2004 SUMMARY REPORT: TENMILE LAKES TOXIC ALGAL SAMPLING

Prepared By:

JACOB KANN, PH.D.
AQUATIC ECOSYSTEM SCIENCES, LLC
295 East Main St.. Suite 7
Ashland, OR 97520

Prepared For:

TENMILE LAKES BASIN PARTNERSHIP
P.O. Box L
Lakeside OR 97520

February 2005

Tenmile Lakes were sampled to assess the dynamics of the potentially toxic blue-green algal species, *Microcystis aeruginosa* and *Anabaena flos-aquae*. *Microcystis* produces hepatotoxins (known as microcystins), and *Anabaena* produces a neurotoxin (anatoxin-a). 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 Tenmmile Lakes in September of 1997, prompting the Oregon Department of Health to issue a health advisory recommending that the lake not be used for drinking water and that contact recreation be avoided (Kann and Gilroy 1997). The goal of 2004 sampling, performed by the Ten Mile Lakes Basin Partnership, was to determine presence and numbers of these potentially toxic species at a limited number of sampling stations. Cell density was then compared to World Health Organization (WHO) and Oregon Health Division (OHD) toxic algal Alert Level threshold values (Table 1).

Four stations (2 in each lake) were sampled to cover a major arm and open-water location in each lake (Fig. 1). 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 8 times beginning June 14th and ending September 27th, 2004.

Year 2004 Tenmile Lakes Sample Site Locations

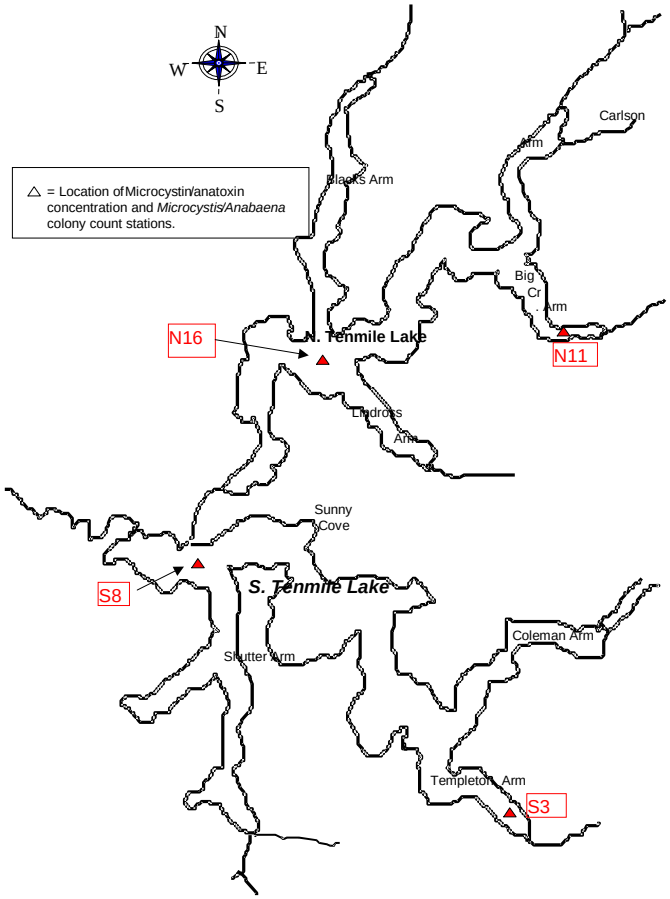

Table 1. Oregon Health Division Management Actions In Response To Toxic Algal Presence In Oregon Lakes.

Alert Level[1]	Density of Toxigenic Species in Sample	Public Info/Outreach	Closures
1	500 - 1,999 cells/ml	**None** *this level is also known as the increased vigilance level where greater sampling frequency and spatial coverage may be initiated.	None
2	2,000 – 14,999 cells/ml	• **OHD News Release** • Avoid swallowing lake water containing these algae; • Avoid skin contact with the water when scums are evident or if bright green or blue-green algae are present in the area; And • Pet owners should prevent animal access to the water.	None
3	15,000 – 99,999 cells/ml	• **OHD News Release** • Ingestion or skin contact with water from the lake is to be avoided until further notice • Post Closure Notice in all recreation areas. • Post Frequently Asked Questions	Water contact including wading, swimming, water skiing, and pets in water
4	100,000+ cells/ml	• **OHD News Release** • Post new Closure Notice in all recreation areas. • Post Frequently Asked Questions	Boating plus all water contact including wading, swimming, water skiing, and fish ingestion

[1]Derived from:

Chorus, I. and J. Bartram. 1999. Toxic Cyanobacteria in Water; A Guide to their Public Health Consequences, Monitoring and Management. World Health Organization Report. E & F Spon, London and New York. 416 p.

Yoo, S.R., W.W. Carmichael, R.C. Hoehn, and S.E. Hrudy. 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)

Because the goal of the *M. aeruginosa* and *A. flos-aquae* sampling was to detect conditions that may pose human health hazards, samples were collected mid-day 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 sand 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. The filtered contents of 3 replicate hauls were composited in a bucket, and 2 portions of the filtered contents placed in sample bottles. The first portion were placed in a 250 ml opaque sample bottle containing 1% Lugol's preservative and were shipped to plankton taxonomist Jim Sweet of Aquatic Analysts, INC., who performed a microscopic analysis for *Microcystis* and *Anabaena* density (cells ml^{-1}). The second portion was placed in a 1 liter bottle with no preservative and shipped overnight air on ice to the laboratory of Dr. Wayne Carmichael at Wright State University (WSU). The enzyme linked immunosorbent assay (ELISA) was used to determine microcystin toxins and LC/MS to determine anatoxin-a. Samples sent to WSU are only analyzed for algal toxins if cell counts exceed the Alert Level 2 threshold of 2000 cells ml^{-1} (note: no samples were analyzed in 2004—see below).

M. aeruginosa was present at low levels (<250 cells ml^{-1}) at both shallow-bay stations (S3 and N11) at the time of the first sample trip on June 14th; while *A. flos-aquae* was present at very low levels at S3 and N16 (Table 2; Figure 2). *A. flos-aquae* then fluctuated at low levels in North Lake with a moderate peak of 1232 cells ml^{-1} at N16 on July 26th and 1083 cells ml^{-1} at N11 on August 8th. These were the only instances of *A. flos-aquae* levels exceeding the WHO Alert Level 1 threshold of 500 cells ml^{-1}. *A. flos-aquae* remained below 50 cells ml^{-1} in South Lake for the entire season. No OHD news releases or lake postings were necessary for *A. flos*-aquae in 2004, and no anatoxin analyses were performed.

On July 6th *M. aeruginosa* exceeded the World Health Organization (WHO) Alert Level 1 guideline of 500 cells ml^{-1} (Yoo et al. 1995) only at N11. *M. aeruginosa* density then remained below the Alert Level 1 guideline on the subsequent three sample dates (7/26 and 8/8, and 8/23) (Table 2; Figure 2). Cell density for *M. aeruginosa* then exceeded the Alert Level 1 guideline at S3 on September 7th and 13th. However, even though the September 7th sample approached the Alert Level 2 guideline of 2000 cells ml^{-1} (1808 cell ml^{-1}), this threshold was not exceeded for the remainder of the season. No OHD news releases or lake postings were necessary for *M. aeruginosa* in 2004, and no microcystin analyses were performed.

Overall, density of toxic algae in Tenmile Lakes in 2004 was similar to 2003 with the exception of one instance of cell counts exceeding Alert Level 2 in 2003 (Fig. 3). By contrast, 2002 experienced several occasions when cell counts exceeded Alert Level 2 and one occasion of exceeding Alert Level 3 (Fig. 3). Data on climatic and in-lake and nutrient loading characteristics would be necessary to evaluate such among-year differences. Some of these data may be available in the near future.

Table 2. 2004 Tenmile Lakes Algal Count and Toxin Results

Station	Lake	Date	*Microcystis aeruginosa (cells/ml)*	*Anabaena flos-aquae (cells/ml)*	*Microcystin (ug/L)*	*Anatoxin (ug/L)*
S3	S	14-Jun-04	256	6	NT*	NT
S8	S	14-Jun-04	0	0	NT	NT
N11	N	14-Jun-04	212	0	NT	NT
N16	N	14-Jun-04	0	21	NT	NT
S3	S	6-Jul-04	368	25	NT	NT
S8	S	6-Jul-04	0	41	NT	NT
N11	N	6-Jul-04	914	0	NT	NT
N16	N	6-Jul-04	0	51	NT	NT
S3	S	26-Jul-04	0	0	NT	NT
S8	S	26-Jul-04	0	44	NT	NT
N11	N	26-Jul-04	57	237	NT	NT
N16	N	26-Jul-04	430	1232	NT	NT
S3	S	8-Aug-04	335	0	NT	NT
S8	S	8-Aug-04	157	0	NT	NT
N11	N	8-Aug-04	0	1083	NT	NT
N16	N	8-Aug-04	22	450	NT	NT
S3	S	23-Aug-04	0	0	NT	NT
S8	S	23-Aug-04	82	0	NT	NT
N11	N	23-Aug-04	106	114	NT	NT
N16	N	23-Aug-04	312	160	NT	NT
S3	S	7-Sep-04	1808	0	NT	NT
S8	S	7-Sep-04	198	0	NT	NT
N11	N	7-Sep-04	60	60	NT	NT
N16	N	7-Sep-04	81	182	NT	NT
S3	S	13-Sep-04	608	0	NT	NT
S3	S	27-Sep-04	447	0	NT	NT
S8	S	27-Sep-04	258	6	NT	NT
N11	N	27-Sep-04	131	305	NT	NT
N16	N	27-Sep-04	85	218	NT	NT

*NT=not tested because 2000 cell/ml Alert Level 2 threshold not exceeded

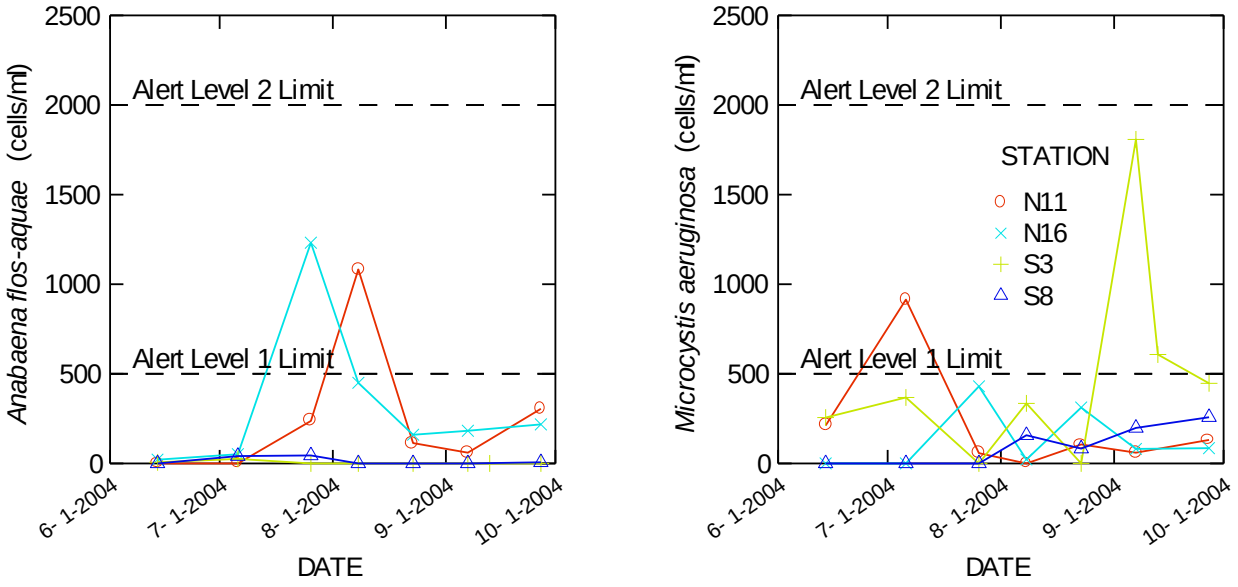

Figure 2. Density of *Microcystis aeruginosa* and *Anabaena flos-aquae* in Tenmile Lakes, 2004.

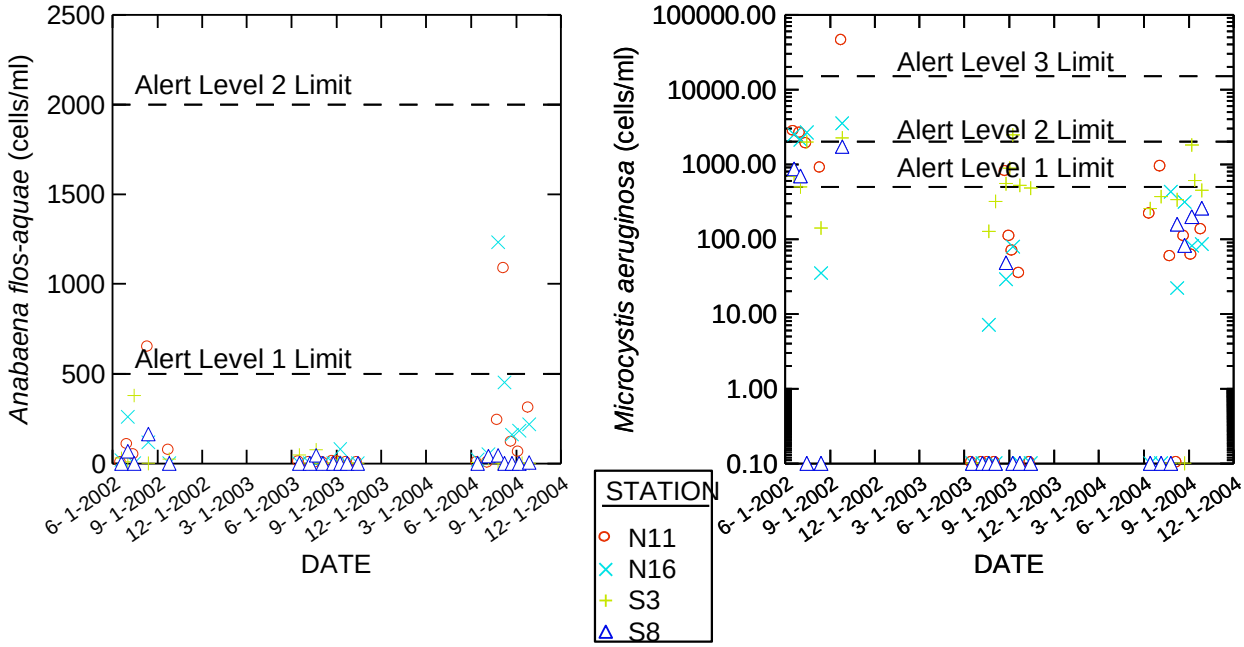

Figure 3. Density of *Microcystis aeruginosa* and *Anabaena flos-aquae* in Tenmile Lakes, 2002-2004

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. 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.

A fact sheet about *Microcystis aeruginosa* and detailed recommendations for lake water treatment may be obtained from Ken Kauffman at (503) 731-3462 or via E-mail at kenneth.w.kauffman@state.or.us or from the Coos County Health Department at (541) 756-2020. Information is also available on the worldwide web at www.dhs.state.or.us/esc/docs/mafact.cfm.

Literature Cited

Chorus, I. and J. Bartram. 1999. Toxic Cyanobacteria in Water; A Guide to their Public Health Consequences, Monitoring and Management. World Health Organization Report. E & F Spon, London and New York. 416 p.

Kann, J., and D. Gilroy. 1998. Ten Mile Lakes toxic *Microcystis* bloom, September-November 1997. Oregon Health Division Technical Report. Environmental Services and Consultation Center for Environment and Health Systems, OHD, 800 NE Oregon St., Ste.608, Portland, OR 97232.

Yoo, S.R., W.W. Carmichael, R.C. Hoehn, and S.E. Hrudy. 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)