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Environmental Impact assessment of a proposed intake on the River Thames at Bray, 19 July 1988

A report to the Mid Southern Water Company

by

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SUMMARY AND CONCLUSIONS

1. Removal of water from the west side of the river (affecting the discharge past the mouth of The Cut and to the west of Queen's Eyot) could influence the existing pollution situation in that area, although the effect will be very small except in times of extremely low flow.

2. To assess the possible effect of flow reduction on the invertebrate fauna the RIVPACS model was used. Reducing the mean discharge produced no significant change in the fauna or scores at any site.

3. In the event of abstraction from the west bank flow, at the maximum proposed rate, during low summer flows it is possible that there would be a further decline in water quality at stations 3 and 4 and even at station 6 due to reduced dilution of polluting inflows.

4. The small change in total discharge values is unlikely to have any significant or sustained effect on communities of planktonic algae.

5. If entrainment of the fry of coarse fish is to be avoided it would be desirable to site the intake in the fastest flow possible, although other factors such as boat traffic and the presence of drifting debris should be taken into account.

BACKGROUND

This report considers the possible environmental impact on the flora and fauna of the River Thames of an application by Mid Southern Water Company to abstract 15 Mgd, possibly increasing later to 30 Mgd (1.57 $m^3 s^{-1}$), of water at Bray. The annual mean flow of the river at the abstraction point is said to be about 950 Mgd (50 $m^3 s^{-1}$). Downstream of the proposed intake point water from a tributary, The Cut, (c. 1.25-2.5 $m^3 s^{-1}$) enters the river and a little further downstream is the entrance to Bray Marina. Opposite the Marina the river is divided into two channels by Queen's Eyot.

OBJECTIVES

1. To determine the biological indices of water quality at locations relevant to the proposed intake point with particular reference to the confluence with The Cut and the position of the Bray Marina.

2. To consider the possible impact of reduced flows downstream of the proposed intake point on the condition of the phytoplankton.

3. To consider the nature and siting of the intake in relation to possible entrainment of fish.

INTRODUCTION

Flow (discharge) and its variations is the single characteristic of running waters which is most likely to influence the biota. As in the case of other physical (and chemical) characteristics it is probable that extreme, rather than average, conditons will exert the greatest influence on the ecology and biology of the system.

Any change which reduces the discharge or velocities of a large lowland river, such as the Thames, will generally result in conditions of greater environmental stress. Dissolved oxygen concentrations are more likely to fall to low levels as retention periods are extended; water temperatures will reach more extreme values and there will be increased concentrations of suspended and dissolved materials from effluents entering the river downstream of the abstraction point. The degree of impact will depend on the proportional reduction in discharge.

MACROINVERTEBRATES AND BIOTIC INDICES

Literature and rationale

The present study was designed to obtain invertebrate data suitable for comparisons with the predictions of a modelling system (RIVPACS) developed and described by Wright et al. (1984) at the FBA's River Laboratory. Much of the previous work on invertebrate communities in the River Thames has been carried out at Reading (Mann 1964, 1972; Berrie 1972; Mann et al. 1972; Mackey 1976a & b, 1977a & b). Mann (1964) comments that there are only relatively small longitudinal variations in the communities of macroinvertebrates in the Thames. A few other publications relate directly to the fauna of the river (Andrews 1977, Aston & Andrews 1978, Banks 1979).

Predictions of the macroinvertebrate taxa present in the river are made on the basis of certain selected environmental features. The methods used to assess water quality characteristics are essentially the BMWP (Biological Monitoring Working Party) score system and its derivative the ASPT (Average Score Per Taxon) (Armitage et al. 1983). The latter is generally the more reliable technique for restricted surveys because it is acknowledged to be almost unaffected by sample size or by restricted coverage of habitat subdivisions and reflects differences in environmental quality of rivers more effectively than any other score or diversity index currently in use. It was thus chosen as the most appropriate measure of conditions in the study area.

In theory ASPT values could range from 1 to 10 but, normally, recorded values vary between 3 and 7. A low value indicates the presence of organisms which are predominantly pollution tolerant and thus indicative of poor water quality. High values are associated with clean, unpolluted conditions and are, to some extent, site specific. For example, values for a clean, unpolluted, hardwater stream ranged from 5.9-6.5 (Pinder pers. comm.) but data presented by Armitage et al. (1983) suggest that the mean ASPT values for the Thames in a relatively unpolluted state would range from 4.4 to 5.3. Further work on the River Thames gives values as follows for Spade Oak, upstream of the present site, and for Runnymede downstream (Table 1).

These values are probably characteristic of this region of the River Thames when water quality conditions are "reasonable". For the purpose of the present study a comparison is made between observed and predicted values at each station examined. As a result it is possible to assign, to each site, a figure which represents the correspondence between the state of the river and its predicted potential. Experience of other river systems has shown that, for ASPT an agreement between observed and predicted at >0.9 can be regarded as very good, 0.7-0.9 as good, 0.6-0.7 as fair, 0.5-0.6 as poor and <0.5 as bad. For BMWP, the corresponding values are >0.8 very good, 0.6-0.8 good, 0.3-0.6 fair, 0.1-0.3 poor and <0.1 bad.

Methods

Three 10 m dredge samples were taken at each site and these were supplemented by pond-netting in the margins. The resultant bulked sample was washed three times, in a large container of water, to remove animals from the substratum and the water and animals was poured through a series of sieves of mesh sizes 8 mm, 1.7 mm and 655 μm. Coarse debris was removed from the top sieve after washing and the contents of the three sieves were combined and transferred to containers and preserved in 70% IMS for laboratory sorting and identification of the fauna.

Animals were identified to family level and BMWP and ASPT scores were calculated. Physical and chemical data from the sites were used in the River Communities Classification Model (RIVPACS) to calculate the scores of the predicted communities and the probability of occurrence for each family (taxon).

Data used in the prediction were:

River width

Mean depth

Substratum cover	a)	boulders and cobbles	65-256 mm
	b)	pebbles and gravel	2.1-64 mm
	c)	sand	0.07-2.0 mm
	d)	silt and clay	0.004-0.06 mm

Altitude

Latitude and Longitude

Distance from source

Slope

Discharge

Total alkalinity

Chloride

In the present study samples were taken in mid-summer when the proposed abstraction would be expected to have the greatest impact. The results of this sampling were analysed to provide BMWP scores which do not require estimates of relative or absolute abundance of macroinvertebrates.

To calculate the BMWP score all invertebrate taxa present in a given sample are identified to the family level (more than 85 possible taxa in all) and the scores for all families present are summed. The ASPT is then determined by dividing the total thus obtained by the number of scoring taxa represented.

Site descriptions are listed (Appendix 1) to supplement the data in Table 2.

<u>Results</u>

Figure 1 shows the disposition of the sites sampled within the study area. The rationale for site choices involved the inclusion of an upstream control (1) above the abstraction point. Downstream of the abstraction point it was recognised that the inflow from The Cut and the presence of the Marina were the main existing influences on the character of the river; hence samples were taken from within The Cut (2), between the mouth of The Cut and that of the Marina (3) and downstream of the Marina but upstream of the confluence of the channels separated by Queen's Eyot (4). Two further samples were intended to represent points at which the river was unaffected by the above influences (5) and a recovery site (6) downstream of the island.

Table 2 lists the physical and chemical characteristics of the above sites which are used to predict the probabilities of presence of invertebrate families (taxa). The same data are used in the RIVPACS program to predict BMWP scores and ASPT values. The only notable feature is the relatively high chloride value for the water of The Cut (more than twice that of the main river).

Tables 3-8 show the invertebrate taxa predicted to be present.

The normal condition of the river should be good to very good. This condition prevailed at sites 1 and 5, both totally unaffected by effluent from The Cut (Table 9). The Cut itself (site 2) is clearly rather heavily polluted (fair to poor) and subsequent samples downstream at sites 3, 4 and 6 all showed deterioration of water quality relative to control sites. Site 4, downstream of the Marina was worse than site 3.

Previous sampling upstream and downstream confirm that the results at sites 1 and 5 are normal. It is clear that The Cut is having an adverse effect on the river downstream.

To assess the effect of flow reduction on the invertebrate fauna the RIVPACS model was used. Reducing the mean discharge from category 9 (40-80 $m^3 s^{-1}$) to category 8 (20-40 $m^3 s^{-1}$) (halving of the discharge) predicted no significant change in the fauna of any site or in the values of BMWP scores or of ASPT.

PHYTOPLANKTON

Much of the work dealing with the flow of the Thames has been related to studies on planktonic algae (Rice 1938; Lack 1969, 1971; Bowles & Quennel 1971; Kowalezeski & Lack 1971; Lack & Berrie 1976; Lack, Youngman & Collingwood 1978; Whitehead & Hornberger 1984). In essence, it has been stated that there are critical discharges characteristic of each section of river, above which phytoplankton fails to increase or is actively reduced. At Reading this critical discharge was regarded as 40 $m^3 s^{-1}$ (Lack 1971), at Medmenham 50 $m^3 s^{-1}$ and at Walton on Thames 70 $m^3 s^{-1}$ (Bowles & Quennel 1971). When the critical discharge is exceeded the plankton is swept downstream and the high discharge dilutes algal suspensions.

In the present context it is improbable that an abstraction of 1-2 $m^3 s^{-1}$ will have any significant effect on algal populations in the affected reach unless, for a prolonged period of time, it was to result in a discharge shift to less than the critical level.

In the study area the phytoplankton population will be dominated by the centric diatom *Stephanodiscus hantzschii* Grunow together with other centric species. It is possible that the present condition is the result of a long term shift from an algal community dominated by *Asterionella*, *Fragilaria* and *Synedra* in the early part of the century (Fritsch 1902, 1903) to the current situation. the proposed abstraction is unlikely to do more than slightly extend the seasonal bloom of algae.

Whitehead and Hornberger (1984) refer to a "bloom" of *Microcystis* (Cyanobacteria) downstream of Staines in the extreme long, hot summer of 1976. The possibility of the present abstraction inducing such a bloom, even in extreme conditions, must be very small.

There is little evidence of nutrient deficiencies limiting the growth of algae in the Thames (Kowalczewski & Lack 1971; Lack 1971; Collie & Lund 1980) and water temperatures are unlikely to be so extreme that growth ceases. In consequence it is concluded that the present proposed abstraction is unlikely to exert an effect through either factor.

No attempt is made to predict the indirect effects of such a relatively small abstraction, the ecological mechanisms involved are far too complex, but, as in other situations, the impact is likely to be greatest when river discharge is at a minimum.

FISH ENTRAINMENT

The smaller the fish the greater is the hazard from intakes withdrawing water from the river. It is essential that fish should detect their approach to an intake and that the velocity of water entering the intake should be low enough to allow fish to escape.

As fish are not adapted to the presence of sudden vertical currents (Weight 1958) intake flows should, if possible, be horizontally disposed or dissipated over a large cross section.

Screening of the intake may be required both for removal of debris and exclusion of fish. Two types of screening are generally available for the exclusion of fish, 1) active and 2) passive.

1) Active screening relies on behavioural avoidance of the intake. By using lights, bubble curtains, louvre screens or electric screens (Langford 1983) it is possible to exclude fish or deter fish from entering the intake. Such mechanisms are often complicated to set up and may be expensive.

2) Passive screening involves the use of mesh material to physically prevent fish above a given size from entering the intake.

Detection of the intake by the fish is both visual and tactile. A fish can see, relative to its surroundings, that it is being drawn towards the intake, it may also respond to changing water velocities. It is critical that a fish should react to such stimuli at a time when it is able to overcome the increasing flow. A fish may be unable to avoid sudden changes if the entrance to the intake pipe is too small, when velocities will be high with a sudden increase. This could result in fish being trapped against the screen. Flat panel screens may be placed at a distance from the intake so that approach velocities are low and the filtration area is large. The disadvantage of such possible screens is the cleaning problem. Intakes are best placed near the bank where lifting gear can be installed to permit regular (daily?) cleaning. Such locations are likely to have the highest concentrations of fish fry.

An improved anti-blockage screen, the wedge-wire screen, has been developed (Espey, Huston and Associates 1981). These screens are positioned in cross-flow currents where the debris can slide off. The through-slot velocity is 15 cm s^{-1} maximum, and the river velocity at the intake point must be greater.

Cylindrical screens are better than flat screens. They can also be made of wedge-wire. A cylindrical screen allows greater control of the surface velocity distribution which improves fish exclusion and self cleaning characteristics. Such screens are particularly suitable for potable water supply intakes in rivers where the abstraction ranges from 0.2-2.0 m^3 s^{-1}. The manufacturer's recommendation is that the screens should be deployed axially to the flow so that cross flowing water cleans the screen surface. The self cleaning facility is improved by periodic backflushing with compressed air which displaces water from within the cylinder back through the screen (Espey Huston and Associates 1981). Wedge-wire cylinders have 1-2 mm slot widths, uniform surface water distribution and low through-slot velocities (<15 cm s^{-1}).

Work on the swimming speeds of small fish indicates that larval cyprinids (roach) of 10 mm can sustain a swimming speed of 11 cm s^{-1} for 1 hour (Lightfoot & Jones 1979) and attain avoidance speeds greater than this for short periods. Larger fry can sustain greater swimming speeds. The natural distribution of roach fry in the River Hull showed that most fry of <15 mm occurred in mean water velocities of <14.5 cm s^{-1}. Siting of the intake in relatively high velocity water in the River Thames would avoid the main areas in which fry concentrate.

The mouth of the intake should be as large as possible to minimise the velocity of water entering the pipe. If it is necessary to site the intake in water of low velocity then screening with wedge-wire of 1-2 mm slot width with a low through-slot velocity (<15 cm s^{-1}) should virtually eliminate entrainment of larval fish down to 10 mm in length, (Lifton 1979, Weisberg et al. 1987). It should be borne in mind that the river velocity must be higher than the intake velocity for efficient self-cleaning of the screen.

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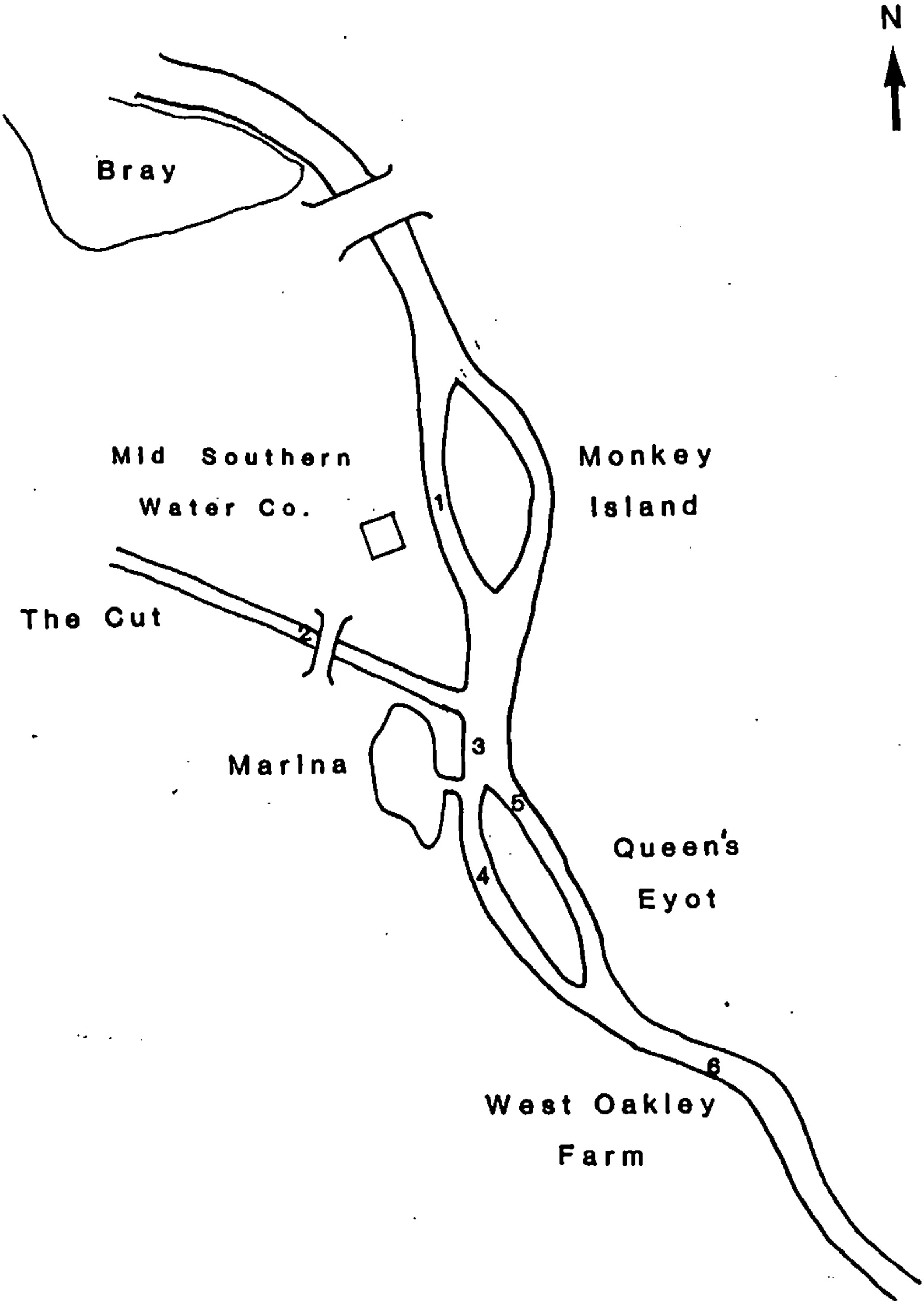

Fig. 1. Sampling sites on the River Thames at Bray.

Table 1. Comparisons of BMWP and ASPT values for stations upstream and downstream of Bray. Single sample values are equivalent to the present sampling approach.

	Spade Oak		Runnymede	
	Full sample	Single Sample	Full sample	Single sample
BMWP score	150	137	122	71
No. of Taxa	28	26	25	15
ASPT	5.36	5.27	4.88	4.73

Table 2. Physical and chemical characteristics of the sites used in the prediction of invertebrate community

Site	1	2	3	4	5	6
width (m) (estimated)	80	15	60	120	120	90
depth (cm) (estimated)	183	120	200	200	200	200
Substratum (%)						
boulders & cobbles	10	0	10	5	10	15
pebbles & gravel	70	2	70	2	77	75
sand	10	3	12	3	10	7
silt & clay	10	95	8	90	3	3
Altitude (m)	21	21	21	21	21	21
Latitude			51° 31'			
Longitude			0° 44'W			
Distance from source (km)	192	23	192	192	192	192
Slope (m km^{-1})	0.31	0.5	0.31	0.31	0.31	0.31
Discharge category	9	4	9	9	9	9
Total alkalinity (mg l^{-1} $CaCO_3$)	212	235	212	212	212	212
Chloride (mg l^{-1} Cl)	38	80	38	38	38	38

Table 3. Predicted BMWP families for summer in decreasing order of probability with families found in the dredges samples from July 1988 asterisked.

Site 1. West channel of Monkey Island

*100.0%	Chironomidae
99.9%	Baetidae
* 99.8%	Sphaeriidae
* 99.7%	Hydrobiidae (incl. Bithyniidae)
* 99.5%	Asellidae
99.0%	Corixidae
* 93.0%	Oligochaeta
* 92.9%	Gammaridae (incl. Crangonyctidae)
* 92.2%	Dytiscidae (incl. Noteridae)
91.7%	Polycentropodidae
* 85.6%	Glossiphoniidae
85.4%	Caenidae
85.1%	Leptoceridae
85.1%	Lymnaeidae
* 84.6%	Sialidae
* 78.9%	Elmidae
78.5%	Haliplidae
77.9%	Planorbidae
* 71.3%	Erpobdellidae
70.7%	Physidae
* 70.7%	Valvatidae
70.2%	Unionidae
* 63.6%	Neritidae
* 56.0%	Molannidae
49.4%	Limnephilidae
49.2%	Viviparidae
42.2%	Phryganeidae
41.9%	Corophiidae
* 36.3%	Ephemerellidae
36.1%	Ancylidae (incl. Acroloxidae)
35.3%	Piscicolidae
35.3%	Psychomyiidae (incl. Ecnomidae)
* 28.3%	Ephemeridae
28.2%	Calopterygidae (=Agriidae)
* 22.5%	Hydropsychidae
22.3%	Hydroptilidae
22.1%	Planariidae (incl. Dugesiidae)
21.1%	Coenagriidae
15.6%	Simuliidae
15.1%	Tipulidae
14.4%	Dendrocoelidae
14.0%	Notonectidae
* 7.5%	Aphelocheiridae
7.4%	Brachycentridae
7.4%	Leuctridae
7.3%	Hydrophilidae (incl. Hydraenidae)
7.2%	Gyrinidae
7.0%	Aeshnidae
0.4%	Leptophlebiidae
0.3%	Rhyacophilidae (incl. Glossosomatidae)
0.2%	Heptageniidae
0.2%	Sericostomatidae
0.2%	Goeridae

Table 4. Predicted BMWP families for summer in decreasing order of probability with families found in the dredges samples from July 1988 asterisked.

Site 2. The Cut.

*	100.0%	Chironomidae
	99.1%	Corixidae
*	98.9%	Oligochaeta
	96.8%	Lymnaeidae
	96.2%	Haliplidae
*	91.7%	Hydrobiidae (incl. Bithyniidae)
	91.5%	Baetidae
	90.1%	Dytiscidae (incl. Noteridae)
*	89.5%	Glossiphoniidae
*	87.7%	Planorbidae
*	83.7%	Sphaeriidae
	83.6%	Asellidae
	82.0%	Gammaridae (incl. Crangonyctidae)
*	77.8%	Physidae
	70.9%	Planariidae (incl. Dugesiidae)
*	70.1%	Valvatidae
	64.6%	Caenidae
	64.1%	Elmidae
	62.9%	Leptoceridae
*	62.9%	Erpobdellidae
	58.2%	Hydrophilidae (incl. Hydraenidae)
*	47.2%	Piscicolidae
	45.8%	Hydroptilidae
	44.6%	Coenagriidae
	39.5%	Sialidae
	31.3%	Ancylidae (incl. Acroloxidae)
	25.4%	Molannidae
	24.8%	Limnephilidae
	23.6%	Polycentropodidae
	19.9%	Dendrocoelidae
	18.7%	Neritidae
	17.7%	Aeshnidae
	17.2%	Gerridae
	15.1%	Phryganeidae
	14.8%	Ephemerellidae
	11.6%	Simuliidae
	11.5%	Notonectidae
	11.3%	Unionidae
	9.6%	Gyrinidae
	9.3%	Leuctridae
	8.6%	Rhyacophilidae (incl. Glossosomatidae)
	8.1%	Nepidae
	8.0%	Viviparidae
	6.6%	Corophiidae
	6.5%	Psychomyiidae (incl. Ecnomidae)
	4.8%	Hydropsychidae
	4.7%	Calopterygidae (=Agriidae)
	4.5%	Ephemeridae
	3.0%	Tipulidae
	1.2%	Aphelocheiridae
	1.1%	Brachycentridae
	0.3%	Platycnemididae

Table 5. Predicted BMWP families for summer in decreasing order of probability with families found in the dredges samples from July 1988 asterisked.

Site 3. Upstream of Bray Marina.

*	100.0%	Chironomidae
	99.8%	Baetidae
*	99.8%	Sphaeriidae
*	99.7%	Hydrobiidae (incl. Bithyniidae)
*	99.4%	Asellidae
	98.6%	Corixidae
*	93.0%	Oligochaeta
*	92.9%	Gammaridae (incl. Crangonyctidae)
	92.0%	Dytiscidae (incl. Noteridae)
	91.2%	Polycentropodidae
*	85.5%	Glossiphoniidae
*	85.3%	Caenidae
*	85.0%	Leptoceridae
*	84.9%	Lymnaeidae
	84.2%	Sialidae
	79.0%	Elmidae
*	78.4%	Haliplidae
*	77.7%	Planorbidae
*	71.2%	Erpobdellidae
	70.5%	Physidae
*	70.5%	Valvatidae
	69.8%	Unionidae
*	63.5%	Neritidae
	55.6%	Molannidae
	49.2%	Limnephilidae
	48.9%	Viviparidae
	41.9%	Phryganeidae
	41.6%	Corophiidae
	36.6%	Ephemerellidae
	36.3%	Ancylidae (incl. Acroloxidae)
*	35.2%	Piscicolidae
	35.2%	Psychomyiidae (incl. Ecnomidae)
	28.2%	Ephemeridae
	28.2%	Calopterygidae (=Agriidae)
*	22.8%	Hydropsychidae
	22.7%	Hydroptilidae
	22.3%	Planariidae (incl. Dugesiidae)
	21.0%	Coenagriidae
	16.0%	Simuliidae
	15.3%	Tipulidae
	14.4%	Dendrocoelidae
	13.9%	Notonectidae
*	7.7%	Aphelocheiridae
	7.5%	Brachycentridae
	7.5%	Leuctridae
	7.3%	Hydrophilidae (incl. Hydraenidae)
	7.3%	Gyrinidae
	6.9%	Aeshnidae
	0.6%	Leptophlebiidae
	0.5%	Rhyacophilidae (incl. Glossosomatidae)
	0.4%	Heptageniidae
	0.3%	Sericostomatidae
	0.2%	Goeridae
	0.1%	Gerridae
	0.1%	Taeniopterygidae

Table 6. Predicted BMWP families for summer in decreasing order of probability with families found in the dredges samples from July 1988 asterisked.

Site 4. Downstream of Bray Marina.

*	100.0%	Chironomidae
*	100.0%	Corixidae
*	100.0%	Hydrobiidae (incl. Bithyniidae)
	100.0%	Baetidae
*	99.9%	Sphaeriidae
	99.9%	Asellidae
*	92.9%	Oligochaeta
	92.8%	Dytiscidae (incl. Noteridae)
*	92.8%	Gammaridae (incl. Crangonyctidae)
	92.6%	Polycentropodidae
*	85.7%	Lymnaeidae
*	85.7%	Glossiphoniidae
	85.7%	Caenidae
	85.6%	Leptoceridae
*	85.6%	Sialidae
	78.6%	Haliplidae
	78.6%	Planorbidae
	78.5%	Elmidae
*	71.4%	Physidae
*	71.4%	Erpobdellidae
*	71.4%	Valvatidae
*	71.2%	Unionidae
	64.1%	Neritidae
	57.0%	Molannidae
	49.9%	Limnephilidae
	49.9%	Viviparidae
	42.8%	Phryganeidae
*	42.7%	Corophiidae
	35.7%	Piscicolidae
	35.7%	Ancylidae (incl. Acroloxidae)
	35.7%	Ephemerellidae
	35.6%	Psychomyiidae (incl. Ecnomidae)
	28.5%	Calopterygidae (=Agriidae)
	28.5%	Ephemeridae
	21.6%	Planariidae (incl. Dugesiidae)
	21.5%	Hydroptilidae
	21.5%	Coenagriidae
	21.4%	Hydropsychidae
	14.3%	Dendrocoelidae
	14.3%	Simuliidae
	14.3%	Notonectidae
	14.3%	Tipulidae
	7.3%	Hydrophilidae (incl. Hydraenidae)
	7.2%	Aeshnidae
	7.2%	Gyrinidae
	7.1%	Leuctridae
	7.1%	Aphelocheiridae
	7.1%	Brachycentridae

Table 7. Predicted BMWP families for summer in decreasing order of probability with families found in the dredges samples from July 1988 asterisked.

Site 5. East channel of Queen's Eyot.

*	100.0%	Chironomidae
*	99.9%	Baetidae
*	99.9%	Sphaeriidae
	99.9%	Hydrobiidae (incl. Bithyniidae)
*	99.8%	Asellidae
	99.5%	Corixidae
*	92.9%	Oligochaeta
*	92.9%	Gammaridae (incl. Crangonyctidae)
	92.5%	Dytiscidae (incl. Noteridae)
	92.3%	Polycentropodidae
*	85.6%	Glossiphoniidae
	85.6%	Caenidae
*	85.4%	Lymnaeidae
*	85.4%	Leptoceridae
	85.2%	Sialidae
	78.7%	Elmidae
	78.5%	Haliplidae
	78.2%	Planorbidae
*	71.4%	Erpobdellidae
	71.1%	Valvatidae
	71.1%	Physidae
	70.8%	Unionidae
*	63.9%	Neritidae
	56.6%	Molannidae
*	49.7%	Limnephilidae
	49.6%	Viviparidae
	42.5%	Phryganeidae
	42.4%	Corophiidae
*	36.0%	Ephemerellidae
*	35.9%	Ancylidae (incl. Acroloxidae)
	35.5%	Piscicolidae
*	35.5%	Psychomyiidae (incl. Ecnomidae)
	28.4%	Ephemeridae
	28.4%	Calopterygidae (=Agriidae)
*	21.9%	Hydropsychidae
	21.9%	Hydroptilidae
	21.8%	Planariidae (incl. Dugesiidae)
	21.3%	Coenagriidae
	14.9%	Simuliidae
*	14.7%	Tipulidae
	14.3%	Dendrocoelidae
	14.2%	Notonectidae
*	7.3%	Aphelocheiridae
	7.2%	Leuctridae
	7.2%	Brachycentridae
	7.2%	Hydrophilidae (incl. Hydraenidae)
	7.2%	Gyrinidae
	7.1%	Aeshnidae
	0.2%	Leptophlebiidae
	0.2%	Rhyacophilidae (incl. Glossosomatidae)

Table 8. Predicted BMWP families for summer in decreasing order of probability with families found in the dredges samples from July 1988 asterisked.

Site 6. West Oakley Farm.

*	100.0%	Chironomidae
	99.9%	Baetidae
*	99.8%	Sphaeriidae
	99.7%	Hydrobiidae (incl. Bithyniidae)
*	99.6%	Asellidae
*	99.0%	Corixidae
*	93.0%	Oligochaeta
*	92.9%	Gammaridae (incl. Crangonyctidae)
	92.3%	Dytiscidae (incl. Noteridae)
	91.7%	Polycentropodidae
*	85.6%	Glossiphoniidae
	85.4%	Caenidae
	85.2%	Leptoceridae
*	85.2%	Lymnaeidae
	84.7%	Sialidae
	78.9%	Elmidae
*	78.5%	Haliplidae
*	77.9%	Planorbidae
*	71.3%	Erpobdellidae
*	70.8%	Physidae
*	70.8%	Valvatidae
	70.3%	Unionidae
*	63.7%	Neritidae
	56.1%	Molannidae
	49.4%	Limnephilidae
	49.2%	Viviparidae
	42.2%	Phryganeidae
	42.0%	Corophiidae
	36.3%	Ephemerellidae
	36.1%	Ancylidae (incl. Acroloxidae)
	35.4%	Piscicolidae
	35.4%	Psychomyiidae (incl. Ecnomidae)
	28.3%	Ephemeridae
	28.3%	Calopterygidae (=Agriidae)
	22.4%	Hydropsychidae
	22.3%	Hydroptilidae
	22.0%	Planariidae (incl. Dugesiidae)
	21.1%	Coenagriidae
	15.5%	Simuliidae
	15.0%	Tipulidae
	14.4%	Dendrocoelidae
	14.0%	Notonectidae
	7.5%	Aphelocheiridae
	7.3%	Brachycentridae
	7.3%	Leuctridae
	7.3%	Hydrophilidae (incl. Hydraenidae)
	7.2%	Gyrinidae
	7.0%	Aeshnidae
	0.4%	Leptophlebiidae
	0.3%	Rhyacophilidae (incl. Glossosomatidae)
	0.2%	Heptageniidae
	0.2%	Sericostomatidae
	0.2%	Goeridae

Table 9. Observed and predicted scores from invertebrate data and RIVPACS model.

Site	Observed BMWP	Predicted BMWP	Obs/Pred	Observed ASPT	Predicted ASPT	Obs/Pred	Overall classification
1	99	130	.76	5.21	5.14	1.01	Good/V.Good
2	28	100	.28	2.80	4.17	.67	Poor/Fair
3	80	130	.64	4.21	5.12	.82	Good
4	51	131	.39	3.64	4.58	.80	Fair/Good
5	95	131	.73	5.28	5.25	1.00	Good/V.Good
6	56	130	.43	3.73	5.24	.71	Fair/Good

Appendix 1

Site descriptions

Site 1   West channel of Monkey Island

Estimated surface velocity >10-25 cm sec^{-1}.

Water clarity and colour - cloudy and greyish.

Macrophytes in sample area - none.

Extra species in survey area - Epilobium hirsutum.

Macrophyte cover % - none.

Detritus - present.

Dominant bankside vegetation - trees and bushes.

Shading in survey area - nil/low.

Influences on survey area - probable dredging. Weir upstream controlling flow. Major flow of river in channel east of Monkey Island.

Site 2   The Cut

Estimated surface velocity - >10-25 cm sec^{-1}.

Water clarity and colour - cloudy and grey-brown.

Macrophytes in sample area - Callitriche sp., Elodea canadensis, Potamogeton sp., Sparganium erectum.

Extra species in survey area: Epilobium hirsutum, Solanum dulcamara

Macrophyte cover (%) ; Algae (10), Higher plants (10). Total 20%.

Detritus - present.

Dominant bankside vegetation - trees and bushes.

Shading in survey area - nil/low.

Influences on survey area - sewage works upstream.

Site 3 Upstream of Bray Marina

Estimated surface velocity - >25-50 cm sec^{-1}.

Water clarity and colour - cloudy and greyish.

Macrophytes in sample area - *Callitriche* sp., *Potamogeton pectinatus*, *Sparganium emersum*, filamentous algae and moss.

Macrophyte cover (%) - Algae (<0.1), Moss (<0.1), Higher plants (0.1). Total <0.2%.

Detritus - present.

Dominant bankside vegetation - trees (east bank only).

Shading in survey area - nil/low.

Influences on survey area - probable dredging, boat traffic, boat refuelling 40 m upstream, The Cut 50 m upstream.

Site 4 West channel of Queen's Eyot

Estimated surface velocity - >25-50 cm sec^{-1}.

Water clarity and colour - cloudy and greyish.

Macrophytes in sample area - none.

Extra species in survey area - *Epilobium hirsutum*, *Lythrum salicaria*, *Rumex* sp. Other terrestrial species.

Macrophyte cover (%) - none.

Detritus - present.

Dominant bankside vegetation - trees.

Shading in survey area - nil/low.

Influences on survey area - downstream of Bray Marina, possible dredging, boat traffic.

Site 5 East channel of Queen's Eyot

Estimated surface velocity - >25-50 cm sec^{-1}.

Water clarity and colour - cloudy and greyish.

Macrophytes in sample area - *Sparganium emersum*, *Schoenoplectus lacustris*, *Phalaris arundinacea*.

Extra species in survey area - *Epilobium hirsutum*.

Macrophyte cover (%) - Higher plants (0.1) Total 0.1%.

Detritus - present.

Dominant bankside vegetation - trees and bushes.

Shading in survey area - nil/low.

Influences on survey area - probable dredging, boat traffic, downstream of The Cut and Bray Marina.

Site 6 West Oakley Farm

Estimated surface velocity - >25-50 cm sec^{-1}.

Water clarity and colour - cloudy and greyish.

Macrophytes in sample area - *Nuphar lutea*, *Schoenoplectus lacustris*, *Typha* sp., *Phalaris arundinacea*, filamentous algae and moss.

Extra species in survey area - none.

Macrophyte cover (%) - algae (<0.1), moss (<0.1), higher plants (5). Total 5%.

Detritus - present.

Dominant bankside vegetation - bushes and low plants.

Shading in survey area - nil.

Influences on survey area - possible dredging, boat traffic, downstream of The Cut and Bray Marina.

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