STRATFORD-AVON RIVER ENVIRONMENTAL MANAGEMENT PROJECT

FISHERIES OF THE AVON RIVER

Technical Report S-10

Wingham District Office
Ministry of Natural Resources

1982

PREFACE

This report is one of a series of technical reports resulting from work undertaken as part of the Stratford-Avon River Environmental Management Project (S.A.R.E.M.P.).

This two-year project was initiated in April 1980, at the request of the City of Stratford. The S.A.R.E.M.P. is funded entirely by the Ontario Ministry of the Environment. The purpose of the project is to provide a comprehensive water quality management strategy for the Avon River basin. In order to accomplish this considerable investigation, monitoring and analysis has taken place. The outcome of these investigations and field demonstrations will be a documented strategy outlining the program and implementation mechanisms most effective in resolving the water quality problems now facing residents of the basin. The project is assessing urban, rural and in-stream management mechanisms for improving water quality.

This report results directly from the aforementioned investigations. It is meant to be technical in nature and not a statement of policy or program direction. Observations and conclusions are those of the authors and do not necessarily reflect the attitudes or philosophy of all agencies and individuals affiliated with the project. In certain cases, the results presented are interim in nature and should not be taken as definitive until such time as additional support data is collected.

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ABSTRACT

A study of the Avon River fisheries resource was conducted in 1981 to assess its current condition and to determine remedial management measures. Shakespeare pond, stocked annually with catchable-sized rainbow trout, currently provides 78% of angling opportunities within the watershed. The fisheries habitat of the Avon River is in an unfavourable state and is presently incapable of supporting a sport fishery. Bait-fishermen are utilizing the resource at maximum levels. Considerable rehabilitative measures would be required to restore the trout fishery above Stratford and establish a bass fishery below Lake Victoria.

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1. INTRODUCTION

In 1981, an analysis of the Avon River fishery was conducted to provide appropriate management directives which could be considered when a water management strategy for the basin was selected. This report reviews the recent history and current status of the Avon River fishery and identifies potential management options.

The goals of the Wingham District of the Ministry of Natural Resources, as they relate to fisheries management, are:

> to protect, rehabilitate, enhance and maintain the district's fish communities and their environments so as to provide an optimum contribution of fish, fishing opportunities and associated benefits to society.

2. NATURAL SETTING OF THE BASIN

The Avon River originates in North Easthope Township and flows through the City of Stratford to empty into the North Thames River, approximately 7 km north of St. Marys. It is 34.9 km in length, drains an area of 166 km^2, and has an average gradient of 2.33 m/km (Figures 1 and 2).

Perth County has a humid continental climate with modifying influences from the Great Lakes. Mean monthly temperatures range from -6.7°C to 20.0°C (mean annual temperature is 5.9°) and the average frost free period is 135 days in length. The mean annual precipitation is 991 mm.

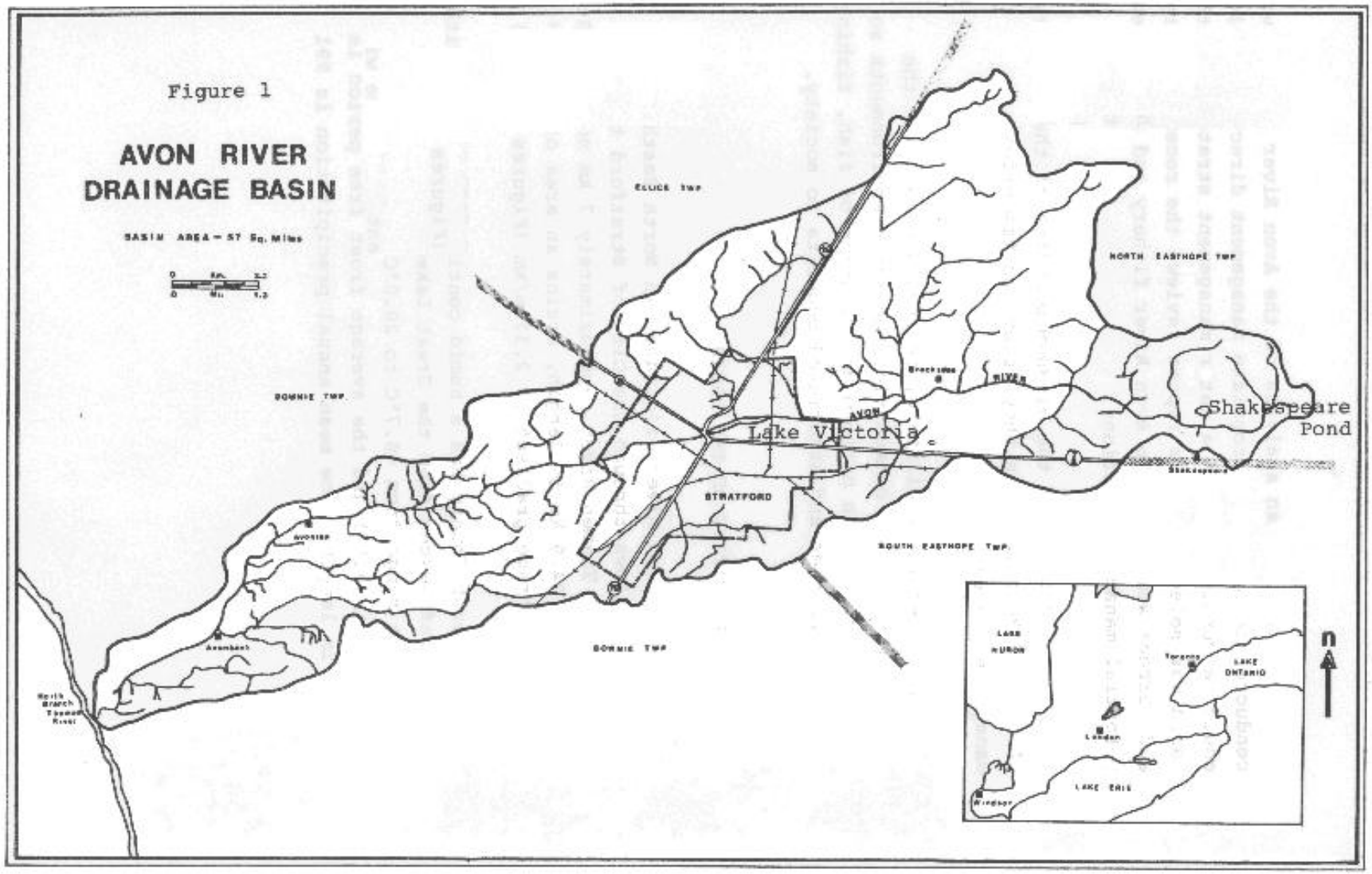
Figure 1
AVON RIVER
DRAINAGE BASIN
BASIN AREA = 57 Sq. Miles
ELLICE TWP.
NORTH EASTHOPE TWP.
DOWNIE TWP.
Lake Victoria
Shakespeare
Pond
STRATFORD
SOUTH EASTHOPE TWP.
DOWNIE TWP.
LAKE HURON
LAKE ONTARIO
LAKE ERIE
London
N

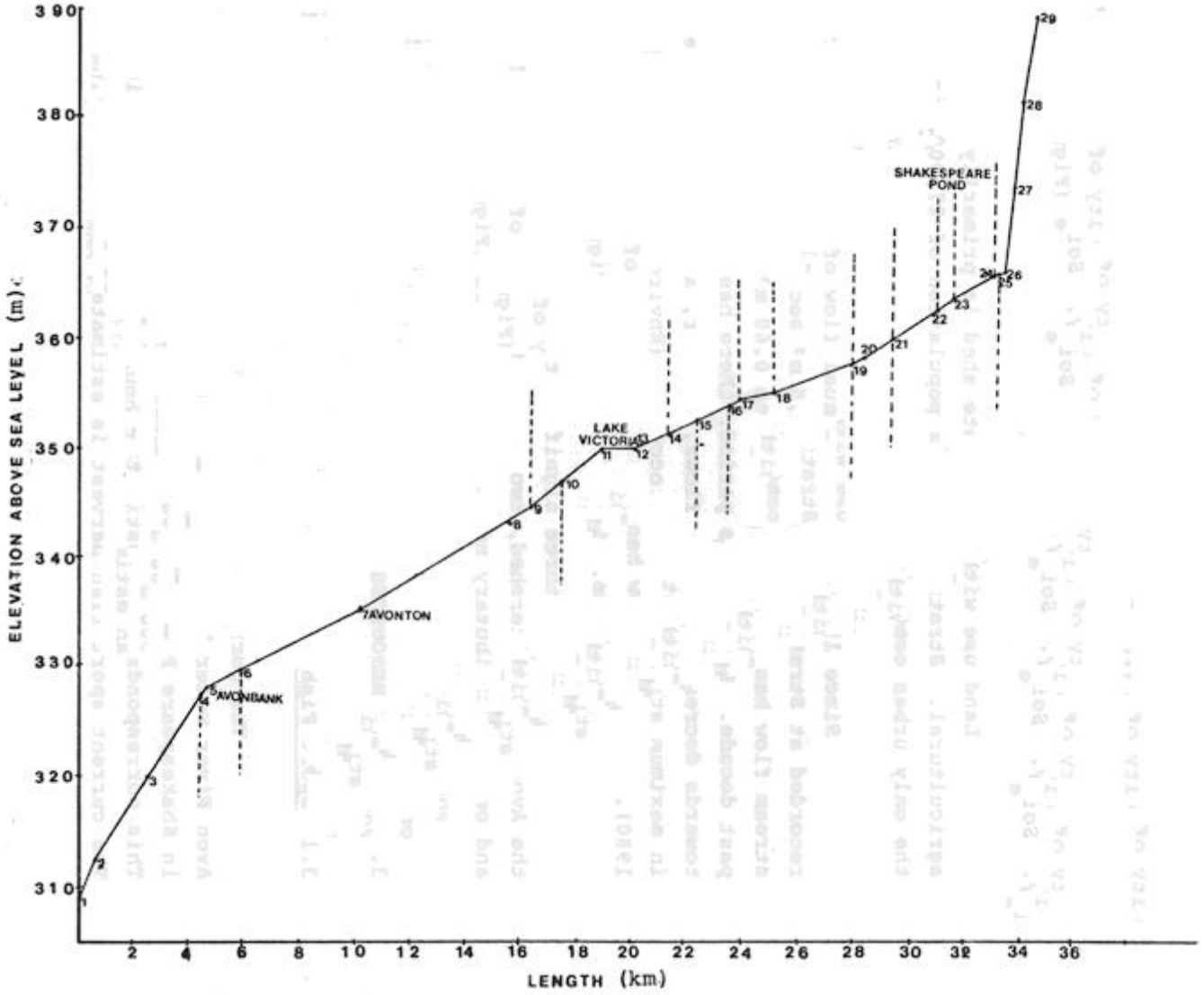

Figure 2. GRADIENT PROFILE OF THE AVON RIVER

Above Stratford, the river passes through the Waterloo Hills minor physiographic region, which consists of sandy hills to ridges of sandy till or kames and kame moraines with outwash sands. Soils include Harriston silt loam, Waterloo sandy loam and Huron clay loam.

Below Stratford lies a broad clay plain with flat uplands and a well defined stream valley. Soils include Brookston and Perth silt loam.

Land use within the watershed is primarily agricultural. Stratford, with a population of 27,000, is the only urban centre.

Since 1964, the mean annual flow of the Avon River recorded at Stratford, has been 1.5 m^3 sec^{-1}. The minimum stream flow has ranged from 0.19 to 0.60 m^3 sec^{-1} in the past decade. During this period, there has been no trend towards decreased minimum flows, however, a gradual increase in maximum stream flows has occurred (Environment Canada, 1980).

There are three significant impoundments within the Avon River watershed, two within the City of Stratford and one on a tributary north of Shakespeare (Figure 1).

3. CURRENT RESOURCES USE

3.1 Sport Fish

The current estimated annual angling effort in the Avon River watershed is 2250 angler hours; 1750 angler hours in Shakespeare Pond and 500 angler hours in the Avon River. This corresponds to an estimated 750 angling opportunities. The current sport fish harvest is estimated at 152 kg. The origin of these anglers is primarily local, 90% living in

Stratford or within 10 km and 10% living within a 50 km radius.

The Avon River is not fished heavily in comparison to other Southern Ontario watercourses. Stocked rainbow trout (*Salmo gairdneri*) are taken in Shakespeare Pond, and children frequently take chub and panfish in Stratford. Smallmouth bass *(Micropterus dolomieui*) and rock bass (*Ambloplites rupestris*) are occasionally angled below Stratford.

3.2. Bait Fish

Ten to thirteen bait-fishermen have held licences for the Avon River watershed since 1975. Their reported harvest in 1980 was 1410 kg, with an economic value of approximately $5,600. The major species harvested are common shiner (Notropis cornutus), white sucker (*Catostomus commersoni*) and creek chub (Semotilus atromaculatus).

3.3 Other

Recreational uses of the river include swimming and boating in the impoundments, and waterfowl hunting. Other primary uses are for watering livestock and assimilating municipal and industrial wastes from the City of Stratford. Lake Victoria provides significant aesthetic amenities for the City of Stratford.

4. FISH COMMUNITIES AND ENVIRONMENTS

4.1. Shakespeare Pond

Shakespeare Pond, a 5.9 ha impoundment, was constructed in 1952 for recreational purposes. The pond has an average depth of 1.48 m and a maximum depth of approximately 3.7 m.

Local residents stocked the pond with largemouth bass shortly after its construction (R. Bellinger, Pers. Comm.) and the pond provided a good fishery through the early 1960's. Brook trout were stocked by the Ministry of Natural Resources from 1953 to 1966. In an attempt to improve the trout fishery, the pond was drained several times through the 1960's and bass removed for stocking elsewhere. No documentation was made of the angling success of trout fishermen.

Water quality conditions in the pond decreased through the sixties and a winter fish kill of several hundred largemouth bass was reported in 1970. A blue-green algal bloom was the apparent cause of another fish kill in 1973.

Water chemistry sampling conducted in 1973 indicated oxygen depletion throughout the water column during the summer (George *et al*, 1973). Water temperatures were well above those preferred by salmonids. Water conditions were much better at the time of measurement in 1981 with increased oxygen concentrations in the bottom depths (7.2 ppm) and temperatures more suitable for salmonids (19°C).

In recent years, the pond has been managed as a put-and-take rainbow trout fishery. An average of 570 catchable-sized rainbow trout have been stocked annually since 1979. A 74% return to the creel was evident during the opening weekend of the 1981 trout season (Malhoit, 1981) .

The fish population of the pond in the summer of 1981 was dominated by yellow perch (*Perca flavescens*) (44%) and brown bullheads (*Ictalurus nebulosus*) (42%). Rainbow trout were present in good numbers. No bass or sunfish were sampled (Table 1).

The bottom composition of Shakespeare Pond is primarily muck and detritus. The water column is choked with aquatic vegetation through the growing season which severely limits angling pressure and reduces the potential harvest. The potential annual fish yield from Shakespeare Pond is 72.2 kg (158.9 lbs) (See the Appendix). The actual estimated yield in 1981 was 16 kg. In addition, 86.4 kg of rainbow trout were stocked in the pond in 1981 to provide additional angling opportunities. It was estimated that 77 kg of fish were harvested from this stocking.

4.2. Avon River Above Stratford

The 14.7 km portion of the Avon River above Stratford has been severely altered by channelization projects. This river section has an average width of 7.1 m and an average summer depth of 40 cm. The average gradient of this section is 2.65 m/km (Figure 2).

Through the 1940's and 1950's the upper Avon River was in a more natural state and contained an excellent trout fishery. Brown trout were stocked from 1946-1959 to

Table 1. Fish Species Sampled by Seine and Gill Nets in Lake Victoria and Shakespeare Pond during 1981.

Lake Victoria

Brassy minnow (*Hybognathus hankinsoni*)
Fathead minnow (*Pimephales promelas*)
Brook stickleback (*Culaea inconstans*)
Golden shiner (*Notemigonus crysoleucas*)
Creek chub (*Semotilus atromaculatus*)
Johnny darter (*Etheostoma nigrum*)
Rainbow darter (*Etheostoma caeruleum*)
Channel darter (*Percina copelandi*)
Pearl dace (*Semotilus margarita*)

Shakespeare Pond

Rainbow trout (*Salmo gairdneri*)
Yellow perch (*Perca flavescens*)
Golden shiner (*Notemigonus crysoleucas*)
Brown bullhead (*Ictalurus nebulosus*)

supplement the existing population, and brook trout were stocked from 1960-1971 on a put-and-take basis. Drainage works were undertaken in the upper watershed during the 1950's and a piecemeal approach to channelize of the river was initiated. By 1970, the upper river was in deplorable condition with unstable stream banks, reduced water quality and a major decline in the trout fishery.

Today, the river continues to suffer from deleterious riparian land-use practises. Livestock are permitted to water throughout much of this section, and less than 11% of the streambanks have shade-producing vegetation (Figure 3) .

As a result of these practices, the river's channel is very uniform with very few pool-riffle sequences. Sedimentation is extensive and gravel exists in only a few remote locations. During the summer, water temperatures exceeding 25°C were observed. Aquatic vegetation is dense, covering from 30 to 100% of the stream bottom, in some locations. This quantity of in-stream vegetation causes tremendous daily oxygen fluctuations. In 1980, dissolved oxygen levels dropped below 6 ppm nightly from July to October, and levels were frequently below 3 ppm. (Huber, 1982).

Fish surveys conducted since 1965 have suggested the existence of a reasonably stable warm water community (Table 2). No trout or bass were sampled on any occasion. Green sunfish, an extremely rare species whose distribution has been documented in only three or four locations in Canada (Scott and Crossman, 1973) were abundant in 1973. They were not sampled in 1977; however, one individual was captured in 1981.

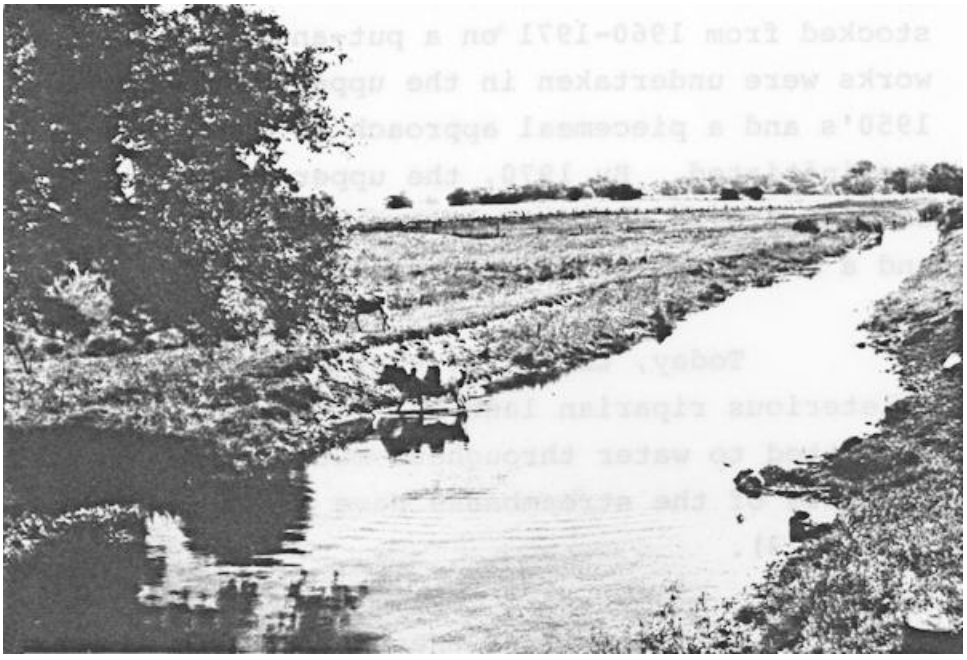

Fig. 3. A typical section of the Avon River above Stratford.

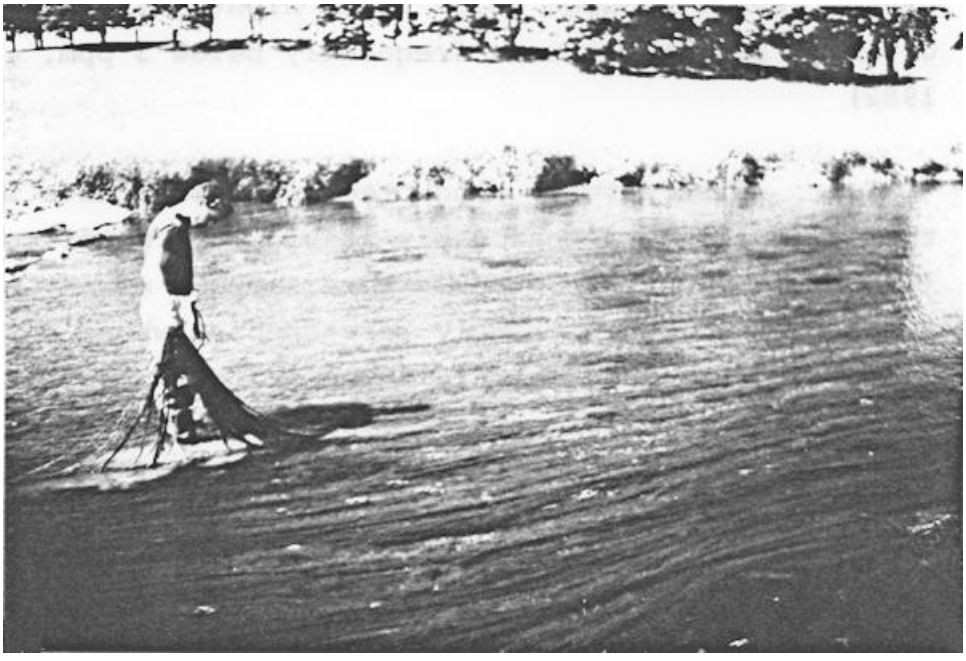

Fig. 4. Extensive *Cladophora* growth below Stratford on the Avon River.

Table 2: Mean Number Of Fish Sampled Per Station In Avon River Surveys Conducted From 1959 to 1981 [1]

	Above Stratford						Stratford To Avon Bank						Avon Bank To Mouth					
	1959-60	1965	1971	1973	1977	1981	1959-60	1965	1971	1973	1977	1981	1959-60	1965	1971	1973	19OWRC	1981
Central Mud minnow		0.2						0.2										
Northern redbelly dace				0.5	3					2	1.3	17.5						
Carp											64	P	P	0.5	1		130	P
Hornyhead chub					2						1			0.8	11	1		
Golden Shiner			5		0.5						1					1		
Common shiner		17.2	67	10.5	63.5				9		56.8	8.8		2.3	65	15	15	
Rosyface shiner											0.3				5			
Bluntnose minnow		14.3	22	8					1	2	3.3			4	6	3	6	
Fathead minnow		8.5	38	8.5	2.5			0.9	30	23	0.8	20.0						
Blacknose dace		7.8	14	21	0.5			0.1	60	3		5.5		0.2				
Creek chub		7.8	28	24	37	0.5		0.6	39		91.8			2.5				
Pearl dace		0.6		1.5														
Brassy minnow			12															
Cyprinid	P					323	P					17.0	P					27
Northern hog sucker					1												20	
White sucker		15.1	7	3	5.5	3.0		3.2			12.5	P		3.8		1	6	1
Stonecat																1		
Catfish	P																	
Brook stickleback	P	0.2		9	10	0.5			1			1.3						
Rock bass		0.2	3	5		3.0						4.8		1.3	1		2	4
Green sunfish		0.2		7.5														
Pumpkinseed					1.5	2.0					0.8							
Smallmouth bass											0.5	P					2	P
Largemouth bass						0.5												
Yellow perch											0.3	0.3						44
Greenside darter		0.7	1		6.5									0.2				
Rainbow darter		1.8		2.5										0.2				
Iowa darter		1.2		11.5														
Fantail darter		0.3	4															
Least darter		0.2	1															
Johnny darter		5.7	40	9	4													
Logperch	P																	
Blackside darter		1.8	2	7	1						0.5							
Darters	P					12.5												
Sculpins	P																	
No. Stations	2	2	1	2	2	2	5	3	1	1	4	4	3	2	1	1	1	1
No. Fish/Station		83.8	244	128.5	138.5	345.5		5	140	30	234.9	77		15.8	89	22	181	76
No. Taxa	6	18	14	15	14	8	1	5	6	4	14	11+	3	10	6	6	7	6+

1. Source - 1959-60 - Anonymous, 1960; 1965, 1971 - Sculpins Anonymous, 1979 , Osmond and Westwood, 1976 , and unpublished results of sampling conducted by the OWRC and MOE; 1973 - George *et al*, 1973; 1981 - Unpublished results of sampling conducted by MNR.

Several fish species from the upper Avon River have been analyzed for contaminant levels. PCB levels were quite low; however, mercury concentrations in some creek chub and longnose suckers were above those recommended in the federal guidelines for fish which were to be commercially marketed (Table 3). All fish were within the acceptable limits for consumption.

Population estimates conducted during the summer of 1981 indicated an average fish biomass above Stratford of 180 kg/ha. If an acceptable annual harvest yield of 25% of their total biomass is assumed, then the current potential annual yield for this section of river would be 469.6 kg (1033.3 lbs), 45% of the maximum potential yield (Appendix). It is estimated that this entire yield is currently being harvested by bait fishermen.

4.3. Lake Victoria

Lake Victoria is a 14.2 ha impoundment in the City of Stratford measuring 1.55 km in length. The lake has a maximum depth of 3.0 m and an average summer depth of 1.53 m. The impoundment has been drawn down approximately 60 cm annually from mid-November to mid-April (K. Clutton, Pers. comm.) .

In 1973, Lake Victoria was found to be extremely turbid with oxygen depletion below the one metre depth contour (George *et al*, 1973). Sampling in 1981 indicated that turbidity had decreased (2.0 FTU); however, oxygen levels below surface water remained too low (5.6 ppm) for a healthy sports fishery. Mean daytime oxygen levels measured at the head of the lake during routine monitoring were 10.5 and 11.3 ppm in 1980 and 1981 respectively (Huber, 1982).

Table 3: Contaminant Analysis of Fish Sampled in the Avon River 1980-81.

Location	Date	Species	Number	Hg (ppm)			PCB (ppb)		
			Analyzed	Mean	Min	Max	Mean	Min	Max
Above Stratford	July, Aug./80	Ln. Sucker	13	0.23	0.06	0.64	19	ND	79
		W. Sucker	7	0.07	0.04	0.09	37	23	51
		Carp	4	0.16	0.07	0.24	41	27	67
		Cr. Chub	4	0.32	0.13	0.53	14	ND	34
Below Stratford	June/81	Rock Bass	17	0.12	0.06	0.21			

The lake has had good cyprinid populations during every sampling period. Nine species were collected in 1981 (Table 1). Green sunfish (*Lepomis cyanellus*) which were common in 1973 were not sampled in 1981.

The maximum potential fish yield from Lake Victoria is 240.2 kg/yr (Appendix). It was estimated that less than 25 kg of fish were harvested in 1981.

4.4. Avon River Below Stratford

The Avon River flows for 19.1 km below Stratford with an average gradient of 2.18 m/km. The river has an average width of 16.6 m and an average summertime depth of 23.8 cm. There are few pools, and water depth seldom exceeds 60 cm.

The substrate in this section varies considerably, ranging from sand to large boulders. Aquatic vegetation, particularly the nuisance alga *Cladophora*, is abundant and is responsible for nighttime oxygen depletion (Figure 4). Summer levels regularly fall below 4 ppm, and levels of less than 2 ppm were common in 1980 (Huber, 1982). Water temperatures regularly exceed 25°C. Approximately 10% of the stream's surface area is shaded by streamside vegetation.

Very little information was documented about the lower Avon River fishery prior to 1960. Fishermen who angled regularly above Stratford were unaware of any fishing pressure below the city. An unstable fish population existed when a survey was conducted in 1959 (Table 2). The fish community appeared to react favourably to improvements in water quality in the next 20 years and by 1977 the number of species present increased substantially. Smallmouth bass were sampled in the river for the first time during this

survey. By 1981, a good diversity of species was present and although not sampled, smallmouth bass were observed in several locations. Yellow perch were quite abundant in the lower reaches of the river; however, no individuals larger than 12 cm in length were sampled. Carp were abundant at all locations below Stratford.

Seventeen rock bass, sampled below Stratford in 1981, were analyzed for contaminant levels. The greatest mercury concentration was 0.21 ppm, which is well within acceptable limits (Table 3).

Population estimates conducted below Stratford in 1981 indicated an average fish biomass of 19.2 kg ha^{-1}. Technical problems, however, prevented the capture of large fish, particularly smallmouth bass and carp. This figure therefore, greatly underestimates the actual fisheries production. The total production below Stratford is believed to equal the current annual harvest by fishermen: 940 kg in bait species and 50 kg in sport fish species (Appendix).

5. SUMMARY OF CONCLUSIONS

5. 1. Shakespeare Pond

Stocked rainbow trout in Shakespeare Pond are currently providing a significant fishery to Stratford-area residents. In recent years, the harvest return has exceeded 50% of the number of fish stocked, which is consistent with the Ministry of Natural Resources policy on minimum standards which justify the maintenance of an artificial fishery.

Water quality conditions would support a self-sustaining largemouth bass population in Shakespeare Pond. This fishery could be restored if the existing population was eradicated and the pond subsequently restocked with largemouth bass and a complementary forage species.

At this time it is anticipated that the Ministry of Natural Resources will continue to manage the pond for a put-and-take fishery. No wild salmonid populations currently exist in the streams of Perth County, and Shakespeare Pond is one of only two public waters stocked with trout in the county. The 1970 Provincial Angler Survey indicated that 30% of Perth County residents fished specifically for brook and rainbow trout. The demand for trout angling opportunities therefore justifies this stock program.

5.2. Avon River above Stratford

Riparian land-use practices have reduced the quality of fisheries habitat in this section of river, to the extent that it will no longer support a cold water fish community. Elevated water temperatures, drastically low summer flows and the elimination of spawning substrate and in-stream hiding cover are the principal factors responsible for this decline. Poor channel morphology and low discharge eliminate the potential for developing a warm water sport fish community. The resource is currently utilized only by bait fishermen.

With considerable effort, a fishery in the upper Avon River could be restored. Channel modification or flow augmentation of about 0.3 m^3 sec^{-1} would be needed to increase depth. It would also be necessary to control existing erosion and nutrient sources, establish riparian buffer strips and construct in-stream fisheries habitat devices. These measures would create conditions that would sustain a warm water fish population. If

these measures also depressed water levels below 20°C, a trout fishery could be reestablished. This would be an extremely expensive undertaking which could not currently be justified by the Ministry of Natural Resources in view of more critical problems affecting the fisheries resource of the Wingham District.

5.3. Lake Victoria

As a result of current drawdown practises, the fisheries potential of this shallow impoundment can never be fully realized. High sediment loadings and poor water quality further impair production capabilities.

Improvements in all of these conditions would be required before a sport fishery could be created in the lake.

5.4. Avon River Below Stratford

As a result of improved sewage treatment measures in the City of Stratford, the water quality of the lower Avon River has improved in the last two decades. High phosphorus levels, however, are responsible, in part, for excessive plant growths. These growths cause nightly oxygen shortages which detrimentally affect the fish population. Also, living space available for larger fish is severely reduced in the critical summer period due to low river discharge. Shallow water depth is considered to be the factor which most severely limits fish production in this portion of the river.

Yellow perch have recently invaded the lower reaches of the Avon, and with the small resident bass population, they represent the only sport fish species in the river. Utilization of this fishery by anglers is extremely low.

High water temperatures and poor channel morphology eliminate any possibility of developing a trout fishery below Stratford. The river has potential for supporting a good warm water fish community with smallmouth bass as the top sport species. To develop this potential the mean summer depth of the river would need to be doubled to 0.5 m from 0.24 m (current). Further production increases would result from aquatic weed control, the creation of pools over 1 m in depth and the establishment of shade-producing riparian vegetation.

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Appendix

Avon River Fish Yield Calculations

MP = Maximum Potential [A] ; CP = Current Potential; A = Actual

Watercourse	Length (km)	Mean Width (m)	Mean Depth (m)	TDS (ppm)	MEI	Surface Area (ha)	Yield (kg/yr)								
							Bait fish			Sport Fish			Total		
							MP	CP	A	MP	CP	A	MP	CP	A
Avon River															
Above Stratford	14.7	7.1	0.40	na	na	10.4	500	470	470	540	0	0	1040	470	470
Lake Victoria	1.6	90.0	1.53	470	309.2	14.2	115	30	0	125	30	25	240	60	25
Below Stratford	19.1	16.6	0.24	na	na	31.7	1520	940	940	1650	50	50	3170	990	990
Total	35.4					56.3	2135	1440	1410	2315	80	75	4450	1520	1485
Shakespeare Pond	0.4		1.48	148	97.4	5.9	35	25	0	37	25	17 [B]	72	50	17
Watershed Total						62.2	2170	1465	1410	2352	105	92	4522	1570	1502

A. Based on the formulae:
$LOG_{10} Y = 0.05$ (mean annual air temp.) + 0.280 (LOG_{10} MEI) + 0.236 for impoundments. (Schlessinger and Regier, in press)
and $Y = 100$ kg ha^{-1} yr^{-1} for rivers and streams. Sport Fish were assumed to produce 52% of the total yield (Malhiot, 1980).

B. Includes natural production only. Stocked fish are not included.

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S-5 Experimental Efforts to Aerate the Avon River with Small In-stream Dams
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