Analysis of Microcystin in Resident Fish and Mussel Tissues in the Vicinity of the Klamath Hydroelectric Project in 2008

Prepared by

CH2M HILL Incorporated

Portland, Oregon

Prepared for

PacifiCorp Energy

Portland, Oregon

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CH2MHILL

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Executive Summary

This report provides the results of sampling conducted in 2008 for the presence of microcystin in tissues of resident fish and mussels in the vicinity of the Klamath Hydroelectric Project (Project) on the Klamath River in California and Oregon. The resident fish include yellow perch (*Perca flavescens*) and black crappie (*Pomoxis nigromaculatus*) from two Project reservoirs (i.e., Copco and Iron Gate), and rainbow trout (*Oncorhynchus mykiss*) from the Klamath River upstream and downstream of the reservoirs. The mussels include the Oregon floater (*Anodonta oregonensis*) and western ridge mussel (*Gonidea angulata*) from the Klamath River upstream and downstream of the reservoirs.

Field sampling collected a total of 272 fish tissue samples over four seasonal sampling events (i.e., May-June, July, September, and November), and 14 mussel tissue samples during one sampling event (November) during 2008. The fish tissue samples consisted of 38 rainbow trout samples from the Klamath River above Copco reservoir, 38 rainbow trout samples from the Klamath River below Iron Gate reservoir, 81 yellow perch samples from Copco reservoir, 85 yellow perch samples from Iron Gate reservoir, 11 crappie samples from Copco reservoir, and 19 crappie samples from Iron Gate reservoir. The mussel tissue samples consisted of two western ridge mussel samples from the Klamath River above Copco reservoir, and seven western ridge mussel and five Oregon floater samples from the Klamath River below Iron Gate reservoir.

The analysis of microcystin was conducted on filet (muscle) tissues from edible-sized resident fish specimens and composite samples of mussel specimens. The laboratory analysis of microcystin in the tissue samples was conducted by the State University of New York (SUNY) College of Environmental Science and Forestry (CESF) Laboratory in Syracuse, NY under the direction of Dr. Greg Boyer. Filet (muscle) tissues from edible-sized specimens were used to allow analysis results to be compared to literature-based guideline values for tolerable microcystin concentrations in freshwater fish tissues subject to potential human consumption.

The SUNY-CESF Laboratory determined that un-bound or "free" microcystin was not detected in any of the tissue samples analyzed by high performance liquid chromatography with mass spectral detection (LCMS). Microcystin also was not detected in additional analyses of the tissue samples using selected ion monitoring (SIM) mode to specifically enhance detection of the common and potentially most-toxic microcystin-LR and -LA congeners.

Ibelings and Chorus (2007) have proposed guideline values for the Tolerable Daily Intake (TDI) of microcystin-LR in freshwater "seafood". The non-detection results indicate that the tissue samples for all fish species across the four sampling events and the November mussel samples are less than the TDI guidance values and therefore would pose no unacceptable health risk from consumption.

Introduction

PacifiCorp Energy operates the Klamath Hydroelectric Project (Project) on the Klamath River in California and Oregon. In the California portion of the Project area, Project facilities include Iron Gate reservoir (located between about River Mile [RM] 190 and 196.8) and Copco reservoir (located between about RM 198.6 and 203.2). In recent years, blooms of the cyanobacteria (blue-green algae) *Microcystis aeruginosa* (MSAE) have occurred during the summer in Iron Gate and Copco reservoirs. MSAE has the capability to produce microcystin – a peptide substance that in sufficient quantity can have adverse health effects on animals including humans. As a result of the occurrence of these recent MSAE blooms, PacifiCorp and other entities have monitored MSAE and microcystin levels in the reservoirs and elsewhere in the Klamath River. This information has been used to facilitate decisions regarding California's voluntary guidance for posting health advisories in recreational waters related to cyanobacteria (SWRCB 2007).

This report provides the results of the analysis of the presence of microcystin in tissues of resident fish and mussels in the vicinity of the Project. The resident fish include yellow perch (*Perca flavescens*) and black crappie (*Pomoxis nigromaculatus*) from Copco and Iron Gate reservoirs, and rainbow trout (*Oncorhynchus mykiss*) from the Klamath River upstream and downstream of the reservoirs. The mussels include the Oregon floater (*Anodonta oregonensis*) and western ridge mussel (*Gonidea angulata*) from the Klamath River upstream and downstream of the reservoirs.

Fish tissue sample collection occurred on four occasions during 2008, including once in the spring (in May-June 2008) before the expected cyanobacteria bloom period, twice in summer (in July and September 2008) during the bloom period, and once in late fall (November 2008) after the bloom period. Mussel tissue sample collection occurred once in November 2008, since mussel tissue analysis was not an original task planned for this study but rather was added later in the study. This report provides results of the analysis of samples collected on each of these four occasions during 2008.

The analysis of microcystin was conducted on filet (muscle) tissues from edible-sized resident fish specimens and composite samples of mussel specimens. The laboratory analysis of microcystin in the 2008 fish and mussel tissue samples was conducted by the State University of New York (SUNY) College of Environmental Science and Forestry (CESF) Laboratory in Syracuse, NY under the direction of Dr. Greg Boyer. Filet (muscle) tissues from edible-sized specimens were used to allow analysis results to be compared to literature-based guideline values for tolerable microcystin concentrations in freshwater fish tissues subject to potential human consumption (see Discussion section).

Background

In recent years, sampling was conducted by PacifiCorp and others related to the occurrence of microcystin in the tissues of Klamath River biota (Fetcho 2006, Kann 2008, PacifiCorp

2008a, PacifiCorp 2008b, CH2M HILL 2009). Fetcho (2006) collected liver and muscle tissue samples from five Chinook salmon and two steelhead specimens taken from the Klamath River at or near Weitchpec (near RM 43) and from Iron Gate Hatchery (at RM 189) during September and October 2005. All Chinook salmon tissue samples (liver and muscle) collected by Fetcho (2006) did not contain detectable levels of microcystin. The two steelhead muscle samples collected by Fetcho (2006) also did not contain detectable levels of microcystin. The two steelhead liver samples (obtained from the river at Weitchpec) did contain detectable levels of microcystin of 0.17 and 0.54 µg/g, respectively (based on a method detection limit of 0.15 µg/g[1]).

CH2M HILL collected liver and muscle tissue samples from eleven adult Chinook salmon and eight adult steelhead specimens taken from various locations in the Klamath River during October 2007 (PacifiCorp 2008a, PacifiCorp 2008b, CH2M HILL 2009). Four Chinook salmon and two steelhead were obtained from angling in the lower Klamath River below the Trinity River from about River Mile (RM) 6 to RM 36. One steelhead and one Chinook salmon were obtained from angling in the middle Klamath River from about RM 75 to RM 143. Six Chinook salmon and five steelhead were obtained from collection at the Iron Gate Hatchery (near RM 189).

All Chinook salmon and steelhead tissue samples (liver and muscle) collected by CH2M HILL (2009) did not contain detectable levels of un-bound or "free" microcystin at the specified Method Detection Limit (MDL). CH2M HILL (2009) reported that the MDL varied with sample type and recovery from 0.09 to 0.24 µg/g on a dry weight[2] (dw) basis, with an average MDL of 0.13 µg/g dw. Correcting for sample moisture content (75 percent), the equivalent MDL on a wet weight[3] (ww) basis varied by sample from 0.02 to 0.06 µg/g ww, with an average MDL of 0.03 µg/g ww[4]. Following receipt of the laboratory results of the October 2007 fish tissue sample analyses, PacifiCorp reported the results to the California Environmental Protection Agency's Office of Environmental Health Hazard Assessment (OEHHA), Siskiyou County Department of Health, and the North Coast Regional Water Quality Control Board (PacifiCorp 2008a, PacifiCorp 2008b).

Kann (2008) reported on the concentrations of eight individual microcystin congeners[5] in three composite samples of liver, stomach, and muscle tissue from six juvenile Chinook salmon obtained at Iron Gate Hatchery in August 2007. The composite liver sample showed a detectable level of microcystin–LA, but not of the other seven congeners analyzed[6]. The composite stomach and muscle samples did not contain detectable levels of any of the eight

[1] Although not discussed by Fetcho (2006), it is assumed that this reported analytical detection limit of 0.15 µg/g is on a wet weight basis, whereby the weight of microcystin found in the analysis is divided by weight of the tissue, including the fraction of weight made up of the tissue's original water content.

[2] Dry weight is the weight of microcystin found in subsequent analysis divided by weight of the dried tissue which once contained it.

[3] Wet weight is the weight of microcystin found in analysis divided by weight of the tissue before water is removed by drying.

[4] To convert dry-weight concentrations to wet-weight concentrations, the dry-weight concentration is multiplied by a factor of 1 minus the percentage of moisture content expressed as a decimal.

[5] Congener is a term in chemistry that refers to one of many variants or configurations of a chemical structure. For example, more than 80 microcystin variants or congeners have been identified to date, although only a relative handful are prevalent in nature, including microcystin–LR, –YR, –RR, and –LA and their demethylated analogs. Microcystin-LR is among the most frequent and most toxic microcystin congeners.

[6] Kann (2008) included results from the analysis of eight congeners: microcystin–LA, –LF, –LR, –LW, –YR, –RR, and the demethylated analogs of microcystin–LR and –RR.

individual microcystin congeners detectable with the analytical method employed (Kann 2008).

Kann (2008) also reported on the concentrations of eight individual microcystin congeners in freshwater mussel tissue samples obtained from the Klamath River in July and November 2007. One composite sample of whole mussel tissue (a composite of 13 individual mussel specimens) taken in July 2007 from the Klamath River near Seiad Valley (at RM 129) showed a detectable level of microcystin–LA, but not of the other seven congeners. Four individual mussel samples taken in July 2007 from the Klamath River at Big Bar (near RM 51), near Seiad Valley (at RM 129), and near the Klamath Highway Rest Area (at RM 178) showed detectable levels of three to five microcystin congeners (of the eight microcystin congeners analyzed). Fifteen individual mussel samples taken in November 2007 from the Klamath River near Orleans (at RM 59), near Happy Camp (at RM 108), near Seiad Valley (at RM 129), at the Brown Bear River Access (at RM 157.5), and near the Klamath Highway Rest Area (at RM 178) did not contain detectable levels of total microcystin or any of the eight microcystin congeners analyzed.

Kann (2008) further reported on the concentrations of eight individual microcystin congeners analyzed in muscle and liver tissue samples of yellow perch (*Perca flavescens*) obtained in September 2007 from Iron Gate and Copco reservoirs. Muscle tissue samples ("filets") from 36 yellow perch specimens were analyzed – 18 specimens from each reservoir. Twenty-four of the 36 yellow perch muscle tissue samples showed detectable levels of the demethylated analog[7] of the microcystin–LR congener (i.e., -LR-DM), and 16 of the 36 muscle samples showed detectable levels of the microcystin–YR congener. The 36 muscle samples did not contain detectable levels of the other microcystin congeners analyzed.

Liver tissue samples from six yellow perch specimens were analyzed – three specimens from each reservoir (Kann 2008). Five of the 6 yellow perch liver tissue samples showed detectable levels of the microcystin–LA congener and the demethylated analog of the microcystin–RR congener (i.e., -RR-DM). Three of the six yellow perch liver tissue samples showed detectable levels of the demethylated analog of the microcystin–LR congener (i.e., -LR-DM), and one liver tissue sample had detectable levels of the microcystin–RR congener. The six liver samples did not contain detectable levels of the other microcystin congeners analyzed.

[7] The demethylated analog is a variant of a particular microcystin congener in which a methyl group is removed, but otherwise is of similar chemical structure. The methyl group is a small molecule made of one carbon and three hydrogen atoms.

Methods

Field Procedures

The object of the field collection was to obtain fillet tissues from edible-sized resident fish and composite mussel samples in the vicinity of the Project for analytical determination of microcystin compounds. Resident fish and mussels in Copco and Iron Gate reservoirs, or in the river upstream and downstream of the reservoirs, are a focus of this investigation because of the recent occurrences in the reservoirs of summertime blooms of the cyanobacteria MSAE, which are capable of producing microcystin.

Fish and Mussel Collection

The field sampling effort focused on collecting fish tissue samples from the following four reservoir and river segments in the Project vicinity (Figure 1):

- Iron Gate reservoir (located on the Klamath River from RM 190 to RM 196.8)
- Copco reservoir (located between RM 198.6 to RM 203.2)
- Klamath River downstream of the Iron Gate dam to the I-5 freeway crossing (RM 176.7 to RM 190.5)
- Klamath River upstream of the Copco reservoir to the Stateline (RM 204 to RM 209)

Yellow perch and crappie were targeted in the reservoirs to represent resident sport fish in the reservoirs that are typically captured and consumed. Ten to twenty adult yellow perch and three to ten crappie were targeted for collection from each reservoir on each sampling occasion as practicable.

Rainbow trout (or steelhead) were targeted in the river segments to represent resident sport fish in the river that are typically captured and consumed. Three to ten rainbow trout (or steelhead) specimens were targeted for collection from each of the river segments on each sampling occasion as practicable.

Fish were collected by hook and line sampling ("angling"). PacifiCorp, CH2M HILL, and fishing guide personnel performed the fish collections.

Mussel sample collection was targeted in the river segments to represent specimens that are available to be collected and potentially consumed. Mussels were collected by hand by CH2M HILL scientists after a visual search of shallow water substrates at the river margins.

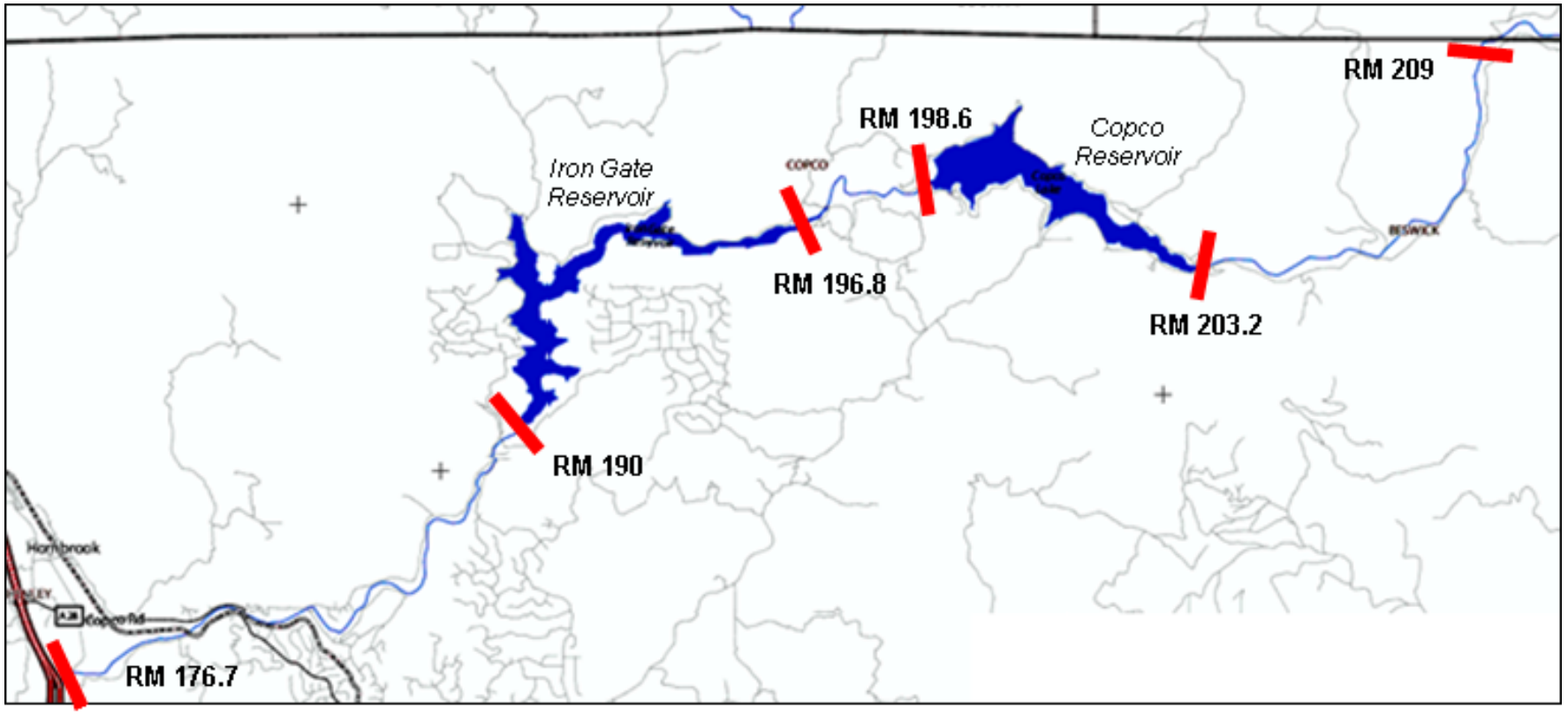

Figure 1. Map of Klamath River showing locations that demark areas from which fish and mussel specimens were collected during 2008.

Fish and Mussel Tissue Sample Preparation and Handling

Immediately following capture, each fish specimen was sacrificed and placed whole into a clean zip-lock bag. The bag was labeled using a permanent marking pen with a unique identification number and immediately placed on ice in an insulated cooler. At the end of each day's sampling activity, individual fish specimens were processed to obtain tissue samples. First, each specimen was weighed to the nearest gram, and a total length was obtained and recorded. Each fish specimen was examined and noted for any abnormal external conditions (e.g., lesions, parasites).

Each fish specimen was then dissected to obtain a skinless fillet. From a skinless fillet, a sub-sample of approximately two to ten grams was obtained and placed into a new pre-labeled 50-ml polyethylene sampling bottle. For quality assurance purposes, a second sample was obtained from a skinless fillet from the opposite side of every twentieth fish specimen processed on a given day. A sample label was placed on each bottle that provided the unique sample number assigned to the fish, the time and date of capture, the species common name, and the collector's initials.

For mussel samples, the external shell of each mussel was cleaned and three to five specimens were combined into each composite sample per site and placed into clean plastic bags. No further preparation was done in the field. The mussels were frozen as whole composite samples for removal and compositing of soft tissue later in the laboratory.

Each completed sample bottle containing fish and mussel tissue samples for analytical determination of microcystin concentrations was placed in a freezer immediately after processing and held in the freezer until shipped to the SUNY-CESF Laboratory in Syracuse, NY for microcystin analyses. During shipment to the analytical laboratory, the samples were contained in an insulated cooler containing dry ice to insure all tissue samples remained frozen during shipment. Frozen samples were shipped using overnight courier service to the SUNY-CESF Laboratory. Upon receipt at the laboratory, samples were held in an ultra-cold freezer until analysis.

Laboratory Analyses

Method for Determination of Tissue Concentrations of Microcystin

Sample Preparation

To prepare the samples for analysis, the frozen samples were lyophilized (i.e., freeze-dried) to dryness at the SUNY-CESF Laboratory and the lyophilizate was vortexed (i.e., mixed by whirlpool effect) to ensure uniformity. A 100 mg (0.1 g dry weight) subsample was mixed with 1 ml of water containing 4 μg of the internal standard 7cys-S-propyl-microcystin-LR (per the methodology of Smith and Boyer 2008). Five ml of 50 percent aqueous methanol was added and the samples were sonicated (21 watts power) on ice for 1 minute. Following sonication, the samples were allowed to stand for 30 min at -20ºC, centrifuged to settle debris, and the clarified supernatant decanted into a clean glass tube. The solvent was removed in vacuo and the dry material reconstituted in 1 ml of 80 percent aqueous methanol. The sample was again allowed to stand for 30 minutes at -20ºC, clarified by

centrifugation, and the supernatant transferred to an autosampler vial, which was sealed and stored at -20°C for subsequent analysis.

Analysis of Total Free Microcystins

Following tissue sample preparation, the total concentrations of microcystin compounds were quantified in each sample by high performance liquid chromatography with mass spectral detection (LCMS). The LCMS assay measured the molecular weight of total microcystin variants or congeners that are not bound to proteins (i.e., free microcystins). The free microcystins are considered the most important from a potential toxicity standpoint, since the mechanism of toxic action by microcystins involves covalent binding to proteins. The bound (i.e., non-free) fraction is no longer accessible or "bioavailable" for toxicity (Ibelings and Chorus 2007).

The LCMS assay was performed using a ZQ4000 single quad instrument and Ace C18 column operating with a 0.02 percent trifluoroacetic acid (TFA) acetonitrile gradient. The LCMS analysis was run in two different formats. First, samples were scanned looking at all masses between 750 and 1250 atomic mass units (amu), a range that encompasses the molecular ions of all of the 80 known microcystin congeners. The molecular ions corresponding to 12 common microcystin congeners found in North America (i.e., microcystin-RR, -dmRR, Nod, -YR, -LR, -dmLR, -AR, -FR, -WR, -LA, -LW, -LF) and the internal standard -tLR were extracted from that total ion trace. Additional mass spectra were scanned for any other peaks of interest that exhibited diagnostic microcystin ultraviolet (UV) signatures. Microcystins were identified on the basis of their UV signatures, liquid chromatography retention times relative to microcystin-RR, -LR, -tLR and -LF standards, and comparison of their molecular weights against a database of the 80 known microcystin congeners.

In addition to the LCMS spectra scan (discussed above), the LCMS also was used in selected ion monitoring (SIM) mode to enhance the selectivity and detectability of the microcystin-LR, -LA, and -RR congeners. The vast majority of reported research on microcystin toxicity is focused on the -LR congener, which is generally regarded as the most toxic microcystin congener (Funari and Testai 2008). The -LA congener was the predominant congener present in the additional LCMS analysis of algal samples from the Project reservoirs provided to SUNY-CESF for this analysis[8]. The –RR congener also was included because it is a very common congener in North American samples (G. Boyer, SUNY, pers. comm.).

The SIM mode considers only four congener ions (i.e., -LR, , -tLR, -LA, and –RR), rather than all of the many ions located between 750 and 1250 amu and is therefore significantly more sensitive than full scan mode. This results in an approximately 100-fold increase in sensitivity but provides less information about the sample in terms of fragment ions and isotope peaks. The instrument was standardized in SIM mode using microcystin-LR at a

[8] CH2M HILL provided samples collected on August 27, 2008 at two open-water reservoir sites in the lower ends of Iron Gate and Copco reservoirs (near the log booms) that were associated with PacifiCorp's 2008 water quality monitoring study (as described in Raymond 2009). These samples were taken as horizontal integrated samples (over a distance of about 50 m) at a depth of 0.5 m below the surface. These particular samples were provided to SUNY because of known levels of microcystin (of 22.2 and 23.1 µg/L, respectively, in the Iron Gate and Copco samples) that were detected in aliquots of these samples by CH2M HILL Applied Sciences Laboratory using the competitive Enzyme-Linked ImmunoSorbent Assay (ELISA) method. The ELISA method does not distinguish between the specific microcystin congeners, but yields one value as the sum of all measurable microcystin variants.

specific mass-to-charge ratio (m/z) = 995.5, -tLR at m/z = 1087.5, -LA at m/z = 910.5 and 932.5, and -RR at m/z = 1038.5.

All results were reported on a weight basis in units of μg/g dry weight of tissue. The Instrument Detection Limit (IDL)[9] is approximately 1 ng microcystin-LR on column[10] in the full scan mode and 0.01 ng on column in the SIM mode. The Method Detection Limit (MDL)[11] relative to the LCMS spectra scan was determined for each sample from the recoveries of the internal standard (7cys-S-propyl microcystin LR) in full scan mode. Analysis in the SIM mode resulted in a second more-sensitive MDL for -LR, -LA, and -RR congeners in each sample, determined from the recoveries of the internal standard (7cys-S-propyl-microcystin-LR) in SIM mode.

Kann (2008) reported the presence of demethylated forms of the -LR and -RR congeners (-dmLR and –dmRR) in some samples following microcystin analysis of fish and freshwater mussel tissues collected in the Klamath River in 2007. To assess if these two demethylated forms would be present in 2008, water samples were provided to the SUNY-CESF laboratory that were representative of the phytoplankton flora present at the time of fish exposure. These water samples were lyophilized to dryness and extracted in 50 percent acidified methanol with ultrasound (Boyer 2007). The resulting samples were clarified by centrifugation and analyzed for microcystins by LCMS using both the full scan and SIM modes as described above.

Data on Microcystins in Waters of the Study Area

The Discussion section of this report includes graphs of data on the concentrations of microcystins in waters of the Klamath River and Project reservoirs in 2008 concurrent with the period of tissue specimen sampling described above. The sources for these data on in-water concentrations are Raymond (2009) and Kann and Corum (2009).

[9] Instrument Detection Limit (IDL) is the concentration equivalent to a signal, due to the analyte of interest, which is the smallest signal that can be distinguished from background noise by a particular instrument. The IDL is similar to the "critical level" and "criterion of detection" as defined in the literature. (Standard Methods, 18th edition).

[10] On-column detection occurs when analytes are detected on the analytical column (LCMS Ace C18) over which the injected sample flows.

[11] Method Detection Limit (MDL) is the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero, and is determined from analysis of a sample in a given matrix containing the analyte. MDLs are statistically determined values that define how easily measurements of a substance by a specific analytical protocol can be distinguished from measurements of a blank (background noise).

Results

Specimens Obtained

A total of 272 fish tissue samples were obtained over the four seasonal sampling events (i.e., May-June, July, September, and November), and 14 mussel tissue samples in November during this study (Table 1). The 272 fish tissue samples consisted of 38 rainbow trout samples from the Klamath River above Copco reservoir, 38 rainbow trout samples from the Klamath River below Iron Gate reservoir, 81 yellow perch samples from Copco reservoir, 85 yellow perch samples from Iron Gate reservoir, 11 crappie samples from Copco reservoir, and 19 crappie samples from Iron Gate reservoir. The 14 mussel tissue samples consisted of two western ridge mussel samples from the Klamath River above Copco reservoir, and seven western ridge mussel and 5 Oregon floater samples from the Klamath River below Iron Gate reservoir.

Table 1. Number of the Tissue Samples Collected at the PacifiCorp Klamath Project in 2008 and Analyzed for Microcystin for Three Species of Resident Fish and Two Species of Freshwater Mussels.

Species	Location	Number of Samples
Resident Fish		
Rainbow trout	Klamath River above Copco	38
	Klamath River Below Iron Gate	38
Yellow perch	Copco Reservoir	81
	Iron Gate Reservoir	85
Black crappie	Copco Reservoir	11
	Iron Gate Reservoir	19
Freshwater Mussels		
Western ridge mussel	Klamath River above Copco	2
	Klamath River Below Iron Gate	7
Oregon floater	Klamath River Below Iron Gate	5

May-June Sampling Event

A total of 61 fish tissue samples (including three duplicate samples) were obtained during the May-June sampling event (Table 2). Eighteen yellow perch and six crappie samples were obtained on May 28 and 29, 2008 from Copco reservoir. These yellow perch averaged 198 mm (7.8 inches) and ranged from 131 to 275 mm (5.1 to 10.8 inches) in length. The six

crappie averaged 201 mm (7.9 inches) and ranged from 153 to 256 mm (6.0 to 10.0 inches) in length.

Twenty-two yellow perch and one crappie samples were obtained on May 29 from Iron Gate reservoir. These yellow perch averaged 210 mm (8.2 inches) and ranged from 168 to 270 mm (6.6 to 10.6 inches) in length. The one crappie was 153 mm (6.0 inches) in length.

Six rainbow trout samples were obtained from the Klamath River downstream of the Iron Gate reservoir, including one rainbow trout caught on May 28, three caught on June 7, and one caught on June 13 (also used to obtain a duplicate sample). These five trout averaged 331 mm (13 inches) and ranged from 240 to 455 mm (9.4 to 17.9 inches) in length. Seven rainbow trout samples were obtained from the Klamath River upstream of Copco reservoir – all caught on June 19. These five trout measured averaged 261 mm (10.3 inches) and ranged from 220 to 291 mm (8.7 to 11.5 inches) in length.

Table 2. Number of the Tissue Samples Collected at the PacifiCorp Klamath Project in May-June 2008 and Analyzed for Microcystin for Three Species of Resident Fish.

Species	Location	Number of Samples
Resident Fish		
Rainbow trout	Klamath River above Copco	7
	Klamath River Below Iron Gate	6
Yellow perch	Copco Reservoir	18
	Iron Gate Reservoir	23
Black crappie	Copco Reservoir	6
	Iron Gate Reservoir	1

July Sampling Event

A total of 65 fish tissue samples (including three duplicate samples) were obtained during the July sampling event (Table 3). Twenty yellow perch and one crappie samples were obtained on July 15, 2008 from Iron Gate reservoir. These yellow perch averaged 204 mm (8.0 inches) and ranged from 151 to 266 mm (5.9 to 10.4 inches) in length. The one crappie was 216 mm (8.5 inches) in length.

Twenty-one yellow perch and three crappie samples were obtained on July 16 from Copco reservoir. These yellow perch averaged 214 mm (8.4 inches) and ranged from 183 to 237 mm (7.2 to 9.3 inches) in length. The three crappie averaged 241 mm (9.5 inches) and ranged from 239 to 243 mm (9.4 to 9.5 inches) in length.

Ten rainbow trout samples were obtained on July 15, 2008 from the Klamath River downstream of the Iron Gate reservoir. These ten trout averaged 267.5 mm (10.5 inches) and ranged from 266 to 344 mm (8.5 to 13.5 inches) in length. Ten rainbow trout samples were obtained on July 16 from the Klamath River upstream of Copco reservoir. These trout averaged 285.6 mm (11.2 inches) and ranged from 175 to 435 mm (6.9 to 17.1 inches) in length.

Table 3. Number of the Tissue Samples Collected at the PacifiCorp Klamath Project in July 2008 and Analyzed for Microcystin for Three Species of Resident Fish.

Species	Location	Number of Samples
Resident Fish		
Rainbow trout	Klamath River above Copco	10
	Klamath River Below Iron Gate	10
Yellow perch	Copco Reservoir	21
	Iron Gate Reservoir	20
Black crappie	Copco Reservoir	3
	Iron Gate Reservoir	1

September Sampling Event

A total of 77 fish tissue samples (including five duplicate samples) were obtained during the September sampling event (Table 4). Twenty-one yellow perch and 11 crappie samples were obtained on September 9, 2008 from Iron Gate reservoir. These yellow perch averaged 199 mm (7.8 inches) and ranged from 167 to 250 mm (6.5 to 9.8 inches) in length. The 11 crappie averaged 204 mm (8.0 inches) and ranged from 180 to 245 mm (7.1 to 9.6 inches) in length. Twenty-one yellow perch and two crappie samples were obtained on September 9 and 10 from Copco reservoir. These yellow perch averaged 222 mm (8.7 inches) and ranged from 197 to 246 mm (7.7 to 9.6 inches) in length. The two crappie were 197 mm (7.7 inches) and 251 mm (9.8 inches) in length.

Table 4. Number of the Tissue Samples Collected at the PacifiCorp Klamath Project in September 2008 and Analyzed for Microcystin for Three Species of Resident Fish.

Species	Location	Number of Samples
Resident Fish		
Rainbow trout	Klamath River above Copco	10
	Klamath River Below Iron Gate	12
Yellow perch	Copco Reservoir	21
	Iron Gate Reservoir	21
Black crappie	Copco Reservoir	2
	Iron Gate Reservoir	11

Twelve rainbow trout samples were obtained on September 9, 2008 from the Klamath River downstream of the Iron Gate reservoir. These trout averaged 231 mm (9.1 inches) on average and ranged from 181to 261 mm (7.1 to 10.3 inches) in length. Ten rainbow trout samples were obtained on September 10 from the Klamath River upstream of Copco

reservoir. These trout measured 293.3 mm (11.5 inches) on average and ranged from 196 to 389 mm (7.7 to 15.4 inches) in length.

November Sampling Event

A total of 69 fish tissue samples (including four duplicate samples) were obtained during the November sampling event (Table 5). Twenty-one yellow perch and six crappie samples were obtained on November 13, 2008 from Iron Gate reservoir. These yellow perch averaged 210 mm (8.2 inches) and ranged from 174 to 275 mm (6.8 to 10.8 inches) in length. The six crappie averaged 208 mm (8.2 inches) and ranged from 186 to 232 mm (7.3 to 9.1 inches) in length.

Twenty-one yellow perch (but no crappie) samples were obtained on November 13 from Copco reservoir. These yellow perch averaged 221 mm (8.2 inches) and ranged from 117 to 257 mm (4.6 to 10.1 inches) in length.

Table 5. Number of the Tissue Samples Collected at the PacifiCorp Klamath Project in November 2008 and Analyzed for Microcystin for Three Species of Resident Fish and Two Species of Freshwater Mussels.

Species	Location	Number of Samples
Resident Fish		
Rainbow trout	Klamath River above Copco	11
	Klamath River Below Iron Gate	10
Yellow perch	Copco Reservoir	21
	Iron Gate Reservoir	21
Black crappie	Copco Reservoir	0
	Iron Gate Reservoir	6
Freshwater Mussels		
Western ridge mussel	Klamath River above Copco	2
	Klamath River Below Iron Gate	7
Oregon floater	Klamath River Below Iron Gate	5

Ten rainbow trout samples were obtained on November 12, 2008 from the Klamath River downstream of the Iron Gate reservoir. These trout averaged 295 mm (11.6 inches) on average and ranged from 215 to 416 mm (8.5 to 16.4 inches) in length. Eleven rainbow trout samples were obtained on November 14 from the Klamath River upstream of Copco reservoir. These ten fish measured 309.5 mm (12.1 inches) on average and ranged from 232 to 415 mm (9.1 to 16.3 inches) in length.

A total of 14 mussel tissue samples were obtained during the November sampling event (Table 5). Two replicate samples of western ridge mussel were obtained on November 11, 2008 from the Klamath River upstream of Copco reservoir. The two replicate samples consisted of composites of three mussels each. The mean lengths of the mussels for these

two replicates ranged from 88 to 89.3 mm (around 3.5 inches), with individuals ranging from 80 to 93 mm each (3.1 to 3.7 inches). Seven replicate samples of western ridge mussel were obtained on November 11 from the Klamath River downstream of Iron Gate reservoir. The seven replicate samples consisted of composites of five mussels each. The mean lengths of the mussels for these seven replicates ranged from 72.7 to 87.2 mm (2.9 to 3.4 inches), with individuals ranging from 53 to 99 mm each (2.1 to 3.9 inches). Five replicate samples of Oregon floater were obtained on November 11 from the Klamath River downstream of Iron Gate reservoir. The five replicate samples consisted of composites of five mussels each. The mean lengths of the mussels for these replicates ranged from 53.8 to 75.4 mm (2.1 to 3.0 inches), with individuals ranging from 43 to 88 mm each (1.7 to 3.5 inches).

Analysis of Microcystin in Fish and Mussel Tissues

Analyses conducted by the SUNY-CESF Laboratory indicate that all of the fish and mussel tissue samples collected in this 2008 study were below detection for total free microcystins. Tables 6, 7, 8, and 9 summarize the analytical results for all tissue samples obtained from fish specimens in the Klamath River area upstream and downstream and within Copco and Iron Gate reservoirs for the May-June, July, September, and November sampling events, respectively. Table 9 also summarizes the analytical results for tissue samples obtained from the two species of mussels collected for whole-body tissue analysis from the river below Iron Gate and above Copco reservoirs during the November sampling event. The SUNY-CESF Laboratory reports are contained in Appendix A.

Of the 286 fish tissue samples, 283 were below detection in the SIM mode specifically for the -LR, –LA, and -RR congeners. Of the remaining three samples, two samples (in the May-June sample set) were classified by the SUNY-CESF lab as “ambiguous” because of interfering peaks detected near the -LR mass-to-charge ratio (m/z) locus in the SIM mode (Table 6). The third sample (also in the May-June sample set) could not be analyzed in the SIM mode because of a broken vial (Table 6).

The SUNY-CESF laboratory also reported no specific detection of the microcystin metabolites desmethyl-LR (dm-LR) and desmethyl-RR (dm-RR) in the LCMS scans for total free microcystins for the May-June, July, and September sample sets (Tables 6, 7, and 8). The SUNY-CESF laboratory did not perform an analysis on detection of -dmLR and –dmRR in LCMS scans for November samples.

Table 6. Analysis Results of Microcystin in Muscle Tissues of Rainbow Trout, Yellow Perch, and Crappie Specimens Collected during May-June 2008 in the Vicinity of the Klamath Hydroelectric Project. (MDL: Method Detection Limit; BDL: below the MDL; ND: not detected in LCMS traces)

Species	Location	Sample ID	Date Collected	Total Free Microcystin Level	MDL (LCMS Full Scan)[12]		SIM for RR, LR and LA Congeners Only	MDL (SIM Mode)[13]		Ion Trace for LR-DM	Ion Trace for RR-DM
					µg/kg dry wt.	µg/kg wet wt.		µg/kg dry wt.	µg/kg wet wt.		
Yellow perch	Copco reservoir	COP-1-YP-01	28-May	BDL	21.1	3.7	BDL	0.8	0.1	ND	ND
Yellow perch	Copco reservoir	COP-1-YP-02	28-May	BDL	19.1	3.1	BDL	1.0	0.2	ND	ND
Yellow perch	Copco reservoir	COP-1-YP-03	28-May	BDL	21.0	3.6	BDL	1.5	0.3	ND	ND
Yellow perch	Copco reservoir	COP-1-YP-04	28-May	BDL	20.9	3.3	BDL	0.7	0.1	ND	ND
Yellow perch	Copco reservoir	COP-1-YP-05	29-May	BDL	21.3	4.2	BDL	0.7	0.1	ND	ND
Yellow perch	Copco reservoir	COP-1-YP-06	29-May	BDL	21.2	4.2	BDL	0.8	0.2	ND	ND
Yellow perch	Copco reservoir	COP-1-YP-07	29-May	BDL	19.1	3.2	BDL	1.1	0.2	ND	ND
Yellow perch	Copco reservoir	COP-1-YP-08	29-May	BDL	21.4	4.0	BDL	0.8	0.1	ND	ND
Yellow perch	Copco reservoir	COP-1-YP-09	29-May	BDL	21.8	4.1	BDL	1.0	0.2	ND	ND
Yellow perch	Copco reservoir	COP-1-YP-10	29-May	BDL	21.6	3.7	BDL	0.8	0.1	ND	ND
Yellow perch	Copco reservoir	COP-1-YP-11	29-May	BDL	21.9	4.3	BDL	1.0	0.2	ND	ND
Yellow perch	Copco reservoir	COP-1-YP-12	29-May	BDL	21.9	4.4	BDL	0.8	0.2	ND	ND
Yellow perch	Copco reservoir	COP-1-YP-13	29-May	BDL	21.3	4.0	BDL	0.7	0.1	ND	ND
Yellow perch	Copco reservoir	COP-1-YP-14	29-May	BDL	21.2	3.6	BDL	0.6	0.1	ND	ND
Yellow perch	Copco reservoir	COP-1-YP-15	29-May	BDL	22.0	3.7	BDL	1.0	0.2	ND	ND

[12] LCMS Full Scan mode is used to scan for all masses between 750 and 1250 atomic mass units (amu), a range that encompasses the molecular ions of all of the 80 known microcystin congeners. The 12 most common microcystin congeners found in North America (i.e., microcystin-RR, -dmRR, Nod, -YR, -LR, -dmLR, -AR, -FR, -WR, -LA, -LW, -LF) and the internal standard -tLR were extracted from that total ion trace.

[13] The selected ion monitoring (SIM) mode was used to enhance the selectivity and detectability of the microcystin-LR, -LA, and -RR congeners. The SIM mode considers only four congener ions (i.e., -LR, , -tLR, -LA, and –RR), rather than all of the many ions located between 750 and 1250 amu and is therefore significantly more sensitive than Full Scan mode.

Table 6. Analysis Results of Microcystin in Muscle Tissues of Rainbow Trout, Yellow Perch, and Crappie Specimens Collected during May-June 2008 in the Vicinity of the Klamath Hydroelectric Project. (MDL: Method Detection Limit; BDL: below the MDL; ND: not detected in LCMS traces)

Species	Location	Sample ID	Date Collected	Total Free Microcystin Level	MDL (LCMS Full Scan)[12]		SIM for RR, LR and LA Congeners Only	MDL (SIM Mode)[13]		Ion Trace for LR-DM	Ion Trace for RR-DM
					µg/kg dry wt.	µg/kg wet wt.		µg/kg dry wt.	µg/kg wet wt.		
Yellow perch	Copco reservoir	COP-1-YP-16	29-May	BDL	21.8	3.7	BDL	1.1	0.2	ND	ND
Yellow perch	Copco reservoir	COP-1-YP-17	29-May	BDL	22.0	4.2	BDL	0.5	0.1	ND	ND
Yellow perch	Copco reservoir	COP-1-YP-18	29-May	BDL	21.2	3.6	BDL	0.6	0.1	ND	ND
Yellow perch	Iron Gate reservoir	IGR-01-YP-01	29-May	BDL	60.3	9.8	BDL	1.8	0.3	ND	ND
Yellow perch	Iron Gate reservoir	IGR-01-YP-02	29-May	BDL	60.5	9.7	BDL	1.6	0.3	ND	ND
Yellow perch	Iron Gate reservoir	IGR-01-YP-03	29-May	BDL	62.2	13.6	BDL	2.0	0.4	ND	ND
Yellow perch	Iron Gate reservoir	IGR-01-YP-04	29-May	BDL	61.8	11.0	BDL	1.6	0.3	ND	ND
Yellow perch	Iron Gate reservoir	IGR-01-YP-05	29-May	BDL	60.6	9.3	BDL	1.6	0.2	ND	ND
Yellow perch	Iron Gate reservoir	IGR-01-YP-06	29-May	BDL	61.1	12.4	BDL	2.4	0.5	ND	ND
Yellow perch	Iron Gate reservoir	IGR-01-YP-07	29-May	BDL	61.4	12.5	BDL	1.6	0.3	ND	ND
Yellow perch	Iron Gate reservoir	IGR-01-YP-08	29-May	BDL	60.3	9.9	BDL	1.5	0.2	ND	ND
Yellow perch	Iron Gate reservoir	IGR-01-YP-09	29-May	BDL	61.0	12.3	BDL	1.8	0.4	ND	ND
Yellow perch	Iron Gate reservoir	IGR-01-YP-10	29-May	BDL	61.9	12.9	BDL	1.7	0.4	ND	ND
Yellow perch	Iron Gate reservoir	IGR-01-YP-11	29-May	BDL	57.1	10.2	BDL	1.8	0.3	ND	ND
Yellow perch	Iron Gate reservoir	IGR-01-YP-12	29-May	BDL	62.2	10.6	BDL	1.8	0.3	ND	ND
Yellow perch	Iron Gate reservoir	IGR-01-YP-13	29-May	BDL	62.1	12.1	BDL	1.5	0.3	ND	ND
Yellow perch	Iron Gate reservoir	IGR-01-YP-14	29-May	BDL	57.1	10.1	BDL	1.6	0.3	ND	ND
Yellow perch	Iron Gate reservoir	IGR-01-YP-15	29-May	BDL	19.1	2.6	BDL	1.1	0.1	ND	ND

Table 6. Analysis Results of Microcystin in Muscle Tissues of Rainbow Trout, Yellow Perch, and Crappie Specimens Collected during May-June 2008 in the Vicinity of the Klamath Hydroelectric Project. (MDL: Method Detection Limit; BDL: below the MDL; ND: not detected in LCMS traces)

Species	Location	Sample ID	Date Collected	Total Free Microcystin Level	MDL (LCMS Full Scan)[12]		SIM for RR, LR and LA Congeners Only	MDL (SIM Mode)[13]		Ion Trace for LR-DM	Ion Trace for RR-DM
					µg/kg dry wt.	µg/kg wet wt.		µg/kg dry wt.	µg/kg wet wt.		
Yellow perch	Iron Gate reservoir	IGR-01-YP-15	29-May	BDL	19.2	2.7	BDL	2.4	0.3	ND	ND
Yellow perch	Iron Gate reservoir	IGR-01-YP-17	29-May	BDL	19.1	3.1	BDL	1.2	0.2	ND	ND
Yellow perch	Iron Gate reservoir	IGR-01-YP-18	29-May	BDL	19.1	3.0	Ambiguous	NA	NA	ND	ND
Yellow perch	Iron Gate reservoir	IGR-01-YP-19	29-May	BDL	19.1	2.7	BDL	0.5	0.1	ND	ND
Yellow perch	Iron Gate reservoir	IGR-01-YP-20a	29-May	BDL	19.1	3.2	BDL	1.1	0.2	ND	ND
Yellow perch	Iron Gate reservoir	IGR-01-YP-20b	29-May	BDL	19.2	3.5	BDL	0.9	0.2	ND	ND
Yellow perch	Iron Gate reservoir	IGR-01-YP-21a	29-May	BDL	19.1	2.1	BDL	0.9	0.1	ND	ND
Yellow perch	Iron Gate reservoir	IGR-01-YP-21b	29-May	BDL	21.9	4.2	Broken	NA	NA	ND	ND
Crappie	Copco reservoir	COP-1-CR-01	29-May	BDL	22.0	4.9	BDL	1.4	0.3	ND	ND
Crappie	Copco reservoir	COP-1-CR-02	29-May	BDL	21.6	3.6	BDL	1.4	0.2	ND	ND
Crappie	Copco reservoir	COP-1-CR-03	29-May	BDL	22.8	4.2	BDL	0.9	0.2	ND	ND
Crappie	Copco reservoir	COP-1-CR-04	29-May	BDL	22.2	3.8	BDL	1.0	0.2	ND	ND
Crappie	Copco reservoir	COP-1-CR-05a	29-May	BDL	22.0	4.2	BDL	1.3	0.2	ND	ND
Crappie	Copco reservoir	COP-1-CR-05b	29-May	BDL	21.3	3.8	BDL	1.1	0.2	ND	ND
Crappie	Iron Gate reservoir	IGR-01-CR-01	29-May	BDL	21.3	4.2	BDL	1.0	0.2	ND	ND
Rainbow trout	River above Copco	UKRC-1-RT-01	19-Jun	BDL	21.1	4.1	BDL	0.8	0.2	ND	ND
Rainbow trout	River above Copco	UKRC-1-RT-02	19-Jun	BDL	22.2	4.0	Ambiguous	NA	NA	ND	ND
Rainbow trout	River above Copco	UKRC-1-RT-03	19-Jun	BDL	21.2	6.1	BDL	0.7	0.2	ND	ND

Table 6. Analysis Results of Microcystin in Muscle Tissues of Rainbow Trout, Yellow Perch, and Crappie Specimens Collected during May-June 2008 in the Vicinity of the Klamath Hydroelectric Project. (MDL: Method Detection Limit; BDL: below the MDL; ND: not detected in LCMS traces)

Species	Location	Sample ID	Date Collected	Total Free Microcystin Level	MDL (LCMS Full Scan)[12]		SIM for RR, LR and LA Congeners Only	MDL (SIM Mode)[13]		Ion Trace for LR-DM	Ion Trace for RR-DM
					µg/kg dry wt.	µg/kg wet wt.		µg/kg dry wt.	µg/kg wet wt.		
Rainbow trout	River above Copco	UKRC-1-RT-04	19-Jun	BDL	19.1	3.7	BDL	1.1	0.2	ND	ND
Rainbow trout	River above Copco	UKRC-1-RT-05	19-Jun	BDL	21.8	4.4	BDL	0.7	0.1	ND	ND
Rainbow trout	River above Copco	UKRC-1-RT-06	19-Jun	BDL	21.8	4.3	BDL	1.0	0.2	ND	ND
Rainbow trout	River above Copco	UKRC-1-RT-07	19-Jun	BDL	22.0	5.3	BDL	1.1	0.3	ND	ND
Rainbow trout	River below Iron Gate	LKR-1-RT-01	28-May	BDL	21.9	5.3	BDL	1.0	0.2	ND	ND
Rainbow trout	River below Iron Gate	LKR-1-RT-02	7-Jun	BDL	21.9	4.4	BDL	1.1	0.2	ND	ND
Rainbow trout	River below Iron Gate	LKR-1-RT-03	7-Jun	BDL	21.8	4.6	BDL	1.0	0.2	ND	ND
Rainbow trout	River below Iron Gate	LKR-1-RT-04	7-Jun	BDL	21.8	5.5	BDL	1.2	0.3	ND	ND
Rainbow trout	River below Iron Gate	LKR-1-RT-05a	13-Jun	BDL	21.8	4.7	BDL	1.1	0.2	ND	ND
Rainbow trout	River below Iron Gate	LKR-1-RT-05b	13-Jun	BDL	21.8	4.6	BDL	1.0	0.2	ND	ND

Table 7. Analysis Results of Microcystin in Muscle Tissues of Rainbow Trout, Yellow Perch, and Crappie Specimens Collected during July 2008 in the Vicinity of the Klamath Hydroelectric Project. (MDL: Method Detection Limit; BDL: below the MDL; ND: not detected in LCMS traces)

Species	Location	Sample ID	Date Collected	Total Free Microcystin Level	MDL (LCMS Full Scan)		SIM for RR, LR and LA Congeners Only	MDL (SIM Mode)		Ion Trace for LR-DM	Ion Trace for RR-DM
					µg/kg dry wt.	µg/kg wet wt.		µg/kg dry wt.	µg/kg wet wt.		
Yellow perch	Copco reservoir	COP-2-YP-01	15-Jul	BDL	82.4	12.8	BDL	1.6	0.2	ND	ND
Yellow perch	Copco reservoir	COP-2-YP-02	16-Jul	BDL	82.9	14.9	BDL	2.2	0.4	ND	ND
Yellow perch	Copco reservoir	COP-2-YP-03	16-Jul	BDL	82.2	9.6	BDL	1.7	0.2	ND	ND
Yellow perch	Copco reservoir	COP-2-YP-04	16-Jul	BDL	82.1	6.9	BDL	1.5	0.1	ND	ND
Yellow perch	Copco reservoir	COP-2-YP-05	16-Jul	BDL	82.7	16.1	BDL	1.5	0.3	ND	ND
Yellow perch	Copco reservoir	COP-2-YP-06	16-Jul	BDL	82.8	15.7	BDL	1.0	0.2	ND	ND
Yellow perch	Copco reservoir	COP-2-YP-07	16-Jul	BDL	82.7	15.9	BDL	1.0	0.2	ND	ND
Yellow perch	Copco reservoir	COP-2-YP-08	16-Jul	BDL	82.4	16.1	BDL	1.1	0.2	ND	ND
Yellow perch	Copco reservoir	COP-2-YP-09	16-Jul	BDL	82.5	14.4	BDL	0.9	0.2	ND	ND
Yellow perch	Copco reservoir	COP-2-YP-10	16-Jul	BDL	82.4	17.1	BDL	0.9	0.2	ND	ND
Yellow perch	Copco reservoir	COP-2-YP-11	16-Jul	BDL	82.5	16.0	BDL	0.5	0.1	ND	ND
Yellow perch	Copco reservoir	COP-2-YP-12	16-Jul	BDL	82.1	15.0	BDL	0.8	0.1	ND	ND
Yellow perch	Copco reservoir	COP-2-YP-13	16-Jul	BDL	82.3	16.4	BDL	1.0	0.2	ND	ND
Yellow perch	Copco reservoir	COP-2-YP-14	16-Jul	BDL	82.7	16.7	BDL	1.2	0.2	ND	ND
Yellow perch	Copco reservoir	COP-2-YP-15	16-Jul	BDL	82.3	15.8	BDL	1.1	0.2	ND	ND
Yellow perch	Copco reservoir	COP-2-YP-16	16-Jul	BDL	82.2	15.8	BDL	1.2	0.2	ND	ND
Yellow perch	Copco reservoir	COP-2-YP-17	16-Jul	BDL	82.8	17.3	BDL	1.2	0.3	ND	ND

Table 7. Analysis Results of Microcystin in Muscle Tissues of Rainbow Trout, Yellow Perch, and Crappie Specimens Collected during July 2008 in the Vicinity of the Klamath Hydroelectric Project. (MDL: Method Detection Limit; BDL: below the MDL; ND: not detected in LCMS traces)

Species	Location	Sample ID	Date Collected	Total Free Microcystin Level	MDL (LCMS Full Scan)		SIM for RR, LR and LA Congeners Only	MDL (SIM Mode)		Ion Trace for LR-DM	Ion Trace for RR-DM
					µg/kg dry wt.	µg/kg wet wt.		µg/kg dry wt.	µg/kg wet wt.		
Yellow perch	Copco reservoir	COP-2-YP-18	16-Jul	BDL	82.9	16.7	BDL	1.3	0.3	ND	ND
Yellow perch	Copco reservoir	COP-2-YP-19	16-Jul	BDL	82.4	15.0	BDL	1.5	0.3	ND	ND
Yellow perch	Copco reservoir	COP-2-YP-20	16-Jul	BDL	82.4	16.9	BDL	1.4	0.3	ND	ND
Yellow perch	Copco reservoir	COP-2-YP-20b	16-Jul	BDL	82.1	12.9	BDL	1.3	0.2	ND	ND
Yellow perch	Iron Gate reservoir	IGR-2-YP-01	15-Jul	BDL	84.9	13.4	BDL	1.0	0.2	ND	ND
Yellow perch	Iron Gate reservoir	IGR-2-YP-02	15-Jul	BDL	84.8	14.9	BDL	1.0	0.2	ND	ND
Yellow perch	Iron Gate reservoir	IGR-2-YP-03	15-Jul	BDL	84.8	13.4	BDL	1.0	0.2	ND	ND
Yellow perch	Iron Gate reservoir	IGR-2-YP-04	15-Jul	BDL	84.7	13.8	BDL	0.9	0.1	ND	ND
Yellow perch	Iron Gate reservoir	IGR-2-YP-05	15-Jul	BDL	85.3	14.7	BDL	1.1	0.2	ND	ND
Yellow perch	Iron Gate reservoir	IGR-2-YP-06	15-Jul	BDL	85.2	13.6	BDL	1.2	0.2	ND	ND
Yellow perch	Iron Gate reservoir	IGR-2-YP-07	15-Jul	BDL	84.7	14.4	BDL	1.3	0.2	ND	ND
Yellow perch	Iron Gate reservoir	IGR-2-YP-08	15-Jul	BDL	84.5	14.4	BDL	1.9	0.3	ND	ND
Yellow perch	Iron Gate reservoir	IGR-2-YP-09	15-Jul	BDL	84.5	15.9	BDL	1.1	0.2	ND	ND
Yellow perch	Iron Gate reservoir	IGR-2-YP-10	15-Jul	BDL	84.5	15.8	BDL	1.0	0.2	ND	ND
Yellow perch	Iron Gate reservoir	IGR-2-YP-11	15-Jul	BDL	85.1	16.4	BDL	1.1	0.2	ND	ND
Yellow perch	Iron Gate reservoir	IGR-2-YP-12	15-Jul	BDL	82.5	14.2	BDL	1.0	0.2	ND	ND
Yellow perch	Iron Gate reservoir	IGR-2-YP-13	15-Jul	BDL	82.8	14.4	BDL	1.0	0.2	ND	ND
Yellow perch	Iron Gate reservoir	IGR-2-YP-14	15-Jul	BDL	82.4	16.0	BDL	1.3	0.3	ND	ND

Table 7. Analysis Results of Microcystin in Muscle Tissues of Rainbow Trout, Yellow Perch, and Crappie Specimens Collected during July 2008 in the Vicinity of the Klamath Hydroelectric Project. (MDL: Method Detection Limit; BDL: below the MDL; ND: not detected in LCMS traces)

Species	Location	Sample ID	Date Collected	Total Free Microcystin Level	MDL (LCMS Full Scan)		SIM for RR, LR and LA Congeners Only	MDL (SIM Mode)		Ion Trace for LR-DM	Ion Trace for RR-DM
					µg/kg dry wt.	µg/kg wet wt.		µg/kg dry wt.	µg/kg wet wt.		
Yellow perch	Iron Gate reservoir	IGR-2-YP-15	15-Jul	BDL	82.7	14.7	BDL	1.8	0.3	ND	ND
Yellow perch	Iron Gate reservoir	IGR-2-YP-16	15-Jul	BDL	82.2	12.9	BDL	1.8	0.3	ND	ND
Yellow perch	Iron Gate reservoir	IGR-2-YP-17	15-Jul	BDL	82.7	15.0	BDL	1.7	0.3	ND	ND
Yellow perch	Iron Gate reservoir	IGR-2-YP-18	15-Jul	BDL	82.7	15.4	BDL	1.1	0.2	ND	ND
Yellow perch	Iron Gate reservoir	IGR-2-YP-19	15-Jul	BDL	82.3	15.6	BDL	1.2	0.2	ND	ND
Yellow perch	Iron Gate reservoir	IGR-2-YP-19b	15-Jul	BDL	82.8	13.0	BDL	1.7	0.3	ND	ND
Crappie	Copco reservoir	COP-2-CR-01	16-Jul	BDL	82.6	15.2	BDL	1.7	0.3	ND	ND
Crappie	Copco reservoir	COP-2-CR-02	16-Jul	BDL	82.1	14.5	BDL	1.5	0.3	ND	ND
Crappie	Copco reservoir	COP-2-CR-03	16-Jul	BDL	82.4	13.3	BDL	1.3	0.2	ND	ND
Crappie	Iron Gate reservoir	IGR-2-CR-01	15-Jul	BDL	82.6	16.7	BDL	1.0	0.2	ND	ND
Rainbow trout	River above Copco	UKRC-2-RT-01	16-Jul	BDL	82.4	20.5	BDL	1.7	0.4	ND	ND
Rainbow trout	River above Copco	UKRC-2-RT-02	16-Jul	BDL	82.5	21.6	BDL	1.6	0.4	ND	ND
Rainbow trout	River above Copco	UKRC-2-RT-03	16-Jul	BDL	82.1	23.2	BDL	1.6	0.5	ND	ND
Rainbow trout	River above Copco	UKRC-2-RT-04	16-Jul	BDL	82.2	27.0	BDL	1.6	0.5	ND	ND
Rainbow trout	River above Copco	UKRC-2-RT-05	16-Jul	BDL	82.4	19.9	BDL	1.8	0.4	ND	ND
Rainbow trout	River above Copco	UKRC-2-RT-06	16-Jul	BDL	82.8	21.6	BDL	1.4	0.4	ND	ND
Rainbow trout	River above Copco	UKRC-2-RT-07	16-Jul	BDL	82.3	20.7	BDL	1.4	0.4	ND	ND
Rainbow trout	River above Copco	UKRC-2-RT-08	16-Jul	BDL	82.4	18.8	BDL	1.2	0.3	ND	ND

Table 7. Analysis Results of Microcystin in Muscle Tissues of Rainbow Trout, Yellow Perch, and Crappie Specimens Collected during July 2008 in the Vicinity of the Klamath Hydroelectric Project. (MDL: Method Detection Limit; BDL: below the MDL; ND: not detected in LCMS traces)

Species	Location	Sample ID	Date Collected	Total Free Microcystin Level	MDL (LCMS Full Scan)		SIM for RR, LR and LA Congeners Only	MDL (SIM Mode)		Ion Trace for LR-DM	Ion Trace for RR-DM
					µg/kg dry wt.	µg/kg wet wt.		µg/kg dry wt.	µg/kg wet wt.		
Rainbow trout	River above Copco	UKRC-2-RT-09	16-Jul	BDL	82.3	19.6	BDL	1.5	0.4	ND	ND
Rainbow trout	River above Copco	UKRC-2-RT-9b	16-Jul	BDL	82.1	21.4	BDL	1.2	0.3	ND	ND
Rainbow trout	River below Iron Gate	LKR-2-RT-01	15-Jul	BDL	85.2	21.1	BDL	1.0	0.2	ND	ND
Rainbow trout	River below Iron Gate	LKR-2-RT-02	15-Jul	BDL	84.7	21.5	BDL	1.0	0.3	ND	ND
Rainbow trout	River below Iron Gate	LKR-2-RT-03	15-Jul	BDL	85.1	22.9	BDL	1.0	0.3	ND	ND
Rainbow trout	River below Iron Gate	LKR-2-RT-04	15-Jul	BDL	85.2	20.9	BDL	1.0	0.2	ND	ND
Rainbow trout	River below Iron Gate	LKR-2-RT-05	15-Jul	BDL	85.1	21.3	BDL	1.0	0.2	ND	ND
Rainbow trout	River below Iron Gate	LKR-2-RT-06	15-Jul	BDL	84.7	21.0	BDL	0.9	0.2	ND	ND
Rainbow trout	River below Iron Gate	LKR-2-RT-07	15-Jul	BDL	84.8	18.1	BDL	1.0	0.2	ND	ND
Rainbow trout	River below Iron Gate	LKR-2-RT-08	15-Jul	BDL	82.7	18.9	BDL	1.0	0.2	ND	ND
Rainbow trout	River below Iron Gate	LKR-2-RT-09	15-Jul	BDL	82.1	19.1	BDL	1.0	0.2	ND	ND
Rainbow trout	River below Iron Gate	LKR-2-RT-10	15-Jul	BDL	82.6	19.8	BDL	1.0	0.2	ND	ND

Table 8. Analysis Results of Microcystin in Muscle Tissues of Rainbow Trout, Yellow Perch, and Crappie Specimens Collected during September 2008 in the Vicinity of the Klamath Hydroelectric Project. (MDL: Method Detection Limit; BDL: below the MDL; ND: not detected in LCMS traces)

Species	Location	Sample ID	Date Collected	Total Free Microcystin Level	MDL (LCMS Full Scan)		SIM for RR, LR and LA Congeners Only	MDL (SIM Mode)		Ion Trace for LR-DM	Ion Trace for RR-DM
					µg/kg dry wt.	µg/kg wet wt.		µg/kg dry wt.	µg/kg wet wt.		
Yellow perch	Copco reservoir	COP-3-YP-01	9-Sep	BDL	124.7	26.2	BDL	1.3	0.3	ND	ND
Yellow perch	Copco reservoir	COP-3-YP-02	9-Sep	BDL	123.8	21.8	BDL	1.3	0.2	ND	ND
Yellow perch	Copco reservoir	COP-3-YP-03	9-Sep	BDL	124.3	25.2	BDL	8.0	1.6	ND	ND
Yellow perch	Copco reservoir	COP-3-YP-04	9-Sep	BDL	123.7	18.7	BDL	1.2	0.2	ND	ND
Yellow perch	Copco reservoir	COP-3-YP-05	9-Sep	BDL	124.7	23.9	BDL	1.0	0.2	ND	ND
Yellow perch	Copco reservoir	COP-3-YP-06	9-Sep	BDL	124.3	22.8	BDL	1.1	0.2	ND	ND
Yellow perch	Copco reservoir	COP-3-YP-07	9-Sep	BDL	124.2	22.8	BDL	1.1	0.2	ND	ND
Yellow perch	Copco reservoir	COP-3-YP-08	9-Sep	BDL	124.4	46.5	BDL	1.0	0.4	ND	ND
Yellow perch	Copco reservoir	COP-3-YP-09	9-Sep	BDL	123.7	22.6	BDL	1.0	0.2	ND	ND
Yellow perch	Copco reservoir	COP-3-YP-10	9-Sep	BDL	123.7	43.8	BDL	1.3	0.5	ND	ND
Yellow perch	Copco reservoir	COP-3-YP-11	9-Sep	BDL	123.7	21.5	BDL	1.3	0.2	ND	ND
Yellow perch	Copco reservoir	COP-3-YP-12	9-Sep	BDL	124.2	23.8	BDL	1.3	0.2	ND	ND
Yellow perch	Copco reservoir	COP-3-YP-13	9-Sep	BDL	124.9	19.0	BDL	1.2	0.2	ND	ND
Yellow perch	Copco reservoir	COP-3-YP-14	9-Sep	BDL	123.8	23.1	BDL	1.2	0.2	ND	ND
Yellow perch	Copco reservoir	COP-3-YP-15	9-Sep	BDL	124.4	22.6	BDL	0.6	0.1	ND	ND
Yellow perch	Copco reservoir	COP-3-YP-16	9-Sep	BDL	124.6	24.4	BDL	1.1	0.2	ND	ND
Yellow perch	Copco reservoir	COP-3-YP-17	9-Sep	BDL	124.1	24.1	BDL	1.3	0.3	ND	ND

Table 8. Analysis Results of Microcystin in Muscle Tissues of Rainbow Trout, Yellow Perch, and Crappie Specimens Collected during September 2008 in the Vicinity of the Klamath Hydroelectric Project. (MDL: Method Detection Limit; BDL: below the MDL; ND: not detected in LCMS traces)

Species	Location	Sample ID	Date Collected	Total Free Microcystin Level	MDL (LCMS Full Scan)		SIM for RR, LR and LA Congeners Only	MDL (SIM Mode)		Ion Trace for LR-DM	Ion Trace for RR-DM
					µg/kg dry wt.	µg/kg wet wt.		µg/kg dry wt.	µg/kg wet wt.		
Yellow perch	Copco reservoir	COP-3-YP-18	9-Sep	BDL	124.7	22.6	BDL	1.1	0.2	ND	ND
Yellow perch	Copco reservoir	COP-3-YP-19	9-Sep	BDL	123.8	21.5	BDL	1.1	0.2	ND	ND
Yellow perch	Copco reservoir	COP-3-YP-20	9-Sep	BDL	123.7	21.9	BDL	1.1	0.2	ND	ND
Yellow perch	Copco reservoir	COP-3-YP-20a	9-Sep	BDL	124.8	23.8	BDL	1.3	0.2	ND	ND
Yellow perch	Iron Gate reservoir	IGR-3-YP-01	9-Sep	BDL	85.1	15.2	BDL	3.6	0.6	ND	ND
Yellow perch	Iron Gate reservoir	IGR-3-YP-02	9-Sep	BDL	85.3	15.4	BDL	4.6	0.8	ND	ND
Yellow perch	Iron Gate reservoir	IGR-3-YP-03	9-Sep	BDL	72.4	12.1	BDL	1.4	0.2	ND	ND
Yellow perch	Iron Gate reservoir	IGR-3-YP-04	9-Sep	BDL	85.2	17.0	BDL	4.1	0.8	ND	ND
Yellow perch	Iron Gate reservoir	IGR-3-YP-05	9-Sep	BDL	85.1	15.2	BDL	5.8	1.0	ND	ND
Yellow perch	Iron Gate reservoir	IGR-3-YP-06	9-Sep	BDL	85.1	14.7	BDL	1.8	0.3	ND	ND
Yellow perch	Iron Gate reservoir	IGR-3-YP-07	9-Sep	BDL	85.7	16.7	BDL	4.4	0.9	ND	ND
Yellow perch	Iron Gate reservoir	IGR-3-YP-08	9-Sep	BDL	85.7	16.6	BDL	4.4	0.9	ND	ND
Yellow perch	Iron Gate reservoir	IGR-3-YP-09	9-Sep	BDL	85.6	15.0	BDL	3.0	0.5	ND	ND
Yellow perch	Iron Gate reservoir	IGR-3-YP-10	9-Sep	BDL	85.2	15.3	BDL	3.4	0.6	ND	ND
Yellow perch	Iron Gate reservoir	IGR-3-YP-11	9-Sep	BDL	85.3	14.2	BDL	3.2	0.5	ND	ND
Yellow perch	Iron Gate reservoir	IGR-3-YP-12	9-Sep	BDL	85.4	16.4	BDL	3.8	0.7	ND	ND
Yellow perch	Iron Gate reservoir	IGR-3-YP-13	9-Sep	BDL	85.8	16.7	BDL	2.8	0.5	ND	ND
Yellow perch	Iron Gate reservoir	IGR-3-YP-14	9-Sep	BDL	85.4	14.6	BDL	3.1	0.5	ND	ND

Table 8. Analysis Results of Microcystin in Muscle Tissues of Rainbow Trout, Yellow Perch, and Crappie Specimens Collected during September 2008 in the Vicinity of the Klamath Hydroelectric Project. (MDL: Method Detection Limit; BDL: below the MDL; ND: not detected in LCMS traces)

Species	Location	Sample ID	Date Collected	Total Free Microcystin Level	MDL (LCMS Full Scan)		SIM for RR, LR and LA Congeners Only	MDL (SIM Mode)		Ion Trace for LR-DM	Ion Trace for RR-DM
					µg/kg dry wt.	µg/kg wet wt.		µg/kg dry wt.	µg/kg wet wt.		
Yellow perch	Iron Gate reservoir	IGR-3-YP-15	9-Sep	BDL	85.6	14.8	BDL	2.7	0.5	ND	ND
Yellow perch	Iron Gate reservoir	IGR-3-YP-16	9-Sep	BDL	85.2	16.8	BDL	3.6	0.7	ND	ND
Yellow perch	Iron Gate reservoir	IGR-3-YP-17	9-Sep	BDL	85.9	15.9	BDL	3.0	0.6	ND	ND
Yellow perch	Iron Gate reservoir	IGR-3-YP-18	9-Sep	BDL	85.2	14.9	BDL	3.9	0.7	ND	ND
Yellow perch	Iron Gate reservoir	IGR-3-YP-19	9-Sep	BDL	124.9	21.9	BDL	1.0	0.2	ND	ND
Yellow perch	Iron Gate reservoir	IGR-3-YP-20	9-Sep	BDL	124.1	23.7	BDL	1.0	0.2	ND	ND
Yellow perch	Iron Gate reservoir	IGR-3-YP-20a	9-Sep	BDL	123.8	24.2	BDL	1.0	0.2	ND	ND
Crappie	Copco reservoir	COP-3-CR-01	10-Sep	BDL	124.6	12.2	BDL	1.9	0.2	ND	ND
Crappie	Copco reservoir	COP-3-CR-02	10-Sep	BDL	72.8	13.8	BDL	2.8	0.5	ND	ND
Crappie	Iron Gate reservoir	IGR-3-CR-01	9-Sep	BDL	124.3	20.6	BDL	1.1	0.2	ND	ND
Crappie	Iron Gate reservoir	IGR-3-CR-02	9-Sep	BDL	72.8	9.2	BDL	2.6	0.3	ND	ND
Crappie	Iron Gate reservoir	IGR-3-CR-03	9-Sep	BDL	124.9	22.2	BDL	1.3	0.2	ND	ND
Crappie	Iron Gate reservoir	IGR-3-CR-04	9-Sep	BDL	123.7	23.4	BDL	1.3	0.2	ND	ND
Crappie	Iron Gate reservoir	IGR-3-CR-05	9-Sep	BDL	124.2	22.6	BDL	1.3	0.2	ND	ND
Crappie	Iron Gate reservoir	IGR-3-CR-06	9-Sep	BDL	124.1	20.8	BDL	1.3	0.2	ND	ND
Crappie	Iron Gate reservoir	IGR-3-CR-07	9-Sep	BDL	124.6	24.5	BDL	1.4	0.3	ND	ND
Crappie	Iron Gate reservoir	IGR-3-CR-08	9-Sep	BDL	124.4	23.8	BDL	1.4	0.3	ND	ND
Crappie	Iron Gate reservoir	IGR-3-CR-09	9-Sep	BDL	124.6	21.2	BDL	1.4	0.2	ND	ND

Table 8. Analysis Results of Microcystin in Muscle Tissues of Rainbow Trout, Yellow Perch, and Crappie Specimens Collected during September 2008 in the Vicinity of the Klamath Hydroelectric Project. (MDL: Method Detection Limit; BDL: below the MDL; ND: not detected in LCMS traces)

Species	Location	Sample ID	Date Collected	Total Free Microcystin Level	MDL (LCMS Full Scan)		SIM for RR, LR and LA Congeners Only	MDL (SIM Mode)		Ion Trace for LR-DM	Ion Trace for RR-DM
					µg/kg dry wt.	µg/kg wet wt.		µg/kg dry wt.	µg/kg wet wt.		
Crappie	Iron Gate reservoir	IGR-3-CR-10	9-Sep	BDL	124.2	21.6	BDL	1.3	0.2	ND	ND
Crappie	Iron Gate reservoir	IGR-3-CR-10a	9-Sep	BDL	124.9	20.2	BDL	1.5	0.2	ND	ND
Rainbow trout	River above Copco	UKRC-3-RT-01	10-Sep	BDL	85.2	19.7	BDL	3.7	0.9	ND	ND
Rainbow trout	River above Copco	UKRC-3-RT-02	10-Sep	BDL	85.4	18.5	BDL	4.1	0.9	ND	ND
Rainbow trout	River above Copco	UKRC-3-RT-03	10-Sep	BDL	85.6	22.4	BDL	4.3	1.1	ND	ND
Rainbow trout	River above Copco	UKRC-3-RT-04	10-Sep	BDL	85.8	18.6	BDL	3.9	0.8	ND	ND
Rainbow trout	River above Copco	UKRC-3-RT-05	10-Sep	BDL	85.2	15.2	BDL	4.1	0.7	ND	ND
Rainbow trout	River above Copco	UKRC-3-RT-06	10-Sep	BDL	85.6	18.5	BDL	4.2	0.9	ND	ND
Rainbow trout	River above Copco	UKRC-3-RT-07	10-Sep	BDL	85.1	17.5	BDL	3.9	0.8	ND	ND
Rainbow trout	River above Copco	UKRC-3-RT-08	10-Sep	BDL	85.3	19.3	BDL	4.0	0.9	ND	ND
Rainbow trout	River above Copco	UKRC-3-RT-09	10-Sep	BDL	85.3	18.8	BDL	5.2	1.1	ND	ND
Rainbow trout	River above Copco	UKRC-3-RT-9a	10-Sep	BDL	85.7	19.4	BDL	1.3	0.3	ND	ND
Rainbow trout	River below Iron Gate	LKR-3-RT-01	9-Sep	BDL	85.4	24.7	BDL	4.6	1.3	ND	ND
Rainbow trout	River below Iron Gate	LKR-3-RT-02	9-Sep	BDL	85.9	22.5	BDL	4.2	1.1	ND	ND
Rainbow trout	River below Iron Gate	LKR-3-RT-03	9-Sep	BDL	85.5	21.5	BDL	4.7	1.2	ND	ND
Rainbow trout	River below Iron Gate	LKR-3-RT-04	9-Sep	BDL	85.2	22.6	BDL	2.0	0.5	ND	ND
Rainbow trout	River below Iron Gate	LKR-3-RT-05	9-Sep	BDL	85.2	23.3	BDL	3.8	1.0	ND	ND
Rainbow trout	River below Iron Gate	LKR-3-RT-06	9-Sep	BDL	85.7	21.2	BDL	3.9	1.0	ND	ND

Table 8. Analysis Results of Microcystin in Muscle Tissues of Rainbow Trout, Yellow Perch, and Crappie Specimens Collected during September 2008 in the Vicinity of the Klamath Hydroelectric Project. (MDL: Method Detection Limit; BDL: below the MDL; ND: not detected in LCMS traces)

Species	Location	Sample ID	Date Collected	Total Free Microcystin Level	MDL (LCMS Full Scan)		SIM for RR, LR and LA Congeners Only	MDL (SIM Mode)		Ion Trace for LR-DM	Ion Trace for RR-DM
					µg/kg dry wt.	µg/kg wet wt.		µg/kg dry wt.	µg/kg wet wt.		
Rainbow trout	River below Iron Gate	LKR-3-RT-07	9-Sep	BDL	85.1	19.0	BDL	3.7	0.8	ND	ND
Rainbow trout	River below Iron Gate	LKR-3-RT-08	9-Sep	BDL	85.4	11.3	BDL	4.3	0.6	ND	ND
Rainbow trout	River below Iron Gate	LKR-3-RT-09	9-Sep	BDL	85.6	3.8	BDL	3.8	0.2	ND	ND
Rainbow trout	River below Iron Gate	LKR-3-RT-10	9-Sep	BDL	85.3	20.7	BDL	4.0	1.0	ND	ND
Rainbow trout	River below Iron Gate	LKR-3-RT-11	9-Sep	BDL	85.2	12.5	BDL	3.7	0.5	ND	ND
Rainbow trout	River below Iron Gate	LKR-3-RT-11a	9-Sep	BDL	85.1	19.8	BDL	3.3	0.8	ND	ND

Table 9. Analysis Results of Microcystin in Muscle Tissues of Rainbow Trout, Yellow Perch, and Crappie Specimens, and Oregon Floater and Western Ridge Mussel Specimens Collected during November 2008 in the Vicinity of the Klamath Hydroelectric Project. (MDL: Method Detection Limit; BDL: below the MDL)

Species	Location	Sample ID	Date Collected	Total Free Microcystin Level	MDL (LCMS Full Scan)		SIM for RR, LR and LA Congeners Only	MDL (SIM Mode)	
					µg/kg dry wt.	µg/kg wet wt.		µg/kg dry wt.	µg/kg wet wt.
Yellow perch	Copco reservoir	COP-4-YP-01	13-Nov	BDL	122.0	24.4	BDL	14.2	2.8
Yellow perch	Copco reservoir	COP-4-YP-02	13-Nov	BDL	175.0	35.0	BDL	11.4	2.3
Yellow perch	Copco reservoir	COP-4-YP-03	13-Nov	BDL	172.0	34.4	BDL	11.3	2.3
Yellow perch	Copco reservoir	COP-4-YP-04	13-Nov	BDL	174.0	34.8	BDL	10.6	2.1
Yellow perch	Copco reservoir	COP-4-YP-05	13-Nov	BDL	193.0	38.6	BDL	10.3	2.1
Yellow perch	Copco reservoir	COP-4-YP-06	13-Nov	BDL	225.0	45.0	BDL	12.5	2.5
Yellow perch	Copco reservoir	COP-4-YP-07	13-Nov	BDL	190.0	38.0	BDL	11.0	2.2
Yellow perch	Copco reservoir	COP-4-YP-08	13-Nov	BDL	177.0	35.4	BDL	10.1	2.0
Yellow perch	Copco reservoir	COP-4-YP-09	13-Nov	BDL	172.0	34.4	BDL	11.4	2.3
Yellow perch	Copco reservoir	COP-4-YP-10	13-Nov	BDL	167.0	33.4	BDL	10.4	2.1
Yellow perch	Copco reservoir	COP-4-YP-11	13-Nov	BDL	182.0	36.4	BDL	11.0	2.2
Yellow perch	Copco reservoir	COP-4-YP-12	13-Nov	BDL	112.0	22.4	BDL	9.1	1.8
Yellow perch	Copco reservoir	COP-4-YP-13	13-Nov	BDL	199.0	39.8	BDL	12.2	2.4
Yellow perch	Copco reservoir	COP-4-YP-14	13-Nov	BDL	188.0	37.6	BDL	11.1	2.2
Yellow perch	Copco reservoir	COP-4-YP-15	13-Nov	BDL	187.0	37.4	BDL	12.1	2.4
Yellow perch	Copco reservoir	COP-4-YP-16	13-Nov	BDL	192.0	38.4	BDL	13.1	2.6
Yellow perch	Copco reservoir	COP-4-YP-17	13-Nov	BDL	178.0	35.6	BDL	9.4	1.9

Table 9. Analysis Results of Microcystin in Muscle Tissues of Rainbow Trout, Yellow Perch, and Crappie Specimens, and Oregon Floater and Western Ridge Mussel Specimens Collected during November 2008 in the Vicinity of the Klamath Hydroelectric Project. (MDL: Method Detection Limit; BDL: below the MDL)

Species	Location	Sample ID	Date Collected	Total Free Microcystin Level	MDL (LCMS Full Scan)		SIM for RR, LR and LA Congeners Only	MDL (SIM Mode)	
					µg/kg dry wt.	µg/kg wet wt.		µg/kg dry wt.	µg/kg wet wt.
Yellow perch	Copco reservoir	COP-4-YP-18	13-Nov	BDL	218.0	43.6	BDL	11.6	2.3
Yellow perch	Copco reservoir	COP-4-YP-19	13-Nov	BDL	198.0	39.6	BDL	9.4	1.9
Yellow perch	Copco reservoir	COP-4-YP-20	13-Nov	BDL	197.0	39.4	BDL	10.8	2.2
Yellow perch	Copco reservoir	COP-4-YP-20a	13-Nov	BDL	188.0	37.6	BDL	9.5	1.9
Yellow perch	Iron Gate reservoir	IGR-4-YP-01	13-Nov	BDL	207.0	41.4	BDL	12.0	2.4
Yellow perch	Iron Gate reservoir	IGR-4-YP-02	13-Nov	BDL	220.0	44.0	BDL	12.4	2.5
Yellow perch	Iron Gate reservoir	IGR-4-YP-03	13-Nov	BDL	177.0	35.4	BDL	11.1	2.2
Yellow perch	Iron Gate reservoir	IGR-4-YP-04	13-Nov	BDL	217.0	43.4	BDL	12.2	2.4
Yellow perch	Iron Gate reservoir	IGR-4-YP-05	13-Nov	BDL	211.0	42.2	BDL	12.0	2.4
Yellow perch	Iron Gate reservoir	IGR-4-YP-06	13-Nov	BDL	206.0	41.2	BDL	11.7	2.3
Yellow perch	Iron Gate reservoir	IGR-4-YP-07	13-Nov	BDL	199.0	39.8	BDL	11.5	2.3
Yellow perch	Iron Gate reservoir	IGR-4-YP-08	13-Nov	BDL	159.0	31.8	BDL	10.2	2.0
Yellow perch	Iron Gate reservoir	IGR-4-YP-09	13-Nov	BDL	192.0	38.4	BDL	9.9	2.0
Yellow perch	Iron Gate reservoir	IGR-4-YP-10	13-Nov	BDL	194.0	38.8	BDL	9.7	1.9
Yellow perch	Iron Gate reservoir	IGR-4-YP-11	13-Nov	BDL	217.0	43.4	BDL	11.8	2.4
Yellow perch	Iron Gate reservoir	IGR-4-YP-12	13-Nov	BDL	183.0	36.6	BDL	10.1	2.0
Yellow perch	Iron Gate reservoir	IGR-4-YP-13	13-Nov	BDL	174.0	34.8	BDL	9.8	2.0
Yellow perch	Iron Gate reservoir	IGR-4-YP-14	13-Nov	BDL	189.0	37.8	BDL	11.6	2.3

Table 9. Analysis Results of Microcystin in Muscle Tissues of Rainbow Trout, Yellow Perch, and Crappie Specimens, and Oregon Floater and Western Ridge Mussel Specimens Collected during November 2008 in the Vicinity of the Klamath Hydroelectric Project. (MDL: Method Detection Limit; BDL: below the MDL)

Species	Location	Sample ID	Date Collected	Total Free Microcystin Level	MDL (LCMS Full Scan)		SIM for RR, LR and LA Congeners Only	MDL (SIM Mode)	
					µg/kg dry wt.	µg/kg wet wt.		µg/kg dry wt.	µg/kg wet wt.
Yellow perch	Iron Gate reservoir	IGR-4-YP-15	13-Nov	BDL	184.0	36.8	BDL	10.6	2.1
Yellow perch	Iron Gate reservoir	IGR-4-YP-16	13-Nov	BDL	165.0	33.0	BDL	10.4	2.1
Yellow perch	Iron Gate reservoir	IGR-4-YP-17	13-Nov	BDL	214.0	42.8	BDL	12.0	2.4
Yellow perch	Iron Gate reservoir	IGR-4-YP-18	13-Nov	BDL	207.0	41.4	BDL	11.5	2.3
Yellow perch	Iron Gate reservoir	IGR-4-YP-19	13-Nov	BDL	195.0	39.0	BDL	10.7	2.1
Yellow perch	Iron Gate reservoir	IGR-4-YP-20	13-Nov	BDL	196.0	39.2	BDL	13.3	2.7
Yellow perch	Iron Gate reservoir	IGR-4-YP-20a	13-Nov	BDL	192.0	38.4	BDL	11.3	2.3
Crappie	Iron Gate reservoir	IGR-4-CR-01	13-Nov	BDL	211.0	42.2	BDL	17.0	3.4
Crappie	Iron Gate reservoir	IGR-4-CR-02	13-Nov	BDL	165.0	33.0	BDL	14.6	2.9
Crappie	Iron Gate reservoir	IGR-4-CR-03	13-Nov	BDL	689.0	137.8	BDL	50.8	10.2
Crappie	Iron Gate reservoir	IGR-4-CR-04	13-Nov	BDL	205.0	41.0	BDL	15.1	3.0
Crappie	Iron Gate reservoir	IGR-4-CR-05	13-Nov	BDL	178.0	35.6	BDL	16.9	3.4
Crappie	Iron Gate reservoir	IGR-4-CR-06	13-Nov	BDL	211.0	42.2	BDL	16.1	3.2
Rainbow trout	River above Copco	UKRC-4-RT-01	14-Nov	BDL	208.0	41.6	BDL	14.5	2.9
Rainbow trout	River above Copco	UKRC-4-RT-02	14-Nov	BDL	221.0	44.2	BDL	14.3	2.9
Rainbow trout	River above Copco	UKRC-4-RT-03	14-Nov	BDL	233.0	46.6	BDL	14.3	2.9
Rainbow trout	River above Copco	UKRC-4-RT-04	14-Nov	BDL	214.0	42.8	BDL	14.2	2.8
Rainbow trout	River above Copco	UKRC-4-RT-05	14-Nov	BDL	248.0	49.6	BDL	98.5	19.7

Table 9. Analysis Results of Microcystin in Muscle Tissues of Rainbow Trout, Yellow Perch, and Crappie Specimens, and Oregon Floater and Western Ridge Mussel Specimens Collected during November 2008 in the Vicinity of the Klamath Hydroelectric Project. (MDL: Method Detection Limit; BDL: below the MDL)

Species	Location	Sample ID	Date Collected	Total Free Microcystin Level	MDL (LCMS Full Scan)		SIM for RR, LR and LA Congeners Only	MDL (SIM Mode)	
					µg/kg dry wt.	µg/kg wet wt.		µg/kg dry wt.	µg/kg wet wt.
Rainbow trout	River above Copco	UKRC-4-RT-06	14-Nov	BDL	210.0	42.0	BDL	115.3	23.1
Rainbow trout	River above Copco	UKRC-4-RT-07	14-Nov	BDL	214.0	42.8	BDL	13.6	2.7
Rainbow trout	River above Copco	UKRC-4-RT-08	14-Nov	BDL	248.0	49.6	BDL	117.5	23.5
Rainbow trout	River above Copco	UKRC-4-RT-09	14-Nov	BDL	341.0	68.2	BDL	21.6	4.3
Rainbow trout	River above Copco	UKRC-4-RT-10	14-Nov	BDL	218.0	43.6	BDL	13.6	2.7
Rainbow trout	River above Copco	UKRC-4-RT-10a	14-Nov	BDL	231.0	46.2	BDL	115.7	23.1
Rainbow trout	River below Iron Gate	LKR-4-RT-01	12-Nov	BDL	208.0	41.6	BDL	12.2	2.4
Rainbow trout	River below Iron Gate	LKR-4-RT-02	12-Nov	BDL	181.0	36.2	BDL	12.0	2.4
Rainbow trout	River below Iron Gate	LKR-4-RT-03	12-Nov	BDL	213.0	42.6	BDL	13.6	2.7
Rainbow trout	River below Iron Gate	LKR-4-RT-04	12-Nov	BDL	192.0	38.4	BDL	12.3	2.5
Rainbow trout	River below Iron Gate	LKR-4-RT-05	12-Nov	BDL	227.0	45.4	BDL	11.9	2.4
Rainbow trout	River below Iron Gate	LKR-4-RT-06	12-Nov	BDL	223.0	44.6	BDL	13.0	2.6
Rainbow trout	River below Iron Gate	LKR-4-RT-07	12-Nov	BDL	224.0	44.8	BDL	115.5	23.1
Rainbow trout	River below Iron Gate	LKR-4-RT-08	12-Nov	BDL	230.0	46.0	BDL	13.9	2.8
Rainbow trout	River below Iron Gate	LKR-4-RT-09	12-Nov	BDL	229.0	45.8	BDL	116.5	23.3
Rainbow trout	River below Iron Gate	LKR-4-RT-09a	12-Nov	BDL	246.0	49.2	BDL	116.2	23.2
Oregon floater	River below Iron Gate	FFR1-04-OF-01	11-Nov	BDL	203.0	40.6	BDL	8.1	1.6
Oregon floater	River below Iron Gate	FFR1-04-OF-02	11-Nov	BDL	210.0	42.0	BDL	8.8	1.8

Table 9. Analysis Results of Microcystin in Muscle Tissues of Rainbow Trout, Yellow Perch, and Crappie Specimens, and Oregon Floater and Western Ridge Mussel Specimens Collected during November 2008 in the Vicinity of the Klamath Hydroelectric Project. (MDL: Method Detection Limit; BDL: below the MDL)

Species	Location	Sample ID	Date Collected	Total Free Microcystin Level	MDL (LCMS Full Scan)		SIM for RR, LR and LA Congeners Only	MDL (SIM Mode)	
					µg/kg dry wt.	µg/kg wet wt.		µg/kg dry wt.	µg/kg wet wt.
Oregon floater	River below Iron Gate	FFR1-04-OF-03	11-Nov	BDL	165.0	33.0	BDL	7.2	1.4
Oregon floater	River below Iron Gate	FFR2-04-WR-01	11-Nov	BDL	184.0	36.8	BDL	7.7	1.5
Oregon floater	River below Iron Gate	FFR2-04-OF-01	11-Nov	BDL	196.0	39.2	BDL	5.8	1.2
Oregon floater	River below Iron Gate	FFR2-04-OF-02	11-Nov	BDL	197.0	39.4	BDL	5.9	1.2
W. ridge mussel	River above Copco	PR1-04-WR-01	11-Nov	BDL	173.0	34.6	BDL	7.6	1.5
W. ridge mussel	River above Copco	PR1-04-WR-02	11-Nov	BDL	163.0	32.6	BDL	7.3	1.5
W. ridge mussel	River below Iron Gate	FFR3-04-WR-01	11-Nov	BDL	185.0	37.0	BDL	5.3	1.1
W. ridge mussel	River below Iron Gate	FFR3-04-WR-02	11-Nov	BDL	185.0	37.0	BDL	5.4	1.1
W. ridge mussel	River below Iron Gate	FFR3-04-WR-03	11-Nov	BDL	194.0	38.8	BDL	6.1	1.2
W. ridge mussel	River below Iron Gate	FFR4-04-WR-01	11-Nov	BDL	184.0	36.8	BDL	5.6	1.1
W. ridge mussel	River below Iron Gate	FFR4-04-WR-02	11-Nov	BDL	203.0	40.6	BDL	6.0	1.2
W. ridge mussel	River below Iron Gate	FFR4-04-WR-03	11-Nov	BDL	206.0	41.2	BDL	6.1	1.2

The MDL for the full-scan analysis of total free microcystins varied with sample and recovery from 2.1 to 137.8 µg/kg on a wet weight[14] (ww) basis, with an average MDL of 22.2 µg/kg ww. The MDL for the SIM mode analysis of the -LR, –LA, and -RR congeners varied with sample and recovery from 0.1 to 23.5 µg/kg ww, with an average MDL of 1.4 µg/kg ww. The average MDLs by species and sampling events for the full-scan analysis of total free microcystins and SIM mode analysis of the -LR, –LA, and -RR congeners are summarized in Table 10.

Table 10. Average Method Detection Limits (MDL) for LCMS Full-Scan Analysis of Total Free Microcystin and SIM Mode Analysis of Microcystin Cogeners LA, LR, and RR by Species and Sampling Events.

Species	Sampling Event	Number	Average MDL LCMS Full Scan (µg/kg wet wt.)	Average MDL SIM Mode (µg/kg wet wt.)
Yellow perch	May-June	41	6.2	0.2
	July	41	14.8	0.2
	September	42	20.7	0.4
	November	42	37.6	2.2
Crappie	May-June	7	4.1	0.2
	July	4	14.9	0.3
	September	13	19.7	0.2
	November	6	55.3	4.4
Rainbow trout	May-June	13	4.7	0.2
	July	20	20.9	0.3
	September	22	18.7	0.8
	November	21	45.3	9.4
Oregon floater	November	6	38.5	1.4
W. ridge mussel	November	8	37.3	1.2

[14] Wet weight is the weight of microcystin found in analysis divided by weight of the tissue before water is removed by drying.

Discussion

Potential Effects on Fish and Mussels in the Klamath River

Relevant Findings from the Research Literature

Research has demonstrated that feeding ingestion is the primary exposure route of fish and other aquatic biota to potential cyanobacterial toxins, including microcystin (Martins and Vasconcelos 2009, Ibelings and Havens 2008, Malbrouck and Kestemont 2006, Smith and Haney 2006). Little, if any, direct uptake by aquatic biota of dissolved microcystins in water occurs because microcystins tend to be quite water soluble and polar, and do not readily pass the lipid bilayer of membranes (Best et al. 2001, Karjalainen et al. 2005, Lurling and van der Grinten 2003, Ibelings and Havens 2008). Also, direct acute exposure of fish to high concentrations of dissolved microcystins is unlikely in the natural ecosystem because processes like mixing, adsorption to clay particles, photolysis, and bacterial degradation contribute to substantial temporal and spatial variability and reductions in dissolved microcystins (Kotak et al. 1996, Vanderploeg et al. 2001, Ozawa et al. 2005, Ibelings and Havens 2008).

The ingestion exposure route is particularly germane for organisms that directly feed on seston that includes cyanobacteria, such as zooplankton and filter feeding bivalves. Kotak et al. (1996) determined that the microcystin-LR detected in the zooplankton in four studied lakes in Canada was from microcystin present in ingested MSAE cells. Vanderploeg et al. (2001) describe that the toxicity and large colonial size of MSAE and other nuisance cyanobacteria can lower ingestion and assimilation rates of zooplankton. Prepas et al. (1997) found that the freshwater clam *Anodonta grandis simpsoniana* accumulated microcystins by grazing on MSAE.

For biota that do not feed directly on cyanobacteria, microcystins must reach them via the food web (Ibelings and Havens 2008, Malbrouck and Kestemont 2006). In general, the risk of being exposed to toxins via the food web is much increased if biomagnification takes place. Biomagnification is the transfer and concentration of a chemical as it moves up the food chain, resulting in a higher concentration in the organism than in its diet. This is commonly found for persistent lipophilic toxicants like polychlorinated biphenyls (PCBs), but does not occur for hydrophilic compounds like microcystins (Ibelings and Havens 2008). In fact, Ibelings and Havens (2008) and Karjalainen et al. (2005) conclude that rather than biomagnification, microcystins may be subject to biodilution in the foodweb whereby microcystin concentrations are decreased through the food chain due to metabolization and excretion at each trophic level.

Of the amount of microcystin ingested with the food, a relatively small percentage is actually taken up into the body. Ibelings and Chorus (2007) cite laboratory studies using dosing with purified microcystin that showed that 2.7 percent of the applied dose was taken up in *Daphnia* zooplankton tissues and 1.5 percent in liver tissues of rainbow trout. Ibelings and Chorus (2007) indicate that even the relatively small percentage of ingested microcystin

taken up into the body is subject to detoxification and excretion that dilute microcystin concentrations.

The presence of microcystins in fish depends on food consumption habits, and microcystin presence is considerably less in carnivorous than herbivorous fish species (Ibelings and Havens 2008, Gkelis et al. 2006). Thus, the feeding guild of the fish is a primary determinant of microcystin exposure and accumulation. The three resident fish species assessed in this study – rainbow trout, yellow perch, and crappie – are not herbivores, and so do not feed directly on algae containing microcystins. Rainbow trout are carnivorous, feeding on a variety of prey including insects, crustaceans, mollusks, fish and fish eggs (Wydoski and Whitney 2003). Yellow perch and crappie as juveniles feed on zooplankton prey, turning to aquatic insects, then small fishes as they grow older (Wydoski and Whitney 2003)

When uptake into the body occurs, the major accumulation site of microcystins in invertebrates and vertebrates is the digestive gland or liver (Vasconcelos 1995, Lance et al. 2006). Concentrations of microcystin are routinely shown to be much higher in fish liver than in other tissues (Fischer et al. 2000, Ibelings et al. 2005, Malbrouck and Kestemont 2006, Smith and Haney 2006, Ibelings and Havens 2008, Ibelings and Chorus 2007, Martins and Vasconcelos 2009). In a 2006 study of microcystin in the tissues of yellow perch exposed to a large bloom of MSAE in the western basin of Lake Erie, Wilson et al. (2008) found a substantial difference between muscle and liver tissue concentrations. The muscle microcystin concentrations of yellow perch were low, and represented only 0.8 percent on average of the concentrations found in liver tissue. Papadimitriou et al. (2009) indicate that preferential accumulation in the liver may be explained by the process known as presystematic hepatic elimination, which prevents or minimizes the distribution of foreign chemicals to other parts of the body.

Microcystins that accumulate in the body are subject to depuration whereby microcystin is subsequently eliminated from the body by physiological detoxification and excretion processes. Lance et al. (2006) describe the process by which accumulated microcystins can be metabolized into less harmful compounds, resulting in microcystin excretion or physiological degradation. Lance et al. (2006) showed that 64 percent of accumulated microcystin-LR in tissues of the freshwater snail *Lymnaea stagnalis* were eliminated during the first week free of microcystin-LR exposure, and 92 percent was eliminated after three weeks. Similar detoxification efficiency was reported by Zurawell et al. (2006), who determined that the cumulative microcystin loss from *L. stagnalis* was 95 percent after six days following the removal from exposure, and 99.5 percent after 30 days. A study by Prepas et al. (1997) found that, when the freshwater clam *A. grandis simpsoniana* was removed from microcystin exposure, 69 percent of the total accumulated microcystin-LR was eliminated from muscle tissue in the first six days.

In a controlled laboratory study, Tencalla and Dietrich (1997) orally injected rainbow trout with microcystin-LR doses equivalent to 5,700 µg/kg of body mass. They detected uptake of microcystin-LR into the liver that reached a peak concentration of 524 µg/kg in liver tissue after several hours, followed by a 92 percent reduction to an average concentration of 44 µg/kg after three days. In an accumulation and depuration experiment, Smith and Haney (2006) fed microcystin-rich zooplankton pellets to sunfish for nine days in the laboratory, and found that fish significantly decreased concentrations in their liver and muscle tissue

after six days of accumulation, indicating the induction of a detoxification and excretion pathway.

Ibelings and Havens (2008) suggest that, although depuration is commonly judged by researchers to be rapid, it appears that depuration may be incomplete even after a considerable period of time. For example, Prepas et al. (1997) determined that the elimination process by the freshwater clam *A. grandis simpsoniana* appeared to be biphasic – 69 percent of microcystin was lost from muscle tissues after six days, but increased only slightly to 81 percent at 21 days. Ibelings and Havens (2008) indicate that the rate of depuration is temperature dependent and slows down as temperatures cool, leaving the potential for remaining microcystin accumulation in late fall to be carried on to the following spring.

Discussion of 2008 Fish and Mussel Tissue Analyses

As described in the Results section, free microcystin was not detected in any of the muscle samples for fish or mussel specimens obtained for this study in 2008. The non-detection of free microcystin in these samples is likely explained by four primary factors:

(1) the seasonally-confined temporal period of potential exposure to microcystins during the summer cyanobacteria "bloom" period;

(2) the highly variable spatial distribution of microcystins in waters of the reservoirs during the summer "bloom" period;

(3) potential biodilution through the foodweb (as described above) that may have resulted in low levels of microcystin ingestion by the specimens in this study; and

(4) possibility of rapid depuration of microcystin (if accumulated) in tissues of the specimens in this study.

The non-detection of free microcystin in the samples obtained for this study does not necessarily mean that microcystins were absent in the tissues of these specimens. As discussed later in this section, it is possible that relatively low levels of microcystins were present below the method detection limits (MDL) for the analytical methods used to analyze the tissue samples (i.e., MDLs as listed in Tables 6 through 9 above).

The first of the four primary factors listed above is important because it dictates the period and duration of exposure of the sampled specimens to microcystin. The presence of microcystin in the Klamath River upstream and downstream of the Project reservoirs (i.e., Copco and Iron Gate reservoirs) is confined predominantly to the months of July, August, September, and October when cyanobacteria blooms are occurring in the upstream lakes and reservoirs in the system. Concentrations of microcystins in waters of the Klamath River in 2008 reached a peak in July and August of about 3 to 6 µg/L, and declined to non-detectable levels by early October (Figure 2). Therefore, the 2008 rainbow trout and mussel monitoring in the Klamath River spanned the period before, during, and after the time of detectable and highest waterborne concentrations in 2008 (Figure 2).

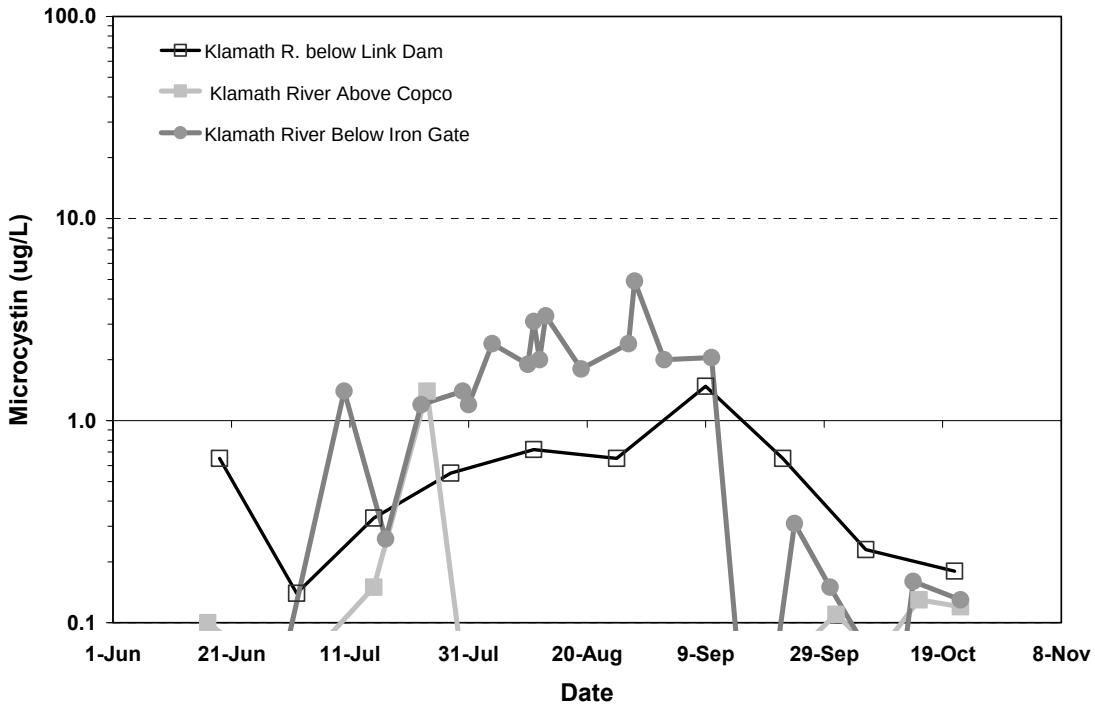

Figure 2. Microcystin data obtained in water samples at three Klamath River sites during May to November 2008. Note that the y-axis is logarithmic in scale.

The presence of microcystin in Copco and Iron Gate reservoirs also is confined predominantly to the months of July, August, September, and October when cyanobacteria blooms are occurring in the system. For example, concentrations of microcystins in surface waters at monitoring station in each reservoir (near the log boom) reached a peak of about 30 to 70 µg/L in July and August 2008, and declined to non-detectable levels by early October (Figure 3). Therefore, the 2008 yellow perch and crappie monitoring in Copco and Iron Gate reservoirs also spanned the period before, during, and after the time of detectable and highest waterborne concentrations in 2008 (Figure 3).

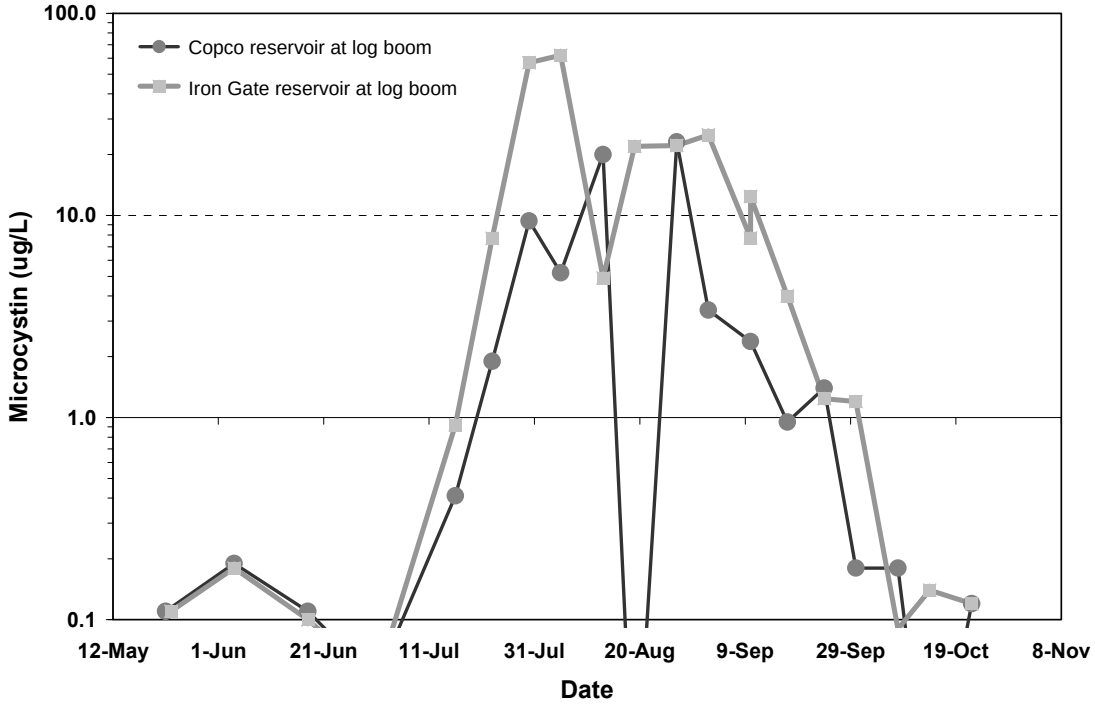

Figure 3. Microcystin data obtained in water samples from the surface waters over the deepest part (near the log boom) in Copco and Iron Gate reservoirs, May to November 2008. Note that the y-axis is logarithmic in scale.

Because of the seasonal nature of cyanobacteria blooms and microcystin in the system, exposure of resident fish and other aquatic biota (such as sampled in 2008) to microcystin is confined predominantly to the months of July, August, and September. Therefore, the non-detection of free microcystin in the samples obtained in this study, especially for the May-June and November sampling events (i.e., before and after the time of detectable and highest waterborne concentrations in 2008), is expected given the likelihood that microcystin, if accumulated, probably depurates within several days to a few weeks (as discussed above).

The highly variable spatial distribution of microcystins, when present, in waters of the reservoirs during the summer "bloom" period also is an important factor in dictating the exposure of the yellow perch and crappie specimens (taken from the reservoirs) to microcystin. During the course of 2008 water quality studies in the Project vicinity, a number of samples were taken to assess in-water concentrations of microcystin at shoreline and open water locations throughout both Copco and Iron Gate reservoirs (Raymond 2009, Kann and Corum 2009). Scatter plots of this data indicate that in-water concentrations of microcystin in the reservoirs during the summer "bloom" period in 2008 had a high spatial variability (Figure 4). For example, concentrations of microcystins in Copco reservoir on August 19, 2008 varied by over six orders of magnitude from near zero (i.e., below detection) in a surface water sample taken near Copco dam to 18,000 µg/L in a surface sample taken in algal scum at the shoreline in Copco Cove (both of these sample results were obtained on August 19 as reported by Kann and Corum 2009). As another example, on September 10, 2008, PacifiCorp took samples to assess in-water concentrations of

microcystin at various depths in Iron Gate reservoir in the forebay and near the log boom. The concentrations varied by two orders of magnitude from a high of 12.4 µg/L at the surface to values of 0.2 µg/L or less at all depths sampled below the surface (i.e., 10, 20, 30, and 40 meters) (Figure 5).

The high spatial variability of in-water concentrations of microcystin in the reservoirs, both laterally across the reservoir surface and vertically with depth, suggests that the exposure of sampled fish to microcystin was highly variable during the "bloom" season of 2008. While there is no evidence that fish can actively avoid high in-water concentrations of microcystin, it is apparent that the higher shoreline and surface water concentrations of microcystin (Figures 3 and 4) do not adequately represent concurrent exposure levels to yellow perch and crappie in the reservoirs. In a 2006 study of microcystin in the tissues of yellow perch exposed to a large bloom of MSAE in the western basin of Lake Erie, Wilson et al. (2008) did not rely on surface samples for estimating microcystin exposure, but rather used integrated samples through the water column "in part because yellow perch are rarely found near the lake surface". Highly variable concentrations in phytoplankton and microcystins were also identified as a key factor in microcystin occurrence and accumulation in studies by Kotak et al. (1996) and Ozawa et al. (2005).

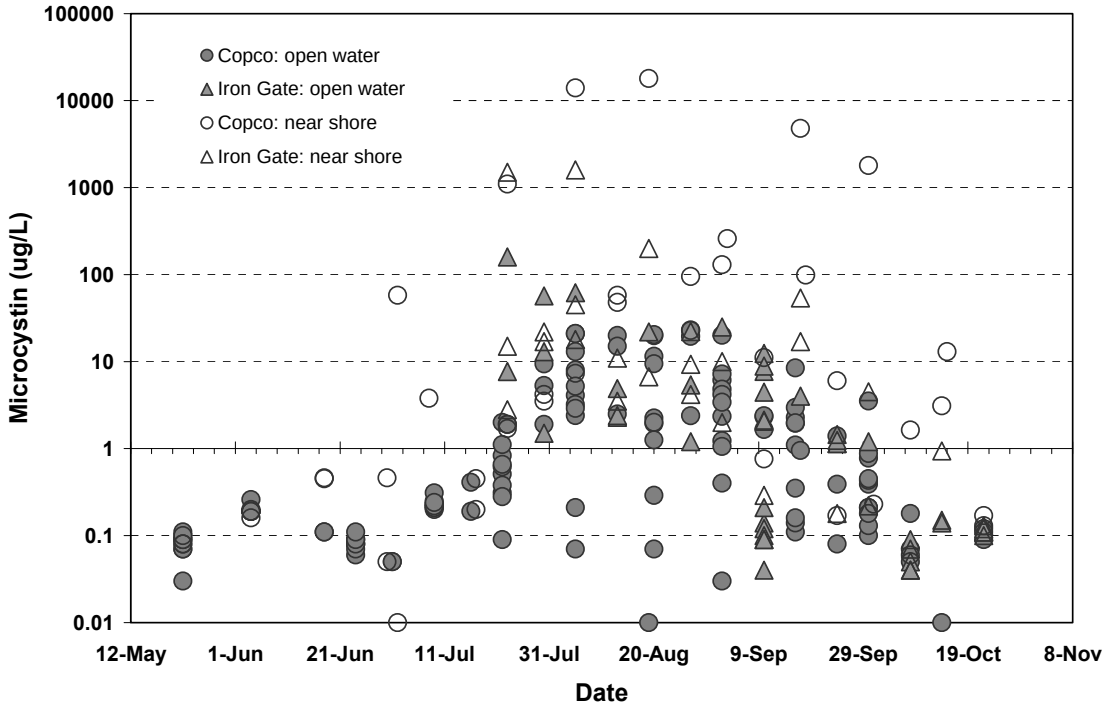

Figure 4. Microcystin data obtained in water samples from shoreline and open water locations throughout both Copco and Iron Gate reservoirs. May to November 2008. Note that the y-axis is logarithmic in scale.

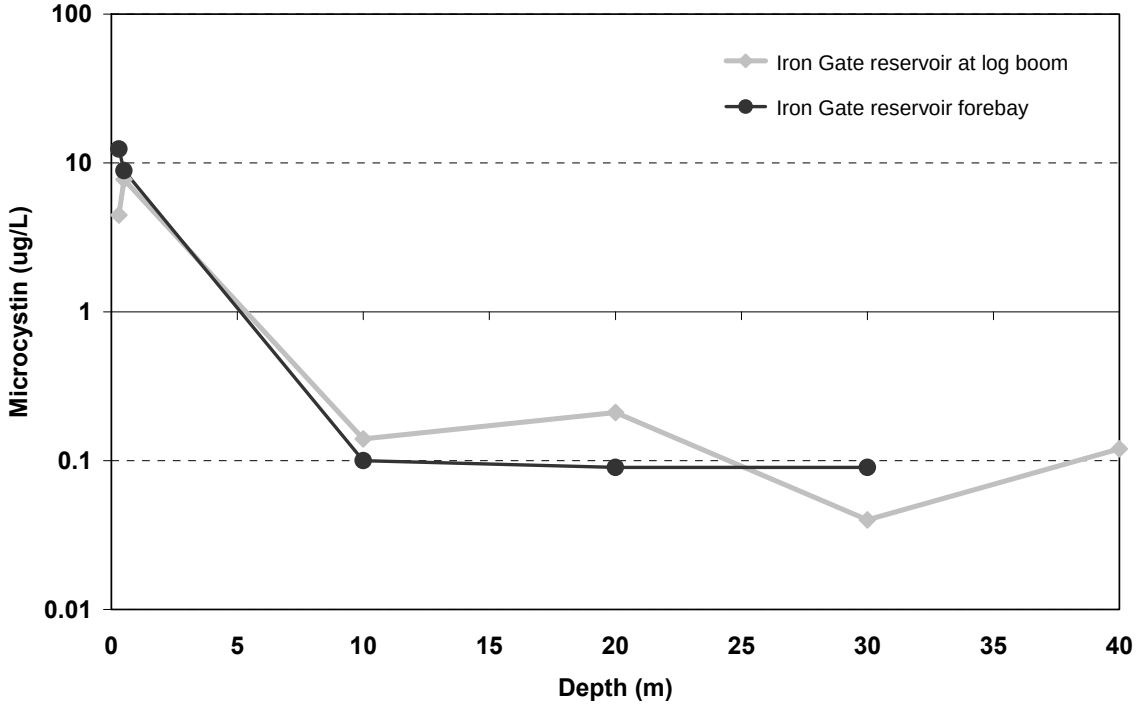

Figure 5. Data obtained on September 10, 2008 to assess in-water concentrations of microcystin at various depths in Iron Gate reservoir in the forebay and near the log boom. Note that the y-axis is logarithmic in scale.

Biodilution through the foodweb and physiological depuration processes could be other key factors that contributed to the non-detection of free microcystin in the 2008 tissue samples analyzed in this study. The research literature related to foodweb biodilution, and detoxification and depuration processes is described above. Ibelings et al. (2005) report that microcystin concentrations in fish tissues tend to be orders of magnitude lower than concentration in ambient water and its associated particulate matter (i.e., seston), due to ambient microbial degradation of microcystin, detoxification and depuration by the fish, and low biotic uptake via food-web transfer. Kotak et al. (1996) examined microcystin-LR concentrations in water, phytoplankton, invertebrates, and two fishes over three years in two hypereutrophic Canadian lakes with extensive summer cyanobacteria blooms (including MSAE and *Anabaena flos-aquae*). Within these two hypereutrophic lakes, Kotak et al. (1996) detected microcystin-LR in water, phytoplankton, and zooplankton. However, microcystin-LR was not detected among nine groups of macroinvertebrates (except in gastropods), and was not detected in the tissues of both sampled fish species – northern pike (*Esox lucius*) and white sucker (*Catostomus commersoni*). Kotak et al. (1996) suggested that a possible explanation for the absence of detectable microcystin-LR in macroinvertebrates and fish was that either microcystin-LR was not taken up from the water, or that given its high water solubility, the microcystin-LR was rapidly eliminated.

Comparison to 2007 Sample Results

Kann (2008) presented results of the microcystin analysis of fish and freshwater mussel tissues collected in the Klamath River in 2007. Included in the sample types reported by

Kann (2008) are 38 yellow perch muscle ("fillet") samples collected from Iron Gate and Copco reservoirs (19 samples from each reservoir) on September 6-7, 2007. These 38 perch muscle samples are the most directly comparable to those collected in this study in 2008. In contrast to the results of this study, Kann (2008) reported detectable levels of two microcystin congeners (i.e., -dmLR and –YR) in many of the perch muscle samples collected in 2007. Kann (2008) reported that levels were non-detect in all perch muscle samples for the other six congeners assessed, including –LA, -LF, -LW, -LR, -RR, and -dmRR.

The specific reasons are unknown for the difference between the non-detect results of the 2008 perch muscle samples and the detectable levels of -dmLR and –YR congeners in many of the 2007 samples reported by Kann (2008). The data tables in Kann (2008) indicate that the dmLR congener was detected in 25 of the 38 samples (66 percent) at relatively high levels of 57 to 422 µg/kg ww, and the –YR congener was detected in 16 of the 38 samples (42 percent) at relatively low levels of 2.5 to 4.2 µg/kg ww. By contrast, as described above, microcystin, including -dmLR and –YR congeners, were not found at detectable levels in any of the 2008 fish tissue samples.

The difference between 2007 and 2008 samples may be a result of change in MSAE and microcystin between the two years. Raymond (2009) indicates that the median biovolume and range of variability of MSAE was substantially lower in 2008 than 2007 in both reservoirs. Monitoring data also suggests that microcystin concentrations in both reservoirs were at consistently lower levels in 2008 than 2007 (Figure 6). Research indicates that there can be considerable temporal and spatial variation and fluctuation – even within a given water body – in MSAE strains and the production of microcystin, including demethylated forms of microcystin (Mikalsen et al. 2003, Via-Ordorika et al. 2004). Therefore, a difference in results from samples collected in two separate years is plausible and perhaps to be expected.

A second possible explanation for the difference between 2007 and 2008 samples may be due to variation in analytical methods. Kann (2008) used a more selective LCMS-MS technique to achieve a lower detection limit for a limited number of microcystins. However, this possible explanation would apply only to the –YR congener and not the -dmLR congener. For the -dmLR congener, both the SIM and full scan method used in 2008 would have been able to detect -dmLR at the concentrations reported for 2007 by Kann (2008). For the –YR congener, the relatively low levels of 2.5 to 4.2 µg/kg ww reported by Kann (2008) would have been below the detection limit for the full scan method utilized in 2008 (as previously discussed, the average MDL for the full scan method was 22.2 µg/kg ww). The more sensitive SIM method was not used to look at the -YR congener at this time. Rather, SIM analysis in this study targeted the -LR, –LA, and -RR congeners for reasons as explained above.

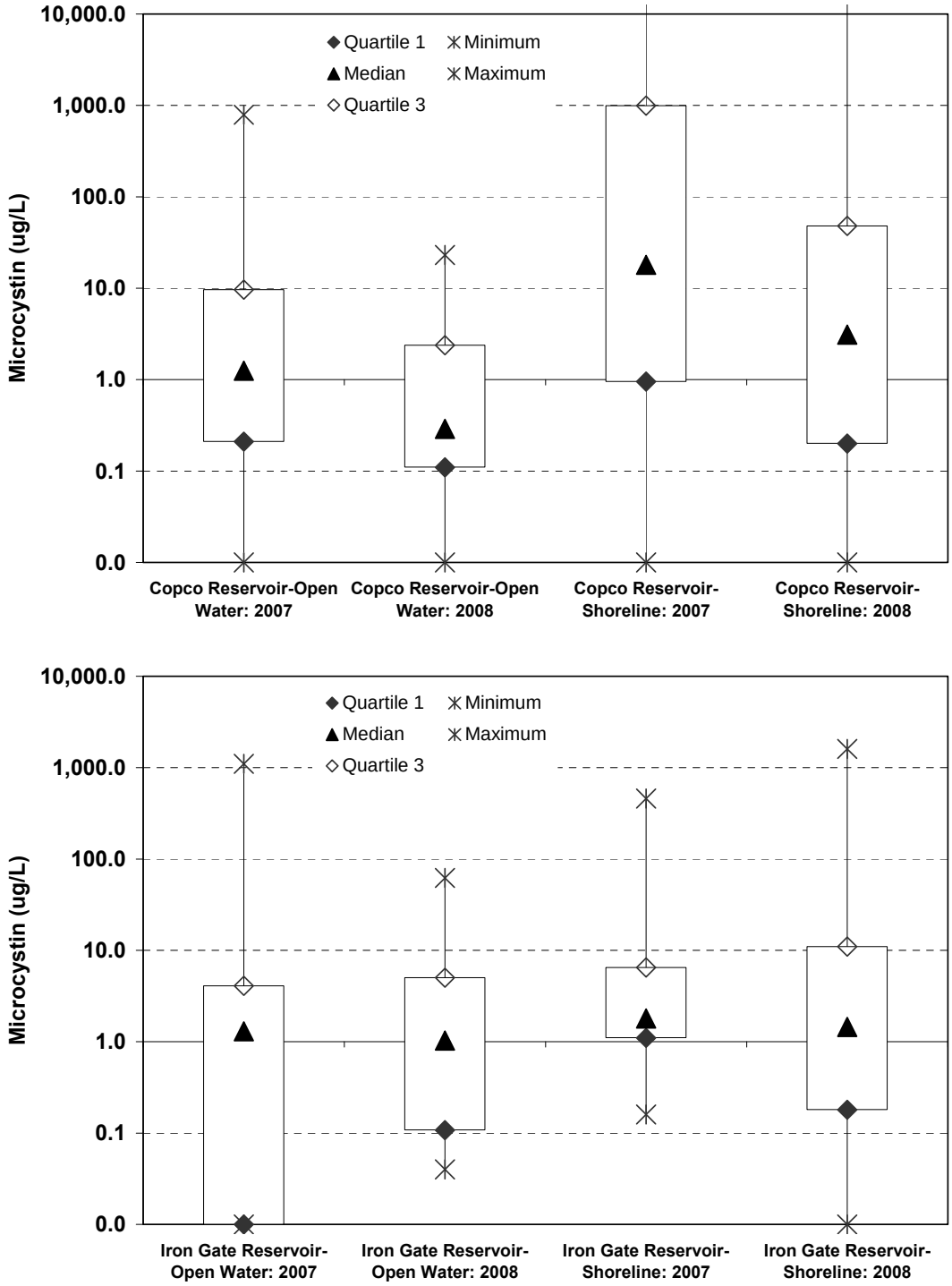

Figure 6. Box plots showing the distribution of microcystin data obtained at open water and shoreline sites in Copco and Iron Gate reservoir in May to November 2007 and 2008. Box plots graphically depict groups of numerical data through their five-number summaries: the smallest observation (sample minimum), lower quartile (Q1), median (Q2), upper quartile (Q3), and largest observation (sample maximum). Note that the y-axis is logarithmic in scale.

Analysis with Respect to Public Health Guideline Values

Relevant Findings from the Research Literature

Microcystin-LR, -LA, -YR, and –RR are generally considered the most-commonly occurring microcystin congeners resulting from cyanobacterial blooms (Butler et al. 2009). Other minor congeners include microcystin-LL, -LF, -LV, and –LM, which are hydrophobic variants that occur in very small quantities relative to the hydrophilic ones, like microcystin-LR (Svrcek and Smith 2004). The toxicities of these microcystin congeners are shown to vary in research conducted to date, based mostly on bioassays using mice (Fisher et al. 2001, Svrcek and Smith 2004). Toxicity is highest for microcystin-LR and –LA (both have a reported LD50[15] of 50 µg/kg as estimated from intra-peritoneal injections in mice). Microcystin-YR is slightly less toxic (LD50 of 70 µg/kg), and microcystin–RR is about ten-fold less toxic (LD50 of 600 µg/kg) (Kuiper-Goodman et al. 1999, Svrcek and Smith 2004).

The primary mode of toxicity of microcystins towards mammals is the inhibition of protein-phosphatase, especially in the liver, due to microcystin intoxication (Runnegar et al. 1993). The variation in toxicities of the microcystin variants depends mainly on differences in molecular structure that affect the affinity for binding with protein-phosphatase (e.g., including the degree of methylation of the amino acids, or isomerization[16] of the "Adda chain") (Fisher et al. 2001, Svrcek and Smith 2004). Alternately, certain structural modifications to the "Adda chain"[17] of the microcystin molecule, such as a change in isomerization, can render the microcystin non-toxic (Sivonen and Jones 1999, Fisher et al. 2001). For example, Kaya and Sano (1998) showed that, with sunlight exposure, non-toxic Adda isomerization occurs and microcystins are decomposed. Sivonen and Jones (1999) indicate that linear forms of microcystins that occur as a product of bacterial breakdown are more than 100 times less toxic than the equivalent cyclic forms of microcystins.

Ibelings and Chorus (2007) evaluated cyanotoxin doses that may occur through human consumption of freshwater fish, and proposed guideline values for tolerable microcystin concentrations in freshwater fish tissues subject to consumption. The guideline values proposed by Ibelings and Chorus (2007) for freshwater "seafood" included a "Lifetime TDI" derived based on the Tolerable Daily Intake (TDI) of microcystin-LR of 0.04 µg/kg-day proposed by the World Health Organization (WHO). This TDI was defined by WHO as an estimate of the tolerable intake of microcystin-LR over a lifetime (WHO 2006), and is likewise referred by Ibelings and Chorus (2007) as the "Lifetime TDI".

The No Observed Adverse Effects Level (NOAEL)[18] assumed by WHO (2006) equals 40 mg/kg body weight (bw), based on slight effects in liver histopathology and serum enzyme level changes detected in a three-month study by Fawell et al. (1999) using chronic oral exposure of mice to pure microcystin-LR. The NOAEL of 40 mg/kg bw was then divided by

[15] An LD50 is a standard measurement of acute toxicity represents the individual dose required to kill 50 percent of a population of test animals (e.g., mice). The lower the LD50 dose, the more toxic the substance.

[16] The chemical process by which a compound is transformed into any of its isomeric forms, i.e., forms with the same chemical composition but with different structure or configuration and, hence, generally with different physical and chemical properties.

[17] Addaglutamate region of the microcystin molecule.

[18] NOAEL denotes the highest tested dose or concentration at which no adverse effect was found in exposed test organisms where higher doses or concentrations resulted in an adverse effect.

a total Uncertainty Factor of 1000 to derive the TDI of 0.04 µg/kg-day. The Uncertainty Factor included multiplication factors of 10 applied twice – one for intra-species variability and one for inter-species variability, which Ibelings and Chorus (2007) note is a common practice in TDI derivation. The Uncertainty Factor assumed by WHO (2006) included a third factor of 10 to account for additional uncertainty assumed because of the extrapolation of the three-month study to lifetime exposure. Ibelings and Chorus (2007) indicate that the use a total Uncertainty Factor of 1000 implies protection in the worst case, but is justified given the limited amount of information available to assess chronic microcystin-LR toxicity.

Ibelings and Chorus (2007) also derived an "Acute TDI" to calculate what they considered a safe dose for a single exposure (consumption) event. The "Acute TDI" derived by Ibelings and Chorus (2007) was the maximum tolerable dose for a single exposure event of 2.5 µg/kg bw determined by Fromme et al. (1999) based on extrapolations from acute toxicity studies of mice exposed to single abdominal injections of microcystin-LR.

Between the Lifetime TDI and Acute TDI, Ibelings and Chorus (2007) derived a "Seasonal TDI" to calculate a safe dose for the more-likely scenario for microcystin exposure from freshwater fish consumption; that is, assuming daily consumption for several weeks during the cyanobacteria "bloom" season. To derive the Seasonal TDI, Ibelings and Chorus (2007) used the NOAEL of 40 mg/kg bw derived by WHO (2006) using the Fawell et al. (1999) study results. However, in this case, Ibelings and Chorus (2007) left out the Uncertainty Factor of 10 that was used for extrapolating from a three-month study to lifetime exposure, leading to a Seasonal TDI of 0.4 mg per kg bw (leaving a residual Uncertainty Factor of 100).

For calculating final guideline values for freshwater "seafood" consumption, Ibelings and Chorus (2007) multiplied the Acute TDI, Seasonal TDI, and Lifetime TDI values by the body weight for an adult person (assumed at a nominal 75 kg) and a child (assumed at a nominal 10 kg), and then divided that product by a daily amount of fish meat ingested (assumed at a nominal 100 g fish per day). The respective guideline values are listed in Table 11. Because the values derived by Ibelings and Chorus (2007) are on a wet-weight (ww) basis, Table 11 also includes values converted to a dry-weight (dw) basis (assuming a fish tissue moisture content of 75 percent per Clark and Maret [1998]) so as to allow easier comparison to the tissue analysis results presented in the Results section of this report.

Table 11. Guideline values for freshwater fish consumption derived from Ibelings and Chorus (2007).

TDI Category	TDI Value (µg/kg)	Guideline Value (µg/kg wet weight)		Guideline Value (µg/kg dry weight)	
		Adult	Child	Adult	Child
Acute	2.5	1900	250	7600	1000
Seasonal	0.4	300	40	1200	160
Lifetime	0.04	30	4	120	16

Discussion of 2008 Fish and Mussel Tissue Analyses

As presented in the Results section of this report, free microcystin was not detected in any of the 2008 fish or mussel samples at the specified MDL. Although free microcystin was not detected in fish filet (muscle) samples or whole mussels at the specified MDL, it cannot be ruled out that microcystin was present at levels less than the MDL (i.e., below the ability of the analytical method to quantify it). This consideration is relevant if guidance values are less than (i.e., below) the MDL.

For this study, it is most appropriate to consider the TDI guideline levels (which are based on microcystin-LR) of Ibelings and Chorus (2007) relative to the MDLs of the SIM mode analysis. The SIM mode analysis specifically includes analysis of both microcystin-LR and –LA (in addition to –RR) – the two most common and potentially-toxic congeners. Also, as previously mentioned, analysis by the SUNY-CESF laboratory indicated that the -LA congener was the predominant congener in algal samples from the Project reservoirs collected in 2008. This suggests that the -LA congener was the predominant congener at the base of the foodweb from which fish and mussel tissue accumulation would derive.

The MDL of the SIM mode analysis (which incorporates analysis of microcystin-LR, along with microcystin–LA and –RR) in the fish filet and mussel samples varied with sample type and recovery from 0.1 to 23.5 µg/kg ww, with an overall average MDL of 1.4 µg/kg ww. The average MDLs of the SIM mode analysis by species are 0.8 µg/kg ww for yellow perch, 1.1 µg/kg ww for crappie, 3.0 µg/kg ww for rainbow trout, 1.4 µg/kg ww for Oregon floater, and 1.2 µg/kg ww for western ridge mussel. The average MDLs of the SIM mode analysis by species by season are summarized in Table 10.

The MDLs of the SIM mode analysis for all five species are less than (i.e., below) the guidance value for Acute TDI of microcystin-LR for an adult or child. This indicates that single-event, single-meal consumption of such fish filet and mussel tissues would pose no unacceptable health risk. The seasonal (i.e., sampling event-based) average MDLs of the SIM mode analysis for all five species also are less than the guidance value for Seasonal TDI of microcystin-LR for an adult or child, indicating that daily consumption of such fish filet and mussel tissues over several weeks would pose no unacceptable health risk. The overall average MDLs of the SIM mode analysis for all five species (i.e., average across the four seasonal sampling events) also are less than the guidance value for Lifetime TDI of microcystin-LR for an adult or child, indicating that daily consumption over a lifetime of such fish filet and mussel tissues would pose no unacceptable health risk.

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Appendix A:
SUNY-CESF Laboratory Reports

Appendix A:
SUNY-CESF Laboratory Reports

Klamath Fish Muscle Tissues : free microcystins **September 27, 2008**

ESF number	Sample ID	Date collected	Date 1st Analyzed	Total Dry Weight (g)	Recovery of internal std	TOTAL Free Microcystin levels	Method Detection Limit (µg/kg dw)	SIM for MCs- RR, LR and LA only	Method Detection Limit (µg/kg dw)
08-720	IGR-01-YP-01	5/29/2008	5-Sep	0.356	74%	Below detection	<60.3	Non-detect	<1.8
08-721	IGR-01-YP-02	5/29/2008	5-Sep	0.563	78%	Below detection	<60.5	Non-detect	<1.6
08-722	IGR-01-YP-03	5/29/2008	5-Sep	0.567	66%	Below detection	<62.2	Non-detect	<2.0
08-723	IGR-01-YP-04	5/29/2008	5-Sep	0.515	77%	Below detection	<61.8	Non-detect	<1.6
08-724	IGR-01-YP-05	5/29/2008	5-Sep	0.748	78%	Below detection	<60.6	Non-detect	<1.6
08-725	IGR-01-YP-06	5/29/2008	5-Sep	1.056	51%	Below detection	<61.1	Non-detect	<2.4
08-726	IGR-01-YP-07	5/29/2008	5-Sep	1.099	78%	Below detection	<61.4	Non-detect	<1.6
08-727	IGR-01-YP-08	5/29/2008	5-Sep	1.166	72%	Below detection	<60.3	Non-detect	<1.5
08-728	IGR-01-YP-09	5/29/2008	5-Sep	1.131	68%	Below detection	<61.0	Non-detect	<1.8
08-729	IGR-01-YP-10	5/29/2008	5-Sep	0.667	78%	Below detection	<61.9	Non-detect	<1.7
08-730	IGR-01-YP-11	5/29/2008	5-Sep	0.569	60%	Below detection	<57.1	Non-detect	<1.8
08-731	IGR-01-YP-12	5/29/2008	5-Sep	0.890	64%	Below detection	<62.2	Non-detect	<1.8
08-732	IGR-01-YP-13	5/29/2008	5-Sep	0.952	78%	Below detection	<62.1	Non-detect	<1.5
08-733	IGR-01-YP-14	5/29/2008	5-Sep	0.995	70%	Below detection	<57.1	Non-detect	<1.6
08-734	IGR-01-YP-15	5/29/2008	25-Sep	0.870	68%	Below detection	<19.1	Non-detect	<1.1
08-735	IGR-01-YP-15	5/29/2008	25-Sep	0.713	42%	Below detection	<19.2	Non-detect	<2.4
08-736	IGR-01-YP-17	5/29/2008	25-Sep	0.897	67%	Below detection	<19.1	Non-detect	<1.2
08-737	IGR-01-YP-18	5/29/2008	25-Sep	0.985	68%	Below detection	<19.1	ambiguous	na
08-738	IGR-01-YP-19	5/29/2008	25-Sep	0.892	104%	Below detection	<19.1	Non-detect	<0.5
08-739	IGR-01-YP-20a	5/29/2008	25-Sep	1.501	69%	Below detection	<19.1	Non-detect	<1.1
08-740	IGR-01-YP-20b	5/29/2008	25-Sep	1.340	71%	Below detection	<19.2	Non-detect	<0.9
08-741	IGR-01-YP-21a	5/29/2008	25-Sep	0.719	78%	Below detection	<19.1	Non-detect	<0.9
08-1094	IGR-01-YP-21b		17-Sep	1.045	66%	Below detection	<21.9	broken	na
08-742	IGR-01-CR-01	5/29/2008	17-Sep	1.072	62%	Below detection	<21.3	Non-detect	<1.0
08-743	COP-1-YP-01	5/28/2008	17-Sep	0.692	83%	Below detection	<21.1	Non-detect	<0.8
08-744	COP-1-YP-02	5/28/2008	25-Sep	0.595	67%	Below detection	<19.1	Non-detect	<1.0

ESF number	Sample ID	Date collected	Date 1st Analyzed	Total Dry Weight (g)	Recovery of internal std	TOTAL Free Microcystin levels	Method Detection Limit (µg/kg dw)	SIM for MCs- RR, LR and LA only	Method Detection Limit (µg/kg dw)
08-745	COP-1-YP-03	5/28/2008	17-Sep	1.115	56%	Below detection	<21.04	Non-detect	<1.5
08-746	COP-1-YP-04	5/28/2008	17-Sep	0.844	91%	Below detection	<20.94	Non-detect	<0.7
08-747	COP-1-YP-05	5/29/2008	17-Sep	1.286	95%	Below detection	<21.29	Non-detect	<0.7
08-748	COP-1-YP-06	5/29/2008	17-Sep	1.744	92%	Below detection	<21.18	Non-detect	<0.8
08-749	COP-1-YP-07	5/29/2008	25-Sep	1.199	65%	Below detection	<19.12	Non-detect	<1.1
08-750	COP-1-YP-08	5/29/2008	17-Sep	1.349	94%	Below detection	<21.39	Non-detect	<0.8
08-751	COP-1-YP-09	5/29/2008	17-Sep	0.988	85%	Below detection	<21.79	Non-detect	<1.0
08-752	COP-1-YP-10	5/29/2008	17-Sep	1.135	86%	Below detection	<21.56	Non-detect	<0.8
08-753	COP-1-YP-11	5/29/2008	17-Sep	1.693	79%	Below detection	<21.88	Non-detect	<1.0
08-754	COP-1-YP-12	5/29/2008	17-Sep	1.407	88%	Below detection	<21.86	Non-detect	<0.8
08-755	COP-1-YP-13	5/29/2008	17-Sep	1.650	97%	Below detection	<21.25	Non-detect	<0.7
08-756	COP-1-YP-14	5/29/2008	17-Sep	1.024	107%	Below detection	<21.20	Non-detect	<0.6
08-757	COP-1-YP-15	5/29/2008	17-Sep	1.286	80%	Below detection	<21.97	Non-detect	<1.0
08-758	COP-1-YP-16	5/29/2008	17-Sep	1.061	82%	Below detection	<21.79	Non-detect	<1.1
08-759	COP-1-YP-17	5/29/2008	17-Sep	1.926	106%	Below detection	<21.99	Non-detect	<0.5
08-760	COP-1-YP-18	5/29/2008	17-Sep	1.479	103%	Below detection	<21.18	Non-detect	<0.6
08-761	LKR-1-RT-01	5/28/2008	17-Sep	3.877	78%	Below detection	<21.93	Non-detect	<1.0
08-762	LKR-1-RT-02	6/7/2008	17-Sep	1.241	77%	Below detection	<21.86	Non-detect	<1.1
08-763	LKR-1-RT-03	6/7/2008	17-Sep	1.415	78%	Below detection	<21.84	Non-detect	<1.0
08-764	LKR-1-RT-04	6/7/2008	17-Sep	3.831	66%	Below detection	<21.79	Non-detect	<1.2
08-765	LKR-1-RT-05a	6/13/2008	17-Sep	2.112	80%	Below detection	<21.79	Non-detect	<1.1
08-766	LKR-1-RT-05b	6/13/2008	17-Sep	2.071	89%	Below detection	<21.84	Non-detect	<1.0
08-767	COP-1-CR-01	5/29/2008	17-Sep	1.926	61%	Below detection	<21.97	Non-detect	<1.4
08-768	COP-1-CR-02	5/29/2008	17-Sep	0.874	54%	Below detection	<21.60	Non-detect	<1.4
08-769	COP-1-CR-03	5/29/2008	17-Sep	1.025	81%	Below detection	<22.75	Non-detect	<0.9
08-770	COP-1-CR-04	5/29/2008	17-Sep	1.082	77%	Below detection	<22.19	Non-detect	<1.0

ESF number	Sample ID	Date collected	Date 1st Analyzed	Total Dry Weight (g)	Recovery of internal std	TOTAL Free Microcystin levels	Method Detection Limit (µg/kg dw)	SIM for MCs- RR, LR and LA only	Method Detection Limit (µg/kg dw)
08-771	COP-1-CR-05a	5/29/2008	17-Sep	1.972	68%	Below detection	<21.99	Non-detect	<1.3
08-772	COP-1-CR-05b	5/29/2008	17-Sep	1.769	66%	Below detection	<21.31	Non-detect	<1.1
08-773	UKRC-1-RT-01	6/19/2008	17-Sep	1.045	96%	Below detection	<21.12	Non-detect	<0.8
08-774	UKRC-1-RT-02	6/19/2008	17-Sep	1.108	62%	Below detection	<22.17	ambiguous	na
08-775	UKRC-1-RT-03	6/19/2008	17-Sep	1.443	104%	Below detection	<21.18	Non-detect	<0.7
08-776	UKRC-1-RT-04	6/19/2008	25-Sep	0.582	72%	Below detection	<19.12	Non-detect	<1.1
08-777	UKRC-1-RT-05	6/19/2008	17-Sep	0.830	107%	Below detection	<21.79	Non-detect	<0.7
08-778	UKRC-1-RT-06	6/19/2008	17-Sep	1.459	84%	Below detection	<21.79	Non-detect	<1.0
08-779	UKRC-1-RT-07	6/19/2008	17-Sep	0.887	75%	Below detection	<21.99	Non-detect	<1.1

Klamath Fish Muscle Tissues : free microcystins **October 21st 2008 (revised December 27th)**

ESF number	Sample ID	Date collected	Date 1st Analyzed	Total Dry Weight (g)	Recovery of internal std	TOTAL Free Microcystin levels	Method Detection Limit (µg/kg dw)	SIM for MCs- RR, LR and LA only	Sample Detection Limit (µg/kg dw)
08-882	IGR-2-YP-01, muscle	7/15/2008	15-Oct	0.792	91%	Below detection	<84.9	Non-detect	<1.0
08-883	IGR-2-YP-02, muscle	7/15/2008	15-Oct	1.304	81%	Below detection	<84.8	Non-detect	<1.0
08-884	IGR-2-YP-03, muscle	7/15/2008	15-Oct	0.759	77%	Below detection	<84.8	Non-detect	<1.0
08-885	IGR-2-YP-04, muscle	7/15/2008	15-Oct	1.009	83%	Below detection	<84.7	Non-detect	<0.9
08-886	IGR-2-YP-05, muscle	7/15/2008	15-Oct	1.292	75%	Below detection	<85.3	Non-detect	<1.1
08-887	IGR-2-YP-06, muscle	7/15/2008	15-Oct	0.875	66%	Below detection	<85.2	Non-detect	<1.2
08-888	IGR-2-YP-07, muscle	7/15/2008	15-Oct	1.143	62%	Below detection	<84.7	Non-detect	<1.3
08-889	IGR-2-YP-08, muscle	7/15/2008	15-Oct	1.158	43%	Below detection	<84.5	Non-detect	<1.9
08-890	IGR-2-YP-09, muscle	7/15/2008	15-Oct	1.016	75%	Below detection	<84.5	Non-detect	<1.1
08-891	IGR-2-YP-10, muscle	7/15/2008	15-Oct	1.350	81%	Below detection	<84.5	Non-detect	<1.0
08-892	IGR-2-YP-11, muscle	7/15/2008	15-Oct	1.330	70%	Below detection	<85.1	Non-detect	<1.1
08-893	LKR-2-RT-01, muscle	7/15/2008	15-Oct	1.688	85%	Below detection	<85.2	Non-detect	<1.0
08-894	LKR-2-RT-02, muscle	7/15/2008	15-Oct	1.191	79%	Below detection	<84.7	Non-detect	<1.0
08-895	LKR-2-RT-03, muscle	7/15/2008	15-Oct	1.639	83%	Below detection	<85.1	Non-detect	<1.0
08-896	LKR-2-RT-04, muscle	7/15/2008	15-Oct	3.011	78%	Below detection	<85.2	Non-detect	<1.0
08-897	LKR-2-RT-05, muscle	7/15/2008	15-Oct	1.773	83%	Below detection	<85.1	Non-detect	<1.0
08-898	LKR-2-RT-06, muscle	7/15/2008	15-Oct	2.576	90%	Below detection	<84.7	Non-detect	<0.9
08-899	LKR-2-RT-07, muscle	7/15/2008	15-Oct	1.027	85%	Below detection	<84.8	Non-detect	<1.0
08-900	LKR-2-RT-08, muscle	7/15/2008	15-Oct	1.072	79%	Below detection	<82.7	Non-detect	<1.0
08-901	LKR-2-RT-09, muscle	7/15/2008	15-Oct	1.812	88%	Below detection	<82.1	Non-detect	<1.0
08-902	LKR-2-RT-10, muscle	7/15/2008	15-Oct	2.587	83%	Below detection	<82.6	Non-detect	<1.0
08-903	IGR-2-YP-12, muscle	7/15/2008	15-Oct	1.133	96%	Below detection	<82.5	Non-detect	<1.0
08-904	IGR-2-YP-13, muscle	7/15/2008	15-Oct	1.256	95%	Below detection	<82.8	Non-detect	<1.0
08-905	IGR-2-YP-14, muscle	7/15/2008	15-Oct	1.318	72%	Below detection	<82.4	Non-detect	<1.3

ESF number	Sample ID	Date collected	Date 1st Analyzed	Total Dry Weight (g)	Recovery of internal std	TOTAL Free Microcystin levels	Method Detection Limit (µg/kg dw)	SIM for MCs- RR, LR and LA only	Sample Detection Limit (µg/kg dw)
08-906	IGR-2-YP-15, muscle	7/15/2008	15-Oct	0.656	64%	Below detection	<82.7	Non-detect	<1.8
08-907	IGR-2-YP-16, muscle	7/15/2008	15-Oct	0.722	60%	Below detection	<82.2	Non-detect	<1.8
08-908	IGR-2-YP-17, muscle	7/15/2008	15-Oct	0.945	60%	Below detection	<82.7	Non-detect	<1.7
08-909	IGR-2-YP-18, muscle	7/15/2008	15-Oct	0.984	83%	Below detection	<82.7	Non-detect	<1.1
08-910	IGR-2-YP-19, muscle	7/15/2008	15-Oct	1.042	80%	Below detection	<82.3	Non-detect	<1.2
08-911	IGR-2-YP-19b, muscle	7/15/2008	15-Oct	0.611	59%	Below detection	<82.8	Non-detect	<1.7
08-912	IGR-2-CR-01, muscle	7/15/2008	15-Oct	1.736	83%	Below detection	<82.6	Non-detect	<1.0
08-913	COP-2-YP-01, muscle	7/15/2008	15-Oct	0.700	62%	Below detection	<82.4	Non-detect	<1.6
08-914	COP-2-YP-02, muscle	7/16/2008	15-Oct	1.042	47%	Below detection	<82.9	Non-detect	<2.2
08-915	COP-2-YP-03, muscle	7/16/2008	15-Oct	0.563	57%	Below detection	<82.2	Non-detect	<1.7
08-916	COP-2-YP-04, muscle	7/16/2008	15-Oct	0.520	68%	Below detection	<82.1	Non-detect	<1.5
08-917	COP-2-YP-05, muscle	7/16/2008	15-Oct	1.093	67%	Below detection	<82.7	Non-detect	<1.5
08-918	COP-2-YP-06, muscle	7/16/2008	15-Oct	1.082	95%	Below detection	<82.8	Non-detect	<1.0
08-919	COP-2-YP-07, muscle	7/16/2008	15-Oct	0.980	93%	Below detection	<82.7	Non-detect	<1.0
08-920	COP-2-YP-08, muscle	7/16/2008	15-Oct	1.384	81%	Below detection	<82.4	Non-detect	<1.1
08-921	COP-2-YP-09, muscle	7/16/2008	15-Oct	0.856	88%	Below detection	<82.5	Non-detect	<0.9
08-922	COP-2-YP-10, muscle	7/16/2008	15-Oct	1.143	83%	Below detection	<82.4	Non-detect	<0.9
08-923	COP-2-YP-11, muscle	7/16/2008	15-Oct	1.457	148%	Below detection	<82.5	Non-detect	<0.5
08-924	COP-2-YP-12, muscle	7/16/2008	15-Oct	1.228	96%	Below detection	<82.1	Non-detect	<0.8
08-925	COP-2-YP-13, muscle	7/16/2008	15-Oct	1.298	77%	Below detection	<82.3	Non-detect	<1.0
08-926	COP-2-YP-14, muscle	7/16/2008	15-Oct	1.454	68%	Below detection	<82.7	Non-detect	<1.2
08-927	COP-2-YP-15, muscle	7/16/2008	15-Oct	1.092	73%	Below detection	<82.3	Non-detect	<1.1
08-928	COP-2-YP-16, muscle	7/16/2008	15-Oct	1.169	67%	Below detection	<82.2	Non-detect	<1.2
08-929	COP-2-YP-17, muscle	7/16/2008	15-Oct	1.778	64%	Below detection	<82.8	Non-detect	<1.2
08-930	COP-2-YP-18, muscle	7/16/2008	15-Oct	1.330	60%	Below detection	<82.9	Non-detect	<1.3

ESF number	Sample ID	Date collected	Date 1st Analyzed	Total Dry Weight (g)	Recovery of internal std	TOTAL Free Microcystin levels	Method Detection Limit (µg/kg dw)	SIM for MCs- RR, LR and LA only	Sample Detection Limit (µg/kg dw)
08-931	COP-2-YP-19, muscle	7/16/2008	15-Oct	1.163	73%	Below detection	<82.4	Non-detect	<1.5
08-932	COP-2-YP-20, muscle	7/16/2008	15-Oct	1.822	74%	Below detection	<82.4	Non-detect	<1.4
08-933	COP-2-YP-20b, muscle	7/16/2008	15-Oct	1.102	80%	Below detection	<82.1	Non-detect	<1.3
08-934	COP-2-CR-01, muscle	7/16/2008	15-Oct	1.910	57%	Below detection	<82.6	Non-detect	<1.7
08-935	COP-2-CR-02, muscle	7/16/2008	15-Oct	1.183	67%	Below detection	<82.1	Non-detect	<1.5
08-936	COP-2-CR-03, muscle	7/16/2008	15-Oct	1.209	74%	Below detection	<82.4	Non-detect	<1.3
08-937	UKRC-2-RT-01, muscle	7/16/2008	15-Oct	2.408	62%	Below detection	<82.4	Non-detect	<1.7
08-938	UKRC-2-RT-02, muscle	7/16/2008	15-Oct	2.670	67%	Below detection	<82.5	Non-detect	<1.6
08-939	UKRC-2-RT-03, muscle	7/16/2008	15-Oct	1.101	67%	Below detection	<82.1	Non-detect	<1.6
08-940	UKRC-2-RT-04, muscle	7/16/2008	15-Oct	1.677	62%	Below detection	<82.2	Non-detect	<1.6
08-941	UKRC-2-RT-05, muscle	7/16/2008	15-Oct	1.645	54%	Below detection	<82.4	Non-detect	<1.8
08-942	UKRC-2-RT-06, muscle	7/16/2008	20-Oct	1.436	68%	Below detection	<82.8	Non-detect	<1.4
08-943	UKRC-2-RT-07, muscle	7/16/2008	20-Oct	1.585	67%	Below detection	<82.3	Non-detect	<1.4
08-944	UKRC-2-RT-08, muscle	7/16/2008	20-Oct	1.617	79%	Below detection	<82.4	Non-detect	<1.2
08-945	UKRC-2-RT-09, muscle	7/16/2008	20-Oct	1.426	63%	Below detection	<82.3	Non-detect	<1.5
08-946	UKRC-2-RT-9b, muscle	7/16/2008	20-Oct	1.302	77%	Below detection	<82.1	Non-detect	<1.2

Klamath Fish Muscle Tissues : free microcystins **December 28th 2008**

ESF number	Sample ID	Date collected	Date 1st Analyzed	Total Dry Weight (g)	Recovery of internal std	TOTAL Free Microcystin levels	Method Detection Limit (µg/kg dw)	SIM for MCs- RR, LR and LA only	Sample Detection Limit (µg/kg dw)
08-1141	LKR-3-RT-01	9/9/2008	1-Dec	1.647	72%	Below detection	<85.4	Non-detect	<4.6
08-1142	LKR-3-RT-02	9/9/2008	1-Dec	1.360	74%	Below detection	<85.9	Non-detect	<4.2
08-1143	LKR-3-RT-03	9/9/2008	1-Dec	0.781	68%	Below detection	<85.5	Non-detect	<4.7
08-1144	LKR-3-RT-04	9/9/2008	1-Dec	0.662	136%	Below detection	<85.2	Non-detect	<2.0
08-1145	LKR-3-RT-05	9/9/2008	1-Dec	1.067	73%	Below detection	<85.2	Non-detect	<3.8
08-1146	LKR-3-RT-06	9/9/2008	1-Dec	0.815	70%	Below detection	<85.7	Non-detect	<3.9
08-1147	LKR-3-RT-07	9/9/2008	1-Dec	1.476	75%	Below detection	<85.1	Non-detect	<3.7
08-1148	LKR-3-RT-08	9/9/2008	1-Dec	0.515	70%	Below detection	<85.4	Non-detect	<4.3
08-1149	LKR-3-RT-09	9/9/2008	1-Dec	0.208	77%	Below detection	<85.6	Non-detect	<3.8
08-1150	LKR-3-RT-10	9/9/2008	1-Dec	1.142	71%	Below detection	<85.3	Non-detect	<4.0
08-1151	LKR-3-RT-11	9/9/2008	1-Dec	0.632	74%	Below detection	<85.2	Non-detect	<3.7
08-1152	LKR-3-RT-11a	9/9/2008	1-Dec	1.189	83%	Below detection	<85.1	Non-detect	<3.3
08-1153	UKRC-3-RT-01	9/10/2008	1-Dec	1.453	76%	Below detection	<85.2	Non-detect	<3.7
08-1154	UKRC-3-RT-02	9/10/2008	1-Dec	0.908	76%	Below detection	<85.4	Non-detect	<4.1
08-1155	UKRC-3-RT-03	9/10/2008	1-Dec	1.228	74%	Below detection	<85.6	Non-detect	<4.3
08-1156	UKRC-3-RT-04	9/10/2008	1-Dec	1.433	76%	Below detection	<85.8	Non-detect	<3.9
08-1157	UKRC-3-RT-05	9/10/2008	1-Dec	0.877	77%	Below detection	<85.2	Non-detect	<4.1
08-1158	UKRC-3-RT-06	9/10/2008	1-Dec	0.582	74%	Below detection	<85.6	Non-detect	<4.2
08-1159	UKRC-3-RT-07	9/10/2008	1-Dec	1.132	74%	Below detection	<85.1	Non-detect	<3.9
08-1160	UKRC-3-RT-08	9/10/2008	1-Dec	1.109	77%	Below detection	<85.3	Non-detect	<4.0
08-1161	UKRC-3-RT-09	9/10/2008	1-Dec	1.236	60%	Below detection	<85.3	Non-detect	<5.2
08-1162	UKRC-3-RT-9a	9/10/2008	1-Dec	1.129	100%	Below detection	<85.7	Non-detect	<1.3
08-1163	IGR-3-YP-01	9/9/2008	1-Dec	0.608	75%	Below detection	<85.1	Non-detect	<3.6
08-1164	IGR-3-YP-02	9/9/2008	1-Dec	0.740	72%	Below detection	<85.3	Non-detect	<4.6
08-1165	IGR-3-YP-03	9/9/2008	19-Dec	0.484	49%	Below detection	<72.4	Non-detect	<1.4

ESF number	Sample ID	Date collected	Date 1st Analyzed	Total Dry Weight (g)	Recovery of internal std	TOTAL Free Microcystin levels	Method Detection Limit (µg/kg dw)	SIM for MCs- RR, LR and LA only	Sample Detection Limit (µg/kg dw))
08-1166	IGR-3-YP-04	9/9/2008	1-Dec	0.957	70%	Below detection	<85.2	Non-detect	<4.1
08-1167	IGR-3-YP-05	9/9/2008	1-Dec	0.555	55%	Below detection	<85.1	Non-detect	<5.8
08-1168	IGR-3-YP-06	9/9/2008	1-Dec	0.587	159%	Below detection	<85.1	Non-detect	<1.8
08-1169	IGR-3-YP-07	9/9/2008	1-Dec	0.917	74%	Below detection	<85.7	Non-detect	<4.4
08-1170	IGR-3-YP-08	9/9/2008	1-Dec	1.335	75%	Below detection	<85.7	Non-detect	<4.4
08-1171	IGR-3-YP-09	9/9/2008	1-Dec	0.786	95%	Below detection	<85.6	Non-detect	<3.0
08-1172	IGR-3-YP-10	9/9/2008	1-Dec	1.168	95%	Below detection	<85.2	Non-detect	<3.4
08-1173	IGR-3-YP-11	9/9/2008	1-Dec	1.048	97%	Below detection	<85.3	Non-detect	<3.2
08-1174	IGR-3-YP-12	9/9/2008	1-Dec	1.134	76%	Below detection	<85.4	Non-detect	<3.8
08-1175	IGR-3-YP-13	9/9/2008	1-Dec	0.854	109%	Below detection	<85.8	Non-detect	<2.8
08-1176	IGR-3-YP-14	9/9/2008	1-Dec	0.802	103%	Below detection	<85.4	Non-detect	<3.1
08-1177	IGR-3-YP-15	9/9/2008	1-Dec	1.070	117%	Below detection	<85.6	Non-detect	<2.7
08-1178	IGR-3-YP-16	9/9/2008	1-Dec	1.026	86%	Below detection	<85.2	Non-detect	<3.6
08-1179	IGR-3-YP-17	9/9/2008	1-Dec	1.076	101%	Below detection	<85.9	Non-detect	<3.0
08-1180	IGR-3-YP-18	9/9/2008	1-Dec	1.087	81%	Below detection	<85.2	Non-detect	<3.9
08-1181	IGR-3-YP-19	9/9/2008	5-Dec	1.140	82%	Below detection	<124.9	Non-detect	<1.0
08-1182	IGR-3-YP-20	9/9/2008	5-Dec	1.051	83%	Below detection	<124.1	Non-detect	<1.0
08-1183	IGR-3-YP-20a	9/9/2008	5-Dec	1.153	86%	Below detection	<123.8	Non-detect	<1.0
08-1184	IGR-3-CR-01	9/9/2008	5-Dec	0.780	83%	Below detection	<124.3	Non-detect	<1.1
08-1185	IGR-3-CR-02	9/9/2008	19-Dec	0.883	39%	Below detection	<72.8	Non-detect	<2.6
08-1186	IGR-3-CR-03	9/9/2008	5-Dec	0.940	76%	Below detection	<124.9	Non-detect	<1.3
08-1187	IGR-3-CR-04	9/9/2008	5-Dec	2.001	79%	Below detection	<123.7	Non-detect	<1.3
08-1188	IGR-3-CR-05	9/9/2008	5-Dec	1.130	79%	Below detection	<124.2	Non-detect	<1.3
08-1189	IGR-3-CR-06	9/9/2008	5-Dec	0.789	73%	Below detection	<124.1	Non-detect	<1.3
08-1190	IGR-3-CR-07	9/9/2008	5-Dec	1.414	68%	Below detection	<124.6	Non-detect	<1.4

ESF number	Sample ID	Date collected	Date 1st Analyzed	Total Dry Weight (g)	Recovery of internal std	TOTAL Free Microcystin levels	Method Detection Limit (µg/kg dw)	SIM for MCs- RR, LR and LA only	Sample Detection Limit (µg/kg dw)
08-1191	IGR-3-CR-08	9/9/2008	5-Dec	1.127	68%	Below detection	<124.4	Non-detect	<1.4
08-1192	IGR-3-CR-09	9/9/2008	5-Dec	0.988	70%	Below detection	<124.6	Non-detect	<1.4
08-1193	IGR-3-CR-10	9/9/2008	5-Dec	0.764	74%	Below detection	<124.2	Non-detect	<1.3
08-1194	IGR-3-CR-10a	9/9/2008	5-Dec	0.599	63%	Below detection	<124.9	Non-detect	<1.5
08-1195	COP-3-YP-01	9/9/2008	5-Dec	0.589	80%	Below detection	<124.7	Non-detect	<1.3
08-1196	COP-3-YP-02	9/9/2008	5-Dec	1.075	81%	Below detection	<123.8	Non-detect	<1.3
08-1197	COP-3-YP-03	9/9/2008	5-Dec	1.236	12%	Below detection	<124.3	Non-detect	<8.0
08-1198	COP-3-YP-04	9/9/2008	5-Dec	0.606	80%	Below detection	<123.7	Non-detect	<1.2
08-1199	COP-3-YP-05	9/9/2008	5-Dec	1.512	72%	Below detection	<124.7	Non-detect	<1.0
08-1200	COP-3-YP-06	9/9/2008	5-Dec	1.066	86%	Below detection	<124.3	Non-detect	<1.1
08-1201	COP-3-YP-07	9/9/2008	5-Dec	0.845	81%	Below detection	<124.2	Non-detect	<1.1
08-1202	COP-3-YP-08	9/9/2008	5-Dec	1.979	75%	Below detection	<124.4	Non-detect	<1.0
08-1203	COP-3-YP-09	9/9/2008	5-Dec	0.731	81%	Below detection	<123.7	Non-detect	<1.0
08-1204	COP-3-YP-10	9/9/2008	5-Dec	1.910	69%	Below detection	<123.7	Non-detect	<1.3
08-1205	COP-3-YP-11	9/9/2008	5-Dec	1.289	71%	Below detection	<123.7	Non-detect	<1.3
08-1206	COP-3-YP-12	9/9/2008	5-Dec	1.861	76%	Below detection	<124.2	Non-detect	<1.3
08-1207	COP-3-YP-13	9/9/2008	5-Dec	0.684	77%	Below detection	<124.9	Non-detect	<1.2
08-1208	COP-3-YP-14	9/9/2008	5-Dec	1.178	74%	Below detection	<123.8	Non-detect	<1.2
08-1209	COP-3-YP-15	9/9/2008	5-Dec	1.325	137%	Below detection	<124.4	Non-detect	<0.6
08-1210	COP-3-YP-16	9/9/2008	5-Dec	1.096	79%	Below detection	<124.6	Non-detect	<1.1
08-1211	COP-3-YP-17	9/9/2008	5-Dec	1.595	71%	Below detection	<124.1	Non-detect	<1.3
08-1212	COP-3-YP-18	9/9/2008	5-Dec	1.017	70%	Below detection	<124.7	Non-detect	<1.1
08-1213	COP-3-YP-19	9/9/2008	5-Dec	0.815		Below detection	<123.8	Non-detect	<1.1
08-1214	COP-3-YP-20	9/9/2008	5-Dec	1.258	80%	Below detection	<123.7	Non-detect	<1.1
08-1215	COP-3-YP-20a	9/9/2008	5-Dec	1.299	61%	Below detection	<124.8	Non-detect	<1.3
08-1216	COP-3-CR-01	9/10/2008	5-Dec	0.452	47%	Below detection	<124.6	Non-detect	<1.9
08-1217	COP-3-CR-02	9/10/2008	19-Dec	1.197	35%	Below detection	<72.8	Non-detect	<2.8

State University of New York
COLLEGE OF ENVIRONMENTAL SCIENCE AND FORESTRY

Klamath Fish Muscle Tissues : free microcystins **September 28, 2009**

ESF number	Sample ID	Date collected	Date 1st Analyzed	Extracted Dry Weight (g)	Recovery of internal std	TOTAL Free Microcystin levels	Method Detection Limit (µg/kg dw)	SIM for MCs- RR, LR and LA only	Sample Detection Limit (µg/kg dw)
08-1496	COP-4-YP-01	11/13/2008	6/15/09	0.101	120%	Below detection	122	Below detection	14.19
08-1497	COP-4-YP-02	11/13/2008	6/15/09	0.101	84%	Below detection	175	Below detection	11.41
08-1498	COP-4-YP-03	11/13/2008	6/15/09	0.101	85%	Below detection	172	Below detection	11.32
08-1499	COP-4-YP-04	11/13/2008	6/15/09	0.101	84%	Below detection	174	Below detection	10.57
08-1500	COP-4-YP-05	11/13/2008	6/15/09	0.101	76%	Below detection	193	Below detection	10.32
08-1501	COP-4-YP-06	11/13/2008	6/15/09	0.099	66%	Below detection	225	Below detection	12.53
08-1502	COP-4-YP-07	11/13/2008	6/15/09	0.100	78%	Below detection	190	Below detection	11.04
08-1503	COP-4-YP-08	11/13/2008	6/15/09	0.101	82%	Below detection	177	Below detection	10.07
08-1504	COP-4-YP-09	11/13/2008	6/15/09	0.100	87%	Below detection	172	Below detection	11.37
08-1505	COP-4-YP-10	11/13/2008	6/15/09	0.100	89%	Below detection	167	Below detection	10.39
08-1506	COP-4-YP-11	11/13/2008	6/15/09	0.099	82%	Below detection	182	Below detection	11.00
08-1507	COP-4-YP-12	11/13/2008	6/15/09	0.101	131%	Below detection	112	Below detection	9.11
08-1508	COP-4-YP-13	11/13/2008	6/15/09	0.098	75%	Below detection	199	Below detection	12.20
08-1509	COP-4-YP-14	11/13/2008	6/15/09	0.100	79%	Below detection	188	Below detection	11.08
08-1510	COP-4-YP-15	11/13/2008	6/15/09	0.101	78%	Below detection	187	Below detection	12.14
08-1511	COP-4-YP-16	11/13/2008	6/15/09	0.099	78%	Below detection	192	Below detection	13.11
08-1512	COP-4-YP-17	11/13/2008	6/15/09	0.101	82%	Below detection	178	Below detection	9.42
08-1513	COP-4-YP-18	11/13/2008	6/15/09	0.099	68%	Below detection	218	Below detection	11.56
08-1514	COP-4-YP-19	11/13/2008	6/15/09	0.101	74%	Below detection	198	Below detection	9.36
08-1515	COP-4-YP-20	11/13/2008	6/15/09	0.098	77%	Below detection	197	Below detection	10.77
08-1516	COP-4-YP-20a	11/13/2008	6/15/09	0.100	79%	Below detection	188	Below detection	9.49
08-1517	IGR-4-YP-01	11/13/2008	6/15/09	0.099	72%	Below detection	207	Below detection	11.95
08-1518	IGR-4-YP-02	11/13/2008	6/15/09	0.100	67%	Below detection	220	Below detection	12.40
08-1519	IGR-4-YP-03	11/13/2008	6/15/09	0.102	83%	Below detection	177	Below detection	11.09
08-1520	IGR-4-YP-04	11/13/2008	6/15/09	0.100	68%	Below detection	217	Below detection	12.24

ESF number	Sample ID	Date collected	Date 1st Analyzed	Extracted Dry Weight (g)	Recovery of internal std	TOTAL Free Microcystin levels	Method Detection Limit (µg/kg dw)	SIM for MCs- RR, LR and LA only	Sample Detection Limit (µg/kg dw))
08-1521	IGR-4-YP-05	11/13/2008	6/15/09	0.099	71%	Below detection	211	Below detection	12.04
08-1522	IGR-4-YP-06	11/13/2008	6/15/09	0.102	71%	Below detection	206	Below detection	11.66
08-1523	IGR-4-YP-07	11/13/2008	6/15/09	0.100	74%	Below detection	199	Below detection	11.47
08-1524	IGR-4-YP-08	11/13/2008	6/15/09	0.101	92%	Below detection	159	Below detection	10.20
08-1525	IGR-4-YP-09	11/13/2008	6/15/09	0.100	77%	Below detection	192	Below detection	9.93
08-1526	IGR-4-YP-10	11/13/2008	6/15/09	0.100	77%	Below detection	194	Below detection	9.72
08-1527	IGR-4-YP-11	11/13/2008	6/15/09	0.101	68%	Below detection	217	Below detection	11.80
08-1528	IGR-4-YP-12	11/13/2008	6/15/09	0.101	80%	Below detection	183	Below detection	10.12
08-1529	IGR-4-YP-13	11/13/2008	6/15/09	0.100	85%	Below detection	174	Below detection	9.83
08-1530	IGR-4-YP-14	11/13/2008	6/15/09	0.101	78%	Below detection	189	Below detection	11.60
08-1531	IGR-4-YP-15	11/13/2008	6/15/09	0.102	79%	Below detection	184	Below detection	10.57
08-1532	IGR-4-YP-16	11/13/2008	6/15/09	0.101	89%	Below detection	165	Below detection	10.40
08-1533	IGR-4-YP-17	11/13/2008	6/15/09	0.101	69%	Below detection	214	Below detection	12.03
08-1534	IGR-4-YP-18	11/13/2008	6/15/09	0.102	70%	Below detection	207	Below detection	11.45
08-1535	IGR-4-YP-19	11/13/2008	6/15/09	0.100	76%	Below detection	195	Below detection	10.70
08-1536	IGR-4-YP-20	11/13/2008	6/15/09	0.099	76%	Below detection	196	Below detection	13.29
08-1537	IGR-4-YP-20a	11/13/2008	6/15/09	0.100	77%	Below detection	192	Below detection	11.33
08-1538	IGR-4-CR-01	11/13/2008	6/15/09	0.099	71%	Below detection	211	Below detection	17.01
08-1539	IGR-4-CR-02	11/13/2008	6/15/09	0.100	90%	Below detection	165	Below detection	14.61
08-1540	IGR-4-CR-03	11/13/2008	6/15/09	0.100	22%	Below detection	689	Below detection	50.79
08-1541	IGR-4-CR-04	11/13/2008	6/15/09	0.100	72%	Below detection	205	Below detection	15.09
08-1542	IGR-4-CR-05	11/13/2008	6/15/09	0.101	83%	Below detection	178	Below detection	16.89
08-1543	IGR-4-CR-06	11/13/2008	6/15/09	0.102	69%	Below detection	211	Below detection	16.14
08-1544	LKR-4-RT-01	11/12/2008	6/15/09	0.100	72%	Below detection	208	Below detection	12.20
08-1545	LKR-4-RT-02	11/12/2008	6/15/09	0.100	82%	Below detection	181	Below detection	12.00

ESF number	Sample ID	Date collected	Date 1st Analyzed	Extracted Dry Weight (g)	Recovery of internal std	TOTAL Free Microcystin levels	Method Detection Limit (µg/kg dw)	SIM for MCs- RR, LR and LA only	Sample Detection Limit (µg/kg dw)
08-1546	LKR-4-RT-03	11/12/2008	6/15/09	0.100	69%	Below detection	213	Below detection	13.64
08-1547	LKR-4-RT-04	11/12/2008	6/15/09	0.100	77%	Below detection	192	Below detection	12.33
08-1548	LKR-4-RT-05	11/12/2008	6/15/09	0.101	65%	Below detection	227	Below detection	11.89
08-1549	LKR-4-RT-06	11/12/2008	6/15/09	0.100	66%	Below detection	223	Below detection	12.99
08-1550	LKR-4-RT-07	11/12/2008	6/15/09	0.100	66%	Below detection	224	Below detection	115.49
08-1551	LKR-4-RT-08	11/12/2008	6/15/09	0.100	65%	Below detection	230	Below detection	13.93
08-1552	LKR-4-RT-09	11/12/2008	6/15/09	0.099	65%	Below detection	229	Below detection	116.45
08-1553	LKR-4-RT-09a	11/12/2008	6/15/09	0.100	60%	Below detection	246	Below detection	116.16
08-1554	UKRC-4-RT-01	11/14/2008	6/15/09	0.099	72%	Below detection	208	Below detection	14.48
08-1555	UKRC-4-RT-02	11/14/2008	6/15/09	0.100	67%	Below detection	221	Below detection	14.29
08-1556	UKRC-4-RT-03	11/14/2008	6/15/09	0.100	64%	Below detection	233	Below detection	14.32
08-1557	UKRC-4-RT-04	11/14/2008	6/15/09	0.102	68%	Below detection	214	Below detection	14.24
08-1558	UKRC-4-RT-05	11/14/2008	6/15/09	0.100	60%	Below detection	248	Below detection	98.47
08-1559	UKRC-4-RT-06	11/14/2008	6/15/09	0.099	71%	Below detection	210	Below detection	115.29
08-1560	UKRC-4-RT-07	11/14/2008	6/15/09	0.100	69%	Below detection	214	Below detection	13.59
08-1561	UKRC-4-RT-08	11/14/2008	6/15/09	0.099	60%	Below detection	248	Below detection	117.46
08-1562	UKRC-4-RT-09	11/14/2008	6/15/09	0.099	44%	Below detection	341	Below detection	21.58
08-1563	UKRC-4-RT-10	11/14/2008	6/15/09	0.100	68%	Below detection	218	Below detection	13.57
08-1564	UKRC-4-RT-10a	11/14/2008	6/15/09	0.099	65%	Below detection	231	Below detection	115.70
08-1565	PR1-04-WR-01	11/11/2008	8/13/09	0.101	88%	Below detection	173	Below detection	7.58
08-1566	PR1-04-WR-02	11/11/2008	8/13/09	0.099	95%	Below detection	163	Below detection	7.26
08-1567	FFR1-04-OF-01	11/11/2008	8/13/09	0.101	75%	Below detection	203	Below detection	8.08
08-1568	FFR1-04-OF-02	11/11/2008	8/13/09	0.099	74%	Below detection	210	Below detection	8.81
08-1569	FFR1-04-OF-03	11/11/2008	8/13/09	0.099	94%	Below detection	165	Below detection	7.22
08-1570	FFR2-04-WR-01	11/11/2008	8/13/09	0.100	83%	Below detection	184	Below detection	7.74

ESF number	Sample ID	Date collected	Date 1st Analyzed	Extracted Dry Weight (g)	Recovery of internal std	TOTAL Free Microcystin levels	Method Detection Limit (µg/kg dw)	SIM for MCs- RR, LR and LA only	Sample Detection Limit (µg/kg dw)
08-1571	FFR2-04-OF-01	11/11/2008	8/13/09	0.101	78%	Below detection	196	Below detection	5.75
08-1572	FFR2-04-OF-02	11/11/2008	8/13/09	0.100	78%	Below detection	197	Below detection	5.88
08-1573	FFR3-04-WR-01	11/11/2008	8/13/09	0.100	83%	Below detection	185	Below detection	5.26
08-1574	FFR3-04-WR-02	11/11/2008	8/13/09	0.101	82%	Below detection	185	Below detection	5.39
08-1575	FFR3-04-WR-03	11/11/2008	8/13/09	0.100	79%	Below detection	194	Below detection	6.14
08-1576	FFR4-04-WR-01	11/11/2008	8/13/09	0.101	83%	Below detection	184	Below detection	5.60
08-1577	FFR4-04-WR-02	11/11/2008	8/13/09	0.100	75%	Below detection	203	Below detection	5.98
08-1578	FFR4-04-WR-03	11/11/2008	8/13/09	0.100	75%	Below detection	206	Below detection	6.07

Klamath Fish Muscle Tissues : DeMethyl LR Group 1 **March 17, 2009**

ESF number	Sample ID	Date collected	Date 1st Analyzed	Total Dry Weight (g)	Recovery of internal std	TOTAL Free Microcystin levels	Method Detection Limit (µg/kg dw)	Extracted Demethyl LR	Extracted Demethyl RR
08-720	IGR-01-YP-01	5/29/2008	5-Sep	0.356	74%	Below detection	<60.3	Non-detect	Non-detect
08-721	IGR-01-YP-02	5/29/2008	5-Sep	0.563	78%	Below detection	<60.5	Non-detect	Non-detect
08-722	IGR-01-YP-03	5/29/2008	5-Sep	0.567	66%	Below detection	<62.2	Non-detect	Non-detect
08-723	IGR-01-YP-04	5/29/2008	5-Sep	0.515	77%	Below detection	<61.8	Non-detect	Non-detect
08-724	IGR-01-YP-05	5/29/2008	5-Sep	0.748	78%	Below detection	<60.6	Non-detect	Non-detect
08-725	IGR-01-YP-06	5/29/2008	5-Sep	1.056	51%	Below detection	<61.1	Non-detect	Non-detect
08-726	IGR-01-YP-07	5/29/2008	5-Sep	1.099	78%	Below detection	<61.4	Non-detect	Non-detect
08-727	IGR-01-YP-08	5/29/2008	5-Sep	1.166	72%	Below detection	<60.3	Non-detect	Non-detect
08-728	IGR-01-YP-09	5/29/2008	5-Sep	1.131	68%	Below detection	<61.0	Non-detect	Non-detect
08-729	IGR-01-YP-10	5/29/2008	5-Sep	0.667	78%	Below detection	<61.9	Non-detect	Non-detect
08-730	IGR-01-YP-11	5/29/2008	5-Sep	0.569	60%	Below detection	<57.1	Non-detect	Non-detect
08-731	IGR-01-YP-12	5/29/2008	5-Sep	0.890	64%	Below detection	<62.2	Non-detect	Non-detect
08-732	IGR-01-YP-13	5/29/2008	5-Sep	0.952	78%	Below detection	<62.1	Non-detect	Non-detect
08-733	IGR-01-YP-14	5/29/2008	5-Sep	0.995	70%	Below detection	<57.1	Non-detect	Non-detect
08-734	IGR-01-YP-15	5/29/2008	25-Sep	0.870	68%	Below detection	<19.1	Non-detect	Non-detect
08-735	IGR-01-YP-15	5/29/2008	25-Sep	0.713	42%	Below detection	<19.2	Non-detect	Non-detect
08-736	IGR-01-YP-17	5/29/2008	25-Sep	0.897	67%	Below detection	<19.1	Non-detect	Non-detect
08-737	IGR-01-YP-18	5/29/2008	25-Sep	0.985	68%	Below detection	<19.1	Non-detect	Non-detect
08-738	IGR-01-YP-19	5/29/2008	25-Sep	0.892	104%	Below detection	<19.1	Non-detect	Non-detect
08-739	IGR-01-YP-20a	5/29/2008	25-Sep	1.501	69%	Below detection	<19.1	Non-detect	Non-detect
08-740	IGR-01-YP-20b	5/29/2008	25-Sep	1.340	71%	Below detection	<19.2	Non-detect	Non-detect
08-741	IGR-01-YP-21a	5/29/2008	25-Sep	0.719	78%	Below detection	<19.1	Non-detect	Non-detect
08-1094	IGR-01-YP-21b		17-Sep	1.045	66%	Below detection	<21.9	Non-detect	Non-detect
08-742	IGR-01-CR-01	5/29/2008	17-Sep	1.072	62%	Below detection	<21.3	Non-detect	Non-detect
08-743	COP-1-YP-01	5/28/2008	17-Sep	0.692	83%	Below detection	<21.1	Non-detect	Non-detect
08-744	COP-1-YP-02	5/28/2008	25-Sep	0.595	67%	Below detection	<19.1	Non-detect	Non-detect

ESF number	Sample ID	Date collected	Date 1st Analyzed	Total Dry Weight (g)	Recovery of internal std	TOTAL Free Microcystin levels	Method Detection Limit (µg/kg dw)	Extracted Demethyl LR	Extracted Demethyl RR
08-745	COP-1-YP-03	5/28/2008	17-Sep	1.115	56%	Below detection	<21.04	Non-detect	Non-detect
08-746	COP-1-YP-04	5/28/2008	17-Sep	0.844	91%	Below detection	<20.94	Non-detect	Non-detect
08-747	COP-1-YP-05	5/29/2008	17-Sep	1.286	95%	Below detection	<21.29	Non-detect	Non-detect
08-748	COP-1-YP-06	5/29/2008	17-Sep	1.744	92%	Below detection	<21.18	Non-detect	Non-detect
08-749	COP-1-YP-07	5/29/2008	25-Sep	1.199	65%	Below detection	<19.12	Non-detect	Non-detect
08-750	COP-1-YP-08	5/29/2008	17-Sep	1.349	94%	Below detection	<21.39	Non-detect	Non-detect
08-751	COP-1-YP-09	5/29/2008	17-Sep	0.988	85%	Below detection	<21.79	Non-detect	Non-detect
08-752	COP-1-YP-10	5/29/2008	17-Sep	1.135	86%	Below detection	<21.56	Non-detect	Non-detect
08-753	COP-1-YP-11	5/29/2008	17-Sep	1.693	79%	Below detection	<21.88	Non-detect	Non-detect
08-754	COP-1-YP-12	5/29/2008	17-Sep	1.407	88%	Below detection	<21.86	Non-detect	Non-detect
08-755	COP-1-YP-13	5/29/2008	17-Sep	1.650	97%	Below detection	<21.25	Non-detect	Non-detect
08-756	COP-1-YP-14	5/29/2008	17-Sep	1.024	107%	Below detection	<21.20	Non-detect	Non-detect
08-757	COP-1-YP-15	5/29/2008	17-Sep	1.286	80%	Below detection	<21.97	Non-detect	Non-detect
08-758	COP-1-YP-16	5/29/2008	17-Sep	1.061	82%	Below detection	<21.79	Non-detect	Non-detect
08-759	COP-1-YP-17	5/29/2008	17-Sep	1.926	106%	Below detection	<21.99	Non-detect	Non-detect
08-760	COP-1-YP-18	5/29/2008	17-Sep	1.479	103%	Below detection	<21.18	Non-detect	Non-detect
08-761	LKR-1-RT-01	5/28/2008	17-Sep	3.877	78%	Below detection	<21.93	Non-detect	Non-detect
08-762	LKR-1-RT-02	6/7/2008	17-Sep	1.241	77%	Below detection	<21.86	Non-detect	Non-detect
08-763	LKR-1-RT-03	6/7/2008	17-Sep	1.415	78%	Below detection	<21.84	Non-detect	Non-detect
08-764	LKR-1-RT-04	6/7/2008	17-Sep	3.831	66%	Below detection	<21.79	Non-detect	Non-detect
08-765	LKR-1-RT-05a	6/13/2008	17-Sep	2.112	80%	Below detection	<21.79	Non-detect	Non-detect
08-766	LKR-1-RT-05b	6/13/2008	17-Sep	2.071	89%	Below detection	<21.84	Non-detect	Non-detect
08-767	COP-1-CR-01	5/29/2008	17-Sep	1.926	61%	Below detection	<21.97	Non-detect	Non-detect
08-768	COP-1-CR-02	5/29/2008	17-Sep	0.874	54%	Below detection	<21.60	Non-detect	Non-detect
08-769	COP-1-CR-03	5/29/2008	17-Sep	1.025	81%	Below detection	<22.75	Non-detect	Non-detect
08-770	COP-1-CR-04	5/29/2008	17-Sep	1.082	77%	Below detection	<22.19	Non-detect	Non-detect

ESF number	Sample ID	Date collected	Date 1st Analyzed	Total Dry Weight (g)	Recovery of internal std	TOTAL Free Microcystin levels	Method Detection Limit (µg/kg dw)	Extracted Demethyl LR	Extracted Demethyl RR
08-771	COP-1-CR-05a	5/29/2008	17-Sep	1.972	68%	Below detection	<21.99	Non-detect	Non-detect
08-772	COP-1-CR-05b	5/29/2008	17-Sep	1.769	66%	Below detection	<21.31	Non-detect	Non-detect
08-773	UKRC-1-RT-01	6/19/2008	17-Sep	1.045	96%	Below detection	<21.12	Non-detect	Non-detect
08-774	UKRC-1-RT-02	6/19/2008	17-Sep	1.108	62%	Below detection	<22.17	Non-detect	Non-detect
08-775	UKRC-1-RT-03	6/19/2008	17-Sep	1.443	104%	Below detection	<21.18	Non-detect	Non-detect
08-776	UKRC-1-RT-04	6/19/2008	25-Sep	0.582	72%	Below detection	<19.12	Non-detect	Non-detect
08-777	UKRC-1-RT-05	6/19/2008	17-Sep	0.830	107%	Below detection	<21.79	Non-detect	Non-detect
08-778	UKRC-1-RT-06	6/19/2008	17-Sep	1.459	84%	Below detection	<21.79	Non-detect	Non-detect
08-779	UKRC-1-RT-07	6/19/2008	17-Sep	0.887	75%	Below detection	<21.99	Non-detect	Non-detect

Klamath Fish Muscle Tissues : DLR Group 2

ESF number	Sample ID	Date collected	Date 1st Analyzed	Total Dry Weight (g)	Recovery of internal std	TOTAL Free Microcystin levels	Method Detection Limit (µg/kg dw)	Extracted Demethyl LR	Extracted Demethyl RR
08-882	IGR-2-YP-01, muscle	7/15/2008	15-Oct	0.792	91%	Below detection	<84.9	Non-detect	Non-detect
08-883	IGR-2-YP-02, muscle	7/15/2008	15-Oct	1.304	81%	Below detection	<84.8	Non-detect	Non-detect
08-884	IGR-2-YP-03, muscle	7/15/2008	15-Oct	0.759	77%	Below detection	<84.8	Non-detect	Non-detect
08-885	IGR-2-YP-04, muscle	7/15/2008	15-Oct	1.009	83%	Below detection	<84.7	Non-detect	Non-detect
08-886	IGR-2-YP-05, muscle	7/15/2008	15-Oct	1.292	75%	Below detection	<85.3	Non-detect	Non-detect
08-887	IGR-2-YP-06, muscle	7/15/2008	15-Oct	0.875	66%	Below detection	<85.2	Non-detect	Non-detect
08-888	IGR-2-YP-07, muscle	7/15/2008	15-Oct	1.143	62%	Below detection	<84.7	Non-detect	Non-detect
08-889	IGR-2-YP-08, muscle	7/15/2008	15-Oct	1.158	43%	Below detection	<84.5	Non-detect	Non-detect
08-890	IGR-2-YP-09, muscle	7/15/2008	15-Oct	1.016	75%	Below detection	<84.5	Non-detect	Non-detect
08-891	IGR-2-YP-10, muscle	7/15/2008	15-Oct	1.350	81%	Below detection	<84.5	Non-detect	Non-detect
08-892	IGR-2-YP-11, muscle	7/15/2008	15-Oct	1.330	70%	Below detection	<85.1	Non-detect	Non-detect
08-893	LKR-2-RT-01, muscle	7/15/2008	15-Oct	1.688	85%	Below detection	<85.2	Non-detect	Non-detect
08-894	LKR-2-RT-02, muscle	7/15/2008	15-Oct	1.191	79%	Below detection	<84.7	Non-detect	Non-detect

ESF number	Sample ID	Date collected	Date 1st Analyzed	Total Dry Weight (g)	Recovery of internal std	TOTAL Free Microcystin levels	Method Detection Limit (µg/kg dw)	Extracted Demethyl LR	Extracted Demethyl RR
08-895	LKR-2-RT-03, muscle	7/15/2008	15-Oct	1.639	83%	Below detection	<85.1	Non-detect	Non-detect
08-896	LKR-2-RT-04, muscle	7/15/2008	15-Oct	3.011	78%	Below detection	<85.2	Non-detect	Non-detect
08-897	LKR-2-RT-05, muscle	7/15/2008	15-Oct	1.773	83%	Below detection	<85.1	Non-detect	Non-detect
08-898	LKR-2-RT-06, muscle	7/15/2008	15-Oct	2.576	90%	Below detection	<84.7	Non-detect	Non-detect
08-899	LKR-2-RT-07, muscle	7/15/2008	15-Oct	1.027	85%	Below detection	<84.8	Non-detect	Non-detect
08-900	LKR-2-RT-08, muscle	7/15/2008	15-Oct	1.072	79%	Below detection	<82.7	Non-detect	Non-detect
08-901	LKR-2-RT-09, muscle	7/15/2008	15-Oct	1.812	88%	Below detection	<82.1	Non-detect	Non-detect
08-902	LKR-2-RT-10, muscle	7/15/2008	15-Oct	2.587	83%	Below detection	<82.6	Non-detect	Non-detect
08-903	IGR-2-YP-12, muscle	7/15/2008	15-Oct	1.133	96%	Below detection	<82.5	Non-detect	Non-detect
08-904	IGR-2-YP-13, muscle	7/15/2008	15-Oct	1.256	95%	Below detection	<82.8	Non-detect	Non-detect
08-905	IGR-2-YP-14, muscle	7/15/2008	15-Oct	1.318	72%	Below detection	<82.4	Non-detect	Non-detect
08-906	IGR-2-YP-15, muscle	7/15/2008	15-Oct	0.656	64%	Below detection	<82.7	Non-detect	Non-detect
08-907	IGR-2-YP-16, muscle	7/15/2008	15-Oct	0.722	60%	Below detection	<82.2	Non-detect	Non-detect
08-908	IGR-2-YP-17, muscle	7/15/2008	15-Oct	0.945	60%	Below detection	<82.7	Non-detect	Non-detect
08-909	IGR-2-YP-18, muscle	7/15/2008	15-Oct	0.984	83%	Below detection	<82.7	Non-detect	Non-detect
08-910	IGR-2-YP-19, muscle	7/15/2008	15-Oct	1.042	80%	Below detection	<82.3	Non-detect	Non-detect
08-911	IGR-2-YP-19b, muscle	7/15/2008	15-Oct	0.611	59%	Below detection	<82.8	Non-detect	Non-detect
08-912	IGR-2-CR-01, muscle	7/15/2008	15-Oct	1.736	83%	Below detection	<82.6	Non-detect	Non-detect
08-913	COP-2-YP-01, muscle	7/15/2008	15-Oct	0.700	62%	Below detection	<82.4	Non-detect	Non-detect
08-914	COP-2-YP-02, muscle	7/16/2008	15-Oct	1.042	47%	Below detection	<82.9	Non-detect	Non-detect
08-915	COP-2-YP-03, muscle	7/16/2008	15-Oct	0.563	57%	Below detection	<82.2	Non-detect	Non-detect
08-916	COP-2-YP-04, muscle	7/16/2008	15-Oct	0.520	68%	Below detection	<82.1	Non-detect	Non-detect
08-917	COP-2-YP-05, muscle	7/16/2008	15-Oct	1.093	67%	Below detection	<82.7	Non-detect	Non-detect
08-918	COP-2-YP-06, muscle	7/16/2008	15-Oct	1.082	95%	Below detection	<82.8	Non-detect	Non-detect
08-919	COP-2-YP-07, muscle	7/16/2008	15-Oct	0.980	93%	Below detection	<82.7	Non-detect	Non-detect
08-920	COP-2-YP-08, muscle	7/16/2008	15-Oct	1.384	81%	Below detection	<82.4	Non-detect	Non-detect

ESF number	Sample ID	Date collected	Date 1st Analyzed	Total Dry Weight (g)	Recovery of internal std	TOTAL Free Microcystin levels	Method Detection Limit (µg/kg dw)	Extracted Demethyl LR	Extracted Demethyl RR
08-921	COP-2-YP-09, muscle	7/16/2008	15-Oct	0.856	88%	Below detection	<82.5	Non-detect	Non-detect
08-922	COP-2-YP-10, muscle	7/16/2008	15-Oct	1.143	83%	Below detection	<82.4	Non-detect	Non-detect
08-923	COP-2-YP-11, muscle	7/16/2008	15-Oct	1.457	148%	Below detection	<82.5	Non-detect	Non-detect
08-924	COP-2-YP-12, muscle	7/16/2008	15-Oct	1.228	96%	Below detection	<82.1	Non-detect	Non-detect
08-925	COP-2-YP-13, muscle	7/16/2008	15-Oct	1.298	77%	Below detection	<82.3	Non-detect	Non-detect
08-926	COP-2-YP-14, muscle	7/16/2008	15-Oct	1.454	68%	Below detection	<82.7	Non-detect	Non-detect
08-927	COP-2-YP-15, muscle	7/16/2008	15-Oct	1.092	73%	Below detection	<82.3	Non-detect	Non-detect
08-928	COP-2-YP-16, muscle	7/16/2008	15-Oct	1.169	67%	Below detection	<82.2	Non-detect	Non-detect
08-929	COP-2-YP-17, muscle	7/16/2008	15-Oct	1.778	64%	Below detection	<82.8	Non-detect	Non-detect
08-930	COP-2-YP-18, muscle	7/16/2008	15-Oct	1.330	60%	Below detection	<82.9	Non-detect	Non-detect
08-931	COP-2-YP-19, muscle	7/16/2008	15-Oct	1.163	73%	Below detection	<82.4	Non-detect	Non-detect
08-932	COP-2-YP-20, muscle	7/16/2008	15-Oct	1.822	74%	Below detection	<82.4	Non-detect	Non-detect
08-933	COP-2-YP-20b, muscle	7/16/2008	15-Oct	1.102	80%	Below detection	<82.1	Non-detect	Non-detect
08-934	COP-2-CR-01, muscle	7/16/2008	15-Oct	1.910	57%	Below detection	<82.6	Non-detect	Non-detect
08-935	COP-2-CR-02, muscle	7/16/2008	15-Oct	1.183	67%	Below detection	<82.1	Non-detect	Non-detect
08-936	COP-2-CR-03, muscle	7/16/2008	15-Oct	1.209	74%	Below detection	<82.4	Non-detect	Non-detect
08-937	UKRC-2-RT-01, muscle	7/16/2008	15-Oct	2.408	62%	Below detection	<82.4	Non-detect	Non-detect
08-938	UKRC-2-RT-02, muscle	7/16/2008	15-Oct	2.670	67%	Below detection	<82.5	Non-detect	Non-detect
08-939	UKRC-2-RT-03, muscle	7/16/2008	15-Oct	1.101	67%	Below detection	<82.1	Non-detect	Non-detect
08-940	UKRC-2-RT-04, muscle	7/16/2008	15-Oct	1.677	62%	Below detection	<82.2	Non-detect	Non-detect
08-941	UKRC-2-RT-05, muscle	7/16/2008	15-Oct	1.645	54%	Below detection	<82.4	Non-detect	Non-detect
08-942	UKRC-2-RT-06, muscle	7/16/2008	20-Oct	1.436	68%	Below detection	<82.8	Non-detect	Non-detect
08-943	UKRC-2-RT-07, muscle	7/16/2008	20-Oct	1.585	67%	Below detection	<82.3	Non-detect	Non-detect
08-944	UKRC-2-RT-08, muscle	7/16/2008	20-Oct	1.617	79%	Below detection	<82.4	Non-detect	Non-detect
08-945	UKRC-2-RT-09, muscle	7/16/2008	20-Oct	1.426	63%	Below detection	<82.3	Non-detect	Non-detect
08-946	UKRC-2-RT-9b, muscle	7/16/2008	20-Oct	1.302	77%	Below detection	<82.1	Non-detect	Non-detect

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Klamath Fish Muscle Tissues : Demethyl LR revisited **March 178, 2009**

ESF number	Sample ID	Date collected	Date 1st Analyzed	Total Dry Weight (g)	Recovery of internal std	TOTAL Free Microcystin levels	Method Detection Limit (µg/kg dw)	Extracted Demethyl LR	Extracted Demethyl RR
08-1141	LKR-3-RT-01	9/9/2008	1-Dec	1.647	72%	Below detection	<85.4	Non-detect	Non-detect
08-1142	LKR-3-RT-02	9/9/2008	1-Dec	1.360	74%	Below detection	<85.9	Non-detect	Non-detect
08-1143	LKR-3-RT-03	9/9/2008	1-Dec	0.781	68%	Below detection	<85.5	Non-detect	Non-detect
08-1144	LKR-3-RT-04	9/9/2008	1-Dec	0.662	136%	Below detection	<85.2	Non-detect	Non-detect
08-1145	LKR-3-RT-05	9/9/2008	1-Dec	1.067	73%	Below detection	<85.2	Non-detect	Non-detect
08-1146	LKR-3-RT-06	9/9/2008	1-Dec	0.815	70%	Below detection	<85.7	Non-detect	Non-detect
08-1147	LKR-3-RT-07	9/9/2008	1-Dec	1.476	75%	Below detection	<85.1	Non-detect	Non-detect
08-1148	LKR-3-RT-08	9/9/2008	1-Dec	0.515	70%	Below detection	<85.4	Non-detect	Non-detect
08-1149	LKR-3-RT-09	9/9/2008	1-Dec	0.208	77%	Below detection	<85.6	Non-detect	Non-detect
08-1150	LKR-3-RT-10	9/9/2008	1-Dec	1.142	71%	Below detection	<85.3	Non-detect	Non-detect
08-1151	LKR-3-RT-11	9/9/2008	1-Dec	0.632	74%	Below detection	<85.2	Non-detect	Non-detect
08-1152	LKR-3-RT-11a	9/9/2008	1-Dec	1.189	83%	Below detection	<85.1	Non-detect	Non-detect
08-1153	UKRC-3-RT-01	9/10/2008	1-Dec	1.453	76%	Below detection	<85.2	Non-detect	Non-detect
08-1154	UKRC-3-RT-02	9/10/2008	1-Dec	0.908	76%	Below detection	<85.4	Non-detect	Non-detect
08-1155	UKRC-3-RT-03	9/10/2008	1-Dec	1.228	74%	Below detection	<85.6	Non-detect	Non-detect
08-1156	UKRC-3-RT-04	9/10/2008	1-Dec	1.433	76%	Below detection	<85.8	Non-detect	Non-detect
08-1157	UKRC-3-RT-05	9/10/2008	1-Dec	0.877	77%	Below detection	<85.2	Non-detect	Non-detect
08-1158	UKRC-3-RT-06	9/10/2008	1-Dec	0.582	74%	Below detection	<85.6	Non-detect	Non-detect
08-1159	UKRC-3-RT-07	9/10/2008	1-Dec	1.132	74%	Below detection	<85.1	Non-detect	Non-detect
08-1160	UKRC-3-RT-08	9/10/2008	1-Dec	1.109	77%	Below detection	<85.3	Non-detect	Non-detect
08-1161	UKRC-3-RT-09	9/10/2008	1-Dec	1.236	60%	Below detection	<85.3	Non-detect	Non-detect
08-1162	UKRC-3-RT-9a	9/10/2008	1-Dec	1.129	100%	Below detection	<85.7	Non-detect	Non-detect
08-1163	IGR-3-YP-01	9/9/2008	1-Dec	0.608	75%	Below detection	<85.1	Non-detect	Non-detect
08-1164	IGR-3-YP-02	9/9/2008	1-Dec	0.740	72%	Below detection	<85.3	Non-detect	Non-detect
08-1165	IGR-3-YP-03	9/9/2008	19-Dec	0.484	49%	Below detection	<72.4	Non-detect	Non-detect

ESF number	Sample ID	Date collected	Date 1st Analyzed	Total Dry Weight (g)	Recovery of internal std	TOTAL Free Microcystin levels	Method Detection Limit (µg/kg dw)	Extracted Demethyl LR	Extracted Demethyl RR
08-1166	IGR-3-YP-04	9/9/2008	1-Dec	0.957	70%	Below detection	<85.2	Non-detect	Non-detect
08-1167	IGR-3-YP-05	9/9/2008	1-Dec	0.555	55%	Below detection	<85.1	Non-detect	Non-detect
08-1168	IGR-3-YP-06	9/9/2008	1-Dec	0.587	159%	Below detection	<85.1	Non-detect	Non-detect
08-1169	IGR-3-YP-07	9/9/2008	1-Dec	0.917	74%	Below detection	<85.7	Non-detect	Non-detect
08-1170	IGR-3-YP-08	9/9/2008	1-Dec	1.335	75%	Below detection	<85.7	Non-detect	Non-detect
08-1171	IGR-3-YP-09	9/9/2008	1-Dec	0.786	95%	Below detection	<85.6	Non-detect	Non-detect
08-1172	IGR-3-YP-10	9/9/2008	1-Dec	1.168	95%	Below detection	<85.2	Non-detect	Non-detect
08-1173	IGR-3-YP-11	9/9/2008	1-Dec	1.048	97%	Below detection	<85.3	Non-detect	Non-detect
08-1174	IGR-3-YP-12	9/9/2008	1-Dec	1.134	76%	Below detection	<85.4	Non-detect	Non-detect
08-1175	IGR-3-YP-13	9/9/2008	1-Dec	0.854	109%	Below detection	<85.8	Non-detect	Non-detect
08-1176	IGR-3-YP-14	9/9/2008	1-Dec	0.802	103%	Below detection	<85.4	Non-detect	Non-detect
08-1177	IGR-3-YP-15	9/9/2008	1-Dec	1.070	117%	Below detection	<85.6	Non-detect	Non-detect
08-1178	IGR-3-YP-16	9/9/2008	1-Dec	1.026	86%	Below detection	<85.2	Non-detect	Non-detect
08-1179	IGR-3-YP-17	9/9/2008	1-Dec	1.076	101%	Below detection	<85.9	Non-detect	Non-detect
08-1180	IGR-3-YP-18	9/9/2008	1-Dec	1.087	81%	Below detection	<85.2	Non-detect	Non-detect
08-1181	IGR-3-YP-19	9/9/2008	5-Dec	1.140	82%	Below detection	<124.9	Non-detect	Non-detect
08-1182	IGR-3-YP-20	9/9/2008	5-Dec	1.051	83%	Below detection	<124.1	Non-detect	Non-detect
08-1183	IGR-3-YP-20a	9/9/2008	5-Dec	1.153	86%	Below detection	<123.8	Non-detect	Non-detect
08-1184	IGR-3-CR-01	9/9/2008	5-Dec	0.780	83%	Below detection	<124.3	Non-detect	Non-detect
08-1185	IGR-3-CR-02	9/9/2008	19-Dec	0.883	39%	Below detection	<72.8	Non-detect	Non-detect
08-1186	IGR-3-CR-03	9/9/2008	5-Dec	0.940	76%	Below detection	<124.9	Non-detect	Non-detect
08-1187	IGR-3-CR-04	9/9/2008	5-Dec	2.001	79%	Below detection	<123.7	Non-detect	Non-detect
08-1188	IGR-3-CR-05	9/9/2008	5-Dec	1.130	79%	Below detection	<124.2	Non-detect	Non-detect
08-1189	IGR-3-CR-06	9/9/2008	5-Dec	0.789	73%	Below detection	<124.1	Non-detect	Non-detect
08-1190	IGR-3-CR-07	9/9/2008	5-Dec	1.414	68%	Below detection	<124.6	Non-detect	Non-detect

ESF number	Sample ID	Date collected	Date 1st Analyzed	Total Dry Weight (g)	Recovery of internal std	TOTAL Free Microcystin levels	Method Detection Limit (µg/kg dw)	Extracted Demethyl LR	Extracted Demethyl RR
08-1191	IGR-3-CR-08	9/9/2008	5-Dec	1.127	68%	Below detection	<124.4	Non-detect	Non-detect
08-1192	IGR-3-CR-09	9/9/2008	5-Dec	0.988	70%	Below detection	<124.6	Non-detect	Non-detect
08-1193	IGR-3-CR-10	9/9/2008	5-Dec	0.764	74%	Below detection	<124.2	Non-detect	Non-detect
08-1194	IGR-3-CR-10a	9/9/2008	5-Dec	0.599	63%	Below detection	<124.9	Non-detect	Non-detect
08-1195	COP-3-YP-01	9/9/2008	5-Dec	0.589	80%	Below detection	<124.7	Non-detect	Non-detect
08-1196	COP-3-YP-02	9/9/2008	5-Dec	1.075	81%	Below detection	<123.8	Non-detect	Non-detect
08-1197	COP-3-YP-03	9/9/2008	5-Dec	1.236	12%	Below detection	<124.3	Non-detect	Non-detect
08-1198	COP-3-YP-04	9/9/2008	5-Dec	0.606	80%	Below detection	<123.7	Non-detect	Non-detect
08-1199	COP-3-YP-05	9/9/2008	5-Dec	1.512	72%	Below detection	<124.7	Non-detect	Non-detect
08-1200	COP-3-YP-06	9/9/2008	5-Dec	1.066	86%	Below detection	<124.3	Non-detect	Non-detect
08-1201	COP-3-YP-07	9/9/2008	5-Dec	0.845	81%	Below detection	<124.2	Non-detect	Non-detect
08-1202	COP-3-YP-08	9/9/2008	5-Dec	1.979	75%	Below detection	<124.4	Non-detect	Non-detect
08-1203	COP-3-YP-09	9/9/2008	5-Dec	0.731	81%	Below detection	<123.7	Non-detect	Non-detect
08-1204	COP-3-YP-10	9/9/2008	5-Dec	1.910	69%	Below detection	<123.7	Non-detect	Non-detect
08-1205	COP-3-YP-11	9/9/2008	5-Dec	1.289	71%	Below detection	<123.7	Non-detect	Non-detect
08-1206	COP-3-YP-12	9/9/2008	5-Dec	1.861	76%	Below detection	<124.2	Non-detect	Non-detect
08-1207	COP-3-YP-13	9/9/2008	5-Dec	0.684	77%	Below detection	<124.9	Non-detect	Non-detect
08-1208	COP-3-YP-14	9/9/2008	5-Dec	1.178	74%	Below detection	<123.8	Non-detect	Non-detect
08-1209	COP-3-YP-15	9/9/2008	5-Dec	1.325	137%	Below detection	<124.4	Non-detect	Non-detect
08-1210	COP-3-YP-16	9/9/2008	5-Dec	1.096	79%	Below detection	<124.6	Non-detect	Non-detect
08-1211	COP-3-YP-17	9/9/2008	5-Dec	1.595	71%	Below detection	<124.1	Non-detect	Non-detect
08-1212	COP-3-YP-18	9/9/2008	5-Dec	1.017	70%	Below detection	<124.7	Non-detect	Non-detect
08-1213	COP-3-YP-19	9/9/2008	5-Dec	0.815		Below detection	<123.8	Non-detect	Non-detect
08-1214	COP-3-YP-20	9/9/2008	5-Dec	1.258	80%	Below detection	<123.7	Non-detect	Non-detect
08-1215	COP-3-YP-20a	9/9/2008	5-Dec	1.299	61%	Below detection	<124.8	Non-detect	Non-detect
08-1216	COP-3-CR-01	9/10/2008	5-Dec	0.452	47%	Below detection	<124.6	Non-detect	Non-detect
08-1217	COP-3-CR-02	9/10/2008	19-Dec	1.197	35%	Below detection	<72.8	Non-detect	Non-detect

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