcystin relative to public health thresholds continues to indicate that the majority of 8 µg/L microcystin exceedances occurred at MSAE levels greater than 40,000 cells/ml (upper right quadrant black dashed line; Figure 10). However, there were also several exceedances of 8 µg/L when MSAE cell density was less than 40,000 cells/ml (upper left quadrant: Figure 10). This is consistent with expectations based upon variable toxin production and presence of non-cell bound toxin as described in Kann and Corum (2009). These relationships continue to indicate that generally (but not always) the SWRCB/OEHHA guideline value for MSAE density is protective of the 8 µg/L microcystin moderate probability of adverse health effect threshold.

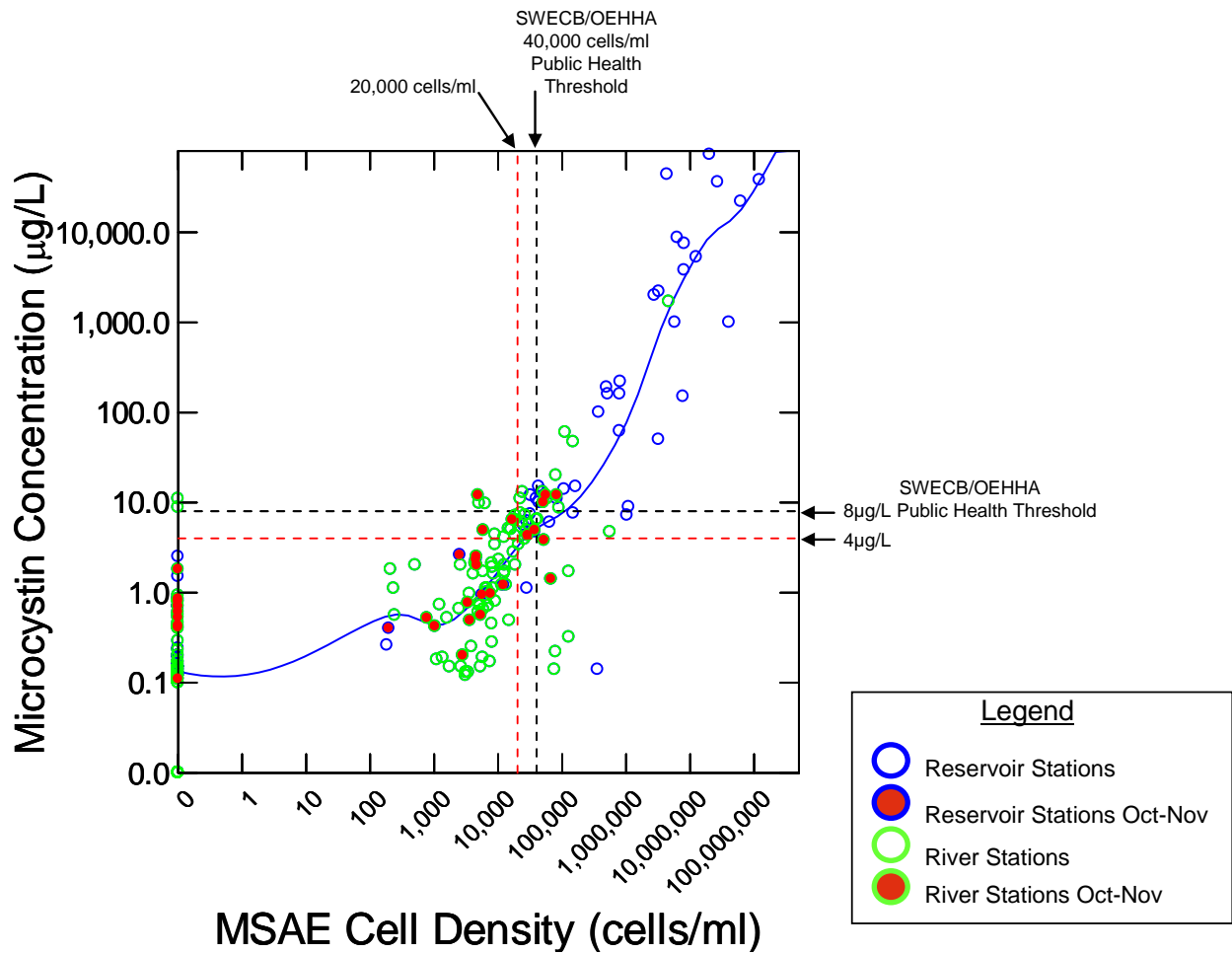
Further evaluation of the relationship between MSAE cell density and microcystin concentration was performed using the World Health Organization low probability of adverse health effect



**Figure 8. Inter annual comparison of MSAE cell density for standard reservoir stations (a) and Copco and Iron Gate Reservoirs individually (b) July through October 2005-2009. All data for reservoir and KRBI-SG stations were provided by PacifiCorp ([www.pacificorp.com/es/hydro/hl/kr.html](http://www.pacificorp.com/es/hydro/hl/kr.html)).**



**Figure 9. Inter annual comparison of microcystin concentration for standard reservoir stations (a) and Copco and Iron Gate Reservoirs individually (b) July through October 2005-2009. All data for reservoir and KRBI-SG stations were provided by PacifiCorp ([www.pacificorp.com/es/hydro/hl/kr.html](http://www.pacificorp.com/es/hydro/hl/kr.html)).**



**Figure 10. Relationship between MSAE cell density and microcystin toxin concentration; shown with distance weighted least squares (DWLS) smoother applied to all data, 2009. Data for reservoir and KRBI-SG stations were provided by PacifiCorp ([www.pacificorp.com/es/hydro/hl/kr.html](http://www.pacificorp.com/es/hydro/hl/kr.html)).**



guideline values of 20,000 cells/ml MSAE and 4 µg/L microcystin (red dashed line Figure 10). Whereas the SWRCB/OEHHA guidelines are considered to protect against a moderate probability of adverse effects, this lower threshold is utilized by the CA North Coast Regional Water Quality Control Board (NCRWQCB) for Total Maximum Daily Load calculations that are expected to further reduce the probability of adverse levels that can impact public health. These evaluations indicate that the more conservative level of 20,000 cells/ml MSAE decreases the frequency of exceeding the 8 µg/L public health guideline value for microcystin (compare upper right quadrants based on black and red dashed lines; Figure 10). A similar trend is noted when data for the entire 2005-2009 period are plotted (Figure 11).

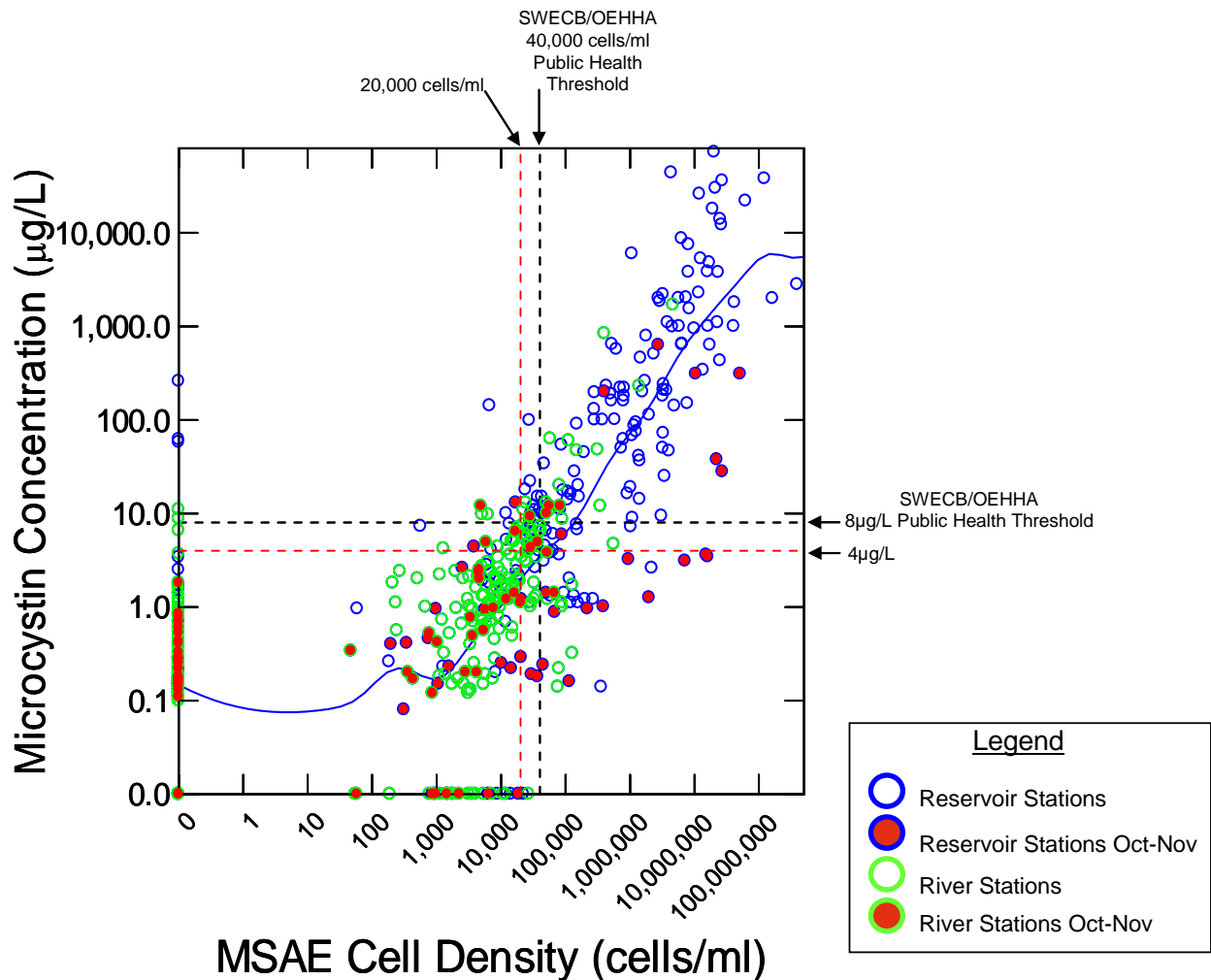


Figure 11. Relationship between MSAE cell density and microcystin toxin concentration for standard reservoir and river stations 2005-2009. Data for reservoir and KRBI-SG stations were provided by PacifiCorp ([www.pacificorp.com/es/hydro/hl/kr.html](http://www.pacificorp.com/es/hydro/hl/kr.html)).

## SUMMARY

Middle Klamath River sampling in 2009 continued to show widespread and high abundance of toxigenic MSAE from July-September, exceeding public health thresholds by numerous times during these months. River stations downstream from Copco and Iron Gate Reservoirs showed levels of both MSAE and microcystin toxin that were lower relative to the reservoir stations; however, on numerous occasions river samples taken in the mixed portion of the channel exceeded the threshold guideline values of 40,000 cells/ml MSAE or 8 µg/L microcystin. Similar to 2008, samples taken in areas of low velocity in Klamath River edge habitat in 2009 showed that MSAE cell density and microcystin concentration were often higher than the open water samples, and more frequently exceeded the 40,000 cells/ml MSAE and 8 µg/L microcystin public health guideline values. Public health exceedances were typically highest at Brown Bear (BB), but a microcystin value of 1700 µg/L was observed at KRBI on 8/3/2009. As in 2008, from a public health perspective these data illustrate that low MSAE or toxin values in open-water (collected in mixed areas of higher velocity) Klamath River samples often translates to values exceeding public health thresholds in river-edge areas.

The ratio of toxin produced per unit MSAE showed that unlike some previous years, 2009 ratios did not show a sharp decline in September or October, and of the five years of record, the ratio of toxin produced per unit MSAE in 2009 ranked among the highest for July, September and October.

A comparison of 2009 data with 2005-2008 data showed generally higher MSAE and microcystin concentrations than the previous two years, and similar concentrations to 2005 and 2006 for both the reservoirs as a whole and for Copco and Iron Gate individually. Of the 5 year period of record, 2008 showed the lowest MSAE distribution both on a combined basis and for reservoirs individually. Aside from 2005 when Copco and Iron Gate showed similar MSAE levels, Iron Gate reservoir had lower overall MSAE densities than Copco Reservoir. Although median microcystin in 2009 was lower than 2005 and 2006, the upper quartile was the highest of the 5 years. The overall distribution of microcystin toxin concentration tended to be lower for Iron Gate Reservoir than for Copco Reservoir in all years.

Similar to relationships indicated for past years, a scatter plot of 2009 data showed a general increasing trend of toxin concentration with cell density. The 2009 relationship of MSAE cell density vs. microcystin relative to public health thresholds continues to indicate that the majority of 8 µg/L microcystin exceedances occurred at MSAE levels greater than 40,000 cells/ml. However, consistent with expectations based upon variable toxin production and presence of non-cell bound toxin there were also several exceedances of 8 µg/L when MSAE cell density was less than 40,000 cells/ml. The data plots indicate that a level of 20,000 cells/ml MSAE further decreases the frequency of exceeding the 8 µg/L public health guideline value for microcystin.

### ***Disclaimer***

*Due to the patchy nature of blue-green algal blooms it is possible for higher Microcystis aeruginosa densities (and therefore higher microcystin toxin concentrations) to have been present in locations not covered in this survey, particularly along shorelines or protected coves and backwaters during calm conditions of little to no wind. Recreational users should always avoid contact with water whenever noticeable surface concentrations of algae are evident. Moreover, because pets or other domestic animals are the most likely to ingest contaminated water, these animals should not be allowed access to areas of either noticeable surface concentrations of algae or when an obvious green to blue-green appearance is evident.*

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## APPENDIX I : Cell Density and cyanotoxin concentration for the Middle Klamath River, 2009.

BM: Baseline Monitoring

PH: Public Health Sample

SG: Surface grab-sampling near shoreline region of low mixing

OC: Sampling near mid-channel mixed region

Date	Station Name	RM	Sample Event	Station Description	Depth	<i>Microcystis aeruginosa</i> (cells/ml)	<i>Planktothrix (Oscillatoria) sp.</i> (cells/ml)	<i>Anabaena sp.</i> (cells/ml)	Microcystin Total (µg/L)	Exceedance of SWRCB <sup>1</sup> risk level of 40,000 cells/ml <i>Microcystis</i> or <i>Planktothrix</i> (x greater than 4 <sup>5</sup> cells/ml)	Exceedance of microcystin TDI of 0.04 µg/kg/day for a 20kg (44lb) child ingesting 100 mls <sup>2</sup> (x greater than TDI)
5/14/09	IG (KRBI)	190	PH	Below Iron Gate	OC	0	0	0	missing	0.0	
5/14/09	WA	157	PH	Walker Bridge	OC	0	0	0	0.13	0.0	0.0
5/14/09	SV	129	PH	Seaid Valley	OC	0	0	0	0.11	0.0	0.0
5/14/09	OR	59	PH	Orleans	OC	0	0	0	0.16	0.0	0.0
5/14/09	SA	0	PH	Mouth of Salmon River	OC	0	0	0	0.13	0.0	0.0
5/14/09	SC	0	PH	Mouth of Scott River	OC	0	0	0	0.11	0.0	0.0
5/14/09	SH	0	PH	Mouth of Shasta River	OC	0	0	0	0.12	0.0	0.0
5/28/09	WA	157	PH	Walker Bridge	OC	0	0	0	0.12	0.0	0.0
5/28/09	SV	129	PH	Seaid Valley	OC	0	0	0	0.14	0.0	0.0
5/28/09	HC	108	PH	Happy Camp	OC	0	0	0	0.14	0.0	0.0
5/28/09	OR	59	PH	Orleans	OC	0	0	0	missing	0.0	
5/28/09	SC	0	PH	Mouth of Scott River	OC	0	0	0	0.19	0.0	0.0
5/28/09	SA	0	PH	Mouth of Salmon River	OC	0	0	0	0.12	0.0	0.0
5/28/09	SH	0	PH	Mouth of Shasta River	OC	0	0	0	0.16	0.0	0.0
6/11/09	IG (KRBI)	190	PH	Below Iron Gate	OC	0	0	495	nd	0.0	0.0
6/11/09	WA	157	PH	Walker Bridge	OC	0	0	251		0.0	
6/11/09	BB	150	PH	Brown Bear River Access	SG <sup>4</sup>	0	0	0	nd	0.0	0.0
6/11/09	SV	129	PH	Seaid Valley	SG	0	0	48	nd	0.0	0.0
6/11/09	SV	129	PH	Seaid Valley	OC	0	0	0	nd	0.0	0.0
6/11/09	SD	129	PH	Seaid Valley Dup	OC	0	0	0	nd	0.0	0.0



Date	Station Name	RM	Sample Event	Station Description	Depth	<i>Microcystis aeruginosa</i> (cells/ml)	<i>Planktothrix (Oscillatoria) sp.</i> (cells/ml)	<i>Anabaena sp.</i> (cells/ml)	Microcystin Total (µg/L)	Exceedance of SWRCB <sup>1</sup> risk level of 40,000 cells/ml <i>Microcystis</i> or <i>Planktothrix</i> (x greater than 4 <sup>5</sup> cells/ml)	Exceedance of microcystin TDI of 0.04 µg/kg/day for a 20kg (44lb) child ingesting 100 mls <sup>2</sup> (x greater than TDI)
6/11/09	HC	108	PH	Happy Camp	SG	0	0	0	0.11	0.0	0.0
6/11/09	OR	59	PH	Orleans	OC	0	0	0	nd	0.0	0.0
6/11/09	OR	59	PH	Orleans	SG	0	0	0	0.10	0.0	0.0
6/11/09	SC	0	PH	Mouth of Scott River	OC	0	0	0	0.09	0.0	0.0
6/11/09	SA	0	PH	Mouth of Salmon River	OC	0	0	0	nd	0.0	0.0
6/11/09	SH	0	PH	Mouth of Shasta River	OC	0	0	0	nd	0.0	0.0
6/25/09	IG (KRBI)	190	PH	Below Iron Gate	OC	289	0	94		0.0	
6/25/09	WA	157	PH	Walker Bridge	OC	0	0	130	nd	0.0	0.0
6/25/09	BB	150	PH	Brown Bear River Access	SG	0	0	20	nd	0.0	0.0
6/25/09	SV	129	PH	Seaid Valley	SG	0	0	0	nd	0.0	0.0
6/25/09	SD	129	PH	Seaid Valley Dup	SG	0	0	0	nd	0.0	0.0
6/25/09	SV	129	PH	Seaid Valley	OC	0	30	0	nd	0.0	0.0
6/25/09	SD	129	PH	Seaid Valley Dup	OC	0	0	0	nd	0.0	0.0
6/25/09	HC	108	PH	Happy Camp	OC	0	0	0	nd	0.0	0.0
6/25/09	HC	108	PH	Happy Camp	SG	0	0	0	0.09	0.0	0.0
6/25/09	OR	59	PH	Orleans	SG	0	0	0	nd	0.0	0.0
6/25/09	OR	59	PH	Orleans	OC	0	0	0	0.11	0.0	0.0
6/25/09	SC	0	PH	Mouth of Scott River	OC	0	0	0	0.09	0.0	0.0
6/25/09	SA	0	PH	Mouth of Salmon River	OC	0	0	0	nd	0.0	0.0
6/25/09	SH	0	PH	Mouth of Shasta River	OC	0	0	0	nd	0.0	0.0
7/9/09	IG (KRBI)	190	PH	Below Iron Gate	OC	235	0	0	1.10	0.0	0.1
7/9/09	WA	157	PH	Walker Bridge	OC	0	0	0	0.39	0.0	0.0
7/9/09	BB	150	PH	Brown Bear River Access	SG	0	0	0	0.79	0.0	0.1
7/9/09	SV	129	PH	Seaid Valley	SG	0	0	0	0.14	0.0	0.0

Date	Station Name	RM	Sample Event	Station Description	Depth	<i>Microcystis aeruginosa</i> (cells/ml)	<i>Planktothrix (Oscillatoria) sp.</i> (cells/ml)	<i>Anabaena sp.</i> (cells/ml)	Microcystin Total (µg/L)	Exceedance of SWRCB <sup>1</sup> risk level of 40,000 cells/ml <i>Microcystis</i> or <i>Planktothrix</i> (x greater than 4 <sup>5</sup> cells/ml)	Exceedance of microcystin TDI of 0.04 µg/kg/day for a 20kg (44lb) child ingesting 100 mls <sup>2</sup> (x greater than TDI)
7/9/09	SV	129	PH	Seaid Valley	OC	0	0	0	0.19	0.0	0.0
7/9/09	HC	108	PH	Happy Camp	SG	0	0	0	nd	0.0	0.0
7/9/09	OR	59	PH	Orleans	SG	0	0	0	nd	0.0	0.0
7/9/09	OR	59	PH	Orleans	OC	0	0	0	nd	0.0	0.0
7/9/09	SC	0	PH	Mouth of Scott River	OC	0	0	0	nd	0.0	0.0
7/9/09	SA	0	PH	Mouth of Salmon River	OC	0	0	0	nd	0.0	0.0
7/9/09	SH	0	PH	Mouth of Shasta River	OC	0	0	0	nd	0.0	0.0
7/22/09	OR	59	PH	Orleans	OC	0	0	215	0.22	0.0	
7/22/09	IB	176	PH	IB (I5 Bridge)	OC	5,941	0	0	0.64	0.1	
7/22/09	SV	129	PH	Seaid Valley	OC	0	0	0	0.12	0.0	
7/22/09	SV	129	PH	Seaid Valley	SG	0	0	0	0.31	0.0	
7/22/09	BB	150	PH	Brown Bear River Access	OC	3,157	0	0	0.12	0.1	
7/22/09	HC	108	PH	Happy Camp	OC	1,756	0	0	0.14	0.0	
7/23/09	WA	157	PH	Walker Bridge	OC	1,114	0	0	0.17	0.0	0.0
7/23/09	BB	150	PH	Brown Bear River Access	SG	210	0	0	1.80	0.0	0.2
7/23/09	SV	129	PH	Seaid Valley	SG	0	0	0	0.56	0.0	0.1
7/23/09	SD	129	PH	Seaid Valley Dup	SG	0	0	0	0.31	0.0	0.0
7/23/09	SV	129	PH	Seaid Valley	OC	1,374	0	0	0.18	0.0	0.0
7/23/09	SD	129	PH	Seaid Valley Dup	OC	1,516	0	0	0.15	0.0	0.0
7/23/09	HC	108	PH	Happy Camp	OC	0	0	0	0.16	0.0	0.0
7/23/09	HC	108	PH	Happy Camp	SG	1,232	0	0	0.72	0.0	0.1
7/23/09	OR	59	PH	Orleans	SG	0	0	0	0.11	0.0	0.0
7/23/09	OR	59	PH	Orleans	OC	0	0	0	0.13	0.0	0.0
7/23/09	SC	0	PH	Mouth of Scott River	OC	0	0	0	0.12	0.0	0.0
7/23/09	SA	0	PH	Mouth of Salmon River	OC	0	0	0	0.09	0.0	0.0

Date	Station Name	RM	Sample Event	Station Description	Depth	<i>Microcystis aeruginosa</i> (cells/ml)	<i>Planktothrix (Oscillatoria) sp.</i> (cells/ml)	<i>Anabaena sp.</i> (cells/ml)	Microcystin Total (µg/L)	Exceedance of SWRCB <sup>1</sup> risk level of 40,000 cells/ml <i>Microcystis</i> or <i>Planktothrix</i> (x greater than 4 <sup>5</sup> cells/ml)	Exceedance of microcystin TDI of 0.04 µg/kg/day for a 20kg (44lb) child ingesting 100 mls <sup>2</sup> (x greater than TDI)
7/23/09	SH	0	PH	Mouth of Shasta River	OC	0	0	0	1.00	0.0	0.1
8/6/09	IG (KRBI)	190	PH	Below Iron Gate	OC	8,569	0	0	1.60	0.2	0.2
8/6/09	WA	157	PH	Walker Bridge	OC	15,033	0	0	0.48	0.4	0.1
8/6/09	BB	150	PH	Brown Bear River Access	SG	561,700	0	0	4.70	14.0	0.6
8/6/09	SV	129	PH	Seaid Valley	SG	12,478	0	0	1.60	0.3	0.2
8/6/09	SV	129	PH	Seaid Valley	OC	8,026	0	96	0.44	0.2	0.1
8/6/09	HC	108	PH	Happy Camp	SG	8,120	0	0	0.27	0.2	0.0
8/6/09	OR	59	PH	Orleans	SG	5,256	0	0	0.70	0.1	0.1
8/6/09	OR	59	PH	Orleans	OC	1,611	0	0	0.51	0.0	0.1
8/6/09	SC	0	PH	Mouth of Scott River	OC	0	0	0	nd	0.0	0.0
8/6/09	SA	0	PH	Mouth of Salmon River	OC	0	0	0	0.11	0.0	0.0
8/6/09	SH	0	PH	Mouth of Shasta River	OC	0	0	0	nd	0.0	0.0
8/13/09	IB	176	PH	IB (I5 Bridge)	SG	12,695	0	0	2.00	0.3	0.3
8/13/09	BB	150	PH	Brown Bear River Access	SG	128,535	0	0	0.31	3.2	0.0
8/13/09	SV	129	PH	Seaid Valley	SG	11,054	0	0		0.3	
8/13/09	SD	129	PH	Seaid Valley Dup	SG	10,022	0	0	2.20	0.3	0.3
8/13/09	HC	108	PH	Happy Camp	SG	26,113	0	0	3.90	0.7	0.5
8/13/09	OR	59	PH	Orleans	SG	9,020	0	133	3.40	0.2	0.4
8/19/09	IB	176	BM	IB (I5 Bridge)	OC	7,517	0	0	0.16	0.2	0.0
8/19/09	BB	150	BM	Brown Bear River Access	OC	5,384	0	0	0.14	0.1	0.0
8/19/09	SV	129	BM	Seaid Valley	OC	2,678	0	0	0.14	0.1	0.0
8/19/09	HC	108	BM	Happy Camp	OC	3,116	0	0	0.11	0.1	0.0
8/19/09	OR	59	BM	Orleans	OC	3,447	0	0	0.12	0.1	0.0
8/20/09	WA	157	PH	Walker Bridge	OC	5,790	0	0	0.18	0.1	0.0
8/20/09	BB	150	PH	Brown Bear River Access	SG	128,857	0	0	1.70	3.2	0.2

Date	Station Name	RM	Sample Event	Station Description	Depth	<i>Microcystis aeruginosa</i> (cells/ml)	<i>Planktothrix (Oscillatoria) sp.</i> (cells/ml)	<i>Anabaena sp.</i> (cells/ml)	Microcystin Total (µg/L)	Exceedance of SWRCB <sup>1</sup> risk level of 40,000 cells/ml <i>Microcystis</i> or <i>Planktothrix</i> (x greater than 4 <sup>5</sup> cells/ml)	Exceedance of microcystin TDI of 0.04 µg/kg/day for a 20kg (44lb) child ingesting 100 ml <sup>2</sup> (x greater than TDI)
8/20/09	SV	129	PH	Seaid Valley	SG	0	0	0	0.92	0.0	0.1
8/20/09	SD	129	PH	Seaid Valley Dup	SG	93,779	0	0		2.3	
8/20/09	SV	129	PH	Seaid Valley	OC	6,663	0	0	0.85	0.2	0.1
8/20/09	SD	129	PH	Seaid Valley Dup	OC	11,275	0	0	0.51	0.3	0.1
8/20/09	HC	108	PH	Happy Camp	OC	3,880	0	0	0.24	0.1	0.0
8/20/09	HC	108	PH	Happy Camp	SG	0	0	0	0.28	0.0	0.0
8/20/09	OR	59	PH	Orleans	SG	5,135	0	0	0.75	0.1	0.1
8/20/09	OR	59	PH	Orleans	OC	244	0	0	0.55	0.0	0.1
8/20/09	SC	0	PH	Mouth of Scott River	OC	0	0	35	nd	0.0	0.0
8/20/09	SA	0	PH	Mouth of Salmon River	OC	0	0	0	nd	0.0	0.0
8/20/09	SH	0	PH	Mouth of Shasta River	OC	0	0	916	nd	0.0	0.0
8/27/09	IB	176	PH	IB (I5 Bridge)	SG	6,807	0	0	1.10	0.2	0.1
8/27/09	BB	150	PH	Brown Bear River Access	SG	112,750	0	0	60.00	2.8	7.5
8/27/09	SV	129	PH	Seaid Valley	SG	5,875	0	0	1.70	0.1	0.2
8/27/09	SD	129	PH	Seaid Valley Dup	SG	5,074	0	0	1.40	0.1	0.2
8/27/09	HC	108	PH	Happy Camp	SG	3,602	0	0	0.96	0.1	0.1
8/27/09	OR	59	PH	Orleans	SG	9,099	0	165	0.79	0.2	0.1
9/3/09	IG (KRBI)	190	PH	Below Iron Gate	OC	22,550	0	0	7.60	0.6	1.0
9/3/09	IB	176	PH	IB (I5 Bridge)	SG	13,463	0	0	1.20	0.3	0.2
9/3/09	WA	157	PH	Walker Bridge	OC	79,762	0	0	0.21	2.0	0.0
9/3/09	BB	150	PH	Brown Bear River Access	SG	81,146	0	0	20.00	2.0	2.5
9/3/09	SV	129	PH	Seaid Valley	SG	8,443	0	0	1.10	0.2	0.1
9/3/09	SD	129	PH	Seaid Valley Dup	SG	5,785	0	0	0.96	0.1	0.1
9/3/09	SV	129	PH	Seaid Valley	OC	6,500	0	0	1.10	0.2	0.1
9/3/09	SD	129	PH	Seaid Valley	OC	4,997	0	0	0.73	0.1	0.1

Date	Station Name	RM	Sample Event	Station Description	Depth	<i>Microcystis aeruginosa</i> (cells/ml)	<i>Planktothrix (Oscillatoria) sp.</i> (cells/ml)	<i>Anabaena sp.</i> (cells/ml)	Microcystin Total (µg/L)	Exceedance of SWRCB <sup>1</sup> risk level of 40,000 cells/ml <i>Microcystis</i> or <i>Planktothrix</i> (x greater than 4 <sup>5</sup> cells/ml)	Exceedance of microcystin TDI of 0.04 µg/kg/day for a 20kg (44lb) child ingesting 100 ml <sup>2</sup> (x greater than TDI)
				Dup							
9/3/09	HC	108	PH	Happy Camp	SG	11,517	0	0	1.20	0.3	0.2
9/3/09	OR	59	PH	Orleans	SG	2,487	0	0	0.65	0.1	0.1
9/3/09	OR	59	PH	Orleans	OC	7,103	0	0	0.70	0.2	0.1
9/3/09	SC	0	PH	Mouth of Scott River	OC	0	0	54	nd	0.0	0.0
9/3/09	SA	0	PH	Mouth of Salmon River	OC	0	0	0	nd	0.0	0.0
9/3/09	SH	0	PH	Mouth of Shasta River	OC	0	107	0	nd	0.0	0.0
9/10/09	IB	176	PH	IB (I5 Bridge)	SG	18,613	0	0	6.40	0.5	0.8
9/10/09	BB	150	PH	Brown Bear River Access	SG	150,119	0	0	47.00	3.8	5.9
9/10/09	SV	129	PH	Seaid Valley	SG	14,734	0	0	5.10	0.4	0.6
9/10/09	SD	129	PH	Seaid Valley Dup	SG	15,869	0	0	2.20	0.4	0.3
9/10/09	HC	108	PH	Happy Camp	SG	23,686	0	0	6.00	0.6	0.8
9/10/09	OR	59	PH	Orleans	SG	10,385	0	0	2.30	0.3	0.3
9/16/09	IB	176	BM	IB (I5 Bridge)	OC	24,241	0	0	13	0.6	1.6
9/16/09	BB	150	BM	Brown Bear River Access	OC	18,792	0	0	7	0.5	0.9
9/16/09	SV	129	BM	Seaid Valley	OC	12,576	0	0	4	0.3	0.5
9/16/09	HC	108	BM	Happy Camp	OC	8,080	0	0	2	0.2	0.3
9/16/09	OR	59	BM	Orleans	OC	4,147	0	0	1.60	0.1	0.2
9/17/09	WA	157	PH	Walker Bridge	OC	28,151	0	0	4.90	0.7	0.6
9/17/09	BB	150	PH	Brown Bear River Access	SG	41,696	0	0	6.50	1.0	0.8
9/17/09	SV	129	PH	Seaid Valley	SG	40,207	0	0	6.40	1.0	0.8
9/17/09	SV	129	PH	Seaid Valley	OC	26,581	0	0	7.20	0.7	0.9
9/17/09	SD	129	PH	Seaid Valley Dup	OC	21,476	301	0	6.50	0.5	0.8
9/17/09	HC	108	PH	Happy Camp	OC	4,412	0	0	2.10	0.1	0.3
9/17/09	HC	108	PH	Happy Camp	SG	12,836	0	0	1.70	0.3	0.2

Date	Station Name	RM	Sample Event	Station Description	Depth	<i>Microcystis aeruginosa</i> (cells/ml)	<i>Planktothrix (Oscillatoria)</i> sp. (cells/ml)	<i>Anabaena</i> sp. (cells/ml)	Microcystin Total (µg/L)	Exceedance of SWRCB <sup>1</sup> risk level of 40,000 cells/ml <i>Microcystis</i> or <i>Planktothrix</i> (x greater than 4 <sup>5</sup> cells/ml)	Exceedance of microcystin TDI of 0.04 µg/kg/day for a 20kg (44lb) child ingesting 100 mls <sup>2</sup> (x greater than TDI)
9/17/09	OR	59	PH	Orleans	SG	6,742	0	0	1.00	0.2	0.1
9/17/09	OR	59	PH	Orleans	OC	4,970	0	0	0.60	0.1	0.1
9/17/09	SC	0	PH	Mouth of Scott River	OC	0	0	0	nd	0.0	0.0
9/17/09	SA	0	PH	Mouth of Salmon River	OC	0	0	0	0.10	0.0	0.0
9/17/09	SH	0	PH	Mouth of Shasta River	OC	0	0	0	nd	0.0	0.0
9/24/09	IB	176	PH	IB (I5 Bridge)	SG	17,567	0	0	2.80	0.4	0.4
9/24/09	BB	150	PH	Brown Bear River Access	SG	21,130	0	0	3.40	0.5	0.4
9/24/09	SV	129	PH	Seaid Valley	SG	18,488	0	0	4.30	0.5	0.5
9/24/09	SD	129	PH	Seaid Valley Dup	SG	8,032	0	0	4.70	0.2	0.6
9/24/09	HC	108	PH	Happy Camp	SG	58,900	0	0	11.00	1.5	1.4
9/24/09	OR	59	PH	Orleans	SG	30,668	0	226	5.60	0.8	0.7
10/1/09	IG (KRBI)	190	PH	Below Iron Gate	OC	37,583	0	0	4.90	0.9	0.6
10/1/09	WA	157	PH	Walker Bridge	OC	51,401	0	0	10.00	1.3	1.3
10/1/09	BB	150	PH	Brown Bear River Access	SG	56,246	0	0	12.00	1.4	1.5
10/1/09	SV	129	PH	Seaid Valley	SG	83,310	0	0	12.00	2.1	1.5
10/1/09	SV	129	PH	Seaid Valley	OC	67,650	0	0	1.40	1.7	0.2
10/1/09	HC	108	PH	Happy Camp	SG	29,245	0	0	4.30	0.7	0.5
10/1/09	OR	59	PH	Orleans	SG	52,713	0	0	3.80	1.3	0.5
10/1/09	OR	59	PH	Orleans	OC	16,837	0	0	6.40	0.4	0.8
10/1/09	SC	0	PH	Mouth of Scott River	OC	0	14	0	0.10	0.0	0.0
10/1/09	SA	0	PH	Mouth of Salmon River	OC	0	0	0	nd	0.0	0.0
10/1/09	SH	0	PH	Mouth of Shasta River	OC	0	0	0	nd	0.0	0.0
10/13/09	IB	176	BM	IB (I5 Bridge)	OC	0	0	0	1.80	0.0	0.2
10/13/09	BB	150	BM	Brown Bear River Access	SG	1,607	0	0		0.0	



Date	Station Name	RM	Sample Event	Station Description	Depth	<i>Microcystis aeruginosa</i> (cells/ml)	<i>Planktothrix (Oscillatoria) sp.</i> (cells/ml)	<i>Anabaena sp.</i> (cells/ml)	Microcystin Total (µg/L)	Exceedance of SWRCB <sup>1</sup> risk level of 40,000 cells/ml <i>Microcystis</i> or <i>Planktothrix</i> (x greater than 4 <sup>5</sup> cells/ml)	Exceedance of microcystin TDI of 0.04 µg/kg/day for a 20kg (44lb) child ingesting 100 ml <sup>2</sup> (x greater than TDI)
10/13/09	BB	159	BM	Brown Bear River Access	OC	4,902	0	0	12.00	0.1	1.5
10/13/09	SV	129	BM	Seaid Valley	SG	1,411	0	0		0.0	
10/13/09	SV	130	BM	Seaid Valley	OC	5,895	0	0	4.90	0.1	0.6
10/13/09	HC	108	BM	Happy Camp	SG	593	0	0		0.0	
10/13/09	HC	109	BM	Happy Camp	OC	4,626	0	0	2.50	0.1	0.3
10/13/09	OR	58	BM	Orleans	OC	4,658	0	0	2.00	0.1	0.3
10/13/09	OR	59	BM	Orleans	SG	1,025	0	0		0.0	
10/15/09	WA	157	PH	Walker Bridge	OC	7,708	0	0	0.96	0.2	0.1
10/15/09	BB	150	PH	Brown Bear River Access	SG	0	0	0	0.79	0.0	0.1
10/15/09	SV	129	PH	Seaid Valley	SG	0	0	0	0.60	0.0	0.1
10/15/09	SV	129	PH	Seaid Valley	OC	0	0	0	0.42	0.0	0.1
10/15/09	SD	129	PH	Seaid Valley Dup	OC	1,720	0	0	0.88	0.0	0.1
10/15/09	HC	108	PH	Happy Camp	OC	778	0	0	0.51	0.0	0.1
10/15/09	HC	108	PH	Happy Camp	SG	0	0	0	0.84	0.0	0.1
10/15/09	OR	59	PH	Orleans	SG	0	0	0	0.70	0.0	0.1
10/15/09	OR	59	PH	Orleans	OC	0	0	0	0.40	0.0	0.1
10/15/09	SC	0	PH	Mouth of Scott River	OC	451	0	0	0.09	0.0	0.0
10/15/09	SA	0	PH	Mouth of Salmon River	OC	0	0	0	0.09	0.0	0.0
10/15/09	SH	0	PH	Mouth of Shasta River	OC	0	0	0	0.09	0.0	0.0
10/26/09	IB	176	PH	IB (I5 Bridge)	OC	3,393	0	0	0.76	0.1	0.1
10/26/09	BB	150	PH	Brown Bear River Access	OC	3,649	0	0	0.48	0.1	0.1
10/26/09	SV	129	PH	Seaid Valley	OC	5,415	0	0	0.55	0.1	0.1
10/26/09	HC	108	PH	Happy Camp	OC	1,038	0	0	0.41	0.0	0.1
10/26/09	OR	59	PH	Orleans	OC	2,826	0	0	0.19	0.1	0.0
11/12/09	SC	0	PH	Mouth of Scott River	OC	0	0	47		0.0	

Date	Station Name	RM	Sample Event	Station Description	Depth	<i>Microcystis aeruginosa</i> (cells/ml)	<i>Planktothrix (Oscillatoria) sp.</i> (cells/ml)	<i>Anabaena sp.</i> (cells/ml)	Microcystin Total (µg/L)	Exceedance of SWRCB <sup>1</sup> risk level of 40,000 cells/ml <i>Microcystis</i> or <i>Planktothrix</i> (x greater than 4 <sup>5</sup> cells/ml)	Exceedance of microcystin TDI of 0.04 µg/kg/day for a 20kg (44lb) child ingesting 100 mls <sup>2</sup> (x greater than TDI)
11/12/09	HC	108	PH	Happy Camp	OC	783	0	0		0.0	
11/12/09	OR	59	PH	Orleans	OC	354	0	0		0.0	
12/10/09	SC	0	PH	Mouth of Scott River	OC	9	9	102		0.0	