Lake Simcoe Environmental Management Strategy

Implementation Program

The Benthic Alga *Dichotomosiphon tuberosus* in Lake Simcoe - 1986

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THE BENTHIC ALGA *Dichotomosiphon tuberosus* IN LAKE SIMCOE, 1986

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for

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LAKE SIMCOE ENVIRONMENTAL MANAGEMENT STRATEGY IMPLEMENTATION PROGRAM

FOREWORD

This report is one of a series of technical reports prepared in the course of the Lake Simcoe Environmental Management Strategy (LSEMS) Implementation Program. This program is under the direction of the LSEMS Steering Committee, comprised of representatives of the following agencies:

- Ministry of Agriculture and Food;
- Ministry of the Environment;
- Ministry of Natural Resources; and
- Lake Simcoe Region Conservation Authority.

The Lake Simcoe Environmental Management Strategy (LSEMS) studies were initiated in 1981 in response to concern over the loss of a coldwater fishery in Lake Simcoe. The studies concluded that increased urban growth and poor agricultural practices within the drainage basin were filling the lake with excess nutrients. These nutrients promote increased weed growth in the lake with the end result being a decrease in the water's oxygen supply. The "Final Report and Recommendations of the Steering Committee" was released in 1985. The report recommended that a phosphorus control strategy be designed to reduce phosphorus inputs from rural and urban sources. In 1990 the Lake Simcoe Region Conservation Authority was named lead agency to coordinate the LSEMS Implementation Program, a five year plan to improve the water quality of Lake Simcoe. The Conservation Authority will have overall coordination responsibilities as outlined in the LSEMS Cabinet Submission and subsequent agreement (Recommendation E.1). At the completion of the five year plan (1994) a report will be submitted to the Cabinet. This report will outline the activities and progress of the LSEMS Implementation Program during its five years. After reviewing the progress of the program the Cabinet may continue the implementation program.

The goal of the LSEMS Implementation Program is to improve the water quality and natural coldwater fishery of Lake Simcoe by reducing the phosphorus loading to the lake. The LSEMS Implementation Program will initiate remedial measures and control options designed to reduce phosphorus inputs entering Lake Simcoe, monitor the effectiveness of these remedial measures and controls and evaluate the overall response of the lake to this program. Through cost sharing programs, environmental awareness of the public and further studies, the goal of restoring a naturally reproducing coldwater fishery in Lake Simcoe by improving water quality can be reached.

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DISCLAIMER

The material presented in these reports is analytical support information and does not necessarily constitute policy or approved management priorities of the Province or the Conservation Authority and/or the evaluation of the data and findings, should not be based solely on this specific report. Instead they should be analyzed in light of other reports produced within the comprehensive framework of this environmental management strategy and the implementation of the recommendations.

Reference to equipment, brand names or suppliers in this publication is not to be interpreted as an endorsement of that product or supplier by the authors, the Ministries of Agriculture and Food, Environment or Natural Resources or the Lake Simcoe Region Conservation Authority.

EXECUTIVE SUMMARY

The alga *Dichotomosiphon tuberosus* was first observed in Lake Simcoe in 1978. In 1983 an initial study *was* undertaken to determine distribution and biomass of the species within the Lake, and the ecological implications associated with its growth. In 1986, a second study was conducted to determine if the distribution or biomass of *Dichotomosiphon* had changed during the intervening period, as well as to investigate the relationship between algal growth and benthic invertebrate production.

A towed SCUBA diver was used to *assess* the distribution of *Dichotomosiphon.* Twenty nine transects, covering 53 km of lake bottom, were surveyed. Growth of *Dichotomosiphon* occurred in depths between 3 and 11 m, and best growth occurred between 5 and 8 m. Unconsolidated substrates consisting of sandy silt mixtures promoted optimal growth. No growth occurred on muck or rocky substrates. Fifty eight km^2, or 8% of the lake bottom area, was estimated to be covered by algal growth. As in 1983, *Dichotomosiphon* growth *was* found primarily in the eastern basin of the Lake where suitable sediments and depths were present. The 1986 areal coverage (58 km^2) was similar to that estimated in 1983 (56 km^2).

Biomass samples were collected *using* a 522.6 cm^2 (9"x9") Ekman dredge. Twenty nine biomass samples were collected, with an average wet weight of 191.6 g/m^2. The average wet weight to dry weight ratio was 0.2 and the average organic content of three analysed samples was 47.5%. The average wet weight was less in 1986 than 1983 (191.6 g/m^2 vrs. 293 g/m^2) and the 1986 estimate of total biomass on a dry, ash free basis was 1.05×10^3 tonnes, similar to the 1983 estimate of 1.28×10^3 tonnes.

Bottom samples were collected in areas supporting algal growth and in areas with bare sediments using an Ekman dredge. Benthic invertebrates from bottom samples were hand sorted and subsequently identified and counted. Large numbers of the crustacean *Gammarus,* were found to inhabit the algal mat, but were rarely collected from sediments not supporting algal growth. Other benthic invertebrates including oligochaetes, mollusks and mayfly nymphs were found in relatively small numbers and evenly distributed between bare and algal covered sediments.

Sediment cores were collected from depths between 10 and 24 m along a transect proceeding south west from Lagoon City. The top layer of sediment from each sample was retained, and examined for remnants of *Dichotomosiphon*. Observation of *Dichotomosiphon* fragments would indicate that drift had occurred from the growth beds to profundal waters. Fragments were found only in the sample collected at 10 m, though algae detachment from the sediments would not have been expected to occur by mid September when the samples were collected.

At present it appears that *Dichotomosiphon* is a stable and integral component of the aquatic community. Whether the presence of *Dichotomosiphon* in Lake Simcoe is a benefit or detriment to the Lake ecosystem remains to be learned.

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1 INTRODUCTION

The alga *Dichotomosiphon tuberosus* was first identified in Lake Simcoe by the Ministry of the Environment (MOE) in 1978. Subsequent collections of the alga from widely separated lake locations indicated that extensive growth might be present. Initial collections of *Dichotomosiphon* were taken from water depths between 12 and 30 m. While *Dichotomosiphon* is widely distributed in North America, it is relatively uncommon and the initial collections from Lake Simcoe may represent the first documented occurrence of the species in Canada.

In 1983, a survey was conducted to investigate the distribution and biomass of *Dichotomosiphon* in Lake Simcoe, and to evaluate the potential effect of the alga on the aquatic environment. This initial study revealed that wide spread growth of *Dichotomosiphon* occurred in the eastern basin of the Lake, where it was found to grow attached to the sediments in waters between 3 and 10 m. Growth occurred where the bottom consisted of sand-silt and mud-sand sediment types. No growth was observed on soft organic bottom or on rock or gravel, except where gravel was interspersed with suitable sediments. The alga was dark green in color, and in areas of good growth, appeared as a continuous green mat covering the bottom where depth and sediments were suitable.

Dichotomosiphon was estimated to cover 56 km^2 of the lake sediment surface in 1983. The total biomass was estimated to be 1.28×10^3 tonnes *(ash* free dry weight). Assuming all of the alga might drift to profundal waters, it was estimated that this biomass could deplete the already stressed hypolimnion summer oxygen reserves by 10%, thus creating a significant and additional demand on the respiration requirements of the hydrosol.

In recent years, steps have been taken to reduce nutrient loading to Lake Simcoe in an effort to slow the rate of eutrophication. In 1986, a second survey of *Dichotomosiphon* growth was undertaken to determine whether distribution and biomass of the species had changed since 1983. As well, the colonization of the alga by benthic organisms was investigated to determine if *Dichotomosiphon* covered sediments had greater benthic productivity than bare sediments. Numerous benthic organisms were previously observed to inhabit the algal mat during the 1983 survey. Core samples of sediments from the hypolimnetic regions of the lake adjacent to the major growth *area* were taken to determine if drift of decaying *Dichotomosiphon* into the hypolimnion had occurred.

Similar to the 1983 study, a towed SCUBA diver was employed to observe the presence, absence and thickness of alga growth on the sediments. Transects were run in the areas where *Dichotomosiphon was* noted to grow in 1983, and additional transects not previously surveyed were run in areas where suitable depths for growth were available. The addition of Loran C positioning to the survey methodology *was* used to improve the accuracy of locational information. A computer directed literature search was carried out to update the published information on *Dichotomosiphon*.

2. METHODS

2.1 DISTRIBUTION

The survey was begun in mid-August to coincide with the survey period of the study conducted in 1983 (Limnos, 1984). Most of the transects run during the 1986 field season duplicated those of the 1983 study. Generally, regions of the eastern basin offering suitable habitat for growth were examined. Three additional transects were incorporated to provide more information on the distribution of *Dichotomosiphon* in the north end of the lake. A number of transects from the original study were not resurveyed in 1986 because bottom materials along these transects consisted of rock and gravel, which was observed to provide unsuitable habitat for growth.

A Raytheon fathometer echo sounder was used to determine depths along the transects, and a Loran C unit provided precise location information. The Raytheon fathometer recorded water depth on a hard copy, paper chart. The accuracy of the instrument *was* 0.5% or 0.075m in the depth range surveyed. Loran C location coordinates *were* recorded for the beginning and end of each transect as well as intermittent points along the transect.

A SCUBA diver on a sled was towed behind a 18 ft. barge powered by a 60 h.p. motor. A communication system using a series of bell signals was used to transmit information between the diver and the barge (Limnos, 1984). A signal from the diver indicating the initiation or disappearance of *Dichotomosiphon* growth was immediately recorded on the echo sounder chart paper and a Loran C position taken. The diver also recorded information on bottom type, appearance of the alga, thickness of the mat, percent coverage, observation of benthic organisms and any comments or general observations on a prepared data sheet upon completion of each transect. Secchi depth measurements and surface and bottom temperatures were recorded for 10 of the transects.

Sediment cores were taken from 10, 12, 14, 16, 18, 20, 22 and 24m depths during September, 1986 along a transect proceeding south west from Lagoon City. A WILDCO KB sampler was used to collect the cores, and the top layer of each core was preserved and retained for later examination. The samples were then examined for the presence or absence of *Dichotomosiphon* using a binocular microscope at 47X magnification.

2.2 BIOMASS

Locations along transects where *Dichotomosiphon* was known to grow were quantitatively sampled to determine biomass. The location of the sample points along a transect were chosen to represent the algal growth at different depths. Loran C locational coordinates were recorded for each biomass location. An Ekman dredge (0.052 m^2) was used to collect bottom samples, and three samples were combined at each sample point to form the biomass sample. The sample was placed in a metal screen box (2 mm openings) and sieved to remove sediments, then picked by hand to remove extraneous material such as pebbles, clams and other benthic organisms. A bilge pump was used to assist in washing out the unwanted material.

The composite sample of alga obtained by these means was then de-watered using a hand operated Moulinex salad spinner with a basket radius of 7 cm. Twenty hand revolutions in a period of 7 seconds produced a basket rotational speed of 1260 rpm. The centripetal acceleration produced during this period was in excess of 1,270 m/s^2, or 130 times the acceleration produced by gravity. Spinning for a longer time period or repeat spinnings was not found to remove additional water from the sample. In previous macrophytes biomass studies, the authors were successful in using a salad spinner to remove a large and uniform fraction of the surficial water of aquatic vascular plants thereby improving the accuracy of wet volume and wet weight measurements. The wet mass and volume of each sample was recorded following de-watering of the sample. Most samples were subsequently air dried and the dry mass determined.

2.3 ASSOCIATED BENTHOS

Sites of known *Dichotomosiphon* growth were sampled for benthic organisms using an Ekman dredge. Locations having unconsolidated sediments but not supporting algal growth were also sampled for comparative benthos colonization. Sediment samples with associated organisms were sieved through a 2 mm screen to remove sand, silt and extraneous material. Forceps were then used to remove the benthic organisms from the remaining alga and debris. The number of organisms from each sample was counted in the field, or in the lab when large numbers of benthic invertebrates were collected. The samples were preserved in a 10% formalin solution following collection. Type specimens were submitted to Rein Jaagumagi, Entomology Department, Royal Ontario Museum, Toronto for identification.

3. RESULTS

3.1 DISTRIBUTION

The field work was carried out during the last two *weeks* of August and five *days* in mid-September. During this period, 28 transects were surveyed *using* a towed diver over a total linear distance of 53 km. Of the 28 transects surveyed, 19 recorded algal growth. The locations of the transects are shown in Figure 1. *Dichotomosiphon* was found primarily in the eastern basin of the lake where water depth and substrate were suitable for growth. The areal coverage of *Dichotomosiphon* as determined in the areas surveyed is illustrated in Figure 1 and covers an estimated area of 58 km^2 of lake bottom.

Growth was observed to occur in waters between 3 and 11 m where sediments consisted of sand, silt and mud mixtures. Rock shoals, gravel and muck bottoms did not support algal growth, but it was observed to commonly grow in troughs around large rocks and in pockets in gravel bottom where finer sediments had collected. In situ the alga was dark green in colour and formed a rug-like mat on the bottom where growth was continuous. The rhizoids penetrate the sediments by only a few mm (Davis and Gworek, 1972) and physical contact by the diver with the sediments usually disrupted the mat and freed the algae from the sediments.

Diver observations provided insight into the coverage and thickness of algal growth. In areas where growth was continuous, the algae had an average height of about 10 cm. Algal growth was thin and patchy in some areas, particularly in areas of gravel sediments, or where water depth became limiting to growth. Filament length in areas of discontinuous growth was shorter than in areas of continuous growth. The alga was also observed to grow in large clumps covering an area of 0.5 to 1.0m^2 and

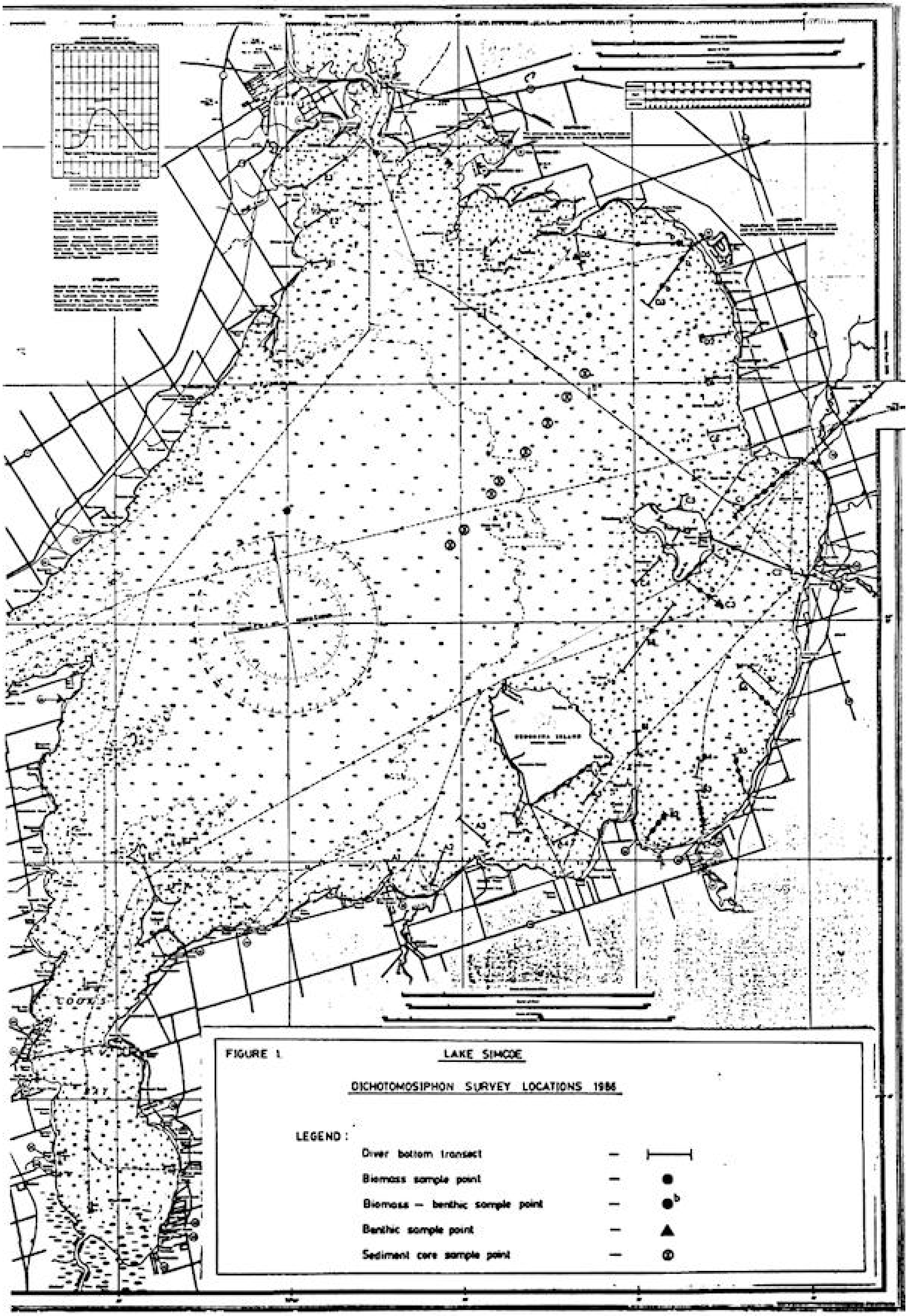

FIGURE 1 LAKE SIMCOE

DICHOTOMOSIPHON SURVEY LOCATIONS 1986

attained a height of 30 cm. These unusual clumps were infrequent (3 or *less* per transect) and were primarily observed in areas of patchy and sparse growth. They were also found in patches where the alga was not observed to normally grow due to sediment type. This would suggest that pockets of suitable sediments had accumulated in these areas.

Bottom and surface temperatures were taken at the beginning and end of a number of transects. In August there was little difference between the temperatures recorded at the surface and the bottom. The surface temperatures remained constant at 21°C and 22°C. The bottom temperatures ranged from 22°C at 1.5m to 19°C at 8.5m, and growth of *Dichotomosiphon* was not observed to extend into the hypolimnion. While Lake Simcoe does not become strongly stratified, the hypolimnion does become established in waters deeper than 15 m by August (MOE, 1980). By mid-September, the water temperature had dropped to 15°C. Some of the alga at this time had paled, lost vigour, and appeared to be senescing.

The deep water sediments collected with the core sample were examined and remnants of *Dichotomosiphon* were found only in the sample obtained at 10 m. The location of the core sampling points are shown in Figure 1.

3.2 BIOMASS

Twenty seven biomass samples were collected during the survey. The average biomass was 191.6 g/m^2 (wet weight). The highest biomass measured was 438.8 g/m^2 in 4.25 m depth near Pefferlaw Brook. Generally, the best growth *was* found between 4 and 6 m depths where suitable substrate was available. The average ratio of dry weight to wet weight was 0.2 (20%). Table 1 shows the wet weight, wet volume and dry weight of collected samples, as well as date, sampling location, and water depth.

The biomass values obtained indicate that there is a slightly higher alga biomass in the southern section of Lake Simcoe, from Pefferlaw Creek to Thorah Island, than in waters north of Thorah Island. The average values of growth from northern waters and southern waters were 206.7 g/m^2 and 147 g/m^2, respectively.

The salad spinner method of surficial water removal appeared to have limitations when working with *Dichotomosiphon.* After the standard 20 rapid revolutions per sample, at least 50% more water could be removed through hand squeezing. Increasing the number of revolutions did not increase the amount of water that could be removed. This is no doubt a reflection on the dense, thread-like form of the plant and its ability to hold water. None the less, the centrifugal removal of water provided a standardized procedure from which comparable wet mass measurements could be made.

3.3 ASSOCIATED BENTHOS

Bottom samples were collected from seven locations supporting *Dichotomosiphon* growth and seven samples from bare sediments. The benthic species and numbers of benthos recovered from each sample point is given in Table 2. Appendix A provides further information as to depth, date and location of each benthos sample point.

Fifteen different species of benthic invertebrates were recovered. Large numbers (up to 145 individuals in a single dredge) of *Gammarus fasciatus* occupied the

Table 1. Lake Simcoe *Dichotomosiphon tuberosus* Biomass.

Date (1986)	General Location	Transect/ Sample	Depth(m)	Loran Location	Wet Weight (g/m^2)	Dry Weight (g/m^2)	Volume (ml/m^2)
Aug.20	Pefferlaw River	B3/1	4.8	15,992.0/59,102.7	237.3	49.8	191.4
		83/2	6.4	90.8/01.7	149.9	25.5	159.5
		B3/3	7.0	90.2/01.7	51.0	7.6	63.8
Aug.21	Pefferlaw Bay	B2/1	4.25	15,994.9/59,092.5	438.9	82.9	382.8
		B2/2	5.3	94.0/93.8	264.8	56.1	191.4
		B2/3	6.5	92.8/94.6	60.6	9.5	31.9
Aug.21	Thorah Beach	85/1	4.75	15,985.7/59,110.9	287.1	65.0	255.2
		B5/2	6.0	84.6/10.0	159.5	32.5	127.6
		85/3	6.8	83.5/9.3	356.0	61.2	319
Aug.21	McRae Shoal	86/1	5.8	15,975.0/59,114.3	255.2	61.9	191.4
		B6/2	6.8	74.1/12.5	302.4	58.0	223.3
Aug.22	Toward Thorah Island	B8/1	8.0	15,967.4/59,089.7	91.9	20.4	127.6
Aug.22	Off Mouth of Trent Canal	C1/1	4.5	15,942.6/59,113.4	285.8	-	127.6
		C1/2	5.2	43.7/11.8	301.8	-	127.6
		C1/3	5.5	44.8/10.5	9.6	-	0
Sept.17	S.W. of Lagoon City	D3/1	5.9	15,915.2/59,090.0	127.6	-	127.6
		D3/2	8.2	19.3/86.3	232.9	42.7	191.4
Sept.17	N. of Pier End at Lagoon City	D4/1	4.9	15,913.6/59,088.9	159.5	43.3	159.5
		D4/2	6.75	15.4/80.6	82.9	24.2	31.9
Sept.18	Between McGinnis Pt. and N.W. Thorah Island	Ra/1	8.5	15,926.3/59,072.4	155.0	-	127.6
Sept.18	Grape Island toward Goffat Island	N4/1	8.0	15,910.2/59,028.3	146.7	-	159.5
Sept.24	Off S.E. Pt. of Thorah Island	C3/1	4.1	15,960.3/59,098.9	76.6	21.0	63.8
		C3/2	6.0	60.8/100.3	216.9	-	191.4
Sept. 24	Trent Canal to Thorah Island	C1/1	4.8	15,942.9/59,113.2	268.0	-	255.2
		C1/2	6.0	45.6/10.6	189.5	-	191.4
		C1/3	6.5	48.4/08.2	135.3	27.7	127.6
Sept.24	Gamebridge Pt.	D2/1	8.0	15,925.1/59,096.1	130.2	21.7	95.7

Table 2. Numbers of benthic organisms found in *Dichotomosiphon* - covered sediments and bare sediments in Lake Simcoe.

	Sites													
	Algae Covered Sediments							Bare Sediments						
Species	D3/1*	D3/2	D4/B1	N3/1	T/1	C1/2	C1/3	Mac/1	Mac/2	D3/1a	D3/1b	D5/1c	Thor 1	Thor 2
Gammarus fasciatus	26	5	37	6	145	3	50	0	1	0	0	1	0	0
Hexagenia limbata	5	0	0	0	0	1	2	0	2	1	0	0	2	1
Asellus intermedius	0	2	0	3	5	2	0	0	0	0	0	0	0	0
Cryptochironomus sp.	0	0	0	0	0	0	0	2	0	0	0	1	0	0
Polypedilum sp.	2	0	0	0	4	0	0	0	0	3	8	17	0	2
Sparganophilus sp.	1	0	0	0	0	1	1	0	0	0	0	0	0	0
Limnodrilus hoffmeisteri	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Glossiphonia complanata	0	0	1	0	0	0	1	0	0	0	0	0	0	0
Valvata tricarinata	0	0	0	0	0	0	0	0	2	0	0	0	0	0
Amnicola limosa	0	0	0	0	0	0	0	0	0	0	2	0	0	0
Lymnaea stagnalis	0	0	0	1	0	0	0	0	1	0	0	0	0	0
Physella gyring sayi	0	0	0	0	0	0	0	0	0	0	2	0	0	0
Pisidium variabile	0	2	0	0	0	0	2	0	0	0	0	0	0	0
Sphaerium rhomboideum	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Elliptio complanata	0	0	0	0	0	0	0	0	0	0	0	0	1	0

* Sample consisted of three Ekman dredges. All other samples consist of one Ekman Dredge.

Dichotomosiphon mat, and were the most common organism collected. *Gammarus* was noted to occupy the mat itself, and did not burrow into the underlying sediment. More *Gammarus* occurred where the alga growth *was* thick and heavy than where the alga was thin and short. Very few *Gammarus* were recovered from sediments not supporting *Dichotomosiphon* growth. Another crustacean, *Asellus intermedius*, *was* found only where *Dichotomosiphon* growth occurred, but *was* present in relatively small numbers. The rest of the benthos recovered were collected in relatively small numbers and were evenly distributed between alga covered sediments and bare sediments.

4 CONCLUSIONS AND DISCUSSION

Distribution of *Dichotomosiphon* was similar in 1986 to the distribution documented in 1983 with the exception that the algae was not found in 1986 in waters west of Georgina Island around Jacksons Point and Sibbald Point. Growth of *Dichotomosiphon* occurred between 3 and 10 m, similar to the depth distribution observed in 1983. Total estimated areal coverage of the lake in 1983 was 56 km^2 compared to a 58 km^2 coverage in 1986.

The average wet biomass was lower in 1986 than in 1983 (191.6 g/m^2 vs. 297 g/m^2). A greater effort was made in 1986 to remove inorganic debris such as sand, pebbles and shells from collected algae samples, which would partially account for the lower values of observed biomass. Three algae samples collected in 1986 were analysed for nutrient and organic content. The average organic content of the three samples was 47.5% compared with 22.0% organic content observed in 1983 (Limnos, 1984). The higher organic content of the 1986 samples indicate that an improvement was made in removing a greater amount of inorganic debris from the samples, resulting in a more accurate but conservative estimate of biomass.

The total organic mass of the algae in the lake was estimated to be $1.05x10^6$ kg in 1986 (Appendix B). This is an 18% reduction from the 1983 estimate of the ash free dry weight of the algae crop ($1.28x10^6$ kg). This difference in biomass estimates is not felt to be significantly different, given the small number of samples analysed for organic content, and the sensitivity of the biomass estimate to the derivation of the percentage organic content. It is concluded, therefore, that little change has occurred in the coverage or biomass of *Dichotomosiphon* since 1983.

Although not part of the terms of reference for the 1986 study, a cursory analysis of tissue nutrients was carried out to provide current information on contained tissue nutrients. Average nitrogen and phosphorus content of the three 1986 samples was 2.1 and 0.27. of the ash free dry weight, respectively. This compares to the reported value in 1983 of 5.93 and 0.62% nitrogen and phosphorus, respectively, on an ash free basis (Limnos, 1984). On the *basis* of the limited analysis performed in 1986, no conclusions have been drawn from the discrepancies noted. The analyses were conducted by the Trent Aquatic Research Centre laboratories, Trent University, Peterborough, Ontario.

Remnants of *Dichotomosiphon* were recovered only from the 10 m depth location along the transect where sediment core sampling occurred. (Figure 1). At this time the growth areas were still intact so that it would not be anticipated that a significant portion of the present year's crop would have become detached and drifted into the hypolimnion. Drift of *Dichotomosiphon* to the hypolimnion may occur later in the season, and there remains the potential for decaying algae to exert a subsequent oxygen demand on hypolimnion oxygen reserves, as proposed in the 1983 study (Limnos, 1984).

Diver observation indicated that in waters south of Thorah Island, growth diminished in depths between 6 to 7 m, while north of Thorah Island, healthy growth to 8, 9 and 10 meters was not uncommon. Sechi depths were deeper in the northern waters than in southern waters, where previous work by the Ministry of the Environment (1980) indicated yearly average Secchi depth north of Thorah Island to be 4.4 m and south of Thorah Island 2.8 m. The general pattern of deeper growth in northern waters is probably a response to better water clarity.

The study of benthos colonization of the algal mat indicates that the presence of *Dichotomosiphon* greatly increases the productivity of benthic animals, particularly members of the class Crustacea. Large numbers of *Gammarus*, and *lesser* numbers of *Asellus*, inhabit the algal mat. Crayfish, though not collected, were observed by divers to be more common on the algal mat, than on bare sediments. Pennak (1953), indicates that *Gammarus* and *Asellus* feed upon vegetative matter, minute plants and animals, and are negatively phototrophic. The alga mat favours the development of amphipods by providing a food source together with shelter from light and predators. The presence of *Gammarus, Asellus*, and *Hexagenia* are considered to be indicators of good quality, well oxygenated waters (Pennak, 1953; Wetzel, 1975).

A study on the late summer feeding habits of six important fish species found in the central basin of Lake Simcoe (OMNR, 1983) indicated that amphipods were of less importance than other dietary components. None the less, amphipods are recognized as an important fish food resource and may be expected to be utilized by fish inhabiting the growth areas at all seasons. The development of a new and productive algal environment that presently occupies 8% of Lake Simcoe may therefore be expected to increase overall fish production and favour those species best able to utilize this food resource.

A literature search was conducted by the Royal Ontario Museum library to update new literature on *Dichotomosiphon tuberosus* and twelve new citations are listed in Appendix C. Little relevant ecological information appears to be available in published form and it is of interest to note that there are no references to any major areas of growth as have been described in Lake Simcoe.

Dichotomosiphon provides habitat for a significant benthic community suggesting that its presence is, in part, a benefit to the lake ecosystem. The concern remains, however, that a large biomass (estimated to be 1.05 x 10^3 tonnes on an ash. free basis) and a broad distribution may exert a significant demand on the oxygen reserves of the hypolimnion during decomposition. There also remains the question as to whether the alga may be an important feedback mechanism in mobilizing sediment nutrient resources that are subsequently utilized for enhanced phytoplankton production.

Much remains to be learned of the ecological implications of *Dichotomosiphon* growth in Lake Simcoe. It appears to have been established as a stable and integral component of the aquatic community and whether it can be considered a net benefit or detriment to the Lake ecosystem has yet to be determined.

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Appendix A. Benthic Sample Site Description.

Sample Pt.	General Location	Loran C Coordinate	Depth (m)	Algae Growth
D3/1*	SW of Lagoon City	15,915.2/59,090.0	5.9	Thin, but continuous
D3/2	SW of Lagoon City	15,919.3/59,086.3	8.2	Good, healthy
D4/81	Just N of Pier At Lagoon City	15,913.6/59,088.9	4.9	Thin, light brown-whitish colour
N3/1	Between N end of Grape Island and S end of Goffat Island	15,910.2/59,028.3	6.5	Little growth, mostly coarse sediments
T/1	Off S Pt. of Thorah Island	15,960.8/59,100.3	6.0	Good, healthy
C1/2	SW from Trent River Pier	15,973.7/59,111.8	5.2	Very thin
C1/3	SW from Trent River Pier	"	"	Good, healthy
Mac/1	N end of McPhee Bay	15,909.6/59,042.6	8.0	None
Mac/2	N end of McPhee Bay	"		None
D5/1a	S. of McGinnis Point	15,918.1/59,070.0	9.2	None
D5/1b	S. of McGinnis Point	"	"	None
D5/1c	S. of McGinnis Point	"	"	None
Thor 1	S.Pt.of Thorah Island	15,961.7/59,107.3	8.2	None
Thor 2	S. Pt. of Thorah Island	"	"	None

* Sample consisted of three Ekman dredges, 11 other samples consist of one dredge.

Appendix B: Lake Simcoe *Dichotomosiphon* Biomass Calculations.

Based on areal coverage and biomass information obtained during the 1986 field study, an estimate of biomass can be developed. Three algae samples were analysed at the Aquatic Research Centre laboratories, Trent University, Peterborough, Ontario for tissue nutrient and organic content.

Required Information

Areal Coverage	=	58 km^2
Average Wet Weight	=	191.6 g/m^2
Dry Weight/Wet Weight Ratio	=	0.2
Average Loss On Ignition	=	47.5%

Calculations

Total Wet Weight = Areal Coverage (km^2) x $1x10^6$ m^2/km^2 x Average Wet Weight (g/m^2)

= 58 km^2 x $1x10^6$ m^2/km^2 x 191.6 g/m^2

= $1.11x10^{10}$ g

= $1.11x10^7$ kg

Dry Weight = Total Wet Weight (kg) x Dry/Wet Weight Ratio

= $1.11x10^7$ kg x 0.2

= $2.22x10^6$ kg

Ash Free Dry Weight = Dry Weight (kg) x Loss on Ignition (%)

= 2.22 x 10^6 kg x 0.475

= 1.05 x 10^6 kg

= 1.05 x 10^3 tonnes

APPENDIX C: New literature on *Dichotomosiphon tuberosus*.

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APPENDIX

MEMBERSHIP ON THE STEERING COMMITTEE FOR THE LAKE SIMCOE ENVIRONMENTAL MANAGEMENT STRATEGY IMPLEMENTATION PROGRAM

A. Morton, Lake Simcoe Region Conservation Authority (Chairman)
J. Barker, Maple District, Ministry of Natural Resources
E. Cavanagh, York County, Ministry of Agriculture and Food
R. DesJardine, Central Region, Ministry of Natural Resources
J. Kinkead, Watershed Management Branch, Ministry of the Environment
J. Merritt, Director - Central Region, Ministry of the Environment
B. Noels, Lake Simcoe Region Conservation Authority (Secretary)

APPENDIX

MEMBERSHIP ON THE TECHNICAL COMMITTEE FOR THE LAKE SIMCOE ENVIRONMENTAL MANAGEMENT STRATEGY IMPLEMENTATION PROGRAM

B. Noels, Lake Simcoe Region Conservation Authority (Chairman)
J. Beaver, Central Region, Ministry of the Environment
R. DesJardine, Central Region, Ministry of Natural Resources (past member)
J. Dobell, Huronia District, Ministry of Natural Resources
D. Green, Resources Management Branch, Ministry of Agriculture and Food (past member)
B. Kemp, Lake Simcoe Region Conservation Authority
J. Kinkead, Watershed Management Section, Ministry of the Environment (past member)
R. MacGregor, Central Region, Ministry of Natural Resources
N. Moore, Victoria-Haliburton County, Ministry of Agriculture and Food
K. Nicholls, Water Resources Branch, Ministry of the Environment
B. Peterkin, Central Region, Ministry of Natural Resources
T. Rance, Maple District, Ministry of Natural Resources
B. Stone, Northumberland County, Ministry of Agriculture and Food
M. Walters, Lake Simcoe Region Conservation Authority
C. Willox, Lake Simcoe Fisheries Assessment Unit, Ministry of Natural Resources
K. Willson, Watershed Management Section, Ministry of the Environment

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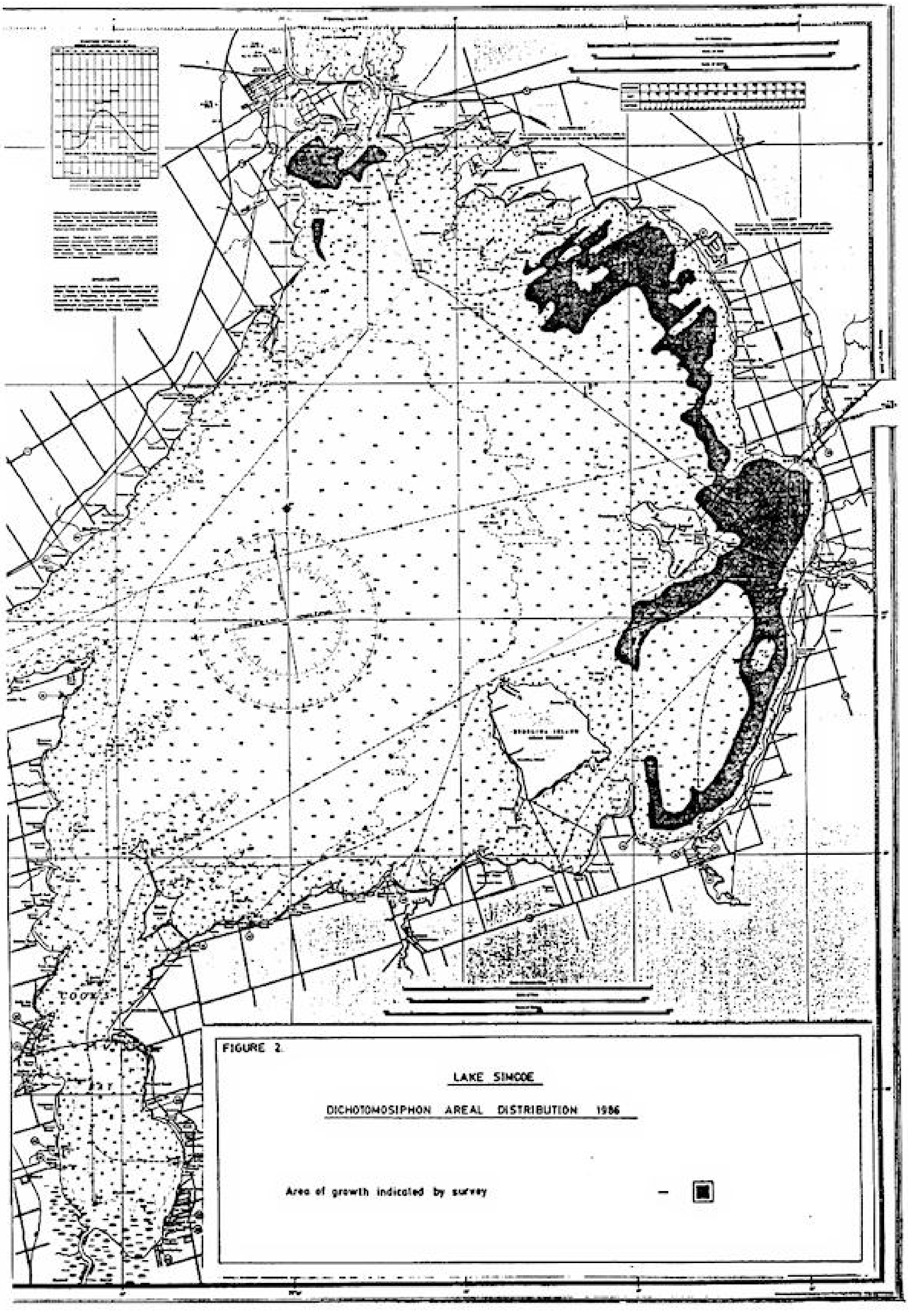
FIGURE 2.
LAKE SIMCOE
DICHOTOMOSIPHON AREAL DISTRIBUTION 1986
Area of growth indicated by survey