

**DOCUMENTATION OF THE NUISANCE ALGA,  
*Cladophora*  
IN THE SYDENHAM RIVER  
GREY COUNTY**

**June 1992**

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## TABLE OF CONTENTS

	PAGE
List of Figures	ii
List of Plates	ii
List of Tables	iii
BACKGROUND	1
INTRODUCTION	2
<i>Cladophora</i> in Southwestern Ontario 1990-1992	3
METHODS	5
RESULTS AND OBSERVATIONS	7
Water Sample Analysis	17
DISCUSSION	21
Effects of <i>Cladophora</i>	21
Nutrient Sources	22
SUMMARY	24
RECOMMENDATIONS	25
LITERATURE CITED	26

## List of Figures

		PAGE
Figure 1	Location of transects and sampling sites on the Sydenham River, June 1992.	8
Figure 2	Observations along site 1 transect, located downstream of Mill Dam in Owen Sound.	13
Figure 3	Observations along site 2 transect, located in Harrison Park.	14
Figure 4	Observations along site 3 transect, located above Inglis Falls.	19

## List of Plates

		PAGE
Plate 1	<i>Cladophora</i> growing on the cement spillway of the Mill Dam.	10
Plate 2	Heavily silted and dying <i>Cladophora</i> in slow flow area downstream of Mill Dam.	10
Plate 3	Sampling <i>Cladophora</i> at transect 1, downstream from Mill Dam.	11
Plate 4	<i>Cladophora</i> covered substrate in a fast flow area, downstream from the Mill Dam, as viewed through a 0.09 m <sup>2</sup> plexi-glass sheet.	11

### **List of Plates - continued**

		PAGE
Plate 5	Cladophora growth in the fast flowing section of river between Harrison Park and Inglis Falls.	12
Plate 6	Cladophora growth upstream from transect 2 in Harrison Park.	12
Plate 7	Luxuriant growths of Cladophora on and at the base of Inglis Falls.	18
Plate 8	Cladophora covered rock at the base of Inglis Falls.	18

### **List of Tables**

		PAGE
Table 1	Observations of Cladophora growth and habitat characteristics in the Sydenham River system upstream of Inglis Falls on June 3, 1992.	9
Table 2	Observations along transects at three locations on the Sydenham River, Grey County, June 1-2, 1992. Values for current, habitat and health are explained in methods.	15
Table 3	Water characteristics at seven stations along the Sydenham River, Grey County, June 3, 1992.	20

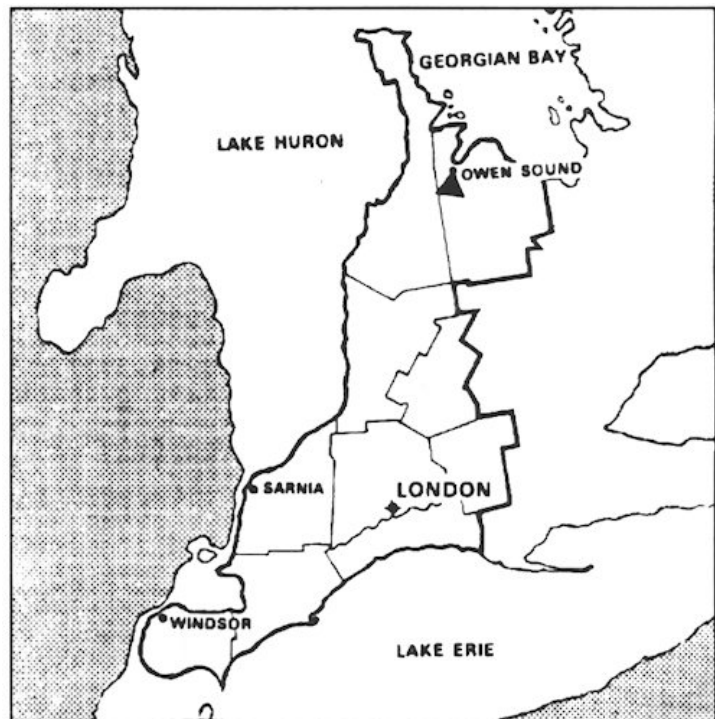


## BACKGROUND

The Sydenham River is a high quality clear flowing trout stream located in Grey County. The river flows north 35 km from its source, Williams Lake in Holland Township, to empty into Owen Sound at the City of Owen Sound. The Spey and North Spey Rivers issue from Sydenham Township and are tributaries to the Sydenham River.

Their combined flows plunge over the Niagara Escarpment at Inglis Falls immediately south of the City of Owen Sound. The 3.5 km section of river and river valley downstream from the falls is unique. There are very few streams in the Southwestern Region which could match the scenic, natural and fishery values of this resource.

The following report was produced to document evidence of degraded water quality in the Sydenham River. Increased nutrient loadings have resulted in the unfortunate arrival of nuisance growths of the alga *Cladophora*.



Study Area: Triangle marks location of Sydenham River Basin.

## INTRODUCTION

*Cladophora* is an opportunistic plant associated with nutrient rich waters and can be said to be indicative of eutrophication (Pitcairn and Hawkes, 1973). Its occurrence is typically documented downstream of human activity, such as sewage treatment plants, agricultural areas, urban or developed areas, and industrial point discharges. *Cladophora* requires a number of conditions to grow:

1. excessive nutrients.
2. sunlight (length of photoperiod).
3. current (flowing water).
4. solid substrate (rock, concrete, logs).

The standing crop of *Cladophora* varies with the above physical conditions. Phosphorus is the primary limiting nutrient affecting its growth (Pitcairn and Hawkes, 1973), but it typically thrives in waters high in nitrogen, calcium, and to a lesser extent, magnesium. The quantity of sunlight reaching the bottom of a stream is affected by turbidity, depth, and vegetative cover. Field observations and studies have indicated that *Cladophora* growth is directly proportional to current and the availability of stable substrate. Moving water transports the necessary nutrients from the source to the plant.

Optimal growth occurs near 18°C and growth ceases near 25°C (Storr and Sweeney, 1971). *Cladophora* has two growth phases each year. The first growth phase occurs in the spring as water temperatures rise to its ideal temperature range. The second growth phase occurs in the autumn, when the water cools back down to the ideal temperature range.

Historically, the availability of nutrients has been the limiting factor inhibiting excessive growths of *Cladophora* in the Sydenham River. The Sydenham River is a clear, cold river with rock and cobble substrate which provides ideal conditions for this invading alga. This report documents the presence of nuisance *Cladophora*, in the Sydenham River, as observed by Ministry of the Environment staff (Water Resources Assessment Unit, Southwestern Region) from June 1 to 4, 1992.

### ***Cladophora* in Southwestern Ontario 1970 - 1992**

The severe nutrient enrichment of Lake Erie through the 1960's and 1970's resulted in luxurious growth of *Cladophora*. Thousands of tonnes of *Cladophora* were annually deposited on beaches and shorelines in the western basin of Lake Erie, contributing to a severe oxygen depletion as it decomposed.

*Cladophora* has similarly caused serious water quality problems in southwestern Ontario streams. The North Thames and Avon Rivers supported dense growths of *Cladophora* throughout the 1970's and early 1980's. Upgrading the sewage treatment plants at Stratford and St. Mary's, and initiating agricultural land-use conservation programs (manure management, soil conservation, etc.) have reduced the problem significantly, but not completely.

Nuisance growths were reported in the Bayfield and Maitland river systems in the 1980's, coincident with increased intensive farming practices, including corn (intensive row cropping) and hog production (liquid manure waste handling problems). These agricultural activities increased the area of land drainage and consequently reduced wetland coverage throughout the Maitland River basin. Farming techniques throughout the 1970's and 1980's promoted larger farms that resulted in the loss of riparian vegetation along streams. The loss of this vegetation exposed streams to full sunlight,

thereby creating ideal conditions for algae growth. Municipal sewage lagoons have contributed significantly to the *Cladophora* problem through nutrient and organic loadings. Sewage facilities are now being upgraded, while the agricultural community is now addressing soil erosion problems and improving farming practices to reduce the nutrient load to streams.

The Ministry of the Environment, Southwestern Region, has repeatedly stated the need for control of nutrients in the high quality, sensitive waters of Grey County. Studies along the Lake Huron and Georgian Bay shoreline have documented the presence of excellent habitat for *Cladophora*. Because of this prime physical environment for *Cladophora*; special efforts have already been made (e.g. Mary Ward Shoals near Collingwood) to prevent problem growths, and these special efforts must continue and intensify.

The Bighead, Beaver, Saugeen, Sydenham and Pottawatomi Rivers have been subject to localized but increased growths of *Cladophora* during the late 1980's and early 1990's. This macroalga was virtually non-existent in these systems in the 1970's (Westwood personal observations). In response to these observations, the Ministry of the Environment requested phosphorus control at Markdale on the Rocky Saugeen River. This river not only has excellent water quality, but is probably the finest brook char stream in Southern Ontario. Markdale has operated a rapid infiltration system for phosphorus control over the past 6 years. Treatment of sewage is afforded by the subsurface geological environment and "final" polishing of the effluent is achieved by various attenuating processes within the soils. This system appears to be working, as *Cladophora* is not a problem downstream of Markdale. At this time, the Village of Flesherton (in the Beaver River basin) is proceeding with the installation of state-of-the-art phosphorus removal technology to address nutrient concerns in the Beaver River before nuisance growths of *Cladophora* are realized.

In summary, the growth of *Cladophora* indicates severe eutrophication processes at work. This problem is preventable and should not be allowed to occur in the high quality waters of Grey and Bruce Counties. A pro-active approach must be continued and increased to control nutrient loadings from new land-use activities and abate existing phosphorus sources.

## **METHODS**

In order to quantify the extent of *Cladophora* growth in the Sydenham River, cross sections were established at three stations. The width of the river was measured and observations were made at 1 metre intervals pertaining to depth, substrate, percent *Cladophora* cover, frond length (filament length), water velocity, and any other pertinent observations. At these three stations, photographs of the river bottom were taken through a sheet of plexi-glass. The plexi-glass was held on the surface in order to break the surface tension and reduce glare.

Nine algal samples were collected using a Surber sampler (0.09 m<sup>2</sup>), three at each cross section. To obtain wet weight values, *Cladophora* samples were squeezed gently by hand, spread out in an enamel tray, damp dried with paper towels and weighed. To obtain air dry weights, samples were dried in the sun for three days (stored in doors during the night) and then weighed. Oven dry weights were obtained by placing samples in an oven at 103°C for 8 hours.

Six additional sites were visited throughout the Sydenham River basin and observations were made regarding water temperature, suitability of habitat, water velocity, percent cover and health of *Cladophora*. A rapid assessment of current, habitat and *Cladophora* health were evaluated visually, and each characteristic was given a rating of 1 - 3. The rating system was as follows:

### **Stream Velocity** (current)

- 1 - slow flow, depositional area.
- 2 - moderate flow areas.
- 3 - fast velocity, riffles, rapids, etc.

### **Habitat**

- 1 - severe habitat limitations, ie. poor substrate, heavy shade.
- 2 - moderate habitat conditions.
- 3 - excellent conditions to support growth, ie. rock bottom, light exposure.

### **Health**

- 1- dead, dying, heavily silted, or decaying *Cladophora*.
- 2- no active growth, dark green *Cladophora*.
- 3- vigorous growth, bright green, long frond length.

Site photographs were taken at each of the observation stations to document existing conditions and sampling locations. Water samples were taken at stations 3 to 9 and analyzed for: suspended solids, total Kjeldahl nitrogen, nitrite, nitrate, ammonia, total phosphorus, soluble reactive phosphorus, chloride, pH, conductivity, and turbidity. Analyses were performed at Ministry of the Environment Laboratories in London.

In addition to the individual stations, a 4-km stretch of the river (from Harrison Park to Highway #6 by-pass) was walked and photographs were taken documenting the presence of *Cladophora*.

Station locations were recorded by written description and by UTM coordinates.

## RESULTS AND OBSERVATIONS

The study area and sampling locations are shown on Figure 1; a map of the Sydenham River. Table 1 documents the *Cladophora* growths observed and the potential of the habitat conditions to support the growth of *Cladophora* in the upper river.

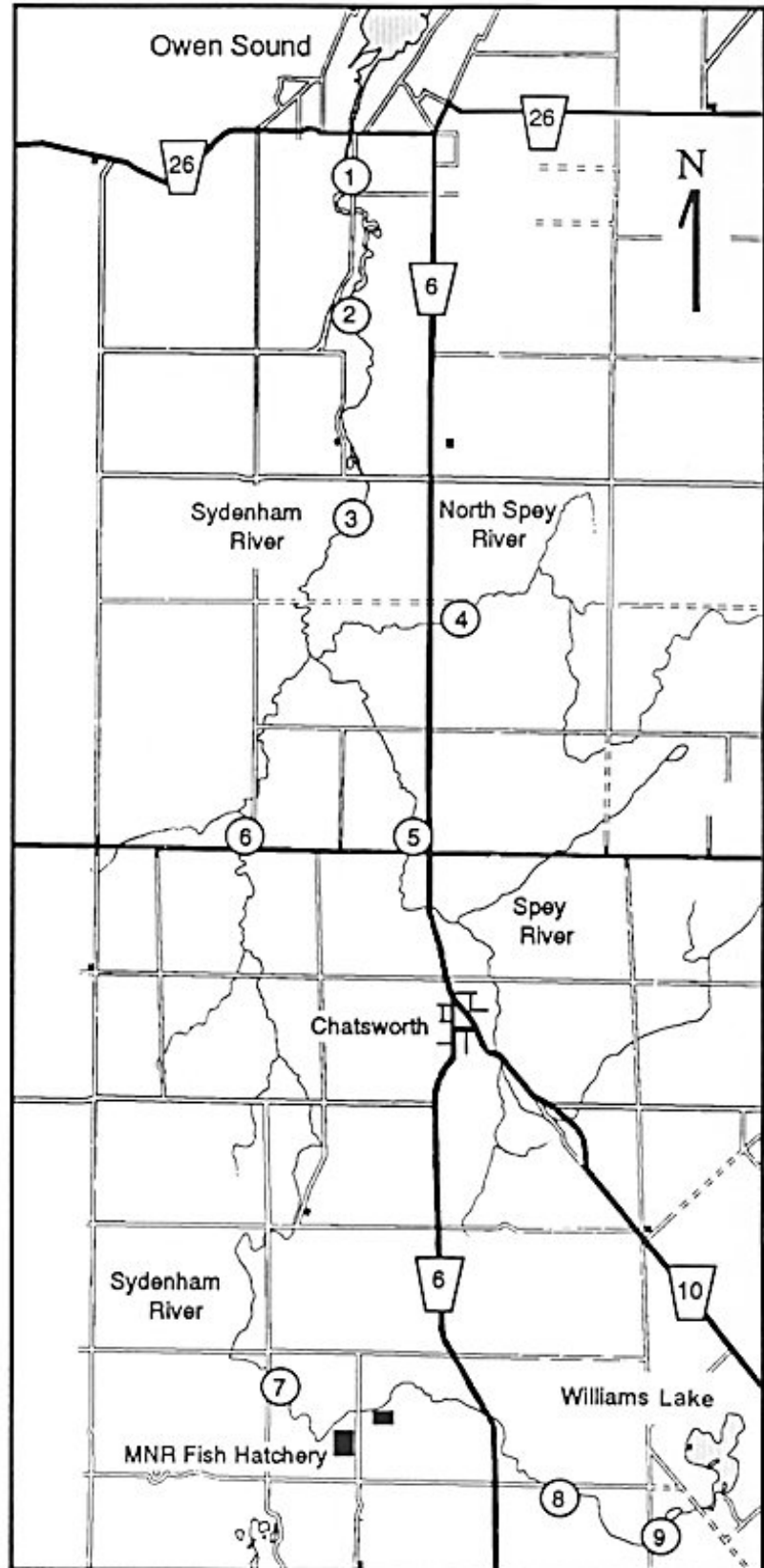
Visual observations June 1 - 3, 1992 documented nuisance growths of *Cladophora* in the Sydenham River upstream from Inglis Falls to downstream of the Mill Dam in Owen Sound. This alga covered the cement spillway of the Mill Dam (Plate 1) and the cobble rock substrate downstream, for a distance of approximately 140 metres at which point substrate conditions become the limiting factor (sand, silt).

The cross-sectional profile of the river 90 metres downstream from the Mill Dam is graphically depicted in Figure 2. The *Cladophora* growths illustrated are representative of the entire growth area downstream from the dam. The shallower, slow flow sections of the river contained heavily silted, rotting deposits of *Cladophora* (Plate 2). The fast flow sections contained lush green growths with maximum frond lengths reaching 75 cm (Plate 3 and 4). Table 2 provides information on the physical data collected: river width, depth, percent *Cladophora* cover, maximum frond lengths, and wet, air dried and oven dried weights of the *Cladophora* samples. This data will be useful for future comparisons.

The second cross-sectional profile of the river was established in Harrison Park upstream from the Mill Pond. The stream flows rapidly over rock and cobble substrate in this section. The river valley is heavily forested and the stream shaded. Despite the shading provided by the hardwood forest cover, *Cladophora* was thriving (Plates 5 and 6). Figure 3 depicts the growth present on June 2, 1992. This sample site produced

**Figure 1:**

Location of transects and sampling sites on the Sydenham River, June, 1992.



**Table 1:** Observations of *Cladophora* growth and habitat characteristics in the Sydenham River system, upstream of Inglis Falls on June 3, 1992.

Station	Time (pm)	River	Location UTM coordinates	Water Temp.	Observations †
3	3:29	Sydenham	505500 E* 4929600 N	17 °C	abundant <i>Cladophora</i> habitat 3, current 3
4	1:33	N. Spey	506800 E* 4927700 N	17° C	<i>Cladophora</i> <10% habitat 3, current 2+
5	1:43	Spey	507180 E** 4924400 N	18° C	<i>Cladophora</i> absent habitat 2 , current 2
6	1:52	Sydenham	504600 E** 4924000 N	15° C	<i>Cladophora</i> absent habitat 1, current 1
7	2:27	Sydenham	506300 E** 4916600 N	15° C	<i>Cladophora</i> <10% habitat 2, current 2
8	2:40	Sydenham	510650 E** 4915600 N	15 °C	<i>Cladophora</i> <10% habitat 1, current 2 abundant watercress
9	2:51	Sydenham	512500 E** 4915050 N	20 °C	<i>Cladophora</i> absent habitat 1, current 2

\*\* NTS 1:50,000 41 A/7

\* NTS 1:50,000 41 A/10

† for habitat and current values, refer to methods

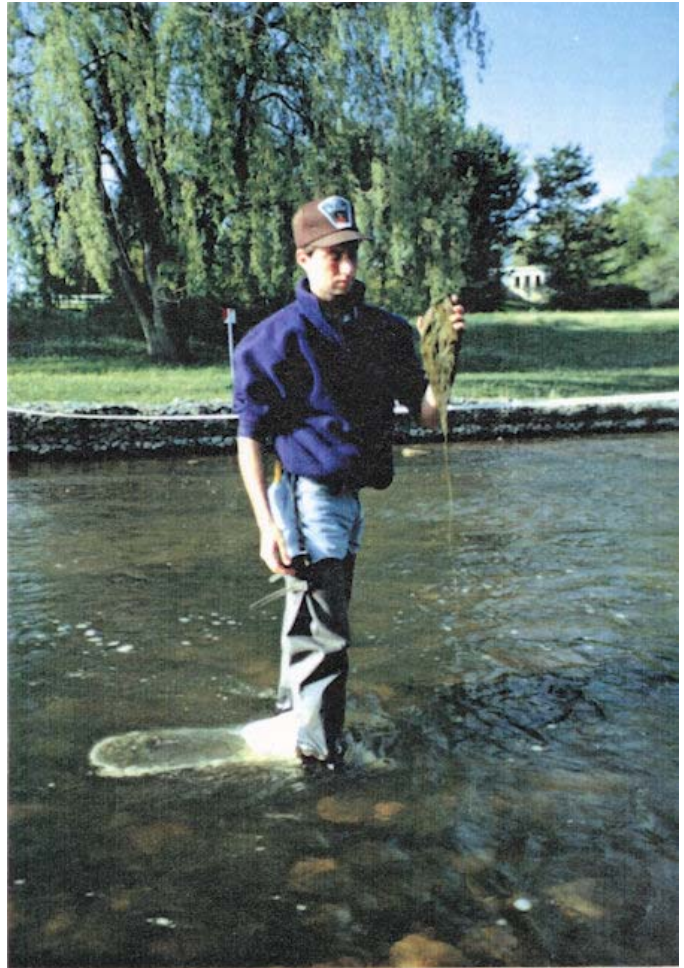


**Plate 1:** *Cladophora* growing on the cement spillway of the Mill Dam.

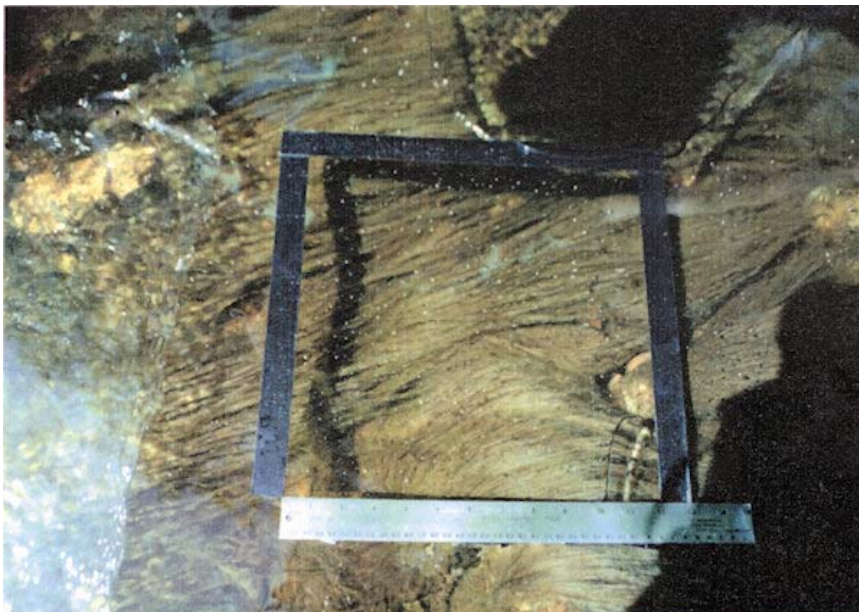


**Plate 2:** Heavily silted and dying *Cladophora* in slow flow area downstream of Mill Dam.

**Plate 3:** (right)  
Sampling *Cladophora* at  
transect 1, downstream from  
Mill Dam.

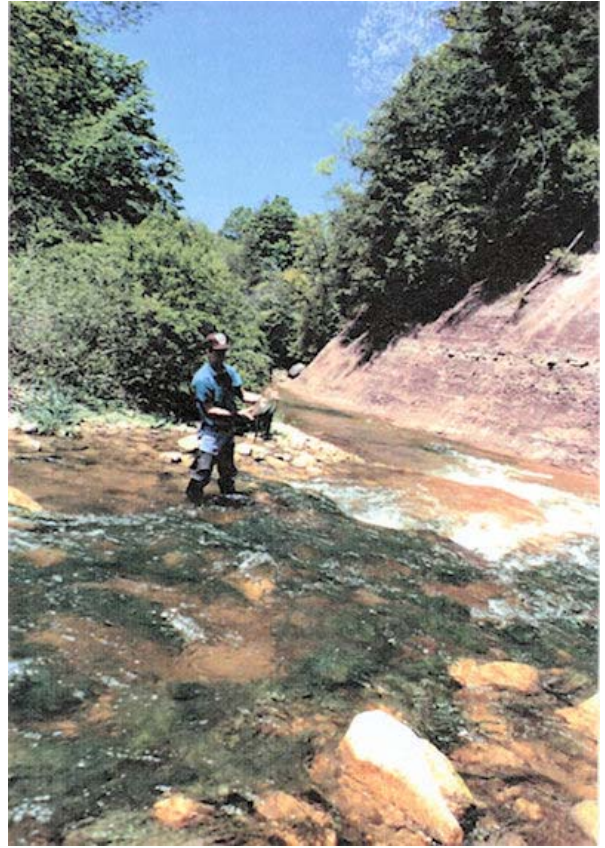


**Plate 4:** (below)  
*Cladophora* covered substrate  
in a fast flow area,  
downstream from the Mill  
Dam, as viewed through a  
0.09 m<sup>2</sup> plexi-glass sheet.



**Plate 5:** (right)

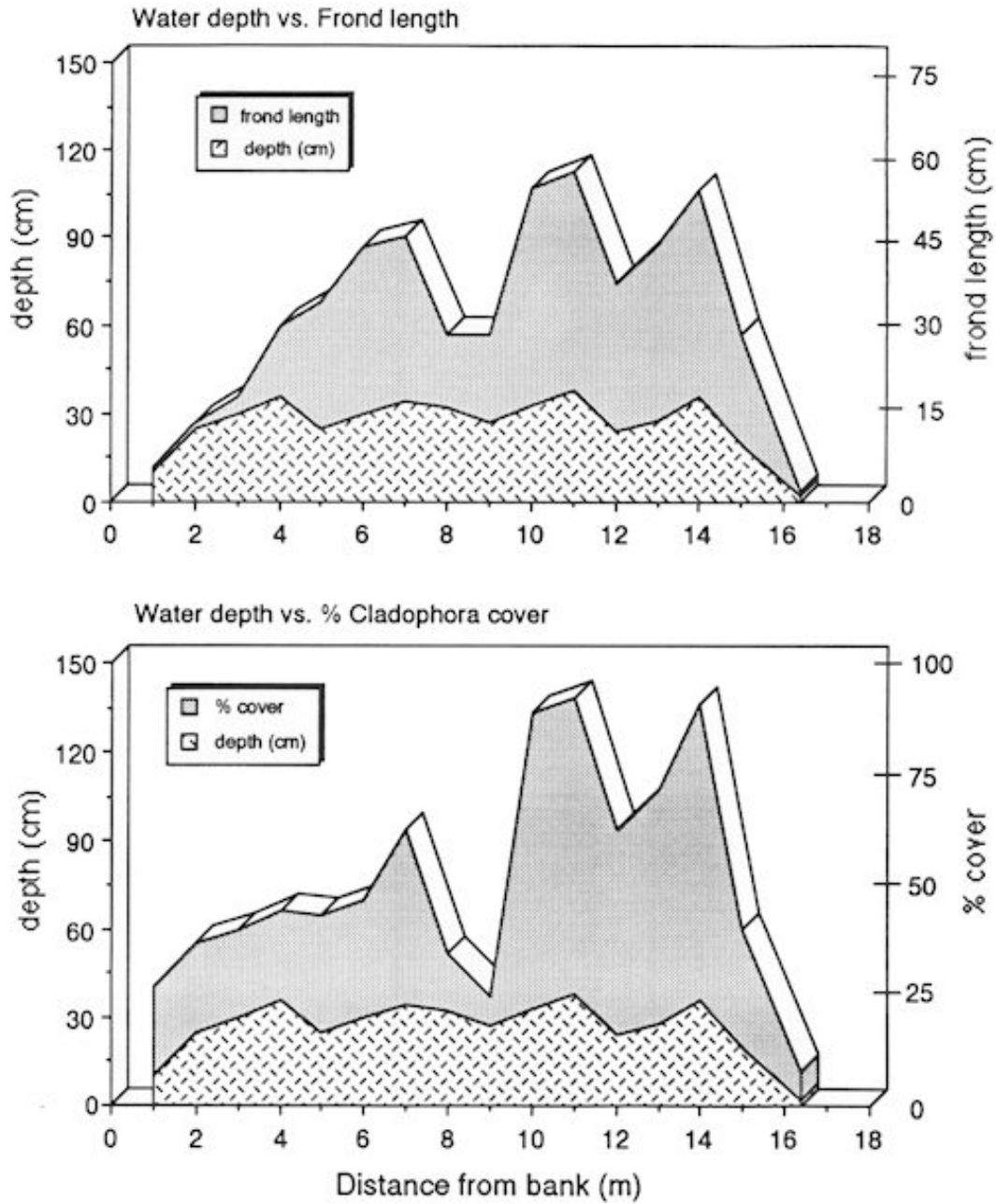
*Cladophora* growth in the fast flowing section of river between Harrison Park and Inglis Falls.



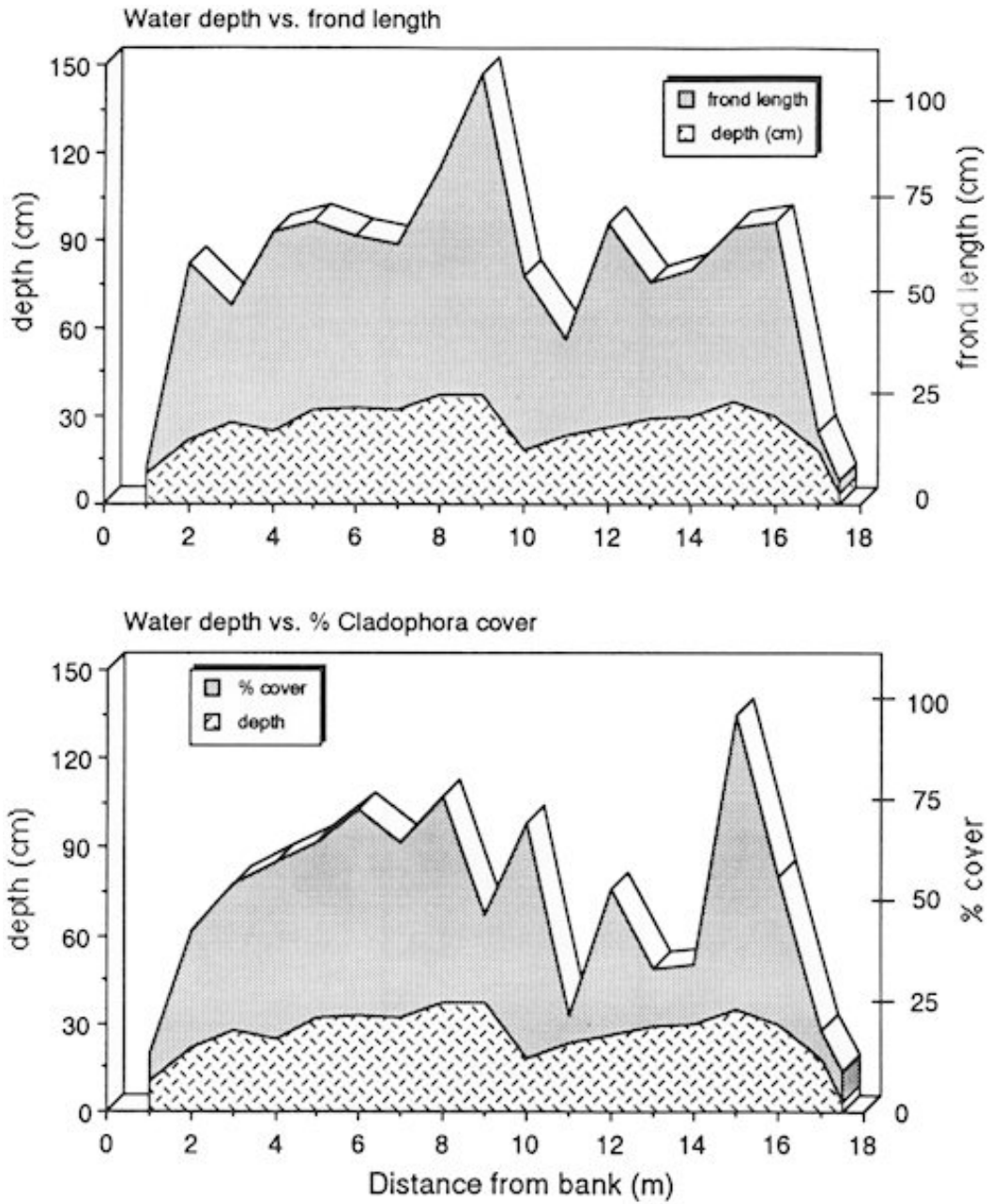
**Plate 6:** (below)

*Cladophora* growth upstream from transect 2 in Harrison Park.





**Figure 2:** Observations along site 1 transect , located downstream of Mill Dam in Owen Sound.



**Figure 3:** Observations along site 2 transect, located in Harrison Park.

**Table 2:** Observations along transects at three locations on the Sydenham River, Grey County, June 1-2, 1992. Values for current, habitat and health are explained in methods.

**A: Transect at site #1, located downstream of Mill Dam in Owen Sound**

width (m)	depth (cm)	current	% cover	habitat	frond length (cm)	health	wet weight (g)	air dry weight (g)	oven dry weight (g)
1	10	1	30	1	2	1			
2	25	2	30	1	2	2			
3	30	2+	30	2-	6	2+			
4	36	2	30	1	24	2+			
5	25	2+	40	2	43	2	52	13.9	13.8
6	30	3-	40	3	57	2+			
7	34	3-	60	3	56	3			
8	32	3	20	3+	25	2			
9	27	3+	10	3+	30	3			
10	33	3+	100	3+	74	3	151	12.9	12.81
11	38	3	100	3	75	3			
12	24	3	70	3+	50	3			
13	28	3	80	3	60	3	158	9.8	9.71
14	36	2+	100	2	70	2			
15	20	1	40	1+	37	1			
16.4	2	1	10	1	2	1			

**B: Transect at site #2, located in Harrison Park**

width (m)	depth (cm)	current	% cover	habitat	frond length (cm)	health	wet weight (g)	air dry weight (g)	oven dry weight (g)
1	10	1+	10	2-	2	1-			
2	22	3-	40	2-	60	3			
3	28	3	50	3	40	3			
4	25	3	60	3	68	3			
5	32	3+	60	3+	65	3	94	4.69	4.66
6	33	3+	70	3+	59	3			
7	32	3+	60	3+	57	3+			
8	37	3+	70	3	78	3+			
9	37	3	30	2	110	3	135	21.05	20.78
10	18	3	80	3+	60	3			
11	23	3	10	2	33	3			
12	26	2+	50	2	70	2+			
13	29	2+	20	2-	47	2+			
14	30	2-	20	2	50	2-	135	14.8	14.7
15	35	2-	100	1+	60	1+			
16	30	1	50	1+	67	1			
17	18	1	10	1	7	1			
17.5	4	1-	10	1	4	1			

**Table 2: CONTINUED****C: Transect at site #3, above Inglis Falls**

width (m)	depth (cm)	current	% cover	habitat	frond length (cm)	health	wet weight (g)	air dry weight (g)	oven dry weight (g)
1	0	1-	0	1-	0	1-			
2	38	3+	50	3+	85	3			
3	40	3+	80	3+	90	3+			
4	36	3+	70	3+	60	3			
5	25	3	70	3	40	3	223	11.2	11.03
6	19	2	80	3+	57	3			
7	22	3-	80	3+	50	3	48	7.03	6.95
8	26	3	70	3	37	3+	240	10.9	10.72
9	26	3	60	3	80	2			
10	13	2	20	2	40	2-			
11	12	1	10	1+	2	1			
12	12	1	10	1	2	1-			

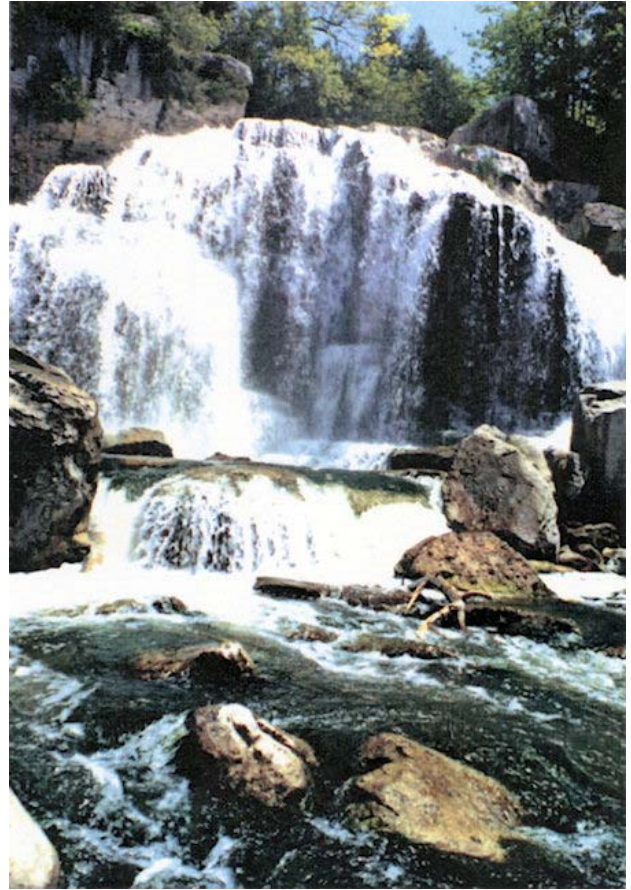
the maximum frond length observed; 110 cm and the heaviest dry weight per 0.09 m<sup>2</sup> sampled (Table 2B). Plates 7 and 8 document the luxuriant *Cladophora* growths on and at the base of Inglis Falls.

Cross-sectional profile 3, was established 20 metres downstream from the old waterworks dam south of Grey County Road 18, upstream from Inglis Falls (Figure 4). *Cladophora* growths appeared at their peak level of production at this site. Large masses easily broke free when disturbed and moved downstream with the current. *Cladophora* covered the cement spillway and was observed on the cement dam abutments. Due to the poor physical condition of the alga at this site, it was difficult to obtain a representative wet weight (Table 2C). The 0.09 m<sup>2</sup> samples could not be properly dried with a paper towel due to their fragile condition. It is at this stage in its growing cycle that *Cladophora* can rapidly slough off, disappearing in a matter of hours or days.

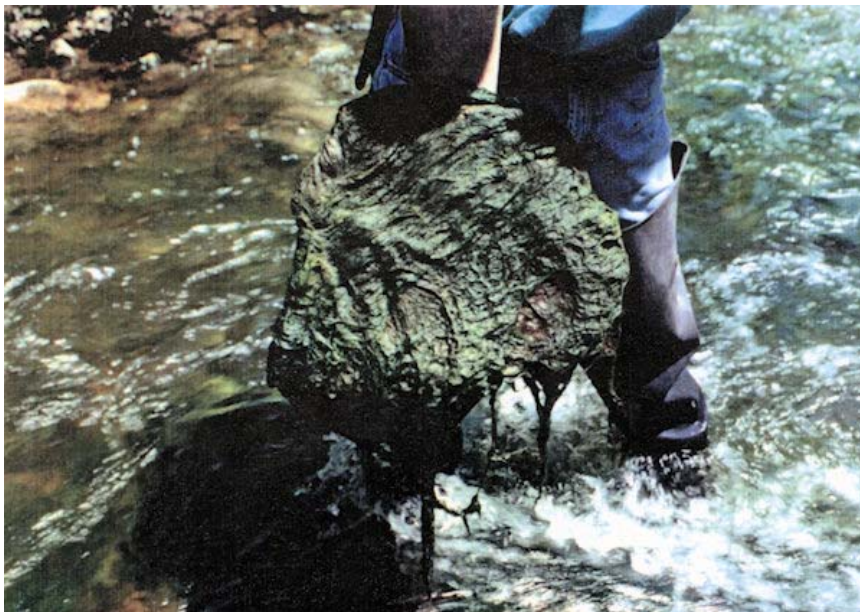
### **Water Sample Analysis**

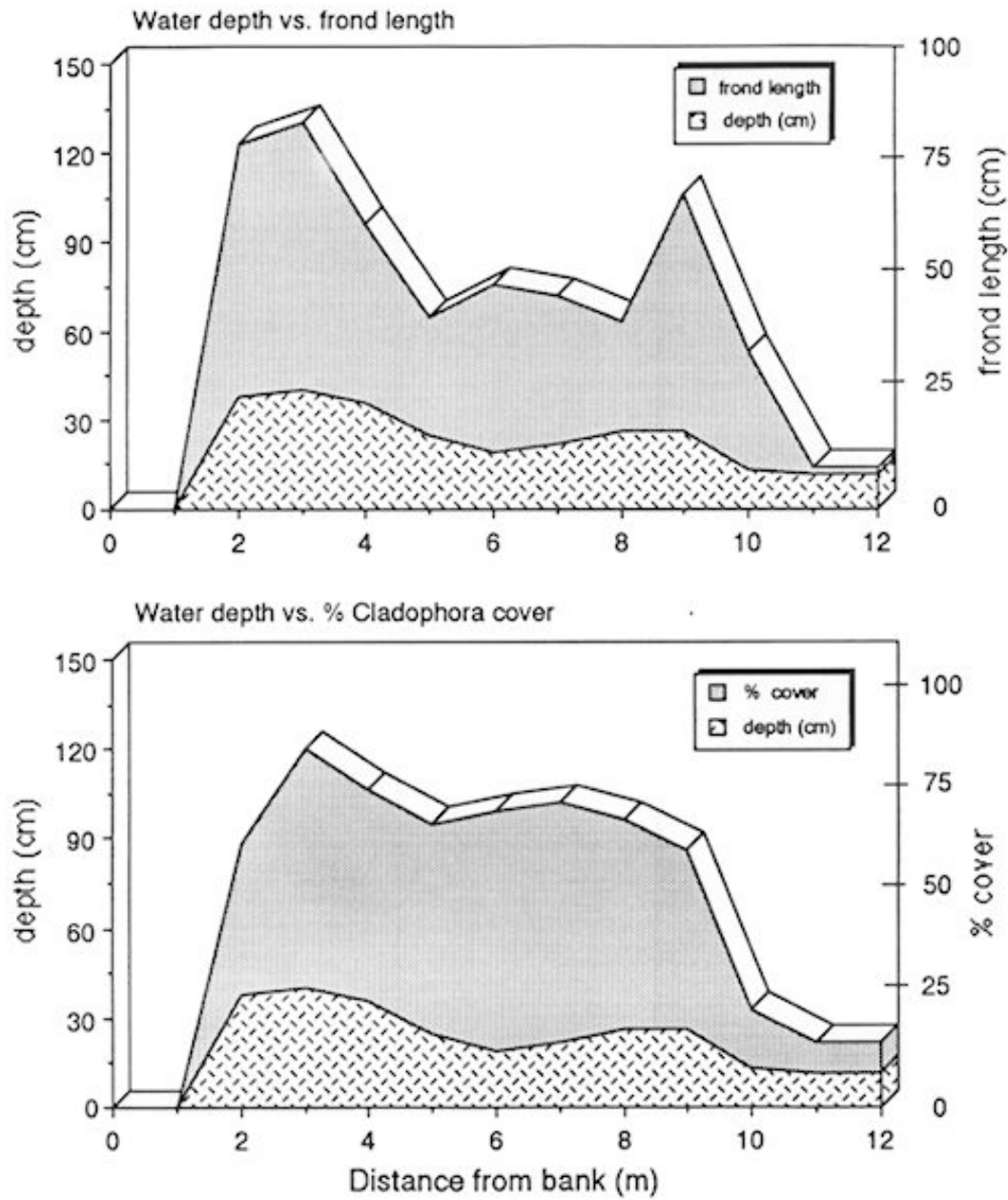
The results of the water chemistry data analysis are tabulated in Table 3. The data document the chemical quality of the water at a given point in time based on one sample. It was not the intent of this study to provide intensive water chemistry data to specifically define pollution sources. The data were collected to provide an insight into the overall character of the stream throughout the upper river basin on June 3, 1992. Due to the sample period occurring in June, which is an active growth period for plants (rapid nutrient uptake period), the nitrogen and phosphorus results would be expected to be extremely low at all stations. It is significant, therefore, that elevated phosphorus levels were documented downstream from the Chatsworth Provincial Fish Hatchery. The hatchery is located in Sullivan Township approximately one Concession west of where the river crosses Highway #6.

**Plate 7:** (right)  
Luxuriant growths of *Cladophora* on  
and at the base of Inglis Falls.



**Plate 8:** (below)  
*Cladophora* covered rock at the base  
of Inglis Falls.





**Figure 4:** Observations along site 3 transect, located above Inglis Falls.

**Table 3:** Water characteristics at seven stations along the Sydenham River Grey County, June 3, 1992.

Site	Suspended Solids	Free Ammonia	Total Kjeldahl Nitrogen	Nitrite	Nitrate	Total Phosphorus	Soluble Reactive Phosphorus	pH	Conductivity	Chloride	Turbidity
3	5.8	0.052	0.4	0.01	0.9	0.018	<0.001	8.53	456	13.4	3.50
4	2.5	0.054	0.4	0.01	<0.01	0.010	0.002	8.48	507	8.7	1.75
5	2.9	0.048	0.34	<0.01	<0.01	0.013	0.002	8.47	516	14.7	1.15
6	8.0	0.040	0.39	0.02	0.9	0.027	0.011	8.36	536	13.8	5.30
7	10.3	0.015	0.28	0.02	0.4	0.028	0.005	8.43	512	11.8	2.00
8	3.3	0.029	0.25	0.01	0.5	0.007	0.004	8.17	493	11.1	0.85
9	<5.0	0.054	0.36	0.01	<0.01	0.007	0.005	8.37	532	13.3	1.29

Total phosphorus levels quadrupled from 0.007 mg/L upstream at station #8 to 0.028 mg/L at downstream station #7. Suspended solids levels also increased downstream from the hatchery at station #7.

Overall, the water chemistry data indicate well buffered waters (pH alkaline). Suspended solids and turbidity levels are extremely low resulting in the clear transparent waters of the Sydenham River.

## **DISCUSSION**

### **Effects of *Cladophora***

Nuisance levels of *Cladophora* have many effects on the ecology of freshwater streams such as the Sydenham River in Grey County. *Cladophora* is known for its aesthetic degradation of streams. As a result of increased photosynthesis and respiration by *Cladophora* severe dissolved oxygen fluctuations occur daily causing stress to aquatic organisms. Large amounts of oxygen are consumed during the decay phase, disrupting the oxygen regime of the river. *Cladophora* covers the substrate thereby reducing natural aquatic habitat. Rotting *Cladophora* can cause severe odour problems. During storm events, large mats of *Cladophora* detach and accumulate in slow moving areas where they continue to grow. Photosynthesis by *Cladophora* in these areas can cause an increase in pH (Bellis and McLarty, 1967). Siltation occurs due to the reduction in water velocity through dense *Cladophora* mats. Siltation of riffle areas may significantly affect the survival of fish eggs.

Control of *Cladophora* growth can be attained by managing nutrient levels in the aquatic environment. Phosphorus is typically the limiting factor in controlling algal growths. It is rapidly taken up by plants in aquatic environments. Aquatic organisms

feed on plants and, in turn, store phosphorus. Phosphorus levels documented by chemical analysis of water samples are often simply a reflection of phosphorus that has not been consumed or stored at a given moment within the biotic environment. Natural systems have nutrient cycles. For example: wetlands store total phosphorus during the growing season but, may release reactive phosphorus after the growing season (fall). The extensive growths of *Cladophora* in the Sydenham River indicate that the aquatic community is under significant stress. Loss of biological diversity in the aquatic community, as a result of these stresses, further reduces the stream's ability to properly process incoming phosphorus loadings.

## **Nutrient Sources**

The nuisance levels of *Cladophora* in the Sydenham River can not be attributed to any one source, but are the result of cumulative impacts.

### **1. Chatsworth Fish Hatchery**

Operated by the Ministry of Natural Resources, the Chatsworth Fish Hatchery is the largest point source discharge on the Sydenham River. Wastes from this hatchery are discharged directly into the Sydenham River with no treatment. Findings from a recent study (Hawkins, 1991) concluded that the hatchery discharge exceeds Ministry of the Environment guidelines. Serious disruption of the macroinvertebrate community resulted from the hatchery operations (Griffiths, 1992, unpublished data). Historically the fish hatchery has been a nutrient source; studies by Bowman, 1978 revealed "an 80% cover of *Cladophora* and luxuriant growths of water cress" in the receiving stream downstream of the hatchery. Studies by Osmond, 1972 summarized, " Impairment was evident on an upstream tributary where additional rearing ponds were being constructed and two miles below the hatchery where mild organic pollution was evident."

The Chatsworth Fish Hatchery discharges into the main branch of the Sydenham River through a short tributary. The water samples collected on June 3, 1992 revealed phosphorus levels one Concession downstream, approximately four times greater than those found upstream of the hatchery. Phosphorus levels in the Spey River and North Spey River were somewhat lower than those found in the main branch of the Sydenham River, downstream of the hatchery (Table 3).

## **2. Increased Residential Development**

Increasing residential development is occurring in the headwaters of the Sydenham River including the areas of Williams Lake, the North Spey River and the upper Spey River. Groundwater contributes a large proportion of the flow to the Sydenham River. Contamination of groundwater because of septic systems may be contributing nutrients to the Sydenham River. Ministry of the Environment long-term monitoring data have shown an increase in the levels of nitrate in groundwater and surface water in many parts of the Southwestern Region. Locating residential developments in headwater areas can result in long term water-quality impacts to surface and groundwaters. Although the Chatsworth Fish Hatchery is itself a significant nutrient source to surface waters, it depends on high quality surface and groundwater supplies to carry out its function. Severance activity in the vicinity of the hatchery now threatens to degrade its water supply. Nitrate loadings from private sewage facilities (septic tanks and filter beds) are not controllable and represent a risk to the fish hatchery.

### **3. Agriculture**

Agricultural practices such as poor manure handling, cattle access to streams and the application of fertilizer are known to be major contributors to elevated levels of nutrients in agricultural river basins. Row crops such as corn leave soils vulnerable to erosion.

Historically, farming in the Sydenham River basin has been non-intensive pasture grass farms. Some row cropping occurs, but from general observation, agriculture appears to be non-intensive, especially when compared to river basins to the south (South Saugeen and Maitland River, etc.).

The majority of the Sydenham River and its tributaries are in near natural state with extensive forest cover and riparian vegetation (wetlands). The rural landowners and conservation and sportsmen's organizations have been working together since the 1940's to protect and enhance the Sydenham River. Their combined conservation efforts include such things as fencing many sections of the river to prevent livestock access and planting trees, which has provided critical water quality protection.

## **SUMMARY**

This report documents the appearance of heavy growths of the nuisance alga *Cladophora* in the lower Sydenham River. These growths are a result of excessive nutrient (particularly phosphorus) loadings to the river. Phosphorus loadings must be controlled to prevent further water-quality degradation.

Phosphorus loadings can be managed by applying wastewater treatment technology to point source discharges. Diffuse agricultural pollution sources can be addressed by applying improved land use and soil and water conservation practices.

Residential development in rural areas should be addressed through land use planning based on resource constraints (carrying capacity of the resource). Residential use establishes long term phosphorus loadings with few management options except high cost communal sewage servicing.

## **RECOMMENDATIONS**

1. The Ministry of Natural Resources should immediately address control of nutrients being discharged from the Chatsworth Fish Hatchery. Suspended solids control and phosphorus polishing technology is required.
2. Development within the drainage area must be thoroughly evaluated to determine their cumulative impact. Proper planning and development can only occur if natural resource constraints are understood by all. Implementation of a river basin planning strategy to define existing resources is a pro-active approach which should be pursued by all agencies and citizens.
3. The agricultural community should be encouraged to continue to implement conservation methods to protect soil and water within the Sydenham River Basin.

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