Soil & Water Conservation Society of Metro Halifax (SWCSMH)
310-4 Lakefront Road, Dartmouth, NS, Canada B2Y 3C4
Email: limnes@chebucto.ns.ca Tel: (902) 463-7777
Master Homepage: http://lakes.chebucto.org

Ref.: PH_Draft2RP 2006
(39 pg., and 22 Exhibits marked as A to V; total=85 pages)

To: **<u>Mayor Peter Kelly and the Regional Council</u>**
c/o Regional Planning, HRM (hand delivered to the offices at the Ferry Terminal, Halifax on January 30, 2006)

From: S. M. Mandaville Post-Grad Dip., Professional Lake Manage.
Chairman and Scientific Director
Date: **January 30, 2006 (revised in 2018 to remove unimportant aspects)**
Subject: **Our final formal submission on the Regional Plan, Draft #2**

(The symbol, §, represents section/item number. D Our web page URLs referenced here are case sensitive.)

There are twenty one (21) primary sections/items here out of which eleven (11) are our specific recommendations, each of them marked as “Recommendation”.

The rest of the sections/items are included to appraise the reader of various scientific rationale and several illustrative diagrams have also been inserted. A significantly upgraded DVD+R disk dated January 30, 2006 accompanies this submission which contains a vast array of scientific info along with twenty (20) of our half hour Tv shows among a total of 323 featuring scientists and Government regulators.

We request the HRM implement our specific recommendations with no further delay, especially since the Regional Plan has several statements stating the intent to protect lakes but the plan is very poor in specifics! We had indeed made similar written recommendations on numerous occasions before.

Section/item # **Table of Contents** **Page #**

1. Overview and Introduction

We are a scientific society specializing in the **Biotic Integrity and Biodiversity** of freshwaters and parts of the marine ecosystems! We have received international accolades for our work.

An upgraded DVD+R disk dated January 30, 2006 accompanies this submission which contains a vast array of scientific info along with twenty (20) of our half hour Tv shows among a total of 323 featuring scientists and Government regulators. The disk is formatted for use only on a DVD reader attached to a computer; hence even the Tv shows have to be viewed on a computer monitor only; you cannot view them on a typical DVD player.

Photos of a handful of leading scientists have been inserted here in celebration of their world class achievements which resulted in extensive benefits to all species inclusive of to *homo sapiens*!

§1.2 has info on our major contributions to the HRM inclusive of to its hired consultants (and its academic subcontractors), numerous citizens and stakeholder groups!

Our members/associates are mostly domiciled all over HRM! Our team has some of the leading scientists in limnology (i.e., freshwater sciences), molecular biology (e.g., DNA fecal source tracking), medical microbiology, and environmental engineering. Some of these have received coveted scientific awards and are widely published. Select among them have published advanced textbooks which are used at universities worldwide. A few of them are domiciled in other parts of Canada and in four states of the USA.

1.1. Our extensive submissions to HRM. The scientific component of the plan is poor and has little relevance to protecting as well as restoring lakes

We had made several submissions directly to the Regional Planning staff, and supplied them with three former versions of our DVD+R disks.

During the public meeting held at the Michael Wallace Elementary School in Port Wallace on May 20, 2004, this signatory raised the question of applied (i.e., practical) limnology and lake management. HRM's staff refused to go into the discussion although there was a lot of time since the meeting had poor attendance by the general public.

We were also in attendance at the extensive workshop at the Dartmouth High School on June 06, 2005**.** Staff had a long list of issues to be discussed, and professional limnology was nowhere in it.

Back in early year-2002, we had requested senior manager, Ms. Anne Muecke MCIP**,** to organize intense round table discussions in professional limnology and lake management. There was no follow up at all.

1.2. Our direct/indirect contributions to the HRM including its formal municipal units (see also Exhibit-K)

We received around sixty (60) unsolicited emails and detailed phone calls from present and former staff of the HRM (inclusive of the formal municipal units) consulting us on a variety of science related aspects as well as asking for our donations of scientific literature and models. Example emails can be found in the accompanying DVD+R disk under "Our dealings with Government agencies".

This signatory co-operated as much as possible and you can obtain an overview from the 5-page letter that we sent His Worship. These do not include discussions generated as a result of our inquiries though.

Further, we continuously receive requests for information from numerous stakeholders all over HRM, from the local academia who work and/or associated with them, as well as, on occasions, from your own consultants.

2. Recommendation: Set up a Lakes Authority staffed with two qualified applied limnologists (also see §16, and Exhibits- C & D)

Pragmatic lake management has rarely been the focus of either the HRM or of its previous municipal units; some negative results are evident by advanced chemical and biological limnology data/reports of ours and of other researchers.

Expenditure of large amount of public funds on consultants as recommended in the Regional Plan and by staff at meetings is totally futile, as proven by significant failures spanning the last two (2) decades (Exhibit-B)!

If HRM hired applied (i.e., practical) limnologists, then staff could carry out in-house lake and river monitoring both in chemical as well as in the more important, biological limnology (§7), prepare follow-up scientific studies and issue summaries, as well as act in the capacity as a scientific scrutinizer when consultants submit data and reports to the HRM.

At present, there are no staff members who carry out any limnological investigations.

This function would also include development of lake carrying capacities (LCC's) prior to signing of development/contract agreements; staff has been including such a requirement as part of certain development agreements (DA's) but that is not the ethical way (see §16).

In other jurisdictions in Ontario, Quebec, Sweden, and in Kings County (NS), the LCC's were developed in-house with some external scientific assistance. This should have been carried out in the HRM area over the last 20 years, but it is still not too late to follow the CCME and Environment Canada's narratives for some subwatersheds where major developments are imminent (see also §6).

2.1. Significant shortcomings in consultants' reports; further, staff has never carried out scientific analyses (see also Exhibits- A & B):

Indeed it was `yours truly' who filled that function and carried out scientific analyses to a considerable extent as a volunteer: for an overview, read the enclosure marked as Exhibit-B, a 6-page letter that we had written the EMS Dept. on February 22, 2005, enunciating case histories.

Also peruse the graphical model that I developed for Sandy Lake, Hammonds Plains as a major example included here as Exhibit-A. Staff had a considerable amount of data supplied by the developer's consultants but they did nothing with it. The only (modelling) data marked as `Th' belongs to this writer. It is quite obvious how rapidly Sandy Lake underwent cultural enrichment in just three (3) years, a process which may never have occurred in nature even in a thousand years! I had published the conglomerate model in an international lakes discussion group, and the respondents were literally shocked that this transpired in the first world which is usually a symptom of the third world.

2.2. The specialty of applied (practical) limnology (science of freshwaters); see also Exhibit-K:

Professional accreditation in this domain can be obtained from a handful of independent scientific societies in North America and Europe!

There has never been staff that addressed and solved any significant complaints from lake stakeholders; indeed staff has approached `yours truly' on important issues for info and advice (see §1.2).

Do not rely on the Nova Scotia Department of Environment & Labour (NSEL) either where there are no practicing and/or accredited applied limnologists on staff either as gracefully admitted by Premier John Hamm MD (Exhibit-K).

We had made a strong appeal on this to the Regional Council on August 21, 2001; staff had responded positively to you on September 19, 2001, but the HRM has not acted on it to date; see staff's response in our URL (http://lakes.chebucto.org/HRM/HISTORY/lakes_authority.html#staff).

3. Recommendation: Consultations regarding lake and river management should not be confined to municipal advisory boards and other appointees alone

We request that you enshrine the enlightened tenets of the North American Lake Management Society (NALMS) which we summarized in the web page titled, “Community goals- Lake and River management“ with the URL of (http://lakes.chebucto.org/INFO/STEWARDSHIP/communitygoals.html).

Dr. Tony Blouin of HRM and Mr. Darrell Taylor (Environmental Analyst) of the NSEL are indeed members of the NALMS. The NS Environment Act clearly states that all natural lakes and rivers are owned by the general public!

The whole aspect of professional lake management is quite specialized and should not be restricted to advisory boards; further, the boards have never conducted any research in advanced limnology inclusive of benthology and phycology. Hence, how can HRM rely exclusively on such boards?

The public also includes some leading scientists who could be of some assistance to the HRM. By involving the public even in making scientific decisions, HRM will be able to develop genuine and effective partnerships.

4. Recommendation: Mandate the requirement of studies by `qualified limnologists' where lakes are located at outfalls or downstream of outfalls

It is indeed recommended in Section V.2 of the Storm Drainage Works Approval Policy (SDWAP) of the NS Dept. of Environment & Labour (NSEL). Such an enlightened requirement is nowhere to be seen in any of the planning documents or contract requirements of HRM.

Even prior to the Province adopting the SDWAP policy on December 10, 2002, pure common sense would have dictated that the specialty of freshwaters vests primarily in the professional discipline of Limnology in the same fashion that designing of sewers, streets, etc., vests in professional civil/environmental engineers. But HRM has never recognized this dire need!

---

5. Recommendation: Lake water sampling and the futility to track the incremental impacts of new developments, especially in shallow and/or coloured lakes (see also §18)

The majority of lakes within HRM are shallow and/or coloured. In such lakes, the standard limnetic (i.e., open-water or pelagic) trophic parameters may not represent the true trophic status of the lake. See §18 for more info.

The limnetic parameters may not reflect changes in the watershed unless those changes are significant in relationship to the overall size of the watershed and/or in its prevailing inputs!

To reliably ascertain incremental inputs from new developments, outflows of every storm pipe outlet, in-situ devices (e.g., CDS, Storm*ceptor* or Vortechnics), constructed wetlands outlets, and others have to be monitored almost on an hourly basis during runoff, and pollutographs have to be developed.

Hence, the large amount of public funds that HRM plans to expend on regular limnetic sampling may be an utter waste as the historical archives have already proven (Exhibit-B).

---

6. Recommendation: The CCME's policy on cultural eutrophication should be strictly enforced by HRM (also see §18)

"It is stressed at this point that the CCME endorses a no degradation policy, and that these values therefore do not provide, and must not be used as pollute up to levels!" (see page 56 in http://lakes.chebucto.org/DATA/PARAMETERS/TP/ccme.pdf)

The year-2004 CCME Policy on Phosphorus (TP) clearly narrates that, not adhering to the reference/background (i.e., the natural pre-development value) + 50% maximum increase concept, even if they fall within the reference trigger ranges, could result in significant changes to the `COMMUNITY STRUCTURE'!

References:

Canadian Council of Ministers of the Environment. 2004. Canadian water quality guidelines for the protection of aquatic life: Phosphorus: Canadian Guidance Framework for the Management of Freshwater Systems. In: Canadian environmental quality guidelines, 2004, Canadian Council of Ministers of the Environment, Winnipeg.

Environment Canada, 2004. Canadian Guidance Framework for the Management of Phosphorus in Freshwater Systems. Ecosystem Health: Science-based Solutions Report No. 1-8. National Guidelines and Standards Office., Water Policy and Coordination Directorate, Environment Canada. pp. 114.

[http://lakes.chebucto.org/DATA/PARAMETERS/TP/popup.html) has more info]

2.5 General Effects of Eutrophication

Eutrophication causes marked changes in biota (Figure 2.10). The effects that have been observed in systems undergoing nutrient enrichment, and the problems to humans associated with these effects are summarized below, and in Table 2.2 (Mason 1991):

Effects on Aquatic Ecosystems

i. Decrease in biodiversity and changes in dominant biota;

ii. Decline in ecologically sensitive species and increase in tolerant species;

iii. Increase in plant and animal biomass;

iv. Increase in turbidity;

v. Increase in organic matter, leading to high sedimentation;

vi. Anoxic conditions may develop.

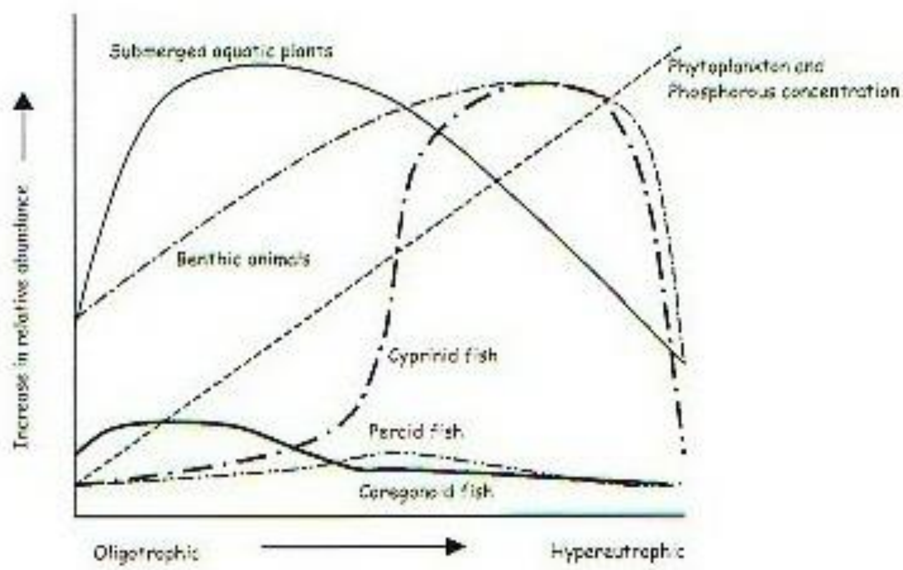


Figure 2.10 General changes in northern temperate lakes as they become eutrophic (source: Moss 1988).

Table 2.2 Summary of the problems associated with eutrophication of lakes, reservoirs, and impoundments (modified from GEMS 1990).

	Caused or indirectly dependent on				
Quality of life concerns	Algal blooms and species composition	Excessive macrophyte and littoral algal growth	Altered thermal conditions	Mineral turbidity	Low dissolved solids
Water quality impairment					
• Taste and odour, colour, filtration, flocculation, sedimentation and other treatment difficulties	Very frequent	Occasional	Occasional	Occasional	
• Hypolimnetic oxygen depletion: Fe, Mn, CO_2, NH_4^+, CH_4, H_2S, etc.	Frequent	Occasional	Occasional		
• Corrosion problems in pipes and other man-made structures	Frequent	Occasional		Occasional	Occasiona
Recreational impairment					
• Poor aesthetics	Frequent	Occasional		Occasional	
• Hazard to bathers		Frequent			
• Increased health hazards	Occasional	Occasional	Occasional		
Fisheries impairment					
• Fish mortality	Occasional		Occasional		
• Undesirable fish stocks	Frequent	Frequent	Occasional	Occasional	
Ecological impairment	Very frequent	Frequent	Frequent	Occasional	Occasiona
Aging and reduced holding capacity and flow					
• Silting	Occasional	Occasional		Frequent	
• Pipe and screen clogging		Occasional			

7. Chemical vs Biological monitoring in limnology (Exhibits- I & J)

"Chemical measurements are like taking snapshots of the ecosystem, whereas biological measurements are like making a videotape."

(David M. Rosenberg PhD, Univ. of Manitoba and the Freshwater Institute, DFO, Winnipeg, and lead author of the EMAN Protocol. *cf.* Bull. Entomol. Soc. Can. 1998. 30(4):144-152.)

By ignoring the all important chemical limnology, the majority of studies carried out to date for HRM as well as for its former municipal units have failed to accurately describe the symptoms and to prevent the problems (Exhibit-B).

"Pollution is a semi-nebulous term used to describe changes in the physical, chemical or biological characteristics of water, air or soil, that can affect the health, survival, or activities of living entities. Organisms respond to pollution usually in one of two ways, acutely or chronically. Acute effects result in serious injury to, or death of, the organism shortly after exposure to high concentrations of a pollutant. Chronic effects are realized following exposure to low concentrations of a pollutant, the results of which appear over time, often as serious diseases (e.g. cancers)".

…………Williams, D. D., and Feltmate, B.W. 1992. Aquatic Insects. CAB International. ISBN: 0-85198-782-6. xiii, 358p.

Exhibit-I is a listing of our web pages in Freshwater Benthic Ecology and Aquatic Entomology, and Exhibit-J is a pictorial on Chironomid mouthpart deformity frequencies as an indicator of community health.

Our scientific team specializes in the aforesaid and we have been conducting extensive biological monitoring of lakes all over HRM; some of our reports are in the public domain (*cf.* http://lakes.chebucto.org/studies.html).

One of the leading experts in this domain is Prof. Dr. Gerrie Mackie of the University of Guelph and a co-Chair of the federal SARA; his year-2004 interactive textbook published by the Kendall/Hunt Publishing Company is a `must read' (http://lakes.chebucto.org/referenc.html#mackie2004)!

8. Recommendation: Enact a Lawn Fertilizer Bylaw restricting use of phosphorus containing fertilizers similar to the City of Minneapolis (Exhibit-E)

We had submitted the bylaw to staff some time ago. Without any further delay, enact a Lawn Fertilizer bylaw similar or superior to that of the Minneapolis City's bylaw; this bylaw essentially prohibits application of phosphorus containing fertilizers with exceptions where soil tests prove the need.

This bylaw has received international accolades among the lake management and limnological community.

---

9. Recommendation: Advanced assessments by qualified limnologists have to be to be carried out on sewage treatment plants (STP)s prior to their construction and/or to establish the need for upgrading

This specialized discipline is not the routine civil/environmental engineering!

9.1. Ecological impacts of nutrients (Exhibit-N):

A leading example of the methodology to be followed is that illustrated in Exhibit-N as proposed by Dr. Joe Kerekes, Scientist-Emeritus with Environment Canada Atlantic, Dartmouth. Dr. Kerekes was also one of the leading scientists who headed the international OECD (Organization for Economic Co-Operation & Development) peer consensus standards-development which are the backbone of the Federal CCME policy on phosphorus management!

Essentially, in the published paper (Exhibit-N), Dr. Kerekes carries out an intensive scientific analysis of the impact of a proposed secondary-level package STP prior to its installation at a development site which drains into Freshwater Lake, Cape Breton Highlands National Park. He warns against secondary treatment as that would result in the Freshwater Lake becoming `Mesotrophic', its management objective being `Oligotrophy.

[For the complete paper, see our web page (http://lakes.chebucto.org/TPMODELS/NOTES/kerekes_1983.html)]

9.2. Investigate the endocrine disrupting compounds (EDCs) in the effluents discharging into lakes and rivers:

Carry out scientifically defensible and peer reviewed assessments of the EDCs at the outlet of STPs draining into lakes and rivers. One of the most sensitive and common tools used to assess exposure to endocrine disrupting chemicals with estrogenic activity is the presence of vitellogenin (VTG), an egg yolk protein precursor, in the plasma of male fish. Recent studies worldwide have shown elevated plasma VTG in male fish downstream of sewage treatment plants.

Considerable evidence exists that aquatic organisms are being exposed to, and impacted by, a wide range of compounds that mimic hormones. Fish exposed to these compounds often exhibit an array of responses including depressed circulating sex steroid levels, reduced gonad size and fecundity, and males have become feminized.

Because many EDCs can only be partially removed with conventional water treatment systems, there is a need to evaluate alternative treatment processes.

The polychromatic medium-pressure (MP) UV radiation source was more effective for direct photolysis degradation as compared to conventional low-pressure (LP) UV lamps emitting monochromatic UV 254 nm radiation. However, in all cases the EDCs were more effectively degraded utilizing UV/H_2O_2 advanced oxidation as compared to direct UV photolysis treatment).

A good overall reference is:-

Rosenfeldt, E.J., and Linden, K.G. 2004. Degradation of Endocrine Disrupting Chemicals Bisphenol A, Ethinyl Estradiol, and Estradiol during UV Photolysis and Advanced Oxidation Processes. Environ. Sci. Technol. 38(20):5476-5483.

10. Recommendation: Mandate total stormwater treatment systems capable of removing the myriad of post-development stressors, not silt/soils alone, in new major developments (Exhibits-Q, R, S, T, & U)

[Reference: http://lakes.chebucto.org/SWT/pollutants.html for "Typical pollutants in stormwater runoff", and http://lakes.chebucto.org/SWT/treatment.html for "Treatment of stormwater runoff"]

There are no proven total stormwater treatment systems anywhere within the urban or suburban areas of HRM.

The post-development stressors (or pollutants) entering our sensitive waterways are varied and multifaceted. The pollutants are generated after occupation of the watershed by the end users.

Exhibit-Q lists street surface pollutants associated with various particle sizes from an extensive nationwide study conducted for the USEPA in 1992.

Exhibit-R (4 pages) is a listing of toxicants found in priority pollutant scans from a latter study in 1993.

“Laser particle sizing has also indicated that a considerable proportion of the particulates in road runoff are less than 10 µm (microns). This size fraction is difficult to capture in current stormwater pollution control devices and has been shown to contain significant quantities of heavy metals, which are of concern in aquatic ecosystems."

Exhibit-S has two scans covering the removal of gross pollutants from stormwater runoff using liquid/solid separation structures for four in-situ technologies, the Stormceptor, CDS, Vortechnics, and the baffle boxes. The removal is poor for typical post development stressors.

A preferable methodology may be to incorporate a pre-treatment technique of pond areas to provide an opportunity for suspended materials to settle out before the flows enter the wetland. Other possible options include routing inflows to the wetlands through upstream grass swales, oil/water separators, heavily vegetated areas (e.g. thick, shallow cattail area), and overland flow areas.

Such a stormwater management system is depicted in Exhibit-T. But it is necessary that the constructed wetland is adequately designed and sized as per the following §10.1.

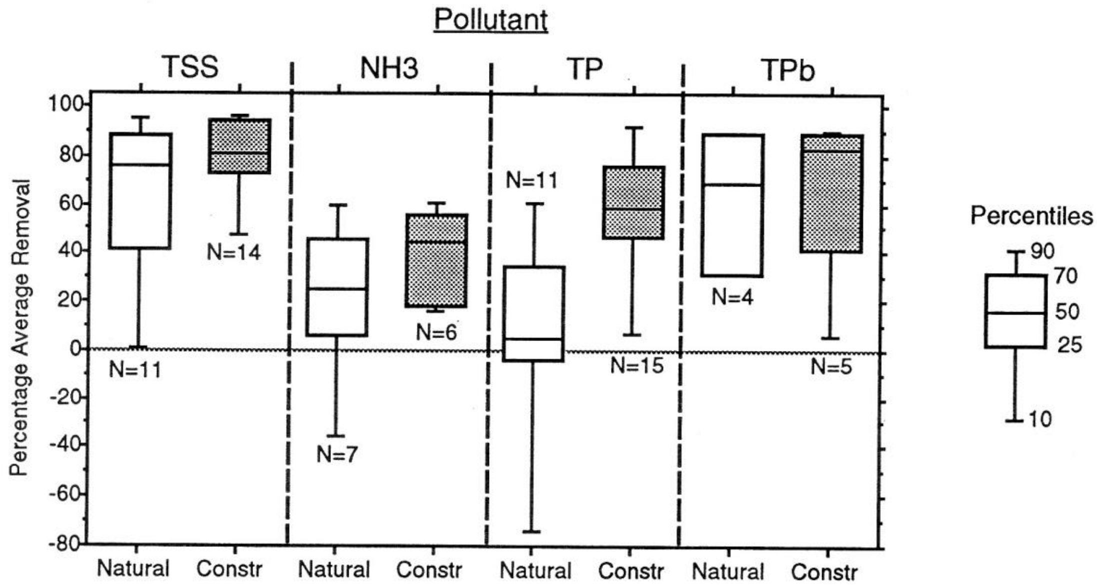
10.1. Constructed Wetlands for stormwater treatment (see also Exhibit-U):

(Strecker, E.W., Kersnar, J.M., Driscoll, E.D., and Horner, R.R. 1992. The Use of Wetlands for Controlling Stormwater Pollution. Technical Advisor: Thomas E. Davenport, U.S. EPA, Region V. The Terrene Institute. iv, 66p.)

Wetlands are receiving attention as attractive systems for removing pollutants from stormwater surface runoff before the runoff enters downstream lakes, streams, and other open water bodies. Wetlands have long been employed for the treatment of wastewaters from municipal, industrial (particularly acid mine drainage), and agricultural sources. The U.S. Environmental Protection Agency (EPA) encourages the use of constructed wetlands for water pollution control.

Exhibit-U (2 pages) has a listing of the wetlands that were researched for their ability to treat stormwater runoff as well as a map of the USA showing their location. Some of the constructed wetlands are located in regions with harsher climate and/or more intensive snow cover than in Nova Scotia.

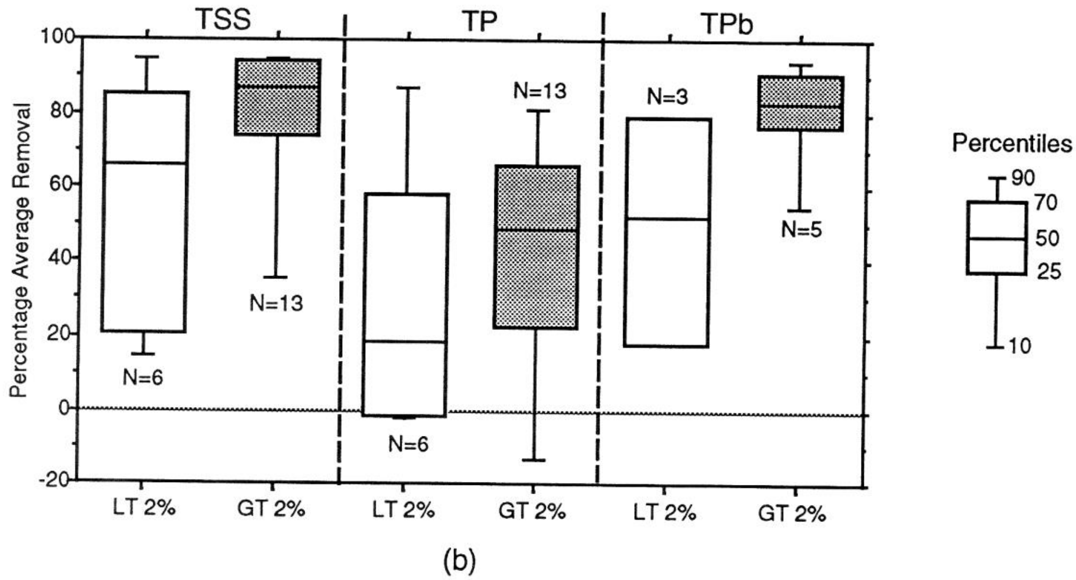
"*....... Several trends were noted. First, constructed systems were generally found to have a higher average removal performance than natural systems, with less variability; and second, larger wetlands as compared to watershed size also showed the same trend, a higher average removal performance, with less variability*".



Box Plot Percentiles Comparison of Site Average Pollutant Removals for Natural and Constructed Wetland Systems

TSS = Total Suspended Solids
NH3 = Ammonia
TP = Total Phosphorus
TPb = Total Lead
N = Number of Wetland Sites

People often question whether it is appropriate to use a natural, healthy wetland for such purposes. The concern is whether the modified flow regime and the accumulation of pollutants will result in undesirable environmental effects. A general consensus from the literature is that the use of a healthy natural wetland for stormwater pollution control should be discouraged.



Average Site Pollutant Removal Comparisons for All Wetlands With Less Than 2% and Greater Than 2% Wetland to Watershed Area Ratios (WWAR): (a) Scatter Plot for TSS and TP and (b) Percentile Box Plots for TSS, TP, and TPb

LT 2% = less than 2% WWAR
GT 2% = greater than 2% WWAR
N = Number of Wetland Sites

TSS = Total Suspended Solids
TP = Total Phosphorus
TPb = Total Lead

---

11. Recommendation: Buffer strips, sound technical sizing, and protection in perpetuity; and do not allow walkways to be constructed within such buffers (also see Exhibit-F)

Buffer strips do not remove any appreciable amount of pollutants entering lakes via stormwater discharges. But they are of value only if they are maintained in their natural state in perpetuity.

We request that Regional Council enact a bylaw where walkways are totally banned in buffer strips even if the local community supports such walkways. Pollution does not discriminate between developers and the general public!

The sizing of buffers has to be based on technical factors which have to include at the least, slope of the land, K (soil erodibility index), and RCN (Runoff Curve

Number). Staff's proposal of emulating the Dept. of Natural Resources standards of 20 metres or so is not based on science and is only a generality!

Alternately, follow the precautionary approach as recommended in research by Environment Canada, and legislate a minimum buffer of one hundred (100) metres around lakes and rivers, where possible, for the long term protection (see Exhibit-F).

---

12. Recommendation: Septic systems: abandon the negative impressions. But in new developments, aim for a 100-metre setback from lakes to prevent nutrient enrichment over multi-decadal time scales (see also §13, and Exhibit-G)

We submit that past history should not develop a `paranoia' about the future. The past (and many of the present) problematic systems may have been in areas served with what are known as "area beds"!

Since around late-1980s, the "CONTOUR SYSTEMS" have become a norm in most cases!

The contour systems basically involve `lateral spread of the effluent plume' and utilize the reduction capacity of the whole downstream site as opposed to the old `area beds' which utilized only the area immediately underneath the bed!

We are herewith pleased to insert an email d/January 15, 2001 that we received in support of our proposal from Engineering Scientist, David Pask PEng., while he was with the world's leading Small Flows Clearing House of the United States Environmental Protection Agency (USEPA) at the University of West Virginia.

It was indeed David Pask who was the inventor/developer of contour systems which was his graduate project at TUNS in 1983. His primary supervisor was the now retired Prof. Dan Thirumurthy PhD PEng, and there were several other professors with varied expertise who also assisted David, a happy acquaintance of this writer!

Soil & Water Cons. Soc. - Hfx
310.4 Lakefront Road 463-7777
Dartmouth, NS, Canada B2Y 3C4
Email: limnos@chebucto.ns.ca

Date: Mon, 15 Jan 2001 12:27:42 -0800 (PST)
From: David Pask <dpask2001@yahoo.com>
To: "S.M. Mandaville" <limnos@chebucto.ns.ca>

Subject: Re: A speedy response begged for: TP export from single family contour beds

Shalom, we returned from 30 days in UK & France yesterday. I do not have much, hardly any data on P adsorption over decade periods. If effluent is travelling laterally through glacial till, there should be P reducton over a greater period than a system where the flow is vertical through a limited depth of adsorbent soil and then considerable distance flow through say sand/siltstone beds of limited p reduction capacity. In addition the spreading effect of contours ensures that maximum use is made of the reduction capacity of the whole site. I am currently making some assessment of the lateral spread of the effluent plume, which may indicate better retention of adsorption capacity over a longer period. Other technologies may appear in the intervening period.

In general I agree with your efforts to provide greater separation distances..

David.

PS I should be back in the office tomorrow.
-

Several studies conducted for the HRM and for the former Halifax County have made unscientific assumptions regarding septic systems. Most of the studies did not provide credible field data to substantiate their claims of malfunction.

The sampling methodology utilizing piezometers and lysimeters has to be undertaken at statistically valid number of onsite systems for monitoring of the effluent plumes before one can establish failure of the systems (Exhibit-G)

13. Marine biotoxins and severe misconceptions at HRM

Based on statements made at the Regional Council by some councillors and staff, especially at the public hearing on May 04, 2004 on the Interim Growth Management Strategy, Regional Planning - Amendments District 1, 2 & 3, we feel HRM is not doing its homework (we have the video taping from EastLink).

Such blame on septic systems and their impact on the marine inlets have also been made by the Regional Planning staff on several occasions; they allegedly obtained the info from a general web page of Environment Canada (http://www.atl.ec.gc.ca/epb/factsheets/sfish_wq.html). If you read the web page in depth, you will observe that it points to all potential sources of pollution, not just septic systems. It enunciates natural biotoxins as well.

To establish the scientific accuracies, this signatory had a long conversation during year-2004 with Mr. Amar Menon, a scientist with Environment Canada Atlantic. Amar did state that he did not have any scientific monitoring to prove that septic systems were the cause; indeed he had no data on groundwater plumes down gradient from septic systems at all!

14. Marine inlets- Eutrophication research conducted by scientists at the BIO-DFO (Exhibit-H)

(Strain, P.M., and Yeats, P.A. 1999. The Relationships between Chemical Measures and Potential Predictors of the Eutrophication Status of Inlets. Marine Pollution Bulletin, Elsevier Science Ltd. 38(12):1163-1170.)

Some startling revelations ensued and relevant scans are included in Exhibit-H. Excerpts from the paper and an email are included below:

“Samples for these analyses were collected in 34 inlets in eastern Canada. The dominant factor (31% of the variance of the dataset) from a principal component analysis of the resulting data was clearly related to eutrophication. This factor included phosphate, ammonia, silicate, dissolved oxygen, iron and manganese, but not cadmium and zinc. It was used to rank inlets according to eutrophication. Comparisons of these rankings with measures of inlet shape revealed that several measures of the significance of sills were good predictors of the eutrophication status. Tidal prism flushing times, and other geometric measures, were poor predictors of eutrophication. Measures of anthropogenic inputs to the inlets were also poor predictors of the eutrophication status; apparently natural processes dominate anthropogenic inputs in these inlets”.

The following are select excerpts from an email that this signatory received from Dr. Peter Strain of BIO in Dartmouth:-

“From: Strain, Peter [StrainP@mar.dfo-mpo.gc.ca]
Sent: Monday, May 01, 2000 8:53 AM
To: 'S.M. Mandaville'
Subject: RE: Thanking you a million and a question

Hi Shalom,

> -----Original Message-----
>
> (5) I do have a question w.r.t. your published paper re the EI
> (Eutrophication Index) in Table 4 on page 1168. Since the EI is
> defined somewhat different from freshwater indices, I like to know how
> to interpret it.
>
> For example, the EI for Ship Harbour inlet was 5.87. How does it
> compare on any standardised scale? Or for that matter are there any
> international (or national, i.e., north temperate) standards for it to
> start with or does one compare among several inlets?

[Strain, Peter] Since we were the first to define a eutrophication indicator in this way, the only direct comparisons we can make are to the other inlets in the study. But to try to give some perspective, the deepest water in Ship Harbour becomes almost totally anoxic in the fall - (this is a relatively rare occurrence in marine inlets in the Maritimes), and has very high nutrients levels (up to 45 uM for NH3, 19 uM for PO4; 35 uM for Si).

These would be relatively extreme conditions in any temperate setting, but still not nearly as eutrophic as some places in the Baltic or Adriatic.

> (6) I find the statement w.r.t. the anthropogenic inputs being poor
> indicators as compared to the physical morphology kind of strange,
> though I AM NOT CHALLENGING THAT in the least.

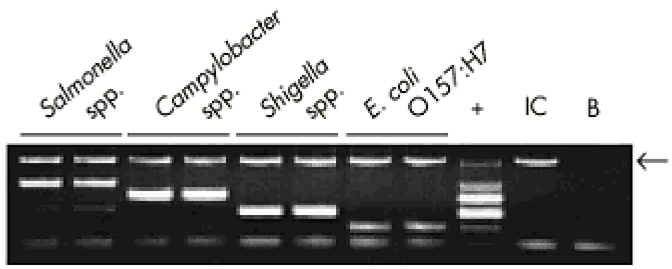
[Strain, Peter] This was one of the most interesting, and surprising, results of this study. What it comes down to is the fact that the waste inputs produced by the modest population densities we have in Nova Scotia are small compared to the natural fluxes of organic materials and nutrients.

Even in Halifax Harbour, the perturbations are only just visible, as far as nutrient levels are concerned. It also highlights another important difference between lakes and the coastal marine environment: lakes are (almost) closed systems, marine inlets usually exchange water freely through tidal action with waters on the continental shelf. It's only when factors that inhibit tidal mixing between inshore and offshore waters are important that you can see the impact of anthropogenic inputs, when the wastes are trapped in the inlets. This is why sills are so important, and why a eutrophication indicator based on sill geometry works.

Cheers,
Peter”

15. Recommendation: Carry out Bacterial Source Tracking (BST) before making public statements on the fecal sources

Bacterial Source Tracking (BST) is a state-of-the-art methodology that is being used in advanced jurisdictions to determine the sources of fecal bacteria in environmental samples (e.g. from human, livestock, or wildlife origins). BST methodology has been described as having the ability to turn nonpoint sources into point sources. BST is also called Microbiological Source Tracking (MST), fecal source tracking, or fecal typing.



Fecal contamination of aquatic environments afflicts many regions and may carry risks to human health. For example, human fecal pollution may spread dangerous bacterial and viral pathogens, such as hepatitis, while other human pathogens such as *Cryptosporidium parvum*, *Giardia lamblia*, *Salmonella* spp., and *E. coli* O157:H7 are associated with animal fecal pollution.

Further, contamination of coastal and inland waters by fecal bacteria results in beach closures that suspend recreation and strike a blow to the economies of beach communities.

Often the source of fecal contamination in water cannot be determined. For example, non-point sources such as failing septic systems, overloads at sewage treatment facilities, overflows from sanitary sewage pumping stations, or flows from sewage pipe breaks may all be candidates. In addition, the contribution of bacterial pollution "stored" in sediments and re-suspended during storm events is unknown. In order to adequately assess human health risks and develop watershed management plans, it is necessary to know the sources of fecal contamination.

See our web page with the URL of http://lakes.chebucto.org/H-2/bst.html for more info. Also read the following synopses carried out for the EMS Department:

Mandaville, S.M. 2002. Bacterial Source Tracking (BST)- A Review. Project H-2, Soil & Water Conservation Society of Metro Halifax. X, 46p., Appendices A to T.

16. Lake Carrying Capacities (LCC's)- History at the HRM and at the former Halifax County (also see §6, and Exhibits- C & D)

16.1. Predictive modelling for a multitude of parameters but focus here on the basic phosphorus modelling

There are several predictive models available widely in international limnological literature, and one can literally model for almost any parameter prior to development; post-development is too late!

As the year-2004 CCME Policy on Phosphorus (TP) clearly narrates that, not adhering to the reference/background (i.e., the natural pre-development value) + 50% maximum increase concept, even if they fall within the reference trigger ranges, could result in significant changes to the `COMMUNITY STRUCTURE'!

Basic common sense dictates that the modelling has to be carried out either by regulatory staff, if they have the scientific competence and experience, or via consultants who are eminently qualified in limnology and lake management.

This is nothing out of the ordinary. LCC's based on phosphorus have indeed been developed as `regulatory tools' since around the mid-1980s in Ontario, and in/around mid-1990s in Kings County right here in Nova Scotia. In each case, they were developed by staff with varying levels of assistance from research scientists.

This signatory was consulted on aspects of them by various parties; and even our NSEL asked him to carry out an independent assessment of the Kings County methodology several years ago during the tenure of the Hon. Robbie Harrison!

But the task should not be left to consultants working for the proponents (even if they can prove they are genuine limnologists) because of potential conflicts-of-interest! If the `proponents' desire to carry out independent modelling to challenge a regulatory value, then it is their prerogative.

Once HRM's regulators develop an LCC (Lake Carrying Capacity) for ex., for Phosphorus, then it should be discussed in a publicly advertised meeting.

16.1.1. Over one thousand (1,000) lakes/ponds within and adjacent to HRM have already been modelled by this signatory:

See http://lakes.chebucto.org/TPMODELS/tpmodels.html for more info!

16.2. Experience at HRM (Papermill Lake proposal; Exhibit-C):

By letters dated July 27, 1996 and September 15, 1996 addressed to the North West Community Council (NWCC), we had requested that the NWCC mandate a firm policy as, “Management Objective for Paper Mill Lake, Bedford= OLIGOTROPHY until the year 2050 AD (at the minimum)”.

The Bedford Waters Advisory Committee (BWAC) fully supported our proposal. At the NWCC meeting of November 28, 1996, Councillors Kelly and Mitchell moved that the “process commence and that this matter be referred to staff”. The motion was put and passed. But nothing pragmatic has transpired over almost a whole decade, alas!

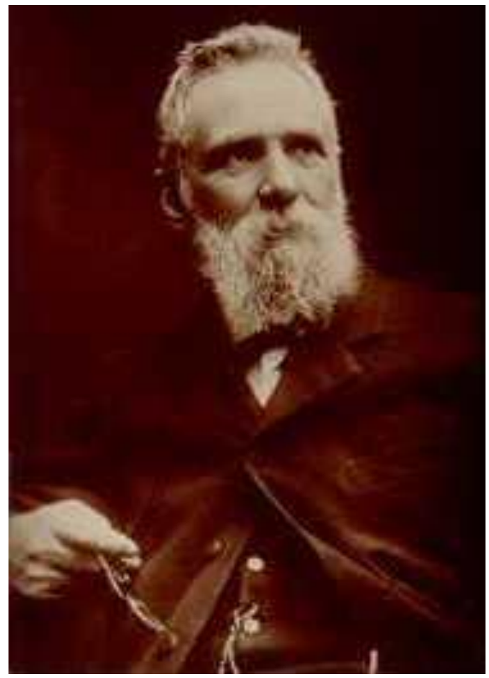
16.3. Experience at former Halifax County (Exhibit-D):

Although staff (Susan Corser MCIP) had strongly supported, the PAC had rejected, by a tie vote, our appeal to have the County set lake carrying capacities (LCC’s) for lakes/ponds within the former districts of 1 & 3 (St. Margaret’s Bay Plan area of HRM). HRM’s councillors, Reg Rankin and David Hendsbee, were members of that PAC.

We had also made similar submissions for the planning strategies of former districts of 14 & 17 (Shubenacadie Lakes area of HRM), and former districts of 15, 18, & 19 (Hammonds Plains/Upper Sackville/Beaverbank area of HRM). The staff did not address these aspects at all; for details see our URL (http://lakes.chebucto.org/HRM/SUBMISSIONS/submissions.html#county).

17. Limnology- selections

Limnology is a discipline that concerns the study of in-land waters (both saline and fresh), specifically lakes, ponds and rivers (both natural and manmade), including their biological, physical, chemical, and hydrological aspects.



François-Alphonse Forel (February 2, 1841 - August 7, 1912) was a Swiss scientist who pioneered the study of lakes, and is thus considered the founder of limnology. Born in Morges on Lake Geneva, he worked as a professor of medicine at the University of Lausanne.

But his real love was the lake; his investigations of biology, chemistry, water circulation, and sedimentation, and most importantly their interactions, established the foundation of a new discipline. In his chief work, Le Léman, published in three volumes between 1892 and 1904, he named his activity limnology in analogy with oceanography ("limnography" could have been confused with the limnograph, which measures water level in lakes). He discovered the phenomenon of density currents in lakes, and explained seiches, the rhythmic oscillations observed in enclosed waters.

17.1. Primary production:

All sound lake management must be based on knowledge of the processes and/or mass-and energy flows in the lake ecosystems. From a thermodynamic point of view a lake may be considered as an open system, which exchanges materials (wastewater, evaporation, precipitation, nitrogen, bacteria) and energy (evaporation, radiation) with the environment. The cycles of the most important elements, C, N, P, Si, O, S, Fe, are a major part of the chemical-biological processes in a lake system. In addition to the biochemical cycles, some physical processes must be mentioned. The flow of energy has a great influence on the system, which means that light penetration, formation of thermocline and evaporation must be included among the essential processes of a lake. Primary production means the organic material formed, and the greatest part of production in lakes and reservoirs is caused by phytoplankton. Macrophytes might have a substantial standing crop, but phytoplankton has generally a much shorter turnover time.

Primary production represents the synthesis of organic matter of aquatic systems and the total process, photosynthesis, whose complex metabolic pathway can be oversimplified as follows:

$$\text{light} + 6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$$

Plants have photosynthetic pigments, one of which, cholorophyll*a* is present in almost all photosynthetic organisms. Several other pigments, such as chlorophyll b, c, d and e, carotenoids, xanthophylls and biliproteins, can be found in plants.

17.2. Shallow Lakes:

Traditionally, limnology is mostly concerned with lakes that stratify in summer. The impact of macrophytes on the community is relatively small in such lakes, as plant growth is restricted to a relatively narrow marginal zone.

These lakes are not expected to stratify for long periods in summer. This type of lake, where the entire water column is frequently mixed, is also referred to as polymictic. The intense sediment-water interaction and the potentially large impact of aquatic vegetation makes the functioning of shallow lakes different from that of their deep counterparts in many aspects.

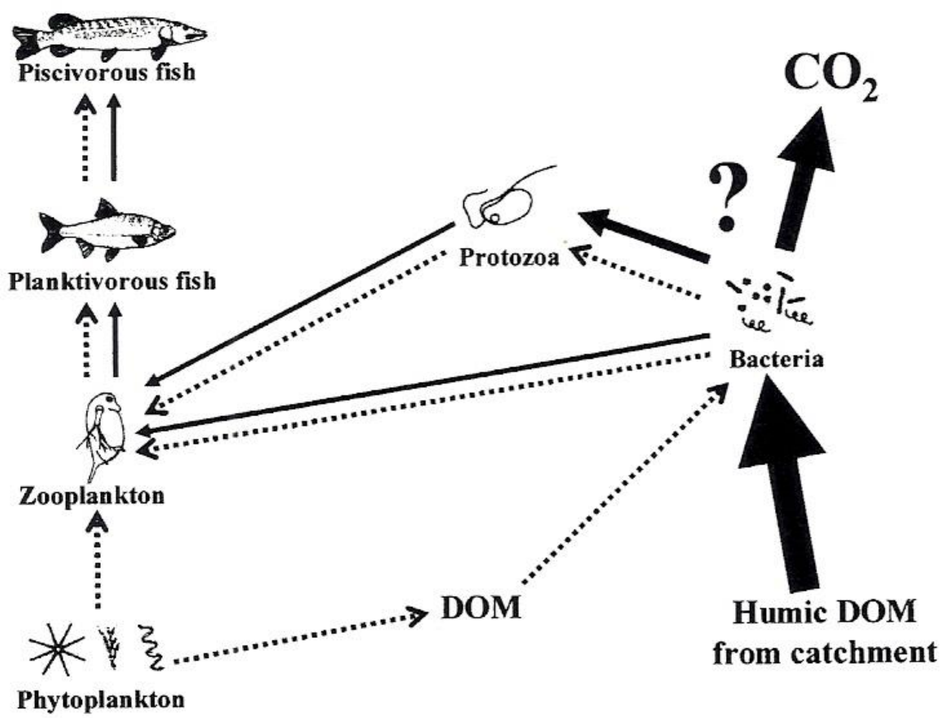
Shallow lakes are defined as lakes where the euphotic zone extends over the bottom. Simply, the euphotic zone is defined as the depth at which the light intensity of the photosynthetically active spectrum (400-700 nm) equals 1% of the subsurface light intensity.

17.3. Typology of (northern) lakes based on metabolic balance and ecosystem stoichiometry:

The humic content of waters (allochthonous loading of organic matter) should be seen as a primary characteristic of natural waters while the degree of nutrient enrichment should be seen as a secondary modifier! All lakes receive some allochthonous loading of humic organic matter and have some inherent heterotrophic metabolic capacity.

Net heterotrophy is arguably the "natural" condition of most northern lakes, with net autotrophy arising only because of anthropogenic impact on catchments. The natural development of many lakes (atleast of boreal lakes) is to become more dilute but richer in DOC and, by inference, more strongly net heterotrophic.

Too many conclusions about net heterotrophy of lakes are based on the "ice-free" or "growing" seasons. When continued respiration during winter conditions is taken into account, even quite eutrophic lakes can be net heterotrophic on an annual basis. This is particularly apparent in lakes with winter ice cover in which considerable under-ice accumulation of CO2 can take place, giving rise to a large springtime CO2 pulse to the atmosphere when the water degasses after ice-melt.



References:

Environment Canada, 2004. Canadian Guidance Framework for the Management of Phosphorus in Freshwater Systems. Ecosystem Health: Science-based Solutions Report No. 1-8. National Guidelines and Standards Office., Water Policy and Coordination Directorate, Environment Canada. pp. 114.

Jones, R.I. 2005. Limnology of humic waters: special theme or universal framework? Plenary lecture, XXIX Congress, 2004, International Association of Theoretical and Applied Limnology. Verh. Internat. Verein. Limnol. 29(1):51-60.

Vollenweider, R.A., and Kerekes, J. 1982. Eutrophication of waters. Monitoring, assessment and control. OECD Cooperative programme on monitoring of inland waters (Eutrophication control), Environment Directorate, OECD, Paris. 154 p.

Wetzel, R.G. 2001. Limnology. Lake and River Ecosystems. Third Ed. Academic Press, San Diego. xvi, 1006 pp. ISBN 0-12-744760-1

[See our web pages on "Shallow Lakes" (http://lakes.chebucto.org/shallow.html), and "Typology of (northern) lakes based on metabolic balance and ecosystem stoichiometry" (http://lakes.chebucto.org/INFO/LIMNOLOGY/stoichiometry.html)]

17.4. The first ever 5-year (2002-2007) paleolimnology of lakes within HRM (Exhibit-V) and a cautionary note:

67 lakes are being studied by the PEARL, Queen's University, and by Trent University, Ontario under the NSERC funded T.E.A.M. project in addition to in-kind contributions (*cf.* http://lakes.chebucto.org/PALEO/hrm.html).

17.4.1. *An example of their research- Russell Lake, Dartmouth:*

Their diatom inferred TP values for Russell Lake ranged between 16.3 and 29.9 µg/l approx., for the period 1850 to 2002, with the lowest value of 16.3 µg/l occurring in 2002.

But their paleo records of chironomid head capsules indicated no improvement in the deep water oxygen levels.

To cite one of their completed thesis, "Improvements in surface water quality, as indicated by diatoms, do not appear be accompanied by the recovery of hypolimnetic oxygen levels, and thus are not reflected in chironomid assemblages."

The extremely high values of 50-90 µg/l (converted to TP) reported by the Nova Scotia Environment Department (NSEL) during the 1970s were not reflected in the paleo work. It seems that most phosphorus data all across Canada were overstated 2-5x prior to twenty (20) years ago (see §19)!

17.4.2. *Cautionary note:*

The work in this NSERC project involves ascertaining certain parameters pre-industrial (1840s) but they do not ascertain the `natural background values'!

The phosphorus management policy of the federal CCME (http://lakes.chebucto.org/DATA/PARAMETERS/TP/popup.html) clearly requires establishing the background values in pristine conditions, i.e., natural background values (or pre-human impact). These can only be obtained by predictive TP modelling (http://lakes.chebucto.org/TPMODELS/tpmodels.html) utilizing phosphorus export coefficients in similar pristine subwatersheds or by paleo techniques which can generate inference models to the pre-human impact era.

But due to time and financial constraints, the Ontario researchers are only going back to the pre-industrial times, approximately the 1840s. They did not core deep enough to date back to the pristine times, i.e., the pre-human impact era, as recommended in the year-2004 CCME phosphorus policy.

But the T.E.A.M's research is still of value for comparison with the pre-industrial era, approx., the 1850s!

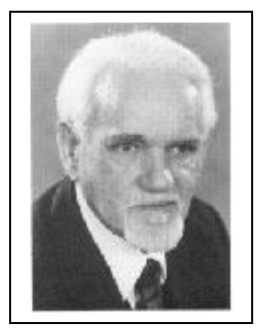
18. Scientific definition of trophic status and most are making significant errors (see also Exhibit-B)!

"Trophy of a lake refers to the rate at which organic matter is supplied by or to the lake per unit time." (Wetzel, 2001)

Trophy, then, is an expression of the combined effects of organic matter to the lake! As developed originally and as largely used today, the trophic concept (e.g., TP, Cha, SD, and TN) refers to the limnetic (i.e., open water) zone-planktonic portion of the lake ecosystem (*cf.* Tables 4.1 and 4.2, Environment Canada-2004). The littoral flora and its often dominating supply of autochthonous organic matter to the system, were, and usually still are, ignored.

18.1. Shortcomings of the Fixed Boundary approach and Vollenweider's dictum on the OECD Probability Distribution Diagrams (Exhibit-L):

What emerged from the assessment of all information available, however, led to the conclusion that there is no possibility of defining strict boundary values between trophic categories. Whilst the progression from oligo- to eutrophy is a gliding one- as has been stressed many times in literature- any one combination of trophic factors, in terms of trophic category allocation, can only be used in a probabilistic sense. Objective reasons exist for the uncertainty of classifying a given lake in different categories by two or more investigators, depending on the management of that body of water.



Average conditions, expressed by "average nutrient concentrations", "average biomass values", "average transparency", etc., do not necessarily express the degree of variability, particularly with regard to peak levels, frequency of their occurrence, and their qualitative nature (type of phytoplankton). From the management viewpoint, such situations and their frequency are as important as average conditions.

For this reason, prediction uncertainties must be accounted for. This can be achieved by reinterpreting the summary values listed in the fixed boundary in terms of classification probabilities. The resulting probability distribution is given in Figures L1 to L4 for the main components: average lake phosphorus, average and peak chlorophyll a concentrations and average yearly Secchi disk transparency.

Click on the 4-minute mp3 sound file (http://lakes.chebucto.org/TPMODELS/OECD/vollenweider.mp3) featuring Dr. Richard Vollenweider explaining the rationale of the OECD Probability Distribution Diagrams relating to the scientifically credible methodology of ascertaining trophic states which can be achieved only in a `probabilistic sense' as described above! The sound file is incorporated in the approx. thirty (30) of the CD+R and/or DVD+R disks that we gave many branches of the HRM inclusive of to thirteen (13) of the councillors and the Mayor!

Environment Canada's Dr. Richard Vollenweider has been the first Canadian (1986/7) to have ever received the top international medal in limnology, the Naumann-Thienemann medal. Only four (4) Canadians have ever been recipient of this coveted medal which has been awarded since as long back as 1942!

18.2. Example of an application of the OECD Probability Distribution Diagrams for lakes in HRM (Exhibit-M):

See Exhibit-M where we summarized the results of applying three of the OECD probability distribution diagrams to our first data of 27 lakes within HRM. Since the data was only seasonal, i.e., three samples per year in most cases, the probability distribution diagram for peak chlorophyll *a* was not considered. One needs more extensive yearly data to confidently ascertain peak chlorophyll *a*.

Subsequently, we carried out such analysis for select indicator lakes based on a range of sampling frequencies, some of them on monthly levels during all the four seasons!

<u>References</u>:

Environment Canada, 2004. Canadian Guidance Framework for the Management of Phosphorus in Freshwater Systems. Ecosystem Health: Science-based Solutions Report No. 1-8. National Guidelines and Standards Office., Water Policy and Coordination Directorate, Environment Canada. pp. 114.

Janus, L.L., and R.A. Vollenweider. 1981. The OECD Cooperative Programme On Eutrophication. Summary Report. Canadian Contribution. Canada Center for Inland Waters, Burlington.

Soil & Water Conservation Society of Metro Halifax. 1991. Limnological study of twenty seven Halifax Metro lakes. 136p.: ill., maps.

Vollenweider, R.A., and Kerekes, J. 1982. Eutrophication of waters. Monitoring, assessment and control. OECD Cooperative programme on monitoring of inland waters (Eutrophication control), Environment Directorate, OECD, Paris. 154 p.

Wetzel, R.G. 2001. Limnology. Lake and River Ecosystems. Third Ed. Academic Press, San Diego. xvi, 1006 pp. ISBN 0-12-744760-1

[See our web page on “Shallow Lakes” (http://lakes.chebucto.org/shallow.html)]

---

19. Phosphorus analytical inaccuracies (see also Exhibit-P)

There are severe concerns raised by several leading limnologists in Canada about the accuracy of phosphorus analyses. This concern not only applies to the older data but somewhat to present data as well.

The present day inaccuracies stem primarily from a combination of questionable field sampling practices, as well as the worry that contamination is commonplace as phosphorus is ubiquitous in the environment, in the labs, etc.

Indeed, the only nationally accredited lab in all of HRM for the low levels of phosphorus, the QEII Environmental Chemistry Labs, no longer carry out the analyses and subcontract to the New Brunswick Environment Department labs. The QEII lab was informed in year 2004 by the national accrediting agency (CAEAL) of severe inaccuracies in their analyses in total phosphorus at the levels that are norm in our lakes and rivers.

See also Exhibit-P which is an email we received from an extensively published chemical limnologist, Prof. Pete Dillon FRSC, of Trent University and Scientist Emeritus with the Dorset Environmental Science Centre of the Ontario Ministry of Environment. Pete Dillon is also one of our Scientific Directors. Indeed, it is primarily his science that most phosphorus models in Nova Scotia are based upon!

---

20. Power boats on shallow lakes (Exhibit-O)

Exhibit is part of an overview scientific paper on this politically charged issue. The paper concludes as, “While this article, and the scientific literature, cannot resolve what may ultimately be a political issue, we can state with reasonable certainty that power boating is likely to have harmful impacts on shallow lakes.”

[See our web page (http://lakes.chebucto.org/INFO/WATERCRAFT/watercraft.html) for the entire article]

---

21. Effects of Golf Course Construction and Operation on the Aquatic Environment

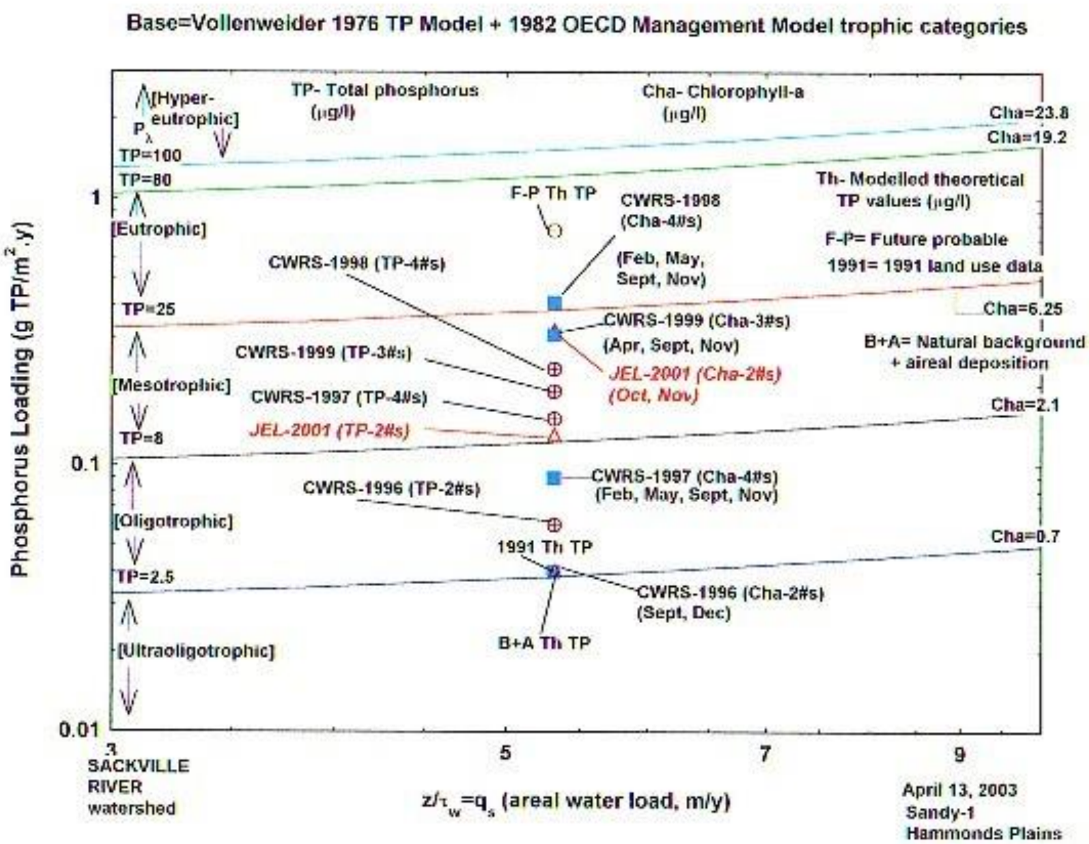
Assess the impact of golf courses and follow the methodology as recommended by scientists at the Ontario Ministry of Environment.

The study integrates projects that investigate the impact of golf courses on physical and chemical water quality parameters with those examining lake and stream biota.

[The paper is in our web page (http://lakes.chebucto.org/INFO/GOLF-COURSES/winter_golf.html)]

---

22. Exhibit-A (1 page): Sandy Lake (Hammonds Plains) model



23. Exhibit-B (6 pages): Scientific shortcomings in consultant reports

(revised to include only relevant parts)

Soil & Water Conservation Society of Metro Halifax (SWCSMH)
310-4 Lakefront Road, Dartmouth, NS, Canada B2Y 3C4
Email: limnes@chebucto.ns.ca Tel: (902) 463-7777
Master Homepage: http://lakes.chebucto.org

Ref.:	ems_2005feb22	(6 pages total)
To:	John Sheppard PEng and Tony Blouin PhD EMS Dept., HRM	
From:	S. M. Mandaville Post-Grad Dip., Professional Lake Manage. Chairman and Scientific Director	
Date:	February 22, 2005	
Subject:	Major errors and scientific shortcomings in many of the studies of HRM- further to your statements at the HWAB on Feb. 16, 2005; written informally as I know both of you well ☺ ☺ ☺ !!	

I was quite concerned regarding some statements both of you made at the Halifax Watershed Advisory Board (HWAB) but since there was no time to address those, this is the reason for this focused letter. I am only pointing out here examples (not all) of events over the last 8 years or so.

(*original in the email*)

(*original in the email)*

(*original in the email)*

(*original in the email)*

(*original in the email)*

(*original in the email)*

24. Exhibit-C (3 pages): Papermill Lake proposal

--- Page C-1 ---

(Only relevant parts of our submission enclosed below)

Soil & Water Conservation Society of Metro Halifax
(a volunteer scientific stakeholder-group)
P.O. Box 911, Dartmouth, N.S., Canada B2Y 3Z6
Email: limnos@chebucto.ns.ca Tel/Fax(call first): (902) 463-7777
Internet Homepage: http://www.ccn.cs.dal.ca/Science/SWCS/SWCS.html

Ref: NWCC02.DOC *(3pg.)*
To: Chairman and Members, North West Community Council, HRM
From: S. M. Mandaville, Co-Ordinator
Date: 27 July 1996
Subject: Paper Mill lake, Community of Bedford, HRM

We herewith respectfully request that your esteemed NW Community Council adopt the following Policy immediately and it be incorporated in your Memorandum. I will be pleased to provide further scientific rationale if needed at a public hearing/meeting, and I would prefer the meeting/hearing be held at the least on a quasi-scientific level as opposed to a political one. TIME IS OF THE UTMOST ESSENCE!

"Policy: Management Objective for Paper Mill Lake, Bedford= OLIGOTROPHY until the year 2050 AD (at the minimum)"

The classification should be based on the 1982 (peer reviewed) OECD Diagnostic Model *(cf. Appendix-A)* which would involve a combination of yearly mean TP, yearly mean Ch*a* and yearly peak Ch*a* values for diagnostic purposes (SD values will not be reliable due to suspended sediment, colour, light variations, operator inconsistencies, etc.). The preferred model to be used for prediction purposes is the 1982 OECD Predictive Trophic State Model (*cf. Appendix-B*). The 1986 Ontario Trophic State Model and its updates (to 1996) can be used to predict the effect of land use changes utilizing applicable TP export and inlake retention coefficients, but the 1982 OECD Predictive Model should be used to ascertain the possible result as it incorporates a safety margin. These models have been developed by several of the leading world experts in Limnology ("science of study of lakes").

Note: Every effort should be made if the lake is proven to be mesotrophic as there has been some conflicting recent *Cha* data. If it is uneconomic to restore Paper Mill lake to an oligotrophic state, then a firm **MAXIMUM TP VALUE OF 8-10μg/l (mean whole year value) should be incorporated as the "Management Objective".**

One of the possible/probable implications of this could be severe restrictions in amount of land that could be developed in the subwatersheds and/or disallowing of direct discharge of stormwater into Paper Mill as well as Kearney and (perhaps other upstream) lakes. At the worst case, stormwater may have to be intercepted with lakeshore interceptors and either diverted and/or treated in a treatment plant (somewhat similar to an area in the City of Nepean, Ontario with TP removal incorporated). The highly touted "community stewardship" programs may be beneficial as well, though we are leery about their guaranteed effectiveness. Though, "community stewardship" has been, is and will always be a very pro-active approach as it concentrates on source reductions, and such programs have been extensively recommended in the USEPA literature as far back as

--- Page C-2 ---

HALIFAX REGIONAL MUNICIPALITY
BEDFORD WATERS ADVISORY COMMITTEE

North West Community Council
November 28, 1996

TO: North West Community Council

FROM: Clarke Bedford, Chair, Bedford Waters Advisory Committee

DATE: November 20, 1996

SUBJECT: CORRESPONDENCE FROM SHALOM MANDAVILLE RE A POLICY FOR PAPER MILL LAKE

The Bedford Waters Advisory Committee, at its meeting of November 13, reviewed the concerns related to Paper Mill Lake, as outlined in correspondence from Shalom Mandaville, Soil & Water Conservation Society of Metro Halifax dated July 27th and September 15th, 1996.

The Committee wishes to advise the Community Council that the Committee, in the past, has recommended the minimum water quality of Paper Mill Lake conform to the C.C.M.E. guidelines for recreational water and the Committee agrees with Mr. Mandaville's conclusions and thank him for his input.

Clarke Bedford,
Chairman,
Bedford Waters Advisory Committee

c.c. S. M. Mandaville

--- Page C-3 ---

Councillor Kelly clarified that he understood there was an overflow of staff in one area which could be reallocated to ease the load in the Central Region. Reallocation, therefore, could be considered before additional staff were hired.

Councillor Rankin pointed out that the community of Hammonds Plains was eager to see the completion of the Plan Review for the former Districts 15/18/19 and additional staff would be able to assist with this Plan Review.

MOTION PUT AND PASSED UNANIMOUSLY.

10.2 Bedford Waters Advisory Committee

10.2.1 Paper Mill Lake Policy

A Memorandum dated November 20, 1996 from Bedford Waters Advisory Committee was before Community Council.

Mr. Bob Kerr, Bedford Waters Advisory Committee provided information on testing being carried out on Paper Mill Lake, particularly with regard to the developer having an agreement to test and reports to the former Town of Bedford. Mr. Mandaville had provided a scientific report which indicated that the status of Paper Mill Lake should try to aim for the year 2050 to be in a certain specific state. Bedford Waters Advisory Committee agreed with Mr. Mandaville's report and felt it was a good policy to keep the lake as pristine as possible. He requested that Community Council support the approach for the area. As well, there was a consistent policy required for all the area served by North West Community Council.

MOVED by Councillors Kelly and Mitchell that the process commence and that this matter be referred to staff. MOTION PUT AND PASSED.

25. Exhibit-D (2 pages): St. Margarets Bay plan area

MUNICIPAL PLANNING ADVISORY COMMITTEE MINUTES
FEBRUARY 13, 1995

THOSE PRESENT:

Councillor Rankin, Chair
Councillor Hendsbee
Councillor Naugle
Councillor Merrigan
Councillor Hache
Anne Merritt
Berit Pittman
Delphis Roy

APPROVED
March 13/95

IN ATTENDANCE:

Paul Morgan, Senior Planner, Policy Division
Susan Corser, Senior Planner, Policy Division
Maureen Ryan, Planner, Policy Division
Gail Foisy, Secretary

Shalom Mandaville, Soil and Water Conservation Society of Metro Halifax

Berit Pittman moved, seconded by Councillor Hache:

THAT THE COMMITTEE APPROVE THE WORDING AS SUGGESTED BY STAFF.

Councillor Rankin questioned whether the wording would inhibit very much residential development within 1000'.

Susan Corser responded that first the community would have to set water quality objectives which would then dictate the degree or density of development on the shore within that 1000' area.

Delphis Roy expressed concern that establishing 1000' would be the standard. He indicated that we have development now which is well within that 1000' and we are going to be moving further and further from that watercourse. He said that he was very reluctant to approve the suggestion.

Susan Corser advised that in terms of onsite septic systems and what they contribute to the soil, 1000' is generally the zone over which those pollutants will gradually make their way into the water. The 1000' is generally what is understood to be the area of impact. The suggested wording is not saying that we would not allow development; it is just saying that that is the area we should look at should development occur.

Delphis Roy commented that Venice is built in the water as is Amsterdam. He suggested deleting the reference to the 1000' and indicating that when we use land near watercourses we have to be careful of the effluent that might get into them.

Councillor Rankin questioned whether the removal of the reference to 1000' would remove some of the spirit.

Susan Corser agreed that the preamble could be reworded. She noted that the policy would not change as there is no reference to the 1000' contained within it.

Councillor Merrigan indicated that he too had a problem with the suggested wording. He said that we are trying to deal with lakes but we are talking about watercourses as well. Also, many parcels of land would have streams going through them.

Berit Pittman noted that the wording is not saying that nothing could not be built within 1000'; it is simply saying that problems might arise within that 1000'.

Anne Merritt said that she would like to see the 1000' recognized as a sensitive area but not as a set space for exclusion of development.

Motion lost.

26. Exhibit-E (3 pages): Minneapolis City: Chapter 55. Lawn Fertilizer Bylaw

exceptions. Provides that no fertilizer shall be applied to impervious surfaces, drainage ditches, waterways, lakes, or within 10 feet of wetlands in certain defined protected waters as specified.

Section 55.60. Exemption and notice requirement. Provides that the prohibition against the use of phosphorus fertilizers does not apply to newly established lawns or to lawns which soil tests confirm are below phosphorus levels established by the University of Minnesota Extension Service. Provides restrictions and procedures.

Section 55.70. Sale of fertilizer containing phosphorus. Provides that effective January 1, 2002, no one within the city shall sell phosphorus-containing fertilizer except as provided in the section. The exceptions include small quantities for use as provided in Section 55.60. Provides phosphorus-containing fertilizer must be clearly marked and the sellers of phosphorus fertilizer shall provide the buyer with a copy of Chapter 55 or a summary thereof.

Section 55.80. Conflict. Provides that in the event of direct conflict with Minnesota statute or federal statute and/or licenses issued pursuant thereto the statute or license shall govern.

Section 55.90. Violations. Provides that a person or entity that violates the ordinance is subject to a fine of up to $300.00 and that commercial applicators are subject to license revocation for repeat violations.

Said ordinance was passed September 28, 2001 by the City Council and approved October 4, 2001 by the Mayor. A complete copy of this ordinance is available for public inspection in the office of the City Clerk.

The following is the complete text of the unpublished summarized ordinance.

ORDINANCE 2001-Or-113
By McDonald and Colvin Roy

Intro & 1st Reading: 8/10/2001
Ref to: PS&RS
2nd Reading: 9/28/2001

Amending Title 3 of the Minneapolis Code of Ordinances relating to Air Pollution and Environmental Protection, by adding a new Chapter 55 relating to Lawn Fertilizer.

The City Council of The City of Minneapolis do ordain as follows:

Section 1. That the Minneapolis Code of Ordinances be amended by adding thereto a new Chapter 55 to read as follows:

CHAPTER 55. LAWN FERTILIZER

55.10. Purpose. The city and the park board have conducted studies and have reviewed existing data to determine the current and predicted water quality of various lakes within the city. Data indicates that lake water quality may be maintained and improved if the city is able to regulate the amount of lawn fertilizer and other chemicals entering the lakes and other surface water as a result of storm water runoff or other causes. The purpose of this ordinance is to define regulations that will aid the city in managing and protecting its water resources.

55.20. Definitions. For the purpose of this chapter, certain terms and words are defined as follows:

Commercial applicator is a person who is engaged in the business of applying fertilizer for hire.

Fertilizer means a substance containing one or more recognized plant nutrients that is used for its plant nutrient content and designed for use or claimed to have value in promoting plant growth. Fertilizer does not include animal and vegetable manures that are not manipulated, marl, lime, limestone, and other products specifically exempted by rule by the Minnesota Commissioner of Agriculture.

Noncommercial applicator is a person who applies fertilizer during the course of gainful employment, but who is not a commercial lawn fertilizer applicator.

55.30. Authority to administer. The authority to administer and enforce the provisions of this chapter of the Minneapolis Code of Ordinances on behalf of the city is vested in the Minneapolis Watershed Management Authority located in the environmental management section of the department of operations and regulatory services. The Minneapolis Watershed Management Authority, hereafter referred to as the "authority", shall have full authority to administer this chapter in addition to all authority given to it pursuant to section 48.70 and other sections of this Code.

55.40. Regulations for commercial lawn fertilizer applicators. (a) *License required.* No person shall engage in the business of commercial lawn fertilizer applicator within the city unless a license has first been obtained from the authority as provided herein.

(b) *License application procedure.* Applications for a commercial lawn fertilizer applicator license shall be submitted to the authority. The application shall consist of the following:

(1) *Application form.* Application forms shall be provided by the authority on a form prepared by the authority from time to time. Applicants shall completely fill out such form.

(2) *Product material safety data sheet.* A copy of the product material safety data sheet, including product chemical analysis for the intended lawn fertilizer, shall be submitted to the city along with the application form and, thereafter, at least seven (7) days before any fertilizer composition changes are implemented.

(3) *Minnesota state licenses.* A copy of all licenses required of the applicant by the State of Minnesota regarding the application of fertilizers.

(4) *The license fee as established in this code or by separate resolution of the city council.* The license shall expire on December 31 each year. The license fee shall not be prorated.

(c) *Conditions of license.* Commercial lawn fertilizer applicator licenses shall be issued subject to the following conditions that shall be specified on the license form:

(1) Random sampling. Commercial lawn fertilizer applicators shall permit the city to sample any commercial lawn fertilizer applications to be applied within the city at any time after issuance of the initial license.

(2) The commercial lawn fertilizer license or a copy thereof shall be in the possession of any party employed by the commercial lawn fertilizer applicator when making lawn fertilizer applications within the city.

(3) Possession of product material safety data sheet. A copy of the product material safety data sheet for the lawn fertilizer being used shall be in the possession of any party employed by the commercial lawn fertilizer applicator when making lawn fertilizer applications within the city.

(4) State regulations. Licensee shall comply with the provisions of the Minnesota fertilizer and soil conditioner laws contained in Minnesota Statutes, Chapter 18C and amendments to or revisions thereof and all other law.

55.50. General regulations on fertilizer application. (a) *When to apply fertilizer.* Commercial applicators and noncommercial applicators shall not apply lawn fertilizer when the ground is frozen or when conditions exist which can be reasonably anticipated to promote or create runoff.

(b) *Cost of sample analysis.* The cost of analyzing fertilizer samples taken from commercial applicators shall be paid by the commercial applicators if the sample analysis shows that phosphorus content exceeds the levels authorized by this chapter.

(c) *Fertilizer content.* No person or commercial or noncommercial applicator, including homeowners or renters, shall apply any lawn fertilizer, liquid or granular, within the City of Minneapolis which contains any amount of phosphorus or compound containing phosphorus, such as phosphate, except:

(1) The naturally occurring phosphorus in unadulterated natural or organic fertilizing products such as yard waste compost; or

(2) As otherwise provided in section 55.60.

(d) *Impervious surfaces and drainage ways.* No person shall apply fertilizer to impervious surfaces, areas within drainage ditches, or waterways.

(e) *Buffer zone.* Fertilizers shall not be applied:

(1) Below the ordinary high water level of a lake as established by the Minnesota Department of Natural Resources; or

(2) Within ten (10) feet of any wetland as defined in section 52.30 of this Code, or within ten (10) feet of protected waters as defined in section 551.460 of this Code.

55.60. Exemption and notice requirement. The prohibition against use of fertilizer containing any quantity of phosphorus under section 55.50 shall not apply to:

(1) Newly established or developed turf and lawn areas during the first growing season; or

(2) Turf and lawn areas which soil tests confirm are below phosphorus levels established by the University of Minnesota Extension Service. The lawn fertilizer application shall not contain an amount of phosphorus exceeding the amount of phosphorus or the appropriate application rate recommended in the soil test evaluation.

Phosphorus applied as lawn fertilizer pursuant to the aforementioned exemption shall be watered into the soil so that it is immobilized and generally protected from loss by runoff.

Any person or commercial or noncommercial applicator, including a homeowner or renter, shall notify the authority at least twenty-four (24) hours prior to applying lawn fertilizer containing phosphorus. Such notice shall be in writing and shall contain the reason for using the fertilizer containing phosphorus and the amount of phosphorus contained in the lawn fertilizer to be applied.

55.70. Sale of fertilizer containing phosphorus. Effective January 1, 2002, no person, firm, corporation, franchise, or commercial establishment shall sell any lawn fertilizer, liquid or granular, within the city of Minneapolis that contains any amount of phosphorus or other compound containing phosphorus, such as phosphates, except:

(1) Effective January 1, 2002, small quantities of such fertilizer may be sold for use as provided in section 55.60. Displays of lawn fertilizers containing phosphorus shall be limited to ten (10) percent of the quantity of non-phosphorus lawn fertilizer on display at any given time.

(2) Effective January 1, 2002, displays of such fertilizer must be clearly marked as containing phosphorus and must be separated from the display of other fertilizers by no less than eight (8) feet.

(3) Effective January 1, 2002, for each sale of such fertilizer, the seller shall, at the time of the sale, provide the buyer with a copy of this chapter of the Minneapolis Code of Ordinances, or a summary prepared by Minneapolis regulatory services.

55.80. Conflict. In the event that the provisions of this chapter shall conflict with any Minnesota statute or any federal statute, the Minnesota statute or federal statute shall govern to the extent of any direct conflict. In the event that any conduct prohibited by this chapter is affirmatively and specifically authorized by a valid permit issued by a duly authorized official of the State of Minnesota or a duly authorized official of the United States of America, then the affirmative and specific authority granted in such permit shall govern to the extent of any direct conflict with this chapter.

55.90. Violations. Any person who violates any provision of this chapter shall be guilty of an ordinance violation and be subject to a fine of up to three hundred dollars ($300.00) and punishment for failure to pay the fine as provided in section 1.40 of this Code. Any holder of a commercial applicator license, in addition to the fine, may have his or her applicator license revoked for repeat violations of this chapter.

Adopted. Yeas, 12; Nays none.
Passed September 28, 2001. J. Cherryhomes, President of Council.
Approved October 4, 2001. S. Sayles Belton, Mayor.
Attest: M. Keefe, City Clerk.

PS&RS - Your Committee, to whom was referred an ordinance amending Title 3, Chapter 48 of the Minneapolis Code of Ordinances relating to *Air Pollution and Environmental Protection: Minneapolis Watershed Management Authority,* improving and increasing knowledge and access to information on chemicals, their uses and releases to the environment at facilities and providing for a registration system for hazardous chemicals, now recommends that said ordinance be given its second reading for amendment and passage.

Your Committee further recommends summary publication of the above-described ordinance.
Adopted. Yeas, 12; Nays none.
Passed September 28, 2001.

27. Exhibit-F (2 pages): Environment Canada's report on 100m and 250m corridors around streams

Environment Canada Environnement Canada

Environmental Conservation Branch
45 Alderney Drive, 16th Floor
Dartmouth, Nova Scotia
B2Y 2N6

March 13, 2003

Mr. Shalom Mandaville
Chairman and Scientific Director
Soil & Water Conservation Society of Metro Halifax
310-4 Lakefront Road
Dartmouth, Nova Scotia
B2Y 3C4

Dear Mr. Mandaville:

In response to your request with regards to some past work on nutrient impacts of land use activities near to aquatic systems, I am providing you with the following information.

A number of years ago, I undertook a small Geographic Information System based study to investigate the geospatial relationship between land use and river nutrient concentrations in Prince Edward Island. This work subdivided the drainage basins of a number of streams into a series of corridors around the stream channel (100m, 250m, 500m, 1Km) and then used the GIS to calculate land use characteristics within each of these corridors. The land use mapping employed was based on 1:50,000 scale land cover characteristics (21 classes) derived from Landsat images collected circa 1987. The twenty-one classes were roll into a "protected" layer (cover types expected to control nutrient supply to aquatic systems) and a "delivery" layer (cover types provide limited nutrient supply protection to aquatic systems) and a subsequent "supply index" (Delivery/Protected) was calculated for each corridor. Regression analysis between the supply index and average nitrogen concentration in the stream indicated a significant relationship for the 100m and 250m corridors based on approximately 30 streams. No correlation was observed for the supply index and total phosphorus concentration.

Although this work provided some interesting preliminary insights into the potential importance of 100m and 250m buffer strips in controlling nutrient supply to aquatic systems, it was not completed and has not been adequately peer reviewed. As such, the work provides an indication of the importance of buffer

strip protection, but would require more detailed analysis to provide definitive evidence on the optimal buffer strip width.
Through the Model Forest Program and in particular the Fundy Model Forest, there have been on-going studies to investigate different harvesting practices on water quality. Some of this work has been published, while other studies are still underway. I would suggest that you contact the Fundy Model Forest office to get information on their work.

Yours sincerely,

Geoff Howell
Manager, Ecosystem Science and Information Division

We are unaware if further research was completed that Geoff Howell was alluding to in his letter. Geoff, a life long resident of Dartmouth and an executive member of our group, departed Mother Earth at a young age in early-2004. When he died, he had the title of a Director at Environment Canada and spent half time in Ottawa and the other half at the Alderney Drive offices.

28. Exhibit-G (2 pages): Monitoring of the effluent plume from an onsite sewage disposal system

Monitoring Effluent Plumes

ENGINEERING SCIENTIST
David Pask

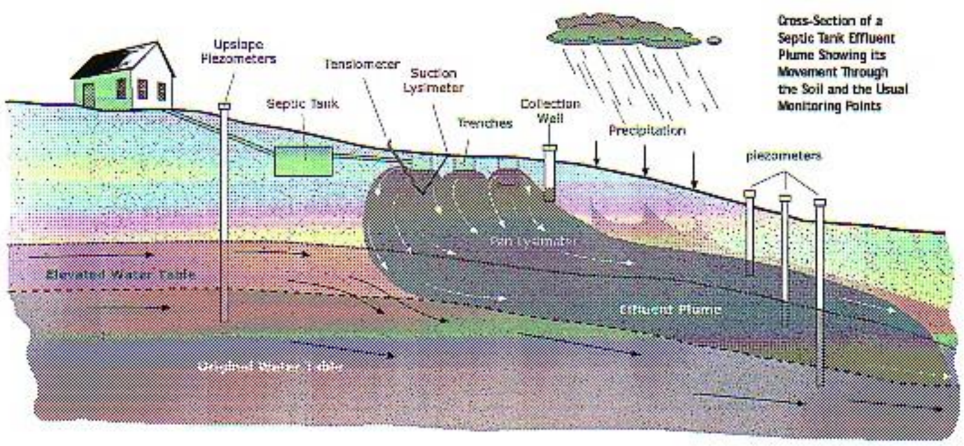
Editor's Note: This column is based on calls received over the National Small Flows Clearinghouse technical assistance hotline. If you have further questions concerning effluent plumes, call (800) 624-8301 or (304) 293-4191 and ask to speak with technical assistance.

Is it possible to easily trace and monitor the effluent plume from an onsite sewage disposal system?

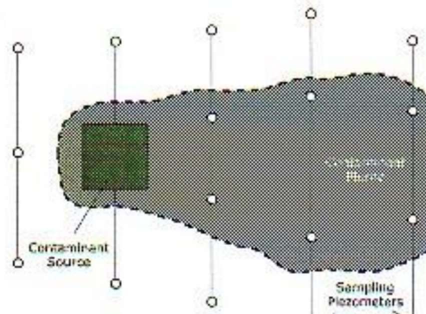
It is very difficult to accurately monitor an effluent plume once it is in the subsoil or groundwater. There are techniques for sampling effluent in the partially saturated vadose zone, with the use of pan and suction lysimeters, but this can be expensive and time consuming. (The pan lysimeter is a collection tray installed below the gravel bed, and the suction lysimeter is a ceramic cup installed in the vadose zone that draws the sample when a vacuum is applied.)

The pan lysimeter will provide samples for microbiological and chemical analysis, but fluid dynamics in the subsoil environment will have been seriously disrupted by the installation of the lysimeter and may not be representative of the complete environment. It is suitable only for sampling of plumes that are travelling vertically. The samples obtained from a suction lysimeter can be tested for five-day biochemical oxygen demand (BOD_5) and chemistry, but the ceramic cup screens out most bacteria. Bacteriophages do pass through (with some reduction in numbers) and can be used to assess potential pathogen transmission. It is necessary to install soil moisture tensiometers adjacent to the lysimeters so that the correct suction pressure can be applied to withdraw the sample. The National Small Flows Clearinghouse (NSFC) can provide information on this technique, if required.

An array of piezometers (small-diameter, screened well tubes installed by hand or ma-



Cross-Section of a Septic Tank Effluent Plume Showing its Movement Through the Soil and the Usual Monitoring Points



An array of piezometers allows maximum contact with an effluent plume (overhead view).

chine auger) can be installed in the expected path of the plume but can sample only below the water table. Moisture in the tension-saturated and vadose zones will not enter the well. The sampling parts of piezometers must cover only a narrow band of the soil and must be sealed (usually with bentonite) to prevent vertical movement of the plume via the piezometer. Piezometers must sample at various levels to provide a three-dimensional representation, either as separate piezometers or as multilevel samples installed in one bore hole. (See diagram above.)

The cost of installing and sampling such an array can be very expensive and is rarely undertaken. One such extensive system is located in southern Ontario. A smaller, but effective, array was installed in southern Nova Scotia.

Simple piezometers do have value in monitoring groundwater levels to estimate the probable depth of the effluent plume, the hydraulic gradient, and direction of movement. A minimum of three piezometers configured to form a triangle and installed below the water table are required to estimate the hydraulic gradient and direction. These are usually installed with one upslope and two downslope from the soil adsorption system.

A dry piezometer still tells us the important information that the water table is currently lower than the bottom of the well. A water sample from a piezometer can only indicate the groundwater properties at a particular region in the soil and cannot be assumed to be the state of the effluent plume. The piezometer must be purged the day before collecting a sample. Accurately tracing an effluent plume requires a large number of multilevel piezometers and can be prohibitively expensive.

A shallow effluent plume (travelling laterally above the natural groundwater) may be traced, under favorable soil conditions, with the use of a soil auger, taking small samples at several depths. It may be advantageous to take a chloride test kit in the field to avoid the expense of analyzing soil samples untouched by effluent. The samples are washed out (elutriated) with demineralized water and reported as such.

Plume Kinetics

The effluent from an onsite sewage disposal system is subject to the influence of capillary action, gravity, and the existing groundwater in the soil. From the infiltration trench, effluent will flow downward through the partially saturated vadose zone and also will be spread laterally by the capillary action of the soil.

On reaching the tension saturated zone (moisture held above the water table by surface tension), the effluent plume will force down and replace the existing groundwater, but the overall water table will be raised. The effluent plume now will be under the influence of the local hydraulic gradient and will move at a velocity determined by the soil permeability and the direction and value of the gradient. Typically, the direction and gradient will approximate that of the ground surface, but this is not always the case due to the often extreme variability in the nature and permeability of the subsoil and bedrock.

The flow of effluent and moisture will be smooth and laminar, and the effluent will remain in the form of a plume with very little mixing and dilution with the existing groundwater. The density will be only slightly greater than the water due to dissolved mineral content, so there will be little gravitational mixing. There will be some vertical dispersion due to seasonal changes in groundwater level.

It should be mentioned that all of the moisture in the soil will be in motion in the direction of the hydraulic gradient. This includes water below the water table, water in the tension-saturated zone above the water table, and the moisture in the vadose or partially saturated zone. The only moisture not affected by the gradient is that which is in the form of droplets or discontinuous films on soil particles.

Precipitation on the downslope side of the system will filter down and accumulate above the effluent plume, again with very little mixing, but may depress the plume into the pressure-saturated zone. This can be a significant feature since the rate of advancement may be as little as 50 feet per year.

Monitoring Protocol

A monitoring protocol was developed for Phase I of the National Onsite Demonstration Program. It deals with methods for sampling and suggested parameters for analysis. If your interest is in monitoring existing systems for compliance with regulations, particularly those with advanced treatment, you may wish to study the *Guidance Handbook for Onsite Sewage System Monitoring Programs*, developed by the Washington State Department of Health and Puget Sound Water Quality Authority. The NSFC can provide photocopies of both of these documents at the cost of reproduction.

29. Exhibit-H (2 pages): Marine inlets

(*cf.* Strain and Yeats, 1999)

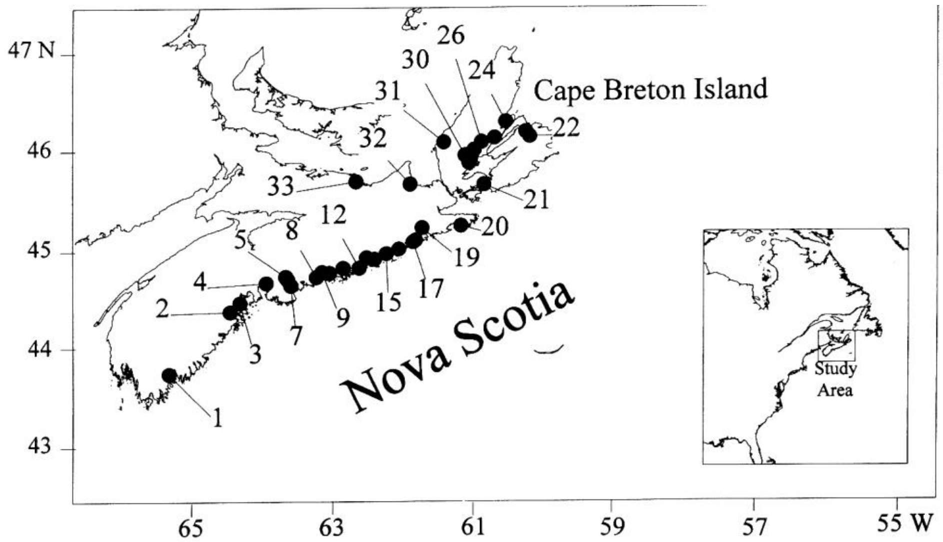


Fig. 1 Nova Scotia inlets sampled during this study. Inlets names corresponding to the numbers on the figure are listed in Table 4.

cation in marine environments. The eutrophication component itself will be a more robust indicator of the status of an inlet, because it includes all of the potential indicating parameters. For simplicity, we will ignore the parameters with small loadings, and define a eutrophication indicator, EI as:

$$\begin{aligned}\mathrm{EI} &= \sum_{i=1}^{6} k_i[X] \\ &= k_{\mathrm{Si}}[\mathrm{Si}] + k_{\mathrm{PO_4}}[\mathrm{PO_4}] + k_{\mathrm{NH_3}}[\mathrm{NH_3}] + k_{\mathrm{O_2}}[\mathrm{O_2}] + k_{\mathrm{Fe}}[\mathrm{Fe}] \\ &\quad + k_{\mathrm{Mn}}[\mathrm{Mn}],\end{aligned}$$

where the values of k_i are the component loadings, and the square brackets indicate either the concentration of that chemical component or its logarithmic transformation. Since the principal component analysis was performed using the correlation matrix, the concentration data must be expressed as standardized variables $(= (x - \bar{x})/\sigma)$. EI can now be used to rank the 34 sample sites according to their eutrophication status. Table 4 lists the inlets, and the values of EI.

TABLE 4

Eutrophication index (EI) for 34 sites in Nova Scotia.[a]

#	Site	EI	f_v	#	Site	EI	f_v
29	[b]Whycocomagh, west	10.98	0.72	1	Shelburne Hbr	−1.16	0.11
17	Wine Hbr	9.03	1.00	33	Pictou Hbr	−2.01	0.28
9	Petpeswick Inlet	8.74	0.85	20	Whitehead Hbr	−2.25	0.44
11	Ship Hbr	5.87	0.56	8	Chezzetcook Inlet	−2.35	0.44
25	[b]Baddeck Bay	4.98	0.56	22	Sydney Hbr - South Arm	−2.37	0.00
10	Jeddore Hbr	4.30	0.52	26	[b]Nyanza Bay	−3.39	0.29
27	[b]Denas Pond	3.55	0.91	14	Beaver Hbr	−3.45	0.06
21	[b]St. Peters Channel	2.78	0.55	7	Halifax Hbr - NW Arm	−3.45	0.14
2	Lahave River	2.57	0.11	33	Pictou Hbr	−3.62	0.25
6	Bedford Basin	2.57	0.51	3	Mahone Bay	−3.75	0.33
13	Sheet Hbr	2.25	0.22	24	St. Anns Bay	−3.96	0.68
12	Popes Hbr	2.23	0.64	23	Sydney Hbr – NW Arm	−4.02	0.00
28	[b]Whycocomagh, east	1.09	0.48	30	[b]Denys Basin	−4.23	0.00
5	Bedford Bay	0.13	0.00	4	St. Margarets Bay	−4.37	0.00
19	Country Hbr	0.10	0.25	32	Antigonish Hbr	−4.42	0.77
31	Mabou Hbr	−0.80	0.47	18	Indian Hbr	−5.15	0.00
16	Liscomb Hbr	−1.14	0.39	15	Mosher River	−5.30	0.00

[a] Inlets are ranked in decreasing order of eutrophication. Entries in the # columns correspond to numbered locations on Fig. 1. f_v is the fraction of water trapped behind an inlet's sill (in the absence of a sill, $f_v = 0$).
[b] Inlet is located in the Bras d'Or Lakes.

TABLE 5

Correlations between eutrophication factor and potential predictors of eutrophication ($n = 34$ in all cases).

Potential predictors	r^{2a}	Comments
Tidal exchange		
Tidal height	0.028	
Tidal volume	0.058	
Tidal prism model		
Flushing time, w/o freshwater flow	0.085	$\tau = -12.4/\ln(V_{ST}/(V_{ST}+V_T))$
Flushing time, with freshwater flow	0.080	$\tau = -12.4/\ln(V_{ST}/(V_{ST}+V_T+V_{FW}))$
Stratification	0.018	$\Delta\sigma_\theta/\Delta z$
Measures of sills		
Sill depth	0.043	
Sounding – sill	0.361[a]	$z_{max} - z_{sill}$
Sample depth – sill depth	0.394[a]	$z_{sample} - z_{sill}$
% of water column hidden by sill	0.382[a]	$100(z_{max} - z_{sill})/z_{max}$
Fraction of inlet volume trapped by sill	0.438[a]	$[(z_{max} - z_{sill})/z_{max}]^2 = f_v$
Measures of horizontal barriers		
Distance to open water	0.033	Sample site to headland
Section width	0.052	Minimum inlet width between sample site and open water
Section area	0.087	x-section area at section width
Surface area/section width	0.022	
Inlet volume/section area	0.021	
Combined measures		
Volume trapped by sill/section area	0.050	
Anthropogenic proxies		
Population in drainage basin	0.010	
Population/inlet volume	0.042	
Drainage basin area	0.047	
Composite of specific activities	0.000	See text
Composite/inlet volume	0.013	Previous index, normalized to inlet volume

[a] For $n = 34$, the critical value of r^2 at 95% confidence level is 0.115.

30. Exhibit-I (2 pages): Freshwater Benthic Ecology and Aquatic Entomology

Following are our select web pages in this specialty all acccessible from the homepage on "Freshwater Benthic Ecology and Aquatic Entomology" (http://lakes.chebucto.org/ZOOBENTH/BENTHOS/benthos.html)

- Taxa Tolerance Values
- Overall Detailed Introduction
- The Zoobenthos of Freshwaters
- Freshwater Benthic Ecology
  - Diversity and Biotic Indices
- Diagnostic features of Superphylum Arthropoda
  - Class Collembola (springtails)
  - Order Ephemeroptera (mayflies)
  - Order Odonata (dragonflies and damselflies)
  - Order Plecoptera (stoneflies)
  - Order Hemiptera (true bugs)

- Order Trichoptera (caddisflies)
- Order Lepidoptera (butterflies and moths)
- Order Aquatic Coleoptera (beetles)
- Order Megaloptera (alderflies, dobsonflies, fishflies)
- Order Aquatic Neuroptera (spongillaflies)
- Order Diptera (two-winged or true flies)
  - Family Chironomidae (midges flies)
    - Chironomid mouthpart deformity frequencies as an Indicator of community health
    - Sublethal parameters in morphologically deformed *Chironomus* larvae- extracts
  - Family Culicidae (mosquitoes)
  - Family Tipulidae (crane flies)
  - Family Simuliidae (black flies)
  - Family Chaoboridae (phantom midges)
- Order Orthoptera and Grylloptera (grasshoppers, crickets)
- Order Hymenoptera (aquatic wasps, etc.)
- Subcohort Hydrachnidia (true water mites)
- Subphylum Crustacea (cladocerans [water fleas], shrimps, copepods, amphipods [scuds], sow bugs, crayfish, fish lice)

- Phylum Mollusca:
  - Class Gastropoda (snails)
  - Class Bivalvia (clams and mussels)
  - Alien Species
- Phylum Annelida: (Diagnostic features of Annelida)
  - Class Oligochaeta (aquatic worms)
  - Class Hirudinea (leeches)
- Phylum Platyhelminthes:
  - Class Turbellaria (flatworms)
- Taxa Tolerance Values

31. Exhibit-J (1 page): Chironomid mouthpart deformity frequencies as an indicator of community health

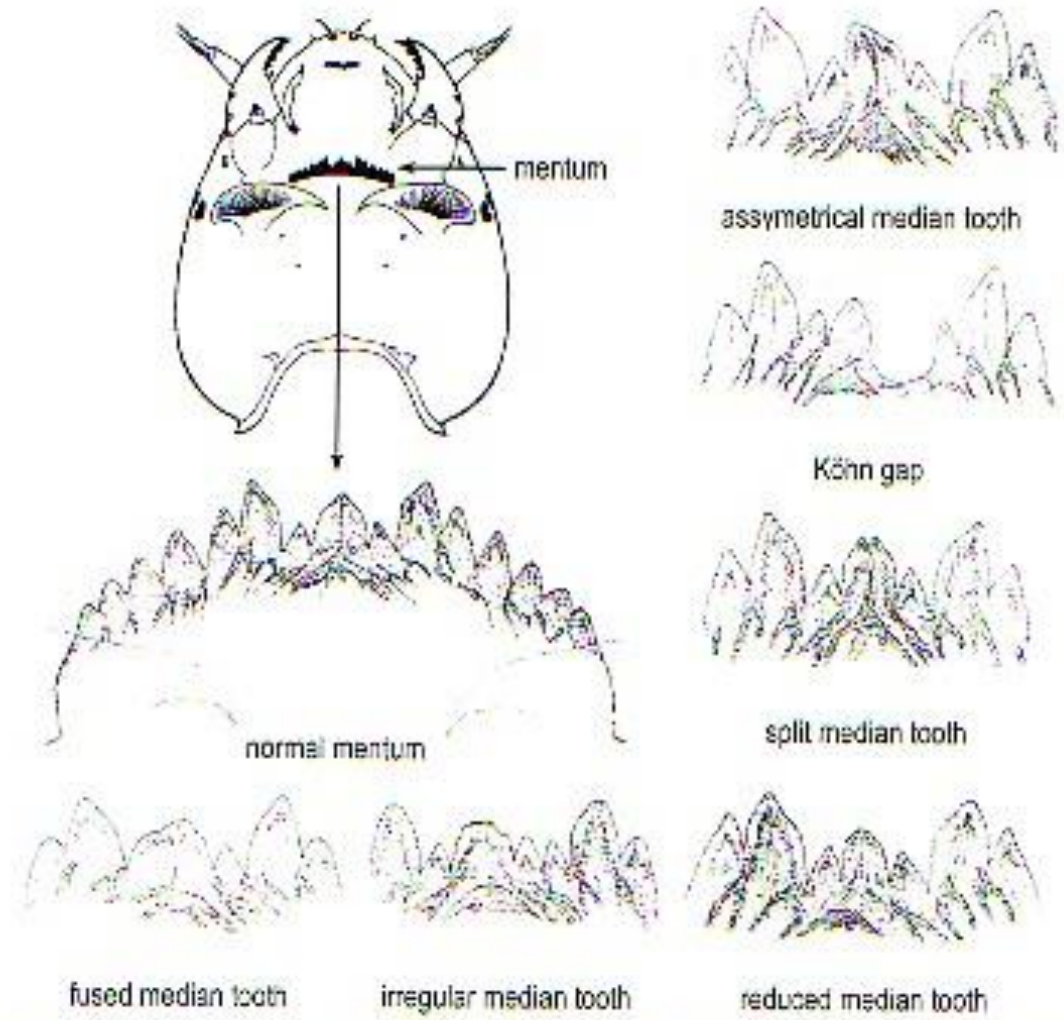


Figure 6.1. Schematic presentation of the ventral view of a *Chironomus* sp. head capsule (adapted from VERMEULEN 1995), with a detailed presentation of a normal mentum and some examples of deformed median teeth (adapted from WARWICK & TISDALE 1988).

32. Exhibit-K (1 page): Premier John Hamm's admission of the lack of any limnologists on the staff of the NSEL

THE PREMIER
HALIFAX, NOVA SCOTIA
B3J 2T3

OCT 08 1999

04-91-0047
04-99-0002

Shalom M. Mandaville
Chairman & Exec. Director
Soil & Water Conservation Society of Metro Halifax
310-4 Lakefront Road, Dartmouth, NS
B2Y 3C4

Dear Mr. Mandaville:

Thank you for your electronic correspondence of August 3, 1999 and July 30, 1999, on the subject of Nova Scotia Department of the Environment's (NSDOE) capacity to properly manage the province's numerous lakes.

As far as the professional composition of NSDOE staff is concerned, this reflects the range of environmental management issues and problems that the department addresses. This includes everything from acid rain and particulate monitoring, to contaminated sites and agricultural practices. Lake water quality is an ongoing concern for the department, not just as it is affected by urban development, but in every way.

With respect to your request that a limnologist be added to the Environment staff, the department will undergo a full program re-assessment as part of the required legislative review. Following that review, there will be better direction on staffing priorities, and the need for a limnologist will be evaluated at this time.

Your personal interest in lake water quality management is indeed evidenced in your website, which I understand to be comprehensive. I very much appreciate the continuing interest of voluntary groups such as your own, and their contribution to our environment. In this regard, I would ask that you maintain contact with NSDOE through Mr. Darrell Taylor (424-2570). I would support collaborative efforts to improve our approaches to environmental management that incorporates the experience of organization's like yours. I have requested that Mr. Taylor follow up with you to discuss this further.

Sincerely,

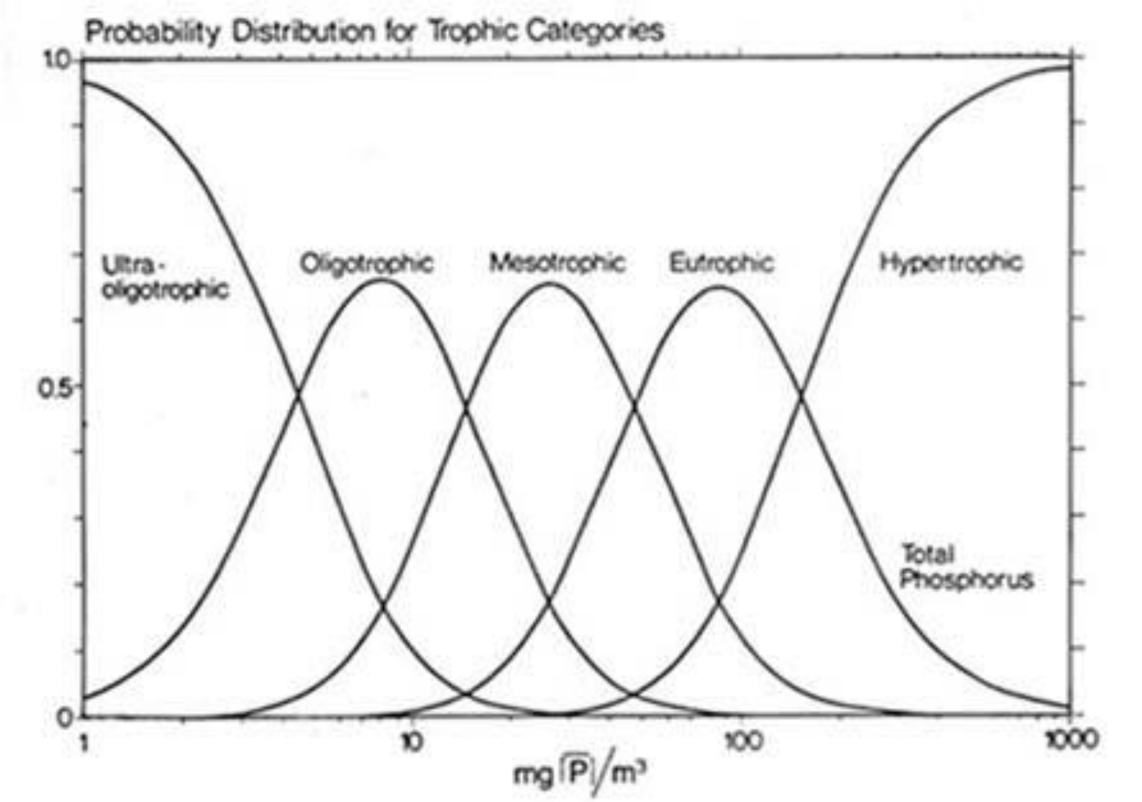
John Hamm

John F. Hamm

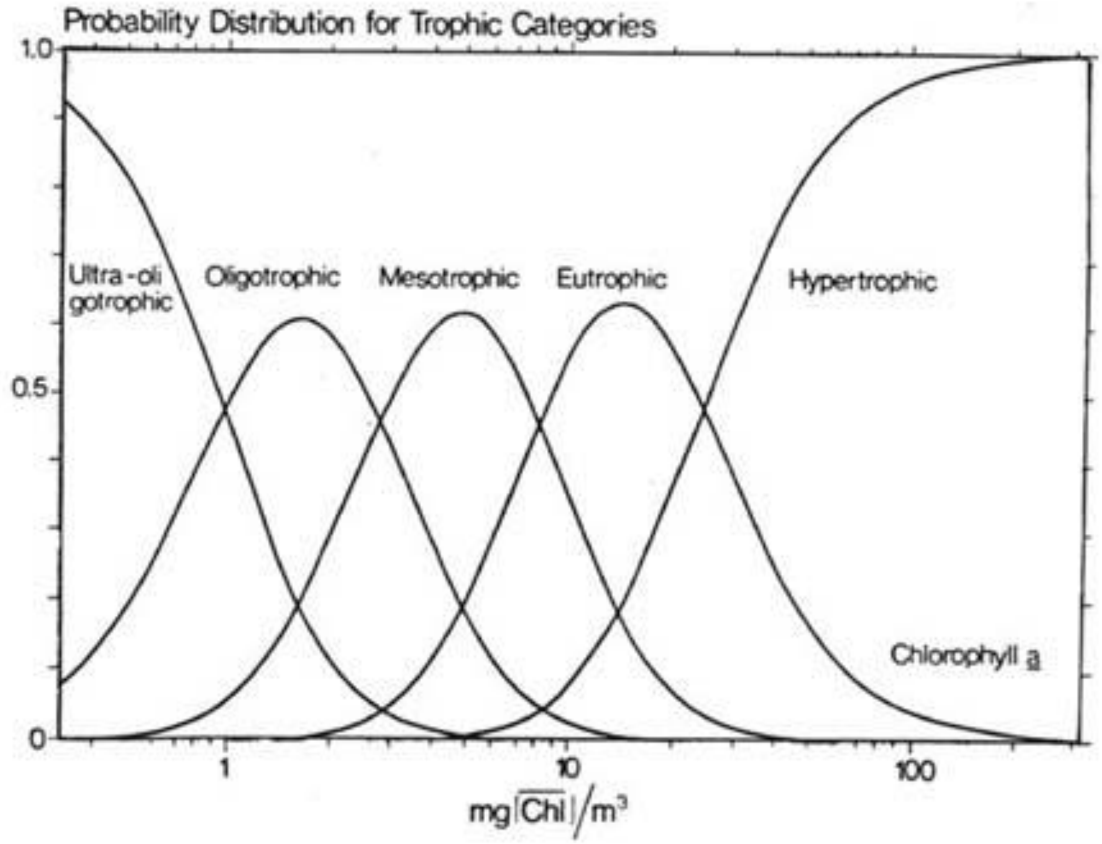
Printed on paper that contains recycled fibre

33. Exhibit-L (4 pages): Probability distribution diagrams

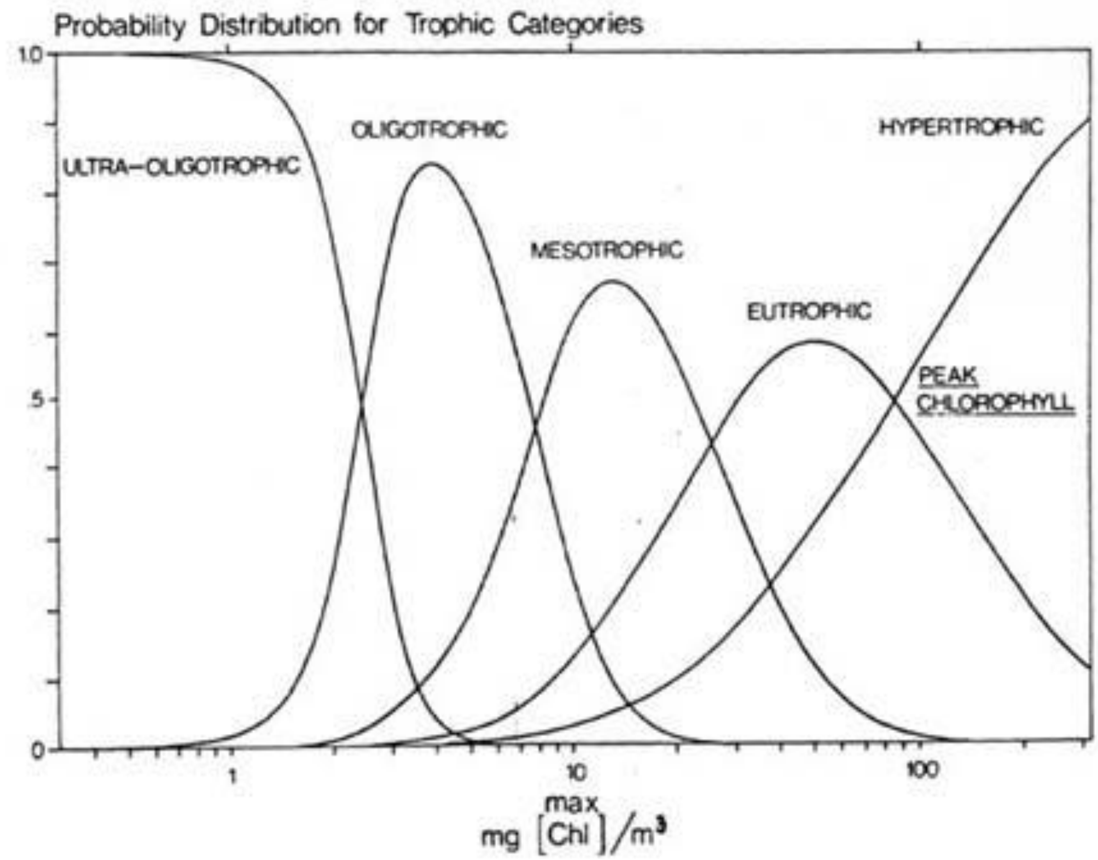
33.1. (Exhibit-L1) Probability distribution curve for yearly average lake phosphorus



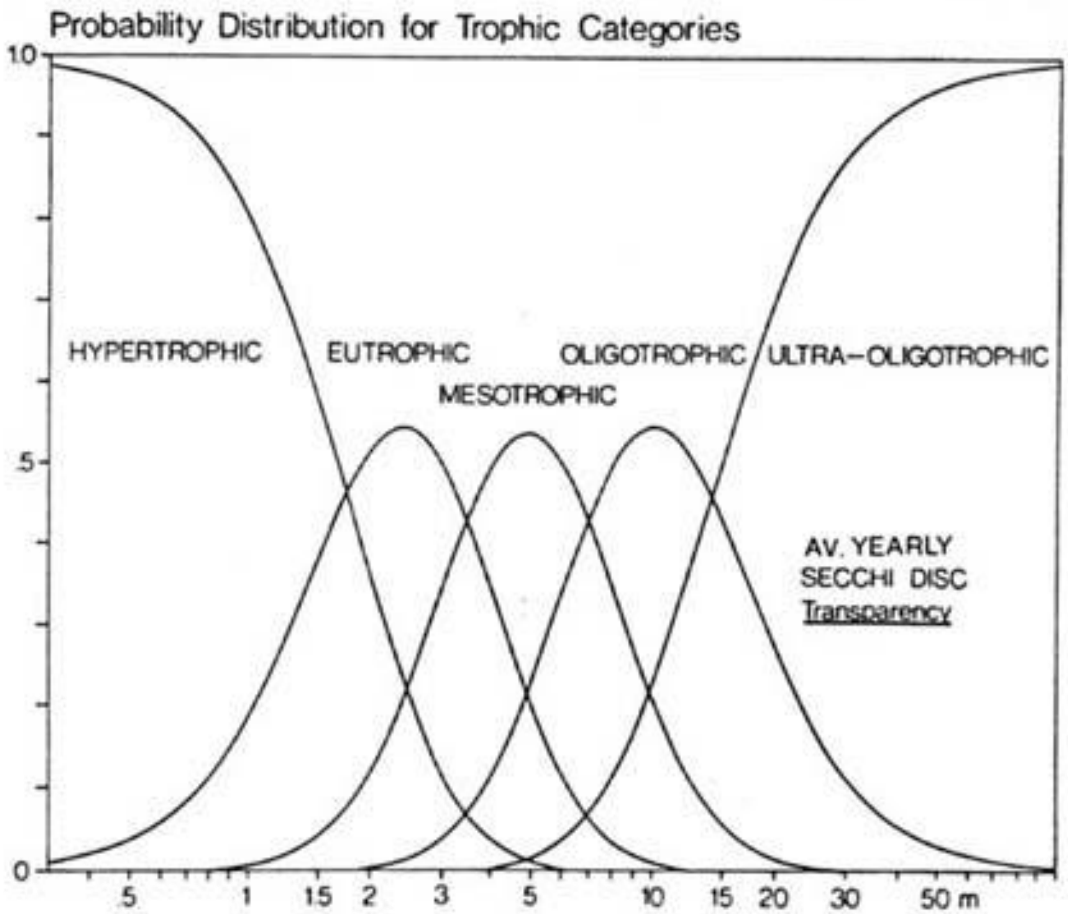
33.2. (Exhibit-L2) Probability distribution curve for yearly average lake chlorophyll *a*



33.3. (Exhibit-L3) Probability distribution curve for yearly peak lake chlorophyll *a*



33.4. (Exhibit-L4) Probability distribution curve for yearly average lake Secchi disk transparency



34. Exhibit-M (1 page): Example of an application of the OECD Probability Distribution Diagrams for lakes in HRM

Soil & Water Conservation Society of Metro Halifax. 1991. Limnological study of twenty seven Halifax Metro lakes. 136p.: ill., maps.

Since, the data of the 27 lakes below was only seasonal, i.e., three samples per year in most cases, peak chlorophyll *a* was not considered. One needs more extensive yearly data to confidently ascertain peak chlorophyll *a*.

We have carried such analysis for numerous other lakes based on a range of sampling frequencies, some of them on monthly levels.

Percentage Probability Classification of 1990 lake trophic states based on the "OECD" probability distribution curves. Classifications based on yearly averages for total phosphorus, chlorophyll a and Secchi disc readings. UO= Ultraoligotrophic, O= Oligotrophic, M= Mesotrophic, E= Eutrophic and HE= Hypereutrophic.

	Percentage Probability Classification														
	Based on Total Phosphorus					Based on Chlorophyll a					Based on Secchi Disc				
Lake	UO	O	M	E	HE	UO	O	M	E	HE	UO	O	M	E	HE
1 Albro	5%	55%	36%	4%	0%	51%	44%	5%	0%	0%	3%	34%	50%	11%	2%
2 Banook	14	66	18	2	0	59	38	3	0	0	0	12	50	35	3
3 Beaverbank	2	37	55	6	0	22	61	17	0	0	0	4	37	51	8
4 Bell	32	61	7	0	0	74	24	2	0	0	2	27	53	16	2
5 Bissett	0	17	65	18	0	0	14	62	24	0	0	0	4	38	58
6 Chocolate	35	60	5	0	0	93	7	0	0	0	32	54	14	0	0
7 First	4	46	46	4	0	0	19	63	18	0	0	0	13	52	35
8 Hubley Big	4	47	45	4	0	8	55	34	3	0	0	3	33	51	13
9 Kearney	22	65	13	0	0	93	7	0	0	0	2	31	51	13	3
10 Kinsac	4	46	46	4	0	8	55	34	3	0	0	8	45	40	7
11 Loon	22	65	13	0	0	82	18	0	0	0	-	-	-	-	-
12 Maynard	17	65	15	3	0	21	61	18	0	0	2	31	51	13	3
13 MicMac	4	47	45	4	0	5	50	42	3	0	2	19	53	24	2
14 Miller	22	65	13	0	0	63	34	3	0	0	0	8	45	40	7
15 Morris	4	46	46	4	0	22	61	17	0	0	0	3	33	51	13
16 Nicholson	14	66	18	2	0	34	56	10	0	0	-	-	-	-	-
17 Oathill	2	43	51	4	0	3	33	56	8	0	0	12	50	33	5
18 Papermill	19	65	14	2	0	22	61	17	0	0	0	8	45	40	7
19 Portuguese Cove	2	43	51	4	0	20	60	20	0	0	0	0	13	52	35
20 Rocky	17	65	15	3	0	59	38	3	0	0	6	44	44	6	0
21 Sandy	5	55	38	2	0	25	60	15	0	0	0	12	50	33	5
22 Second	5	55	36	4	0	20	60	20	0	0	2	19	53	24	2
23 Settle	0	20	65	15	0	0	11	58	29	2	0	0	4	38	58
24 Springfield	4	54	39	3	0	22	61	17	0	0	0	8	45	40	7
25 Third	35	60	5	0	0	20	60	20	0	0	0	12	50	35	3
26 Tucker	10	63	26	1	0	3	33	56	8	0	0	3	35	51	11
27 Williams	17	65	15	3	0	20	60	20	0	0	6	44	44	6	0

35. Exhibit-N (2 pages): A lead example of the methodology to assess the downstream impacts of a proposed STP (only 2 pages of the paper are inserted)

PROC. N.S. INST. SCI. (1983)
Volume 33, pp. 7-18

PREDICTING TROPHIC RESPONSE TO PHOSPHORUS ADDITION IN A CAPE BRETON ISLAND LAKE

JOSEPH KEREKES
Environment Canada
Canadian Wildlife Service
c/o Biology Department
Dalhousie University
Halifax, N.S. B3H 4J1

Freshwater Lake in Cape Breton Island is characterized by clear water (2-8 Hazen u), and high water temperature (10-12°C) and low oxygen levels (0-20% air saturation) in the hypolimnion in late summer. The lake receives ca. 27 mgP/m²/y from developments and sea spray in addition to the natural, edaphic phosphorus load of 106 mgP/m²/y. The lake is considered oligo-mesotrophic based on transparency (Secchi depth 7 m), total phosphorus (7.6 mg/m³), annual mean and peak chlorophyll (2.5 and 6.4 mg/m³, respectively), low hypolimnetic oxygen levels and relatively dense growth of macrophytes in shallow areas. A proposed development would increase the phosphorus load by ca. 5 mgP/m² during the summer which would increase the epilimnetic total phosphorus concentration to 8.6 mg/m³ and peak chlorophyll to 9.8 mg/m³, assuming an average lake response. These changes would place the lake into the mesotrophic category. Close to the outflow of the secondary treatment discharge, nuisance levels of algal response and macrophyte growth could be expected.

Vers la fin de l'été, le lac Freshwater, situé dans l'Île du Cap Breton, est caractérisé par une eau claire (2-8 Hazen u), une température de l'eau élevée (10-12°C) et de faibles niveaux d'oxygène (0-20% de saturation d'air) dans l'hypolimnion. Le lac reçoit environ 27 mg P/m²/ an des diverses exploitations et de l'embrun marin en plus de la charge naturelle de phosphore édaphique de 106 mg P/m²/an. Ce lac est considéré oligo-mésotrophe basé sur la transparence (profondeur du disque de Secchi 7 m), le phosphore total (7.6 mg/m³), la moyenne annuelle et le maximum de chlorophylle (2.5 et 6.4 mg/m³ respectivement), le faible taux d'oxygène de l'hypolimnion et la croissance relativement dense des macrophytes en eaux peu profondes. Une proposition d'exploitation augmenterait la charge de phosphore de 5 mg P/m² pendant l'été, ce qui aurait pour effet d'augmenter la concentration totale de phosphore de l'épilimnion à 8.6 mg/m³ et le maximum de chlorophylle à 9.8 mg/m³, en supposant une reponse moyenne pour le lac. Ces transformations placeraient le lac dans la catégorie des lacs mésotrophes. Une croissance nuisible d'algues et de macrophytes peut survenir près de la bouche d'écoulement du traitement secondaire des eaux.

Introduction

Freshwater Lake (46° 38' 40"N, 60° 23' 45" W) is the second largest lake in Cape Breton Highlands National Park and the largest boulder-beach (barachois) pond in the National Parks in Canada. Its location near the Park entrance, makes it highly visible and it is used for swimming. This necessitates that the lake and its catchment be managed to ensure its unimpaired recreational and aesthetic values.

Recently a development site on the northwest shore of the lake near the park entrance has been proposed as a preferred location for several reasons. Concerns have been raised about possible detrimental impact of the facility on the lake, which is already showing some signs of man-made eutrophication, unlike the other pristine, oligotrophic lakes nearby.

The freshwaters of Cape Breton Highlands National Park were surveyed during 1976 and 1977 and the information thus obtained was used in combination with some of the findings (Vollenweider & Kerekes 1980) of the Organization for Economic Co-operation and Development (OECD) Cooperative Programme on Monitoring of Inland Waters (Eutrophication Control) to evaluate the possible im-

Table III. Selected trophic and hydrological features and phosphorus loading estimates of Freshwater Lake, Nova Scotia. Abbreviations are given in methods.

	Existing Conditions	Natural (edaphic) Conditions	Expected Epilimnetic Concentration After Development
$[\overline{P}]_\lambda$ mg/m³	7.5	6.0	*8.6
$[\overline{P}]_i$ mg/m³	13.7	10.9	—
L(P) mg/m²/y	132.7	105.6	—
Annual total phosphorus load kg/y	56.0	44.6	—
Anthropogenic total phosphorus load kg/y	**11.4	—	(13.56)
T(w) y	.67	.67	—
q_s m/y	9.69	9.69	—
$[\overline{Chl}]$ mg/m³	2.5	1.6	*3.8
$[\overline{Chl}]^{max}$ mg/m³	6.4	4.2	*9.8

*summer epilimnetic value
**includes sea spray

latter value to the phosphorus-chlorophyll-a relationships (Vollenweider and Kerekes 1980), the expected increase in chlorophyll and peak chlorophyll would be 1.3 and 3.5 mg/m³ respectively (Table III).

These estimated chlorophyll values would put the lake into mesotrophic category. This is based on the assumption that the lake would respond "normally" without a shift in algal (chlorophyll) response.

The foregoing discussion would apply for the lake as a whole. Close to the outflow of the secondary treatment discharge in a relatively well sheltered, shallow part of the lake, a more dense, nuisance-type algal response and macrophyte growth could be expected.

Acknowledgements

I am grateful to Dr. P. Schwinghamer and Mr. R. Scott, both formerly with the Canadian Wildlife Service, for their excellent assistance in all phases of this project. Appreciation is extended to Messrs. J.D. MacDonald, B. Buchanan, J. Wentzell, A. Rogers, D. Couchie and B. Baldwin of Cape Breton Highlands National Park and R. Kendall, D. LeSauteur and Ms. L. Charon, Parks Canada, Atlantic Region, for their assistance and support of this study. I am grateful to Messrs. Al Smith, J. Inder, and W. Prescott of the Canadian Wildlife Service, Atlantic Region for their continuous support. I am greatly indebted to Dr. I. A. McLaren for his critical review of the manuscript.

36. Exhibit-O (2 pages): Power boats on shallow lakes

Power boats on shallow lakes: A brief summary of literature and experience on Lake Mohegan (NY)

By David O. Wright
and Kenneth J. Wagner

Introduction

Among the questions the authors are most often asked at various lake management conferences is whether there is any information available concerning the impacts of powers boats on shallow lakes (defined as those ≤ 30 ft). Unfortunately, the issue of managing powerboating too often is based entirely on subjective criteria—residents opposing noisy powerboats, for example—and too infrequently based upon sound scientific considerations. This article attempts to summarize the state of the literature, with a bibliography to help lake managers conduct analyses for themselves and presents a preliminary case history of this issue at Lake Mohegan, NY.

Early Studies

The early scientific concern was largely with the emissions of outboard motors. Studies by academic institutions and the outboard motor industry, many with the support of government agencies, analyzed whether the two-cycle engines were polluting lakes with their by-products, unburned hydrocarbons and lead. In the 1970's, the general consensus came to be that advances in engine technology meant that there was little risk to the lake environment from release of lead and hydrocarbons.

These studies generally concluded that outboard engines, with recent technological improvements, had minor impacts on water quality because there was little increase in the concentration of hydrocarbons. This, however, missed a major impact of powerboating on shallow lakes—the impact of stirring up bottom sediments that increased turbidity and accelerated algae growth. This problem was particularly acute in soft-bottomed lakes with sediments rich in nitrogen and phosphorus.

David Wright is an attorney practicing in New York City and a director of the Mohegan Lake District. Ken Wagner is a scientist with Baystate Environmental Consultants in East Longmeadow, MA.

1974 EPA Study

In 1974, the EPA published a study by Yousef, conducted at several Florida lakes, analyzing the impact of boating activity on turbidity in shallow lakes. Based on a review of the "Monthly List of Government Publications," from 1974 to 1990, this appears to be the only study published by the EPA on this issue. The study focused on "shallow" lakes, defined as lakes with a maximum depth of 30 ft and examined the impact of varying horsepower engines on lakes of varying depths. The study concluded that even 10 horsepower engines could produce significant stirring of bottom sediments at depths up to 15 ft, and that engines with greater horsepower can do even more damage than smaller engines.

The 1974 EPA study found that the activity of a 100 hp outboard motorboat causes significant increases in turbidity (Fig. 1), orthophosphorus (Fig. 2) and total phosphorus (Fig. 3). A primary reason for the decision by the Mohegan Lake District to seek a powerboat ban is the concern that power boats stir up the nutrient-rich bottom sediments in shallow Lake Mohegan, which releases phosphorus and accelerates algae growth. The 1974 study confirms that this occurs—at horsepowers well below those currently used on lakes deeper than Lake Mohegan.

As Figures 1 through 3 show, at shallow Lake Osceola, the impact of a 100 hp powerboat even for 30 minutes could produce increases in turbid-

Table 3.—Characteristics of lake ecosystems which influence ecological impact by motorized watercraft.

1. Lake area
   a. Low (<20 ac)
   b. Medium (20-100 ac)
   c. Large (100-300 ac)
   d. Very large (>300 ac)
2. Epilimnetic volume
   a. Low (<130 million gal)
   b. Medium (130-653 million gal)
   c. Large (653-1960 million gal)
   d. Very large (>1960 million gal)
3. Hydraulic residence time
   a. Low (<21 days)
   b. Medium (21-90 days)
   c. High (90-365 days)
   d. Very high (>365 days)
4. Shoalness ratio
   (area <20 ft deep/total area)
   a. Low (<0.25)
   b. Medium (0.25-0.50)
   c. High (0.50-0.75)
   d. Very high (0.75-1.00)
5. Shallowness ratio
   (area <5 ft deep/total area)
   a. Low (<0.10)
   b. Medium (0.10-0.25)
   c. High (0.25-0.50)
   d. Very high (>0.50)
6. Shoreline development
   (shoreline length/circumference of circle with lake area)
   a. Low (<1.5)
   b. Medium (1.5-3.0)
   c. High (>3.0)
7. Littoral zone bottom coverage by rooted plants
   a. Low (<25%)
   b. Medium (25-50%)
   c. High (50-75%)
   d. Very high (75-100%)
8. Substrate type
   a. Cobble
   b. Gravel or sand
   c. Silt or clay
   d. Organic muck

from previous page

though we do not know the purpose for which this one-sided summary was prepared, or who was paying for it, we can state that Bahl et al.'s summary of literature is incomplete and misleading. While it purports to summarize the literature, it ignore the only study ever published by the EPA, as well as a wealth of other literature available. It claims to summarize a study prepared for (and paid for by) the Association of Outboard Motor Manufacturers, and comes to conclusions that not only contradict a wealth of scientific evidence—but also violate common sense.

Conclusion

The outcome of the struggle between powerboaters and those seeking a powerboat ban on Lake Mohegan is as yet uncertain. As has been the case at many other lakes, emotions are strong and a careful scientific study is lacking. As enforcement of boating regulations has greatly reduced boating activity and improved water clarity, the Mohegan Lake District believes that a power boat ban will serve both water quality and public safety interests. Furthermore, powerboating threatens the success of other management actions, such as alum application, and interferes with the aesthetic interests of other lake users.

While this article, and the scientific literature, cannot resolve what may ultimately be a political issue, we can state with reasonable certainty that power boating is likely to have harmful impacts on shallow lakes.

References

Bahl, Chiasson, Desrochers, Lalonde & Assoc. and W.C. Belschner. 1979. Summary of research reports relating to outboard motorboat activities and their effects on aquatic ecology and sound emissions on popular boating lakes. Unpublished.

Wagner, K. H. 1990. Assessing impacts of motorized watercraft on lakes. Pages 77-94 *in* Proceedings of Enhancing the State's Lake Management Programs, May 17-18, 1990, Chicago, IL. (extensive bibliography). Northeastern Illinois Planning Comm., Chicago.

Yousef. 1974. Assessing effects on water quality by boating activity. EPA 670/2-74-072. U.S. Environ. Prot. Agency.

Yousef, et. al. 1979. Changes in phosphorus concentrations due to mixing by motor boats in shallow lakes. Wat. Res. 14: 841.

37. Exhibit-P (2 pages): Phosphorus analytical inaccuracies

From: Prof. Peter Dillon FRSC, Trent Univ., Ontario (also Scientist-Emeritus, Dorset Centre, Ontario Ministry of Environment-OME)
Sent: Monday, November 14, 2005 11:00 AM

To: Shalom M. Mandaville
Cc: Prof. John Smol FRSC (PEARL-Queens Univ.); John K. Underwood PhD (former limnologist-NSEL); NSEL-Water Line

Hello Shalom

However, in the interim, I will try to clarify a few points, just to be sure that we are all on the same page. What I originally said was that P measurements reported by many labs in the '60's and '70's were often suspect. I know this for a fact as I conducted blind QA/QC tests on the Ont Min Envir in the mid-70's and, quite bluntly, our lab failed miserably. Results were too high most of the time, often 2 to 5x the real value. I also carried out some testing on other govt. labs with poor results. Detection limits in most labs were often 0.01 or 0.02 mg/L, i.e. 10 or 20 ug/L, which is of course useless if your study site has 5 ug/L. Part of the problem was that the focus before this was on waste effluents (our OME started as the Water Resources Commission and was responsible for sewage treatment in Ontario and did virtually nothing else - the OME only began in 1971 or 1972). Also, most good chemical work was being done on oceanography then and good results were achieved, but the oceans don't have a few ug/L TP as many lakes do, so those labs didn't have to push detection limits down.

By about 1977 or 78, OME was producing good TP results for my studies - we had set up a low-level P lab specifically for my work at Dorset and Sudbury. However, the rest of the Ministry was getting along with much poorer results than we were achieving - better than the early '70's but still not great. In the early '80's the Great Lakes group pushed for low level P analyses as we had done earlier, and finally the Ministry lab acceded and switched to comparable methods for the rest of the Ontario work.

I believe that similar situations existed in most labs. There are probably a few exceptions, but bear in mind that most govt. labs have large numbers of samples to analyze and low-level P was, at that time, very labour-intensive - this pre-dated standard use of auto-analyzers.

I'm sure that John Underwood would agree that P analyses in the '60's and much of the '70's were often inaccurate, often imprecise. We all, ofcourse, went through the same thing with SO4 analyses - the first of our data that I use are from 1980 - prior to that the data are quite useless unless the water had very low DOC, e.g. precipitation data are good, almost all lakes and streams are not.

There is a certain amount of art to P analyses. Unlike some trace elements, contamination is commonplace as P is ubiquitous in the environment, in the labs, etc. I still routinely see consultant's documents reporting P levels that I know are ridiculous. A few years ago, I was involved in a study with a group that was contesting a consultant's report (one of the biggest environmental consulting companies in the country) and it was obvious that the company's P analyses were nonsense. It was very simple to demonstrate this and their whole argument went out the window. As I'm sure you are aware, few consulting companies do their own analyse any more - its now, in a way, centralized in just a few companies or done for fees by govt. or academic labs.

If you have any other questions, I'd be glad to address them.

Sincerely
Peter Dillon

bcc'd to govt. offices, consultants. etc.

38. Exhibit-Q (1 page): Street Surface Pollutants associated with various particle sizes

(USEPA, 1976 [Source: Sartor and Boyd, 1972])

Measured Pollutant	Particle size				
	<43μ		43μ - 246μ		>246μ
	(% by weight)				
TS	5.9		37.5		56.5
BOD_5	24.3		32.5		43.2
COD	22.7		57.4		19.9
VS	25.6		34.0		40.4
Phosphates	56.2		36.0		7.8
Nitrates	31.9		45.1		23.0
Kjeldahl Nitrogen	18.7		39.8		41.5
All heavy metals		51.2		48.7	
All pesticides		73		27	
PCB		34		66	

39. Exhibit-R (4 pages): Toxicants found in Priority Pollutant Scans

(Storm*ceptor* [Source: Schueler and Shepp, 1993])

Key:

* = Found in water column also sampling

(G) = Observed predominantly in gas station

** = Observed only in water column samples station sampling

(NG) = Observed predominantly in non-gas

(S) = Suspected (a result of gas chromatography testing)

(AS) = Observed in both sampling

Potential Toxicant	**Typical Use**	**Probable Pathway to Oil-Grit Separator (OGS)**
	-------------------- Sediment Samples --------------------	
Semi-volatile Organics		
Naphthalene*	Component of gasoline, fossil fuel.	Incomplete combustion of fossil fuels. Atmospheric deposition of the vapours, Gasoline spillage, crankcase motor oil drippings. (G)
2-Methylnaphthalene*	“ “	“ “
Acenapthene	“ “	“ “
Fluorene	“ “	“ “
Phenanthrene	“ “	“ “
Pyrene	“ “	“ “
Chrysene*	“ “	“ “
Benzo (b) fluoranthene	“ “	“ “
Indeno (123-cd) pyrene	“ “	“ “
Benzo (g,h,i) perylene	“ “	“ “
Di-nbutyl phthalate	Plasticizer- component of plastics, polymeric substances.	Leaches from plastic products such as garden hoses, floor tiles, plastic containers and food packaging. (NG) May leach into motor oils and other automotive fluids from their plastic containers. (G) Motor oil is a suspected source of compound of OGS. (AS)
Butylbenzyl phthalate	“ “	“ “

Bis (2-Ethylhexyl) phthalate*	“ “	“ “
Di-n-cotyle-phthalate	“ “	“ “
Volatile Organics		
Toluene*	Used as solvent and in chemical synthesis.	Improper disposal of industrial waste. Atmospheric deposition of vapours resulting from incomplete combustion of fuels. (AS)
Ethylbenzene*	Intermediate in chemical synthesis, solvent component of antifreeze.	Antifreeze spillings. (AS)
Total Xylenes*	“ “	“ “
Methylene Chloride	Used as refrigerant. Component of PVC.	Improper disposal of industrial waste. Refrigerant leakage. (S) Car air conditioners, coolants. (S)
Pesticides/PCBs		
Aldrin	Pesticide	Used in farming, gardening and landscaping.
4,4-DDT	Pesticide	“ “
Metals		
Antimony	Component of lead alloys, rubber, matches, ceramics, enamel, paints, lacquers and textiles.	Leaches from painted and rubber waste articles. Household and industrial waste erosion from rocks and soils. (G)
Arsenic*	Component of fossil fuel, insecticide, food preservatives. Used in treatment of leukemia and as a tonic.	Product of incomplete combustion of fossil fuels and incomplete atmospheric deposition of vapours. (AS)
Beryllium*	Used to manufacture non-sparking alloys for tools, nuclear reactors and lightweight alloys.	Erosion from rocks and soils. (AS)
Cadmium*	Used in manufacture of batteries, paints and plastics. Used to plate iron products such as nuts and bolts for corrosion prevention.	Waste from plating processes. Motor vehicle exhaust. Leached from galvanized copper and plastic pipes. (G)
Chromium*	Used to make alloys, catalysts and refractories. Used in plating processes. Used in paints, leather tanning, plastics.	Improper disposal of industrial waste. Corrosion of alloys and plated surfaces. (AS) Spillage of brake fluid.
Copper*	Used as alloy component. Sulphate salt used as algicide in water supply	Corrosion of copper pipes and fittings. Improper disposal of waste from industry.

	reservoirs. Component of fungicide. Used in electroplating industry. Found in coolant, brake fluid, motor oil, gasoline.	Algicide. (AS) Spillage of listed automobile products.
Lead*	Used as an additive to gasoline, motor oil, brake fluid and coolant. Component of pipes, paints and dyes. Used in manufacture of batteries, insecticide.	Atmospheric deposition of motor vehicle exhaust. Gasoline, motor oil, brake fluid and coolant leakage. Leaching from paints, stains, plastics. Improper disposal of batteries and insecticides.
Nickel	Used in electroplating, food processing (gelatin, baking powder). Present in gasoline, transmission fluid, motor oil, brake fluid, coolants.	Wastewater from electroplating operations. Product of incomplete combustion of fossil fuels and atmospheric deposition. Gasoline leakage, coolant, motor oil and brake fluid spillage. (AS)
Silver	Used in electroplating industry. Silver halides are used in photography. Component of germicide, antiseptic and astringent. Found in diesel fuel.	Improper disposal of industrial waste. (AS)
Zinc*	Used in electroplating industry. Component of bronze, rubber, enamel, glass and paper. Component of automobile tires, road salt and paint.	Wastewater from electroplating operations. Weathering and abrasion of galvanized iron and steel. Leaching from road salt, automobile tires. (AS)
Cyanide/Phenols		
Phenol*	Product of plating operations. Anticaking ingredient in road salts. Intermediate in production resins.	Waste from coal coking and refinery operations. Leaching from road salt. (AS)
-------------------- Water Column Samples --------------------**		
Semi-volatile Organics		
Benzyl alcohol	Component of gasoline, fossil fuel.	Incomplete combustion of fossil fuel and atmospheric deposition of vapours. (G)
2-Methylphenol	“ “	“ “
3-4-Methylphenol	“ “	“ “
2,4-Demithylphenol	“ “	“ “
Volatile Organics		

Acetone	Used as gasoline additive. Solvent for paints, resins, lacquers and plastics.	Leaching of paints and plastics. Automobile product, motor oil leakage.
2-Butanone	“ “	“ “
Benzene	“ “	“ “

Key:

* = Found in water column also

(G) = Observed predominantly in gas station sampling

** = Observed only in water column samples

(NG) = Observed predominantly in non-gas station sampling

(S) = Suspected (a result of gas chromatography testing)

(AS) = Observed in both sampling

40. Exhibit-S (1 page): Removal of Gross Pollutants From Stormwater Runoff Using Liquid/Solid Separation Structures for four in-situ technologies

Comparison of Estimated Removal Efficiencies (*cf.* Herr and Harper)

Structure	Removal Efficiencies %		
	Litter	Debris	Sediments
Vortechs System	?(10-50)	?(10-50)	60-80
Storm*ceptor*	?(10-50)	?(10-50)	60-80
CDS	98	98	?(10-50)
Baffle Box	?(10-50)	?(10-50)	60-80

Estimated Net Mass Reduction in Stormwater Constituents Achieved Based on 70% TSS Removal (*cf.* Herr and Harper)

Parameter	Estimated Annual Mass Load Reduction (%)
Total N	30
Total P	25
TSS	70
BOD	20
Cadmium	15
Chromium	18
Copper	15
Lead	38
Nickel	15
Zinc	33

41. Exhibit-T (1 page): Integrating Constructed Wetlands With Stormwater Management (*cf.* Wong *et al.*, 1999)

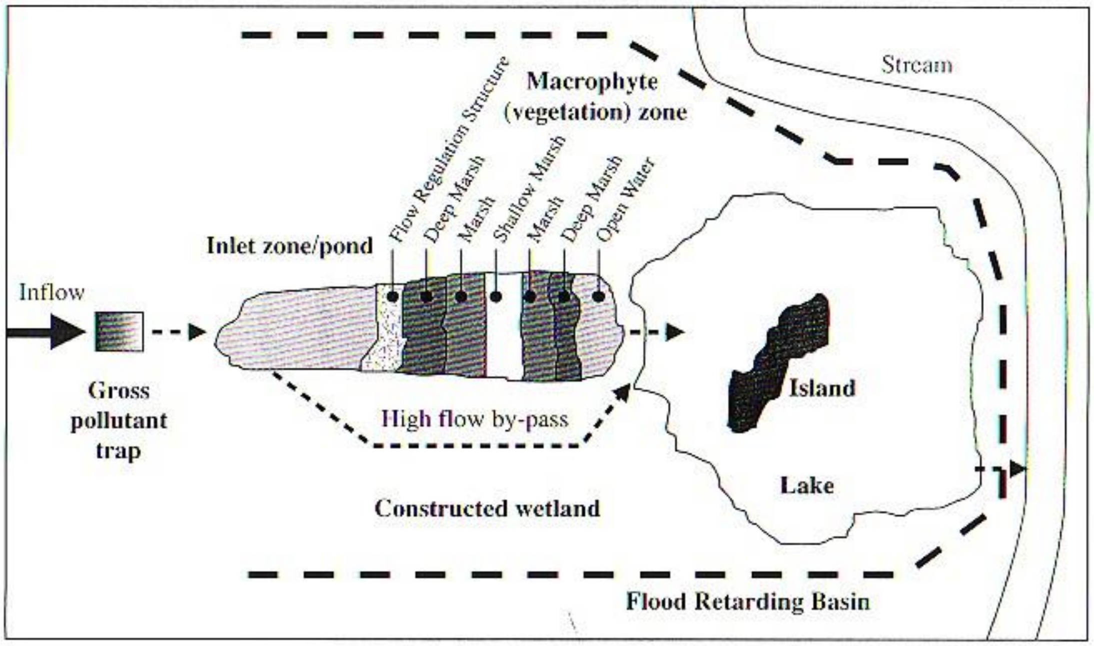


Figure 1: Modular elements in an integrated stormwater management system

42. Exhibit-U (2 pages): Location of wetlands researched, and comparison of reported removal rates for constructed and natural stormwater wetlands (*cf.*, Strecker *et al.*, 1992)

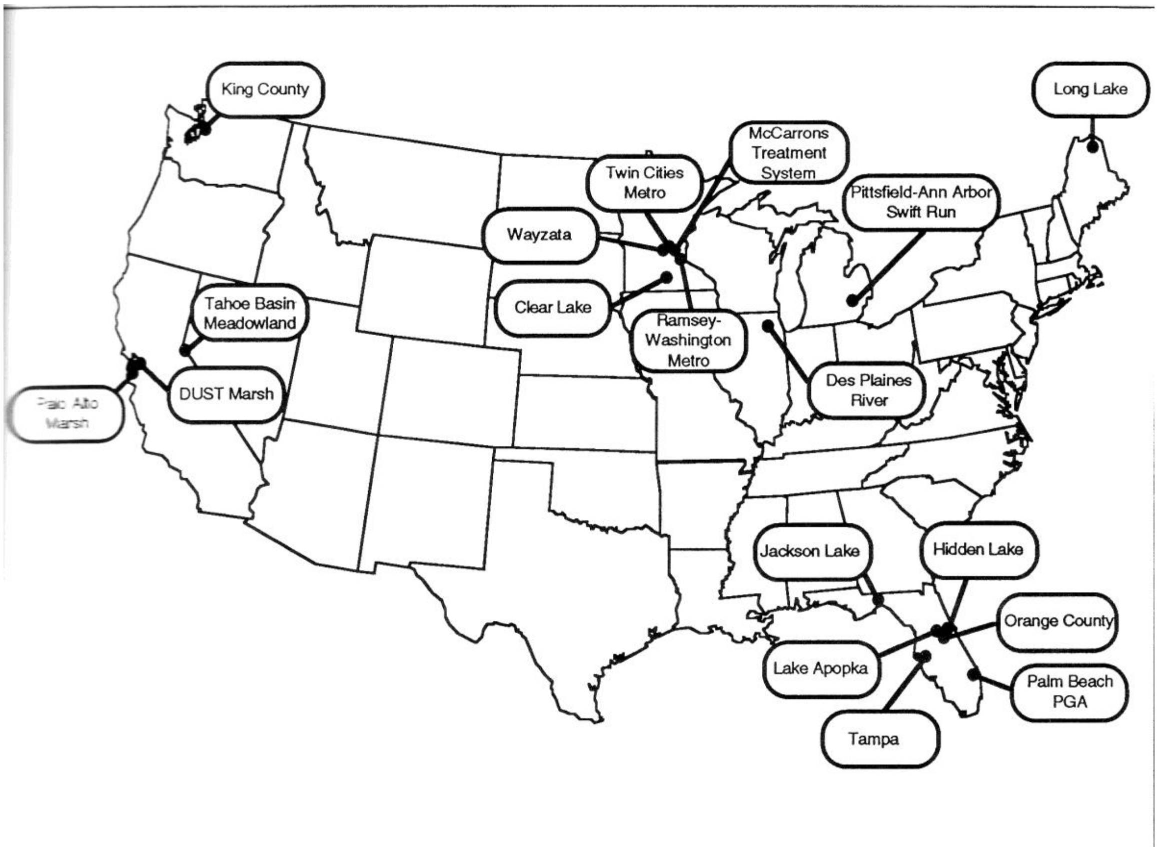


Figure 1. LOCATION OF WETLANDS RESEARCHED FOR THEIR ABILITY TO TREAT STORMWATER RUNOFF

Constructed Wetlands

Wetland Sites	WWAR	DAR	TSS	NH3	TP	Pb	ZN
Lake Ridge	0.18%	565	85	-	37	52	-
Carver Ravine	0.22%	459	20	-	1	6	-
DUST Marsh	1.10%	91	76	16	58	88	42
Jackson Lake	1.30%	77	96	37	90	-	-
Orange County	2.40%	42	89	61	43	83	70
Clear Lake	4.90%	20	76	55	54	-	-
Tampa Office	5.60%	18	64	-	55	-	34
McCarrons	6.00%	17	94	-	78	90	-
Long Lake	8.30%	12	95	-	92	-	-
Palm Beach	12.60%	8	50	17	62	-	-
Lake Apoka	-	-	-	52	7.3	-	-
EWA3	-	-	72	-	59	-	-
EWA4	-	-	76	-	55	-	-
EWA5	-	-	89	-	69	-	-
EWA6	-	-	98	-	97	-	-
Median	3.65%	31	80.5	44.5	58.0	83.0	42.0
CV	94.6%	156.2%	27.7%	49.4%	48.5%	56.1%	38.8%
Average	4.26%	131	77.1	39.7	57.2	63.8	48.7
N	10	10	14	6	15	5	3

Natural Wetlands

Wetland Site	WWAR	DAR	TSS	NH3	TP	Pb	ZN
B3I	1.10%	91	14	-	-2	-	-
PC12	1.70%	59	56	-	-2	-	-
Swift Run	2.10%	48	76	-	49	83	-
Fish Lake	2.30%	43	95	0	37	-	-
Lake Riley	3.10%	32	-20	25	-43	-	-
Palo Alto	3.50%	29	87	-	-6	-	-
Hidden Lake	4.50%	22	83	62	7	55	41
Lake Elmo	10.90%	9	88	50	27	-	-
Wayzata	11.70%	9	94	-44	78	94	82
Angora Creek	-	-	54	20	5	5	-
Tallac Creek	-	-	36	33	-120	-	-
Median	3.10%	32	76.0	25.0	5.0	69.0	61.5
CV	87.2%	68.6%	61.7%	167.8%	1900.6%	67.0%	47.1%
Average	4.54%	38	60.3	20.9	2.7	59.3	61.5
N	9	9	11	7	11	4	2

All Wetlands	WWAR	DAR	TSS	NH3	TP	Pb	ZN
Median	3.10%	32	76.0	33.0	46.0	83.0	42.0
CV	88.5%	176.4%	42.9%	99.7%	139.2%	56.9%	38.9%
Average	4.39%	87	69.7	29.5	34.1	61.8	53.8
N	19	19	25	13	26	9	5

Table Notes

WWAR= Ratio of wetland system to watershed area (expressed as a percent)
DAR= Drainage Area Ratio (ratio of Watershed to Wetland Areas)
CV= Coeffiecient of Variation

TSS = Total Suspended Solids
NH3 = Ammonia
TP = Total Phosphorus
TPb = Total Lead

43. Exhibit-V (1 page): Excerpts from the T.E.A.M's websites on paleolimnology

"The two major water-quality issues facing the Maritime region of Canada are acidification and eutrophication. Due to the lack of long-term data sets, it is impossible to measure directly the extent of degradation (or possible recovery) in water quality. Fortunately, new approaches are available to reconstruct these missing data. This 5-year, multi-disciplinary, program combines novel paleolimnological (using information archived in lake sediments to reconstruct environmental conditions) and biogeochemical modeling approaches to address key issues related to water-quality changes in Nova Scotia and Southern New Brunswick. Long-term goals are to develop pattern- and process-based models on regional scales to help address the diversity of water-quality issues facing eastern Canada. These techniques will be widely applicable to other regions.

To achieve these objectives, a series of strategic projects will be undertaken to address key processes related to acidification and eutrophication, and their interactions with other environmental stressors (e.g. climate change). Consequently, short-term goals are to apply new approaches to provide detailed information on the trajectories of changes in water quality that have occurred in specific lakes of interest to our users. This will allow us to determine if individual lakes are deteriorating or improving in water quality, and to determine what levels of stressors or pollutants result in detrimental water-quality changes (e.g. what are the critical loads for each lake? At what level of sulphate deposition do we see the first signs of acidification or at what level of watershed development does eutrophication become a problem? Are hypolimnetic oxygen levels in NS brook trout lakes decreasing? If so, what are the causes?). Moreover, by reconstructing pre-impact, background conditions, we will establish realistic mitigation targets (i.e., are these lakes naturally acidic or naturally eutrophic or do they naturally suffer from deepwater oxygen depletions?). These data will also provide insights into biogeochemical processes and models so that more realistic assessments of environmental change will be possible."