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Ref.: Fenerty_Lake2013 (6 pages)
To: **Chair & Members, North West Community Council, HRM**
From: S. M. Mandaville Post-Grad Dip., Professional Lake Manage.
Chairman and Scientific Director
Date: September 05, 2013
Subject: FENERTY LAKE, Beaverbank:- Accelerated eutrophication based on HRM's chlorophyll*a* data of 2006-2011

Please feel free to ask me any questions, and I will endeavour my level best to respond either via emails and/or in person at one of your meetings, if invited to do so. Written informally, hence may have typos.

When I recently perused HRM's data for Fenerty Lake, I was quite concerned with the high values of Ch*a* (chlorophyll*a*) which are representative of the `algal production'. HRM's Ch*a* data ranged 1.84 - 26.47 µg/l during the years 2006 to 2011. Compare that with the 1974 data of Environment Canada which ranged 0.1 – 1.1 µg/l, and our own data of 1995 which ranged 1.94 – 5.69 µg/l (our water samples for this lake were also analyzed by the Environment Canada lab in Moncton).

The fact that the sampling events are limited per year may have some (scientific) weight but it should raise some red flags anyway!

Environment Canada (2004) published a table which was derived from the 18-country OECD peer consensus (http://lakes.chebucto.org/TPMODELS/OECD/oecd.html) which I reproduce below:-

Table 4.1 Trophic classifications of lakes, with their corresponding phosphorus and chlorophyll concentrations and transparency (Secchi depth) (sources: Wetzel 2001; Vollenweider and Kerekes 1982).

Trophic level	Total Phosphorus (µg·L⁻¹)		Chlorophyll *a* (µg·L⁻¹)		Secchi depth (m)	
	Wetzel (2001)	Vollenweider and Kerekes (1982)	Vollenweider and Kerekes (1982)		Vollenweider and Kerekes (1982)	
			Mean	Max	Mean	Max (Min.)
Ultra-oligotrophic	< 5	< 4	< 1	< 2.5	> 12	> 6
Oligo-mesotrophic	5-10	4-10	< 2.5	< 8	> 6	> 3
Meso-eutrophic	10-30	10-35	2.5-8	8-25	6-3	3-1.5
Eutrophic	30-100	35-100	8-25	25-75	3-1.5	1.5-0.7
Hypereutrophic	> 100	> 100	> 25	> 75	< 1.5	< 0.7

To further understand the relevance of Ch*a* values, kindly note that **Kings County of Nova Scotia** set a maximum objective Ch*a* values in the low range of 2.5 µg/l for 18 lakes. I herewith insert a scan from their policy in my archives:-

Kings County adopted water quality objectives for 18 lakes in the county, through amendment of MPS and LUB. The maximum objective value of chlorophyll-a for most of these lakes is 2.5 µgm/L. Seven of the lakes' objectives were set below the level of 2.5. Based on predictive modelling, the estimated maximum number of dwellings that could be added to the contributing area without exceeding the threshold value was established. This number of dwellings was set as a limit for development in the LUB. Policy in the MPS enables application for a permit with a development having "near-zero impact" through site standards or performance standards. Primarily this condition is expected to be met with septic field fill with a 20 year phosphorus input retention and a requirement to replace the fill every 20 years. A condition in adopting these limits was implementation of an annual monitoring program for a minimum of six years. The sampling required was to be completed by volunteers.

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I have provided a synopsis of the data from various sources referenced appropriately (see page-4).

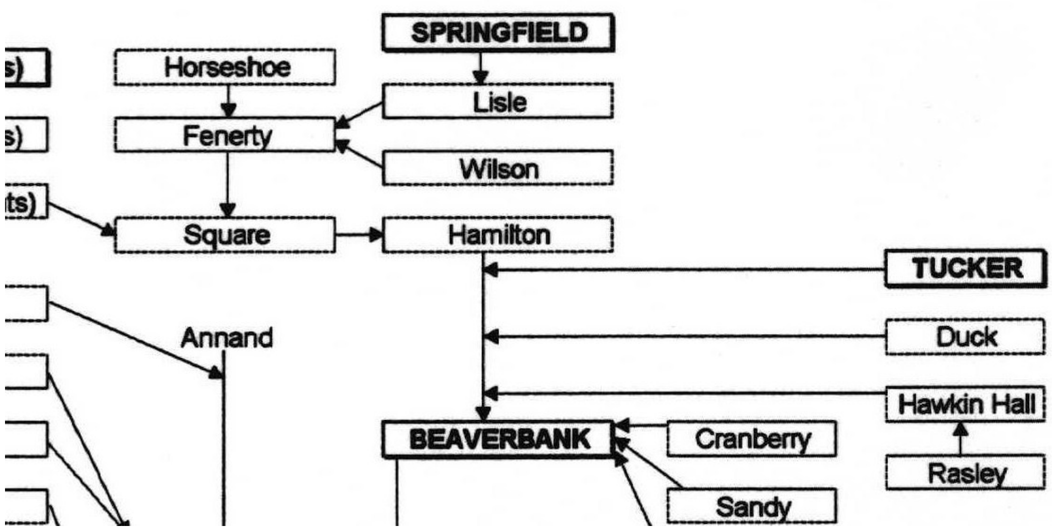
I also include the predictive phosphorus modelling conducted by my team some years back (see page-6). The prime purpose of predictive modeling is to anticipate nutrient enrichment even before it occurs so that regulatory agencies can take the `precautionary approach' and protect the lake, hopefully in perpetuity.

We have not studied the zoobenthos (i.e., the preferred indicator organisms within the sediments) there yet since we have numerous other scientific priorities right now.

<u>Suggested deliberation by the NWCC</u>: I am wondering if a major source (not the only one) is the STP (sewage treatment plant) at Springfield Lake since its effluent would be highly biologically available, more so than phosphorus from several other sources. See the partial flow chart for the Shubie system inserted below from our archives. Perhaps, there are residential developments which drain into the lake as well, in which case it may be excess residential fertilizers. I am unaware of any intense agricultural usage there since during the 1970's, I used to walk all around in the backlands there with some local land owners from Upper Sackville.

<u>Councillor Brad Johns</u> would be aware of the residents of Springfield Lake being concerned about the said STP since they had also liaised with me, and I had provided historical archives on their lake to their community association. The STP may have bypasses during heavy precipitation events. Since the STP's outflow is into the outflow of Springfield Lake, it would not affect Springfield (unless there are back currents), but most probably affect Fenerty Lake.

One needs to carry out extensive `source investigations' in the Fenerty Lake watershed if the NWCC is concerned.



Data archives

Source of field data	Date(s) of sampling	#s of sampling events and type of sampling	TP (µg/l)		Cha (µg/l)	
			mean	range	mean	range
Environment Canada	June-Sept. 1974	7#s (surf. & bottom; surf. values included here only)	10.0	5.0 – 20.0	0.34	0.1 – 1.1
NS Lands & Forests	July 1984	1# (surf.)	13.0	-	-	-
SWCSMH	June-Sept. 1995	4#s (vol. wtd.) colour=27	17.8	12.0 – 26.5	3.68	1.94 – 5.69
SWCSMH's Predictive Modelling (also see graph on page 6)		Pre-cultural	5.8	-	-	-
		Based on 1988 land use in the entire watershed	13.9	-	-	-
HRM	2006	2#s (1 m.)	13.5	5 – 22	10.33	6.19 – 14.46
HRM	2007	2#s (1 m.)	11.5	9 – 14	8.45	3.63 – 13.27
HRM	2008	3#s (1 m.)	27.0	15 - 36	8.48	2.72 – 13.40
HRM	2009	3#s (1 m.)	24.0	17 – 30	5.29	3.58 – 7.50
HRM	2010	3#s (1 m.)	30.0	26 - 35	17.08	10.67 – 26.47
HRM	2011	3#s (1 m.)	18.0	15 - 20	9.96	1.84 – 22.32

Acronyms & brief explanation of the aforesaid table:-

vol.wtd.= volume weighted
surf.= surface samples
1 m.= 1 metre depth sampling

SWCSMH- Soil & Water Conservation Society of Metro Halifax's research
SWCSMH's predictive modelling- Computer modelling carried out by the Soil & Water Conservation Society of Metro Halifax
HRM- Halifax Regional Municipality (2006 to 2011; the Cha values are means of the 2 methodologies reported)

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Basic Morphometric and Hydrologic data
(computed by us from bathymetric maps supplied by the Provincial Fisheries Dept.)

- Shoreline length= 6.338 km
- Surface area= 64.7 ha
- maximum depth= 8.8 m; mean depth= 3.8 m
- volume= 1.96x106 cu.m.

- watershed (local)= 1287 ha; watershed (total)= 2363 ha
- Flushing rate= 11.4 times/yr (approx.)

- In-lake TP retention= 0.26

- Zr , Relative depth=1.0 % ………. (for most lakes, Zr < 2%. Deep lakes with small surface areas exhibit greater resistance to mixing and usually have Zr > 4%).

- DL, Shoreline dev.=2.2 …………. (DL is important because it reflects the potential for development of littoral communities which are usually of high biological productivity. Only a few lakes, such as Crater Lake in Oregon and a few kettle lakes approach the circular shape, i.e., DL = 1 (circular). DL is approx=2 in many subcircular and elliptical lakes. DL is large for lakes of flooded river valleys).

- Dv, Deve. of volume=1.3 ………….. (For the majority of lakes, Dv will be greater than 1 (i.e. a conical depression). Dv is greatest in shallow lakes with flat bottoms (eg. Carolina Bay lakes). Among deep lakes, caldera lakes, graben lakes, and fjord lakes, Dv will be much greater than 1.5 (also in many rock basins). Most lakes in easily eroded rock have Dv in the range of 1 to 1.5. Extremely small values are found in only a few lakes with highly localized deep holes (ponors or sinks, sublacustrine kettle holes). Extensive action of shore processes is apt to reduce the ratio.

- Index of Basin Permanence (IBP)=0.32 10^6 cu.m/km ………… (The Index of Basin Permanence (IBP) is a morphometric index that reflects the littoral effect on basin volume. Lakes within the Atlantic National Parks (IBP < 0.1) are dominated by rooted aquatic plants and indicate senescence (excessive shallowness, high water color and high TP). Lakes with IBP≥ 0.2 are more permanent. Lake Baikal has an IBP of 10,000, for Lake Superior IBP = 4,000, for Lake Erie IBP = 450, and for Caspian Sea (largest inland water basin) IBP = 13,000).

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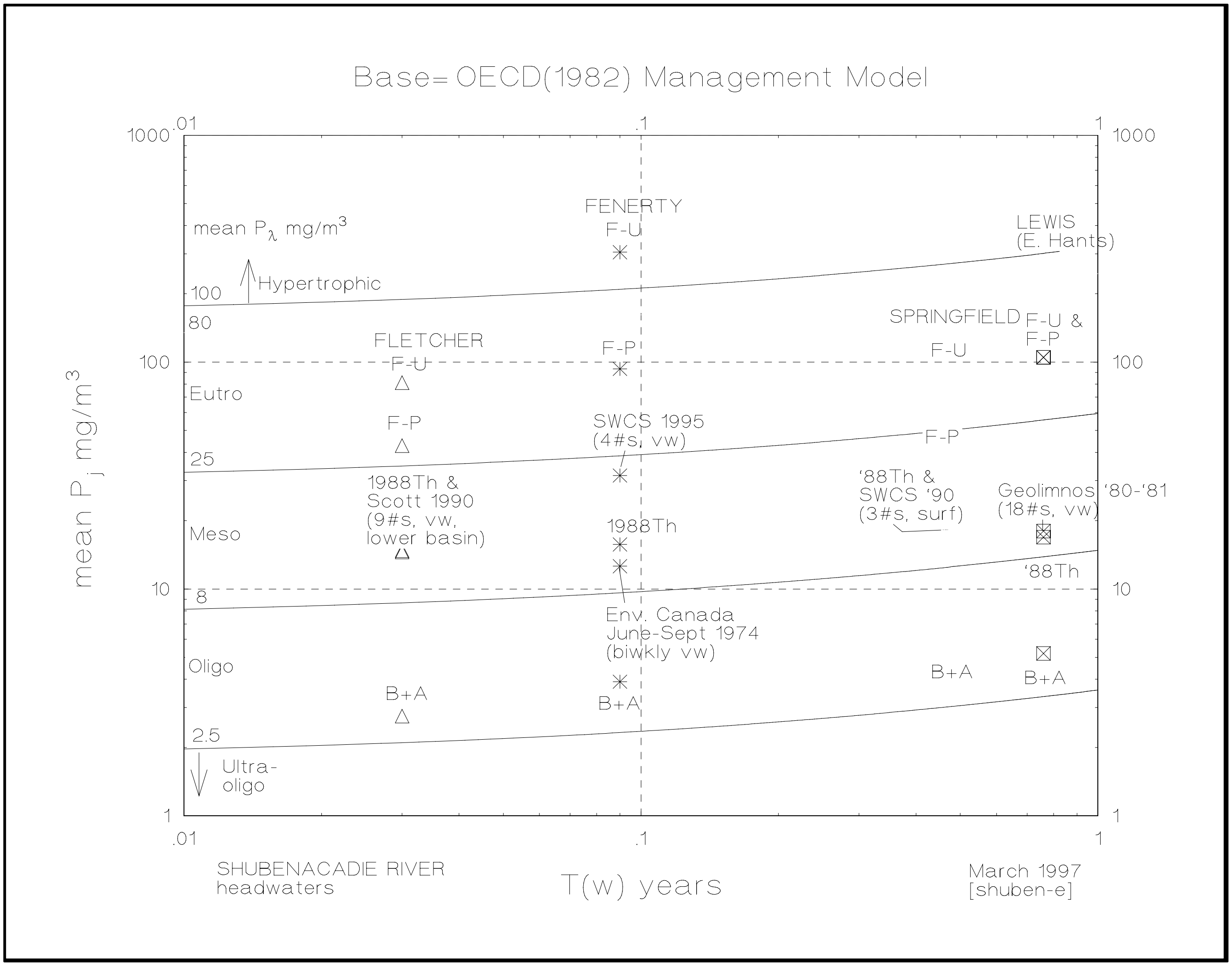
<u>Our predictive model utilizing the 18-country OECD (Organization for Economic Co-Operation and Development) peer consensus base models</u>



<u>Notes for the log-log graph above</u>:-

The X-axis is the water retention time. The Y-axis is the inflow TP concentration. The pelagic (i.e., open water) phosphorus concentrations are shown as curved lines with values of 2.5, 8, 25, 80, and 100 µg/l expressed as total phosphorus (TP) respectively. Chlorophyll*a* values have not been plotted though they can be with some more work.