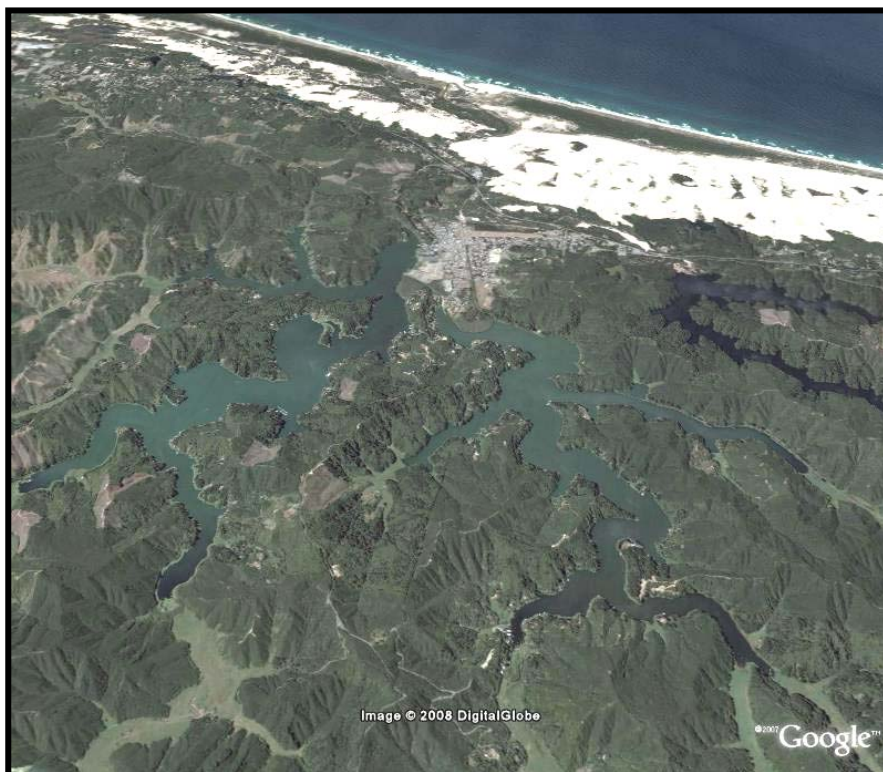

TENMILE LAKES TOXIC ALGAL SAMPLING PROGRAM: 2009 DATA SUMMARY
REPORT



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April 2010

BACKGROUND

Long-term public health monitoring for potentially toxigenic cyanobacteria (blue-green algae) in Tenmile Lakes has occurred since 2002 (Kann 2008; Jacoby and Kann 2007). Tenmile Lakes were again sampled in 2009 to assess the dynamics of potentially toxic blue-green algal species, including *Microcystis aeruginosa*, *Gloeotrichia echinulata*, and various *Anabaena* species. *Microcystis* and *Gloeotrichia* can produce hepatotoxins (known as microcystins), and *Anabaena* produces both neurotoxins (anatoxin-a) and microcystins. Both toxins are capable of harmful effects to animals and humans (Chorus and Bartram 1999). A toxic bloom of *M. aeruginosa* was first documented in Tenmile Lakes in September of 1997, prompting the Oregon Department of Health to issue a health advisory recommending that the lakes not be used for drinking water (numerous private homes around the lakes utilize treated lake water for potable purposes) and that contact recreation be avoided (Kann and Gilroy 1997). The goal of 2009 sampling, performed by the Tenmile Lakes Basin Partnership, was to determine presence and cell density of these potentially toxic species at a limited number of sampling stations. Cell density of potentially toxigenic species was then compared to drinking water guidance levels for lakes and reservoirs (e.g., Yoo et al. 1995; Chorus and Bartram 1999), as well as State of Oregon recreational guideline values (Oregon DHS 2009; Stone and Bress 2007).

METHODS

Four long-term standard sampling stations (2 in each lake) were monitored to cover a major arm and open-water location in each lake (Fig. 1; red circles). Stations S8 and N16 are centrally located and S3 and N11 are located near the terminus of Templeton Arm and Big Creek Arm, respectively. These stations were sampled 9 times beginning June 22nd and ending November 12th, 2009.

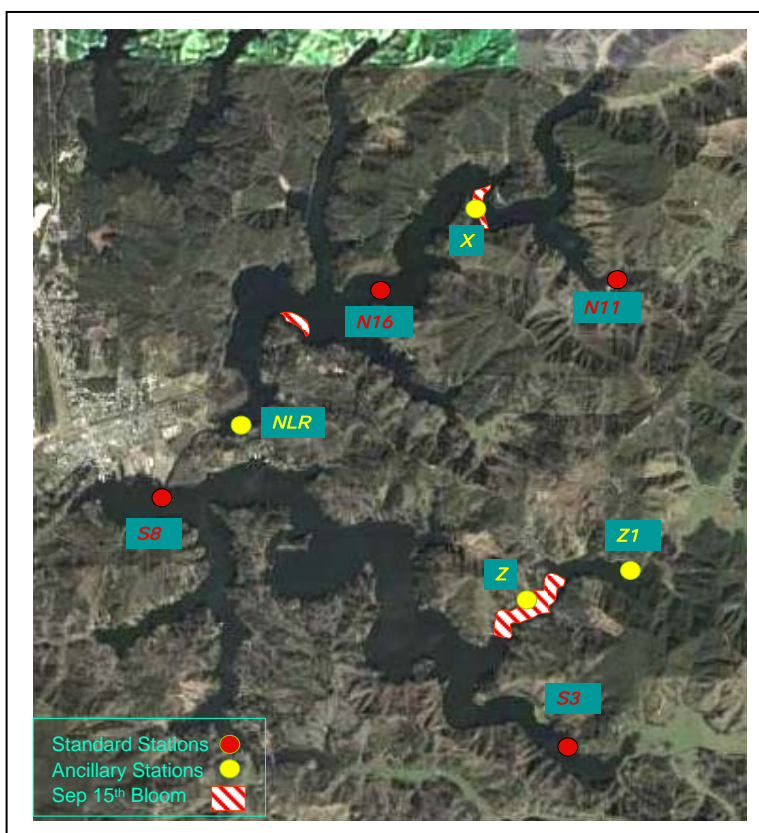


Figure 1. Location of standard and ancillary toxic algal sampling stations in Tenmile Lakes, 2009.

At these standard stations, samples were collected mid-day (to facilitate detection of conditions that may pose human health risk) and integrated over the upper 1/3 of the water column at the open-water stations (S8 and N16), and over the entire water column at the shallow stations (S3 and N11). At each of the established sampling locations a vertical tow ranging between 1 to 2.5 meters of the water column (depending on location) was made using a 64- μm plankton net.

In addition, grab-samples were obtained from a series of ancillary stations (Fig. 1; yellow circles) that were sampled to assess blooms that were visibly noticeable in areas not overlapping the standard long-term stations.

For both standard (where filtered contents of 3 replicate hauls were composited in a bucket) and ancillary stations, contents were placed in a 250 ml opaque sample bottle containing 1% Lugol's preservative and shipped to plankton taxonomist Jim Sweet of Aquatic Analysts, INC., who performed a microscopic analysis for algal cell density (cells ml^{-1}). For toxin analyses at standard stations the contents of 3 replicate hauls taken with a tube sampler were composited in a bucket and then placed in a 1 liter bottle with no preservative and frozen at the TLBP office. Similarly, 1-Liter grab-samples from the ancillary stations were frozen and stored at the TLBP office. If cell density results received the following week from Aquatic Analysts, INC showed that density considerably exceeded the Alert Level 2 threshold of 2000 cells ml^{-1} , select frozen samples were then shipped overnight air to CyanoLab (division of GreenWater Labs in Palatka, FL) for the enzyme linked immunosorbent assay (ELISA) of microcystin toxin and LC/MS analysis to determine anatoxin-a (note: because health advisories and media outreach are initiated based upon cell density and not toxin concentration, toxin analysis is not prioritized when budgetary constraints exist or when cell counts are generally below 15,000 cells/ml).

RESULTS

2009 Trends-Standard Stations

Results from the first sample trip of June 23rd showed low levels of blue-green algae, with only one station (S3) exceeding the WHO Alert Level 1 drinking water guideline (Yoo et al. 1995; also known as the increased vigilance level for drinking water systems) of 500 cells ml^{-1} for potentially toxigenic species (Table 1; Figure 2: the species *Anabaena planctonica* had a cell density of 501 cells per ml). On the following sample date of July 13th, overall blue-green algae levels were still low, but *Gloeotrichia echinulata* (GTEC) at station N16 exceeded the Alert Level 2 guideline of 2000 cells/ml (at which time DHS and local health services typically issue a public alert for drinking water lakes and reservoirs). The combined density of *Microcystis aeruginosa* (MSAE) and GTEC is computed because both MSAE and GTEC are potential microcystin producers (Carey et al. 2007). Levels of *Anabaena flos-aquae* (ABFA) and *planctonica* (ABPL) remained below the Alert Level 2 guideline.

Overall biovolume, which had previously been dominated by the diatoms *Fragilaria crotonensis* and *Asterionella formosa* on June 22nd, switched to domination by the cyanobacterium (blue-green) *Aphanizomenon flos-aquae* (APFA) on July 13th. Although APFA has been shown to produce neurotoxins in other areas of the world, evidence indicates that toxin-producing species differ from those typically occurring in Oregon or other areas of North America (Li et al. 2000). Various Chrysophytes, Cryptophytes, and Diatoms comprised the remainder of the biovolume at all stations (Appendix I).

Table 1. Algal Cell Density for Potentially Toxigenic Species in Tenmile Lakes, 2009 (see below description for public health color coding). Blue shaded stations refer to ancillary stations located in the vicinity of visual blooms.

Station	Date	<i>Microcystis aeruginosa</i> (cells/ml)	<i>Gloeotrichia echinulata</i> (cells/ml)	<i>Microcystis + Gloeotrichia</i> (cells/ml)	<i>Anabaena flos-aquae</i> (cells/ml)	<i>Anabaena planktonica</i> (cells/ml)	<i>Anabaena circinalis</i> (cells/ml)	<i>Anabaena sp.</i> (cells/ml)	Total <i>Anabaena</i> (cells/ml)
S3	6/22/2009	0	0	0	0	501	0	0	501*
S8	6/22/2009	0	0	0	0	0	0	0	0
N11	6/22/2009	0	0	0	0	0	0	0	0
N16	6/22/2009	0	0	0	0	0	0	0	0
S3	7/13/2009	0	0	0	0	348	0	0	348
S8	7/13/2009	0	0	0	259	677	0	0	936
N11	7/13/2009	0	0	0	0	0	0	0	0
N16	7/13/2009	0	3,191	3,191**	0	53	0	0	53
S3	7/27/2009	0	0	0	353	6,611	0	0	6,964
S8	7/27/2009	2,181	0	2,181	0	2,523	0	0	2,523
N11	7/27/2009	0	0	0	0	1,667	0	0	1,667
N16	7/27/2009	0	0	0	0	2,075	0	0	2,075
S3	8/10/2009	3,719	0	3,719	0	5,397	0	0	5,397
S8	8/10/2009	1,018	0	1,018	15	2,684	0	0	2,699
N11	8/10/2009	0	0	0	0	10,966	0	0	10,966
N16	8/10/2009	172	0	172	0	3,536	0	0	3,536
S3	8/25/2009	0	0	0	0	1,945	0	0	1,945
S8	8/25/2009	3,915	0	3,915	0	514	23	0	537
N11	8/25/2009	741	0	741	0	293	0	0	293
N16	8/25/2009	1,611	0	1,611	0	941	0	0	941
S3	9/8/2009	2,497	0	2,497	0	0	0	0	0
S8	9/8/2009	2,689	0	2,689	0	440	0	0	440
N11	9/8/2009	1,222	0	1,222	0	50	0	0	50
X	9/8/2009	300,940	0	300,940***	0	605,160	0	0	605,160
N16	9/8/2009	2,158	0	2,158	0	610	62	0	672
X	9/15/2009	1,104,048	0	1,104,048	0	147,703	0	0	147,703
Z	9/15/2009	2,158,388	0	2,158,388	0	2,137	0	0	2,137

Station	Date	<i>Microcystis aeruginosa</i> (cells/ml)	<i>Gloeotrichia echinulata</i> (cells/ml)	<i>Microcystis + Gloeotrichia</i> (cells/ml)	<i>Anabaena flos-aquae</i> (cells/ml)	<i>Anabaena planktonica</i> (cells/ml)	<i>Anabaena circinalis</i> (cells/ml)	<i>Anabaena sp.</i> (cells/ml)	Total <i>Anabaena</i> (cells/ml)
S3	9/21/2009	12,362	0	12,362	0	260	0	0	260
S8	9/21/2009	1,901	0	1,901	0	184	0	0	184
Z	9/21/2009	1,008,139	0	1,008,139	0	17,932	0	0	17,932
N11	9/21/2009	4,126	0	4,126	0	428	0	0	428
N16	9/21/2009	3,479	0	3,479	0	1,516	87	0	1,603
S3	10/5/2009	1,974	0	1,974	2	17	0	0	19
S8	10/5/2009	1,112	0	1,112	26	24	0	0	50
N11	10/5/2009	4,507	0	4,507	0	40	0	0	40
N16	10/5/2009	4,599	0	4,599	46	147	0	0	193
NLR	10/5/2009	2,612,788	0	2,612,788	814	30,527	0	0	31,341
Z1	10/5/2009	3,197,474	0	3,197,474	39,783	86,400	56,498	0	182,681
Dock	10/5/2009	10,561	0	10,561	223	1,169	135	0	1,527
N16	10/20/2009	6,797	0	6,797	182	358	0	0	540
NLR	10/20/2009	601,663	0	601,663	9,456	5,621	0	0	15,077
Z1	10/20/2009	4,664,468	0	4,664,468	770,835	82,308	0	0	853,143
S3	11/12/2009	516	0	516	112	32	0	0	144
S8	11/12/2009	535	0	535	51	0	0	0	51
N11	11/12/2009	199	0	199	13	29	0	0	42
N16	11/12/2009	1,377	0	1,377	90	45	0	0	134

*Exceeds World Health Organization Alert Level 1 increased vigilance guideline level of 500 cells ml⁻¹ for potentially toxigenic species in drinking water systems.

**Exceeds World Health Organization Alert Level 2 public health posting guideline level of 2000 cells ml⁻¹ for potentially toxigenic species in drinking water systems.

***Exceeds State of Oregon Recreational Guideline Levels of 40,000 cells/ml for *Microcystis* or 100,000 cell/ml for *Anabaena*.

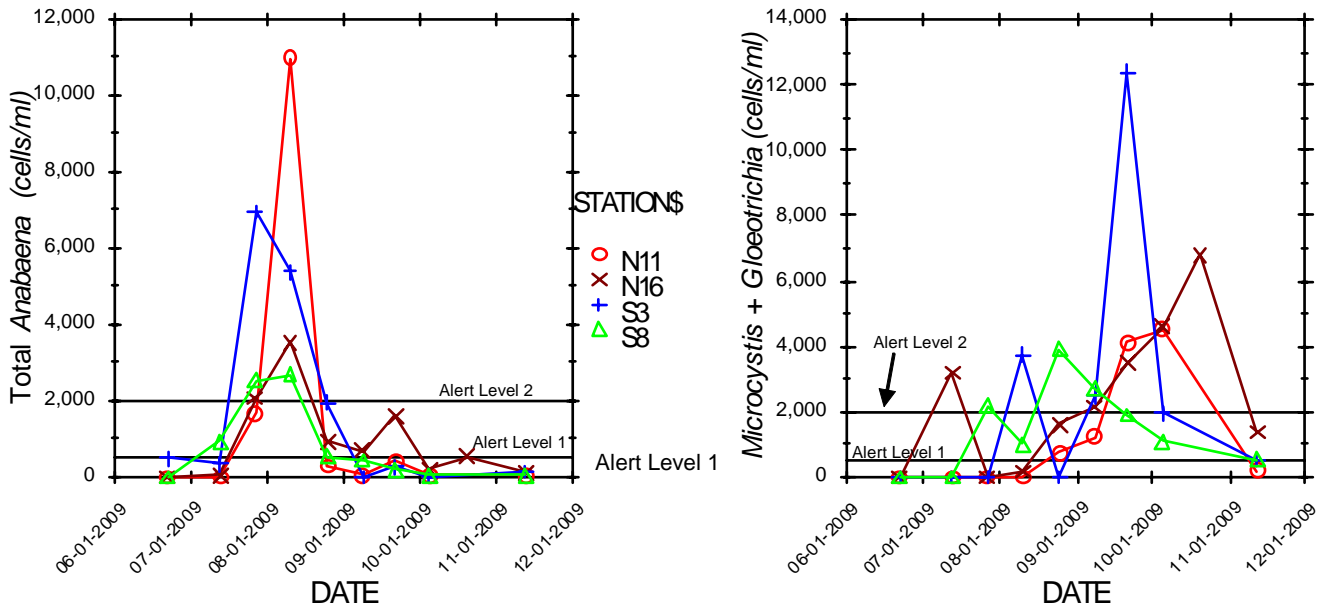


Figure 2. Cell Density of *Microcystis aeruginosa* and total *Anabaena sp.* in Tenmile Lakes at standard sampling stations, 2009.

Although MSAE levels exceeded Alert Level 2 only at station S8 on July 27th, *Anabaena* began to increase lake-wide, with S3, S8, and N16 exceeding Alert Level 2 (Table 1; Figure 2). However, as stated in previous Technical Memos, the predominant *Anabaena* species was *Anabaena planctonica* (Appendix I), a species less commonly associated with toxin production.

Samples from August 10th showed that although MSAE at station S8 (see Figure 2) declined below the WHO Alert Level 2 guideline of 2000 cells/ml, MSAE at station S3 increased sharply to 3719 cells/ml. Total *Anabaena* continued to remain high overall, exceeding Alert Level 2 at all stations. Overall, blue-green algae (cyanobacteria) continued to increase since the last sample date of July 27th (Figure 2); however, the predominant species switched from *Aphanizomenon flos-aquae* to *Anabaena planktonica* (Appendix I). Maximum ABPL was 10,966 cells/ml at station N11. Total *Anabaena* then declined sharply by August 25th, and continued to remain low for the duration of the season at all standard sampling stations (however see data for ancillary stations below).

In contrast, *Microcystis*, although still variable (stations S3 and S8 reversed as they did between 7/27 and 8/10 with MSAE at station S3 declining to a non-detect and station S8 increasing to 3915 cells/ml), increased overall on August 25th (Figure 2). MSAE then continued to increase at S3, N11, and N16 on September 8th, with a further increase in those stations on September 21st (Table 1; Figure 2). At that time S3, N11, and N16 all exceeded the 2000 cell/ml Alert Level 2 guideline, with a maximum of 12,362 cells/ml of MSAE at station S3. In past years such levels in Tenmile Lakes (>2000-5000 cells/ml) have been associated with microcystin toxin levels exceeding the WHO 1 µg/L drinking water level.

On subsequent sample dates in October, MSAE levels in North Lake (N11 and N16) remained above Alert Level 2, while those in South Lake (S3 and S8) were below Alert Level 2 (Figure 2). Although cyanobacteria continued to comprise the majority of algal biomass at S3 and S8, with *Aphanizomenon flos-aquae* comprising the majority of biovolume (Appendix I) on November 12th; at N11 the green alga *Chlamydomonas* was dominant with APFA second; while at N16 MSAE, APFA, and *Anabaena* comprised 50.6% of the biovolume (Appendix I). However, by November 12th MSAE at all standard stations was below 2000 cells/ml.

2009 Trends-Ancillary Stations

As noted above (see methods), several ancillary (non-standard) stations were sampled to account for patchy concentrations of cyanobacteria occurring in areas that did not overlap the standard stations (i.e., S3, S8, N11, and N16). The first such event was noted during the September 8th sampling (Figure 3), and an additional sample was collected from North Tenmile at sample station “X” (see Figure 1 above for location). Results from this station showed a high concentration of both *Anabaena planctonica* and *Microcystis* (Table 2; ABPL: 605,160 cell/ml and MSAE: 300,940 cells/ml). Algal toxin results (Appendix II) show that on September 8th sample station “X” had 20 µg/L of microcystin, exceeding the 8 µg/L State of Oregon recreational posting guideline by 2.5x (Table 2). These results confirm that MSAE levels exceeding 40,000 cells/ml can be associated with microcystin toxin levels that constitute a high probability of adverse health effects not only for those utilizing the lake for drinking water, but for recreational users of the lake as well.



Figure 3. September 8th 2009 cyanobacterial bloom condition at station “X” located in North Tenmile (see map above).

Table 2. Cell density and toxin results for September 8th and algal cell density results for September 15th, 2009.

Station	Location	Date	Potentially Toxicogenic Algal Species			Algal Toxins		
			<i>Microcystis</i> (cells/ml)	<i>Anabaena planktonica</i> (cells/ml)	<i>Aphanizomenon flos-aquae</i> (cells/ml)	Microcystin (µg/L)	Anatoxin -a (µg/L)	Saxitoxin (µg/L)
X	North Lake	9/8/2009	300,940	605,160	560,880	20	ND	ND
X	North Lake	9/15/2009	1,104,048	147,703	736,709	NT	NT	NT
Z	South Lake	9/15/2009	2,158,388	2,137	145,667	NT	NT	NT

World Health Organization Alert Level 1 increased vigilance guideline level is 500 cells ml⁻¹ for potentially toxicogenic species in drinking water systems.
 World Health Organization Alert Level 2 public health posting guideline level is 2,000 cells ml⁻¹ for potentially toxicogenic species in drinking water systems
 State of Oregon Recreational Guideline Levels is 40,000 cells/ml for *Microcystis* or 100,000 cells/ml for *Anabaena*
 ND=not detect
 NT=not tested

The above results also support previous statements that *Anabaena planktonica* (ABPL) has not been generally found to be associated with the algal toxin anatoxin-a in Tenmile Lakes (despite a cell density of >600,000 cells/ml, anatoxin-a was not detected). Likewise, as noted above, although *Aphanizomenon flos-aquae* (APFA) has been associated with toxin production in other regions, the blooms typically experienced in Oregon have not been associated with toxin production; at a cell density of >560,000 cells/ml neither anatoxin nor saxitoxin were detected (Table 2).

One week later on September 15th, blooms continued to be noticed visually (see red shaded areas in Figure 1), showing typical cyanobacterial bloom appearance (Figure 4). A sample collected at North Lake station “X” continued to show prevalent blue-green algae, including a 3.6 fold increase in MSAE (Table 2; 1,104,048 cells/ml). An additional sample from South Tenmile (Figure 1; station “Z”) also showed a very high density of MSAE (2,158,388 cells/ml) and was the predominant species at that station (Table 2; Appendix 1). ABPL and APFA also comprised the bloom at both stations. Thus, prevalent blue-green blooms were evident in varying areas of both North and South Tenmile Lakes, with both cell density and microcystin toxin results exceeding guidelines for recreation posting. In addition, given varying effectiveness of homeowner drinking water treatment systems and the prevalence of toxic blooms, utilizing lake water for potable purposes was advised against at that time.



Figure 4. September 15th 2009 bloom conditions at varying locations in Tenmile Lakes (see map above).

Sample station “Z” in Colman Arm of South Tenmile was again sampled on September 21st, and continued to show a very high concentration of MSAE (>1 million cells/ml; Table 1), greatly exceeding adverse health effect levels for recreational use of the lake.

In October, stations Z1 (located in the Coleman Arm area of South Lake) and NLR (located in North Lake) were sampled on 10/5 and 10/20 in persistent bloom areas (Figure 1). Both stations showed very high concentrations of MSAE and *Anabaena* species (both ABFA and ABPL), with a maximum MSAE density of >4.5 million cells/ml; and a maximum total *Anabaena* of over 850 thousand cells/ml (Table 1). Both stations exceeded drinking water and recreational posting guidelines. Moreover, *Anabaena flos-aquae* (Table 1: 770,835 cells/ml), a species more commonly associated with neurotoxin production than is *A. planctonica*, dominated at station Z1 on 10/20.

An additional sample taken near Coleman Arm at a homeowner dock on October 5th (sample station “Dock” in Table 1 above) showed levels below recreational guidelines, but above the Drinking Water Alert Level 2 guideline of 2000 cell/ml. On September 26th at this same station (“Dock”), algal toxin samples for microcystin were collected both near the intake of the water treatment system and from treated tap water. The lab report for those data showed that near the intake, microcystin toxin was 1.8 µg/L (which is above the WHO 1 µg/L drinking water standard), but that microcystin toxin was not detected in the treated tap water (Appendix II).

2002-2009 Comparison

As noted previously (Kann 2008), unlike 2007 when density and consistency of detection of *Microcystis* in Tenmile Lakes was somewhat higher than all previous years, values in 2008 were more similar overall to years 2003-2006 (Figure 5). However, in 2009 *Microcystis* cell densities (at standard stations only) were not only higher than 2008, but tended to be higher than all earlier years, showing the greatest frequency of exceedance of the Alert Level 2 guideline (Figure 5).

Although somewhat lower than 2007 and 2008, total *Anabaena* density continued to remain noticeably higher in 2009 than for the previous 2002-2006 period, with numerous occurrences when cell density exceeded the Alert Level 2 guideline (Figure 5). As noted above, the predominant *Anabaena* species was *Anabaena planktonica* (Table 1), a species less commonly associated with toxin production than *Anabaena flos-aquae*. However, note that *Anabaena flos-aquae* was found in high concentrations at non-standard locations (see above).

Summary

Initial exceedances of public health guideline values for drinking water began in early July for MSAE and in late July for *Anabaena* at standard sampling stations S3, S8, N11, and N16. These exceedances continued through October for MSAE and August for total *Anabaena*, during which time DHS and local health services issued a public alert (precipitated by exceedance of the WHO Alert Level 2 guideline of 2000 cells/ml for drinking water lakes and reservoirs). The maximum value of >12,000 cells/ml MSAE at S3 on September 21st was among the highest of the 2002-2009 period.

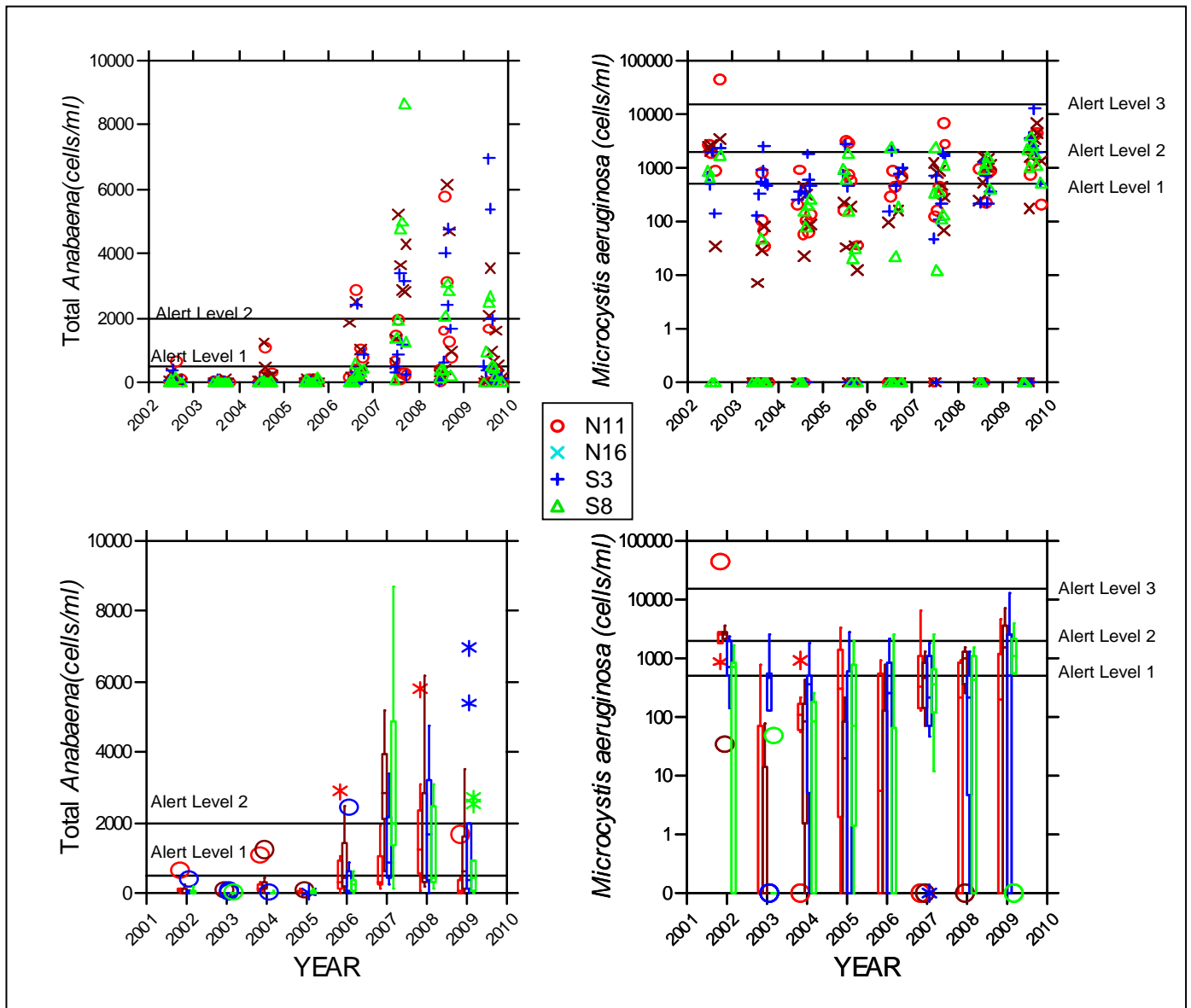


Figure 5. Cell density of *Microcystis aeruginosa* and *Anabaena flos-aquae* in Tenmile Lakes, 2002-2009; time-series of individual data points (a), and box plots grouped by station (b).

In addition, although cell density levels at the standard monitoring stations (stations S3, S8, N11, and N16) were still relatively low with respect to recreational guidelines (e.g., which would be 100,000 cells/ml for *Anabaena* and 40,000 cells/ml for *Microcystis*; Stone and Bress 2007), localized blooms and blue-green algal scums were noted that clearly had the potential exceed recreational guidelines. Ancillary samples collected from these areas in both North and South Tenmile Lakes confirmed exceedance of these recreational guidelines, and Oregon DHS issued a public health advisory between 9/18 and 11/30 (Oregon Harmful Algae Bloom Program 2009 Bloom Season Recap; www.oregon.gov/DHS/ph/hab/2009_Bloom_Season_Recap.pdf). Maximum MSAE and total *Anabaena* values (occurring at station Z1 on 10/20) exceeded the recreational advisory levels by over 100 times and 8 times, respectively.

Select samples analyzed for algal toxins showed that the September 8th sample at station “X” had 20 µg/L of microcystin, exceeding the 8 µg/L State of Oregon recreational posting guideline by 2.5x, confirming that MSAE levels exceeding 40,000 cells/ml can be associated with microcystin toxin levels that constitute an increased probability of adverse health effects not only for those utilizing the lake for drinking water, but for recreational users of the lake as well. Another toxin sample collected on September 26th at a homeowner dock showed that near the water intake that microcystin toxin was 1.8 µg/L (which is above the WHO 1 µg/L drinking water standard), but that microcystin toxin was not detected in the treated tap water (Appendix II).

Finally, because reported levels indicate the general trend but can not guarantee that levels of potentially toxigenic species at a particular location do not exceed guideline values, and the fact that cyanobacterial cells have been previously reported in home-owner drinking water treatment systems (see Kann 2007), drinking water protection efforts should always be in place. Patchy distribution of blue-green algae and accumulation in localized areas has been compellingly demonstrated in several years, and although levels of all potentially toxigenic cyanobacteria were well below the recreational guidelines of 40,000 cells/ml for *Microcystis* or 100,000 cells/ml for *Anabaena* at the standard sampling stations, they were greatly exceeded in adjacent areas.

Thus, as previously noted in Tenmile Lakes monitoring memoranda: “...*those utilizing the lake for drinking water should always follow Oregon Health Division recommendations for purification (attached). In addition, recreational users should always avoid contact with water whenever noticeable surface concentrations of algae are evident or when the lake has an obvious green to blue-green appearance.*”

Disclaimer

Due to the patchy nature of blue-green algal blooms it is possible for higher *Microcystis* and *Anabaena* densities (and therefore higher microcystin or anatoxin concentrations) to be present in areas not sampled in this survey, particularly along shorelines or during calm conditions of little to no wind. Given the lakes’ demonstrated history of toxic *Microcystis* and *Anabaena* blooms, and the fact that all areas of the lake cannot be tested at all times, those utilizing the lake for drinking water should always follow Oregon Health Division recommendations for purification (see Appendix III). In addition, recreational users should always avoid contact with water whenever noticeable surface concentrations of algae are evident or when the lake has an obvious green to blue-green appearance. Moreover, because pets or other domestic animals are the most likely to ingest contaminated water, these animals should not be allowed access to the lakeshore whenever either noticeable surface concentrations of algae or an obvious green to blue-green appearance is evident.

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Appendix I: Aquatic Analysts, Inc Phytoplankton Reports

Appendix II: GreenWater Labs Algal Toxin Results

**Appendix III: Oregon DHS and Tenmile Lakes Harmful Algal Bloom
Information**

Phytoplankton Sample Analysis					
Sample:		Tenmile Lake			
Sample Site:		S8			
Sample Depth:					
Sample Date:		22-Jun-09			
Total Density (#/mL):		591			
Total Biovolume (um³/mL):		2,442,011			
Trophic State Index:		56.3			
Species	Density #/mL	Density Percent	Biovolume um³/mL	Biovolume Percent	Group
1 Aphanizomenon flos-aquae	244	41.3	338,250	13.9	bluegreen
2 Mallomonas sp.	165	28.0	62,856	2.6	chrysophyte
3 Fragilaria crotonensis	114	19.3	1,913,333	78.4	diatom
4 Dinobryon sertularia	27	4.6	24,079	1.0	dinoflagellate
5 Synedra radians	8	1.4	2,929	0.1	diatom
6 Ceratium hirundinella	8	1.4	79,722	3.3	dinoflagellate
7 Rhodomonas minuta	5	0.9	108	0.0	cryptophyte
8 Melosira granulata	5	0.9	5,966	0.2	diatom
9 Asterionella formosa	5	0.9	5,369	0.2	diatom
10 Navicula sp.	3	0.5	407	0.0	diatom
11 Dictyosphaerium ehrenbergianum	3	0.5	2,603	0.1	green
12 Melosira ambigua	3	0.5	6,389	0.3	diatom
Note: 200 count					
Aphanizomenon flos-aquae cells/mL = 5,369					
Aphanizomenon flos-aquae heterocysts/mL = 111					
Aquatic Analysts			Sample ID: MB45		

Phytoplankton Sample Analysis					
Sample:	Tenmile Lake				
Sample Site:	N16				
Sample Depth:					
Sample Date:	22-Jun-09				
Total Density (#/mL):	1,031				
Total Biovolume (um³/mL):	1,549,916				
Trophic State Index:	53.0				
Species	Density #/mL	Density Percent	Biovolume um³/mL	Biovolume Percent	Group
1 Aphanizomenon flos-aquae	796	77.2	952,671	61.5	bluegreen
2 Synedra radians	95	9.2	34,109	2.2	diatom
3 Asterionella formosa	72	7.0	77,625	5.0	diatom
4 Fragilaria crotonensis	45	4.4	420,226	27.1	diatom
5 Melosira granulata	8	0.7	25,013	1.6	diatom
6 Ceratium hirundinella	4	0.4	37,141	2.4	dinoflagellate
7 Gloeocystis ampla	4	0.4	970	0.1	green
8 Cryptomonas erosa	4	0.4	1,971	0.1	cryptophyte
9 Ankistrodesmus falcatus	4	0.4	189	0.0	green
Note: 200 count					
Aphanizomenon flos-aquae cells/mL =	15,122				
Aphanizomenon flos-aquae heterocysts/mL =	42				
Aquatic Analysts			Sample ID: MB47		

Phytoplankton Sample Analysis					
Sample:		Tenmile Lake			
Sample Site:		S8			
Sample Depth:					
Sample Date:		8-Sep-09			
Total Density (#/mL):		105			
Total Biovolume (um³/mL):		264,003			
Trophic State Index:		40.3			
Species	Density #/mL	Density Percent	Biovolume um³/mL	Biovolume Percent	Group
1 Melosira granulata	49.3	47.1	124,795	47.3	diatom
2 Anabaena planctonica	17.1	16.3	78,115	29.6	bluegreen
3 Microcystis aeruginosa	12.8	12.2	21,514	8.1	bluegreen
4 Melosira ambigua	6.6	6.3	18,382	7.0	diatom
5 Aphanizomenon flos-aquae	5.2	5.0	5,259	2.0	bluegreen
6 Dictyosphaerium ehrenbergianum	4.3	4.1	3,458	1.3	green
7 Asterionella formosa	2.8	2.7	3,130	1.2	diatom
8 Mallomonas sp.	1.4	1.4	1,244	0.5	chrysophyte
9 Melosira granulata angustissima	1.4	1.4	1,885	0.7	diatom
10 Cryptomonas erosa	0.9	0.9	493	0.2	cryptophyte
11 Rhodomonas minuta	0.5	0.5	9	0.0	cryptophyte
12 Glenodinium sp.	0.5	0.5	332	0.1	dinoflagellate
13 Staurastrum gracile	0.5	0.5	256	0.1	green
14 Sphaerocystis schroeteri	0.5	0.5	266	0.1	green
15 Cocconeis placentula	0.5	0.5	218	0.1	diatom
16 Ceratium hirundinella	0.5	0.5	4,648	1.8	dinoflagellate
Note: 200 count					
Anabaena planctonica cells/mL =	427				
Anabaena planctonica heterocysts/mL =	11				
Anabaena planctonica akinetes/mL =	2				
Microcystis aeruginosa cells/mL =	2,689				
Aphanizomenon flos-aquae cells/mL =	83				
Aquatic Analysts			Sample ID: MB65		

Phytoplankton Sample Analysis					
Sample:		Tenmile Lake			
Sample Site:		N11			
Sample Depth:					
Sample Date:		8-Sep-09			
Total Density (#/mL):		16			
Total Biovolume (um³/mL):		36,016			
Trophic State Index:		26.1			
Species	Density #/mL	Density Percent	Biovolume um³/mL	Biovolume Percent	Group
1 Aphanizomenon flos-aquae	8.2	52.3	10,884	30.2	bluegreen
2 Anabaena planctonica	1.8	11.5	8,914	24.8	bluegreen
3 Microcystis aeruginosa	1.6	10.1	9,780	27.2	bluegreen
4 Melosira granulata	1.2	7.8	2,497	6.9	diatom
5 Cocconeis placentula	1.0	6.4	465	1.3	diatom
6 Melosira ambigua	0.4	2.8	1,581	4.4	diatom
7 Cryptomonas erosa	0.4	2.3	188	0.5	cryptophyte
8 Fragilaria crotonensis	0.1	0.9	1,091	3.0	diatom
9 Eunotia pectinalis	0.1	0.9	104	0.3	diatom
10 Scenedesmus quadricauda	0.1	0.9	38	0.1	green
11 Sphaerocystis schroeteri	0.1	0.9	121	0.3	green
12 Cosmarium sp.	0.1	0.5	15	0.0	green
13 Melosira granulata angustissima	0.1	0.5	72	0.2	diatom
14 Chlamydomonas sp.	0.1	0.5	23	0.1	green
15 Staurastrum gracile	0.1	0.5	39	0.1	green
16 Gomphonema angustatum	0.1	0.5	13	0.0	diatom
17 Gomphonema subclavatum	0.1	0.5	43	0.1	diatom
18 Gloeocystis ampla	0.1	0.5	148	0.4	green
Note: 200 count					
Aphanizomenon flos-aquae cells/mL =		173			
Aphanizomenon flos-aquae heterocysts/mL =		1			
Anabaena planctonica cells/mL =		49			
Anabaena planctonica heterocysts/mL =		1			
Microcystis aeruginosa cells/mL =		1,222			
Aquatic Analysts			Sample ID: MB66		

Phytoplankton Sample Analysis					
Sample:		Tenmile Lake			
Sample Site:		S3			
Sample Depth:					
Sample Date:		21-Sep-09			
Total Density (#/mL):		76			
Total Biovolume (um³/mL):		207,383			
Trophic State Index:		38.5			
Species	Density #/mL	Density Percent	Biovolume um³/mL	Biovolume Percent	Group
1 Microcystis aeruginosa	34.7	45.5	98,893	47.7	bluegreen
2 Aphanizomenon flos-aquae	13.5	17.6	18,685	9.0	bluegreen
3 Anabaena planctonica	9.8	12.8	46,649	22.5	bluegreen
4 Ochromonas sp.	6.5	8.6	556	0.3	chrysophyte
5 Dinobryon sertularia	4.1	5.3	539	0.3	dinoflagellate
6 Fragilaria crotonensis	2.9	3.7	38,433	18.5	diatom
7 Sphaerocystis Schroeteri	1.6	2.1	1,601	0.8	green
8 Ankistrodesmus falcatus	1.2	1.6	31	0.0	green
9 Asterionella formosa	0.4	0.5	719	0.3	diatom
10 Synedra ulna	0.4	0.5	813	0.4	diatom
11 Staurastrum gracile	0.4	0.5	221	0.1	green
12 Fragilaria vaucheriae	0.4	0.5	235	0.1	diatom
13 Rhodomonas minuta	0.4	0.5	8	0.0	cryptophyte
Note: 200 count.					
Microcystis aeruginosa cells/mL =	12,362				
Aphanizomenon flos-aquae cells/mL =	297				
Aphanizomenon flos-aquae heterocysts/mL =	6				
Anabaena planctonica cells/mL =	255				
Anabaena planctonica heterocysts/mL =	5				
Anabaena planctonica akinetes/mL =	0.4				
Aquatic Analysts			Sample ID: MB72		

Phytoplankton Sample Analysis					
	Sample:	Tenmile Lake			
	Sample Site:	N11			
	Sample Depth:				
	Sample Date:	21-Sep-09			
	Total Density (#/mL):	127			
	Total Biovolume (um³/mL):	197,659			
	Trophic State Index:	38.2			
Species	Density #/mL	Density Percent	Biovolume um³/mL	Biovolume Percent	Group
1 Aphanizomenon flos-aquae	47	37.1	50,373	25.5	bluegreen
2 Microcystis aeruginosa	25	19.7	33,007	16.7	bluegreen
3 Anabaena planctonica	19	15.0	76,702	38.8	bluegreen
4 Cocconeis placentula	10	7.5	4,382	2.2	diatom
5 Chlamydomonas sp.	5	3.8	1,548	0.8	green
6 Melosira granulata	4	3.3	11,232	5.7	diatom
7 Melosira ambigua	4	2.8	7,364	3.7	diatom
8 Cryptomonas erosa	2	1.4	929	0.5	cryptophyte
9 Eunotia pectinalis	1	0.9	857	0.4	diatom
10 Fragilaria crotonensis	1	0.9	6,001	3.0	diatom
11 Melosira granulata angustissima	1	0.9	595	0.3	diatom
12 Gomphonema angustatum	1	0.9	214	0.1	diatom
13 Navicula cryptocephala	1	0.9	220	0.1	diatom
14 Sphaerocystis schroeteri	1	0.5	333	0.2	green
15 Rhodomonas minuta	1	0.5	12	0.0	cryptophyte
16 Oocystis pusilla	1	0.5	129	0.1	green
17 Gomphonema subclavatum	1	0.5	357	0.2	diatom
18 Synedra ulna	1	0.5	1,185	0.6	diatom
19 Gloeocystis ampla	1	0.5	152	0.1	green
20 Achnanthes minutissima	1	0.5	30	0.0	diatom
21 Fragilaria capucina mesolepta	1	0.5	1,518	0.8	diatom
22 Asterionella formosa	1	0.5	393	0.2	diatom
23 Cosmarium sp.	1	0.5	125	0.1	green
Note: 200 count.					
Aphanizomenon flos-aquae cells/mL =	800				
Aphanizomenon flos-aquae heterocysts/mL =	2				
Anabaena planctonica cells/mL =	419				
Anabaena planctonica heterocysts/mL =	8				
Anabaena planctonica akinetes/mL =	1				
Microcystis aeruginosa cells/mL =	4,126				
Aquatic Analysts	Sample ID: MB73				

Phytoplankton Sample Analysis					
Sample:		Tenmile Lake			
Sample Site:		N16			
Sample Depth:					
Sample Date:		21-Sep-09			
Total Density (#/mL):		713			
Total Biovolume (um³/mL):		1,253,168			
Trophic State Index:		51.5			
Species	Density #/mL	Density Percent	Biovolume um³/mL	Biovolume Percent	Group
1 Aphanizomenon flos-aquae	580	81.3	730,693	58.3	bluegreen
2 Anabaena planctonica	55	7.7	272,209	21.7	bluegreen
3 Microcystis aeruginosa	23	3.3	27,836	2.2	bluegreen
4 Fragilaria crotonensis	14	2.0	170,495	13.6	diatom
5 Melosira ambigua	12	1.6	25,276	2.0	diatom
6 Asterionella formosa	12	1.6	13,268	1.1	diatom
7 Oocystis lacustris	3	0.4	893	0.1	green
8 Chlamydomonas sp.	3	0.4	942	0.1	green
9 Anabaena circinalis	3	0.4	6,176	0.5	bluegreen
10 Cryptomonas erosa	3	0.4	1,508	0.1	cryptophyte
11 Ochromonas sp.	3	0.4	246	0.0	chrysophyte
12 Melosira granulata angustissima	3	0.4	3,624	0.3	diatom
Note: 200 count.					
Aphanizomenon flos-aquae cells/mL = 11,598					
Aphanizomenon flos-aquae heterocysts/mL = 9					
Anabaena planctonica cells/mL = 1,487					
Anabaena planctonica heterocysts/mL = 26					
Anabaena planctonica akinetes/mL = 3					
Microcystis aeruginosa cells/mL = 3,479					
Anabaena circinalis cells/mL = 87					
Aquatic Analysts			Sample ID: MB74		

Phytoplankton Sample Analysis					
Sample:		Tenmile Lake			
Sample Site:		Z			
Sample Depth:					
Sample Date:		21-Sep-09			
Total Density (#/mL):		9,237			
Total Biovolume (um³/mL):		15,823,810			
Trophic State Index:		69.8			
Species	Density #/mL	Density Percent	Biovolume um³/mL	Biovolume Percent	Group
1 Microcystis aeruginosa	4,166	45.1	8,065,112	51.0	bluegreen
2 Aphanizomenon flos-aquae	3,577	38.7	4,056,555	25.6	bluegreen
3 Anabaena planctonica	589	6.4	3,231,714	20.4	bluegreen
4 Chlamydomonas sp.	226	2.5	73,582	0.5	green
5 Asterionella formosa	136	1.5	38,851	0.2	diatom
6 Melosira ambigua	136	1.5	184,027	1.2	diatom
7 Rhodomonas minuta	91	1.0	1,811	0.0	cryptophyte
8 Ankistrodesmus falcatus	91	1.0	2,264	0.0	green
9 Tabellaria fenestrata	45	0.5	108,675	0.7	diatom
10 Nitzschia frustulum	45	0.5	5,434	0.0	diatom
11 Achnanthes linearis	45	0.5	5,977	0.0	diatom
12 Pinnularia sp.	45	0.5	18,112	0.1	diatom
13 Glenodinium sp.	45	0.5	31,697	0.2	dinoflagellate
Note: 200 count.					
Microcystis aeruginosa cells/mL =	1,008,139				
Aphanizomenon flos-aquae cells/mL =	64,390				
Aphanizomenon flos-aquae heterocysts/mL =	181				
Anabaena planctonica cells/mL =	17,660				
Anabaena planctonica heterocysts/mL =	272				
Aquatic Analysts			Sample ID: MB75		

Appendix I: Aquatic Analysts Phytoplankton Lab Sheets

Phytoplankton Sample Analysis					
Sample:		Tenmile Lake			
Sample Site:		S3			
Sample Depth:					
Sample Date:		5-Oct-09			
Total Density (#/mL):		25			
Total Biovolume (um ³ /mL):		32,128			
Trophic State Index:		25.3			
Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent	Group
1 Microcystis aeruginosa	11.2	45.0	15,791	49.2	bluegreen
2 Aphanizomenon flos-aquae	6.0	23.9	6,765	21.1	bluegreen
3 Sphaerocystis schroeteri	2.4	9.6	1,921	6.0	green
4 Anabaena planctonica	1.4	5.7	3,144	9.8	bluegreen
5 Rhodomonas minuta	1.0	3.8	19	0.1	cryptophyte
6 Cocconeis placentula	0.7	2.9	329	1.0	diatom
7 Dinobryon sertularia	0.7	2.9	1,289	4.0	dinoflagellate
8 Melosira ambigua	0.5	1.9	2,305	7.2	diatom
9 Melosira granulata	0.2	1.0	197	0.6	diatom
10 Anabaena flos-aquae	0.2	1.0	144	0.4	bluegreen
11 Ankistrodesmus falcatus	0.1	0.5	3	0.0	green
12 Asterionella formosa	0.1	0.5	26	0.1	diatom
13 Glenodinium sp.	0.1	0.5	84	0.3	dinoflagellate
14 Ulothrix sp.	0.1	0.5	57	0.2	green
15 Navicula viridula	0.1	0.5	54	0.2	diatom
Note: 200 count.					
Aphanizomenon flos-aquae cells/mL =		107			
Aphanizomenon flos-aquae heterocysts/mL =		1			
Microcystis aeruginosa cells/mL =		1,974			
Anabaena planctonica cells/mL =		17			
Anabaena planctonica heterocysts/mL =					
Anabaena flos-aquae cells/mL =		2			
Aquatic Analysts		Sample ID: MV25			

Phytoplankton Sample Analysis						
	Sample:	Tenmile Lake				
	Sample Site:	S8				
	Sample Depth:					
	Sample Date:	5-Oct-09				
	Total Density (#/mL):	18				
	Total Biovolume (um³/mL):	29,617				
	Trophic State Index:	24.7				
Species	Density #/mL	Density Percent	Biovolume um³/mL	Biovolume Percent	Group	
1	Microcystis aeruginosa	4.8	27.1	8,893	30.0	bluegreen
2	Dinobryon sertularia	3.6	19.9	5,114	17.3	dinoflagellate
3	Aphanizomenon flos-aquae	1.7	9.4	2,007	6.8	bluegreen
4	Chlamydomonas sp.	1.1	6.1	353	1.2	green
5	Melosira granulata	0.9	5.0	2,783	9.4	diatom
6	Anabaena planctonica	0.9	5.0	4,386	14.8	bluegreen
7	Melosira ambigua	0.9	5.0	2,510	8.5	diatom
8	Anabaena flos-aquae	0.8	4.4	1,692	5.7	bluegreen
9	Sphaerocystis Schroeteri	0.7	3.9	242	0.8	green
10	Cocconeis placentula	0.3	1.7	136	0.5	diatom
11	Cryptomonas erosa	0.3	1.7	154	0.5	cryptophyte
12	Fragilaria crotonensis	0.3	1.7	671	2.3	diatom
13	Glenodinium sp.	0.3	1.7	207	0.7	dinoflagellate
14	Rhodomonas minuta	0.3	1.7	6	0.0	cryptophyte
15	Mallomonas sp.	0.1	0.6	37	0.1	chrysophyte
16	Gloeocystis ampla	0.1	0.6	51	0.2	green
17	Scenedesmus quadricauda	0.1	0.6	26	0.1	green
18	Cyclotella stelligera	0.1	0.6	5	0.0	diatom
19	Oocystis lacustris	0.1	0.6	122	0.4	green
20	Nitzschia paleacea	0.1	0.6	10	0.0	diatom
21	Fragilaria capucina mesolepta	0.1	0.6	151	0.5	diatom
22	Gomphonema tenellum	0.1	0.6	21	0.1	diatom
23	Gomphonema angustatum	0.1	0.6	18	0.1	diatom
24	Cosmarium sp.	0.1	0.6	21	0.1	green
25	Ankistrodesmus falcatus	0.1	0.6	2	0.0	green
Note: 200 count.						
Microcystis aeruginosa cells/mL =		1,112				
Anabaena flos-aquae cells/mL =		25				
Anabaena flos-aquae heterocysts/mL =		1				
Anabaena planctonica cells/mL =		24				
Anabaena planctonica heterocysts/mL =		1				
Aphanizomenon flos-aquae cells/mL =		32				
Aphanizomenon flos-aquae heterocysts/mL =		1				
Aquatic Analysts			Sample ID:		MV26	

Phytoplankton Sample Analysis					
Sample:		Tenmile Lake			
Sample Site:		dock			
Sample Depth:					
Sample Date:		5-Oct-09			
Total Density (#/mL):		841			
Total Biovolume (um³/mL):		603,468			
Trophic State Index:		46.2			
Species	Density	Density	Biovolume	Biovolume	Group
	#/mL	Percent	um ³ /mL	Percent	
1 Rhodomonas minuta	302	35.9	6,043	1.0	cryptophyte
2 Chlamydomonas sp.	79	9.4	25,615	4.2	green
3 Microcystis aeruginosa	79	9.4	84,490	14.0	bluegreen
4 Anabaena planctonica	74	8.9	204,329	33.9	bluegreen
5 Aphanizomenon flos-aquae	57	6.8	71,722	11.9	bluegreen
6 Asterionella formosa	31	3.6	6,743	1.1	diatom
7 Melosira ambigua	26	3.1	49,517	8.2	diatom
8 Cryptomonas erosa	22	2.6	11,384	1.9	cryptophyte
9 Ankistrodesmus falcatus	22	2.6	547	0.1	green
10 Fragilaria capucina mesolepta	22	2.6	16,748	2.8	diatom
11 Anabaena flos-aquae	18	2.1	14,082	2.3	bluegreen
12 Fragilaria crotonensis	13	1.6	18,758	3.1	diatom
13 Melosira granulata	13	1.6	9,392	1.6	diatom
14 Gomphonema angustatum	9	1.0	1,576	0.3	diatom
15 Sphaerocystis Schroeteri	9	1.0	3,678	0.6	green
16 Peridinium cinctum	9	1.0	36,781	6.1	dinoflagellate
17 Cocconeis placentula	9	1.0	4,028	0.7	diatom
18 Melosira distans alpigena	9	1.0	2,299	0.4	diatom
19 Navicula sp.	4	0.5	657	0.1	diatom
20 Dinobryon sertularia	4	0.5	525	0.1	dinoflagellate
21 Meridion circulare	4	0.5	1,686	0.3	diatom
22 Anabaena circinalis	4	0.5	9,327	1.5	bluegreen
23 Nitzschia frustulum	4	0.5	525	0.1	diatom
24 Glenodinium sp.	4	0.5	3,065	0.5	dinoflagellate
25 Gloeocystis ampla	4	0.5	1,121	0.2	green
26 Achnanthes minutissima	4	0.5	219	0.0	diatom
27 Epithemia turgida	4	0.5	18,609	3.1	diatom
Note: 200 count					
Aphanizomenon flos-aquae cells/mL = 1,138					
Aphanizomenon flos-aquae heterocysts/mL = 26					
Anabaena planctonica cells/mL = 1117					
Anabaena planctonica heterocysts/mL = 39					
Anabaena planctonica akinetes/mL = 13					
Anabaena flos-aquae cells/mL = 210					
Anabaena flos-aquae heterocysts/mL = 13					
Microcystis aeruginosa cells/mL = 10561					
Anabaena circinalis cells/mL = 131					
Anabaena circinalis heterocysts/mL = 4					
Aquatic Analysts			Sample ID: MV31		

Phytoplankton Sample Analysis					
	Sample:	Tenmile Lake			
	Sample Site:	N16			
	Sample Depth:				
	Sample Date:	5-Oct-09			
	Total Density (#/mL):	75			
	Total Biovolume (um³/mL):	125,041			
	Trophic State Index:	34.9			
Species	Density #/mL	Density Percent	Biovolume um³/mL	Biovolume Percent	Group
1 Microcystis aeruginosa	28.6	38.1	36,789	29.4	bluegreen
2 Melosira granulata	12.4	16.5	23,777	19.0	diatom
3 Melosira ambigua	8.5	11.3	19,006	15.2	diatom
4 Anabaena planctonica	6.6	8.8	26,418	21.1	bluegreen
5 Aphanizomenon flos-aquae	4.6	6.2	4,669	3.7	bluegreen
6 Sphaerocystis schroeteri	3.9	5.2	4,593	3.7	green
7 Asterionella formosa	3.1	4.1	1,087	0.9	diatom
8 Chlamydomonas sp.	2.7	3.6	878	0.7	green
9 Cocconeis placentula	1.5	2.1	710	0.6	diatom
10 Anabaena flos-aquae	1.2	1.5	3,103	2.5	bluegreen
11 Rhodomonas minuta	0.8	1.0	15	0.0	cryptophyte
12 Fragilaria crotonensis	0.4	0.5	3,242	2.6	diatom
13 Synedra radians	0.4	0.5	556	0.4	diatom
14 Gloeocystis ampla	0.4	0.5	198	0.2	green
Note: 200 count.					
Microcystis aeruginosa cells/mL =	4,599				
Anabaena planctonica cells/mL =	144				
Anabaena planctonica heterocysts/mL =	3				
Aphanizomenon flos-aquae cells/mL =	74				
Aphanizomenon flos-aquae heterocysts/mL =	1				
Anabaena flos-aquae cells/mL =	46				
Aquatic Analysts			Sample ID:	MV28	

Phytoplankton Sample Analysis						
Sample:		Tenmile Lake				
Sample Site:		NLR				
Sample Depth:						
Sample Date:		5-Oct-09				
Total Density (#/mL):		16,444				
Total Biovolume (um³/mL):		28,423,502				
Trophic State Index:		74.0				
Species	Density #/mL	Density Percent	Biovolume um³/mL	Biovolume Percent	Group	
1	Microcystis aeruginosa	10,664	64.9	20,902,303	73.5	bluegreen
2	Chlamydomonas sp.	1,954	11.9	634,982	2.2	green
3	Anabaena planctonica	1,058	6.4	5,422,746	19.1	bluegreen
4	Rhodomonas minuta	488	3.0	9,769	0.0	cryptophyte
5	Asterionella formosa	326	2.0	143,278	0.5	diatom
6	Cocconeis placentula	244	1.5	112,343	0.4	diatom
7	Sphaerocystis schroeteri	244	1.5	162,409	0.6	green
8	Gomphonema angustatum	163	1.0	43,960	0.2	diatom
9	Melosira ambigua	163	1.0	143,848	0.5	diatom
10	Aphanizomenon flos-aquae	163	1.0	153,861	0.5	bluegreen
11	Glenodinium sp.	163	1.0	113,971	0.4	dinoflagellate
12	Gomphonema acuminatum	81	0.5	141,650	0.5	diatom
13	Nitzschia paleacea	81	0.5	7,978	0.0	diatom
14	Anabaena flos-aquae	81	0.5	54,543	0.2	bluegreen
15	Oocystis pusilla	81	0.5	35,168	0.1	green
16	Fragilaria pinnata	81	0.5	19,538	0.1	diatom
17	Gomphonema truncatum	81	0.5	110,715	0.4	diatom
18	Melosira granulata	81	0.5	179,097	0.6	diatom
19	Navicula sp.	81	0.5	12,211	0.0	diatom
20	Ankistrodesmus falcatus	81	0.5	4,070	0.0	green
21	Navicula cryptocephala	81	0.5	15,060	0.1	diatom
Note: 200 count.						
Microcystis aeruginosa cells/mL =		2,612,788				
Anabaena planctonica cells/mL =		29,632				
Anabaena planctonica heterocysts/mL =		651				
Anabaena planctonica akinetes/mL =		244				
Anabaena flos-aquae cells/mL =		814				
Aphanizomenon flos-aquae cells/mL =		2,442				
Aphanizomenon flos-aquae heterocysts/mL =		81				
Aquatic Analysts			Sample ID: MV29			

Phytoplankton Sample Analysis					
Sample:		Tenmile Lake			
Sample Site:		Z1			
Sample Depth:					
Sample Date:		5-Oct-09			
Total Density (#/mL):		32,214			
Total Biovolume (um³/mL):		60,971,400			
Trophic State Index:		79.5			
Species	Density #/mL	Density Percent	Biovolume um³/mL	Biovolume Percent	Group
1 Microcystis aeruginosa	13,051	40.5	25,579,795	42.0	bluegreen
2 Aphanizomenon flos-aquae	9,251	28.7	12,239,446	20.1	bluegreen
3 Anabaena planctonica	4,130	12.8	15,115,934	24.8	bluegreen
4 Anabaena circinalis	1,652	5.1	3,753,377	6.2	bluegreen
5 Anabaena flos-aquae	1,652	5.1	2,545,755	4.2	bluegreen
6 Chlamydomonas sp.	991	3.1	322,143	0.5	green
7 Trachelomonas volvocina	661	2.1	1,245,619	2.0	euglenoid
8 Synedra rumpens	165	0.5	23,128	0.0	diatom
9 Ankistrodesmus falcatus	165	0.5	4,130	0.0	green
10 Cocconeis placentula	165	0.5	75,993	0.1	diatom
11 Tetradron minimum	165	0.5	29,736	0.0	green
12 Asterionella formosa	165	0.5	36,344	0.1	diatom
Note: 200 count.					
Microcystis aeruginosa cells/mL =	3,197,474				
Anabaena planctonica cells/mL =	82,601				
Anabaena planctonica heterocysts/mL =	1,982				
Anabaena planctonica akinetes/mL =	1,817				
Anabaena circinalis cells/mL =	52,864				
Anabaena circinalis heterocysts/mL =	2,643				
Anabaena circinalis akinetes/mL =	991				
Aphanizomenon flos-aquae cells/mL =	194,277				
Aphanizomenon flos-aquae heterocysts/mL =	2,808				
Anabaena flos-aquae cells/mL =	37,996				
Anabaena flos-aquae heterocysts/mL =	1,817				
Aquatic Analysts			Sample ID: MV30		

Phytoplankton Sample Analysis					
Sample:		Tenmile Lake			
Sample Site:		N11			
Sample Depth:					
Sample Date:		5-Oct-09			
Total Density (#/mL):		122			
Total Biovolume (um ³ /mL):		163,864			
Trophic State Index:		36.8			
Species	Density #/mL	Density Percent	Biovolume um ³ /mL	Biovolume Percent	Group
1 Melosira granulata	30	24.7	61,319	37.4	diatom
2 Microcystis aeruginosa	26	21.5	36,054	22.0	bluegreen
3 Cocconeis placentula	12	9.7	5,424	3.3	diatom
4 Sphaerocystis Schroeteri	10	8.6	15,407	9.4	green
5 Rhodomonas minuta	7	5.9	144	0.1	cryptophyte
6 Melosira ambigua	7	5.4	20,449	12.5	diatom
7 Aphanizomenon flos-aquae	6	4.8	7,428	4.5	bluegreen
8 Asterionella formosa	5	3.8	1,715	1.0	diatom
9 Ankistrodesmus falcatus	4	3.2	98	0.1	green
10 Chlamydomonas sp.	3	2.7	1,064	0.6	green
11 Anabaena planctonica	2	1.6	7,192	4.4	bluegreen
12 Trachelomonas volvocina	2	1.6	3,704	2.3	euglenoid
13 Eunotia pectinalis	2	1.6	1,415	0.9	diatom
14 Gomphonema angustatum	1	1.1	236	0.1	diatom
15 Achnanthes minutissima	1	0.5	33	0.0	diatom
16 Gomphonema gracile	1	0.5	160	0.1	diatom
17 Cymbella affinis	1	0.5	1,179	0.7	diatom
18 Cryptomonas erosa	1	0.5	341	0.2	cryptophyte
19 Gloeocystis ampla	1	0.5	168	0.1	green
20 Synedra rumpens	1	0.5	92	0.1	diatom
21 Cymbella minuta	1	0.5	242	0.1	diatom
Note: 200 count.					
Microcystis aeruginosa cells/mL =		4,507			
Aphanizomenon flos-aquae cells/mL =		118			
Aphanizomenon flos-aquae heterocysts/mL =		1			
Anabaena planctonica cells/mL =		39			
Anabaena planctonica heterocysts/mL =		1			
Aquatic Analysts			Sample ID: MV27		

Appendix I: Aquatic Analysts Phytoplankton Lab Sheets

Phytoplankton Sample Analysis					
Sample:		Tenmile Lake			
Sample Site:		N16			
Sample Depth:					
Sample Date:		20-Oct-09			
Total Density (#/mL):		96			
Total Biovolume (um³/mL):		164,554			
Trophic State Index:		36.9			
Species	Density #/mL	Density Percent	Biovolume um³/mL	Biovolume Percent	Group
1 Microcystis aeruginosa	45.9	47.8	54,378	33.0	bluegreen
2 Anabaena planctonica	13.5	14.0	64,012	38.9	bluegreen
3 Aphanizomenon flos-aquae	9.3	9.7	14,613	8.9	bluegreen
4 Anabaena flos-aquae	6.5	6.8	11,749	7.1	bluegreen
5 Mallomonas sp.	6.0	6.3	2,521	1.5	chrysophyte
6 Chlamydomonas sp.	2.3	2.4	754	0.5	green
7 Melosira granulata	2.3	2.4	3,827	2.3	diatom
8 Dinobryon sertularia	1.9	1.9	3,340	2.0	dinoflagellate
9 Melosira ambigua	1.4	1.4	1,639	1.0	diatom
10 Dictyosphaerium ehrenbergianum	0.9	1.0	668	0.4	green
11 Asterionella formosa	0.9	1.0	919	0.6	diatom
12 Nitzschia palea	0.9	1.0	167	0.1	diatom
13 Chrysosphaerella sp.	0.9	1.0	557	0.3	chrysophyte
14 Cryptomonas erosa	0.9	1.0	482	0.3	cryptophyte
15 Sphaerocystis Schroeteri	0.5	0.5	260	0.2	green
16 Achnanthes lanceolata	0.5	0.5	84	0.1	diatom
17 Ankistrodesmus falcatus	0.5	0.5	12	0.0	green
18 Ceratium hirundinella	0.5	0.5	4,546	2.8	dinoflagellate
19 Cyclotella stelligera	0.5	0.5	26	0.0	diatom
Note: 200 count.					
Microcystis aeruginosa cells/mL =	6,797				
Anabaena flos-aquae cells/mL =	175				
Anabaena flos-aquae heterocysts/mL =	7				
Anabaena planctonica cells/mL =	350				
Anabaena planctonica heterocysts/mL =	7				
Anabaena planctonica akinetes/mL =	1				
Aphanizomenon flos-aquae cells/mL =	232				
Aphanizomenon flos-aquae heterocysts/mL =	6				
Aquatic Analysts			Sample ID:	MV32	

Phytoplankton Sample Analysis						
Sample:		Tenmile Lake				
Sample Site:		NLR				
Sample Depth:						
Sample Date:		20-Oct-09				
Total Density (#/mL):		3,128				
Total Biovolume (um³/mL):		6,868,250				
Trophic State Index:		63.7				
Species	Density #/mL	Density Percent	Biovolume um³/mL	Biovolume Percent	Group	
1	Microcystis aeruginosa	1,426	45.6	4,813,305	70.1	bluegreen
2	Rhodomonas minuta	364	11.6	7,274	0.1	cryptophyte
3	Chlamydomonas sp.	247	7.9	80,380	1.2	green
4	Anabaena planctonica	218	7.0	998,383	14.5	bluegreen
5	Anabaena flos-aquae	204	6.5	614,087	8.9	bluegreen
6	Cocconeis placentula	160	5.1	73,615	1.1	diatom
7	Nitzschia palea	116	3.7	20,950	0.3	diatom
8	Glenodinium sp.	102	3.3	71,287	1.0	dinoflagellate
9	Aphanizomenon flos-aquae	58	1.9	73,324	1.1	bluegreen
10	Fragilaria crotonensis	44	1.4	54,993	0.8	diatom
11	Gomphonema angustatum	29	0.9	5,237	0.1	diatom
12	Asterionella formosa	29	0.9	6,401	0.1	diatom
13	Sphaerocystis Schroeteri	15	0.5	2,037	0.0	green
14	Pinnularia sp.	15	0.5	5,819	0.1	diatom
15	Navicula sp.	15	0.5	2,182	0.0	diatom
16	Melosira ambigua	15	0.5	8,569	0.1	diatom
17	Synedra radians	15	0.5	5,237	0.1	diatom
18	Navicula pupula	15	0.5	3,928	0.1	diatom
19	Synedra rumpens	15	0.5	2,037	0.0	diatom
20	Eunotia pectinalis	15	0.5	10,475	0.2	diatom
21	Gomphonema subclavatum	15	0.5	8,729	0.1	diatom
Note: 200 count.						
Microcystis aeruginosa cells/mL =		601,663				
Aphanizomenon flos-aquae cells/mL =		1,164				
Anabaena planctonica cells/mL =		5,456				
Anabaena planctonica heterocysts/mL =		175				
Anabaena flos-aquae cells/mL =		9,165				
Anabaena flos-aquae heterocysts/mL =		291				
Aquatic Analysts			Sample ID: MV34			

Appendix I: Aquatic Analysts Phytoplankton Lab Sheets

Phytoplankton Sample Analysis					
Sample:	Tenmile Lake				
Sample Site:	S3				
Sample Depth:					
Sample Date:	12-Nov-09				
Total Density (#/mL):	79				
Total Biovolume ($\mu\text{m}^3/\text{mL}$):	92,816				
Trophic State Index:	32.8				
Species	Density #/mL	Density Percent	Biovolume $\mu\text{m}^3/\text{mL}$	Biovolume Percent	Group
1 Aphanizomenon flos-aquae	36.1	45.5	45,469	49.0	bluegreen
2 Mallomonas sp.	5.7	7.2	2,165	2.3	chrysophyte
3 Cryptomonas erosa	5.3	6.7	2,765	3.0	cryptophyte
4 Dinobryon sertularia	5.3	6.7	3,893	4.2	dinoflagellate
5 Asterionella formosa	4.6	5.7	3,209	3.5	diatom
6 Anabaena flos-aquae	4.2	5.3	7,279	7.8	bluegreen
7 Microcystis aeruginosa	3.4	4.3	4,130	4.4	bluegreen
8 Rhodomonas minuta	3.0	3.8	61	0.1	cryptophyte
9 Chlamydomonas sp.	2.3	2.9	741	0.8	green
10 Melosira italica	2.3	2.9	5,797	6.2	diatom
11 Anabaena planctonica	1.5	1.9	5,561	6.0	bluegreen
12 Melosira distans alpigena	1.5	1.9	2,526	2.7	diatom
13 Melosira granulata	1.1	1.4	4,575	4.9	diatom
14 Synedra radians	1.1	1.4	410	0.4	diatom
15 Ankistrodesmus falcatus	0.8	1.0	19	0.0	green
16 Melosira ambigua	0.4	0.5	447	0.5	diatom
17 Ceratium hirundinella	0.4	0.5	3,723	4.0	dinoflagellate
18 Stephanodiscus hantzschii	0.4	0.5	46	0.0	diatom
Note: 200 count.					
Aphanizomenon flos-aquae cells/mL =	722				
Aphanizomenon flos-aquae heterocysts/mL =	7				
Anabaena flos-aquae cells/mL =	109				
Anabaena flos-aquae heterocysts/mL =	3				
Anabaena flos-aquae akinetes/mL =	0				
Microcystis aeruginosa cells/mL =	516				
Anabaena planctonica cells/mL =	30				
Anabaena planctonica heterocysts/mL =	1				
Anabaena planctonica akinetes/mL =	1				
Aquatic Analysts	Sample ID: MV35				

Phytoplankton Sample Analysis					
Sample:		Tenmile Lake			
Sample Site:		S8			
Sample Depth:					
Sample Date:		12-Nov-09			
Total Density (#/mL):		54			
Total Biovolume (um³/mL):		71,204			
Trophic State Index:		30.9			
Species	Density #/mL	Density Percent	Biovolume um³/mL	Biovolume Percent	Group
1 Aphanizomenon flos-aquae	35.2	65.0	53,175	74.7	bluegreen
2 Microcystis aeruginosa	3.5	6.5	4,276	6.0	bluegreen
3 Anabaena flos-aquae	2.4	4.5	3,263	4.6	bluegreen
4 Synedra radians	1.9	3.5	682	1.0	diatom
5 Melosira ambigua	1.9	3.5	4,462	6.3	diatom
6 Dinobryon sertularia	1.4	2.5	552	0.8	dinoflagellate
7 Chlamydomonas sp.	1.4	2.5	440	0.6	green
8 Mallomonas sp.	1.4	2.5	514	0.7	chrysophyte
9 Cryptomonas erosa	1.1	2.0	563	0.8	cryptophyte
10 Ankistrodesmus falcatus	0.8	1.5	20	0.0	green
11 Asterionella formosa	0.5	1.0	357	0.5	diatom
12 Fragilaria crotonensis	0.5	1.0	2,272	3.2	diatom
13 Crucigenia quadrata	0.3	0.5	92	0.1	green
14 Achnanthes hauckiana	0.3	0.5	13	0.0	diatom
15 Gloeocystis ampla	0.3	0.5	69	0.1	green
16 Rhodomonas minuta	0.3	0.5	5	0.0	cryptophyte
17 Fragilaria vaucheriae	0.3	0.5	78	0.1	diatom
18 Eunotia incisa	0.3	0.5	155	0.2	diatom
19 Sphaerocystis schroeteri	0.3	0.5	151	0.2	green
20 Dictyosphaerium ehrenbergianum	0.3	0.5	65	0.1	green
Note: 200 count.					
Aphanizomenon flos-aquae cells/mL = 844					
Aphanizomenon flos-aquae heterocysts/mL = 25					
Anabaena flos-aquae cells/mL = 49					
Anabaena flos-aquae heterocysts/mL = 2					
Microcystis aeruginosa cells/mL = 535					
Aquatic Analysts			Sample ID: MV36		

Phytoplankton Sample Analysis					
Sample:		Tenmile Lake			
Sample Site:		N11			
Sample Depth:					
Sample Date:		12-Nov-09			
Total Density (#/mL):		104			
Total Biovolume (um³/mL):		55,757			
Trophic State Index:		29.1			
Species	Density	Density	Biovolume	Biovolume	Group
	#/mL	Percent	um ³ /mL	Percent	
1 Chlamydomonas sp.	63.1	61.0	20,511	36.8	green
2 Cocconeis placentula	14.3	13.8	6,581	11.8	diatom
3 Aphanizomenon flos-aquae	3.8	3.7	11,451	20.5	bluegreen
4 Achnanthes minutissima	2.9	2.8	147	0.3	diatom
5 Gomphonema angustatum	2.1	2.0	379	0.7	diatom
6 Microcystis aeruginosa	1.7	1.6	1,589	2.8	bluegreen
7 Navicula cryptocephala	1.3	1.2	304	0.5	diatom
8 Anabaena planctonica	1.3	1.2	5,313	9.5	bluegreen
9 Anabaena flos-aquae	1.3	1.2	846	1.5	bluegreen
10 Melosira granulata	1.3	1.2	2,291	4.1	diatom
11 Cryptomonas erosa	0.8	0.8	438	0.8	cryptophyte
12 Navicula viridula	0.8	0.8	379	0.7	diatom
13 Gomphonema subclavatum	0.8	0.8	505	0.9	diatom
14 Pinnularia sp.	0.8	0.8	337	0.6	diatom
15 Synedra rumpens	0.8	0.8	118	0.2	diatom
16 Achnanthes linearis	0.8	0.8	111	0.2	diatom
17 Asterionella formosa	0.8	0.8	278	0.5	diatom
18 Tabellaria flocculosa	0.4	0.4	248	0.4	diatom
19 Sphaerocystis Schroeteri	0.4	0.4	236	0.4	green
20 Rhodomonas minuta	0.4	0.4	8	0.0	cryptophyte
21 Desmidium sp.	0.4	0.4	1,473	2.6	green
22 Achnanthes hauckiana	0.4	0.4	20	0.0	diatom
23 Nitzschia frustulum	0.4	0.4	50	0.1	diatom
24 Dinobryon sertularia	0.4	0.4	202	0.4	dinoflagellate
25 Ankistrodesmus falcatus	0.4	0.4	11	0.0	green
26 Synedra ulna	0.4	0.4	837	1.5	diatom
27 Eunotia pectinalis	0.4	0.4	303	0.5	diatom
28 Trachelomonas volvocina	0.4	0.4	793	1.4	euglenoid
Note: 200 count.					
Aphanizomenon flos-aquae cells/mL = 182					
Aphanizomenon flos-aquae heterocysts/mL = 0.4					
Microcystis aeruginosa cells/mL = 199					
Anabaena planctonica cells/mL = 29					
Anabaena planctonica heterocysts/mL = 0.4					
Anabaena flos-aquae cells/mL = 13					
Aquatic Analysts			Sample ID:		MV37

Phytoplankton Sample Analysis					
Sample:		Tenmile Lake			
Sample Site:		N16			
Sample Depth:					
Sample Date:		12-Nov-09			
Total Density (#/mL):		32			
Total Biovolume (um³/mL):		44,467			
Trophic State Index:		27.5			
Species	Density #/mL	Density Percent	Biovolume um³/mL	Biovolume Percent	Group
1 Microcystis aeruginosa	7.9	24.6	11,017	24.8	bluegreen
2 Aphanizomenon flos-aquae	4.7	14.8	5,652	12.7	bluegreen
3 Anabaena flos-aquae	3.6	11.3	5,821	13.1	bluegreen
4 Asterionella formosa	2.8	8.9	2,431	5.5	diatom
5 Anabaena planctonica	2.0	6.4	7,863	17.7	bluegreen
6 Rhodomonas minuta	1.9	5.9	38	0.1	cryptophyte
7 Chlamydomonas sp.	1.6	4.9	511	1.2	green
8 Cryptomonas erosa	1.3	3.9	655	1.5	cryptophyte
9 Melosira ambigua	1.1	3.4	2,855	6.4	diatom
10 Dinobryon sertularia	0.9	3.0	986	2.2	dinoflagellate
11 Melosira granulata	0.8	2.5	1,904	4.3	diatom
12 Fragilaria crotonensis	0.6	2.0	3,437	7.7	diatom
13 Sphaerocystis Schroeteri	0.5	1.5	264	0.6	green
14 Cyclotella stelligera	0.5	1.5	26	0.1	diatom
15 Melosira distans alpigena	0.3	1.0	386	0.9	diatom
16 Dictyosphaerium ehrenbergianum	0.3	1.0	227	0.5	green
17 Cocconeis placentula	0.3	1.0	145	0.3	diatom
18 Nitzschia acicularis	0.2	0.5	44	0.1	diatom
19 Ankistrodesmus falcatus	0.2	0.5	4	0.0	green
20 Oocystis pusilla	0.2	0.5	34	0.1	green
21 Mallomonas sp.	0.2	0.5	60	0.1	chrysophyte
22 Desmidium sp.	0.2	0.5	110	0.2	green
Note: 200 count					
Anabaena planctonica cells/mL =	43				
Anabaena planctonica heterocysts/mL =	1.3				
Anabaena planctonica akinetes/mL =	0.2				
Microcystis aeruginosa cells/mL =	1,377				
Aphanizomenon flos-aquae cells/mL =	90				
Aphanizomenon flos-aquae heterocysts/mL =	1.9				
Aphanizomenon flos-aquae akinetes/mL =	0.2				
Anabaena flos-aquae cells/mL =	87				
Anabaena flos-aquae heterocysts/mL =	2.8				
Aquatic Analysts			Sample ID:	MV38	

Appendix II: GreenWater Labs Algal Toxin Results



aquatic analysis ... research ... consulting

Anatoxin-a, Microcystin and Saxitoxin Analysis Report

Project: TLBP
(Tennile – North Lake)

Sample IdentificationSample Collection Date

Tennile - North Lake

9/8/09

Toxin – Anatoxin-a (ANTX-A), microcystin (MC), saxitoxin (STX)

Sample Prep – The sample was ultra-sonicated to lyse cells and release toxins. Solid phase extraction (SPE) was also utilized for ANTX-A prep and preconcentration (100x). Duplicate samples were spiked with 0.1 µg/L of ANTX-A and 0.5 µg/L STX, which provided quantitative capability and additional qualitative confirmation.

Analytical Methodology – Liquid chromatography/ mass spectrometry/ mass spectrometry (LC/MS/MS) was utilized for the determination of ANTX-A. The [M+H]⁺ ion for ANTX-A (*m/z* 166) was fragmented and the major product ions (*m/z* 149, 131, 107, and 91) provided both specificity and sensitivity. The current methodology established a detection limit of 0.05 µg/L and a quantification limit of 0.1 µg/L for ANTX-A.

A microcystins enzyme linked immunosorbent assay (ELISA) was utilized for the quantitative and sensitive congener-independent detection of MCs. The current assay is sensitive to down to a detection/quantification limit of 0.15 µg/L for total MCs.

A saxitoxin enzyme linked immunosorbent assay (ELISA) was utilized for the quantitative detection of saxitoxin. The current assay is sensitive down to a detection/quantification limit of 0.1 µg/L saxitoxin.

Summary of ANTX-A/MC/STX Results

<u>Sample</u>	<u>ANTX-A level</u> (µg/L)	<u>MC level</u> (µg/L)	<u>STX level</u> (µg/L)
Tennile – North Lake	ND	≈ 20	ND

ND = Not detected above the detection limit

Detection Limit = 0.05 µg/L (ANTX-A), 0.15 µg/L (MC), 0.1 µg/L (STX)

Limit of Quantification = 0.1 µg/L (ANTX-A & STX), 0.15 µg/L (MC)

Submitted by:

Mark T. Aubel, Ph.D.

Date:

9/16/09

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Tennile Lake Basin Partnership								
SAXITOXIN RESULTS								
Tested on:		9/16/2009						
Method:		Enzyme-Linked ImmunoSorbent Assay (ELISA)						
Analyte:		Saxitoxin						
Analyzed by:		Amanda Foss						
Sample ID/ Date Collected	Initial Conc. Factor	Dilution Ratio	Assay Value, ug/L	Final Dilution Factor	Avg. Std. Recovery(%)	Avg. Spike Recovery(%)	Final Concentration (ug/L)	Average (ug/L)
Tennile North Lake 9/8/2009	1x	none	ND	1	99	96	ND	ND
	1x	none	ND	1	99	96	ND	ND
ND = Not detected above Quantification limit Quantification limit = 0.10 µg/L Standard = 0.5 µg/L STX Sample spike = 0.5 µg/L STX								

Submitted by: 
 Mark T. Aubel, Ph.D.
 Date: 9/18/2009

Submitted to: Tennile Lake Basin Partnership
 Jason Frederickson
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Tennile Lake Basin Partnership								
MICROCYSTIN RESULTS								
Tested on:		9/16/2009						
Method:		Enzyme-Linked ImmunoSorbent Assay (ELISA)						
Analyte:		Microcystins						
Analyzed by:		Amanda Foss						
Sample ID/ Date Collected	Initial Conc. Factor	Dilution Ratio	Assay Value, ug/L	Final Dilution Factor	Avg. Std. Recovery(%)	Final Concentration (ug/L)	Average (ug/L)	
Tennile North Lake 9/8/2009	1x	1:10	1.97	10	100	19.7	20	
	1x	1:10	2.01	10	100	20.1		
		1:100	0.20	100	100	20.0		
		1:100	0.20	100	100	20.0		
ND = Not detected above Quantification limit Quantification limit = 0.15 µg/L Standard = 1 µg/L MCLR Sample spike = 1 µg/L MCLR								

Submitted by: 
 Mark T. Aubel, Ph.D.
 Date: 9/18/2009

Submitted to: Tennile Lake Basin Partnership
 Jason Frederickson
 915 N Lake Rd
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aquatic analysis ... research ... consulting

Microcystin Data Report
Project: Tenmile Lake Basin Partnership

<u>Sample Identification</u>	<u>Collected</u>
Tenmile Residence Tap	9/26/09
Tenmile Residence Intake	9/26/09

Toxin –Microcystin (MC)

Sample Preparation

The samples were ultra-sonicated to lyse all cells and release toxins. Each sample was analysed in duplicate and assay values averaged to approximate toxin concentration. A duplicate sample of Tenmile Residence Intake sample was spiked at a concentration of 1 µg/L MC-LR to support quantitative capability and additional qualitative confirmation.

Analytical Methodology

Microcystin (MC)

A microcystin Enzyme-linked Immunosorbent Assay (Abraxis) was utilized for the quantitative detection of MC. The current assay is sensitive down to a detection/quantification limit of 0.15 µg/L.


<u>Sample</u>	<u>MC levels</u> (µg/L)
Tenmile Residence Tap	ND
Tenmile Residence Intake	1.8

ND = Not detected above the detection limit

Detection Limit = 0.15 µg/L

Limit of Quantification = 0.15 µg/L

Submitted by:


 Mark T. Aubel, Ph.D.

Date:

10/13/2009

Cyano
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APPENDIX III

Oregon Health Division
Drinking water treatment guidance
August 31, 2001

DHS Contact Information:

Harmful Algae Program Coordinator: Jennifer Ketterman at 877-290-6767
If she is not available call the main line for the Office of Environmental
Public Health at: (971) 673 – 0440 or
Toll Free: (877) 290 – 6767.

1. Treatment systems should consist of sand filtration followed by chlorination, followed by activated charcoal filtration. It is essential that sand filtration be done before disinfection to remove as many algal cells as possible without killing or rupturing them.
2. Chlorination systems should be capable of maintaining at least 1 ppm of chlorine residual for at least 20 minutes contact time before the water enters the activated charcoal system.
3. The final step in the process should be effective activated charcoal treatment to remove toxin remaining after the sand filtration and disinfection processes.
4. All treatment equipment used should meet NSF standard 53, and should be adequately sized to treat the maximum amount of water that you use. Treatment equipment needs regular monitoring and servicing to assure that it functions properly.
5. Ideally all water entering your home should be treated as recommended. It is possible to treat only water used in the kitchen, but this increases chances that animals or pets would inadvertently drink untreated water.

As more monitoring is done and toxin levels are measured this advisory may be altered. The advisory is to remain in effect until specifically changed or lifted by county and state health officials.

FACT SHEET

TOXIC *MICROCYSTIS* BLOOMS IN TENMILE LAKES

(information modified from Oregon Health Division Document: Hazards from *Microcystis aeruginosa* in Fresh Water – <http://www.ohd.hr.state.or.us/esc/docs/mafact.htm>)

➤ **What is a toxic bloom of *Microcystis aeruginosa*?**

Microcystis aeruginosa is a species of blue-green algae that grows naturally in many surface waters. In most bodies of fresh water and most weather conditions it does not pose a hazard to wildlife or human beings. However, under certain conditions (such as when the water is warm with abundant nutrients) *Microcystis aeruginosa* can grow more rapidly than normal. The result can be excessive numbers of large colonies that form floating masses on the water surface or that are dispersed within the water column. These occurrences are called "algal blooms". *Microcystis aeruginosa* can produce natural toxins (called microcystins) that are very potent, and these toxins are higher in concentration during bloom conditions. The microcystin toxins are produced and contained inside the *Microcystis* cells, and are released to the water when the cells die and disintegrate. Also, since the cells are very small, they can be ingested along with the water. Toxin levels in a water body tend to be higher near shorelines and at the surface of the water where animal and human contact is most likely.

➤ **What are the primary toxic effects of these blooms?**

The primary toxic effect of microcystins is on the liver. At very high doses, death of liver cells and destruction of blood vessels in the liver can result in serious injury and possibly death. Though less is known about the long-term effects of microcystin toxins, animal studies have shown these toxins can cause chronic liver damage and may promote the formation of liver tumors. These effects are more likely to occur if exposure is frequent over a long period of time.

The levels of toxin necessary to produce immediate or acute illness in humans and animals are much higher than levels that may cause chronic liver injury. Drinking water standards are usually based on chronic effects. Currently, there is no drinking water standard in the U.S. for microcystins. Canada, Australia, and Great Britain have developed a guideline level of 1 microgram toxin per liter of water, or 1 part per billion (1 ppb). During algal blooms, toxin levels can greatly exceed 1 ppb.

➤ **How is it determined when the water becomes safe once a bloom is reported?**

Changes in weather or in other conditions in a water body influence the growth of blue-green algae. Generally, cooler weather, rainfall, and reduced sunshine will lead to reductions in algal growth and toxin levels. Algal blooms generally peak and die off rapidly and toxin levels in the water decline over days or weeks. Only blue-green algae experts can distinguish visually between different kinds of algal growth, and are able to determine when blooms have disappeared. Testing of the water is the only way to be certain that toxin levels are no longer dangerous.

➤ **When does the Oregon Health Division Issue Warnings?**

Drinking Water -- When measured or estimated toxin levels reach 1 ug/l the Department of Human Services, Office of Public Health Systems issues public advisories or warnings. These will include warnings regarding the use of water for drinking or food preparation unless the water has been treated following specific guidelines for destroying and removing toxins. Animals should be kept away from water during periods when microcystin toxin levels exceed 1 ug/l, because drinking the water can cause serious or even fatal illness.

Contact Recreation -- If levels are high enough to pose hazards for swimming, water-skiing or other direct skin contact activities, the advisories will warn against water contact. Generally skin hazards occur where the water has a green or blue-green color or where there are visible clumps or mats of algae present in the water. When measured toxin levels reach 5 ug/L or cell counts reach 15,000 cells/ml, contact recreation is considered unsafe.

➤ **Can testing ensure that all areas of the lake are safe?**

No, due to the patchy nature of blue-green algal blooms it is possible for higher *Microcystis* densities (and therefore higher microcystin toxin concentrations) to be present in areas not sampled in a given survey, particularly along shorelines or during calm conditions of little to no wind. **Therefore, when a lake has a demonstrated history of algal toxicity or the presence of known toxin producing algal species, those utilizing the lake for drinking water should always follow Oregon Health Division recommendations for purification. In addition, recreational users should always avoid contact with water whenever noticeable surface concentrations of algae are evident or when the lake has an obvious green to blue-green appearance.**

➤ **Are domestic animals at risk during blooms?**

Yes, pets or other domestic animals are the most likely to ingest contaminated water, these animals should not be allowed access to the lakeshore whenever either noticeable surface concentrations of algae or an obvious green to blue-green appearance is evident.

➤ **Is it safe to eat fish and other aquatic life?**

Clams, mussels, snails and other shellfish should not be eaten during microcystin advisory periods, but it is believed that fish can be safely eaten if they are cleaned and all internal organs discarded. Internal organs of such fish may be toxic even to animals.

➤ **How much does testing cost?**

Samples must be shipped to qualified laboratories for analysis. A microscopic determination to quantify the number of Microcystis colonies and cells costs \$90 per sample. A specialized test to analyze for the microcystin toxin concentration costs \$100 per sample (overnight shipping costs not included), and for anatoxins the cost is \$250/sample .

NOTE: Additional information can be obtained online from the Oregon Harmful Algae Bloom Surveillance Program: <http://www.oregon.gov/DHS/ph/hab/>