2005 DATA SUMMARY REPORT: TENMILE LAKES TOXIC ALGAL SAMPLING

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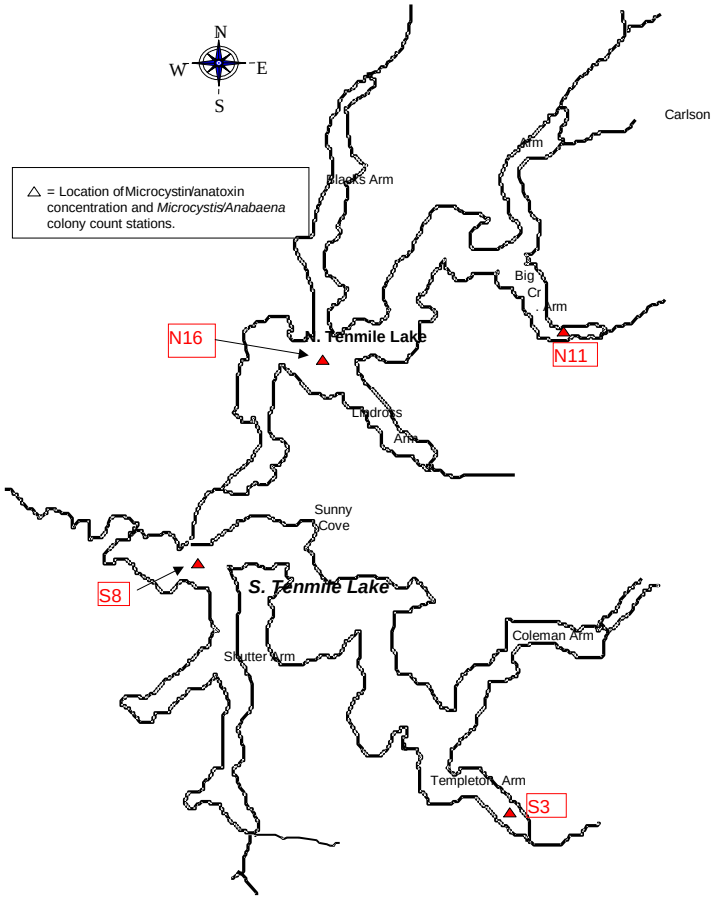
Tenmile Lakes were sampled to assess the dynamics of the potentially toxic blue-green algal species, *Microcystis aeruginosa* and *Anabaena flos-aquae*. *Microcystis* produces hepatotoxins (known as microcystins), and *Anabaena* produces a neurotoxin (anatoxin-a). Both toxins are capable of harmful effects 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 lakes not be used for drinking water and that contact recreation be avoided (Kann and Gilroy 1997). The goal of 2005 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 of the two potentially toxigenic species was then compared to drinking water guidance levels (e.g., Yoo et al. 1995; Chorus and Bartram 1999).

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 20th and ending October 10th, 2005.

Year 2005 Tenmile Lakes Sample Site Locations



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 was 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 *Microcystis* and *Anabaena* density (cells ml^{-1}). The second portion was placed in a 1 liter bottle with no preservative and frozen at the TMLBP office. If counts received the following week from Aquatic Analysts, INC show that cell counts significantly exceed the Alert Level 2 threshold of 2000 cells ml^{-1}, the frozen samples are then shipped overnight air on ice to the laboratory of Dr. Wayne Carmichael at Wright State University (WSU). The enzyme linked immunosorbent assay (ELISA) is then used to determine microcystin toxins and LC/MS 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 cell counts are below 15,000 cells/ml)

M. aeruginosa (MSAE) was present at all stations at the time of the first sample trip on June 20th, with both south lake stations above the Alert Level 1 guideline of 500 cells ml^{-1} (Yoo et al. 1995; also known as the increased vigilance level, Table 2; Figure 2). MSAE at north lake stations was below 500 cells ml^{-1} and *A. flos-aquae* and total *Anabaena* were present but at low levels at all stations (Table 2; Figure 2). *A. flos-aquae* then fluctuated at low levels in both lakes for the remainder of the season, while the total *Anabaena* density increased to 1230 cells ml^{-1} on August 22nd; however, the predominant *Anabaena* was *A. planktonica*. No OHD news releases or lake postings were issued for *Anabaena* in 2005, and no anatoxin analyses were performed.

On July 11th *M. aeruginosa* exceeded the World Health Organization (WHO) Alert Level 1 guideline of 500 cells ml^{-1} at all stations except N16 (Figure 2), and both S3 (2717 cell ml^{-1}) and N11 (3178 cells ml^{-1}) exceeded the Alert Level 2 Guideline of 2000 cells ml^{-1}(Yoo et al. 1995). MSAE cell density then declined to below Alert Level 2 at all stations on 7/25; and aside from an increase at station N11 (2943 cells ml^{-1}) on 8/8, MSAE density then declined through the remainder of the season (Table 2: Figure 2). Subsequent to the July 11th Alert Level 2 exceedances, Coos County Health Department and media outreach occurred. No OHD news releases or lake postings were issued for *M. aeruginosa* in 2005, and due to relatively low levels and budgetary constraints no microcystin analyses were performed.

Density of MSAE in Tenmile Lakes in 2005 was slightly higher than 2004, with two instances when cell counts exceeded Alert Level 2 in 2005 (Fig. 3). By contrast, 2003 experienced one instance of MSAE density exceeding 2000 cell ml-1, while in 2002 there were several occasions when cell counts exceeded Alert Level 2, and one occasion of exceedance of Alert Level 3 (Fig. 3).

Table 2. 2005 Tenmile Lakes Algal Count and Toxin Results

Station	*Lake*	*Date*	*Microcystis aeruginosa (cells/ml)*	*Anabaena flos-aquae (cells/ml)*	*Anabaena planktonic a (cells/ml)*	*Anabaena circinalis (cells/ml)*	*Anabaena sp. (cells/ml)*	*Total Anabaena (cells/ml)*	*Microcystin (µg/L)*	*Anatoxin (µg/L)*
S3	S	20-Jun-05	742	15	0	0	0	15	NT*	NT
S8	S	20-Jun-05	964	0	145	0	0	145	NT	NT
N11	N	20-Jun-05	158	16	39	0	0	55	NT	NT
N16	N	20-Jun-05	218	0	70		0	70	NT	NT
S3	S	11-Jul-05	2717	0	0	0	0	0	NT	NT
S8	S	11-Jul-05	622	113	367	244	0	724	NT	NT
N11	N	11-Jul-05	3178	59	159	50	0	268	NT	NT
N16	N	11-Jul-05	33	90	511	33	0	634	NT	NT
S3	S	25-Jul-05	450	0	0	0	0	0	NT	NT
S8	S	25-Jul-05	1914	18	53	71	0	142	NT	NT
N11	N	25-Jul-05	722	124	0	124	0	248	NT	NT
N16	N	25-Jul-05	0	10	196	16	0	222	NT	NT
S3	S	8-Aug-05	0	20	0	0	0	20	NT	NT
S8	S	8-Aug-05	160	0	0	0	0	0	NT	NT
N11	N	8-Aug-05	2943	32	16	56	0	104	NT	NT
N16	N	8-Aug-05	0	0	109	50	1008	1167	NT	NT
S3	S	22-Aug-05	0	0	0	0	0	0	NT	NT
S8	S	22-Aug-05	0	0	0	0	0	0	NT	NT
N11	N	22-Aug-05	588	7	251	44	29	331	NT	NT
N16	N	22-Aug-05	195	0	937	215	78	1230	NT	NT
S3	S	6-Sep-05	0	0	0	0	0	0	NT	NT
S8	S	6-Sep-05	21	0	0	14	0	14	NT	NT
N11	N	6-Sep-05	0	83	n	107	0	190	NT	NT
N16	N	6-Sep-05	0	0	340	463	0	803	NT	NT
S3	S	28-Sep-05	0	0	0	0	0	0	NT	NT
S8	S	28-Sep-05	31	11	0	0	0	11	NT	NT
N11	N	28-Sep-05	0	0	14	0	0	14	NT	NT
N16	N	28-Sep-05	36	0	669	0	0	669	NT	NT

Station	*Lake*	*Date*	*Microcystis aeruginosa (cells/ml)*	*Anabaena flos-aquae (cells/ml)*	*Anabaena planktonica (cells/ml)*	*Anabaena circinalis (cells/ml)*	*Anabaena sp. (cells/ml)*	*Total Anabaena (cells/ml)*	*Microcystin (µg/L)*	*Anatoxin (µg/L)*
S3	S	10-Oct-05	0	0	0	0	0	0	NT	NT
S8	S	10-Oct-05	0	133	0	0	0	133	NT	NT
N11	N	10-Oct-05	36	0	110	0	0	110	NT	NT
N16	N	10-Oct-05	12	0	97	0	0	97	NT	NT

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

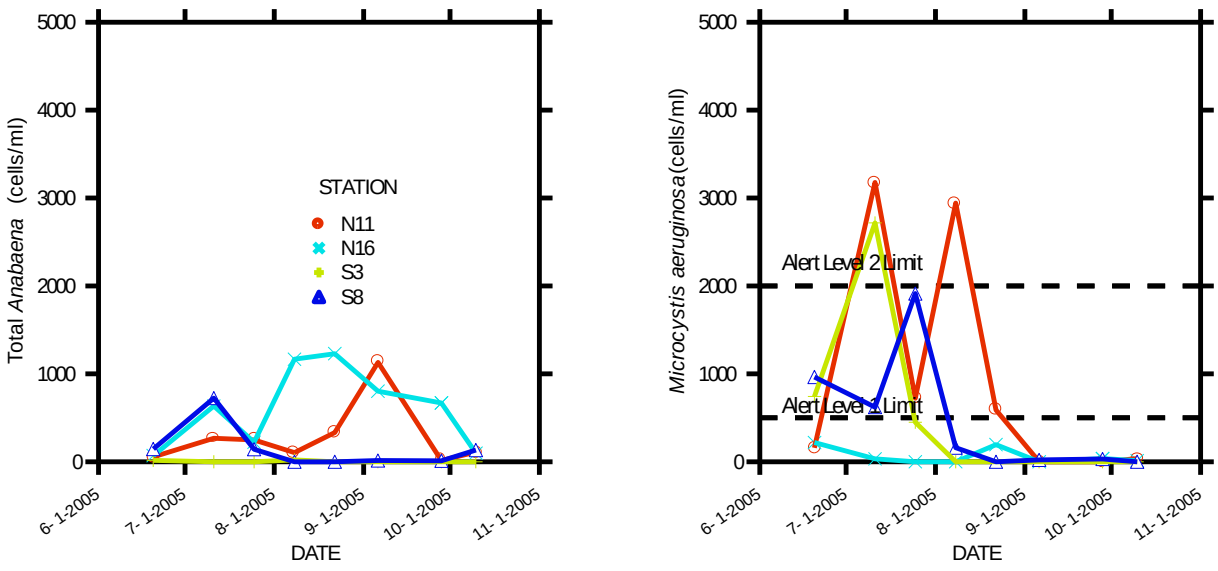


Figure 2. Density of *Microcystis aeruginosa* and total *Anabaena sp.* in Tenmile Lakes, 2005.

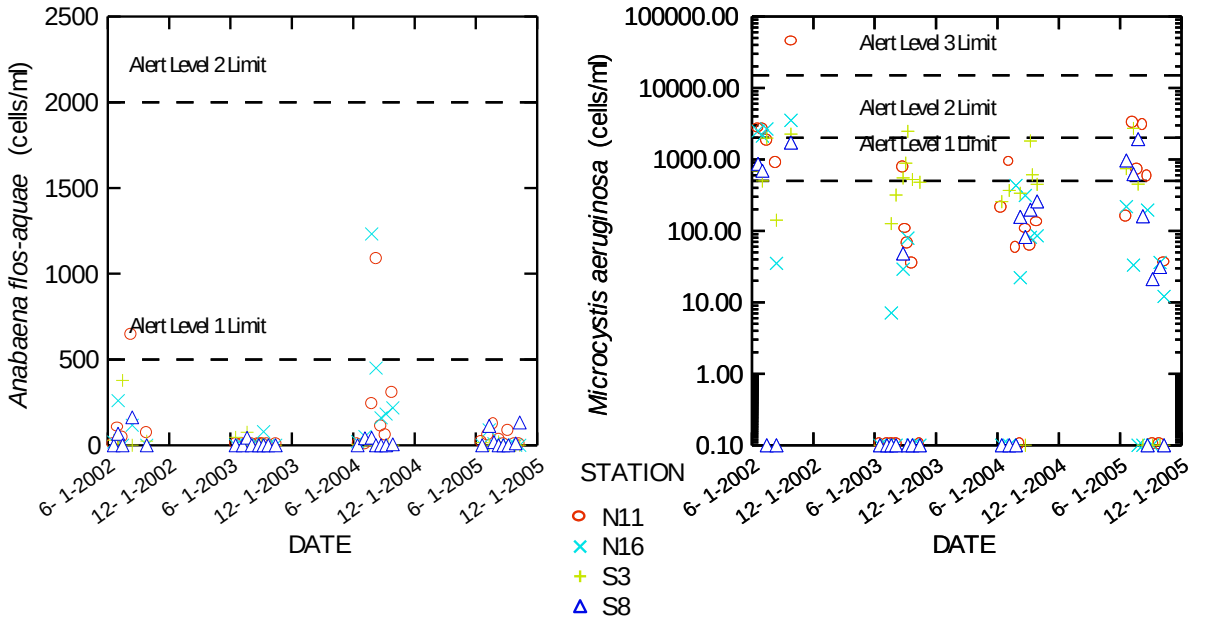


Figure 3. Density of *Microcystis aeruginosa* and *Anabaena flos-aquae* in Tenmile Lakes, 2002-2005

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)

ELECTRONIC APPENDIX I: Aquatic Analysts, Inc Phytoplankton Reports (attached electronically)