Soil & Water Conservation Society of Metro Halifax (SWCSMH)

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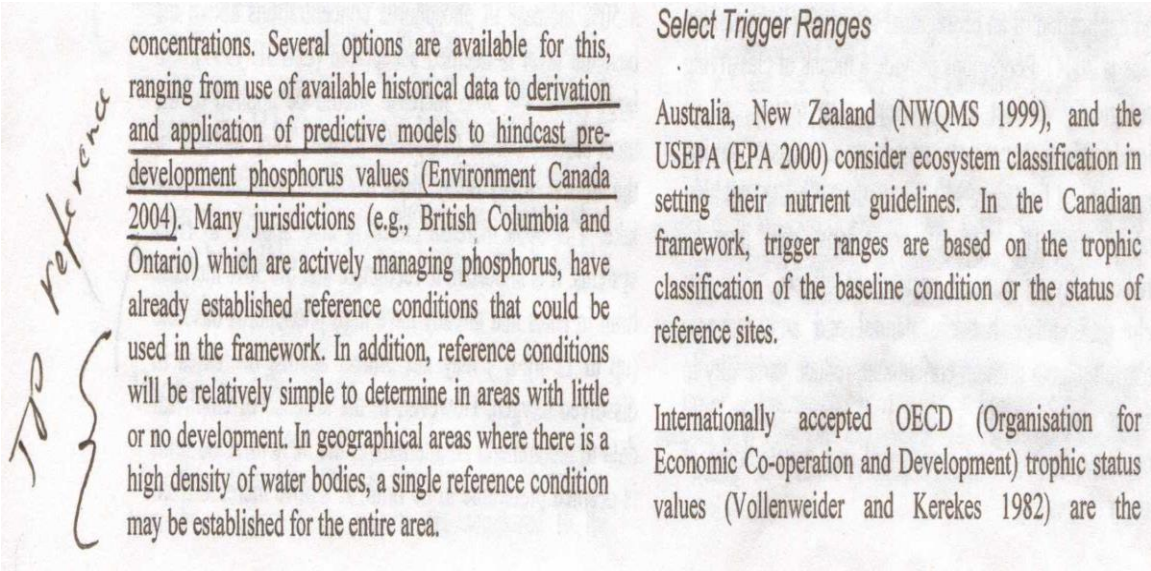
To:	**Environment & Sustainability Standing Committee (ESSC)**	
From:	S. M. Mandaville Post-Grad Dips. Chairman and Scientific Director	
Date:	June 06, 2016	
Subject:	Lake Carrying Capacities (LCCs) based on TP (Total Phosphorus) for the ESSC meeting of June 09, 2016	

Dear Chair & members:- Please share this submission with your colleagues in the Regional Council and senior staff as well. See page-3 for the artificially high threshold values for TP selected by the present and former Halifax's staff, and adopted by the Community Councils over time. For brevity, this is only a 3-page submission. I will be happy to answer any questions during the Public Participation period. We had already made several detailed printed submissions with scientific rationale on this to all the present/former Community Councils, as well as to the Regional Plan and the RP+5.

The LCCs MUST be based on the natural background values of TP, i.e., those that existed prior to any human development in the local as well as the upstream watersheds. The HRM's staff had picked the recent field values and that is a major error! It is not difficult to ascertain the natural background values, and my team has done that in 2,000 (two thousand) lakes/ponds over 1 hectare in size in 4 counties.

2 scanned excerpts from the Canadian Council of Ministers of the Environment (CCME, 2004) guideline, a methodology published by numerous scientists in several peer reviewed scientific journals dating back to the 1970's:-



concentrations. Several options are available for this, ranging from use of available historical data to derivation and application of predictive models to hindcast pre-development phosphorus values (Environment Canada 2004). Many jurisdictions (e.g., British Columbia and Ontario) which are actively managing phosphorus, have already established reference conditions that could be used in the framework. In addition, reference conditions will be relatively simple to determine in areas with little or no development. In geographical areas where there is a high density of water bodies, a single reference condition may be established for the entire area.

Select Trigger Ranges

Australia, New Zealand (NWQMS 1999), and the USEPA (EPA 2000) consider ecosystem classification in setting their nutrient guidelines. In the Canadian framework, trigger ranges are based on the trophic classification of the baseline condition or the status of reference sites.

Internationally accepted OECD (Organisation for Economic Co-operation and Development) trophic status values (Vollenweider and Kerekes 1982) are the

recommended trigger ranges (Table 1). The only proposed variation is that the OECD meso-eutrophic category (10-35 $\mu g \cdot L^{-1}$) is subdivided into mesotrophic (10-20 $\mu g \cdot L^{-1}$) and meso-eutrophic (20-35 $\mu g \cdot L^{-1}$). This subdivision was necessary because considerable variation in community composition and biomass exist in Canadian waters over the OECD range of 10-35 $\mu g \cdot L^{-1}$. These trigger ranges are recommended for both rivers and lakes.

A trigger range is a desired concentration range for phosphorus; if the upper limit of the range is exceeded, it indicates a potential environmental problem, and therefore, "triggers" further investigations. Natural physical and chemical water quality variables (e.g., salinity, pH, nutrients) inherently vary within and between ecosystem types, and so the preferred method for determining the trigger ranges is to use similar, high quality reference sites to determine natural levels. These ranges are then categorised according to the trophic status of the reference site (Table 1). This approach provides a trigger range that is relevant to the ecosystem type and locality. These phosphorus limits allow management to define where their water bodies lie, and define a trigger range for that water body.

Table 1. Total phosphorus trigger ranges for Canadian lakes and rivers.

Trophic Status	Canadian Trigger Ranges Total phosphorus ($\mu g \cdot L^{-1}$)
Ultra-oligotrophic	< 4
Oligotrophic	4-10
Mesotrophic	10-20
Meso-eutrophic	20-35
Eutrophic	35-100
Hyper-eutrophic	> 100

The selection of appropriate trigger ranges and reference conditions can potentially benefit from the development and application of an ecoregional approach (Environment Canada 2004). Ecoregions provide a means of classifying ecologically distinct areas, where each region can be viewed as a discrete system made up of areas of similar geographical landform, soil, vegetation, climate, wildlife, water, etc. The use of ecoregions can improve predictability of nutrient enrichment effects. They can help differentiate between natural and anthropogenic contributions to nutrient enrichment, reduce variability in trigger ranges within a class and among classes, and contribute to improved assessment and development of trigger ranges.

Determine Current Phosphorus Concentration

Under normal conditions, TP is the only meaningful measurement of phosphorus for water (Wetzel 2001). TP can be expressed as a single measurement taken at spring turnover or as an average of several observations made on a seasonal basis; it may be an estimate for a specific zone (e.g., euphotic zone), or as a whole lake approximation. It is important that an appropriate number of samples are collected to accurately reflect TP concentrations in a system. Specific attention should be given to sites that are receiving variable phosphorus loads or exhibiting marked morphological and hydrological differences (Environment Canada 2004).

Compare Current or Predicted Concentration to Trigger Range

The upper concentration of the trigger range represents the maximum acceptable concentration of phosphorus within each of the trophic categories. If the upper limit of the trigger range is exceeded, or is likely to be exceeded, there is a risk of an impact either occurring or having occurred. At this stage, additional information on local environmental factors needs to be considered, and thus further assessment is recommended. The assessment could potentially lead to remedial advice and the restoration of a degraded water body. If the trigger range is not exceeded, the risk of an impact is regarded as low.

Compare Current or Predicted Concentration to Baseline Condition

Due to the general nature of the trigger values and the size of some of the phosphorus ranges defined, a second precaution is taken in the assessment of possible effects of phosphorus. In the event that the trigger value has not been exceeded, the question is now raised as to the degree of increase in phosphorus levels from the baseline. Up to a 50% increase in phosphorus concentrations above the baseline level is deemed acceptable (OMOE 1997). In large lakes, the 50% increase should be applied to the most sensitive areas (e.g., river mouth, point sources, or the littoral zone) rather than averaged over the whole lake. The 50% increase check is also applied to river systems. It is important to recognize that the 50% increase limit in lakes that already have high phosphorus baseline (up to 12 $\mu g \cdot L^{-1}$) may not protect against decreases in dissolved oxygen. However, in the absence of empirical data to recommend an alternative, the 50% increase limit is deemed preferable to no limit. If a 50% increase from

Management/Restoration:- Excerpt from the OECD (Organization for Economic Co-Operation and Development) research which is the outcome of several years' concerted effort by 18 Member countries.

Natural limnological conditions vary considerably among countries and also among different regions, particularly the larger countries. Consequently, the water quality objectives would differ in each country, taking local conditions and expectations into account. In the absence of human activities, the nutrient load and the trophic response in waterbodies are determined by the natural fertility of soils on the drainage basin which in turn depends on the geology and the climate of the area in question. Ideally, the objective of lake management should be to maintain or restore waterbodies to their natural state determined by the basic natural nutrient load of the area in question (e.g. free from human activities). In practice, this is not always possible.

HRM set the following artificially high Threshold/LCC values of TP:-

HRM had set 15 µg/l as the Threshold/LCC values for Lakes Morris and Russell, and 10 µg/l for Lakes Kearney and Papermill.

Scan from the HRM's Shubenacadie Lakes Sub-watershed Study Report d/September 20, 2013:-

Lake	Trophic State Objective	Numerical Objective	Early Warning	Evaluation
Grand, Lewis	Oligotrophic	< 10 µg/L	9 µg/L	Based on 3 year running average
Charles, Micmac, Banook, First, Second, Third, Thomas, Fletcher, Tucker, Kinsac, Barrett, and Powder Mill	Mesotrophic	< 20 µg/L	15 µg/L	
Loon, William, Rocky, Springfield	Mesotrophic	< 20 µg/L	18 µg/L	
Cranberry	Mesotrophic	< 20 µg/L	20 µg/L	
Fenerty	Meso-Eutrophic	22 µg/L	22 µg/L	Fenerty should be maintained at its current average phosphorus concentration of 22 µg/L.
Duck and Lisle	Both Duck (43 µg/L) and Lisle (50 µg/L) are eutrophic lakes. Water quality should not be allowed to deteriorate further and should be improved where feasible.			
Miller, Beaverbank, Fish and Beaver Pond	Insufficient data exist. More sampling is required to set WQO for these lakes.			