Hutchinson
Environmental Sciences Ltd.

Interpret It !
What do your water quality data mean ?

Muskoka Stewardship Conference
April 27, 2013

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Environmental Sciences Ltd.

And what can you do about it??

Topics

- Why were you sampling again?
- Are the data good?
- Can you relate the data to your purpose?

Topics

- What makes “good” data ?
- How do I know if water quality is good or bad?
  - What is natural and what is not ?
  - What might be causing changes ?
- Is it getting worse? What makes a trend?

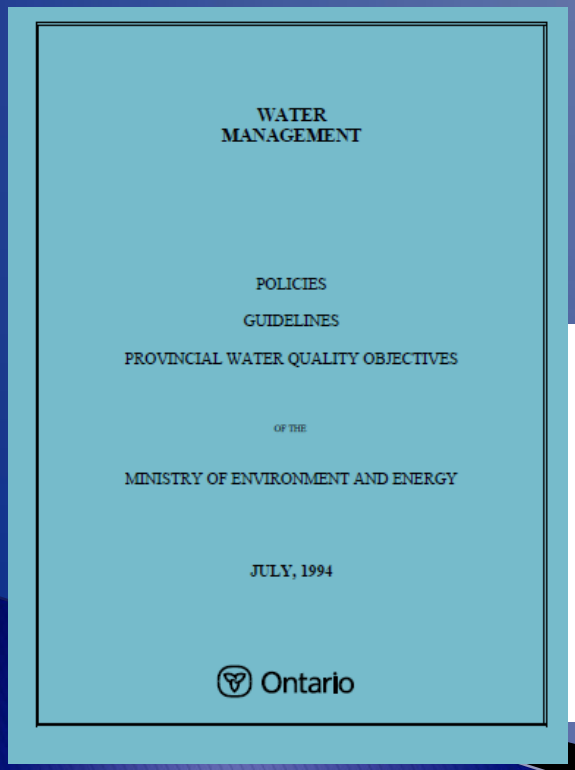
What kinds of water quality are we concerned about ?

- Is it toxic?
  - Metals, organic pollutants
    - Expensive, few sources to worry about in Muskoka
    - Not much you can do about it
      - Except political pressure
- Is it bacterial?
  - Inexpensive, can “do it yourself”
  - May be able to do something about it
  - But be careful !
    - Bacteria are everywhere, lots of natural sources
- Is it aesthetic?
  - “Recreational “ water quality (DMM, LPP, LOBA, MLA…)
  - Phosphorus and water clarity and algae
  - Easy to relate to, easy to measure
  - Harder to interpret
    - Seasonal, development, interannual variance, climate change

What is acceptable water quality?
Water Quality Objectives–Government derived guidance
Not enforceable
Useful guidance

PWQOs are numerical and narrative ambient surface water quality criteria.

Management (1994), PWQOs are set at a level of water quality which is protective of all forms of aquatic life and all aspects of the aquatic life cycle during indefinite exposure to the water. The PWQOs for protection of recreational water uses are based on public health and aesthetic considerations.


WATER
MANAGEMENT

POLICIES

GUIDELINES

PROVINCIAL WATER QUALITY OBJECTIVES

OF THE

MINISTRY OF ENVIRONMENT AND ENERGY

JULY, 1994

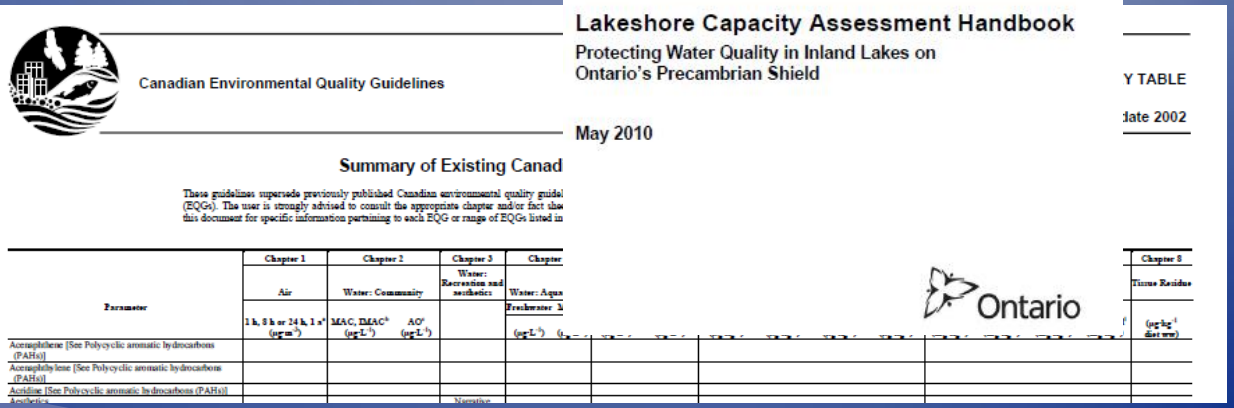
Ontario

Lakeshore Capacity Assessment Handbook

Protecting Water Quality in Inland Lakes on
Ontario's Precambrian Shield

May 2010

Ontario


Canadian Environmental Quality Guidelines

Summary of Existing Canad

These guidelines supersede previously published Canadian environmental quality guidel
(EQGs). The user is strongly advised to consult the appropriate chapter and/or fact she
this document for specific information pertaining to each EQG or range of EQGs listed in

Y TABLE

late 2002

Parameter	Chapter 1 Air	Chapter 2 Water: Community	Chapter 3 Water: Recreation and aesthetics	Chapter Water: Aqua Freshwater	Chapter 8 Tissue Residue
	1 h, 8 h or 24 h, 1 a	MAC, IMAC, AO			
	($\mu g\,m^{-3}$)	($\mu g\,L^{-1}$) ($\mu g\,L^{-1}$)		($\mu g\,L^{-1}$)	($\mu g\,kg^{-1}$ diet ww)
Acenaphthene [See Polycyclic aromatic hydrocarbons (PAHs)]					
Acenaphthylene [See Polycyclic aromatic hydrocarbons (PAHs)]					
Acridine [See Polycyclic aromatic hydrocarbons (PAHs)]					
Aesthetics			Narrative		

Guidance for Interpretation

- Two types of Objectives
  - Toxic contaminants
  - Non toxic / aesthetic contaminants

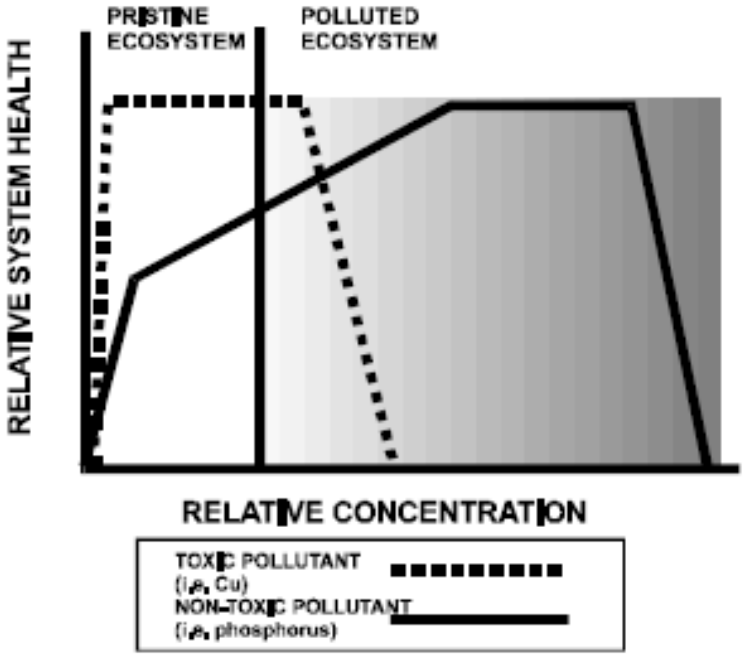


Figure 1. Generalized responses of an ecosystem to toxic and non-toxic pollutants

Objective Development – Toxic Substances

CCME

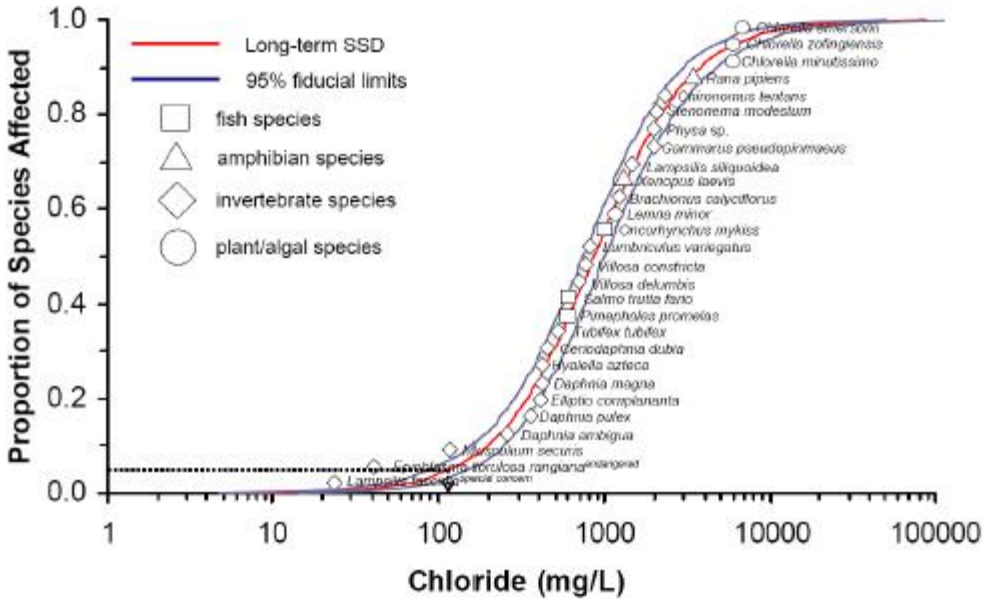
Canadian Council of Ministers of the Environment | Le Conseil canadien des ministres de l'environnement

Scientific Criteria Document for the Development of the Canadian Water Quality Guidelines for the Protection of Aquatic Life

CHLORIDE ION

Canadian Water Quality Guideline for the chloride ion[a] for the protection of aquatic life

	Long-Term Exposure[b] (mg Cl⁻/L)	Short-Term Exposure[c] (mg Cl⁻/L)
Freshwater	120[d]	640
Marine	NRG	NRG



Objective Development – Toxic Substances

Heavy research and statistical component

Interpretation

If < Objective – likely okay

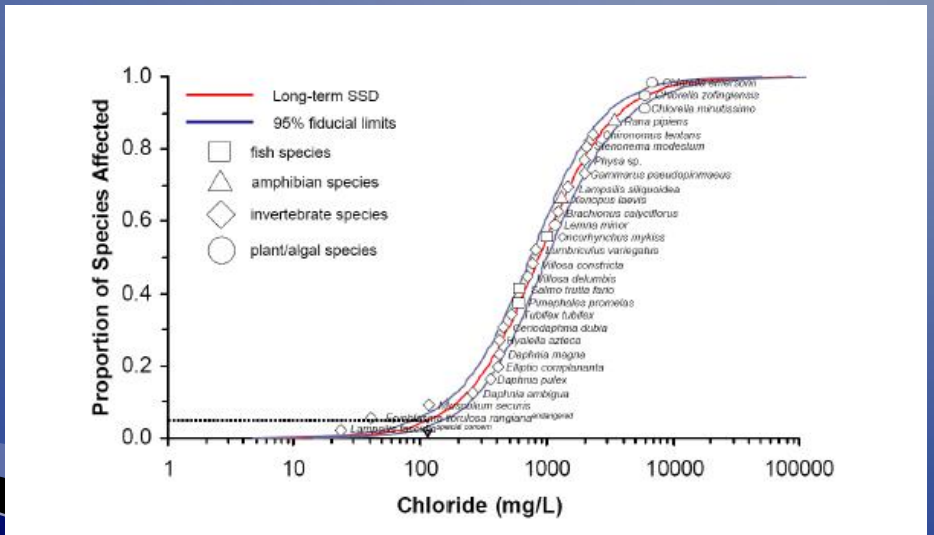
If > Objective – May be in trouble

Need to consider site specific issues

Need to consider exposure time

Need to do more work

But a good place to start –screening tool



Objective Development – Non Toxic Substances
Total Phosphorus

Highly variable concentrations
Vital ecosystem component –can't live without it
Concern is obesity and not toxicity

But first – some history

Objective Development – Non Toxic Substances Total Phosphorus

Phosphorus, total
CAS No. 7723-14-0

Interim PWQO[1]:

Current scientific evidence is insufficient to develop a firm Objective at this time. Accordingly, the following phosphorus concentrations should be considered as general guidelines which should be supplemented by site-specific studies:

To avoid nuisance concentrations of algae in lakes, average total phosphorus concentrations for the ice-free period should not exceed 20 μg/L;

A high level of protection against aesthetic deterioration will be provided by a total phosphorus concentration for the ice-free period of 10 μg/L or less. This should apply to all lakes naturally below this value;

Excessive plant growth in rivers and streams should be eliminated at a total phosphorus concentration below 30 μg/L.

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

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

Objective Development – Non Toxic Substances Total Phosphorus

Canadian Water Quality Guidelines for the Protection of Aquatic Life

PHOSPHORUS: CANADIAN GUIDANCE FRAMEWORK FOR THE MANAGEMENT OF FRESHWATER SYSTEMS

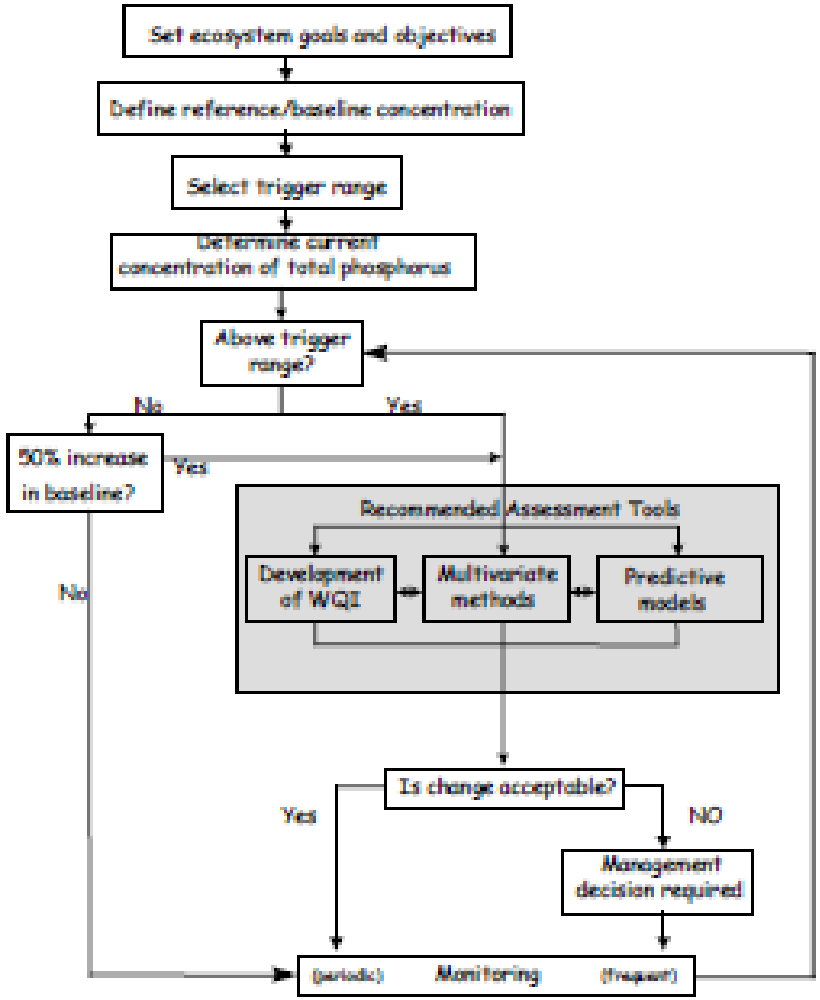
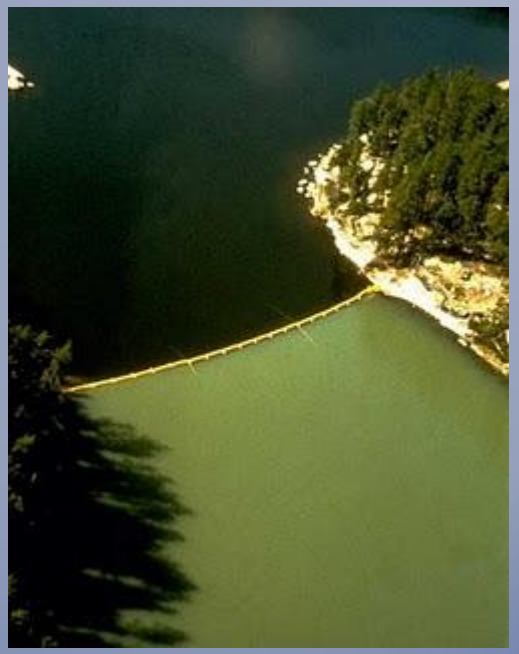
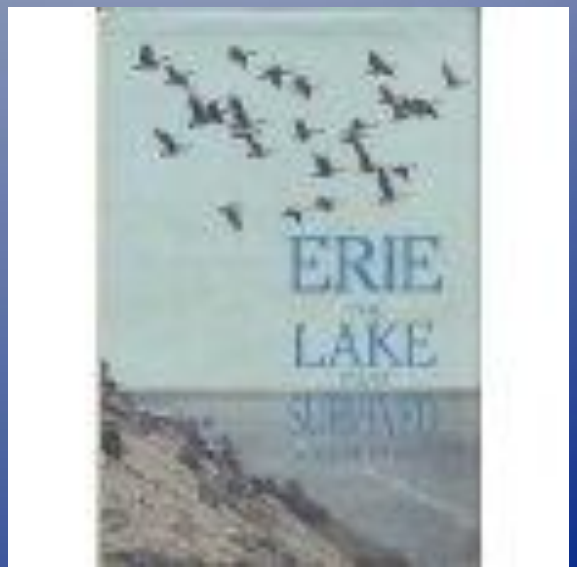


Figure 1. Canadian Guidance Framework for the management of phosphorus in freshwater systems.

The Phosphorus Story

Algal Blooms. Cladophora and anoxia in Lake Erie
Macleans Magazine Pronounces Lake Erie dead
Scientific Investigation Identifies Phosphorus as Limiting Nutrient
Industry spokespeople say it is carbon and nitrogen
Scientific Persistence – The Definitive Experiment by David Schindler
Public Pressure
Political Will
Great Lakes Water Quality Agreement **Phosphorus Limits in Detergent** **Phosphorus Removal at WWTPs**





The Climate Change Story

Greenhouse Effect in my 1974 Ecology Textbook (Odum)

Scientists Raise Concerns in 1990s

Denial and Life as Usual

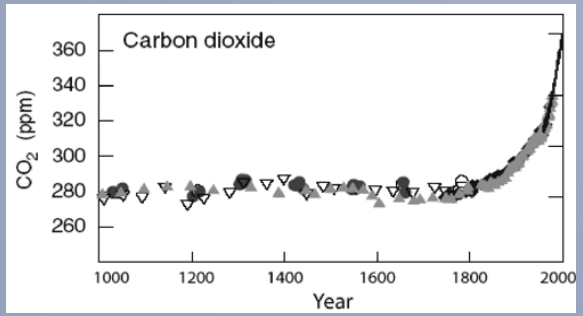
1992 Rio Summit Climate Change Convention
1997 Kyoto Protocol

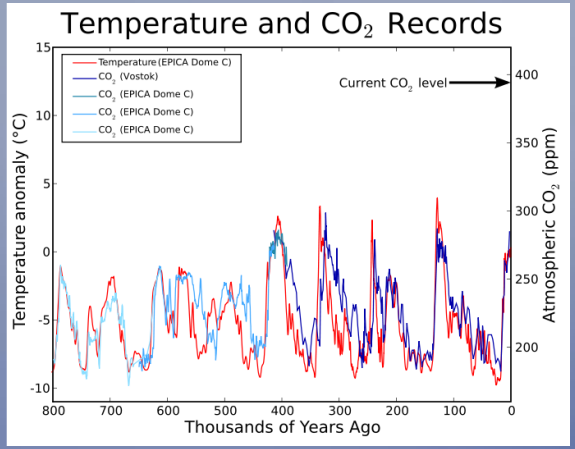
Scientific Persistence
IPCC 2002 and 2007

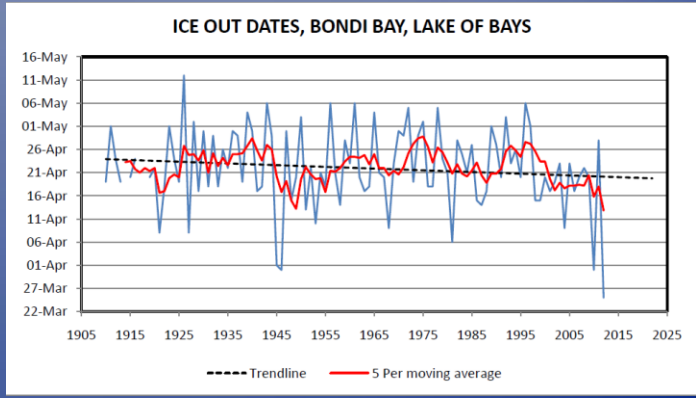
Emergence of "Climate Change Deniers"

No Political Will
Harper Government – Deniers in opposition
Chretien Government – Lip Service in Government

Harper Government
No action in minority or majority government
- lay off scientists
- muzzle government scientists
-threaten environmental groups
- ignore their own targets

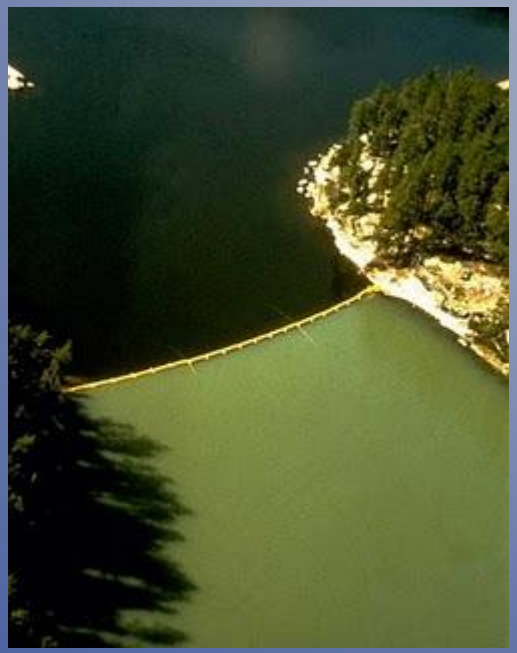






The Lesson

Get good data
Interpret it well
Tell your story



A Few Lessons from Data Interpretation #1 DMM are on top of it !

Review of Long-Term Water Quality Data for Lake System Health Classification

Prepared for
The District Municipality of Muskoka

Submitted by
Gartner Lee Limited

August, 2008

Lesson #1
How good is your lab ?
Detection – Precision – Interpretation

Data Quality Parameter	Dorset Laboratory - 3036	Rexdale Laboratory - 3367
W value – Standard Deviation (SD) between duplicates (rounded down to nearest 1, 2 or 5 μg/L): no measurable response	0.2 μg/L	2.0 μg/L
T value "Trace" set to 5 x W: a measurable but not verifiable amount	1 μg/L	10 μg/L
Actual mean 1994 SD between duplicates (mean of values for 10-20 μg/L range)	0.3 μg/L (2SD = 0.6 μg/L)	3 μg/L (2SD = 6 μg/L)

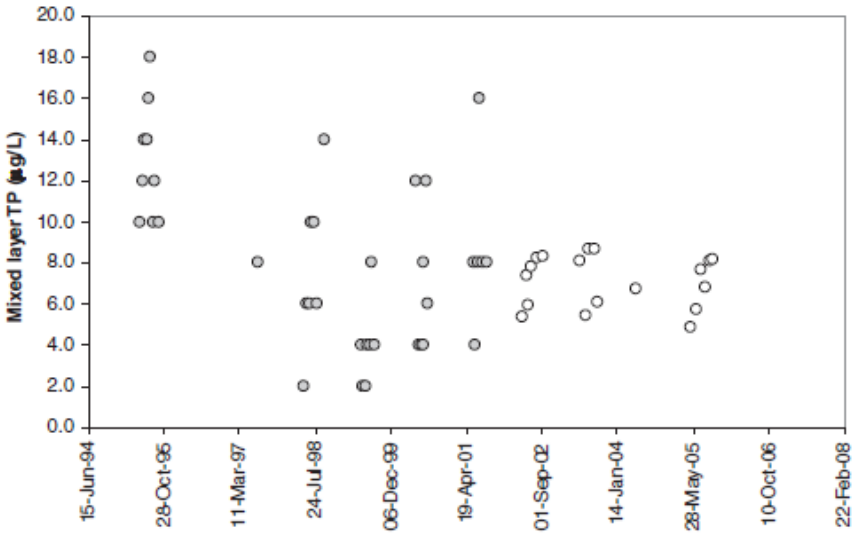


Figure 2.-Variation due to precision in analysis shown for one of the Lake Partner Program sample locations. Data prior to 2002 are approx +/– 6μg/L. Post 2002 data are +/– 0.7μg/L.

Clark BJ, Paterson AM, Jeziorski A, Kelsey S. 2010. Assessing variability in total phosphorus measurements in Ontario lakes. Lake Reserv Manage 26:63–72.

Lesson # 2

Examine your data

Trust your eyes

But there will be statistics !

Identify “outliers”

Lesson # 2
Examine your data

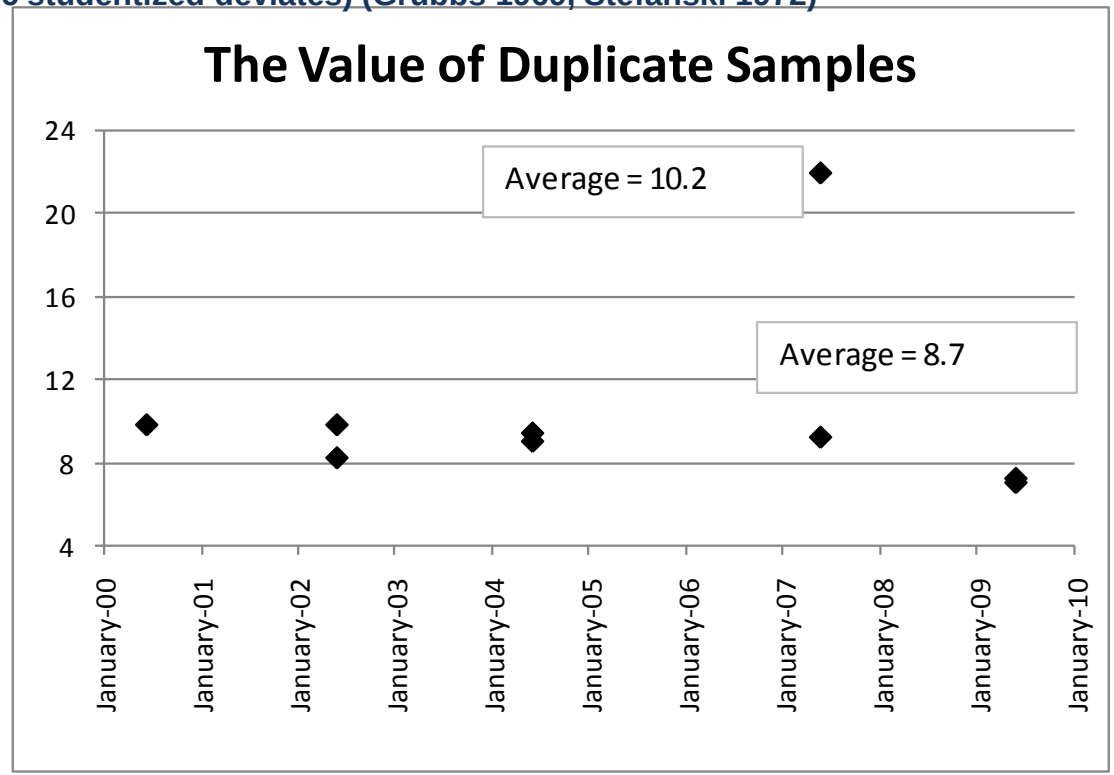
Trust your eyes

"An outlier is defined as an observation that appears to be inconsistent with other observations in the data set."

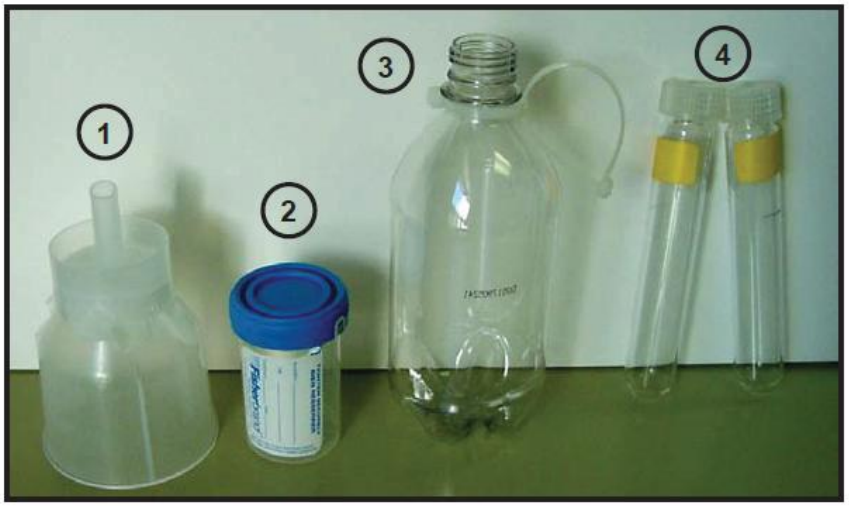
Verify with statistical techniques

"An outlier has a low probability that it originates from the same statistical distribution as the other observations in the data set."

- **Grubb's test for outliers (= extreme studentized deviates) (Grubbs 1969, Stefanski 1972)**



Then Find the Problem- Those dirty little Daphnia! (filter your samples)



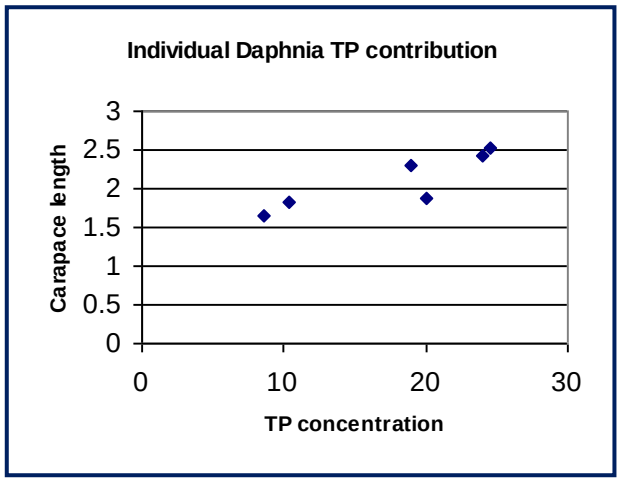


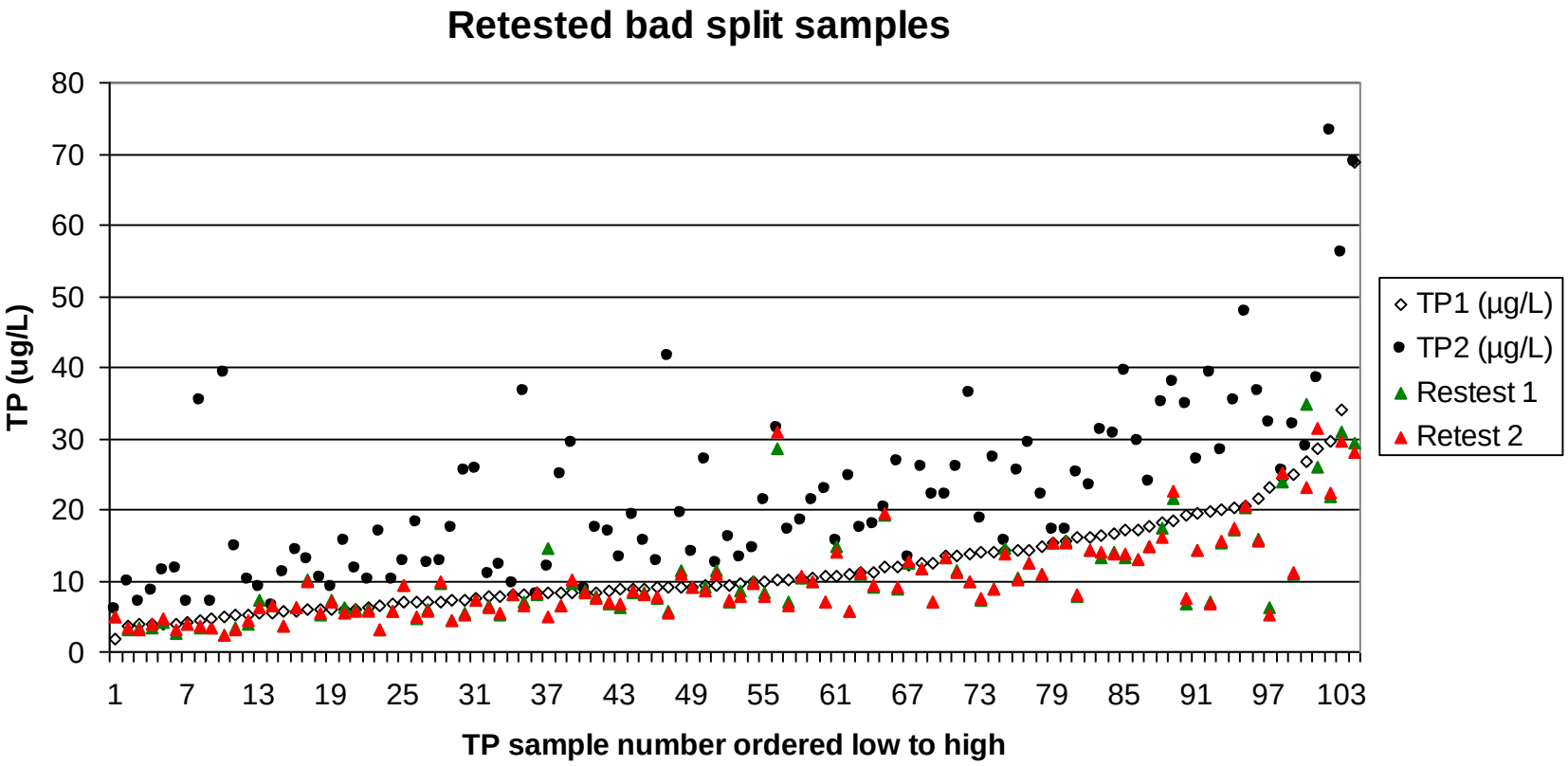
Table 2.-The TP concentrations yielded by digesting 6 individual *Daphnia* in 35 mL distilled water (TP < 1 μg/L) using the DESC total phosphorus analytical methods.

Daphnia #	Carapace Length (mm)	Total Phosphorus (μg/L)
1	1.64	8.6
2	1.82	10.3
3	1.88	20.0
4	2.53	24.6
5	2.31	18.9
6	2.43	24.0

Clark BJ, Paterson AM, Jeziorski A, Kelsey S. 2010. Assessing variability in total phosphorus measurements in Ontario lakes. Lake Reserv Manage 26:63–72.

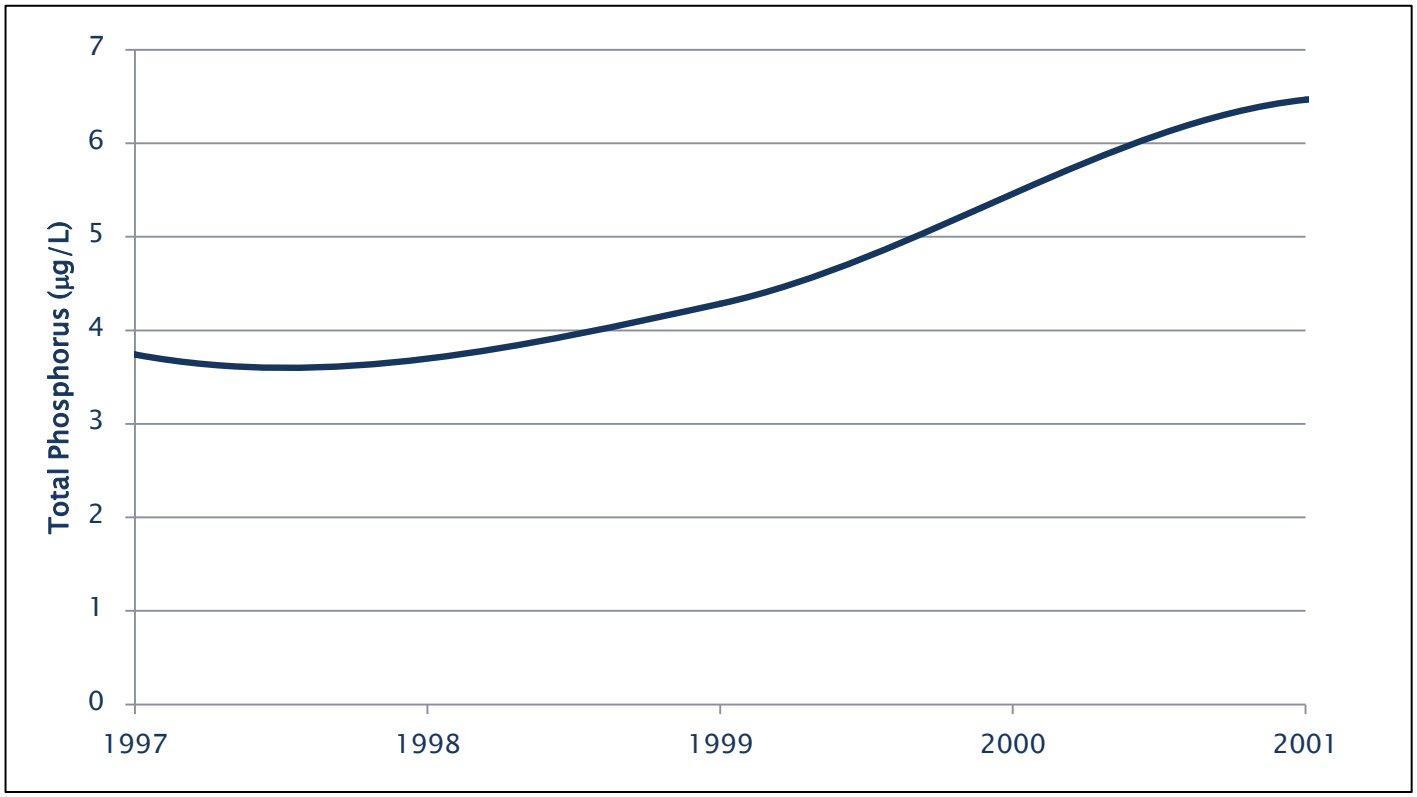
On the bigger scale – trust your low numbers

Larger numbers = contamination

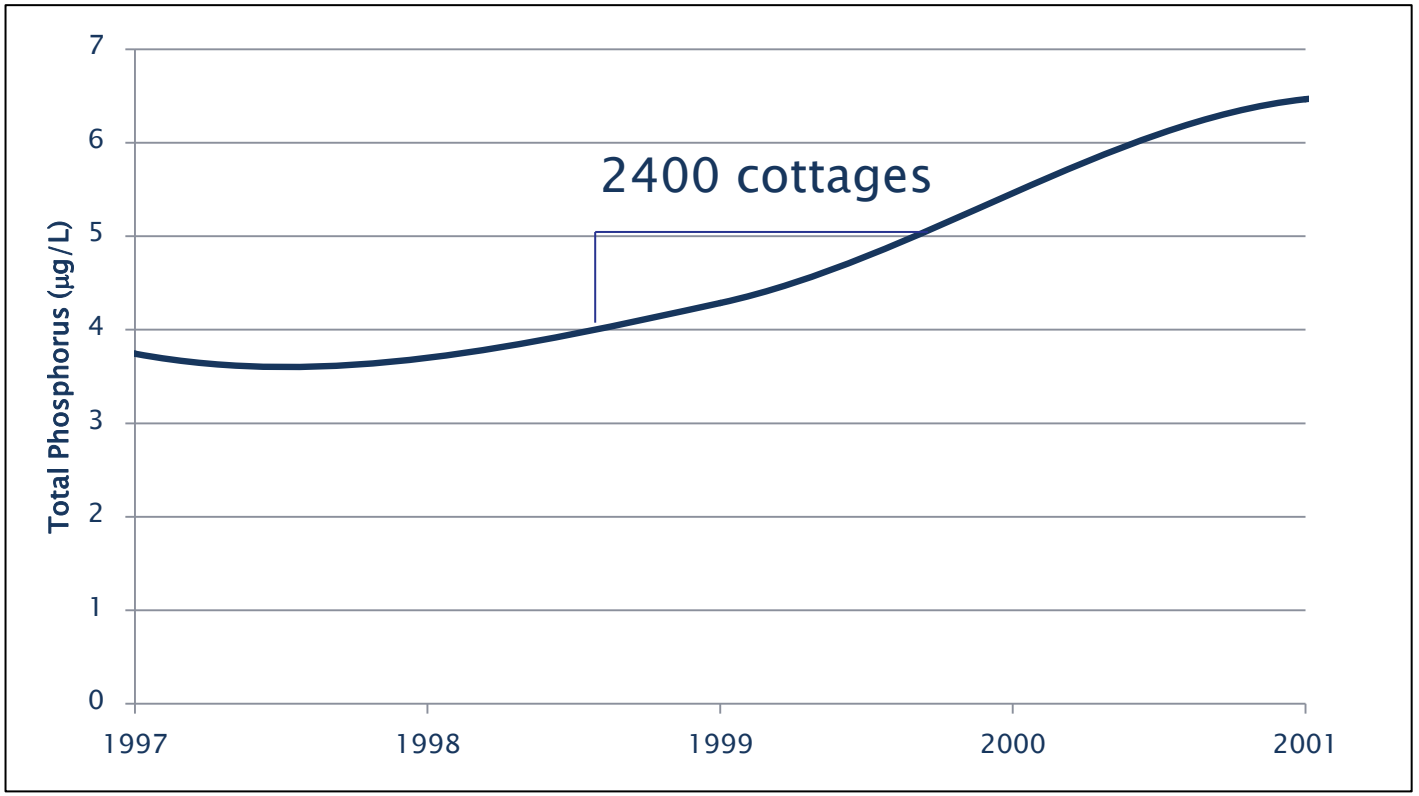


So Okay– the numbers are good
How many do I need ?

What is happening to my lake ?
Phosphorus increased by > 50% over 4 years !!

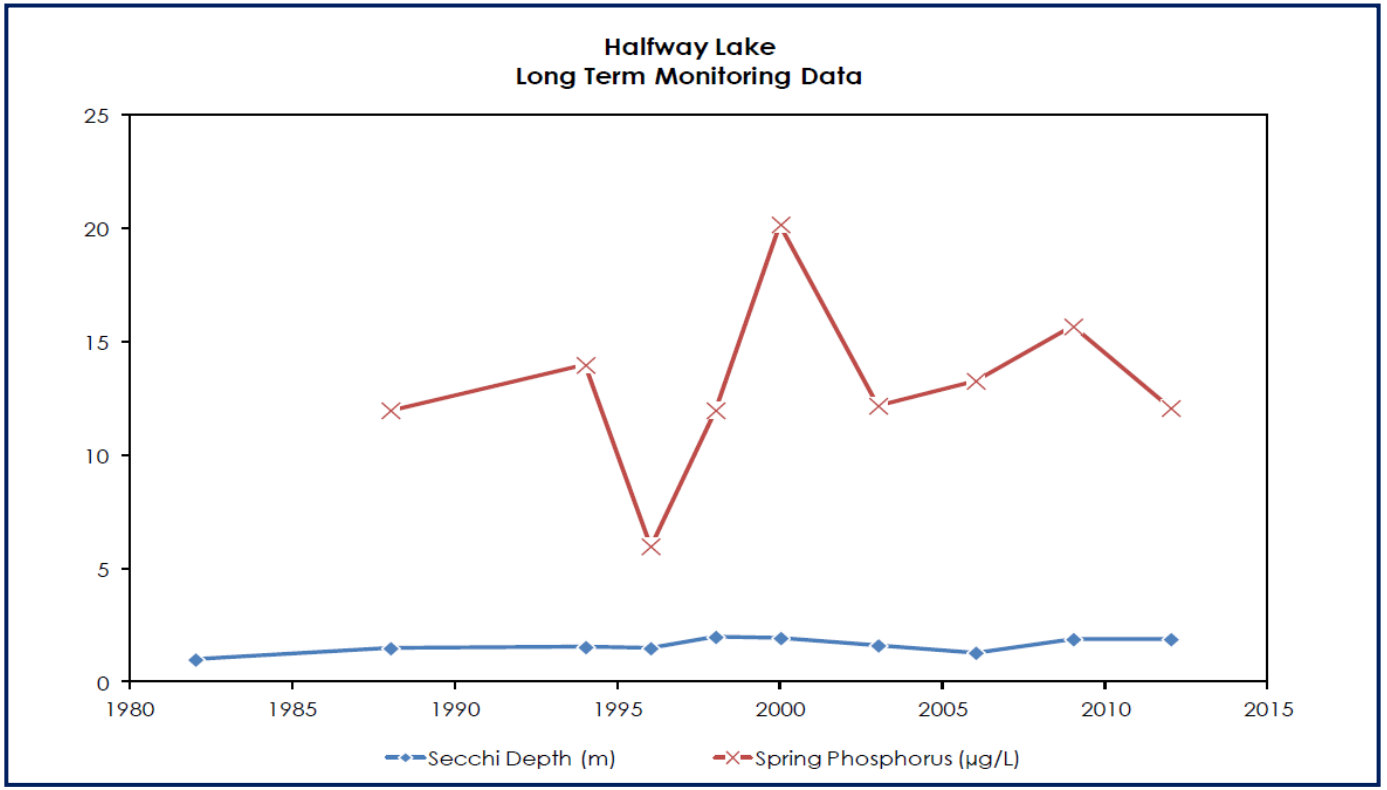


What is happening to my lake ?
Is it too many cottages?



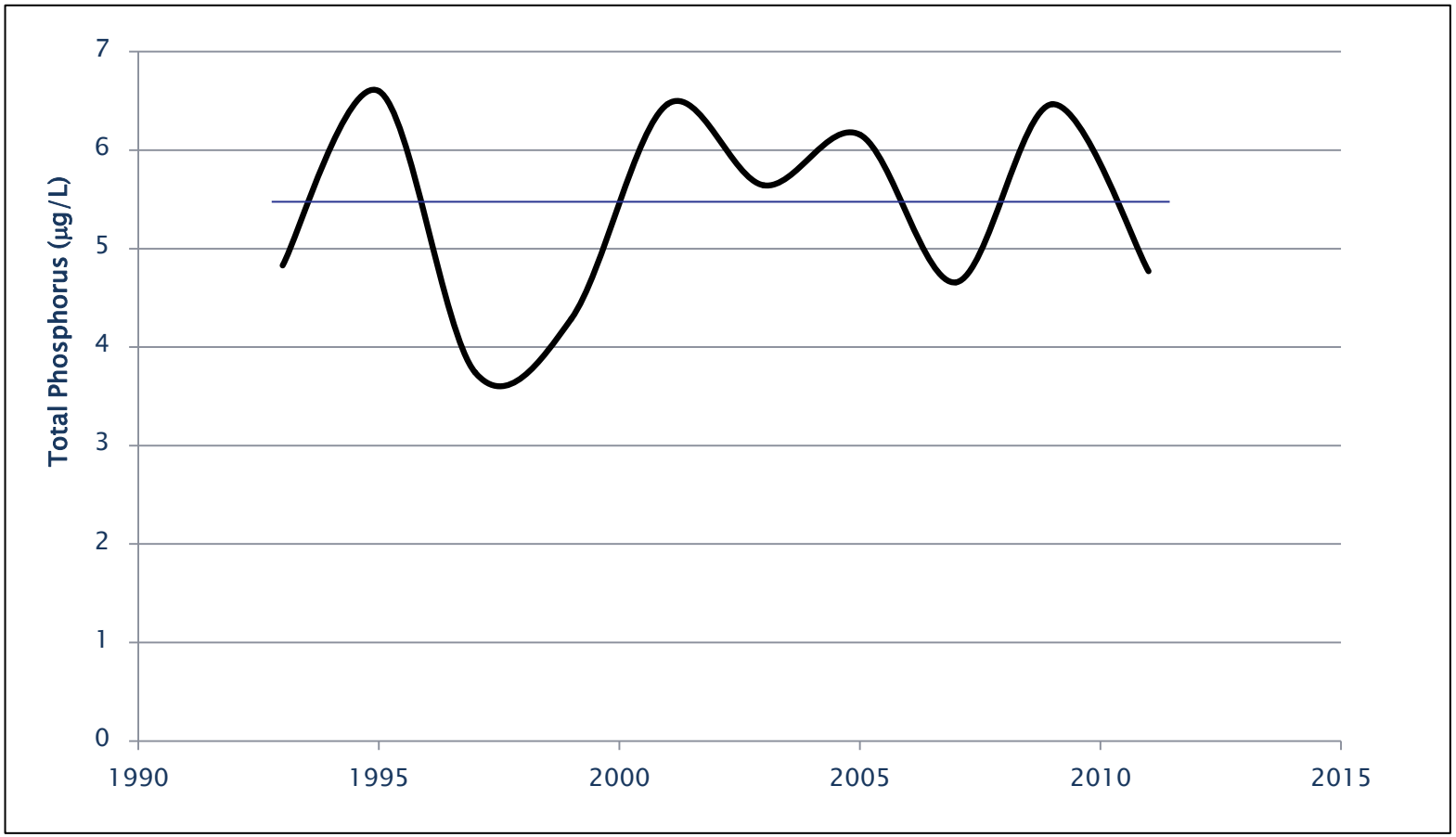
Lake of Bays : 2400 cottages = 1 ug/L
Mary Lake : 1345 cottages = 1 ug/L

What is happening to my lake ?
Is it too many cottages?



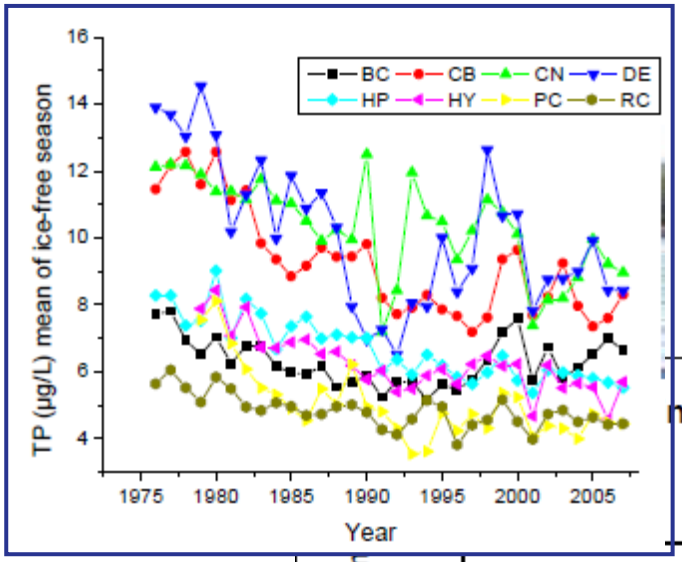
Halfway Lake (14 ha, headwater): 4 cottages = 1 ug/L

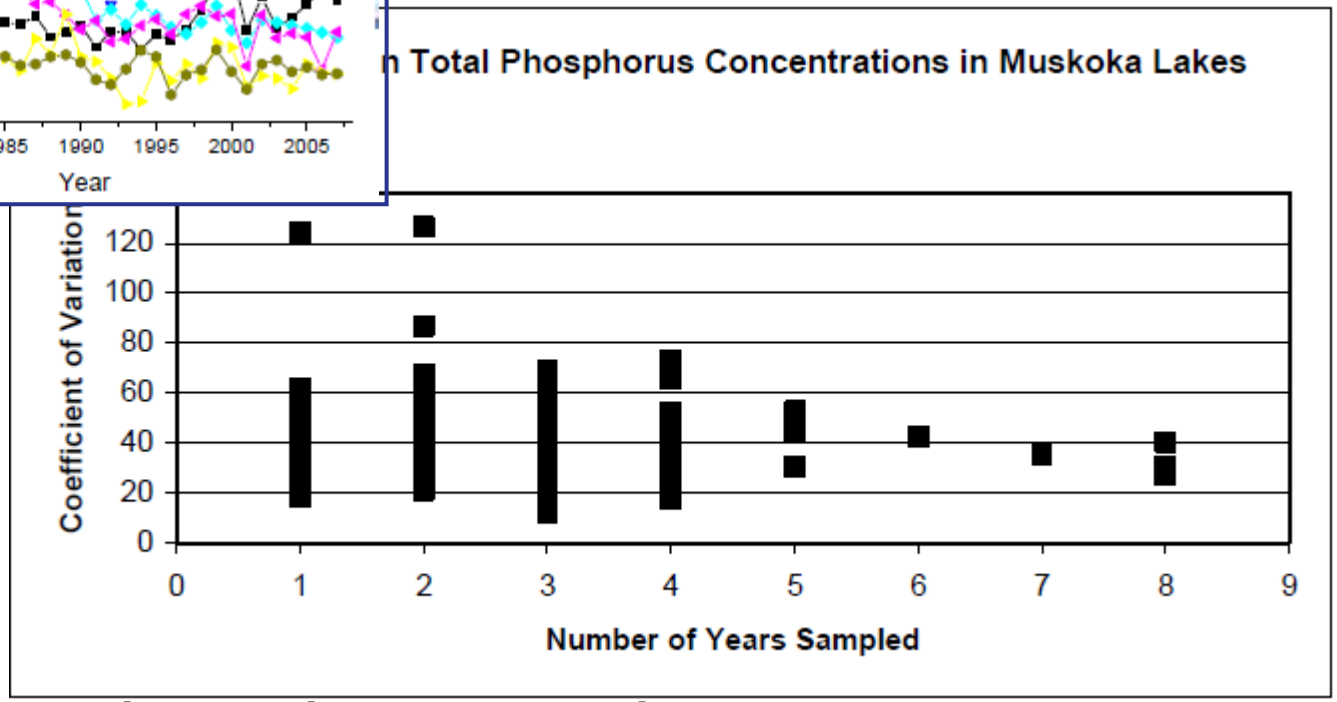
What is happening ?
Lake is going through a cycle – Watch for the big picture
Long term mean = 5.54 ug/L



There is great value in long term data sets
MOE, DMM, MLA, LOBA

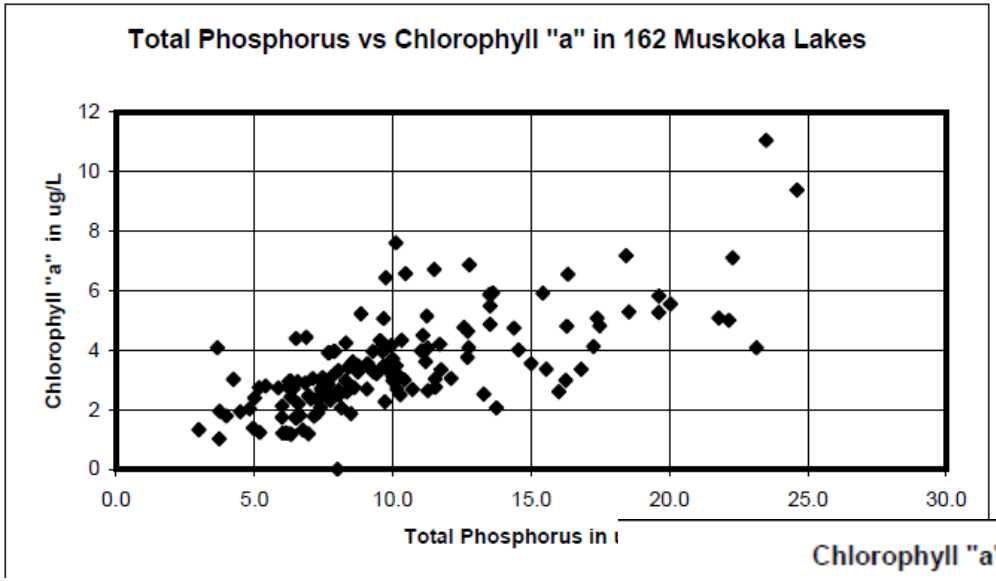
What is happening ?
Lake is going through a cycle – Watch for the big picture

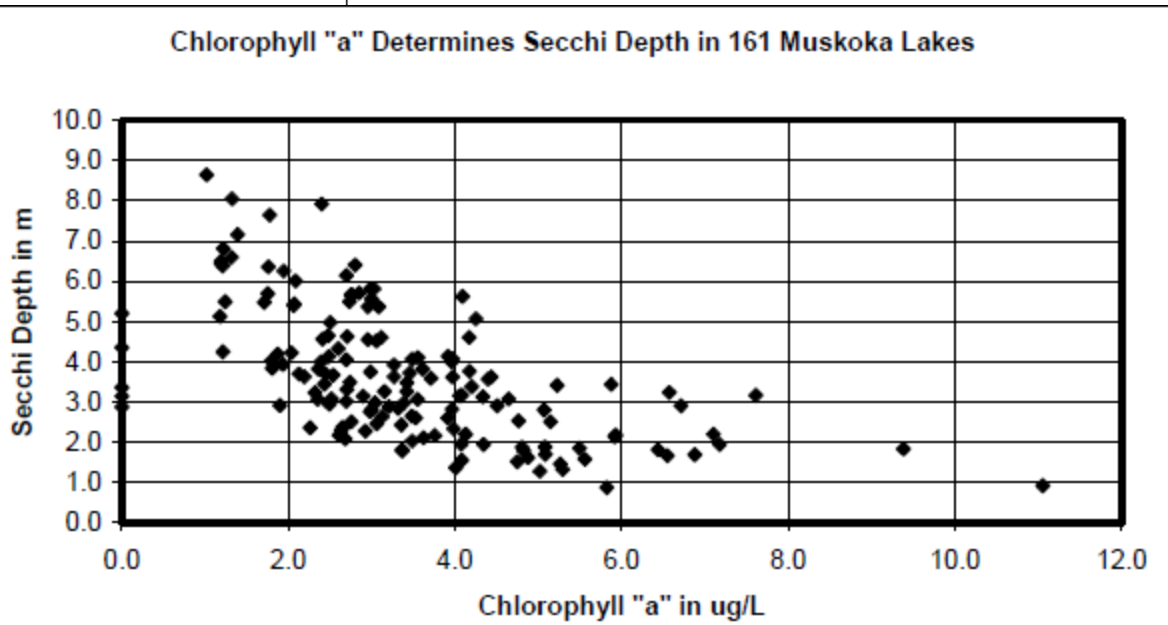




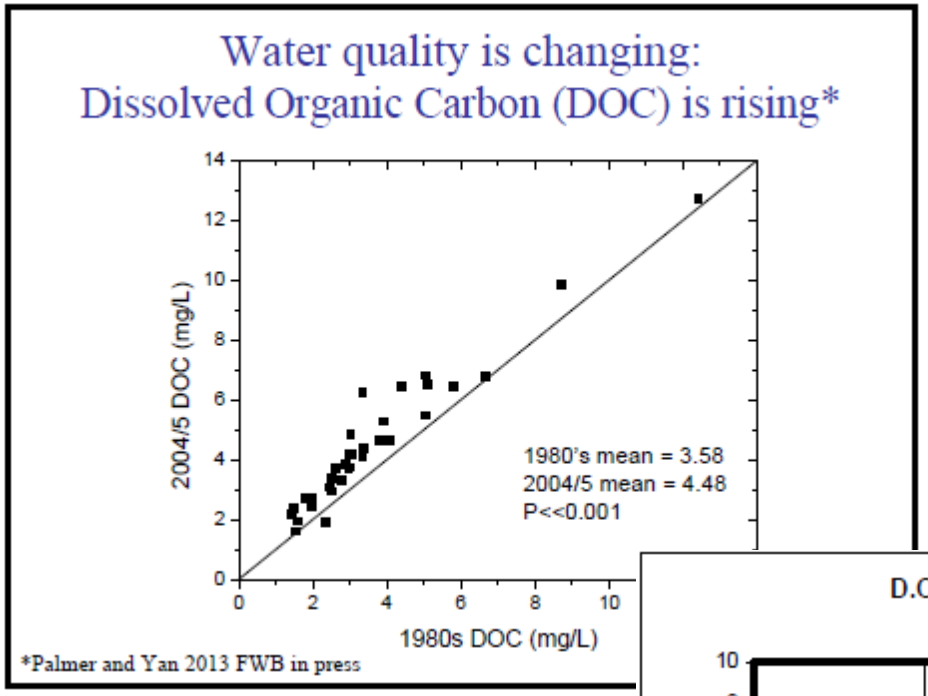
There is great value in long term data sets
MOE, DMM, MLA, LOBA

What else is happening ?
Why we monitor phosphorus and water clarity (recreational/aesthetic pollutants)





But things are changing



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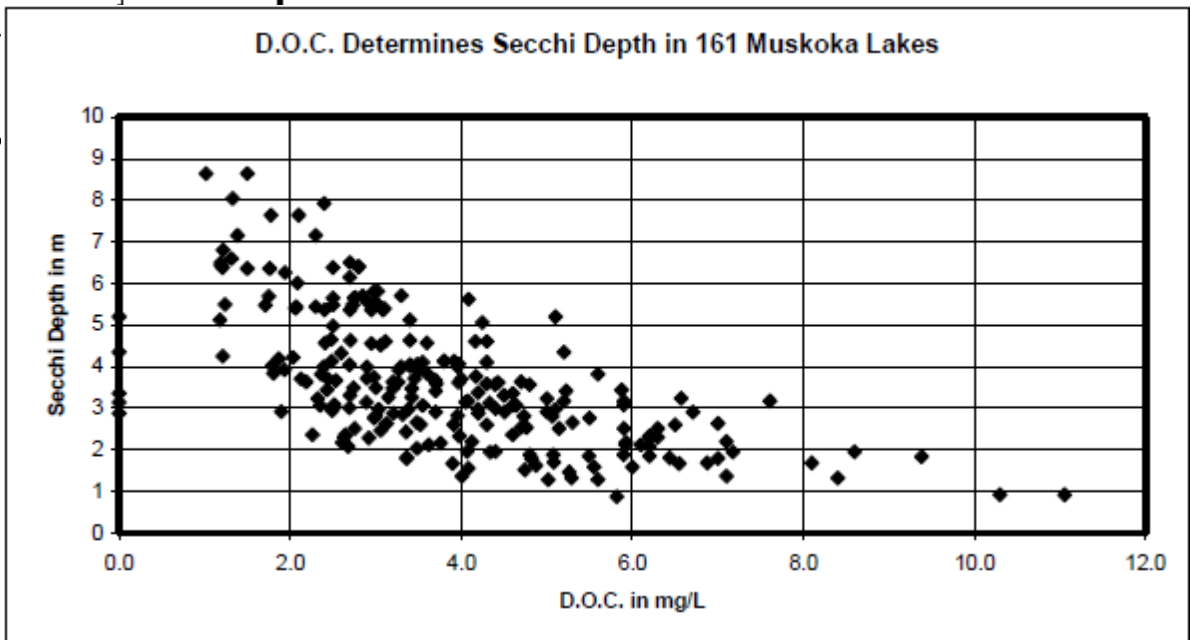

What is happening ?

Do not jump to conclusions
Unfortunately
There is a lot going on in our lakes
- Changing rainfall and runoff patterns
- Changing climate
- Invading species
- Changing development pressures

There is great value in long term data sets
MOE, DMM, MLA, LOBA

There is great value in having good help

What is happening ?

There is great value in having good help
- Dorset Environmental Science Centre
- District of Muskoka
- Universities – Trent, Waterloo, York, Toronto, Guelph, Nipissing ….

And citizen observations
- LOBA, MLA ….

And the Story is changing too