2.0 Water Quality - Introduction

Water quality is central to the health of the Rideau River. Water quality is important (and intimately linked) to both human and natural communities along the River. Many human activities can have adverse affects on water quality. Deterioration in water quality can arise from contamination by toxic substances and/or bacteria, increases in suspended matter, and enrichment by nutrients. This pollution originates from easily identified point sources, such as sewage treatment plants, as well as non-point (or diffuse) sources such as surface run-off, and is hastened by human activities such as shoreline development, which result in the loss of riverbank vegetation and accelerated erosion.

The definition of water quality differs, depending on how the water is to be used. Different water quality criteria are set depending on whether the water is intended for drinking, recreation, industrial or agricultural use or is considered as habitat for aquatic life. Water quality criteria have been established for a wide range of parameters, at the national and provincial levels. These parameters include physical or chemical characteristics (such as temperature and pH), major ions (ex. calcium and sodium), nutrients (ex. nitrogen and phosphorus), organic compounds (such as pesticides), inorganics (metals) and microorganisms (ex. fecal coliform bacteria).

Water quality has been evaluated in the Rideau River by several different organizations. These include the Ministry of the Environment (MOE), the City of Ottawa (formerly RMOC), the Canadian Museum of Nature (CMN), the Rideau Valley Conservation Authority (RVCA) and a number of different health units. In addition, several research projects conducted by researchers at the University of Ottawa have focused on water quality in the Rideau River over the last decade.

The purpose of this section is to characterize the current surface water quality of the Rideau River between Smiths Falls and Ottawa, and to discuss trends in various water quality parameters where long-term monitoring results are available. Two water uses are considered in this report: water quality for aquatic habitat, and water quality for recreational use. Six water quality indicators are included in this report: total phosphorus, nitrate/nitrite nitrogen, dissolved oxygen, algal abundance (chlorophyll *a*), metals, and bacteria (*E. coli*). Other water quality indicators such as total suspended solids and pH were considered but it was decided that they are not of particular concern in the Rideau River.

2.1 Water Quality Indicator: Total Phosphorus

Background

Phosphorus is an essential nutrient for all living organisms. Since phosphorus is usually available in very small quantities in water, it is often a growth-limiting element. However, human activities may result in high phosphorus inputs to freshwaters, leading to the increased growth of algae and aquatic plants, the loss or degradation of habitat and changes in biodiversity. In addition, the aesthetic and recreational value of lakes and rivers may be impaired by algal blooms, which produce increased turbidity, discolouration, odours, and occasionally, toxins.

Expansion of human populations and a variety of human activities have greatly increased the amount of biologically available nutrients entering freshwaters. The principal sources of phosphorus to Canadian freshwaters include municipal and rural wastewater, manure and fertilizer in agricultural runoff, industrial discharges, and aquaculture operations. The eutrophication (nutrient enrichment) of freshwaters due to inputs of nutrients, particularly phosphorus, became a major environmental issue in the 1970s. Since then, controls on phosphates in detergents and improvements to sewage systems have led to reductions in phosphorus inputs to freshwaters.

Under the Ontario Provincial Water Quality Objectives (PWQOs) for the protection of aquatic life in freshwater, the interim guideline for the maximum total phosphorus (TP) concentration to avoid excessive plant growth in rivers is 0.030 mg/L.

Results

Since the 1960s, there has been a gradual but steady decrease in average TP concentrations in the Rideau River (Figure 4). Until 1990, average TP levels were above the PWQO. Within the last decade, although there has been an overall decline in TP concentrations, TP increases along the course of the Rideau River, and continues to exceed the PWQO in the lower section of the River (Figure 5). Construction of a new tertiary wastewater treatment facility in Smiths Falls in 1993 appears to have reduced TP levels immediately downstream of Smiths Falls. The gradual increase in total phosphorus along the course of the River points to non-point sources of nutrient pollution, but the relative importance of the different phosphorus loading sources along the Rideau is not known.

Limitations

Total phosphorus concentration in the water may greatly underestimate the amount of phosphorus that is actually available for plant growth in the River. Continued inputs of phosphorus to the River over the years can lead to the accumulation of high levels of phosphorus in riverbed sediments. Therefore, decreases in TP concentrations in the water of the Rideau may not immediately lead to dramatic declines in the growth of rooted plants and filamentous algae, which will continue to obtain the phosphorus they need from sediments, for many years to come.

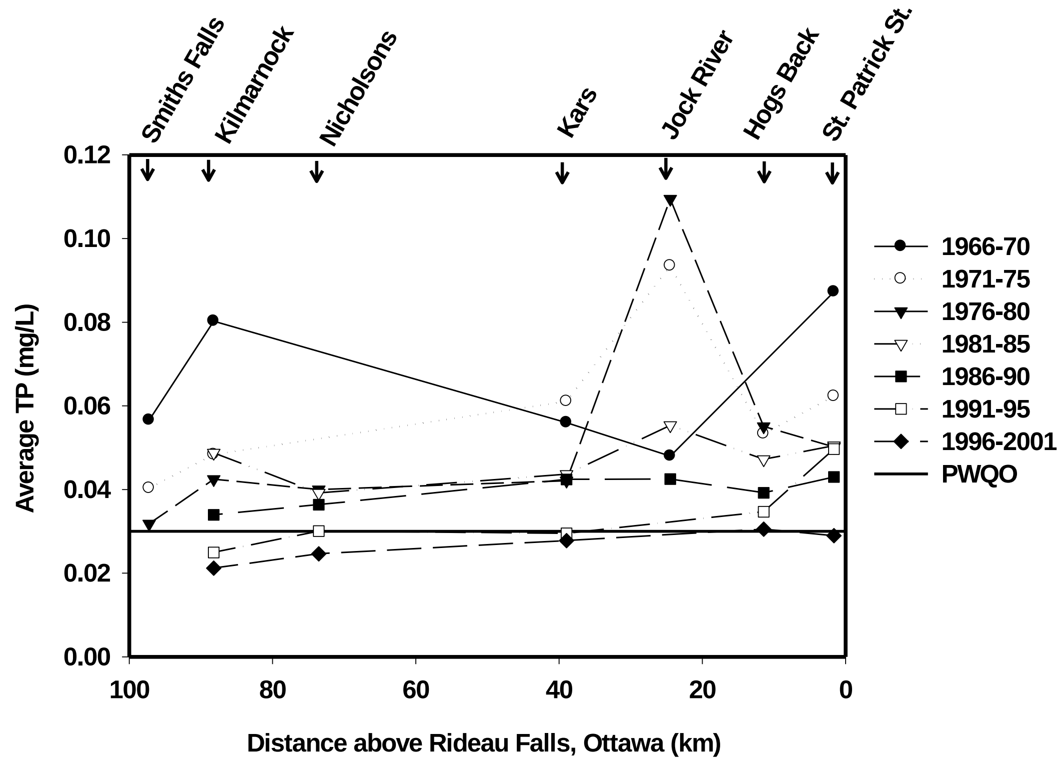

Figure 4 Average annual total phosphorus, 1966-2001.
Source: Ministry of the Environment

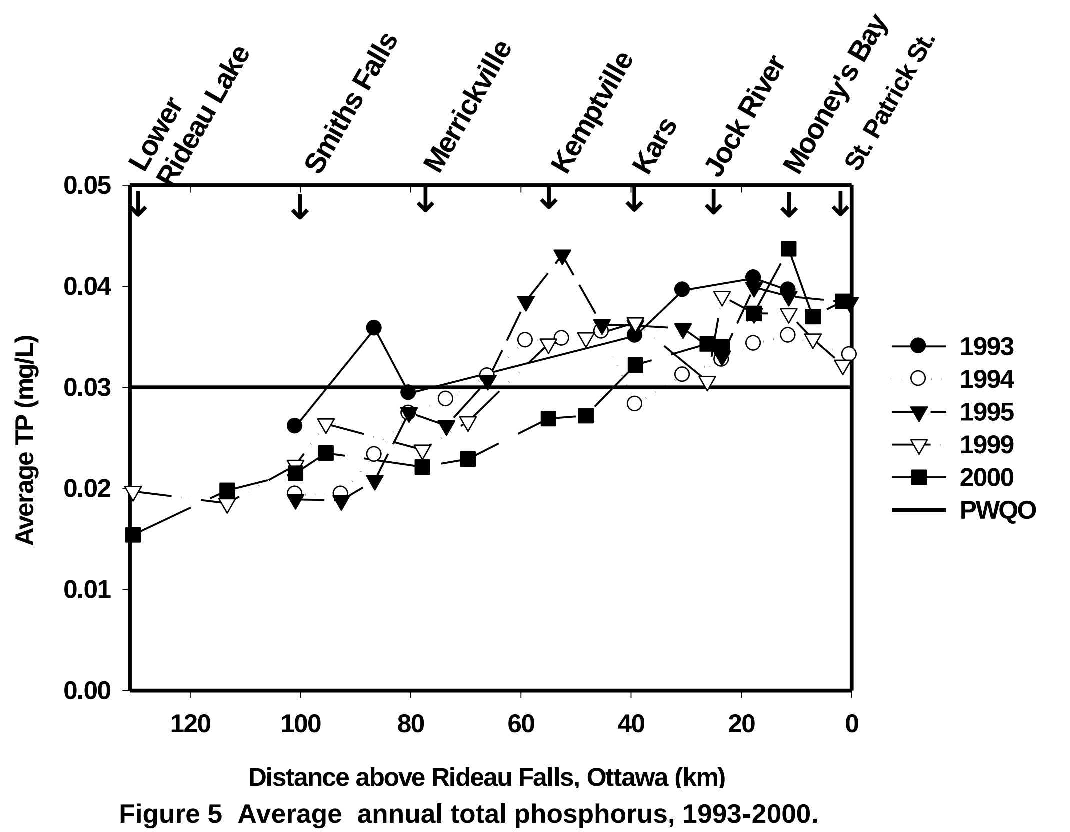

Figure 5 Average annual total phosphorus, 1993-2000.
Sources: Basu & Pick 1995, 1997 (1993-1995 data); Canadian Museum of Nature (1999-2000 data)

2.2 Water Quality Indicator: Nitrate and Nitrite

Background

Nitrogen is another essential nutrient for all living organisms. The biologically available supply of nitrogen has greatly increased as a result of increasing human activities, principally from municipal and rural wastewater, agriculture and industrial waste. While phosphorus compounds are the major cause of eutrophication in freshwaters, there are also concerns about increasing concentrations of nitrogen compounds. Nitrogen plays a major role in eutrophication of saltwater ecosystems, and contributes to acidification of freshwaters. In addition, excessive concentrations of nitrogen compounds such as ammonia and nitrates can be toxic to aquatic organisms, and can be harmful in human drinking water supplies.

While nitrates are considered relatively non-toxic in water, concentrations between 1-10 mg/L have been found to be lethal to some fish eggs and fry. Nitrate is also lethal to amphibians at concentrations ranging between 13 and 40 mg/L, although concentrations as low as 2.5 mg/L can cause chronic effects. Nitrate is thought to play a role in the decline in Canada's amphibian populations. Nitrite is even more toxic, but high concentrations of nitrite are uncommon, as it naturally undergoes rapid chemical reactions in the environment, oxidizing to nitrate.

The Canadian water quality guidelines for the protection of aquatic life in freshwaters recommend a maximum nitrite concentration of 0.06 mg/L, and state that nitrate concentrations that stimulate weed growth should be avoided. There are no Ontario Provincial Water Quality Objectives (PWQOs) for the protection of aquatic life for nitrate or nitrite. The guidelines for Canadian drinking water quality set the maximum acceptable nitrate concentration at 10 mg/L and the maximum concentration of nitrite at 1 mg/L to protect human health.

Results

Unlike phosphorus, there has not been a dramatic decrease in average total nitrogen or nitrate concentrations in the Rideau River since the 1970s. While phosphorus loading from municipal wastewater treatment plants in Canada has declined greatly over the last 3 decades due to advanced treatment methods, nitrogen loads from municipal wastewater have actually risen across the nation.

The average concentration of combined nitrate and nitrite, measured between 1993 and 2000, generally remains low, under 0.05 mg/L, along the Rideau River, until downstream of Kars, where an increase is observed in some years (Figure 6). This increase may be due to a reduction in the natural uptake of nitrogen, resulting from channelization of the River and removal of shoreline habitat in areas of increasing residential development. Higher nitrogen loading may also occur in the lower section of the River, due to inputs from agricultural land, or in stormwater outfalls in the City of Ottawa. However, even in this lower region of the Rideau, average combined nitrate and nitrite concentrations still remain far below the level considered a health risk to humans and aquatic

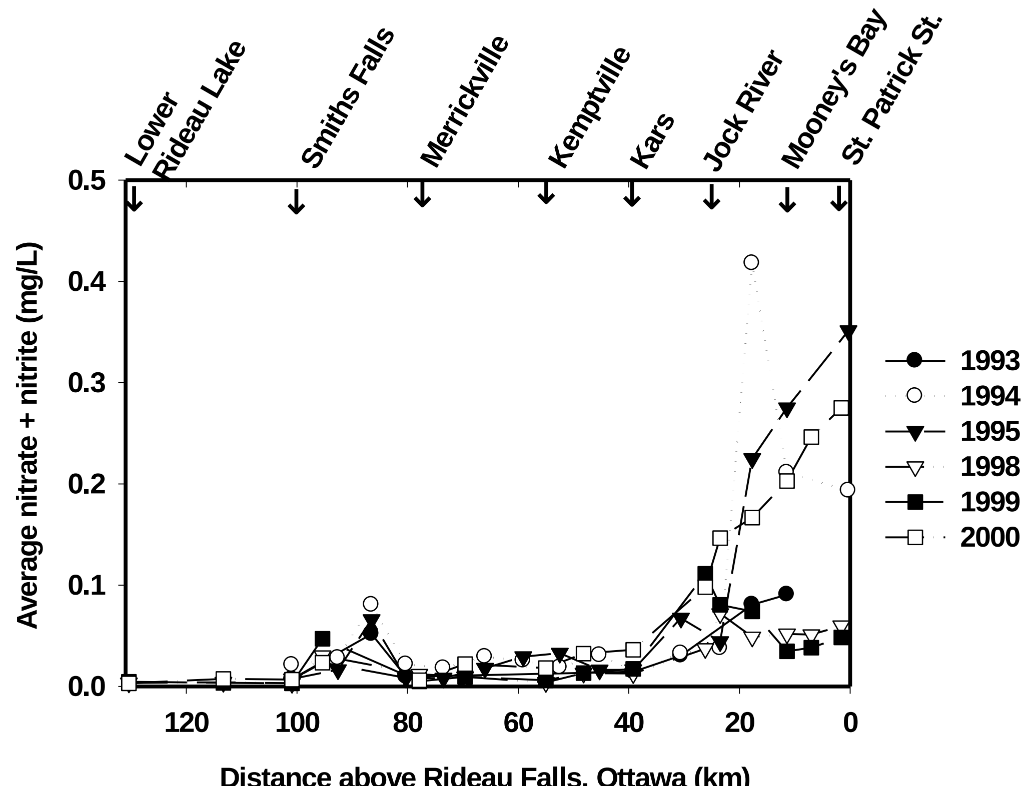

Figure 6 Average annual nitrate + nitrite, 1993-2000.
Sources: Basu & Pick 1995, 1997 (1993-1995 data); Canadian Museum of Nature (1998-2000 data)

life. In addition, total nitrite concentrations in the Rideau, as measured by MOE between 1997 and 2001, have ranged between 0.001 and 0.026 mg/L, well below the Canadian guideline for protection of aquatic life.

2.3 Water Quality Indicator: Dissolved Oxygen

Background

Dissolved oxygen (DO) is essential to aquatic life and plays an important role in biogeochemical processes in freshwater environments. DO in water comes from two sources: atmospheric oxygen, and oxygen generated by photosynthetic organisms (algae and aquatic plants) in the water. The amount of DO is dependent on many factors, including temperature, turbulence (mixing), atmospheric pressure, nutrient levels, salinity, water depth, the type of sediments, and biochemical oxygen demand (BOD).

While algae and aquatic plants produce oxygen during photosynthesis in daylight, they consume it at night when only respiration occurs, thereby creating a diurnal pattern of alternating high and low oxygen concentrations. Oxygen depletion at night may be sufficient to cause oxygen stress to fish and invertebrates in some eutrophic (nutrient-rich) systems. High concentrations of algae and aquatic plants produce large amounts of organic detritus, which can result in de-oxygenation of water during bacterial decomposition. High oxygen consumption can greatly reduce the oxygen concentration at depths where photosynthesis is light-limited. Under conditions of low or no oxygen (hypoxia or anoxia), phosphorus can be released from the bottom sediments, during chemical reduction of iron-phosphate complexes, in a process known as “internal phosphorus loading”.

The Canadian guidelines and provincial water quality objectives for the protection of aquatic life recommend minimum DO concentrations ranging between 4 and 9.5 mg/L, depending on water temperature, type of biota (cold-water or warm-water species), and life stage (Appendix 1).

Results

In recent years, DO concentrations measured in the Rideau River (averaged for the whole water column) between May and September have remained well above 4 mg/L, at least during the day (Figure 7). However, average DO in Mooney’s Bay is shown as being consistently lower than in the rest of the River, because it contains some deep regions, which become oxygen-depleted during the summer. Concentrations of DO lower than 5 mg/L (the minimum concentration recommended for warm-water aquatic animals at summer water temperatures) are also occasionally recorded in the deepest regions at other sites.

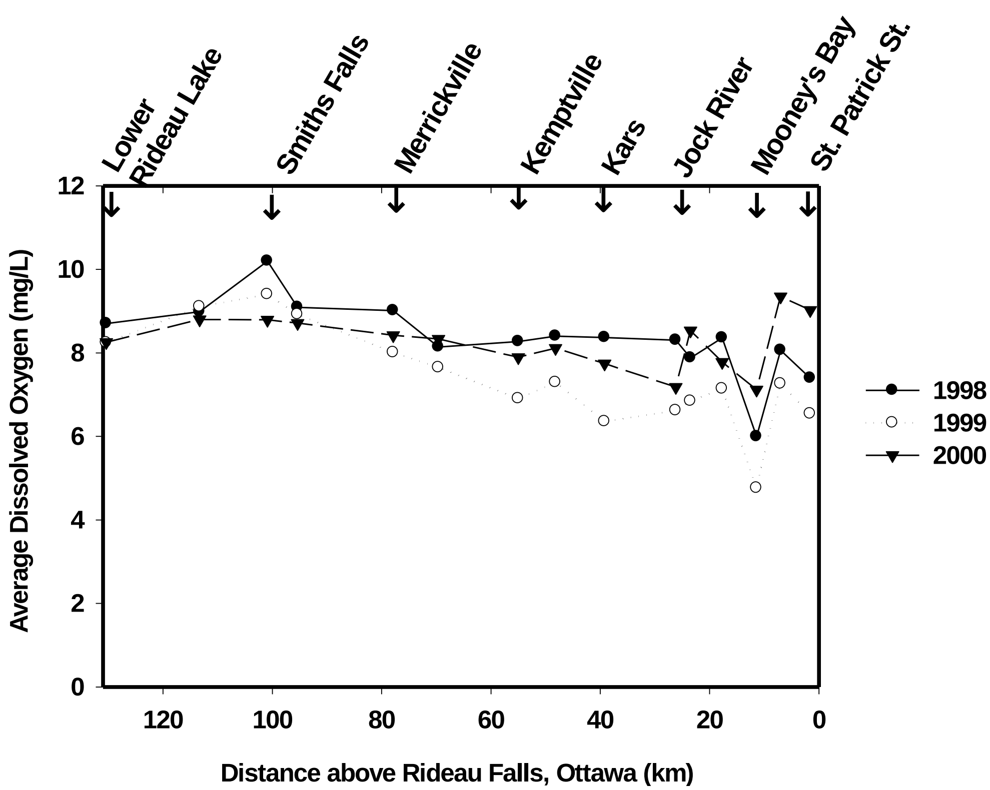

Figure 7 Average dissolved oxygen concentration, 1998-2000.
Source: Canadian Museum of Nature

Limitations

Monitoring of DO in the Rideau is carried out in the main channel, and only during the day. A pattern of alternating high oxygen concentrations (during daylight) and oxygen depletion (at night) has been found in other lakes and rivers during the summer when aquatic plants and algal mats are at their peak. Dissolved oxygen may also become depleted when plants and algal mats decay. Although DO concentrations in the Rideau appear to be sufficient for the needs of fish and other aquatic animals, conditions in shallow plant-rich areas remain to be investigated.

2.4 Water Quality Indicator: Algal Abundance

Background

Microscopic algae (phytoplankton) in rivers are an essential food supply for microscopic animals, or zooplankton, which in turn support larger animals including fish. Algal growth is dependent on a supply of nutrients in the water, and is often limited by the amount of nutrients, particularly phosphorus, in freshwaters. Thus, algal growth is mainly a function of the phosphorus concentration. High concentrations of nutrients may produce excessive algal growth, or blooms, so that the water resembles pea soup. Algal blooms have many deleterious effects in freshwaters, including reduced aesthetic appeal and recreational use, and taste and odour problems in drinking water. Algal blooms can also have adverse ecological effects, including shading out of aquatic plants, and depletion of oxygen as algae decay, which reduces the habitat available to fish. Some algae can produce potent toxins, which can poison aquatic animals, and sometimes even livestock and humans.

Phytoplankton biomass can be estimated from the concentration of chlorophyll *a* (Chl *a*) in water samples. Chl *a* is a photosynthetic pigment found in algae and other plants. There are no water quality objectives or guidelines for Chl *a* concentrations in Ontario rivers or lakes. However, Chl *a* measurements can be used for monitoring changes in algal biomass in rivers, or for comparing different rivers. Heavily polluted European rivers may have Chl *a* concentrations as high as 250 or 300 micrograms per litre (µg/L). Canadian rivers, by contrast, have much lower phytoplankton biomass. A 1994 study of rivers in eastern Canada (Basu & Pick, 1996) found Chl *a* ranging between 2and 28 µg/L (average 10 µg/L) in lowland rivers.

Results

Mid-channel Chl *a* concentrations along the Rideau River range between 2 and 28 µg/L throughout the year. When compared with other lowland rivers in eastern Canada in 1994, Chl *a* in the Rideau was slightly lower than average (8.8 µg/L). Chl *a* concentrations along the Rideau River, averaged for the months between May and September or October, are shown in Figure 8. Chl *a* decreases somewhat as water flows out of Lower Rideau Lake, builds gradually along the upper section of the Rideau River, and then decreases again in the lower part of the River.

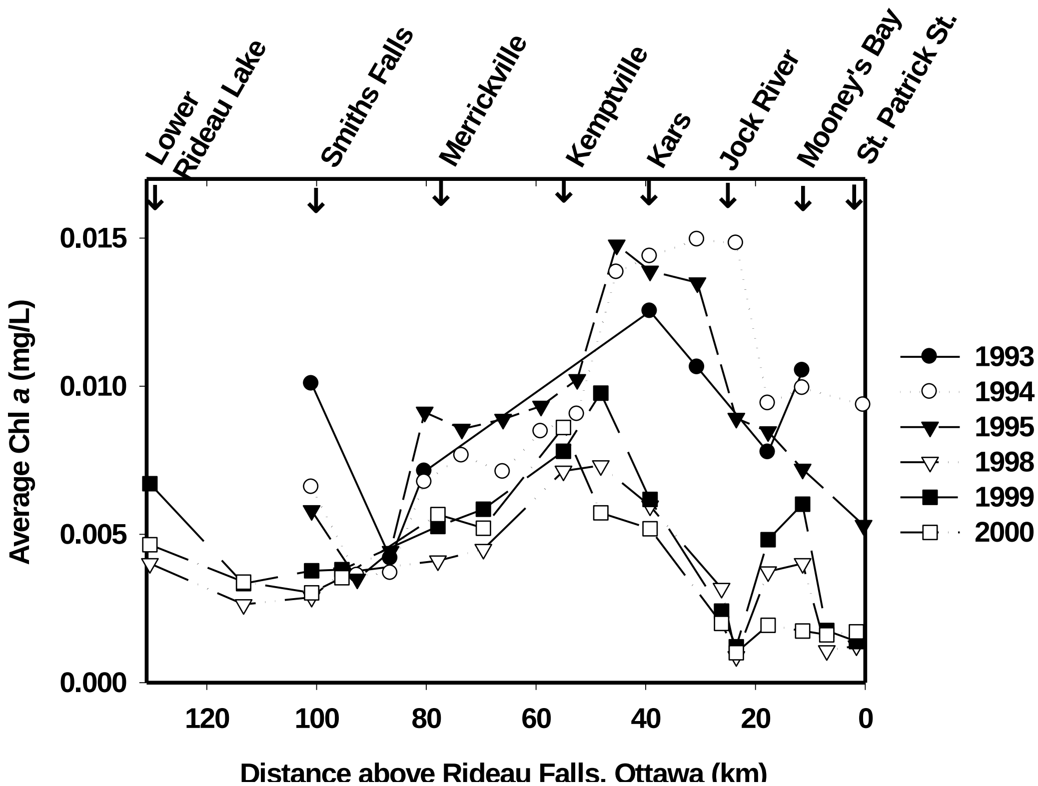

Figure 8 Average annual chlorophyll *a* concentration, 1993-2000.
Sources: Basu & Pick 1995, 1997 (1993-1995 data); Canadian Museum of Nature (1998-2000 data)

Overall, average Chl *a* levels along the Rideau have decreased somewhat since the 1993-1995 sampling period, when they ranged between about 4 and 16 µg/L. During the 1998-2000 period, average Chl *a* dropped to between 2 and 10 µg/L along the Rideau. The location at which Chl *a* begins to decline in the River has also moved upstream, since the earlier sampling period. Decreased phytoplankton biomass in the lower part of the Rideau River is due to colonization of the channel by zebra mussels, filter feeders that have been associated with steep declines in phytoplankton density in other North American rivers and lakes.

The Rideau River supports a diverse community of algae. The dominant algae vary with site, season, and year. Since 1995, cryptophytes have typically dominated the community for most of the year, with blooms of diatoms occurring for short periods in the spring, and occasional blooms of chlorophytes and blue-green algae (cyanobacteria) occurring in the summer.

Limitations

While the Rideau River does not support excessive concentrations of phytoplankton, there are nevertheless problems associated with algae in the River. Water monitoring takes place in the centre of the navigation channel, and results do not reflect conditions in the shallower regions near the shores, which make up as much as 70% of the area of the River. During spring and summer, these shallow near-shore areas with low or no flow are dominated by dense colonies of filamentous green algae, which float to the surface in mid-summer, forming thick algal mats. Algal mats are considered a problem, particularly in urban areas, where they contribute to odours and clogging of the waterway.

Another concern is the possible development of toxic algal blooms in the Rideau River. Some species of blue-green algae can produce toxins that are lethal to wildlife, and may cause contact irritation, gastroenteritis, and even serious poisonings in humans. *Microcystis aeruginosa*, a species of blue-green algae which produces a toxin called microcystin, has been found occasionally in the Rideau in past years. *Microcystis* colonies form a film on the surface of water in shallow sheltered areas, and so are less likely to be detected during main-channel water sampling.

2.5 Water Quality Indicator: Metals

Background

Some metals are trace elements, occurring naturally in low concentrations in rocks, water and the atmosphere. Of these, some, including cobalt, copper, zinc, nickel and molybdenum, are essential to life in minute quantities, although they can be harmful at higher concentrations. Other trace elements such as mercury and lead are toxic to organisms even at extremely low concentrations.

Aquatic organisms ranging from phytoplankton to invertebrates and fish have been found to suffer from the toxic effects of metals in surface waters, and metals are known to bioaccumulate in the tissue of fish and other animals. While metals may occur naturally in waters as a result of natural weathering and erosion, they may also enter aquatic environments as a result of human activities. Processes such as mining and smelting, manufacturing, combustion of gasoline and wood, waste incineration, and leaching from landfill sites may all contribute to increased levels of metals in surface waters.

The concentration of zinc will be shown as an example of trends in metal concentrations in the Rideau River. Zinc, along with 14 other metals (commonly referred to as “heavy” metals), is monitored monthly by the Ontario Ministry of the Environment at 6 sites between Smiths Falls and Ottawa. Zinc has been found to produce chronic toxic effects in invertebrates and fish at concentrations as low as 0.07 mg/L. The Ontario Provincial Water Quality Objectives (PWQOs) for the protection of aquatic life in freshwaters recommend a maximum zinc concentration of 0.02 mg/L (Appendix 1).

A common way of expressing water quality is to report the frequency with which water samples exceed criteria such as the provincial water quality objectives. The frequency of these “exceedances” of PWQOs is reported below, for the various metals measured in the Rideau River by MOE between 1997 and 2001.

Results

Since 1981, average zinc concentrations in the Rideau River have been lower than the PWQO for the protection of aquatic life, generally ranging between about 0.002 and 0.010 mg/L (Figure 9). These values are similar to average zinc concentrations reported in the Great Lakes, Ottawa River and St. Lawrence River between 1985 and 1990 (0.0073, 0.0111 and 0.0071 mg/L respectively). However, while average annual concentrations of zinc remain below the objective of 0.02 mg/L, individual samples sometimes exceed it. Between 1981 and 2001, 59 samples (or 6.2%) exceeded the PWQO, generally ranging between 0.02 and 0.17 mg/L. Average zinc levels appear to have risen somewhat in the last decade, at least within the City of Ottawa.

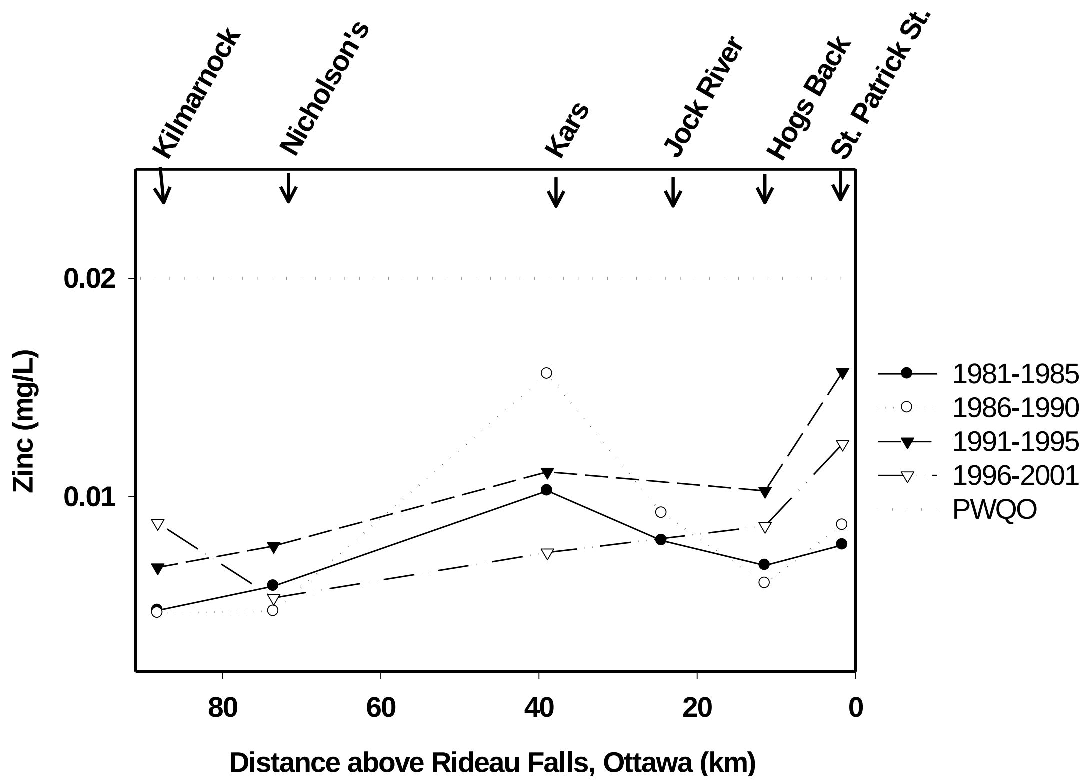

Figure 9 Average zinc concentrations, 1981-2000.
Source: Ministry of the Environment

Between 1997 and 2001, the PWQO values for the protection of aquatic life were rarely exceeded for the 15 metals monitored by MOE in the Rideau River (Table 2). Metal concentrations were usually very low, (below or near the detection limits). Aluminum most frequently exceeded the PWQO, although this may have been influenced by the presence of clay in samples. Aluminum is commonly associated with clay particles, and samples taken from the Rideau are likely not clay-free (as specified in the PWQO). Levels of molybdenum and nickel, considered highly toxic metals, never exceeded the objectives. Exceedances were also not recorded for beryllium, copper, iron, or vanadium. However, cadmium, another highly toxic metal, exceeded the PWQO in 4.4% of samples. The less toxic, zinc, lead and cobalt also occasionally exceeded the provincial objectives.

Table 2 Metal concentrations in the Rideau River, 1997-2001 (mean and maximum concentrations, and percentage of samples exceeding provincial water quality objectives for the protection of aquatic life).

METAL	TOXICITY RATING *	PWQO (MG/L)	#SAMPLES	MEAN	MAX	NUMBER OF EXCEEDANCES	PERCENTAGE OF EXCEEDANCES
Aluminum	12	75	206	38.14	142	16	7.8
Barium	NA	none	206	43.80	68.70		
Beryllium	NA	1100	206	0.01	0.03	0	0
Cadmium	19	0.5	206	0.01	0.88	9	4.4
Chromium	9	1(Cr VI),8.9(Cr III)	205	0.04	2.31	?	?
Cobalt	7	0.9	206	0.05	1.56	7	3.4
Copper	13	5	206	0.25	2.13	0	0
Iron	2	300	166	75.19	292	0	0
Lead	7	5	206	0.25	7.35	9	4.4
Molybdenum	24	40	206	0.00	0.90	0	0
Nickel	22	25	206	0.50	6.66	0	0
Strontium	NA	none	206	150.38	412		
Titanium	NA	none	205	1.08	9.18		
Vanadium	NA	6	206	0.53	2.41	0	0
Zinc	10	20	205	8.38	147	14	6.8

* Toxicity ratings ≥14 = highly toxic; between 7 and 14 = medium toxicity; ≤ 7 = low toxicity; NA = not available

Source: Ministry of the Environment

Limitations

Changes in analytical methods, as well as high error values and reporting of negative values create challenges for interpreting trends in metals data. Some metal concentrations cannot be compared to PWQO values (ex. only total chromium is measured, but PWQOs are given for trivalent and hexavalent forms of chromium). PWQO values are likely fairly conservative, and so it is not clear what the effect on aquatic life of exceedances of these objectives may actually be.

2.6 Water Quality Indicator: Bacteria (*E. coli*)

Background

Both pathogenic (disease-causing) and non-pathogenic microorganisms are found in freshwaters. Pathogenic bacteria, viruses and protozoa may enter rivers through inadequately treated industrial and municipal sewage, storm water overflows, agricultural runoff, leaking septic tanks, and even from large populations of waterfowl. Fecal coliform bacteria, including *Escherichia coli* (*E. coli*) are members of the *Enterobacteriaceae*, which make up approximately 10% of the intestinal microorganisms of humans and other animals. They are widely used as indicator organisms, to provide an index of possible water contamination by human pathogens.

Contact with such fecal pathogens may occur during recreational activities such as swimming, canoeing and sailing. Exposure can increase the risk of developing infections such as stomach disorders and minor infections of the skin, eye, nose and throat. The Ontario Provincial Water Quality Objectives (PWQOs) for safe recreational use of freshwater recommend a maximum acceptable *E. coli* concentration of 100 cells per 100 mL. Swimming beaches are tested weekly during the summer by local medical officers of health, and when average counts of *E. coli* (geometric mean of at least 5 samples) exceed 100 cells per 100 mL, beaches are closed for swimming.

Results

Average *E. coli* concentrations (monitored monthly by the Ministry of the Environment at 5 sites between Smiths Falls and Ottawa) are well below the provincial objective along the Rideau River (Figure 10). However, within the City of Ottawa, *E. coli* counts are consistently higher, and exceeded 100 cells per 100 mL on 18 occasions since 1997. Twelve of these samples were taken at the St. Patrick's Street site, and four were taken from Mooney's Bay at Hog's Back.

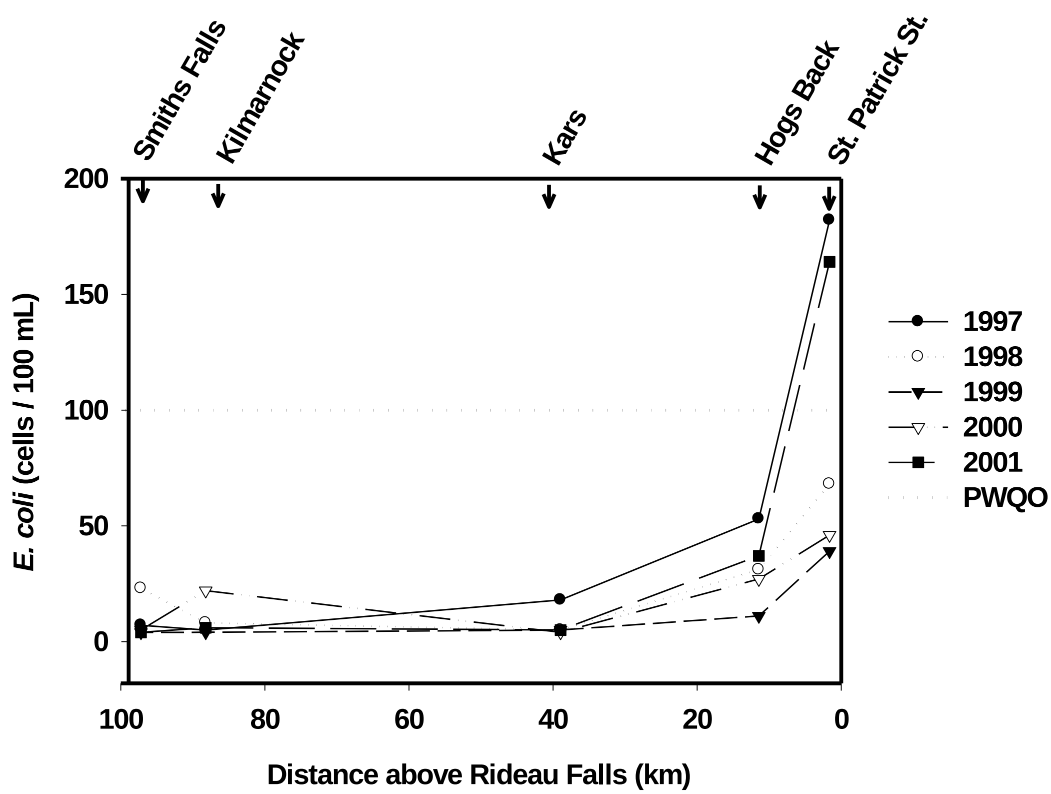

Figure 10 Average *E. coli* concentrations, 1997-2001.
Source: Ministry of the Environment

Six public swimming beaches are located along the Rideau River (Table 3). Beach closures are rare at most beaches; the Baxter Conservation Centre beach has never been closed due to high *E. coli* levels in more than 15 years of operation. However, the Smiths Falls "junior" beach has been closed on at least one occasion for each of the last six summers.

Table 3 Number of annual beach closures on the Rideau River, 1994-2001.

BEACH	NUMBER OF BEACH CLOSURES							
	1994	1995	1996	1997	1998	1999	2000	2001
Smiths Falls "Junior"	0	0	**4**	**1**	**3**	**1**	**2**	**3**
Smiths Falls "Senior"	0	0	0	0	**1**	0	**1**	**2**
Merrickville	0	0	**3**	**1**	0	0	**2**	**1**
Rideau River Provincial Park	0	0	0	0	0	0	0	**1**
Baxter Centre	0	0	0	0	0	0	0	0
Mooney's Bay	N/A	0	0	0	0	0	**3**	0

Sources: Leeds, Grenville and Lanark Health Unit, MNR Public Health Inspector, RVCA (Baxter Conservation Centre), City of Ottawa Public Health Department

2.7 Water Quality - Summary

Water quality in the Rideau River is generally very good. Although the Rideau is a moderately eutrophic, or nutrient-rich river, it is characterized by abundant aquatic plant growth, rather than high concentrations of suspended algae. Therefore, the Rideau River has relatively clear water, and its suspended algal community is dominated by "clean" water species.

- **Total phosphorus (TP)**

There has been a general decline in TP, an important indicator of nutrient enrichment, in the Rideau River since the 1960s. Average annual TP concentrations in the water are currently below the PWQO for the prevention of excessive plant growth in the upper Rideau River, between Smiths Falls and Merrickville. However, TP levels increase downstream along the Rideau, often exceeding the PWQO in the lower reaches of the River. Monitoring TP provides an indication of the level of phosphorus loading, and serves as a predictor of the amount of suspended algae that can develop. However, much of the phosphorus used by rooted plants and filamentous mat-forming algae may be supplied by sediments, rather than the water. Therefore, monitoring TP levels does not necessarily provide information on phosphorus sources that encourage the growth of "problem" aquatic plants and algal mats in the Rideau River. Even if water quality improves, there will still continue to be abundant plant growth in the Rideau.

- **Nitrate + nitrite**

Unlike phosphorus, there has not been a decline in nitrogen concentrations in the Rideau over the past few decades. Average annual nitrate + nitrite concentrations are relatively low in the upper Rideau River, but some years they increase substantially in the urban section below the Jock River. This may be the result of inputs from agricultural land along the Jock River or urban sources in the City of Ottawa, or decreases in the natural uptake of nitrogen resulting from the loss of natural shoreline in developed areas. Substantial year-to-year variations may be due to yearly differences in precipitation and river discharge. Nevertheless, nitrate + nitrite concentrations are lower than those considered potentially harmful to aquatic life and hazardous to human health.

- **Dissolved oxygen (DO)**

On average, DO concentrations are well above the minimum concentrations recommended for the protection of warm-water aquatic life. However, during the summer, DO is sometimes very low at the river bottom in deep areas, particularly in Mooney's Bay. It is likely that aquatic organisms in these deep areas suffer from oxygen stress. In addition, oxygen might become depleted in shallow weedy areas at nighttime or while plants and algal mats are decaying, but these areas are currently not being monitored.

- **Algal abundance (Chl *a*)**

On average, the Rideau River has somewhat lower Chl *a* than other lowland rivers in eastern Canada. Algal biomass has declined slightly since 1993, particularly in the lower section of the Rideau (below Kars), probably as a result of heavy colonization of the River by zebra mussels. While Chl *a* concentration is useful as a rough estimate of the abundance of phytoplankton, it does not give any information regarding the composition of the algal community. Continued monitoring of the taxonomic composition of this algal community is critical for assessing water quality. Currently, concerns with algae in the Rideau involve the development of filamentous algal mats, and the possibility of the growth of colonies of toxic blue-green algae. These algae are mainly associated with the extensive shallow areas of the River, and monitoring efforts to date have focused primarily on the deeper main navigation channel.

- **Metals**

Metal concentrations generally meet the PWQOs for the protection of aquatic life. Most "heavy" metals are usually found at trace levels, or at concentrations below detection limits. The concentrations of some metals (aluminum, cadmium, cobalt, lead and zinc) occasionally exceed PWQO levels, particularly in the lower Rideau River as it passes through the City of Ottawa.

- ***E. coli***

Concentrations of *E. coli* are typically low in the Rideau River. Generally, beach closures are infrequent on the Rideau. However, there are recurring problems with elevated levels of *E. coli* at some sites, notably in Ottawa, (near St. Patrick St.) and at the "Junior" beach in Smiths Falls.