AN ASSESSMENT OF THE IMPACT OF BERKHAMSTED AND MAPLE LODGE STWS ON THE GRAND UNION CANAL BASED ON MACROINVERTEBRATE SURVEYS

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COMPILED BY JUDY ENGLAND,

NRA BIOLOGY, WALTHAM CROSS

The assistance of the following people during the survey of the Grand Union Canal is acknowledged:

Biology East: Derek Tinsley, Dave Leeming,

Students: Jo Smith, Southampton University, Claudia Bryan, Polytechnic of Central London,

SUMMARY.

Developing projects for students gave us the opportunity to study the impact of two Sewage Treatment Works on the Grand Union Canal (GUC). Both studies were designed to identify the impact of the sewage effluent on the macroinvertebrate fauna of the canal and to investigate the distribution of the macroinvertebrates within the various canal habitats.

The two STWs studied were Berkhamsted STW, which enters the Pix Farm reach of the GUC, and Maple Lodge STW, which enters the Harefield reach. The sampling strategies of the surveys varied due to the different nature of the canal at the sites, but in both cases involved sampling both above and below the works and in the different habitats present at each site.

Biological Monitoring Working Party (BMWP) scores were obtained for each macroinvertebrate sample and the scores compared between sites and habitats.

A comparison of the scores upstream and downstream of both Berkhamsted STW and Maple Lodge STW showed a drop in BMWP score downstream of the works accompanied by a change in the invertebrate community. This shows the detrimental effect of the STWs on the canal.

The habitat surveys showed that the vast majority of macroinvertebrates were found in the marginal vegetation. The mid-channel bed in the Berkhamsted part of the GUC is limited in both BMWP score and the number of taxa present. This was not the case at Maple Lodge STW where the benthos is more diverse and clearly impacted by the STW.

The survey highlighted a requirement to produce a national protocol in order to standardise the methodology for sampling canals and also a need to update the IFE RIVPACS prediction programme for use on canals taking into account the habitat variations possible.

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1. INTRODUCTION

Macroinvertebrate surveys are carried out by NRA biologists nationwide to assess the water quality of rivers. In the Thames Region this includes monitoring the impact of effluent from major sewage treatment works.

A protocol exists for the collecting of invertebrate samples from most river sites. This involves an active 3-minute kick/sweep sample with a 400mm deep, 1mm mesh-size sampling net, followed by a search of one minute in all other habitats. This method is employed when looking at the impact of most sewage works. Samples are taken upstream and downstream of where the effluent discharges into the watercourse.

The situation is rather more complex where the effluent enters a canal or canalised river. Not only is the sampling itself more complex (requiring a dredge or grab) but also the lack of diverse habitats reduces the number of niches available for colonisation by macroinvertebrates.

Developing projects for students gave us the opportunity to study the impact of two such STW's in more detail. Both projects were designed to identify the impact of the sewage effluent on the macroinvertebrate fauna of the canal and to investigate the distribution of the macroinvertebrates within the various habitats of the canal.

Due to the different nature of the GUC at the two locations the sampling strategy varied. For this reason the two studies have been reported separately within this report with a overall discussion comparing the findings.

2. BERKHAMSTED STW

2.1 INTRODUCTION

In conjunction with a student from Southampton University a survey of Berkhamsted STW was conducted in June 1990. Berkhamsted Sewage Treatment Works is situated south-east of Berkhamsted, Buckinghamshire. The effluent from this works enters the Pix Farm Reach of the Grand Union Canal (TL01500680). It's consented discharge volume is 12 531 cubic metres per day.

2.2 METHODS.

2.2.1 Site description.

Eight sites were selected along the length of the Grand Union Canal from approximately 1 km upstream to 1.5 km downstream of Berkhamsted sewage treatment works. Three sites were situated at intervals upstream of the works and five downstream. Fig.1 is a map of the GUC showing the location of the sampling sites.

At each site the depth was measured across the canals to give a depth profile. Secchi disk measurements were taken to give an indication of the water clarity and the level of suspended solids in the water.

2.2.2 Bacteriology.

Water samples were taken from each site for bacteriological analysis. The membrane filtration technique, outlined in HMSO (1982), was followed to obtain the number of *Escherichia coli* bacteria per 100 ml of water. The results were used to show the area of influence of the sewage treatment works effluent on the canal.

2.2.3 Invertebrate sampling.

At each site samples of invertebrates were taken from 4 discrete habitats -

DIAGRAM SHOWING THE POSITION OF THE SAMPLING SITES ON THE GRAND UNION CANAL.

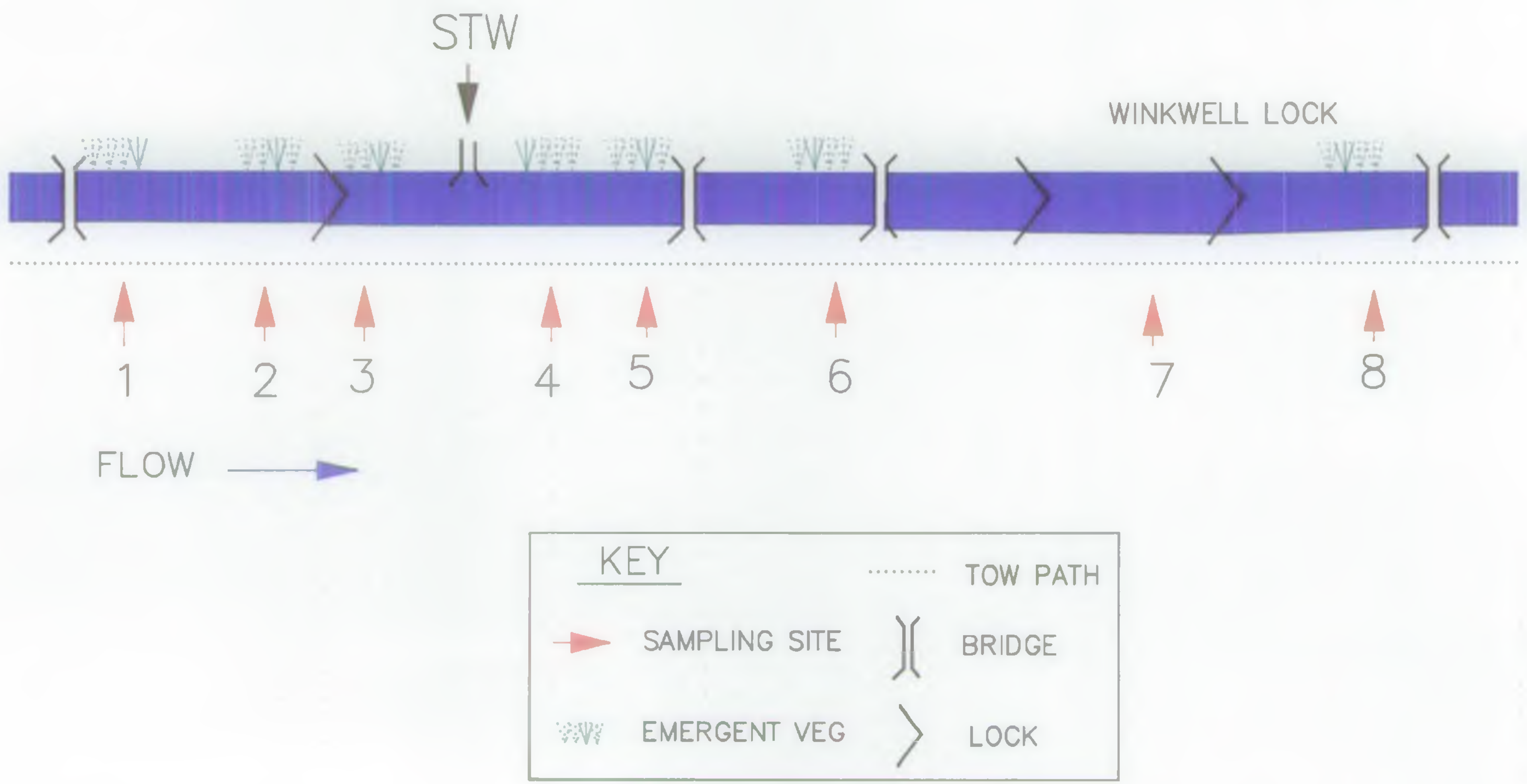


FIG 1.

1. Emergent marginal vegetation using a net sweep, (one minute)
2. Kick sample on the marginal gravel shelf, (one minute)
3. A grab sample of the mid-channel bed, (3 grab loads, each load approx. 2.8×10^3 cm^3)
4. 'Scrape' using a hand net on the piling sides of the bank. (one minute)

The macroinvertebrates in the samples were sorted and identified. Biological Monitoring Working Party (BMWP) scores were calculated to assess the diversity and pollution status of the invertebrate community at each site. The BMWP score system involves the identification of the invertebrates to family level. Each family is allocated a score in the range 1 to 10 based on its tolerance to pollution. The most tolerant group scores 1 (oligochaete worms) and the most pollution sensitive families score 10 (eg. most caddis-flies and mayflies). The scores for all the families present are added together to give a total BMWP score for the sample. A high score indicates good water quality.

A BMWP score was calculated for each sample and a total score obtained for each site. The overall score for each site was compared with the predicted score for that site (obtained using the IFE RIVPACS programme).

The results were compared to show any differences between sites upstream and downstream of the sewage treatment works and between habitats at each site.

Abundance/rank diagrams were used to compare the macroinvertebrate community at each site. These diagrams are obtained by plotting an index of abundance against species or family rank. They provide a means of examining invertebrate abundance distribution which is lost in the calculation of more simplistic parameters (Townsend et al. 1983).

2.3 RESULTS/DISCUSSIONS.

2.3.1 Site details.

Fig.2 depicts the depth profile of the canal at each of the sample sites. The same basic channel shape can be seen at each site. The maximum depth was greatest at site 3 (170cm) and least at site 8 (110cm). Marginal shelves, devoid of submerged vegetation, were present along both banks of the canal. Sampling sites were selected opposite clumps of emergent narrow-leaved vegetation. Since the emergent vegetation was sparsely distributed this was not possible at site 7.

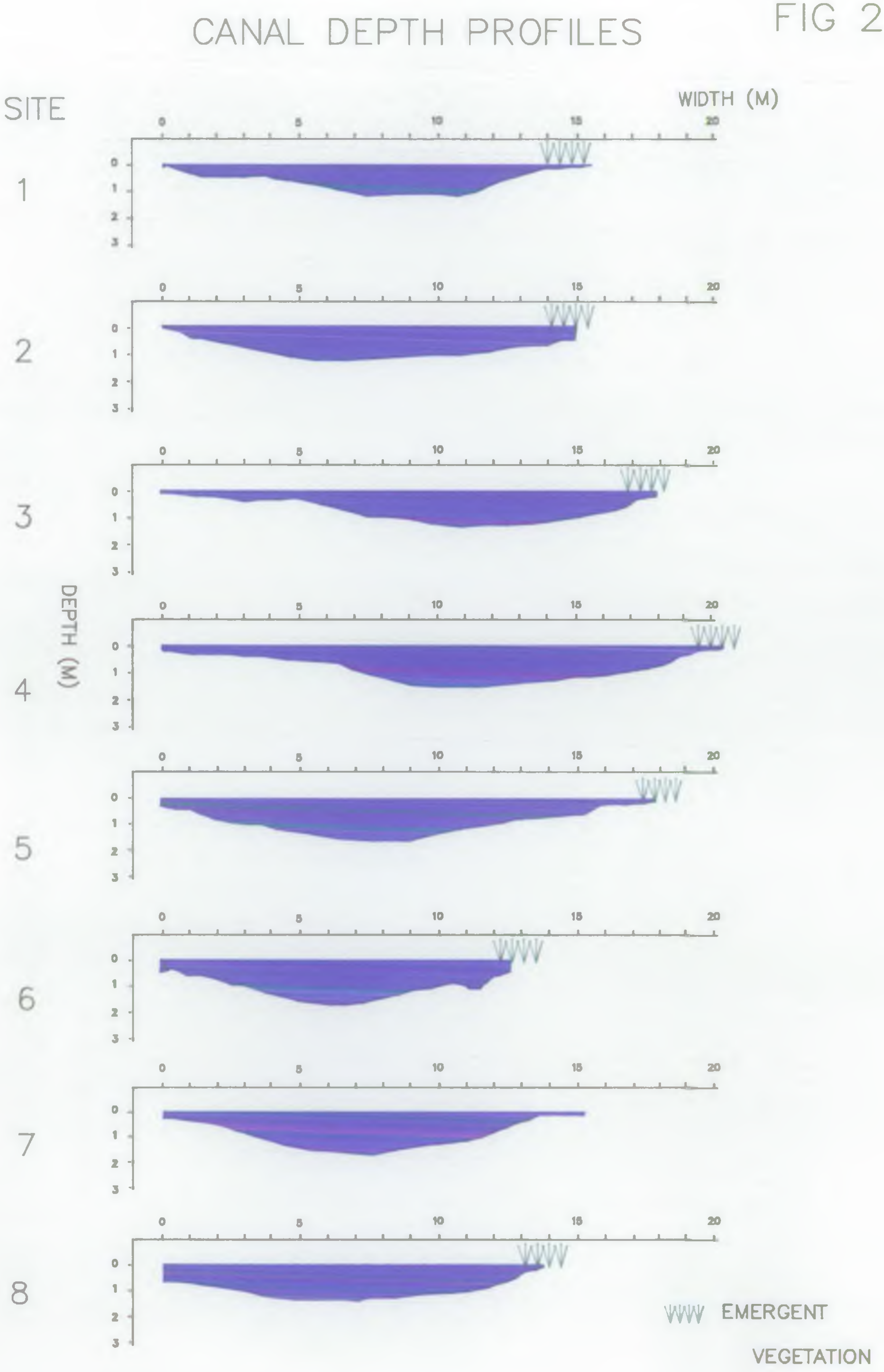
Fig.3 shows the results from the secchi disk measurements. There was no trend in water clarity along the length of the canal. The average depth at which the secchi disc was visible was 46cm upstream of the works and 53cm downstream. It is unlikely that the difference in depth is significant due to the error of the crude method of measurement. The reasons for the turbid waters is probably a combination of boat wash, phytoplankton and the movement of water as the locks open and close.

At all sites the depth at which the secchi disc was visible was greater than the depth of the marginal shelf. This suggests that the lack of submerged plants is not due to reduced light levels. The absence of both emergent and submerged vegetation is likely to be due to the abrasive action of boat wash - a problem evident in the Norfolk Broads (Mason and Bryant, 1975).

2.3.2 Bacteriology.

The results from the bacteriology analysis are given in Fig. 4. The results clearly show the area of sewage effluent contamination downstream of the sewage works. The bacterial levels are highest directly below the works (the levels indicate serious contamination which could pose a possible health risk). The levels then decrease with distance downstream. At site 8, the furthest downstream site, the levels of *E.coli* were still higher than the background levels found in the canal upstream of the works.

FIG 2.


CANAL DEPTH PROFILES
SITE
WIDTH (M)
DEPTH (M)
0
5
10
15
20
0
1
2
3
1
2
3
4
5
6
7
8
EMERGENT
VEGETATION

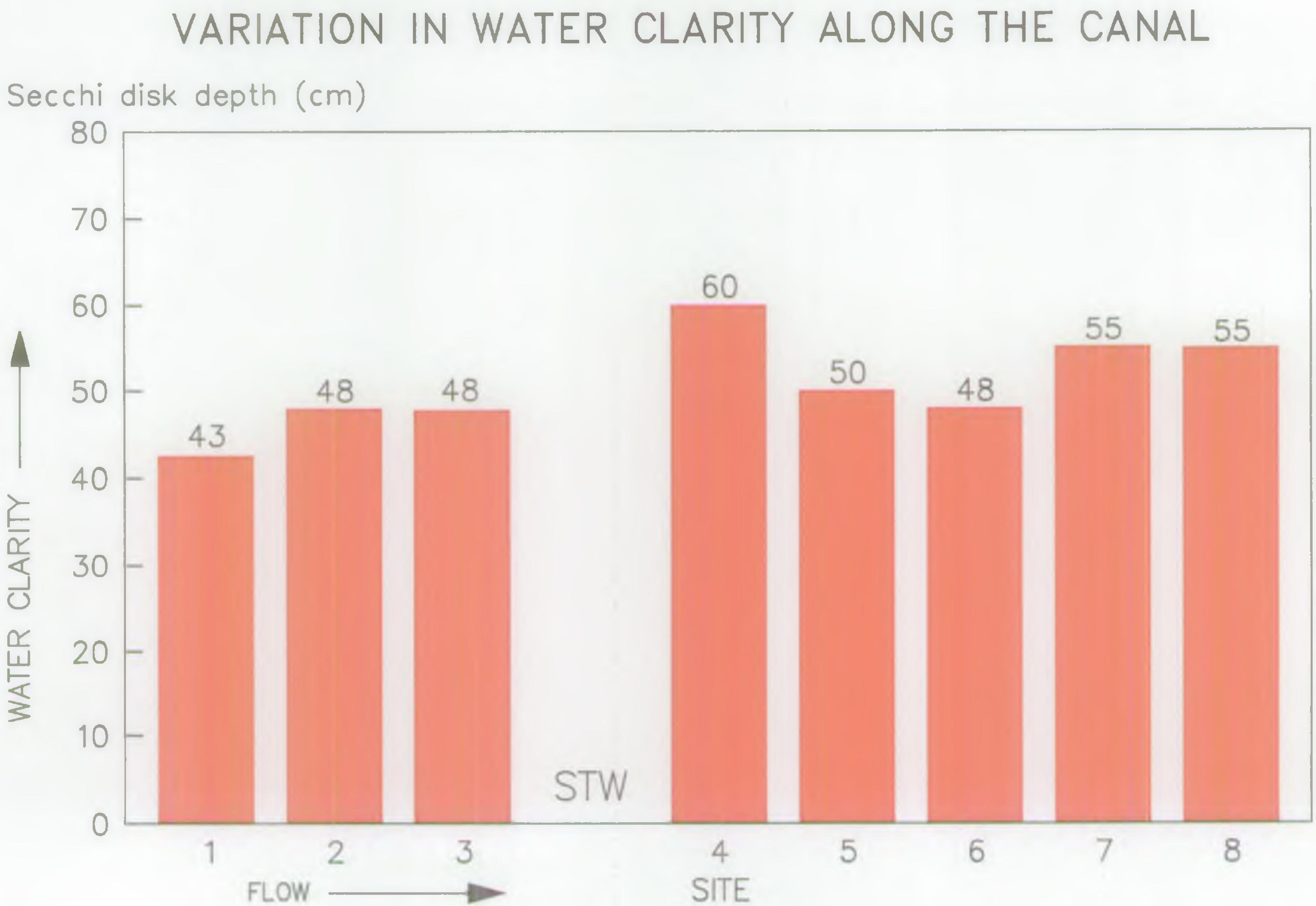

VARIATION IN WATER CLARITY ALONG THE CANAL
Secchi disk depth (cm)
80
70
60
50
40
30
20
10
0
WATER CLARITY
43
48
48
60
50
48
55
55
STW
1
2
3
4
5
6
7
8
FLOW
SITE

FIG 3.

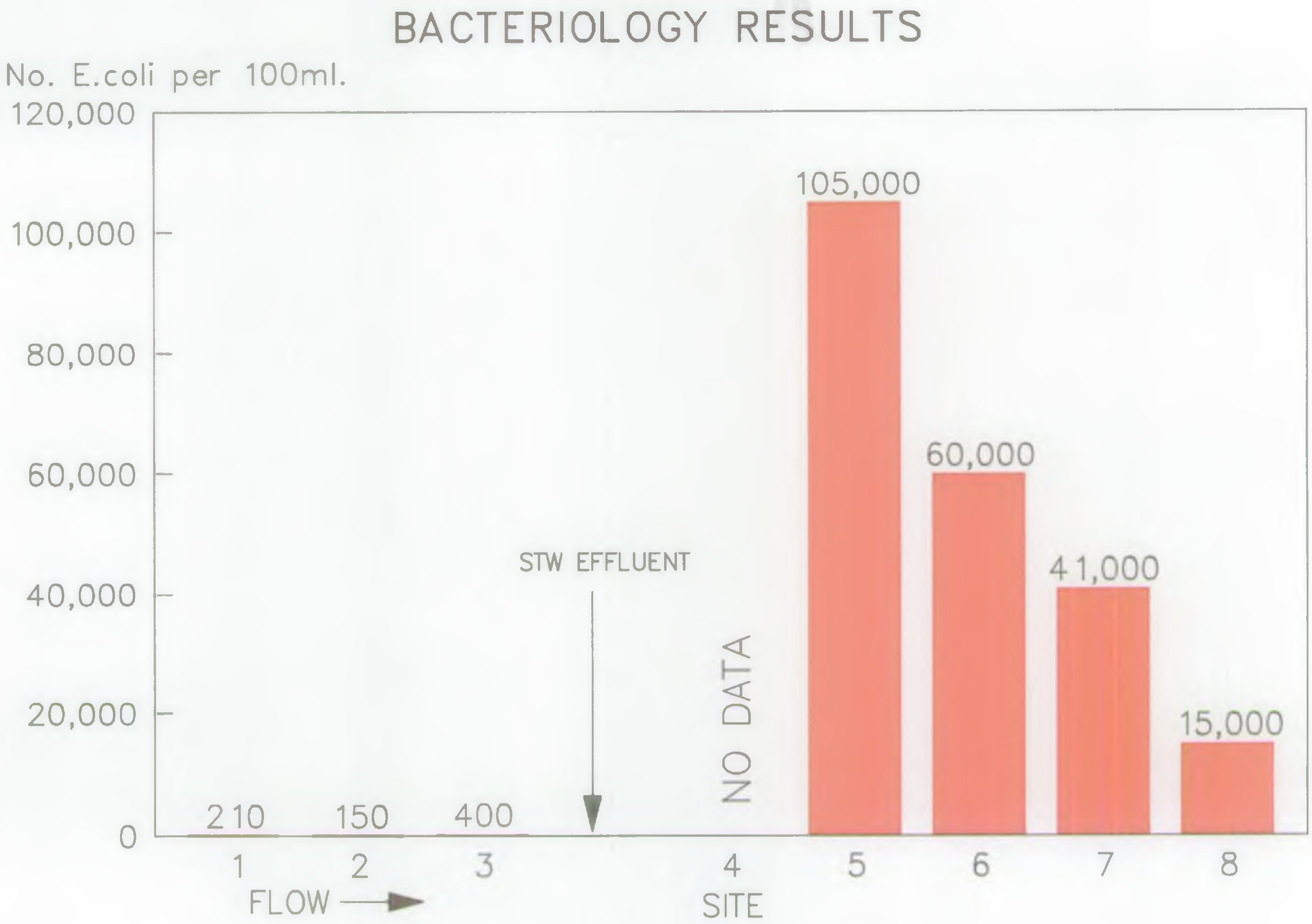

BACTERIOLOGY RESULTS
No. E.coli per 100ml.
120,000
100,000
80,000
60,000
40,000
20,000
0
210
150
400
STW EFFLUENT
NO DATA
105,000
60,000
41,000
15,000
1
2
3
4
5
6
7
8
FLOW
SITE

FIG 4.

There was no evidence of backwash of effluent upstream of the works. This might have been expected due to the intermittent water flow resulting from lock action.

2.3.3 Macroinvertebrate Community.

BMWP scores for each site.

The total BMWP scores for each site are given in Fig. 5, together with the predicted scores for the sites. The scores have been compared and the percentage of the predicted score achieved is also given.

The total BMWP score obtained for each site was fairly constant upstream of the sewage works with an average score of 63. There was a drop in BMWP score below the works with the lowest BMWP score seen at site 6 (score=24). The predicted scores were also fairly constant upstream but were more variable downstream. Canals are not suited to the use of the RIVPACS prediction programme since they are 'man-made' rivers and were not considered when the programme was first developed. The predicted scores produced have a large error term but do give some basis for comparison even though they are unlikely to be attained. The percentage of score achieved was greater upstream (mean for sites 1-3 = 47%) than downstream (mean for sites 4-6 = 21%). There was some evidence of a recovery with distance downstream. (i.e. Site 8 showed a 33% achievement of the predicted score.)

BMWP score according to habitat.

BMWP scores were calculated for each habitat, the results are given in Fig.6. The results for the emergent vegetation habitat show that the upstream sites are similar in both score and taxa composition. The sites downstream are all lower in score and sites 4, 5 and 8 have comparable scores and faunas. The low score seen at site 7 may be accounted for by the lack of emergent vegetation at this site (over-hanging vegetation was sampled instead). Site 6 also shows a

FIG 5.

TOTAL AND PREDICTED BMWP SCORES FOR EACH SITE.

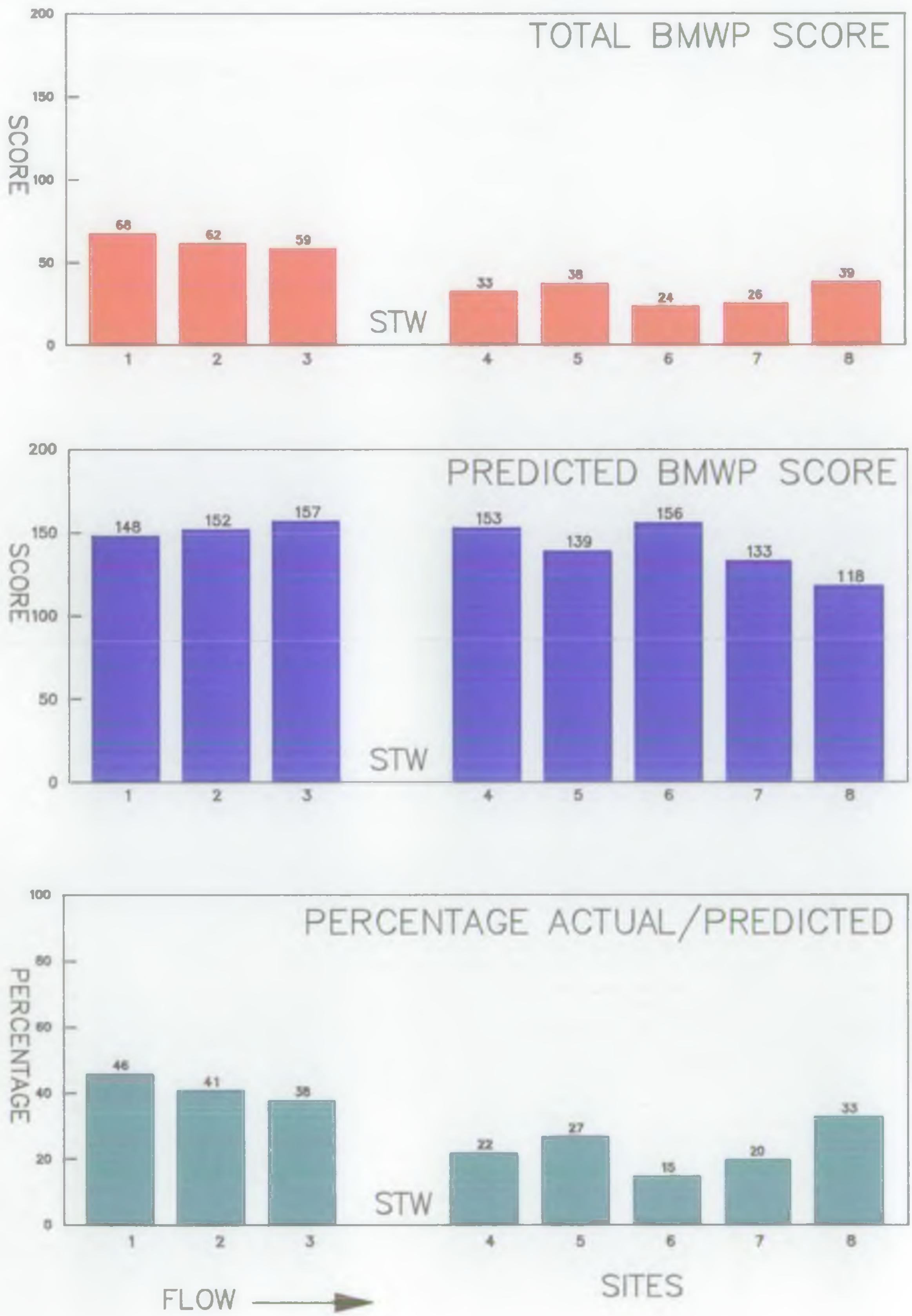
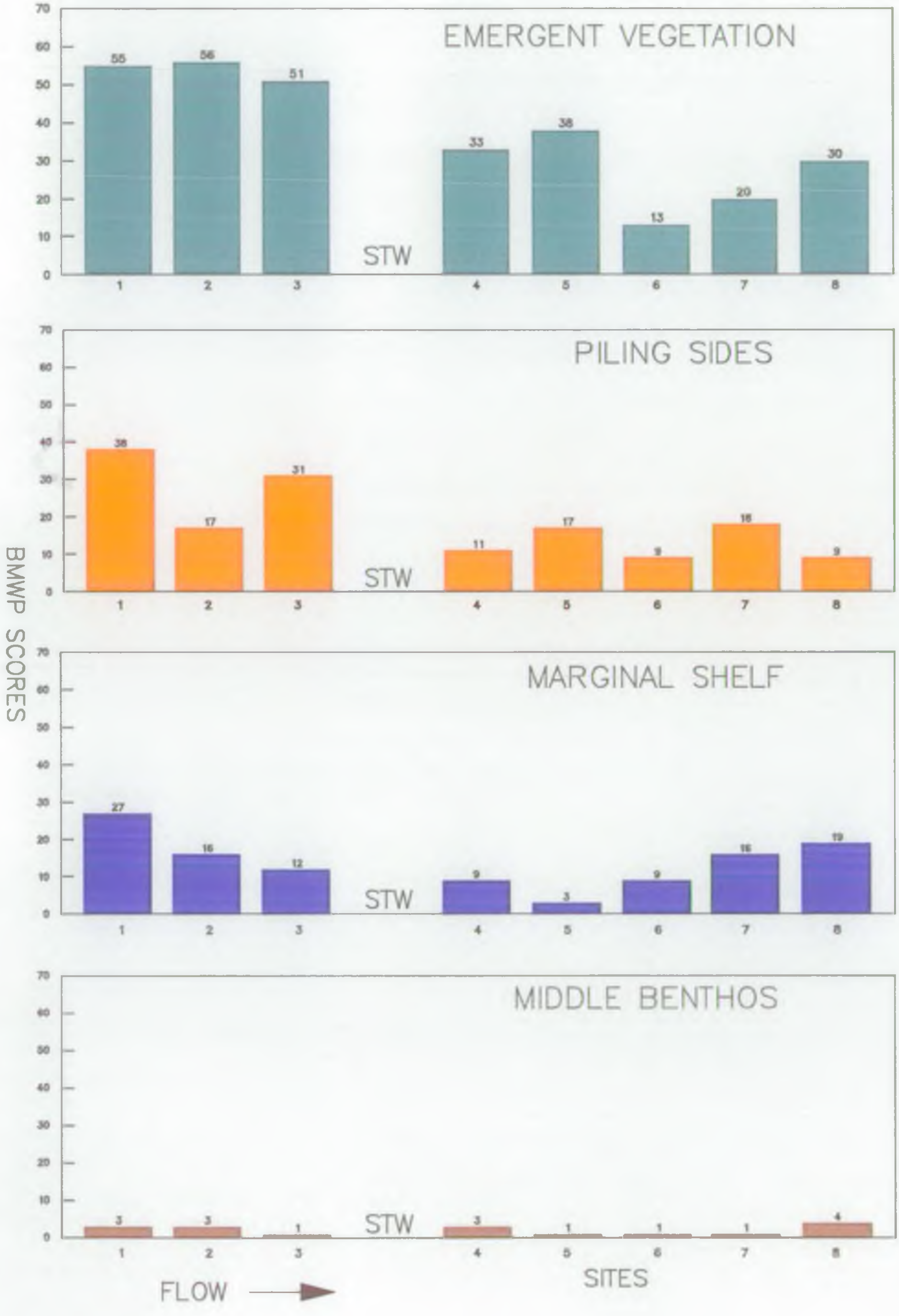


FIG.6

BMWP SCORE ACCORDING TO HABITAT TYPE



lower than expected score, in this case it is probably due to student sampling error.

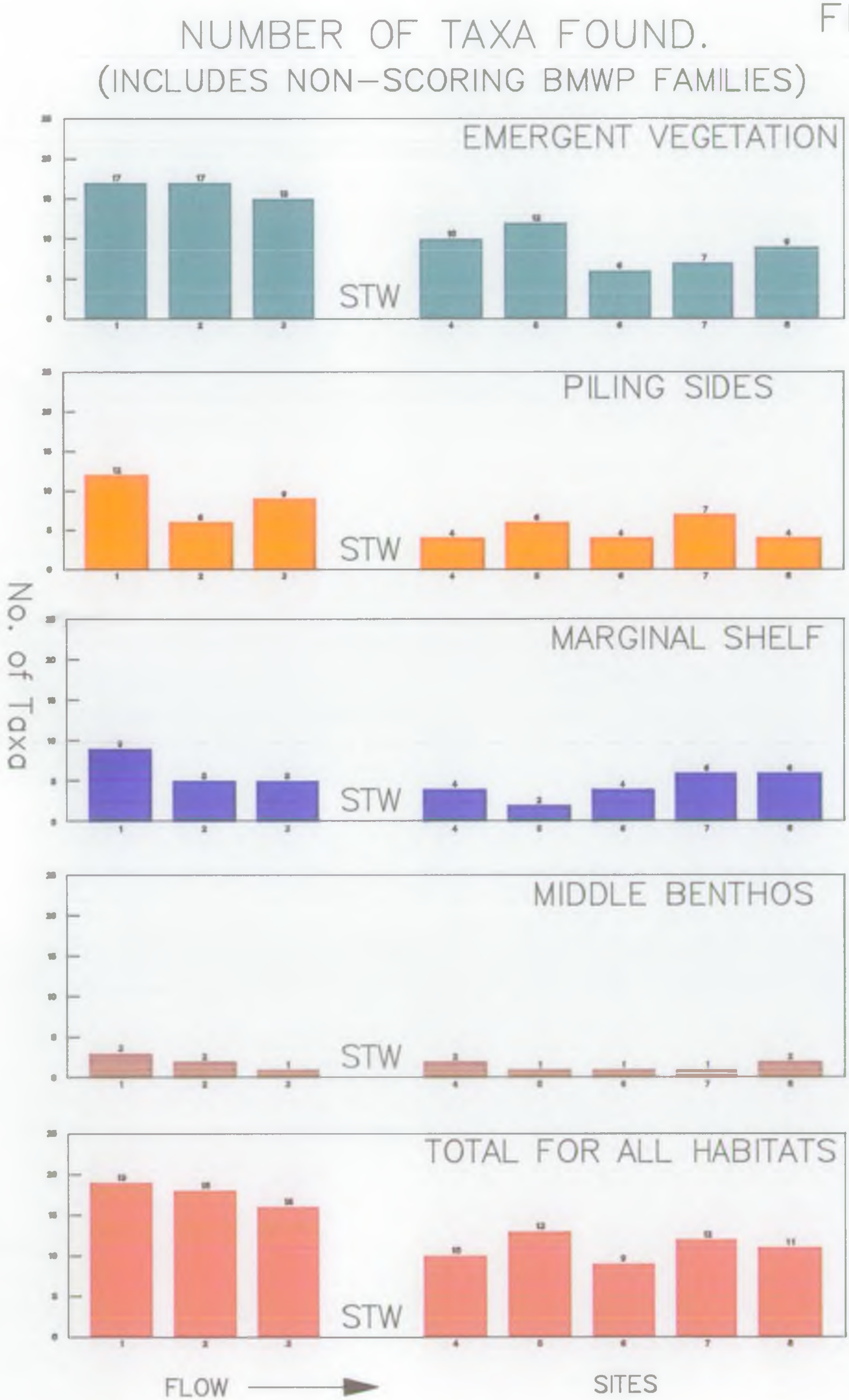
The scores obtained for the piling sides are much more variable and in some instances higher than expected. This is because it was impossible to sample the piling sides without inadvertently sampling the varying amount of over-hanging vegetation present at all sites. Again a trend of higher scores upstream of the works than downstream is seen.

The highest scores for the marginal shelf are seen upstream of the sewage works. Directly downstream of the works there was a drop in score with some evidence to suggest a recovery with distance downstream at site 8.

In contrast to the other habitats, the invertebrate community living in the mid-channel bed remained constant throughout the length of the canal. There was no effect of the sewage effluent on the BMWP score of the middle benthos. The invertebrate fauna at the centre of a canal is greatly restricted due to soft deoxygenated sediments and fish predation in exposed areas of bed. The score for this habitat might have been expected to be higher if families such as Unionidae had been found. The quantitative sampling technique adopted (for comparability) sampled a smaller area than net sweeps applied elsewhere and the patchy distribution of mid-channel fauna meant that Unionidae were less likely to be encountered.

The importance of sampling all habitats present can be seen from the results. At each site the overwhelming majority of BMWP scoring taxa were found in the emergent vegetation. The piling sides and the marginal shelf habitats showed a variable composition of the overall score. In this study, the mid channel bed produced only very low scores due to the restrictions mentioned above. In other, less restricted, canals the invertebrates of the channel bed may expected to be much more diverse and the bed play a more important role in providing a habitat for invertebrates. Although the emergent vegetation provided the majority of the score, it is necessary to sample all habitats since emergent vegetation is not always present or available for sampling.

FIG 7.


NUMBER OF TAXA FOUND.
(INCLUDES NON-SCORING BMWP FAMILIES)
EMERGENT VEGETATION
PILING SIDES
MARGINAL SHELF
MIDDLE BENTHOS
TOTAL FOR ALL HABITATS
STW
No. of Taxa
FLOW
SITES

Number of taxa found.

Fig. 7 shows the number of taxa that were found in the four habitats at each site, together with the total number for each site. The results mirror the trends shown by the total BMWP scores, that greater number of taxa were found at sites upstream of the sewage works than downstream. This trend was particularly clear for the emergent vegetation and the piling sides.

These results reinforce the conclusions that the majority of families are found in the emergent vegetation habitat, the number of taxa on the piling sides was variable and the mid-channel benthos was highly restricted.

Abundance/Rank Diagrams.

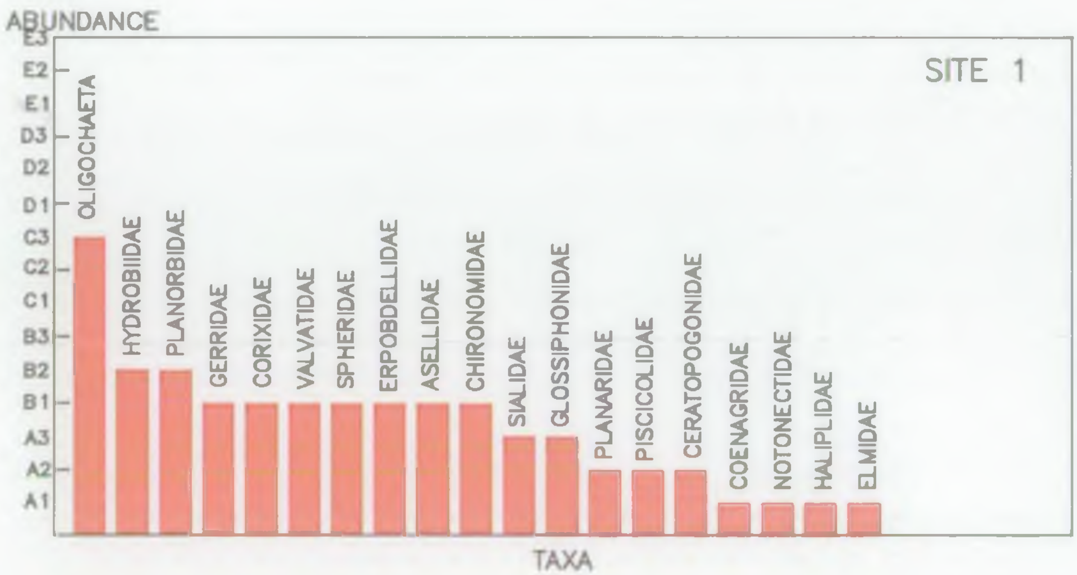
Abundance/Rank diagrams were drawn for the macroinvertebrate communities found at each of the sites. They are given in Figs 8a to 8c. Abundance/Rank diagrams describe communities in terms of the relative dominance or abundance of the component taxa. Fig 9. shows the type of diagram produced by three contrasting communities. Line A shows a community that is inequitable and dominated by a limited number of taxa. The overall number of taxa is low. Such a community would be produced if water quality or some other physicochemical factor limited the spread of taxa that could survive at a site. Those taxa that can exist at this site benefit from reduced competition and can therefore expand their population densities, (opportunistic). Line B shows an intermediate community with a wider spread of taxa and a less marked dominance by the highest ranking taxa. Line C shows a characteristically diverse and equitable community with a complex interaction of taxa. The site might have dominant groups of animals but numbers are reduced by competitive interactions with the other members of the community.

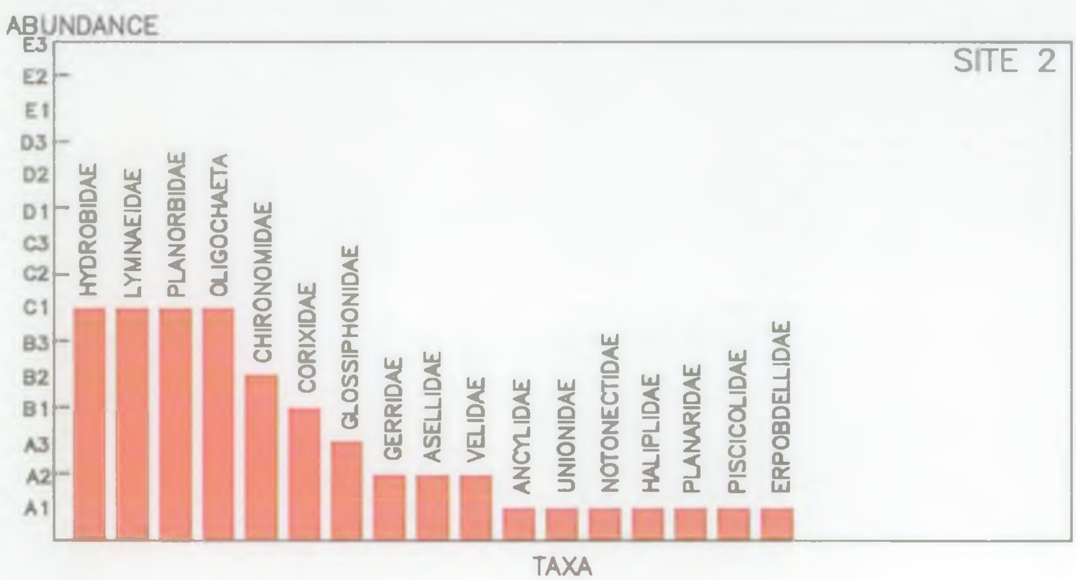
Examination of the communities found along the GUC show that those found at the sites upstream of the STW appear to be type B,

ABUNDANCE/RANK DIAGRAMS. FIG 8a

ABUNDANCE CATEGORIES

A1=1	C2=200–499
A2=2–4	C3=500–999
A3=5–9	D1=1000–1999
B1=10–19	D2=2000–4999
B2=20–49	D3=5000–9999
B3=50–99	E1=10000–19999
C1=100–199	E2=20000–49999

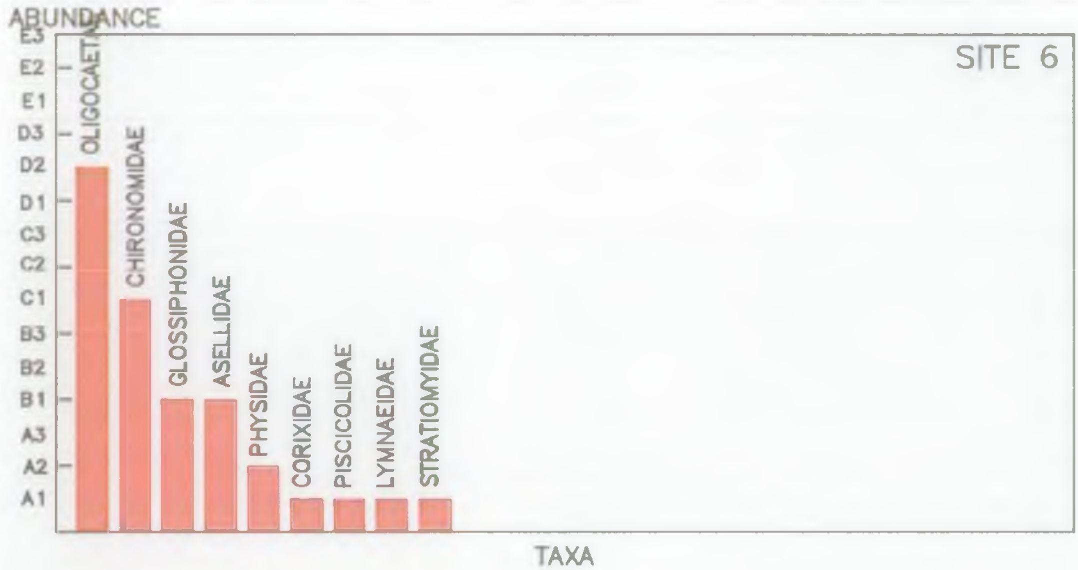


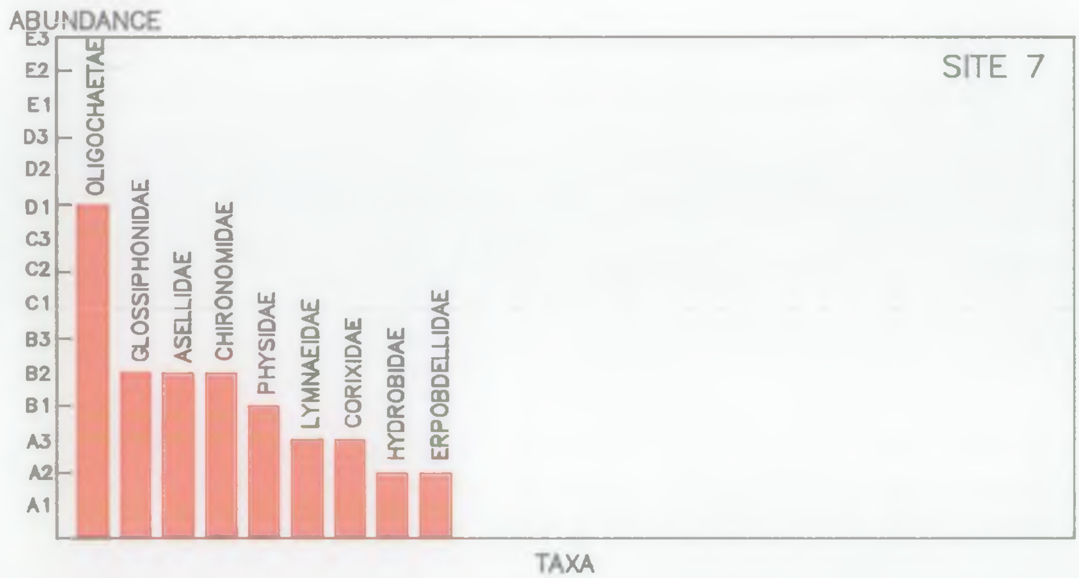


ABUNDANCE/RANK DIAGRAMS.

FIG. 8b

ABUNDANCE/RANK DIAGRAMS. FIG. 8c





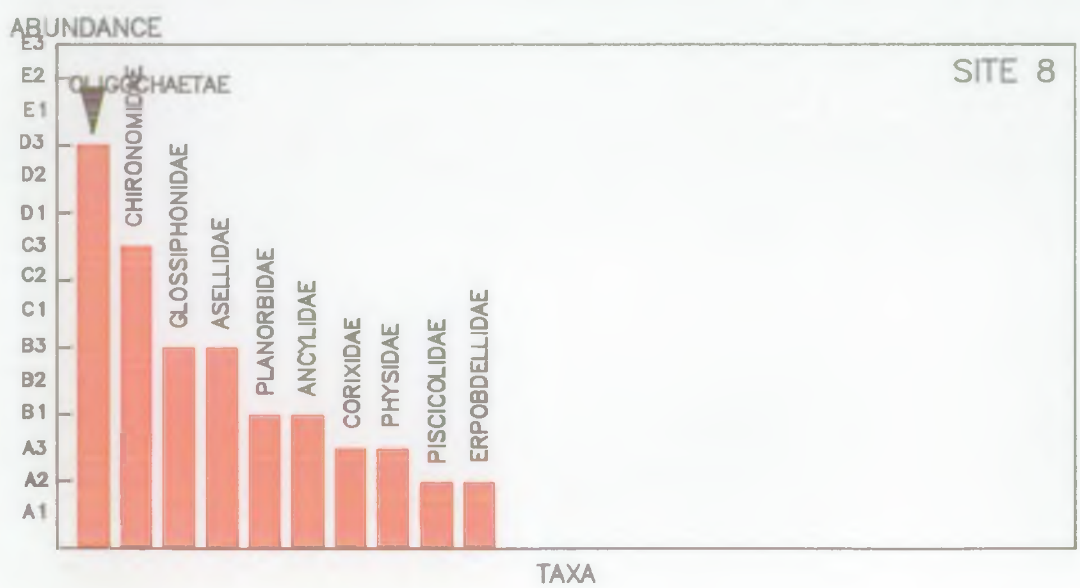
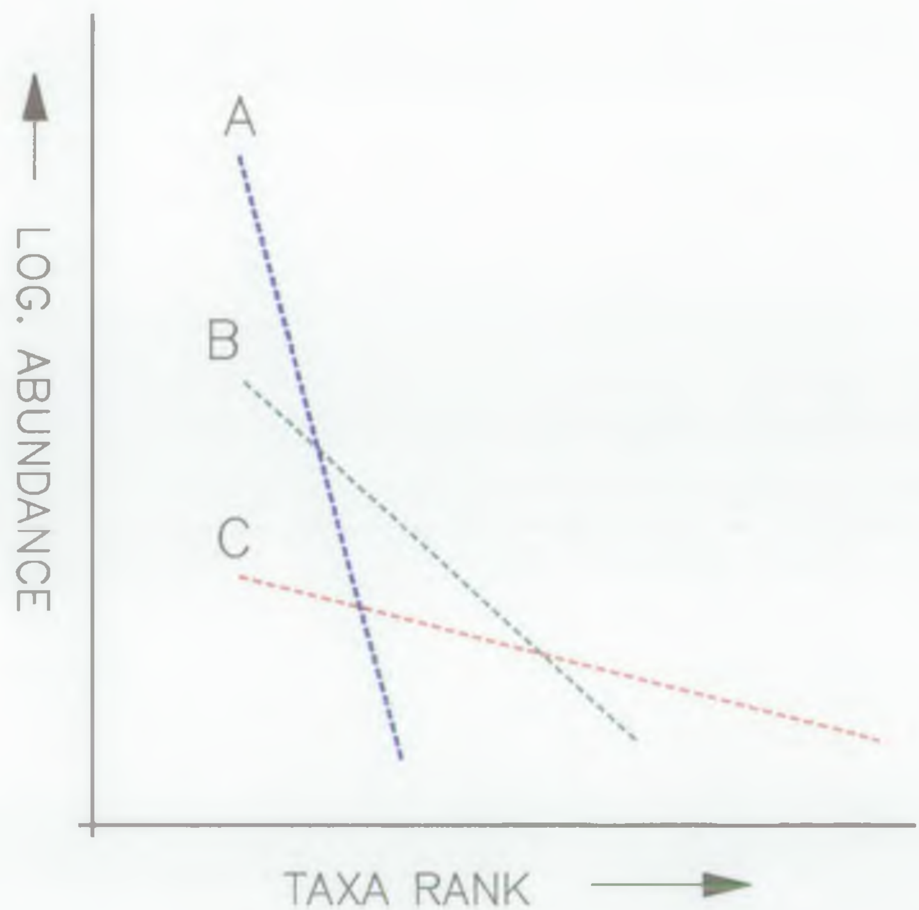


FIG. 9

ABUNDANCE / RANK DIAGRAMS.



A = Inequitable Community.
B = Intermediate Community.
C = Diverse, Equitable Community.

Intermediate Communities. Whereas those communities found downstream of the works appear to be type A, Inequitable communities dominated by opportunistic taxa. Since the habitats available to the macroinvertebrates for colonisation remained fairly constant at all the sites (except 7) this shows that a reduction in water quality downstream of the works is responsible for the change in community structure.

2.4 CONCLUSIONS.

The results from this survey have shown that the effluent from Berkhamsted Sewage Treatment Works is having a detrimental effect on the fauna of the Grand Union Canal. This has been shown by a significant reduction in both the BMWP score and the number of taxa downstream of the works accompanied by a change in community type from type B to type A.

3. MAPLE LODGE STW

3.1 INTRODUCTION.

In conjunction with a student from the Polytechnic of Central London a survey of Maple Lodge STW was conducted in October 1990. Maple Lodge STW is situated south of Rickmansworth. The effluent enters the Harefield Reach of the GUC (TQ04209200). It's consented discharge volume is 130 000 cubic meters per day.

3.2 METHODS.

3.2.1 Site description.

Four sites were sampled. Two above the effluent channel from Maple Lodge STW, one below and the effluent channel itself. Of the two sites situated above the works one was located on the River Colne and the other on the canal. Two upstream sites were necessary since the River Colne joins the Grand Union Canal above the effluent channel and there was no suitable site between this confluence and the effluent channel. Fig.10 is a map of the area showing the location of the sampling sites.

At each site on the main watercourses a depth profile was determined. Secchi disk measurements were also taken to give an indication of the water clarity and the level of suspended solids in the water.

3.2.2 Bacteriology.

Water samples were taken from each site for bacteriological analysis. The membrane filtration technique, outlined in HMSO (1982), was followed to obtain the number of *E.coli* per 100 ml of water. The results were used to show the area of influence of the sewage treatment works effluent on the canal.

DIAGRAM SHOWING THE POSITION OF THE SAMPLING SITES.

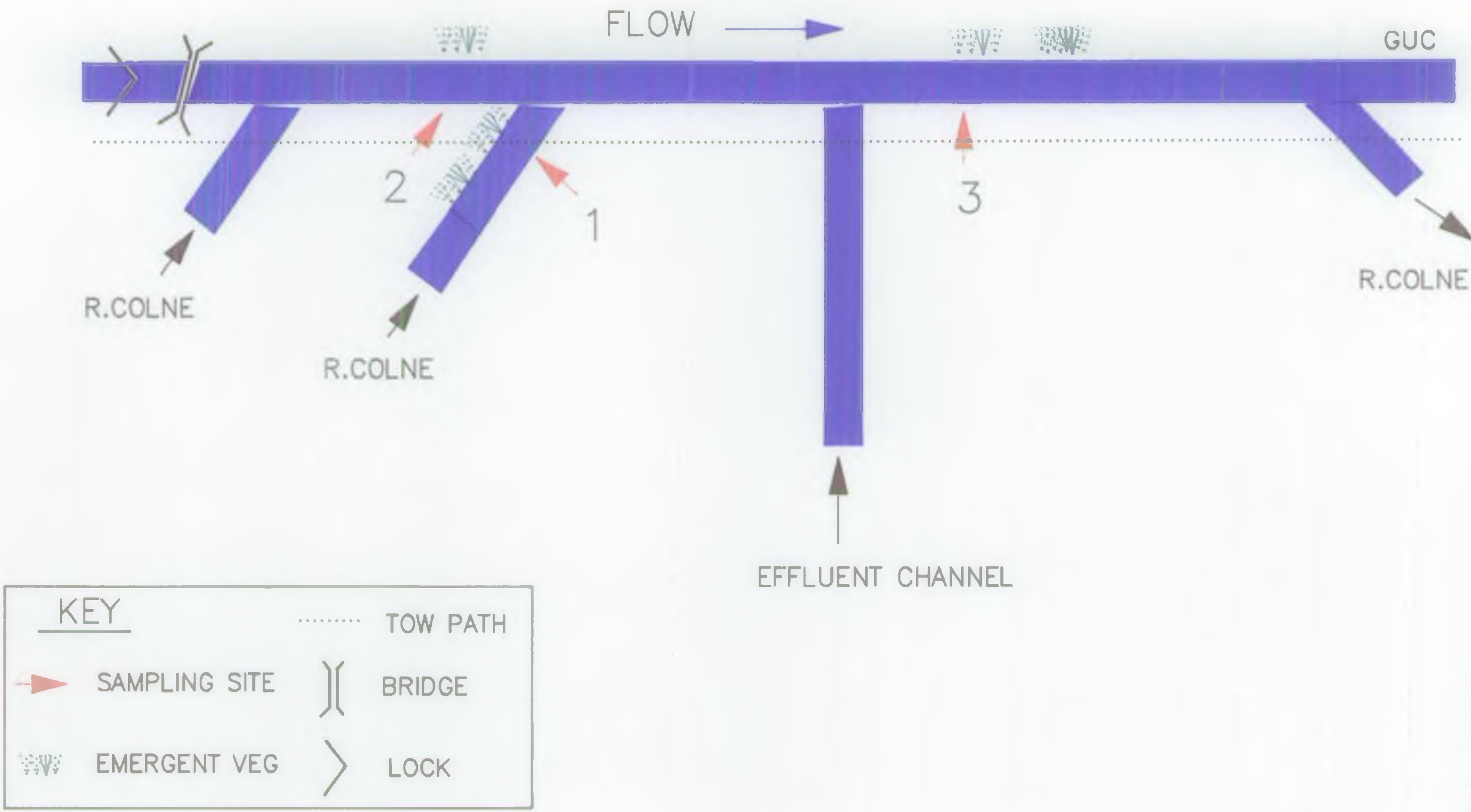


FIG 10.

3.2.3 Invertebrate sampling.

Three sites were sampled for invertebrates. The two sites on the canal and one on the River Colne. At each site samples of invertebrates were taken from 4 discrete habitats -

1. Emergent marginal vegetation using a net sweep, (one minute - three replicates)
2. Submerged vegetation using a net sweep, (one minute - three replicates)
3. Ekman grab samples of the mid-channel bed, (3 grab loads, each load approx. 2500 cm^3)
4. 'Scrape' using a handnet on the piling sides of the bank. (one minute - three replicates)

BMWP scores were calculated for each of the habitats at a site and for each site itself. The BMWP score system has been explained previously in the section for Berkhamsted STW. The results were compared to show any differences between sites upstream and downstream of the sewage treatment works and between habitats at each site.

As for Berkhamsted STW abundance/rank diagrams were used to compare the macroinvertebrate community at each site, (Townsend et al. 1983).

3.3 **RESULTS/DISCUSSIONS.**

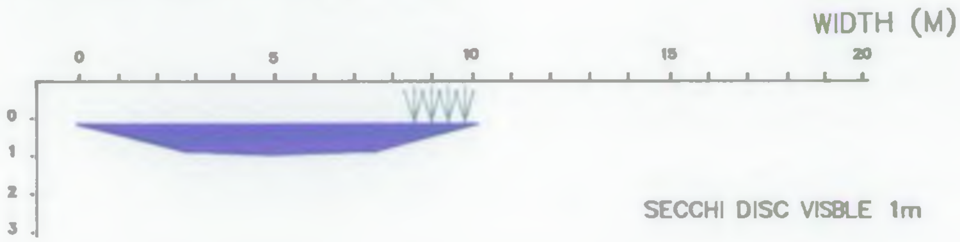
3.3.1 Site details.

Fig. 11 depicts the depth profile of the canal at each of the sample sites. The cross-sectional area of the canal was much greater at the downstream site than either of the upstream sites. At all the sites the sides of the canal slope towards the centre of the canal. The maximum depth was greatest below the STW (185cm) and least at the Colne (100cm). The marginal shelves were deep and silty so no kick sampling was possible. Sampling sites were selected opposite clumps of emergentnarrow-leaved vegetation and were submerged vegetation was

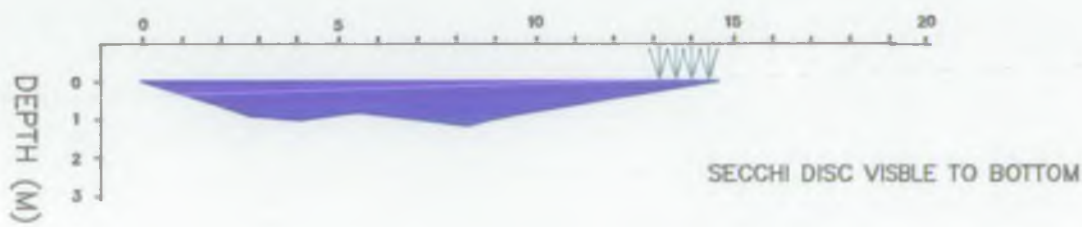
CANAL DEPTH PROFILES

FIG 11.

GUC BELOW MAPLE LODGE STW



GUC ABOVE COLNE



RIVER COLNE

present. Secchi disc depth is given next to the cross sections on fig. 10. This did not vary between the sites.

The marginal shelf was deeper than at Berkhamsted STW and this section of the canal does not suffer from boat wash wave action. Submerged vegetation was present at all of the sites. The least amount was present at the site above the Colne. The submerged vegetation was *Nuphae lutea* (Yellow Water Lily). The emergent vegetation present at the sites was a variety of narrow leaved species.

3.3.2 Bacteriology.

The results from the bacteriology analysis are given in Fig. 12. The results clearly show the area of sewage effluent contamination downstream of the sewage works. The bacterial counts were low upstream of the STW and similar to the natural background levels in the Colne and low or intermittent contamination in the canal. Below the STW, the bacteria levels were high and of the same order of magnitude as the effluent itself. These levels indicate serious contamination which could pose a possible health risk. A second survey was conducted and the results confirmed the trend of the original samples. On each occasion there was no evidence of backwash of effluent upstream of the works.

3.3.3 Macroinvertebrate Community.

BMWP scores for each site.

The total scores for each site are given in Fig. 13, together with the predicted scores for the sites. The predicted scores were the same for all three sites, so it is possible to compare the actual scores instead of the percentage of the predicted scores achieved.

The total BMWP scores obtained for both the upstream sites (98 and 86) were higher than for the downstream site (60). Of the two upstream sites the River Colne produced a higher score (98) than the canal (86).

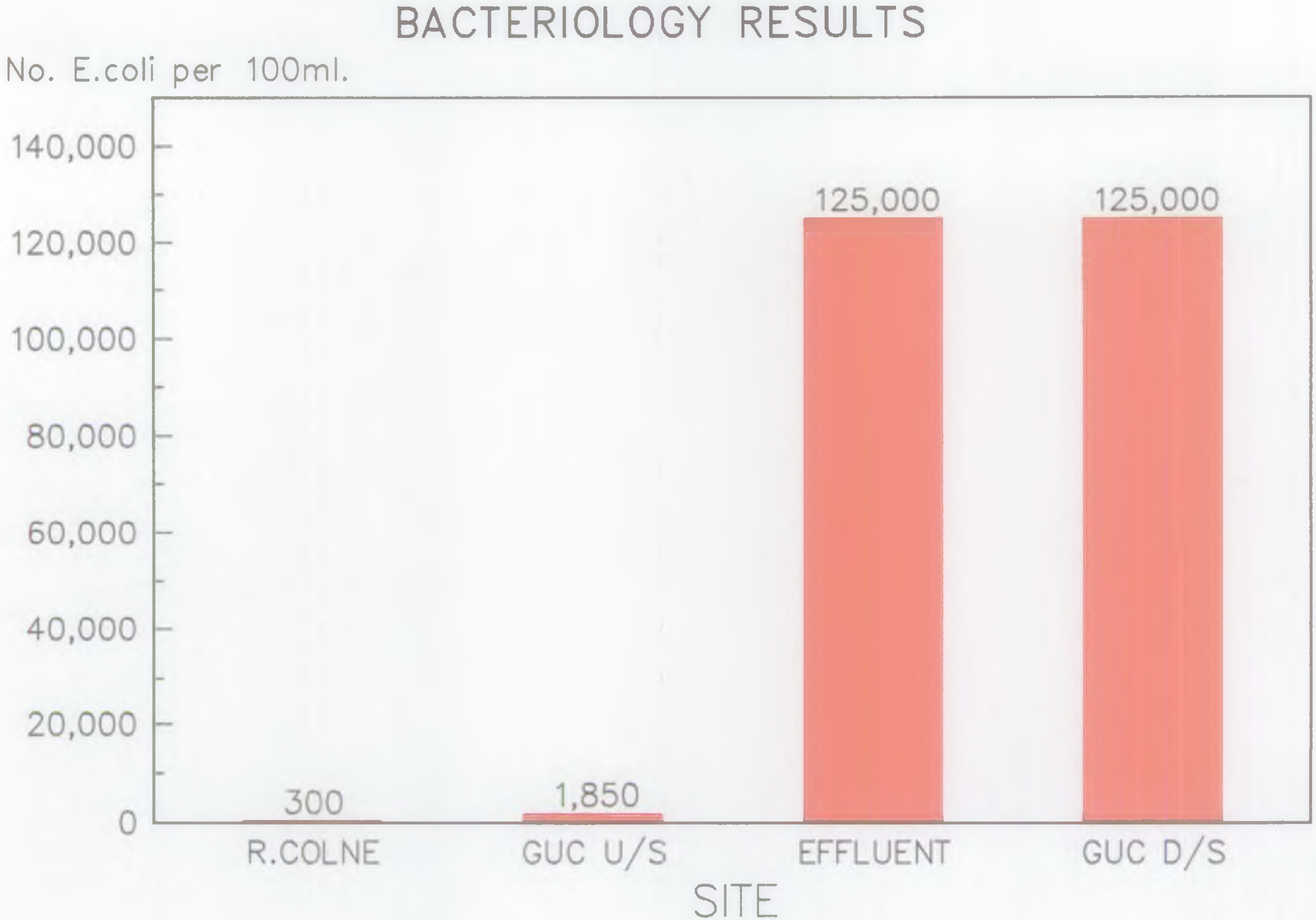

BACTERIOLOGY RESULTS
No. E.coli per 100ml.
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
300
1,850
125,000
125,000
R.COLNE
GUC U/S
EFFLUENT
GUC D/S
SITE

FIG 12.

FIG 13.


BMWP SCORES FOR EACH SITE
BMWP SCORE
SITE
COLNE
GUC U/S
GUC D/S
P=125
P=121
P=125
29
42
66
88
98
24
68
53
18
86
6
17
46
35
60
0
20
40
60
80
100
120
NO. FAMILIES FOR EACH SITE
NO. FAMILIES
SITE
COLNE
GUC U/S
GUC D/S
P=25
P=25
P=25
7
10
16
20
21
6
14
13
6
18
3
6
12
9
15
0
5
10
15
20
25
ASPT'S FOR EACH SITE
ASPT
SITE
COLNE
GUC U/S
GUC D/S
P=4.9
P=5.0
P=5.0
4.1
4.2
4.1
4.4
4.7
4
4.9
4.1
3
4.8
2
2.8
3.8
3.9
4
0
1
2
3
4
5
6
BENTHOS
PILING
EMERGENT VEG
SUBMERED VEG
TOTAL

The same pattern is seen for the numbers of families found at each site. The ASPT value for the canal above the STW (4.8) was slightly higher than the ASPT for the River Colne (4.7). However the difference is slight and both again scored higher than the site situated below the STW (4.0).

The drop in score between the upstream sites and the downstream site is attributable to Maple Lodge STW, since this is the only input to the canal here and there was no significant difference in habitats between the two canal sites. Since the River Colne enters the canal here and 'seeds' the canal with invertebrates we would expect the site below the confluence with the Colne to score higher than the upstream site. This was not the case, which again emphasises the deleterious effect that Maple Lodge STW is having on the biota of the canal.

BMWP scores according to habitat.

BMWP scores, ASPT's and number of families were calculated for each habitat. The results are given in Fig. 12.

The BMWP scores for the submerged vegetation show that the site on the River Colne produced a significantly higher score (88) than either of the sites on the canal (18 and 35). This is due to the seeding of this section of river by the taxa rich waters of the River Colne upstream and the plentiful habitats available for colonization. The submerged vegetation score for the GUC below the STW was significantly lower (35). This is despite the seeding from the River Colne. The lowest score for the emergent vegetation was found at the upstream site on the canal (18). There was less submerged vegetation present at this site than at the other two sites. This combined with the lack of a seeding source above the site explains the low score. The same pattern was seen for the number of families present and the ASPT's.

The BMWP scores, number of families and the ASPT's produced by the emergent vegetation closely follow the pattern of the total scores. The River Colne scored highest followed by the GUC above the Colne and then the GUC below Maple Lodge STW.

The same pattern was seen for the mid-channel benthos. However unlike Berkhamsted STW, Maple Lodge STW did have an effect on the mid-channel benthos. Above the STW 6 families were found (both sites) whereas only the 3 most pollution tolerant families were found downstream.

The scores obtained for the piling sides did not follow the trends seen in the other habitats. In this case, the highest score was seen in the GUC above the River Colne (68). The next highest was the River Colne (42) and again the effects of Maple Lodge STW suppressed the score at the downstream site (17). Unlike the GUC at Berkhamsted, there was less overhanging vegetation present at these sites effecting the score.

As for the study of Berkhamsted STW, this study shows why it is necessary to sample all habitats present at a site. At each of these sampling sites the majority of BMWP scoring taxa were found in the vegetation (both emergent and submerged). The piling sides showed a significant contribution to the score, especially at the site on the GUC above the River Colne.

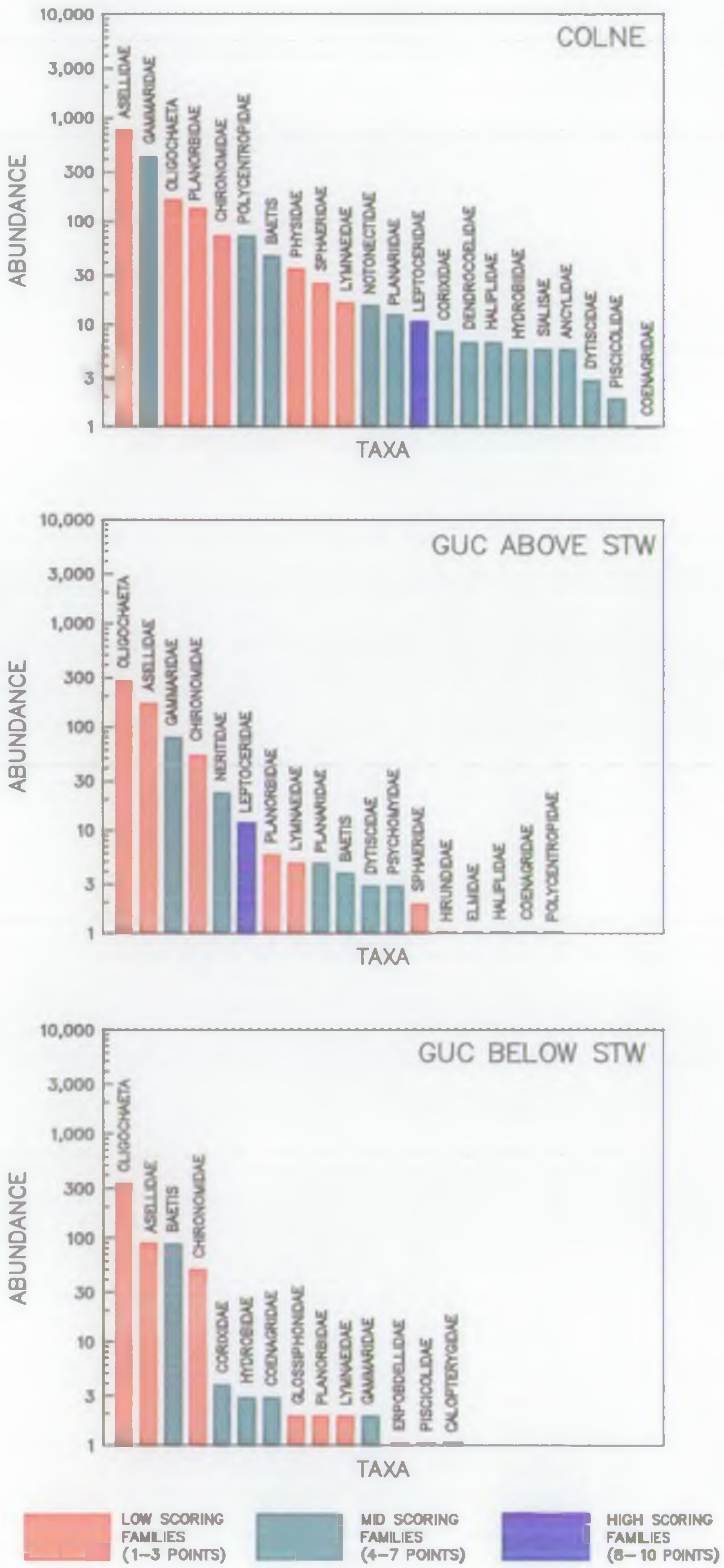
Abundance/Rank Diagrams.

Abundance/Rank diagrams were drawn for the macroinvertebrate communities found at each of the sites (Fig. 13). The results from all the samples, at each site, were combined to produce these diagrams. An explanation and interpretation of these diagrams has been given in the section on Berkhamsted STW.

Examination of the biotic assemblages found at each of the sites shows that the Colne above the GUC has a diverse, equitable type C community. The more restricted habitats of a canal and the lack of seeding source have contributed to the presence of some families represented by only one individual at the GUC above the Colne. This has resulted in a type B/C community at this site. The community found at the GUC site below Maple Lodge STW is not effected by the lack of seeding, however the influence of Maple Lodge STW has shifted this assemblage to an intermediate, slightly unstable community in comparison with the more stable communities upstream.

ABUNDANCE/RANK DIAGRAMS.

FIG 14.



3.4 CONCLUSIONS.

This survey has demonstrated that Maple Lodge STW is having a significant detrimental effect on the fauna of the Grand Union Canal. This has been shown by a significant drop in the BMWP score, number of families and ASPT below the works. There was also a change from a stable type C community to an intermediate type B community.

4. GENERAL DISCUSSION AND CONCLUSIONS.

4.1 THE EFFECTS OF THE STW'S UPON THE GUC.

The results from these surveys have shown that both Berkhamsted and Maple Lodge STW are having a significant effect on the fauna of the Grand Union Canal. This has been shown in both cases by a significant reduction in the BMWP score, the number of taxa and ASPT's found downstream of the works, accompanied by a change in community type.

Canals provide a different aquatic environment compared to similar sized slow flowing rivers. Canals lack the abundant areas of emergent vegetation found in natural rivers. Canals are slow flowing and do not have the re-aerating riffle sections found in most rivers. This means there are typically fewer niches or refuges available to the invertebrates and that they are unsuitable habitats for most of the top scoring families that require high levels of dissolved oxygen.

Any effluent discharged into a canal will not be transported away very quickly due to the flow regime. This means that the effluent will become concentrated and the effects on the macroinvertebrates more pronounced. This also has significant repercussions with regard to public health since both bacteria and viruses may also become concentrated. Both these factors emphasise the need for the consents on such sewage works to be very strict to minimise the impacts.

4.2 MONITORING OF CANALS.

These studies have stressed the importance of sampling all habitats available to macroinvertebrates for colonisation. This is not always achievable due to limited access to some habitats at most sites. Access is usually from the tow-path which is often short mown grass or concrete. Emergent or over-hanging vegetation is usually found on the opposite bank to the towpath and is only accessible using a boat.

There is a need to establish a standardised methodology and protocol for monitoring canals. This protocol may also involve the Chronomid

Pupae Exuviae Technique (CPET) which has been developed to monitor water quality in a range of watercourses. One of the disadvantages of CPET is that it does not provide any information on the conservation status of an area. Techniques developed for still waters such as algal and zooplankton monitoring may be more appropriate. Any protocol is likely to comprise a combination of methodologies.

The RIVPACS prediction programme has been used in these studies although the predictions are unreliable because it was not designed for canals. If RIVPACS is to be used in future for the monitoring of the water quality of canals, modifications need to be undertaken and clean water canal sites added to its database for prediction and classification.

These studies have shown the importance of habitat diversity which may not always be present at a site. A factor needs to be introduced into the programme to account for the limited range of habitats available. A comparison of clean water canal sites with and without vegetation will be needed. The best canal sites sampled in the 1990/91 National River Survey could be used as a guide for attainment.

The other main reason why the RIVPACS programme is unsuitable is that since canals are artificial watercourses they have an unrealistic distance from source. If it were possible to exclude such parameters from the system this problem would be overcome.

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