Missouri
Department of
Natural Resources

Notes from Nutrient Criteria Technical Subcommittee – February 9, 2012

In attendance: Bob Bacon – ERC, Nick Bauer, St Louis MSD, Ed Bolliner – Boone County, Georganne Bowman – Boone County, Robert Brundage – Newman, Comley & Ruth PC, John Christianson – Geosyntec, Suzanne Femmer – USGS, John Hoke – DNR, Dave Michaelson – DNR, Rebecca O'Hearn – MDC, Dan Obrecht – UMC, Mark Osborn – DNR, Tim Rielly – DNR, Trish Rielly – DNR, Tony Thorpe – UMC, Tom Wallace – Geosyntec, Gary Welker – EPA.

Chlorophyll Maxima

Dan Obrecht gave a presentation on recently published work that addresses the effects of maximum chlorophyll values on chlorophyll/total phosphorus ratios in Missouri reservoirs. An analysis of nearly 9,000 data points comparing TP and simultaneous Chl concentrations yielded a curve for maximum Chl concentrations in the form of a 3rd order equation (in which the coefficient for log $TP^2 = 0$). This upper boundary was not entirely distinct. It was exceed by about 1.4 percent of the observed chlorophyll values. This is similar to the results of research in Florida.

The variation of ratios of observed Chl (Chl_{obs}) to maximum Chl (Chl_{max}) at any given TP concentration had a median of 0.31 and an interquartile range of 0.22 to 0.44. When the Chl/TP ratios of individual samples are compared to the range of trophic conditions (as defined by TP concentration), the resulting pattern is equivalent to a near normal distribution, with the maximum ranges of observed Chl/TP in the eutrophic zone. When the Chl_{max}:TP curve forms a dome that fits over this distribution. The left side of this dome, generally across the oligotrophic and mesotrophic zones, reflects a rapid increase in the Chl_{max}/TP ratio as TP concentration goes up. The top of the dome, over the eutrophic zone, reflects a deceleration of this trend. Looked at another way, in the oligotrophic and mesotrophic zones, Chl_{max} increases at twice the rate as TP when TP concentration rises, and in the eutrophic zone Chl_{max} increases at a more equal rate with increases in TP. In the hypereutrophic zone, Chl_{max} declines, most likely as a consequence of the blockage of sunlight due to higher turbidity.

The use of Chl_{max} as a response factor does not necessarily capture all algal bloom events. For a more inclusive model, a near maximum concentration for chlorophyll (Chl_{nm}) was calculated, based on the 95 percent confidence interval for mean Chl_{obs}. This came to about 70 percent of Chl_{max} across the TP gradient. About 5 percent of Chl_{obs} values were between the Chl_{nm} and Chl_{max} lines and a total of 6.5 percent of Chl_{obs} were greater than Chl_{mn}.

In intensively sampled reservoirs, the frequency of $Chl_{obs} > Chl_{nm}$ was considerably influenced by temporal factors, with most instances occurring during July and August.

Trophic state does not appear to be a good predictor of Chl_{nm} exceedence. Dan demonstrated this with a table identifying ten data rich lakes, the percent of time that Chl_{obs} exceeded Chl_{nm}, their mean TP and their mean Chl levels. At the top of the list was Lake Tywappity, with a Chl_{nm} exceedence level of 43 percent, mean TP was 50 µg/L and mean Chl was 38.8 µg/L.

Question: How is the fishing in Lake Tywappity? Is aquatic life use actually impaired?
Answer: We don't know, we haven't been there in a while.

If specific numeric Chl thresholds are evaluated, such as 10, 30, or 50 µg/L, the proportion of Chl_{obs} that exceeds these values is reduced to 0 in the lower part of the gradient for long term mean TP. As the TP value increases, the respective proportions climb from 0 to 1 in a generally sigmoid pattern. Frequency of exceedence of select Chl concentrations, as well as observation of algae bloom frequency, may be useful tools for decision making in lake management.

Lines of Evidence

Mark and Gary explained how the numbers for the various lines of evidence were derived. EPA had recommended that, since there is a relatively small quantity of data for the previously delineated Ozark Border region, it be combined with the Ozark Highland region. The ranges for the lines of evidence are presented in the Table 1.

Table 1 – Ranges for lines of evidence

	Chl (µg/L)	Total N (µg/L)	Total P (µg/L)
Plains	5.4 – 13.1	195 – 1000	20 – 50
Ozarks	1.8 – 9.3	157 – 750	10 – 35

Mark distributed the data sets from which he had performed regressions and change point analysis. The statistics were based on geomeans calculated from lakes that had at least twelve data points from a period of three years or longer. The latter is a relatively recent statistical technique which can be used to identify inflection points or ranges in paired data point distributions. With this data set, the approach worked well when Secchi depth was used as a response variable. The calculated inflection points are shown in Table 2.

Table 2 – Inflection points from nonparametric change point analysis

	Total N (µg/L)	Secchi Depth re: TN (cm)		Total P (µg/L)	Secchi Depth re: TP (cm)		Mean Secchi Depth
Plains	797	88		48	85		91
Ozarks	459	161		24	132		171

Mark then discussed a reference point from Knowlton and Jones' 2003 paper "Developing nutrient criteria for Missouri lakes", which was included as one of the lines of evidence. As a calculation of "background" nutrient concentrations, the authors developed regressions for lakes in the Plains and in the Ozarks that included cropland, mean depth, and flushing rate as independent variables and TN and TP as response variables. They then reduced the cropland variable to 0, resulting in TP values of 10 µg/L in the Ozarks and 25 µg/L in the Plains, and TN values of 280 µg/L in the Ozarks and 360 µg/L in the Plains.

Question: Does this mean that row crop farmers will have to cease operations and quit? *Answer:* Certainly not, this is only one line of evidence to determine nutrient levels in a reference condition.

Gary explained that some of the other lines of evidence were developed by the Regional Technical Assistance Group (RTAG) for EPA Region VII (IA, KS, MO, and NE). This was a workgroup that was started in 1999 to assist the states in nutrient criteria development through data collection, analysis, and the development of bench marks to be used as starting points for the states. The work group included participants from government and academic institutions, who shared a range of expertise in regional limnology.

The recently approved criteria for Nebraska (reportedly now on the Governor's desk) were included in the Plains line of evidence. Northwestern Missouri includes part of the Western Cornbelt Plains nutrient ecoregion, which also covers eastern Nebraska.

Dan pointed out that the lakes listed in Table M are not specifically "reference" lakes. They were placed in that list because they had TP values in the lowest 10th percentile of the range. This represents a lower range then what would be considered as a normal "reference" range. Removal these figures from the table should be considered.

Discussion: Several participants raised concerns that certain fish populations would not thrive as they now do if nutrient levels were restricted to the numbers that are proposed. Several species, such as large mouthed bass and channel catfish, benefit from higher nutrient levels. The Missouri Department of Conservation (MDC) owns and maintains, and in most cases built, a large number of lakes for game fishing, as well as managing

others that are owned by different entities. (Dan reports that 29 out of the 108 lakes in the data list are owned by MDC and in total they manage about 73 percent of the lakes in the list.) In some of them nitrogen fertilizer is deliberately added to promote growth and propagation. Several years ago, it was proposed that these lakes be allowed higher levels for nutrient criteria, but EPA indicated that such an approach would not be approvable. Other species, such as trout and small mouthed bass, are more adapted to mesotrophic and oligotrophic conditions.

A counter point to this is that if a reservoir is managed to promote game species in this manner, it may be at the expense of aquatic diversity. According to water quality regulations, the designated use of aquatic life protection, which applies to all classified lakes, includes the protection of a wide variety of warm-water biota.

In order to accommodate the variety of intended aquatic life regimes for which the reservoirs in the state were designed, it was suggested that a tiered aquatic life use classification for lakes be developed. Lakes would be classified over time as information concerning their intended use is accumulated. The Missouri Department of Conservation (MDC) is responsible for managing fisheries, and they have the most extensive data concerning what types of fish populations inhabit which water bodies, and how they are faring.

Rebecca O'Hearn of MDC informed the group that her colleague, Paul Michaletz, has been doing a study of fish metrics that takes into account ambient TP levels as a factor. She indicated that she would ask him to do a presentation on his findings at the next meeting. (She has since reported that he has agreed to do so.) She also agreed to the following tasks:

- Provide fish data for the lakes in the nutrient data set that was distributed.
- Provide a list of MDC stocked lakes and any data available for sports- and non-sports fish populations in those lakes.
- Provide sports- and non-sports fish population data for MDC lakes that are no longer stocked.
- Provide a list of MDC lakes that are currently fertilized for fish production and the fertilization regime.
- Find out if MDC has desired minimums and maximums for nutrient levels for healthy sports- and non-sports fisheries.

<u>Draft Rule Revisions:</u>

Because of the uncertainties about aquatic life protection that were raised, this discussion was deferred.

<u>Next Meeting:</u>

April 5, 2012