AQUATIC ECOSYSTEM SCIENCES, LLC

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Tech Memo

To:	Mike Mader/Jason – TLBP	From:	Jake Kann
Fax:	(503) 731-4077 541-759-3711	Pages:	11
Phone:		Date:	08-15-06
Re:	*Tenmile Sampling*	CC:	Dave Stone – OHD

Mike and Jason,

Aug 7th toxic algal cell count results for Tenmile Lakes are as follows:

STATION	DATE	*Microcystis* Cells (no./ml)	*Anabaena* Cells (no.ml)
S3	8-7-06	0	328
S8	8-7-06	0	585
N11	8-7-06	0	424
N16	8-7-06	0	196

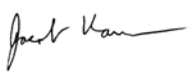
Microcystis aeruginosa (MSAE) was not detected at any of the sampling stations on 8-7-06. *Anabaena* density remained relatively low but increased slightly at all stations since the 7-24 sample date (Fig. 1). Only S8 exceeded the WHO Alert Level 1 density of 500 cells/ml (Alert Level 1 is the increased vigilance level for drinking water systems).

South Lake station S3 was dominated by the diatoms *Fragilaria* and *Melosira*, while S8 continued to be dominated by the cyanobacterium *Aphanizomenon flos-aquae*. Both north lake stations were dominated by primarily by *Aphanizomenon,* and secondarily by *Anabaena.* Various Chrysophytes, Cryptophytes, and Diatoms comprised the remainder of the biovolume at all stations.

Due to the patchy nature of blue-green algal blooms it is possible for higher *Microcystis aeruginosa* and *Anabaena flos-aquae* densities (and therefore higher microcystin toxin and 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 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 (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. 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.

Please call if you have any questions.

Sincerely,



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References for Alert Levels

Yoo, S.R., W.W. Carmichael, R.C. Hoehn, and S.E. Hrudy. 1995. Cyanobacterial (blue-green algal) toxins: a resource guide. AWWA Research Foundation and American Water Works Association. Denver, CO. 229 p. (ISBN 0-89867-824-2)

Falconer et al. 1999. Safe levels and safe practices. Pages 155-177 *in*: I. Chorus and J. Bartram, editors. *Toxic Cyanobacteria in water: a guide to their public health consequences*. World Health Organization Report. E & FN Spon, London and New York.

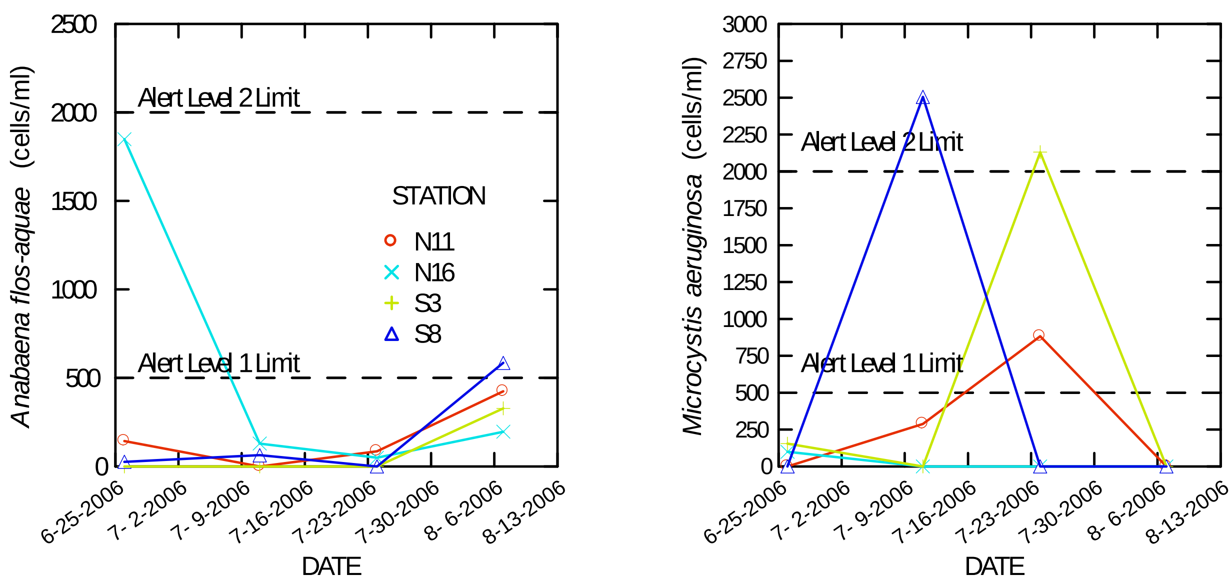
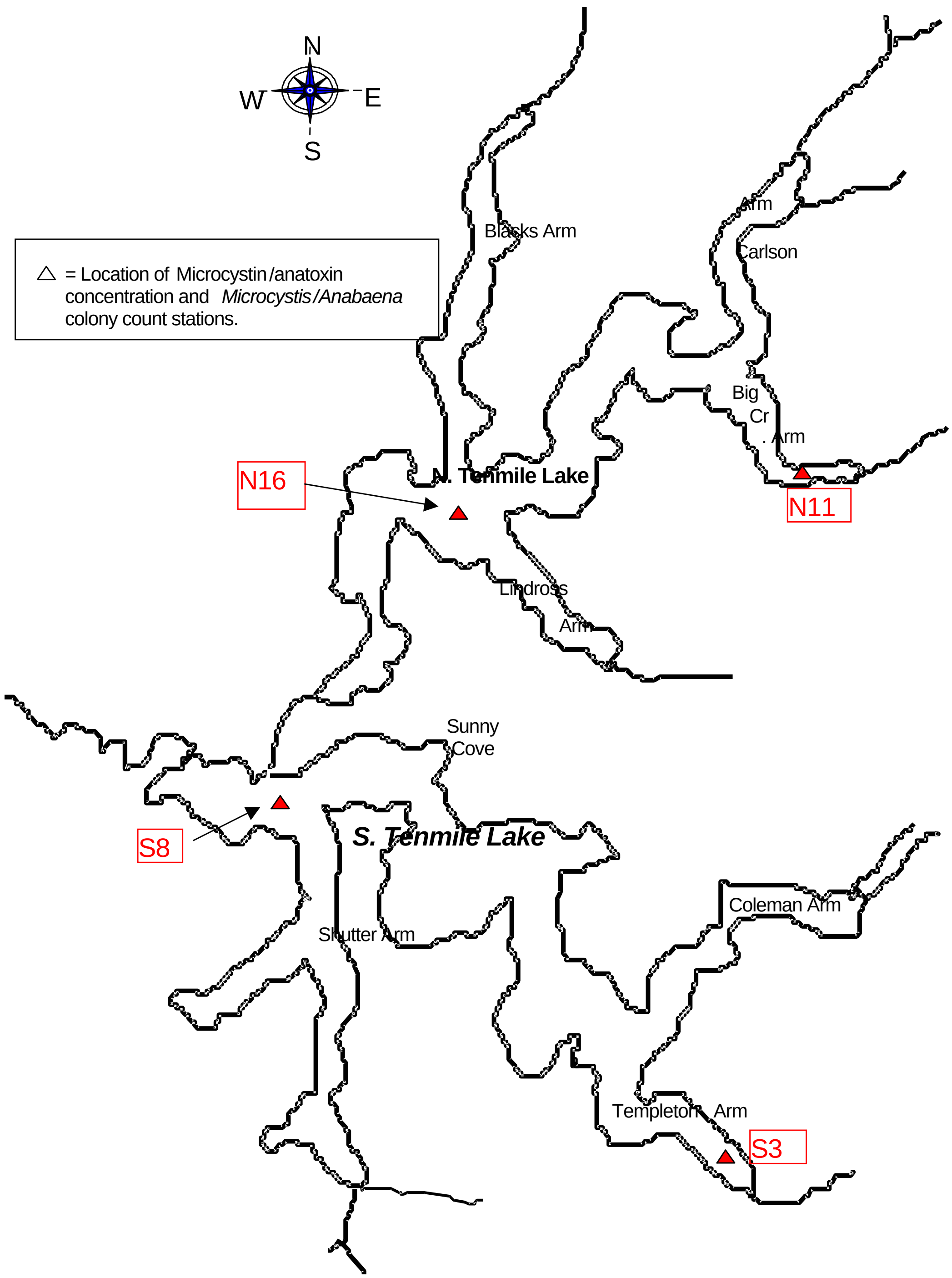


Figure 1. Tenmile Lakes 2006 Toxic Cyanobacteria Trends

Year 2006 Tenmile Lakes Sample Site Locations



Phytoplankton Sample Analysis

Sample: Tenmile Lake
Sample Station: S3
Sample Depth:
Sample Date: 7-Aug-06

Total Density (#/mL): 887
Total Biovolume (um^3/mL): 1,712,436
Trophic State Index: 53.7

	Species	Density #/mL	Density Percent	Biovolume um^3/mL	Biovolume Percent
-	-	-	-	-	-
1	Melosira granulata angustissima	476	53.7	536,025	31.3
2	Melosira granulata	238	26.9	615,833	36.0
3	Aphanizomenon flos-aquae	74	8.3	65,210	3.8
4	Fragilaria crotonensis	25	2.8	414,033	24.2
5	Anabaena flos-aquae	16	1.9	11,008	0.6
6	Melosira ambigua	16	1.9	43,547	2.5
7	Staurastrum gracile	8	0.9	4,436	0.3
8	Cocconeis placentula	8	0.9	3,779	0.2
9	Sphaerocystis schroeteri	8	0.9	4,600	0.3
10	Anabaena circinalis	8	0.9	11,665	0.7
11	Nitzschia acicularis	8	0.9	2,300	0.1

Aphanizomenon flos-aquae cells/mL = 1,035
Aphanizomenon flos-aquae heterocysts/mL = 33

Anabaena flos-aquae cells/mL = 164

Anabaena circinalis cells/mL = 164
Anabaena circinalis heterocysts/mL = 8

Aquatic Analysts **Sample ID:** JU65

Phytoplankton Sample Analysis

Sample: Tenmile Lake
Sample Station: S8
Sample Depth:
Sample Date: 7-Aug-06

Total Density (#/mL): 296
Total Biovolume (um^3/mL): 447,271
Trophic State Index: 44.1

	Species	Density #/mL	Density Percent	Biovolume um^3/mL	Biovolume Percent
-	-	-	-	-	-
1	Aphanizomenon flos-aquae	198	66.9	237,142	53.0
2	Melosira granulata angustissima	28	9.4	28,668	6.4
3	Dinobryon sertularia	9	3.1	2,774	0.6
4	Synedra radians	7	2.4	2,517	0.6
5	Anabaena planctonica	7	2.4	34,549	7.7
6	Melosira ambigua	7	2.4	24,711	5.5
7	Nitzschia acicularis	5	1.6	1,305	0.3
8	Anabaena circinalis	5	1.6	4,964	1.1
9	Asterionella formosa	5	1.6	1,538	0.3
10	Cryptomonas erosa	5	1.6	2,424	0.5
11	Anabaena flos-aquae	5	1.6	21,862	4.9
12	Melosira granulata	2	0.8	8,973	2.0
13	Eudorina elegans	2	0.8	14,544	3.3
14	Glenodinium sp.	2	0.8	1,632	0.4
15	Synedra rumpens	2	0.8	326	0.1
16	Rhodomonas minuta	2	0.8	47	0.0
17	Fragilaria crotonensis	2	0.8	58,735	13.1
18	Staurastrum sp.	2	0.8	559	0.1

Aphanizomenon flos-aquae cells/mL = 3,764
Aphanizomenon flos-aquae heterocysts/mL = 119

Anabaena circinalis cells/mL = 70
Anabaena circinalis heterocysts/mL = 7

Anabaena planctonica cells/mL = 189
Anabaena planctonica heterocysts/mL = 7

Anabaena flos-aquae cells/mL = 326
Anabaena flos-aquae heterocysts/mL = 12

Aquatic Analysts **Sample ID:** JU66

Phytoplankton Sample Analysis

Sample: Tenmile Lake
Sample Station: N11
Sample Depth:
Sample Date: 7-Aug-06

Total Density (#/mL): 301
Total Biovolume (um^3/mL): 435,876
Trophic State Index: 43.9

	Species	Density #/mL	Density Percent	Biovolume um^3/mL	Biovolume Percent
1	Aphanizomenon flos-aquae	248	82.5	281,289	64.5
2	Anabaena planctonica	13	4.2	50,437	11.6
3	Anabaena flos-aquae	8	2.5	6,547	1.5
4	Melosira granulata angustissima	8	2.5	9,960	2.3
5	Dinobryon sp.	8	2.5	940	0.2
6	Dinobryon sertularia	3	0.8	596	0.1
7	Rhodomonas minuta	3	0.8	50	0.0
8	Gloeocystis sp.	3	0.8	20,846	4.8
9	Chlamydomonas sp.	3	0.8	814	0.2
10	Anabaena circinalis	3	0.8	356	0.1
11	Fragilaria crotonensis	3	0.8	63,140	14.5
12	Synedra radians	3	0.8	902	0.2

Aphanizomenon flos-aquae cells/mL = 4,465
Aphanizomenon flos-aquae heterocysts/mL = 100

Anabaena planctonica cells/mL = 276
Anabaena planctonica heterocysts/mL = 10

Anabaena flos-aquae cells/mL = 98
Anabaena flos-aquae heterocysts/mL = 10

Anabaena circinalis cells/mL = 50
Anabaena circinalis heterocysts/mL = 3

Aquatic Analysts **Sample ID:** JU67

Phytoplankton Sample Analysis

Sample: Tenmile Lake
Sample Station: N16
Sample Depth:
Sample Date: 7-Aug-06

Total Density (#/mL): 228
Total Biovolume (um^3/mL): 264,371
Trophic State Index: 40.3

	Species	Density #/mL	Density Percent		Biovolume um^3/mL	Biovolume Percent
-	-	-	-	-		-
1	Aphanizomenon flos-aquae	200	87.6		214,303	81.1
2	Anabaena planctonica	11	4.8		35,822	13.5
3	Chlamydomonas sp.	2	1.0		707	0.3
4	Melosira granulata	2	1.0		2,392	0.9
5	Cyclotella pseudostelligera	2	1.0		141	0.1
6	Navicula cryptocephala	2	1.0		402	0.2
7	Melosira granulata angustissima	2	1.0		544	0.2
8	Asterionella formosa	2	1.0		957	0.4
9	Ankistrodesmus falcatus	2	1.0		54	0.0
10	Gloeocystis sp.	2	1.0		9,048	3.4

Aphanizomenon flos-aquae cells/mL = 3,402
Aphanizomenon flos-aquae heterocysts/mL = 50

Anabaena planctonica cells/mL = 196
Anabaena planctonica heterocysts/mL = 9

Aquatic Analysts **Sample ID:** JU68

Oregon Health Division
Drinking water treatment guidance
August 31, 2001

Contact Person: Ken Kauffman
503-731-4015
kenneth.w.kauffman@state.or.us

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: A fact sheet about microcystin toxin and its effects may be found on the Web at www.dhs.state.or.us/publichealth/esc/docs/mafact.cfm