A Biological and Chemical Assessment of the Kingston Brook Flowing Through Manor Park, East Leake.

Report produced by Ian Morrissey

School of Geography and Environmental Sciences
University of Birmingham, Edgbaston
Birmingham, B15 2TT.

Introduction

Kingston Brook forms the centrepiece of Manor Park, flowing from Gotham Road for approximately 600m before its exit from the park at the Great Central Railway line (Figure 1). Stream systems are major contributors to the biological diversity of areas such as Manor Park, as well as their aesthetic appeal, they provide habitat for fish, aquatic macroinvertebrates and aquatic plants.

From field observations it is evident that the section of Kingston Brook, which flows through the park, has been subjected to a number of human impacts. Stream channel engineering has resulted in the loss of channel sinuosity and caused the over deepening of certain sections. This would have been done primarily to reduce the risk of flooding, but the result is has been a reduction in instream physical habitat diversity and alteration to the natural flow pattern through the removal of riffle/pool sequences.

In Manor Park riparian zone (area adjacent to stream channel) clearance has resulted in a narrow strip of vegetation alongside both banks dominated by *Salix* sp. (Willow), *Crataegus monogyna* (Hawthorn) and *Sambucus nigra* (Elder) tree species. This again acts to reduce habitat diversity as well as the supply of valuable organic matter required by stream biota in the form of leaf litter. Agricultural practises within the catchment have increased the possibility of stream water contamination from fertilisers and pesticides, and storm drains entering into the Brook are potential sites of pollution associated with urban run-off.

Structure of report

This report concentrates on the aquatic environment of Kingston Brook and uses biological monitoring techniques, water quality data and instream habitat characteristics to infer details on the general "health" of the stream in Manor Park and possible improvements. The comments and conclusions made in this report are those solely of the author, based on data collected in person on the 4/05/02. They do not necessarily reflect the opinion of the University of Birmingham.

Biological Monitoring

Biological monitoring, or biomonitoring, is the use of biological responses to assess changes in the environment, generally changes caused by human impact e.g. agricultural and sewage pollution. This study has used benthic aquatic macroinvertebrate taxa (invertebrate animals living on or in the stream bed substrates) collected from Kingston Brook as indicators of stream quality.

Why use benthic macroinvertebrates?

- Benthic macroinvertebrates are found in most aquatic habitats.
- There are a large number of species, and different stresses (e.g. pollution and habitat degradation) produce different macroinvertebrate communities.
- Macroinvertebrates generally have limited mobility. Thus they are indicators of localized environmental conditions and respond quickly to changes in water quality.
- Benthic macroinvertebrates are small enough to be easily collected and identified.
- Macroinvertebrates are the primary food source for recreationally and commercially important fish. An impact on macroinvertebrates impacts the food web and designated uses of the water resource.
- Government agencies (Environment Agency) have a long history of use of macroinvertebrate data to assess stream water quality.

How has the macroinvertebrate data collected been used?

A biotic index called the British Monitoring Workers Party (BMWP) has been used to assess stream quality. This index is commonly used within the field of freshwater biology to classify the degree of organic pollution in stream systems. Each type of macroinvertebrate collected is assigned a score (Appendix I) based on its tolerance to organic pollution. A species which scores a BMWP of 10 is very intolerant of pollution and therefore will be found only in very “healthy” stream systems. If the water quality deteriorates high scoring species will be lost. In contrast, a species that scores 1 will be able to persist in very “unhealthy” stream systems. Biotic indices assume that a polluted stream will contain fewer species than an unpolluted one and the species that are present will reflect their particular sensitivity to a pollutant. An Average Score Per Taxa (ASPT) has also been calculated. This is simply the BMWP

score for a sample site, divided by the number of scoring taxa in the same site. The ASPT is then used to biologically classify stream water quality.

Collection of aquatic macroinvertebrates

Aquatic macroinvertebrate samples were collected from 5 sites along the length of Kingston Brook (Figure 1), using a pond net and a 1 ½ minute kick sample technique, a standard Environment Agency methodology. Macroinvertebrates were preserved in 90% ethanol solution and identified to species (where possible) using standard British Identification Keys. Each species recorded was then assigned an abundance classification using the **DAFOR** scale.

Dominant	100 + individuals belonging to species x,
Abundant	50 to 99
Frequent	11 to 55
Occasional	3 to 10
Rare	1 to 2

Field notes were also taken in which general information on instream habitat and riparian zone structure were made.

Water chemistry analysis

Water samples were also collected from each site and analysed for Nitrate, Phosphate and Ammonia concentrations to give an indication of the level of organic pollutant in the system. In addition, a water sample was taken from the outflow pipe from the new estate (see Figure 1). Nitrates and phosphates occur naturally in freshwater systems and are utilised by aquatic plants. However, elevated levels caused by fertiliser and sewage inputs can cause excessive growth of water plants. This can have detrimental effects because of the removal of oxygen caused by the decay of dead plant matter.
Stream water Biological Oxygen Demand (BOD) was calculated for the reach. This is a measure of the oxygen used by microorganisms (bacteria), which decompose organic waste such as dead plants, leaves, grass clippings, manure, sewage, or even food waste that is present in a water supply. Elevated levels of organic waste in a stream will increase bacteria levels as a result the demand for oxygen will be high (due to all the bacteria) so the BOD level will be high. If bacteria use up the majority

of dissolved oxygen within streams, then other aquatic organisms such as fish and macroinvertebrates are deprived of the oxygen they need to survive. The water chemistry data in this report is used in conjunction with Environment Agency standards to classify water quality.

Results and Discussion

Sampling conducted at the 5 Sites on Kingston Brook yielded 26 aquatic macroinvertebrate taxa (Table 1). A number of invertebrate orders were represented including caddisfly larvae, mayfly nymphs, molluscs and leeches, all of which are typically found in lowland stream systems like Kingston Brook. The most common taxa recorded were *Valvata piscinalis, Sphariidae* (Molluscs), Chironomidae (non-biting midge larvae), *Glossiphonia complanata* (leech), and worms.

Species richness values were found to be very low at Sites 1, 2, 3 and 4, with a minimum of 5 taxa recorded at Site 1. In contrast, Site 5 had the greatest species richness, with a total of 21 taxa recorded. The low species richness recorded in Sites 1 to 4 is indicative of habitat degradation. The calculated British Workers Monitoring Party (BMWP) scores for individual sites were also low, ranging from 15 at Site 1 to a maximum value of 69 at Site 5. To place these results in context, BMWP scores for pristine sites may be in excess of 200, whilst heavily polluted urban rivers may have BMWP scores of 5 or less. Average Score Per Taxa (ASPT) values, which are calculated from BMWP scores, classify Kingston Brook Sites 2, 4 and 5 as suffering from moderate levels of pollution and Sites 1 and 3 from moderate to server levels. The presence *Cyrnus trimaculatus* , at Site 1 which score 7 on the BMWP and *Mystacides azurea* at Site 3 which scores 10 on the BMWP throw doubt on the classification produced by the ASPT. These taxa are intolerant of organic pollution and therefore should not have been found at sites classified as suffering from server pollution problems.

Table 1. Benthic macroinvertebrate taxa and abundance classification recorded from sampling sites on Kingston Brook. Species richness (total number of species recorded), BMWP and ASPT scores are shown for each site.

Macroinvertebrate taxa	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**

Mayfly nymphs					
Baetis rhodani					F
Caenis luctuosa				R	R
Caddis larvae					
Hydropsyche siltalai					R
Hydropsyche pellucidula					R
Halesus digitatus		R			R
Hydroptila sp.		R		R	F
Cyrnus trimaculatus	R			R	
Mystacides azurea			R		
Molluscs					
Planorbis vortex			R	R	R
Planorbis albus		R			
Ancylus fluviatilis					O
Lymnaea peregra			F		O
Valvata piscinalis	R	F	D	R	F
Sphariidae	O	F	A	F	D
Potamoprygus jenkinsi		F	F		F
Bithynia tentaculata			O		
Leeches					
Erpobdella octoculata					O
Glossiphonia complanata		O	O	O	F
Diptera (True-fly larvae)					
Chironomidae	A	O	F	F	D
Stratiomyidae					R
Ceratopogonidae					F
Crustacea					
Gammarus pulex		R		O	F
Asellus aquaticus				R	
Coleoptera (Beetles)					
Dytscidae (l)					R
Hemiptera (Water bugs)					
Sigara dorsalis		R			
Other					
Oligochaeta (Worms)	D	O	O		F
Hydracarina (Mites)		R		R	A
Species richness	**5**	**12**	**10**	**11**	**21**
BMWP	**15**	**41**	**30**	**43**	**69**
ASPT	**3.8**	**4.1**	**3.8**	**4.3**	**4.3**

The results obtained from the bioassessment of macroinvertebrate communities in Kingston Brook are also not fully supported by the water chemistry data obtained from sampling sites (Table 2).

Table 2. Water chemistry measured at sampling sites and inflow from new estate. *Biological Oxygen Demand (BOD) has been calculated from 3 replicate samples take at Site 2.

	Phosphate PO_4 (mg/l)	Nitrate $N0_3$ (mg/l)	Ammonia N (mg/l)	BOD (mg/l)
Site 1	0.28	2.7	1.2	-
Site 2	0.08	2.6	0.1	-

Site 3	0.24	4.0	1.9	-
Site 4	0.26	4.3	1.7	-
Site 5	0.20	3.1	0.2	-
Mean	0.21	3.3	1.0	2.9*
Inflow	2.2	3.2	5.1	-

Nitrate (mean value 3.3 mg/l) and phosphate (mean value 0.2 mg/l) concentrations fall within the expected range for a stream receiving moderate levels of organic pollution from the surrounding catchment and the ammonia and Biological Oxygen Demand (BOD) concentrations classify water quality as fair/good and good respectively (Environment Agency Standards). There is however some concern over the quality of water entering the Kingston Brook from the storm drain located between Site 2 and Site 3. Water sampled from the inflow at the time of this study had much higher levels of phosphate (2.2 mg/l) and ammonia (5.1 mg/l) than those recorded in the stream water. Although the dilution of storm drain discharge by the main flow had resulted in there being no significant increase in the concentration of the chemical parameters measured.

The assessment of physical habitat quality in conjunction with biological and water chemistry data is required to draw prudent conclusions on the general "health" of Kingston Brook in Manor Park. From field observations it was evident that the instream habitat of Kingston Brook is very homogenous. Past physical alteration of the stream channel has resulted in relatively slow flowing sections characterised by a high degree of siltation over the streambed substrates. This type of habitat is dominant in Manor Park and Sites 1, 2, 3 and 4 fall into this category (Table 3).

In contrast, Site 5 located at downstream end of the study area (see Figure 1) retains some sinuosity and exhibits what are termed riffle/pool sequences. Riffles are shallow, relatively fast flowing sections, composed of cobble/gravel substrate that are delimited by deeper slower flowing pool sections. The faster flow velocity over the shallow riffle sampled at Site 5 acts to reduce levels of fine sedimentation and increase localised oxygen concentrations.

Table 3. Physical habitat descriptions for study sample sites.

	Instream	Riparian zone
Site 1	Over deepened section with cobble substrate overlying clay. Slow flowing section with large	Dense riparian vegetation of hawthorn, elder and willow

	amount of silt deposition.	shading channel.
Site 2	Widened, slow flowing section with heavily silted cobble substrate. Some instream vegetation (*Potamogeton*).	Riparian zone open with few tree species.
Site 3	Slow flowing section with silt deposition over cobble and boulder substrate. No instream vegetation. Chub x2 observed at this site.	Willow trees on left bank only.
Site 4	Slow flowing deep, narrow section with *Glyceria* bed encroaching from right bank. Silt deposition over cobble substrate.	Dense, hawthorn dominated riparian zone shading channel.
Site 5	Sinuous section with riffle/pool sequence and marginal gravel bar. Fast/moderate flow over clean cobble/gravel.	Mixed tree species, hawthorn, elder and willow shading channel.

Poor physical habitat quality equates to low habitat diversity; the result is a reduction in the number of macroinvertebrate taxa that can persist at a site, even if the water quality remains high. This is evident from the low species richness and BMWP scores for Sites 1 to 4. The species richness and BMWP scores at Site 5, in which physical habitat quality/diversity is greatly increased by the presence of riffle/pool sequences, are almost 2 times greater than those of the other sampling sites. The increase in instream habitat diversity at site 5 also creates additional environments that are favoured by macroinvertebrate taxa that are not recorded in the other sampling sites e.g. *Baetis rhodani* (Mayfly nymph), and *Hydropsyche* sp. (Caddisfly larvae). Both these species require relatively fast flow velocities that are provided by the riffle habitats.

In summary, habitat degradation within the Kingston Brook has resulted in the miss-classification of water quality with bioassessment techniques (macroinvertebrates), through the reduction in species richness at certain sites.