

**STATE OF THE
LAKE
ENVIRONMENT
REPORT
2004**



RIDEAU VALLEY WATERSHED WATCH PROGRAM



THE ONTARIO TRILLIUM FOUNDATION
LA FONDATION TRILLIUM DE L'ONTARIO

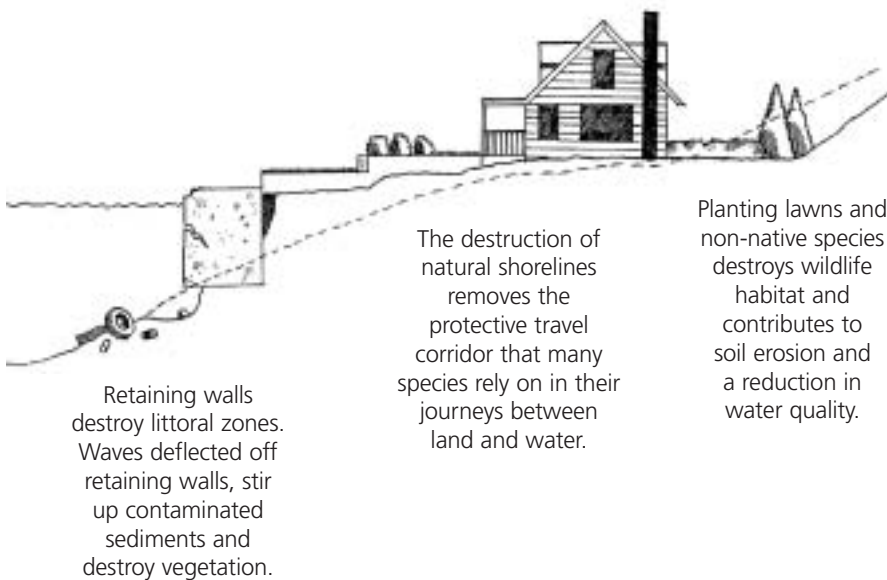
FENDOCK



- ▶ Alliance of Rideau Lakes Associations
 - ▶ Big Rideau Lake Association
 - ▶ Eagle Lake Property Owners Association
 - ▶ Farren Lake Property Owners Association
 - ▶ Rideau Valley Conservation Foundation and its many donors
 - ▶ Township of Bathurst Burgess Sherbrooke
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"The Ribbon of Life" Where the Land Meets the Water

Water quality is affected by many things: natural processes of erosion and runoff accelerated by clearing of shorelines, the use of artificial fertilizers and leachate from sewage disposal systems. All result in too many nutrients reaching the lake.



Retaining walls destroy littoral zones. Waves deflected off retaining walls, stir up contaminated sediments and destroy vegetation.

The destruction of natural shorelines removes the protective travel corridor that many species rely on in their journeys between land and water.

Planting lawns and non-native species destroys wildlife habitat and contributes to soil erosion and a reduction in water quality.

Too many nutrients causes profuse weed and algae growth which affects the aquatic animal species makeup by altering habitat and food sources and by reducing oxygen and light penetration.

The shallow waters and first ten metres of shoreland area form a "Ribbon of Life" around lakes. This ribbon — where the land meets the water — is where much of the lake life is born, raised and fed. Many landowners, unaware of the importance of this area, have cleared the shorelines of native vegetation and replaced it with lawns, non-native ornamental vegetation, retaining walls and boathouses. This has a negative effect on fish and wildlife habitat and water quality. Natural vegetation retained or restored along the shoreline helps prevent erosion and improves water quality by binding nutrients before they can enter the lake.

The Rideau Valley Conservation Authority has long recognized the recreational and aesthetic value of lakes within the watershed and is committed to maintaining and protecting water quality and fish habitat. The Conservation Authority has joined together with volunteer Lake Stewards throughout the watershed to take steps to protect and restore water quality by launching the **Watershed Watch** program. **Watershed Watch** is an environmental monitoring and awareness program. The objectives of the program are to collect reliable environmental data to document current water quality conditions and use the data as an essential educational tool to encourage shoreline residents, both seasonal and permanent, to become personal stewards of their lake and to adopt sound stewardship practices aimed at preserving and protecting water quality. By taking an active role in restoring and enhancing their shoreline, they can help to maintain water quality and a healthy lake environment.

Recreational water quality can be expressed in terms of how clear the water appears. Water clarity is influenced by the amount of soil sediment and phytoplankton, or microscopic algae, present in the water. Clarity is measured by a simple visual test using a **Secchi Disk**, a 20 centimetre black and white disk attached to a measured line that is lowered into the lake until it is no longer visible. Analysis of water samples for **chlorophyll a**, which provides the green pigment in phytoplankton, gives a more specific measure of the abundance of small creatures in the water. Another perspective is gained through analysis of samples for nutrients, particularly **phosphorus** but also **nitrogen**, which tells how much food is available for the algae and aquatic plants. In the late summer when the algae drops to the bottom of the lake, its decomposition uses oxygen so, to find out how much oxygen is available for fish and other aquatic animals, **dissolved oxygen and temperature** profiles are done.

These tests combine to give an indication of the age of a lake and what can be expected. An old or eutrophic lake will have profuse plant growth and relatively few fish species

because of the lack of open water and the competition for oxygen. A middle-aged or **mesotrophic** lake will support the greatest diversity of fish species with a variety of habitats and sufficient oxygen available. Young or **oligotrophic** lakes have very little or no vegetation and are usually well oxygenated but have relatively few fish species.

While lake users are interested in how weedy a lake is and what kind of fishing stories they can experience, they also want to know if the water is safe for drinking and swimming. Eschericia coli (**E.coli.**) are in a family of fecal coliform bacteria common to warm-blooded mammals. A few members of the family are harmful themselves but E.coli. are also a good indicator of the presence of pathogenic or other hazardous bacteria because where there is E.coli., the others will usually be present. Analysis of water samples for E.coli., which is relatively more abundant and easier to count than the other organisms, gives an indication of problems with leaking septic systems or other sources of contamination.

Through **Watershed Watch**, lakes in the watershed will be monitored for these key water quality indicators. Knowing what is in the water will assist the lake stewards when devising a strategy to protect the Ribbon of Life which will reduce the human impact on the aging process and ensure that our lakes will endure for future generations to enjoy.

FIVE EASY STEPS TO IMPROVE WATER QUALITY

1. Build at least 30 metres away from the shoreline.
2. Keep your lot well treed and preserve or replant native vegetation along the shoreline.
3. Pump out your septic tank every three to five years and have the tank and tile field inspected periodically.
4. Reduce water use and use phosphate free soaps and detergents.
5. Keep the size of your lawn to a minimum and do not use fertilizers, herbicides or pesticides.

Low Phosphorus Lifestyle

Human Waste	535 g
No Dishwasher	0 g
No fertilizer	0 g
Uses phosphate-free products	20 g

High Phosphorus Lifestyle

Human Waste	535 g
Dishwasher using powdered detergent once per day	650 g
Lawn fertilized once/year	1,960 g
Uses products with phosphates	180 g

In a Bit More Detail:

The basic characteristics of a lake depend on the physical properties (dimensions and geology) and climate. Six processes or actions further define an individual lake:

- Precipitation directly onto the lake surface deposits phosphorus and other chemicals and runoff from the lake watershed carry bacteria and pathogens, plant debris and soil particles which bear phosphorus and other chemical elements, into the water ;
- Use by aquatic plants of the nutrients (phosphorus, etc.) has two impacts:
 - plant communities develop in the lake, becoming profuse over time, which limits the development and diversity of other plants and aquatic animals, and
 - along with plant debris and sediment from the shoreline, dead phytoplankton and other plants settle to the lake bottom where it decomposes using up oxygen and releasing nutrients;
- Each spring and fall temperature changes in the lake cause a mixing or turnover of the waters which can bring phosphorus from bottom waters to the surface to be available for aquatic plant and microorganism growth;
- A “sink” of phosphorus is created by settling of phosphorus-bearing sediment and the decay process at the bottom of all lakes with the phosphorus either held adsorbed to the lake bed soil particles when dissolved oxygen levels are high or in solution when the dissolved oxygen levels decline.
- After the spring turnover, the lake warms and stratification occurs creating a warmer surface layer (epilimnion), a transition zone (metalimnion) and colder deep waters (hypolimnion). As water warms, the ability to hold dissolved oxygen decreases. While the warm waters of the epilimnion can hold less the air/water contact and wave action ensures that there is a constant supply. As the deep waters of the hypolimnion warm, there is no mechanism to get new oxygen. The demand for oxygen for the decay process can cause the hypolimnion to become anoxic (no dissolved oxygen);
- Lakeshore development affects the shoreline runoff/erosion characteristics which usually leads to increased sediment, bacterial and nutrient loading of lake waters by changes to the vegetation composition, hardening the surface (buildings, roads, retaining walls, etc.) and installation and operation of septic facilities;

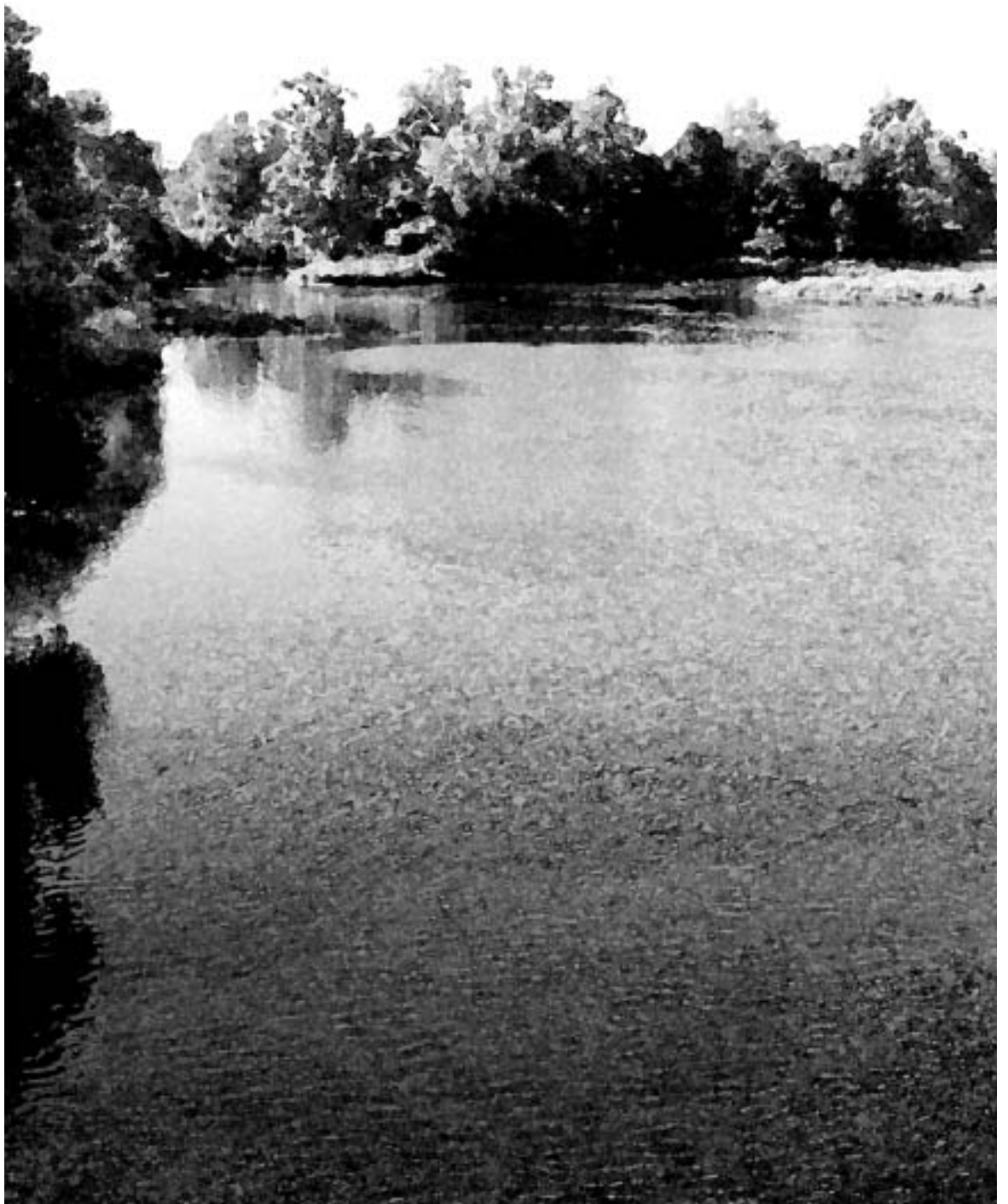
There are several methods of measuring the impacts of these processes or actions. The common ones are:

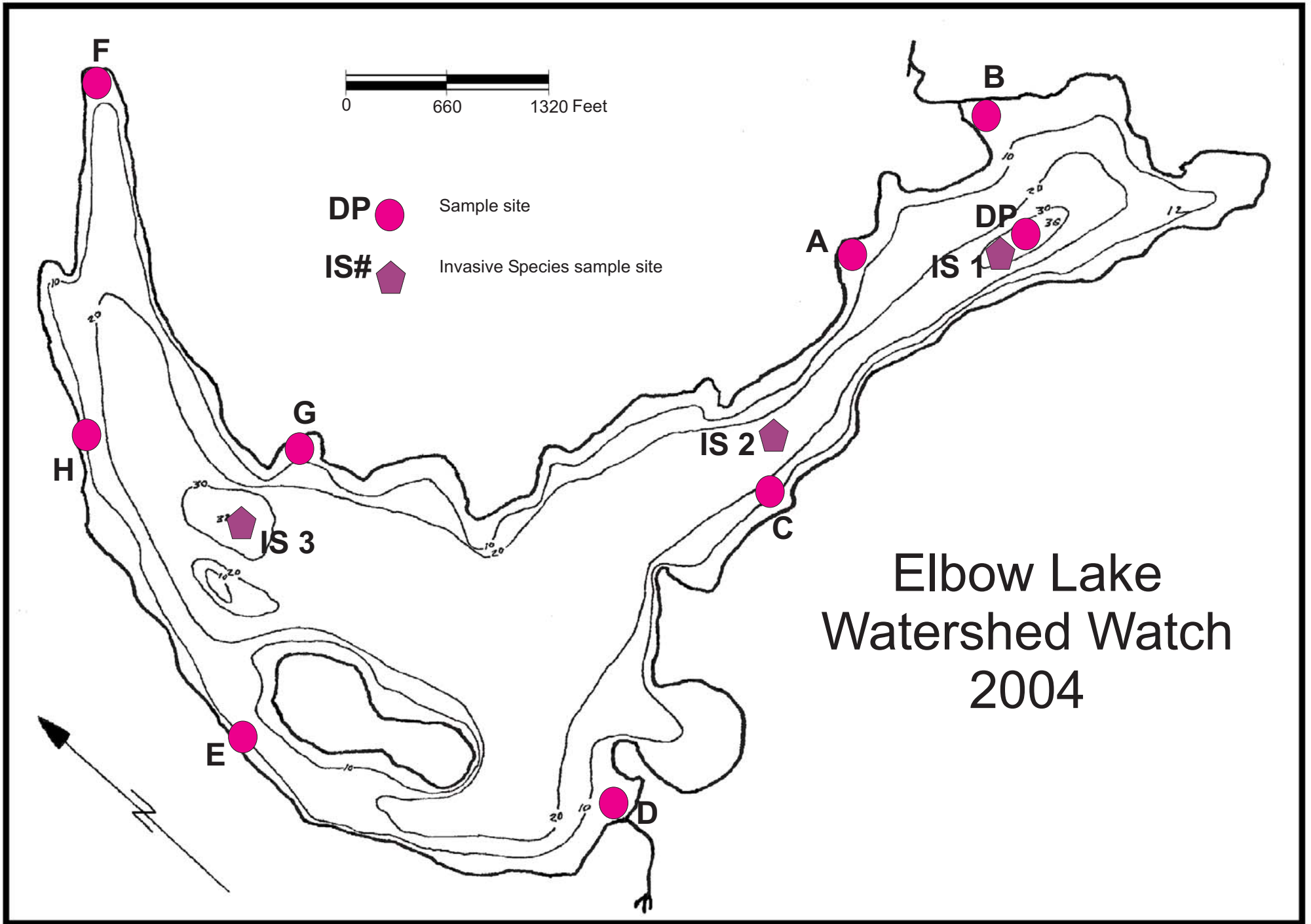
- measurement of **water clarity** or the presence of suspended material using a **Secchi disk**,
- dissolved oxygen (DO)/Temperature profiles to show what the extents of the habitable waters are (most fish species inhabit the warmer, oxygenated surface waters),
- analysis of samples for nutrients: **Total Phosphorus (TP)** - the limiting nutrient for plant and microorganism growth, and/or
- presence or concentration of phytoplankton indicated by the amount of **chlorophyll a**, a pigment in phytoplankton (aquatic plants) – Chlorophyll a was used as the primary indicator of lake trophic state (age or nutrient level) until 1994 when it was replaced by total phosphorus because sampling and analysis for TP was shown to be more reliable and more economical. The relationship between the two is that chlorophyll a is one of the pigments found in phytoplankton giving it a green colour and phosphorus is the primary nutrient for the phytoplankton. In other words, the higher the concentration of TP, the greater the potential for growth of phytoplankton would be which, in turn, would mean that there would be a correspondingly high concentration of chlorophyll present. In such a case, the water clarity could be poor from the abundance of suspended plant material.

Added for the Watershed Watch program were:

- Total Kjeldahl Nitrogen (TKN), a secondary nutrient, to see what is available to work with the phosphorus and to see if the high counts found elsewhere in the watershed occur in the lakes;
- Escherichia Coliform (E.Coli) sampling around the lake nearshore to check for bacterial pollution problems, and
- Dissolved Organic Carbon (DOC) that comes typically from wetlands and can have a limiting effect on the nutrient uptake process.

Elbow Lake 2004





ELBOW LAKE - 2004

LOCATION:	Township of Central Frontenac. Outflow is via Fish Creek at the northeast end of the lake, where it eventually enters Bob's Lake.
ELEVATION:	lake surface approximately 174 metres above mean sea level
DIMENSIONS:	perimeter: 13.32 kilometres; maximum depth: 9.76 metres.; area: 125.5 hectares; volume: 6,560,000 m ³
LAKE WATERSHED:	drainage area: 19.21 km ² ; mainly wooded, some agriculture
FISHERY:	warm water fishery - largemouth bass, smallmouth bass, walleye, pickerel, pike
DEVELOPMENT LEVEL:	49 seasonal cottages, no permanent cottages, one resort (as of count in 1982)
BACKGROUND DATA:	Ministry of Environment Self-Help and Lake Partner Programs; Ministry of Environment Recreational Lakes Program- total phosphorus, chlorophyll <u>a</u> , secchi disk, dissolved oxygen profiles.

The sampling component of the Watershed Watch program consisted of the following:

SITES:	one site at deepest point of lake, eight around shoreline adjacent to cottage groupings, inflow and outflow points (see map)
TOTAL PHOSPHORUS (TP):	a composite sample taken in the euphotic zone (layer which light penetrates – twice the secchi disk depth) at the deepest point (where there is least point source input) and one metre above the bottom; at eight shoreline sites at approximately half metre depth in one metre of water
TOTAL KJELDAHL NITROGEN (TKN):	samples from deepest point at the surface and one metre above the bottom; at eight shoreline sites at half metre depth in one metre of water
SECCHI DISK (SD):	at deepest point – measurement is depth where disk can no longer be seen
DISSOLVED OXYGEN/TEMPERATURE (DO):	at deepest point readings taken at intervals from surface to bottom and back to the surface
CHLOROPHYLL <u>a</u> (CHL A):	a composite sample taken in the euphotic zone (layer which light penetrates – twice the secchi disk depth) at deepest point <u>not done in 2004 Watershed Watch</u>
ESCHERICHIA COLI (E. Coli):	at eight shoreline sites at approximately half metre depth in one metre of water
INVASIVE SPECIES (IS):	Sampling for Zebra Mussel veligers and Spiny Water Flea completed during July sampling
BENTHIC MACRO INVERTEBRATES:	Not completed in 2004 Watershed Watch Program

Looking a little deeper:

At the outset, it should be noted that, because some of the historical data (Table 1) are annual averages of a number of samples taken through a summer and others are single sample results recorded for a year, statistical analyses would not be appropriate. Therefore, what follows is discussion about the various aspects of the data in order to come to some conclusions about the general water quality of Elbow Lake.

Chlorophyll a (CHL A) is the green pigment in phytoplankton and algae and its concentration in water was used as the indicator of aquatic productivity until 1994. CHL A concentrations in Elbow Lake were relatively high

with three of the ten years of record having concentrations in excess of the **provincial water quality objective (PWQO)** of 5 milligrams per litre of sample (above which excessive plant growth could be expected). The water clarity, as measured with a **Secchi disk**, was in keeping with the CHL A concentrations. In other words, a higher CHL A concentration should coincide with low water clarity, which was generally the case.

Total Phosphorus (TP) was found to be a more reliable and less costly indicator of general water quality in lakes than CHL A. It is a measure of the nutrient loading available for plant growth. The move to TP as the indicator of aquatic productivity occurred after 1994. The TP data from 1996 to the present for Elbow Lake fluctuates to a similar extent as the CHL A data (keeping in mind the differences in the dataset mentioned above) except that none exceeded the PWQO for TP of 20 micrograms per litre ($\mu\text{g/L}$). This could indicate that there has been a slight decline in nutrient concentrations although there is no obvious trend and water clarity measurements have been fairly consistent throughout the period of record. The data for 2005 from the Lake Partners Program and an RVCA sample show a similar concentration of nutrients and water clarity.

Table 1: Elbow Lake – Historical Data

Sample Year	Secchi Disk (metres)	Total Phosphorus ($\mu\text{g/L}$)	Chlorophyll <i>a</i> ($\mu\text{g/L}$)
1982	2.4		3.9
1983	3.3		3.3
1984	3.1		5.7
1985	3.2		6.3
1986	2.4		8.0
1987	2.8		4.8
1991	3.1		3.4
1992	3.7		4.1
1993	3.1		2.9
1994	3.4		3.7
1996	3.3	8	
1997	3.5	6	
1998	3.1	11	
1999	4.1	10	
2000	3.5	18	
2001	3.8	8	
2002	3.3	15	
2003	3.2	13	
2004	2.6	14	
2005	3.2	13	
Number	20	10	10
Minimum	2.4	6	2.9
Maximum	4.1	18	8.0
Mean	3.2	11	4.6

Throughout the 2004 sampling period, TP concentrations at the deep point surface sample site did not vary significantly from the average except in October when thermal destratification, or turnover, was occurring (Table 2 and Figure 2, below). As the lake cools and tends toward a uniform temperature each fall, phosphorus from the bottom waters can be circulated to the surface and be available in the spring for new plant growth. This could be a significant source given the high concentrations of TP in the bottom waters found in all samples

More significant were the concentrations of **total Kjeldahl nitrogen (TKN)**. TKN is the secondary nutrient in lake systems, limited by the available phosphorus. The elevated concentrations in the surface waters and the

extreme concentrations at the bottom could dramatically multiply the impact of relatively minor increases in phosphorus.

Figure 1:

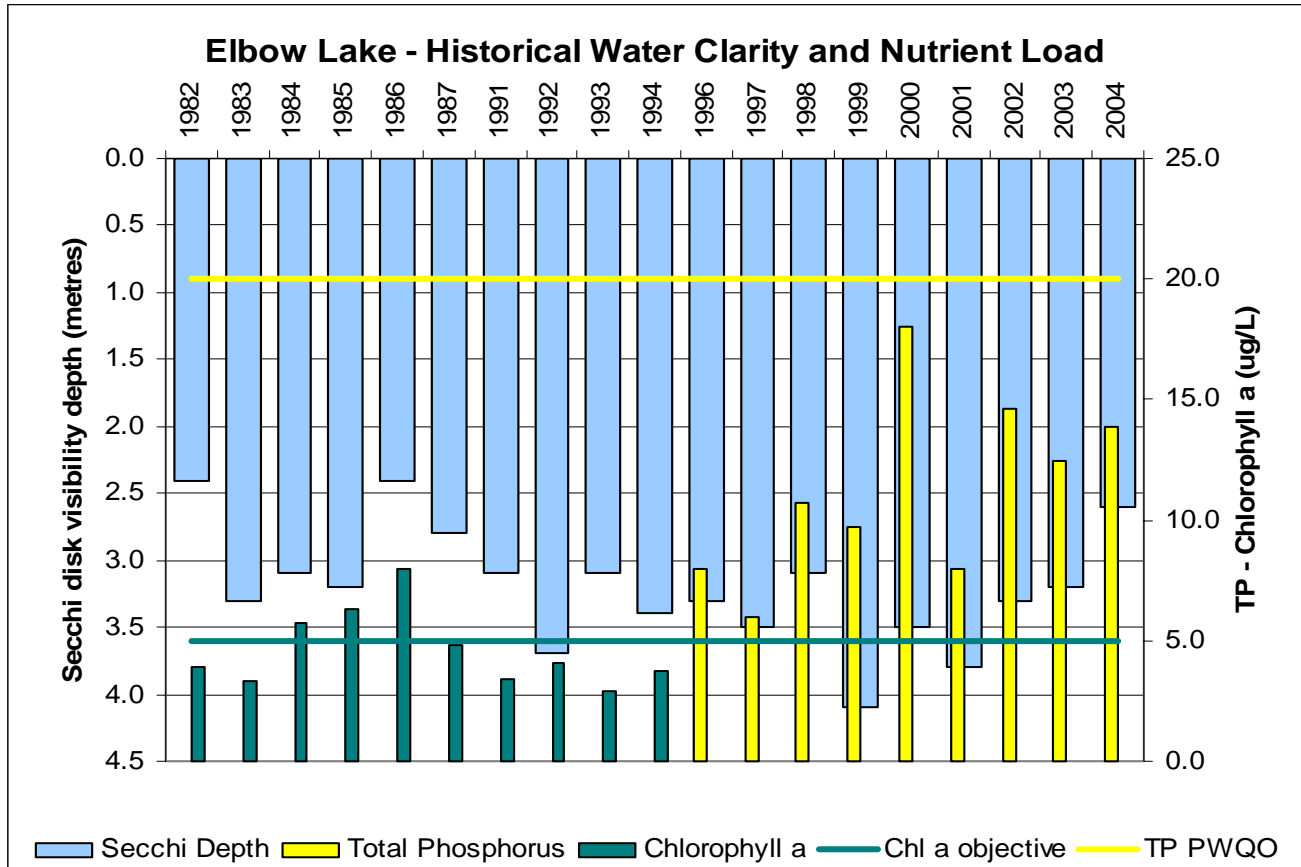
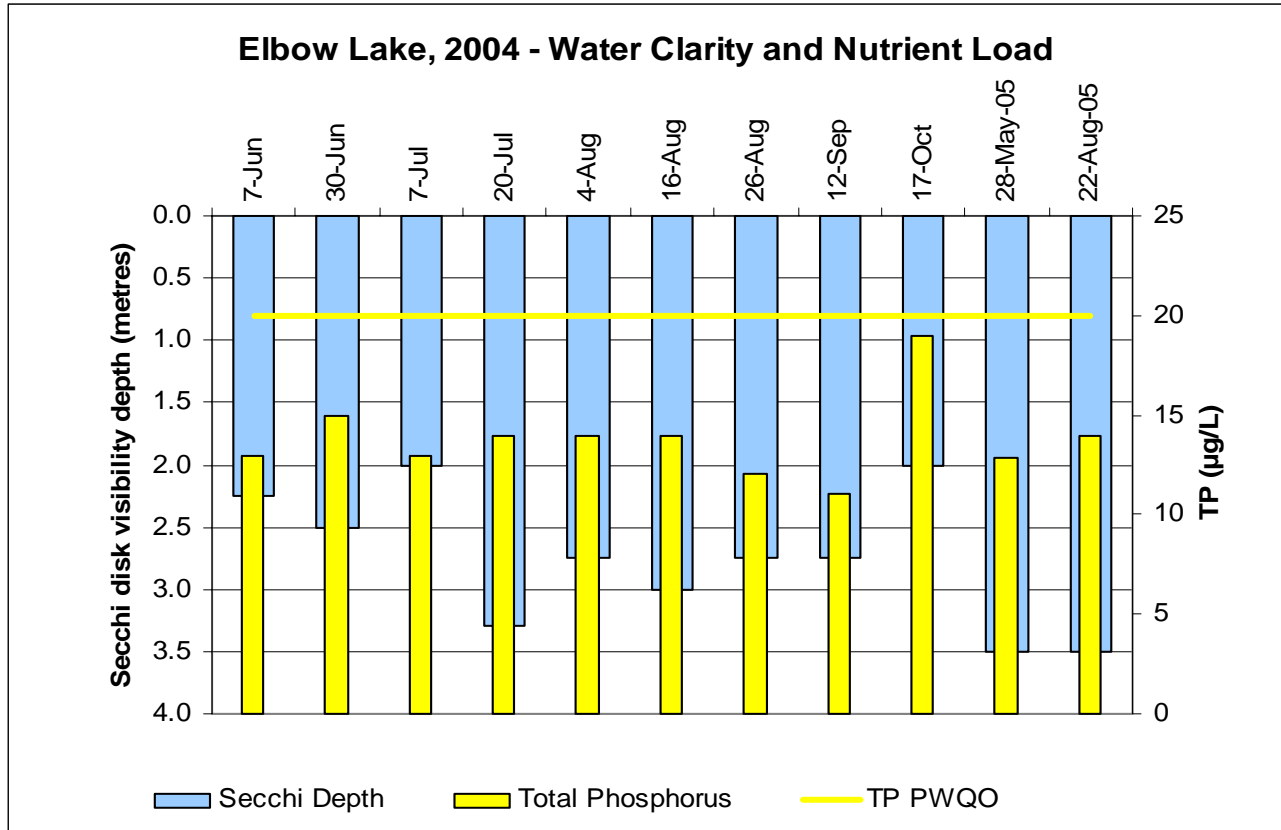


Table 2: Deep Point – Elbow Lake (RVL-30), 2004, May, August, 2005

Date	TP deep point surface (µg/L)	TP, Deep Point Bottom (µg/L)	TKN deep point surface (µg/L)	TKN, Deep Point Bottom (µg/L)	Secchi disk (metres)
7-Jun	13	162	550	1130	2.3
30-Jun	15	128	530	940	2.5
7-Jul	13	132	530	910	2.0
20-Jul	14	50	500	650	3.3
4-Aug	14	490	530	1990	2.8
16-Aug	14	340	550	1480	3.0
26-Aug	12	115	500	910	2.8
12-Sep	11	460	490	2100	2.8
17-Oct	19	520	490	2400	2.0
average 04	14	266	511	1412	2.8
28-May-05	13				3.5
22-Aug-05	14	360	440	1610	3.5

As with the historical data, the Secchi disk measurements (Table 2, 6th column) remained relatively consistent through the summer. The average is in keeping with previous years and the average TP concentration.

Figure 2:



Dissolved oxygen and temperature profiling is important for lakes because both parameters affect all aquatic organisms and the chemistry of the lake environment. The primary source of oxygen in aquatic systems is the atmosphere with wind action constantly recharging the surface waters. Lake waters also gain oxygen as a byproduct of photosynthesis by algae and macrophytes. However, as these die, they settle to the bottom of the lake where bacteria convert the organic material into carbon dioxide, consuming oxygen in the process. Because the lake becomes thermally stratified early in the summer, oxygen cannot be replenished in the water in the hypolimnion, the lower part of the lake, so that, as oxygen levels decline, phosphorus that has been adsorbed to the bottom sediments is returned to solution adding to the loading available for plant growth.

Profiles were done at the lake deep point site once a month through the 2004 sampling period (tabular and graphical form in Appendix 2). The mid-June profile shows that the lake was still in the process of stratifying with some oxygen throughout almost the entire depth. However, the oxygen concentration was suitable for a warm water fishery, which requires no less than 4 mg/L concentration of oxygen at a maximum of 25 degrees Celsius to only five metres depth (fish can survive at lower oxygen concentrations and higher temperatures but only for brief periods without suffering severe stress). By July 7th, stratification was complete and the waters below 6 metres depth were nearly anoxic (without oxygen) and only the top four metres had suitable oxygen concentrations for fish. Two profiles done in August showed similar conditions. By September 12th, the lake was cooling and the oxygen concentration had increased through 6 metres and by October 17th only the lowest 2 metres depth were anoxic.

Near the shore:

In addition to sampling at the deep point in the lake, the Watershed Watch program included sampling at a number of sites near the shore. The objectives were:

- a) To look at the phosphorus and nitrogen distribution around the lake.
- b) To do general sampling for bacterial pollution (*E.Coli*) in proximity to the developed areas to see if there was a problem with septic and grey water entering the lake.

TP concentrations at sample sites around the lake were similar to those at the deep point (DP1, Table 3, below) except at site "D" located at the inflow to the lake. Concentrations were good in all samples of the June 7th run when the lake was in the process of destratification. After that, all sample results from site "D" in 2004 were significantly higher than others and all exceeded the PWQO. Beyond the 8 results for site "D", there were only three from other sites that met or exceeded the PWQO. However, nineteen results from sites other than "D" were concentrations above 15 µg/L, indicating a possible potential for higher concentrations. It was much drier in 2005 than is normal for the area and that had a definite affect on inflow to the lake from streams and overland. The single sample date in 2005 had the highest concentration again at site "D" but it was well below the previous August. 2004 was not a particularly wet year either so it appears that it takes relatively little precipitation for inflows carrying elevated concentrations of TP to occur.

Table 3: TP (µg/L) – Elbow Lake (RVL-30), 2004, August, 2005

SITE	A	B	C	D	E	F	G	H	DP1	average	DP2
7-Jun	10	11	13	11	11	14	12		13	12	162
30-Jun	18	17	15	56	13	12	12	13	15	19	128
7-Jul	17	14	13	47	12	12	13	12	13	17	132
20-Jul	15	16	12	38	12	12	12	17	14	16	50
4-Aug	18	15	12	54	13	13	12	13	14	18	490
16-Aug	18	17	13	25	13	12	11	12	14	15	340
26-Aug	14	14	14	46	12	16	13	18	12	18	115
12-Sep	17	12	12	32	11	19	11	26	11	17	460
17-Oct	21	16	15	20	18	20	18	15	19	18	520
average '04	16	15	13	37	13	14	13	16	14	17	266
22-Aug-05	12	13	11	15	9	10	9	10	14	11	360

The same pattern as for phosphorus concentrations occurred for TKN with highest concentrations at site "D" and lower concentrations in the single 2005 sample. There is no PWQO for TKN at present so RVCA has adopted 500 µg/L, which was previously used as a guideline, above which profuse weed growth could be expected. Such concentrations were normal in 2004.

Table 4: TKN (µg/L) – Elbow Lake (RVL-30), 2004, August, 2005

SITE	A	B	C	D	E	F	G	H	DP1	average	DP2
7-Jun	530	670	600	990	580	610	620		550	644	1130
30-Jun	520	550	490	1010	460	520	470	520	530	563	940
7-Jul	540	530	530	940	500	500	540	500	530	568	910
20-Jul	520	510	490	820	520	490	510	540	500	544	650
4-Aug	560	540	500	950	520	560	520	520	530	578	1990
16-Aug	550	580	560	820	540	520	510	590	550	580	1480
26-Aug	520	540	520	920	500	530	510	540	500	564	910
12-Sep	500	480	480	880	480	490	490	640	490	548	2100
17-Oct	520	500	490	640	510	530	510	500	490	521	2400
average '04	529	544	518	886	512	528	520	544	519	567	1390
22-Aug-05	400	420	420	470	390	410	390	400	440	416	1610

The third parameter, *Escherichia coliform (E.Coli)* is used as an indicator of the potential presence of other harmful bacteria and pathogens in water. The main sources of bacteria are animal (decay of dead animals, defecation near and in the water) and human (septic systems, grey water, lawn fertilizers). Levels above the PWQO of 100 counts/100 mL can mean that the water is unsafe for swimming. As a general precaution, untreated lake water should not be used as the primary drinking water source and use for washing and cooking should be limited. When successive samples have results that are at or exceed the PWQO, it may reasonably be assumed that there is a pollution source and further investigation should be done. However, there are often individual samples with high counts which are not significant.

The only exceedance of the PWQO for *E.Coli* in 2004 occurred at site "D". However, 31% of the data were above 20 counts/100 mL indicating an active animal population in and around the lake and, possibly, some human sources, particularly at or near sites "A", "G" and "H".

Table 5: *E.Coli* (counts/100 millilitres of sample) – Elbow Lake (RVL-30),

SITE	A	B	C	D	E	F	G	H
7-Jun	3	6	22	21	6	3	3	
30-Jun	2	1	8	14	9	2	1	17
7-Jul	19	19	29	38	2	17	81	4
20-Jul	2	12	2	20	2	2	6	14
4-Aug	44	46	2	20	10	8	4	2
16-Aug	10	56	4	20	4	24	2	4
26-Aug	32	22	6	22	8	8	46	6
12-Sep	16	20	4	116	8	14	12	42
17-Oct	6	52	2	46	4	12	40	10
average '04	15	26	9	35	6	10	22	12
2004 AVERAGE, SITES A TO H:								17
22-Aug-05	2	16	20	2	2	4	10	4

Invasive Species:

The 2004 Watershed Watch program included sampling for the invasive species Zebra Mussel and Spiny Water Flea. Analysis of samples indicated that there were no Zebra Mussel veligers present. Follow-up sampling in 2005 also was negative for both veligers and water fleas. In addition to the sampling, signs were posted to inform boaters of precautions to take to prevent the spread of these invasives from waterbody to waterbody.

The Ontario Federation of Anglers and Hunters (OFAH), in co-operation with the Ministry of Natural Resources have published "ZEBRA MUSSELS: A Guide for Boaters and Cottagers". This publication, along with fact sheets, brochures, watchcards, signs and stickers, are available free of charge. OFAH also have videos and slide presentations available for purchase or loan, perfect for lake association meetings and information sessions. Visit <http://www.invadingspecies.com> or call the Invading Species Hotline (1-800-563-7711) for more information.

In conclusion:

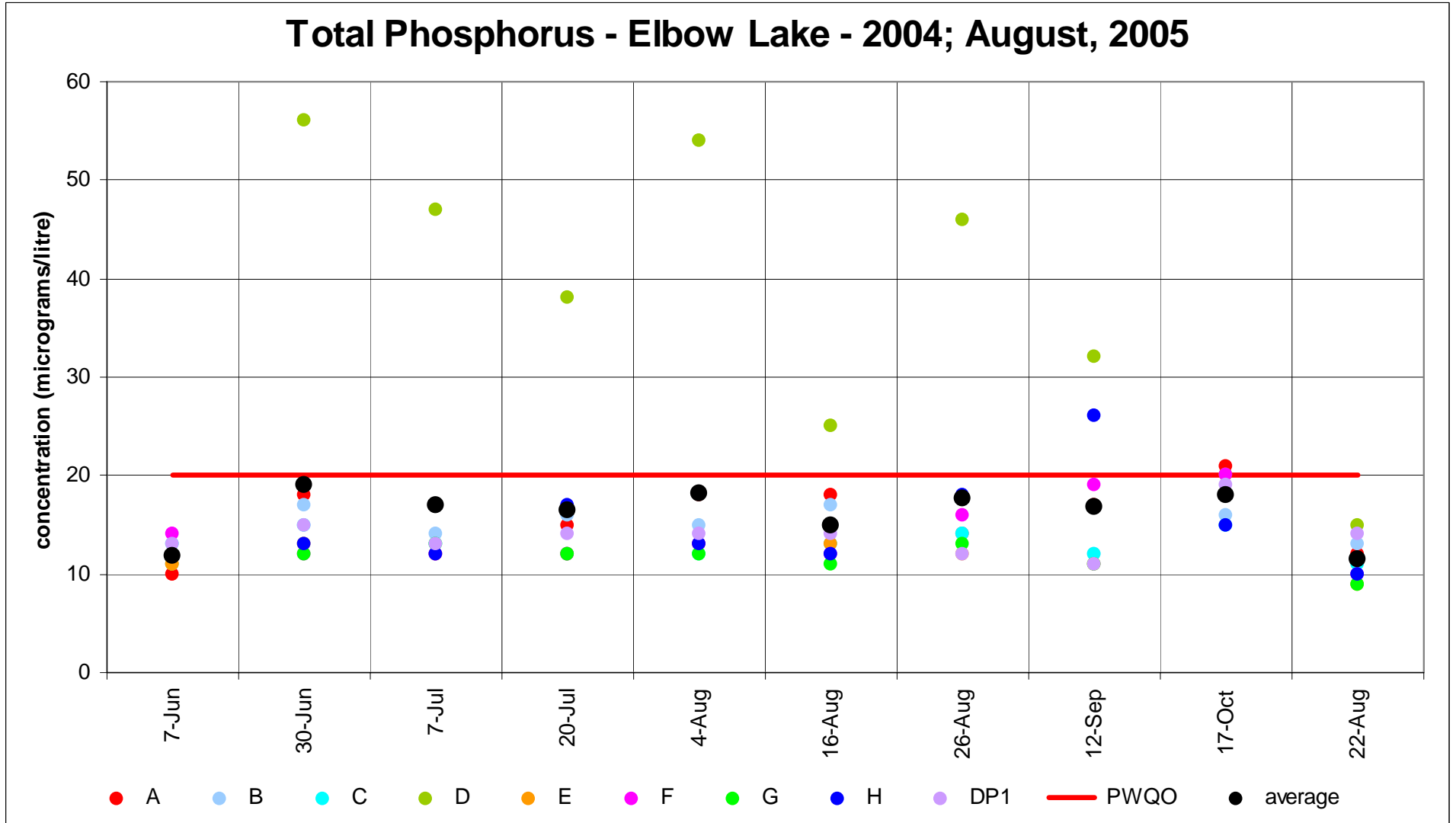
Of note are the high concentrations of total phosphorus that were measured at site "D" and high total Kjeldahl nitrogen found throughout the lake. Both are sufficient to produce substantial algae blooms but none were noted on the sample dates. At all sample dates when TP and TKN concentrations were high, it was noted that the water was tea coloured which meant that dissolved organic carbon (DOC) was present in the inflow waters. DOC interferes with the uptake of phosphorus and nitrogen nutrients by aquatic plants. The water colour at all other sample sites was light yellow so it appears that the incoming DOC was not in sufficient concentrations to discolour the whole lake but may still have limited algae growth. The significance of the much lower TP and TKN concentrations in samples from August 2005 is not entirely clear but it appears that the inflow stream

brings considerable loadings with average rainfall and runoff. The counts of *E.Coli*, while not exceeding the PWQO, were elevated at several sites which should be further assessed through ongoing monitoring.

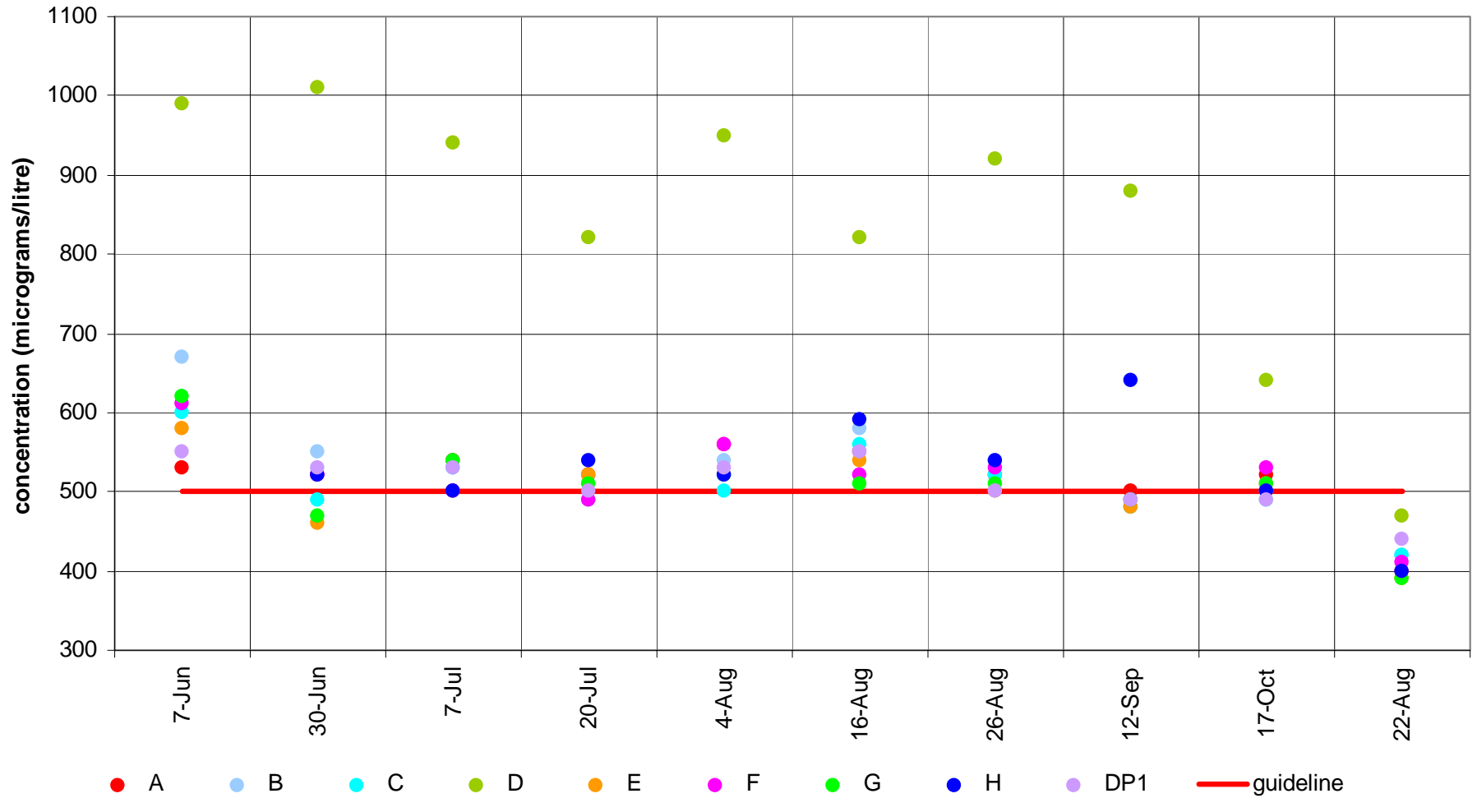
Nonetheless, Elbow Lake is reasonably healthy. However, it would be worthwhile for owners of existing properties to do an audit to check that their property is not a contributor to lake degradation.

Thanks got to Brian Graham for providing on-water transportation to our staff to get the samples.

Figures 3, 4, 5: Total Phosphorus, Total Kjeldahl Nitrogen, *Eschericia Coliform*



Total Kjeldahl Nitrogen - Elbow Lake - 2004, August, 2005



Eschericia Coliform - Elbow Lake - 2004, August, 2005

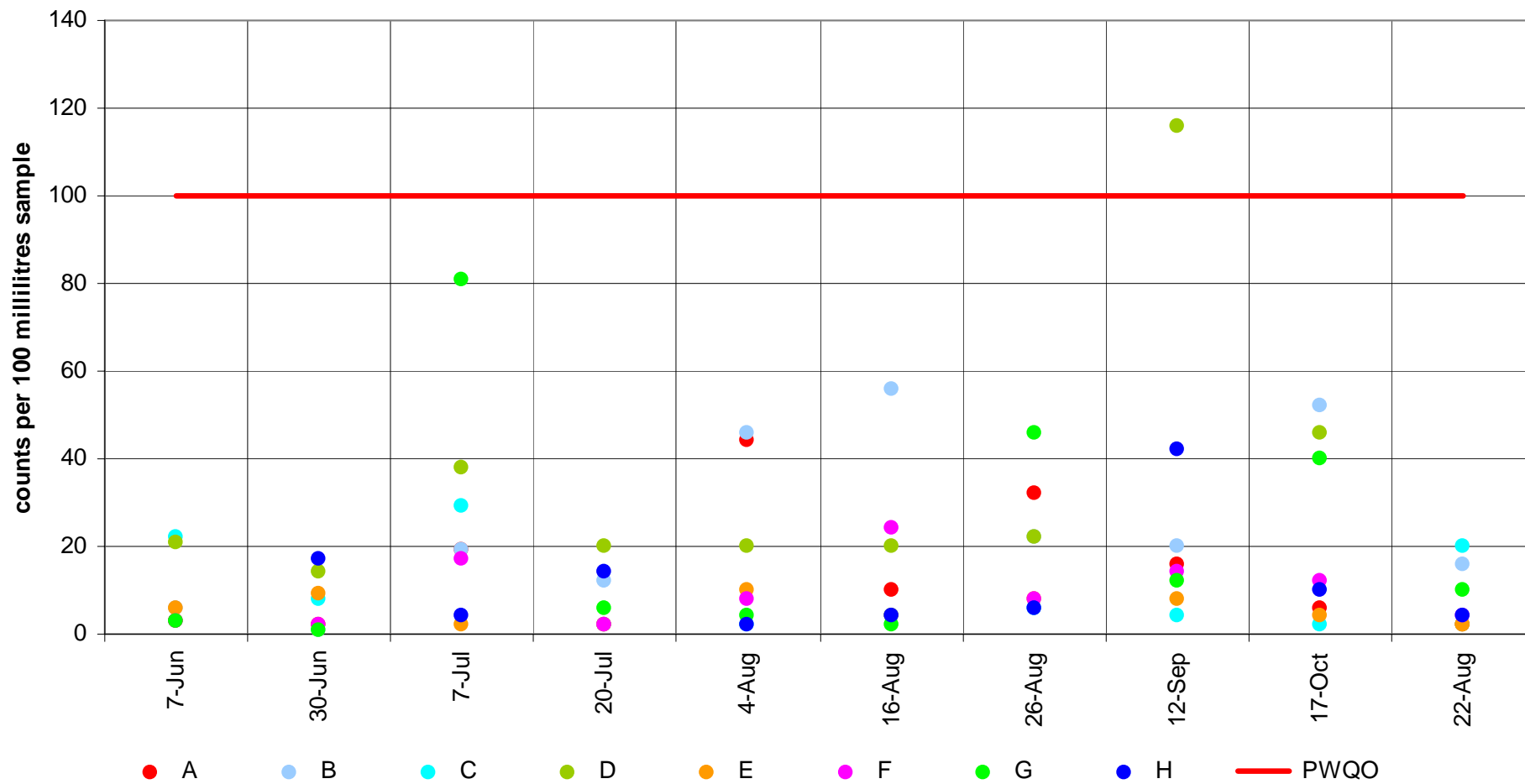


Figure 4: Elbow Lake Dissolved Oxygen/Temperature Profiles

June 7, 2004

Depth (metres)	Temperature (degrees C)	Dissolved Oxygen (mg/L)	Saturation (%)	Lake Stratification
0.1	20.8	6.3	70.0	Epilimnion
1	19.9	6.3	69.2	
2	19.3	6.2	68.6	
3	18.9	6.1	65.1	
4	17.1	5.3	55.8	Metalimnion
5	14.6	4.1	40.3	
6	11.9	3.0	28.6	
7	11.1	1.9	18.5	Hypolimnion
8	10.8	1.6	15.3	
9	10.0	0.4	4.5	

July 7, 2004

Depth (metres)	Temperature (degrees C)	Dissolved Oxygen (mg/L)	Saturation (%)	Lake Stratification
0.1	22.3	6.3	73.2	Epilimnion
1	22.0	6.3	72.9	
2	21.5	6.1	70.1	
3	20.9	5.9	66.8	
4	19.4	5.2	57.2	Metalimnion
5	16.9	3.2	32.4	
6	13.3	0.6	5.8	
7	11.6	0.3	2.5	Hypolimnion
8	11.1	0.2	1.6	
9	10.4	0.2	1.4	
10	9.8	0.1	1.2	
11	9.8	0.1	1.2	
12	10.2	0.1	1.1	

August 4, 2004

Depth (metres)	Temperature (degrees C)	Dissolved Oxygen (mg/L)	Saturation (%)	Lake Stratification
0.1	24.1	5.6	67.7	Epilimnion
1	24.2	5.6	52.7	
2	24.1	5.6	67.5	
3	23.3	5.1	61.0	
4	21.4	3.7	42.4	Metalimnion
5	18.6	1.1	12.7	
6	14.5	0.1	1.1	
7	12.0	0.1	0.8	Hypolimnion
8	11.1	0.1	0.8	
9	10.4	0.1	0.7	
10	9.9	0.1	0.7	
11	9.9	0.1	0.7	

August 26, 2004

Depth (metres)	Temperature (degrees C)	Dissolved Oxygen (mg/L)	Saturation (%)	Lake Stratification
0.1	20.8	5.6	62.7	Epilimnion
1	20.6	5.5	62.2	
2	20.5	5.5	61.5	
3	20.3	5.3	59.1	
4	20.1	4.7	52.2	
5	19.5	3.5	38.9	
6	16.9	0.2	2.6	Metalimnion
7	12.3	0.1	0.5	
8	11.3	0.1	0.4	

September 12, 2004

Depth (metres)	Temperature (degrees C)	Dissolved Oxygen (mg/L)	Saturation (%)	Lake Stratification
0.1	21.0	6.0	68.3	Epilimnion
1	21.0	6.0	67.9	
2	20.8	6.0	67.6	
3	19.7	5.9	65.0	
4	19.2	5.4	58.7	
5	19.0	5.0	54.1	
6	18.6	4.1	44.9	Metalimnion
7	14.3	1.3	12.1	
8	11.8	0.3	2.2	Hypolimnion
9	10.9	0.1	1.2	
10	10.2	0.1	1.0	
11	10.0	0.1	1.0	
12	10.1	0.1	0.9	

October 17, 2004

Depth (metres)	Temperature (degrees C)	Dissolved Oxygen (mg/L)	Saturation (%)	Lake Stratification
0.1	13.2	6.3	60.2	Epilimnion
1	13.2	6.2	59.5	
2	13.2	6.2	59.1	
3	13.2	6.1	58.6	
4	13.2	6.1	58.3	
5	13.1	6.0	57.5	
6	13.1	6.0	57.1	
7	13.1	5.9	56.4	
8	13.1	5.7	55.0	
9	12.4	4.6	43.3	
10	10.3	0.7	6.2	Metalimnion
11	10.0	0.7	6.3	Hypolimnion

Warm Water Fisheries Habitat (e.g. bass, walleye, pike) defined as Dissolved Oxygen concentrations > 4 mg/L at temperature < 25 degrees Celsius.

Figure 5: Elbow Lake Dissolved Oxygen/Temperature Profiles

