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# Tenmile Lakes Algal Memo

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|---|---|---|---|
| To: | Mike Mader/Jason – TLBP | From: | Jake Kann |
| Date: | 08-19-08 | Pages: | 12 |
| Re: | *Tenmile Sampling* | CC: | Ken Kauffman – OHD |

Tenmile Lakes cell count results for potentially toxigenic species on Aug 11th, 2008 are as follows:

| Station | Date | *Microcystis* (cells/ml) | *Gloeotrichia* (cells/ml) | Total *Microcystis*+ *Gloeotrichia* | Total *Anabaena* (cells/ml) |
|---|---|---|---|---|---|
| S3 | 8/11/2008 | 0 | 0 | 0 | 4,015 |
| S8 | 8/11/2008 | 952 | 0 | 952 | 2,048 |
| N11 | 8/11/2008 | 0 | 0 | 0 | 5,787 |
| N16 | 8/11/2008 | 1,579 | 0 | 1,579 | 415 |

These results show that on Aug 11th *Microcystis* cell densities at sample stations S8 and N16 (Figure 1) exceeded the WHO Alert Level 1 guideline (increased vigilance level for drinking water systems) of 500 cells/ ml for potentially toxigenic species. Total Anabaena (combined levels of *Anabaena flos-aquae, A. planctonica, and A. circinalis*) remained just below Alert Level 1 at N16; however, stations S3, S8, and N11 all exceeded the Alert Level 2 guideline for drinking water systems (2000 cells/ml; at which time DHS and local health services typically issue a public alert for drinking water lakes and reservoirs and reminds homeowners to follow water treatment guidelines—see Appendix II).

Levels of total *Anabaena* remained similar to the previous sample period at N16; but increased at S3, S8, and N11 (Figure 2). Station N11 at 5787 cells per ml exceeded the Alert Level 2 guideline by 2.9 times. However, as stated in previous Tech Memos, the predominant *Anabaena* species was *Anabaena planctonica* (Appendix I), a species less commonly associated with toxin production.

Aside from N11 which was dominated by *Anabaena planktonica* (56.9% by biovolume), biovolume at remaining stations was dominated by the cyanobacterium *Aphanizomenon flos-aquae,* with a maximum cell density value of 18,677 cells/ml at N16 (Appendix 1). Although this exceeds the drinking water Alert Level 2 guideline, this species has not demonstrated toxin production in Oregon. *A. planctonica* as well as various Chrysophytes, Cryptophytes, and Diatoms comprised the remainder of the biovolume, with diatom biovolume increasing in importance since the last sample date.

Because reported levels for non-dominant species 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 reported in home-owner drinking water treatment systems (see Kann 2007), all drinking water protection efforts should be in place. 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* or *Aphanizomenon*.

Please let me know if you have any questions.

Sincerely,

Jacob Kann Ph.D.

Aquatic Ecologist

*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.*

**References for Alert Levels**

Kann, J. 2007. Tenmile Lakes Toxic Algal Sampling Program: 2006 Data Summary Report. Tenmile Lakes Basin Partnership, Lakeside OR 97520

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.

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)

Year 2008 Tenmile Lakes Sample Site Locations

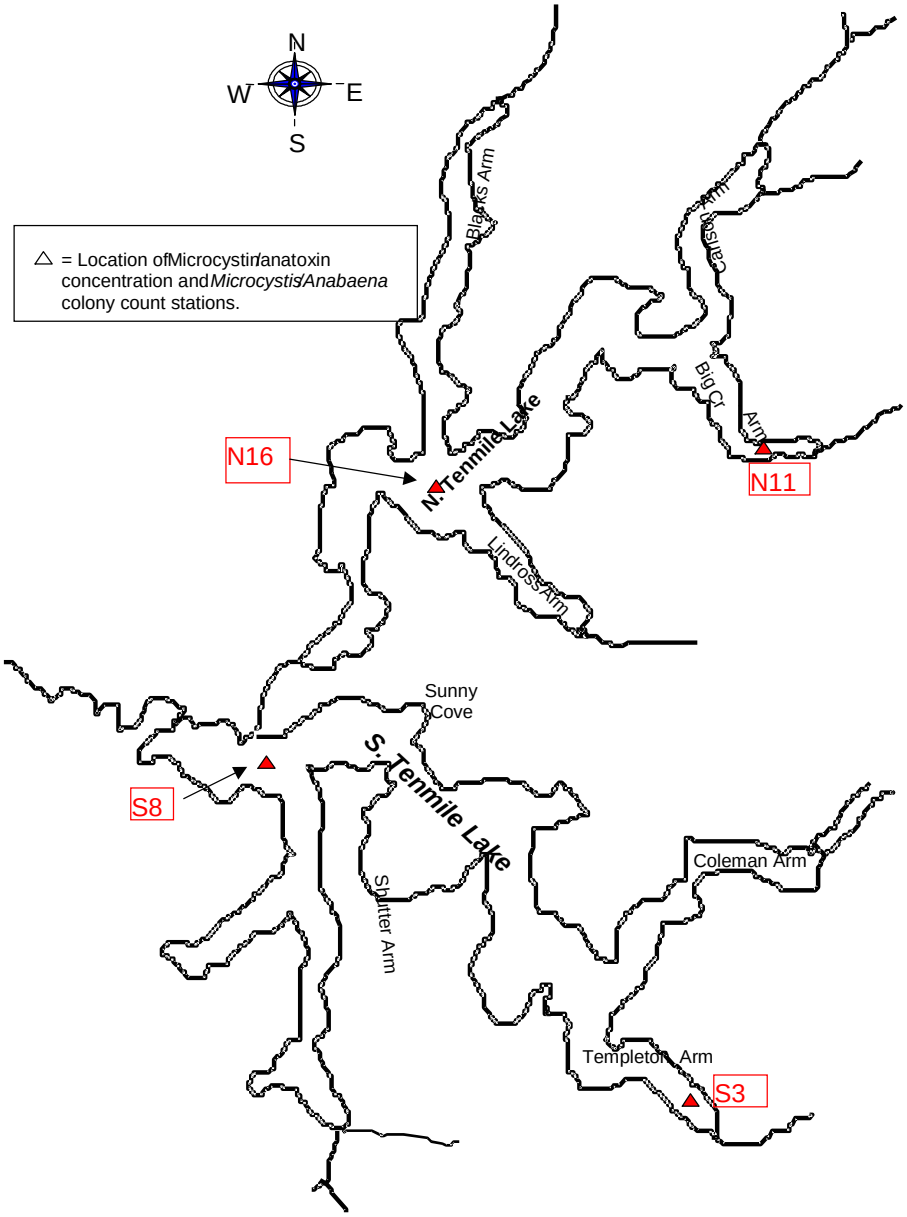


Figure 1. Sample station location for toxic cyanobacteria sampling in Tenmile Lakes, 2008.

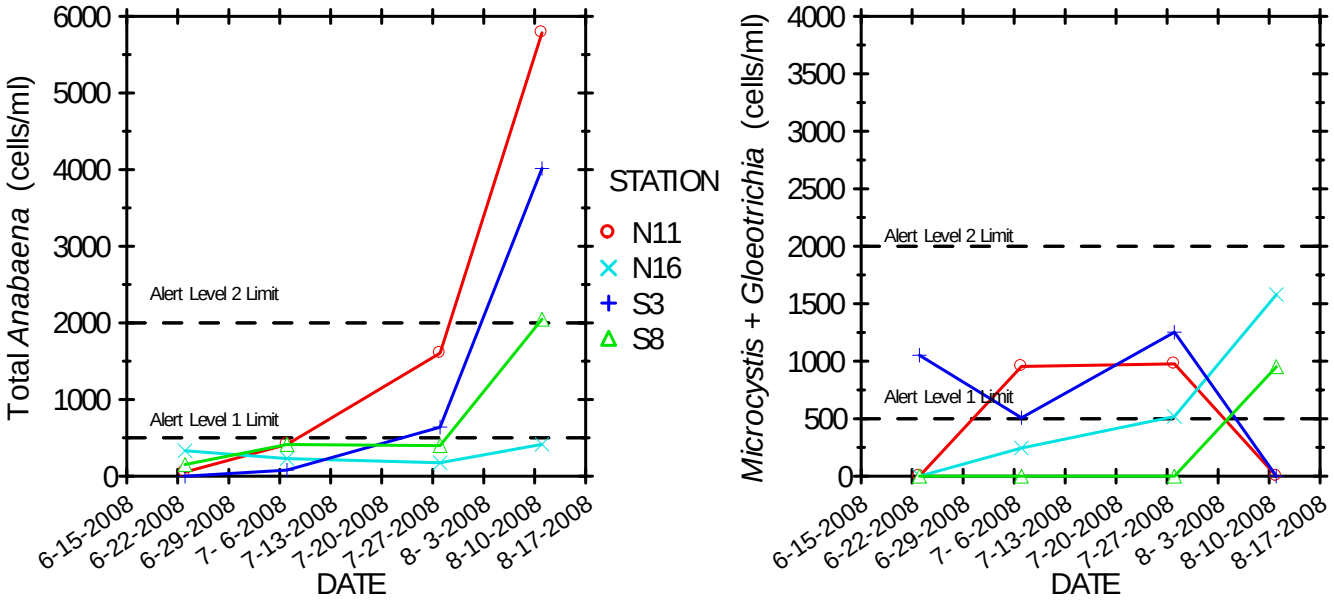


Figure 2. Trend of potentially toxic cyanobacteria in Tenmile Lakes, 2008.

## Phytoplankton Sample Analysis

| | |
|---|---|
| **Sample:** | Tenmile Lake |
| **Sample Station:** | S3 |
| **Sample Depth:** | |
| **Sample Date:** | 11-Aug-08 |
| **Total Density (#/mL):** | 855 |
| **Total Biovolume (um$^3$/mL):** | 1,496,660 |
| **Trophic State Index:** | 52.8 |

| | Species | Density #/mL | Density Percent | Biovolume um$^3$/mL | Biovolume Percent | Group |
|---|---|---|---|---|---|---|
| 1 | Aphanizomenon flos-aquae | 690 | 80.7 | 739,318 | 49.4 | bluegreen |
| 2 | Anabaena planctonica | 138 | 16.1 | 707,426 | 47.3 | bluegreen |
| 3 | Cryptomonas erosa | 8 | 0.9 | 3,988 | 0.3 | cryptophyte |
| 4 | Oocystis pusilla | 4 | 0.4 | 3,313 | 0.2 | green |
| 5 | Fragilaria capucina mesolepta | 4 | 0.4 | 15,647 | 1.0 | diatom |
| 6 | Melosira granulata | 4 | 0.4 | 6,328 | 0.4 | diatom |
| 7 | Melosira ambigua | 4 | 0.4 | 18,071 | 1.2 | diatom |
| 8 | Anabaena flos-aquae | 4 | 0.4 | 2,569 | 0.2 | bluegreen |

| | |
|---|---|
| Aphanizomenon flos-aquae cells/mL = | 11,735 |
| Aphanizomenon flos-aquae heterocysts/mL = | 69 |
| Anabaena planctonica cells/mL = | 3,866 |
| Anabaena planctonica heterocysts/mL = | 111 |
| Anabaena flos-aquae cells/mL = | 38 |

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| **Aquatic Analysts** | |
| **Sample ID:** | LS13 |

## Phytoplankton Sample Analysis

| | |
|---|---|
| **Sample:** | Tenmile Lake |
| **Sample Station:** | S8 |
| **Sample Depth:** | |
| **Sample Date:** | 11-Aug-08 |
| **Total Density (#/mL):** | 299 |
| **Total Biovolume ($um^3$/mL):** | 1,043,658 |
| **Trophic State Index:** | 50.2 |

| | Species | Density #/mL | Density Percent | Biovolume $um^3$/mL | Biovolume Percent | Group |
|---|---|---|---|---|---|---|
| 1 | Melosira granulata | 86 | 28.6 | 150,841 | 14.5 | diatom |
| 2 | Anabaena planctonica | 65 | 21.8 | 370,443 | 35.5 | bluegreen |
| 3 | Melosira ambigua | 52 | 17.3 | 176,601 | 16.9 | diatom |
| 4 | Dinobryon sertularia | 33 | 10.9 | 3,885 | 0.4 | dinoflagellate |
| 5 | Fragilaria crotonensis | 24 | 8.2 | 308,539 | 29.6 | diatom |
| 6 | Aphanizomenon flos-aquae | 24 | 8.2 | 20,055 | 1.9 | bluegreen |
| 7 | Asterionella formosa | 4 | 1.4 | 2,424 | 0.2 | diatom |
| 8 | Melosira granulata angustissima | 4 | 1.4 | 2,755 | 0.3 | diatom |
| 9 | Rhodomonas minuta | 3 | 0.9 | 54 | 0.0 | cryptophyte |
| 10 | Microcystis aeruginosa | 3 | 0.9 | 7,618 | 0.7 | bluegreen |
| 11 | Chlamydomonas sp. | 1 | 0.5 | 442 | 0.0 | green |

| | |
|---|---|
| Anabaena planctonica cells/mL = | 2,024 |
| Anabaena planctonica heterocysts/mL = | 23 |
| Anabaena planctonica akinetes/mL = | 1 |
| Aphanizomenon flos-aquae cells/mL = | 318 |
| Microcystis aeruginosa cells/mL = | 952 |

**Aquatic Analysts** **Sample ID:** LS14

## Phytoplankton Sample Analysis

| | |
|---|---|
| **Sample:** | Tenmile Lake |
| **Sample Station:** | N11 |
| **Sample Depth:** | |
| **Sample Date:** | 11-Aug-08 |
| **Total Density (#/mL):** | 1,015 |
| **Total Biovolume ($um^3$/mL):** | 1,729,056 |
| **Trophic State Index:** | 53.8 |

| | Species | Density #/mL | Density Percent | Biovolume $um^3$/mL | Biovolume Percent | Group |
|---|---|---|---|---|---|---|
| 1 | Aphanizomenon flos-aquae | 771 | 76.0 | 728,820 | 42.2 | bluegreen |
| 2 | Anabaena planctonica | 234 | 23.0 | 984,313 | 56.9 | bluegreen |
| 3 | Anabaena flos-aquae | 5 | 0.5 | 13,335 | 0.8 | bluegreen |
| 4 | Cryptomonas erosa | 5 | 0.5 | 2,587 | 0.1 | cryptophyte |

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|---|---|
| Aphanizomenon flos-aquae cells/mL = | 11,569 |
| Aphanizomenon flos-aquae heterocysts/mL = | 119 |
| Anabaena planctonica cells/mL = | 5,379 |
| Anabaena planctonica heterocysts/mL = | 209 |
| Anabaena flos-aquae cells/mL = | 199 |

**Aquatic Analysts** **Sample ID:** LS15

## Phytoplankton Sample Analysis

| | |
|---|---|
| **Sample:** | Tenmile Lake |
| **Sample Station:** | N16 |
| **Sample Depth:** | |
| **Sample Date:** | 11-Aug-08 |
| **Total Density (#/mL):** | 1,366 |
| **Total Biovolume ($um^3$/mL):** | 1,397,595 |
| **Trophic State Index:** | 52.3 |

| | Species | Density #/mL | Density Percent | Biovolume $um^3$/mL | Biovolume Percent | Group |
|---|---|---|---|---|---|---|
| 1 | Aphanizomenon flos-aquae | 1,323 | 96.8 | 1,166,465 | 83.5 | bluegreen |
| 2 | Anabaena planctonica | 24 | 1.7 | 73,690 | 5.3 | bluegreen |
| 3 | Fragilaria crotonensis | 8 | 0.6 | 126,015 | 9.0 | diatom |
| 4 | Dinobryon sertularia | 8 | 0.6 | 18,792 | 1.3 | dinoflagellate |
| 5 | Microcystis aeruginosa | 4 | 0.3 | 12,633 | 0.9 | bluegreen |

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|---|---|
| Aphanizomenon flos-aquae cells/mL = | 18,515 |
| Aphanizomenon flos-aquae heterocysts/mL = | 162 |
| Anabaena planctonica cells/mL = | 403 |
| Anabaena planctonica heterocysts/mL = | 12 |
| Microcystis aeruginosa cells/mL = | 1,579 |

**Aquatic Analysts** **Sample ID:** LS16

August 19, 2008

**Oregon Health Division** **Contact Person: Ken Kauffman**
**Drinking water treatment guidance** **503-731-4015**
**August 31, 2001** **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