Phosphorus Loading and Concentration Recommendations

From the
Loading and Concentration Subcommittee of the
Ohio Phosphorus Task Force

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Subcommittee Members

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The following recommendations represent our scientific judgment based on the best available information. The loading targets we recommend represent a conservative first step. Meeting these targets will significantly improve the health of Lake Erie, but may or may not reduce algal blooms to acceptable levels. Therefore, it is important that we use an adaptive management approach to address this problem. That is, as we strive for phosphorus (P) reductions to reduce harmful algal blooms (HABs), we must continue to review the targets in conjunction with HAB bloom events. This approach requires a robust monitoring program to measure progress toward loading and concentration targets and HAB reduction, and to allow us to annually evaluate and modify those targets in the future, as needed. If the Phosphorus Task Force chooses not to take an adaptive management approach, then the target levels recommended in this report would have to be significantly reduced.

Our goal is to develop a loading target for the Western Basin of Lake Erie that will significantly reduce HABs. By virtue of its location, its high discharges, and its high loads and concentrations of total and dissolved phosphorus, we believe that the Maumee River watershed is the primary driver of algal blooms in the Western Basin of Lake Erie. The Maumee River watershed is well monitored by Heidelberg University and represents 4.2 million of the 7.1 million acres in the Western Basin watersheds between Monroe, Michigan and Sandusky, Ohio. Dr. Richard Stumpf, NOAA, has demonstrated that the severity of Western Basin HABs is highly correlated with Maumee River total phosphorus loads from 1 March to 30 June each year. Heidelberg has also shown that unit area loads for all of the tributaries between Monroe and Sandusky are similar (River Raisin is lower). Therefore, it is

reasonable to assume that all tributaries between Monroe and Sandusky mirror the loads of the Maumee in proportion to the size of their watersheds. We further believe that actions taken to reduce nutrient loading to reach target loads for the Maumee should be implemented in all watersheds between Monroe, Michigan and Sandusky, Ohio. Attainment of the proposed target loads for the Maumee River, our indicator of progress, and simultaneous implementation of the same actions to reduce the loads in these other watersheds, would significantly reduce HABs in the Western Basin and Lake Erie as a whole.

In our discussions we considered the following issues.

1. Pros and cons of targets based on total and/or dissolved reactive P.
2. Pros and cons of seasonal versus annual P loads.
3. The maximum P load from the Maumee River that will not produce a HAB.
4. The minimum P concentration required to produce a HAB or the maximum P concentration that will not produce a HAB. For example, blue-green algae need a P concentration of at least "X" to produce a bloom.

Loading Recommendations

For the Maumee River, we recommend targets for spring loads (defined as 1 March to 30 June) and annual loads (water years, 1 October to 30 September) for both total phosphorus (TP) and dissolved reactive phosphorus (DRP) based on eleven years (2002-12) of observation and models that have proved to be highly accurate. Spring P loading in particular has been shown to be highly predictive of subsequent HAB size. Because of the large, weather-induced, annual variability in loads, the subcommittee is proposing targets based on reduction in multi-year average loads rather than acceptable peak loads. We believe that sufficient reductions in average loads will significantly reduce the frequency and severity of HAB-inducing P loads entering the lake. Note that the subcommittee would like more time to consider the utility of using flow-weighted mean concentrations as targets in place of, or in addition to, loads.

- **For TP**, we recommend a 37% reduction in the average spring TP load of 1,275 metric tons for 2007-12, or a target of 800 metric tons (Table 1). The 2007-12 time period was selected to better address predicted increases in the frequency of severe storms due to climate change. For annual TP loads we recommend a 39% reduction from the average annual TP load from 2007-12 of 2,630 metric tons, or a target of 1600 metric tons. We believe achieving these targets will significantly reduce HABs.
- **For DRP**, we recommend a spring loading reduction of 41% in the average spring load from 2007-12 of 256 metric tons or a target of 150 metric tons. We are confident that restricting loads to this level or lower would significantly reduce HABs. (Table 1).

For reference, Figure 1 shows the relative size of the blooms that were produced each year in Western Lake Erie.

Concentration Recommendations

Concentration targets are much more challenging and would require more discussion by this subcommittee. However, we can say that a consistent/prolonged TP concentration of 50 µg/l or higher or a consistent DRP concentration of 10 µg/l or higher in a river or lake will produce a HAB. Therefore, these may be reasonable targets. However, the subcommittee would like to discuss this further as lower targets for Lake Erie could be appropriate, e.g., HABs have been observed at the majority of Western Basin sampling stations when the DRP concentration was 6 µg/l. It is also worth noting that the 50 µg/l target for TP was exceeded in the Maumee River at Waterville 100% of the time between 2004-12 and the 10 µg/l target for DRP was exceeded 76% of the time. It may be that these are reasonable targets for the river, but that a lower target is needed in the Lake. Note that there are long standing TP target of 15 µg/L for the Western Basin and 10 µg/L for the Central and Eastern Basins.

Table 1. Comparison of discharge, total phosphorus loads, and dissolved reactive phosphorus (DRP) loads for the Maumee River for water year and spring (March-June) totals for 2000 through 2012. Loads are in metric tons (tonnes). **Bolded** observations are the largest observed.

	Water Year Total			Spring March-June		
Year	Discharge m^3/year (millions)	Total phosphorus (tonnes/yr)	DRP (tonnes/yr)	Discharge m^3/5 mos (millions)	Total phosphorus (tonnes/5 mos)	DRP (tonnes/5 mos)
2000	3,352	1,190	202	2,374	965	152
2001	3,770	940	260	1,910	509	108
2002	5,957	2,100	442	2,763	1,044	173
2003	5,764	2,240	576	3,146	1,366	301
2004	5,439	1,810	494	2,687	976	195
2005	5,857	2,750	613	1,254	291	79
2006	5,150	1,790	393	1,857	572	123
2007	7,510	3,500	822	2,356	1,014	253
2008	**8,026**	**3,560**	**835**	3,364	1,293	260
2009	5,075	2,160	346	3,279	1,360	210
2010	4,648	1,530	404	3,494	1,284	317
2011	6,229	2,780	570	**5,022**	**2,310**	**429**
2012	6,106	2,250	607	1,010	391	63
Mean (00-12)	5,606	2,200	505	2,655	1,029	205
Mean (07-12)	6,266	2,630	597	3,087	1,275	256

Figure 1. Temporal variation in *Microcystis* biovolume in western Lake Erie, 2002-2012. Source: Bridgeman, T.B., Chaffin, J.D., and Filbrun, J.E. 2013. A novel method for tracking western Lake Erie Microcystis blooms, 2002–2011, J Great Lakes Res. 39, 83-89. http://dx.doi.org/10.1016/j.jglr.2012.11.004