An Investigation of Ecological Change in the Rivers Kennet and Lambourn

Progress report for the period April 2000 – March 2001

J. F. Wright, R. J. M. Gunn, J. M. Winder,
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Centre for Ecology and Hydrology, Dorset

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Environment Agency

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Statement of Use

This report presents the results of a repeat survey of invertebrates and plants on the Rivers Kennet and Lambourn. It is intended for use by the Agency's staff and others interested in the ecology and management of chalk rivers and the effects of low flows on them.

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The study would not have been possible without the active cooperation and help of riparian landowners and river keepers. Once again, the team was allowed access to each study site and for this we are most grateful. At Bagnor, we were granted access to the River Lambourn by Mr C Robins of the Donnington Grove Country Club, at the Littlecote Estate we received help and advice from Head Keeper Mr P Woolnough and at Savernake we received similar assistance from Head Keeper Mr J Hounslow.

KEY WORDS

Chalk streams; low flows; ecological change; macrophytes; macroinvertebrates

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EXECUTIVE SUMMARY

The Kennet and Lambourn catchments are important regionally for water supply, fisheries and conservation. There is a need for reliable long-term data on the ecology of these chalk streams to ensure effective management and to fulfil the UK Biodiversity Action Plan. Between 1971 and 1979, an intensive study took place on the macrophytes and macroinvertebrates at a site on the River Lambourn at Bagnor. Between 1974 and 1976, further studies took place at three sites on the River Kennet (Upper and lower sites at Savernake downstream of Marlborough and at Littlecote, upstream of Hungerford).

In 1997, the Environment Agency (Thames Region) commissioned the Institute of Freshwater Ecology (IFE) to re-examine these four sites in summer (June/July) and winter (December) using the 1970s protocols. The macrophytes were mapped and a quantitative sampling programme for macroinvertebrates was undertaken at each site. The objective was to obtain information on long-term ecological change and examine the impact of the 1996-97 drought. The results are reported in Wright *et al.* (1999a), which gives photographs for each site in the mid-1970s and 1997 together with macrophyte and macroinvertebrate data.

The winter of 1997/98 marked the end of the drought and autumn 1997 saw the beginning of phosphate stripping at Marlborough STW. The IFE and the Environment Agency both recognised the need to document long-term consequences of the drought and/or changes in water quality. Because management practices had changed on some sites between the 1970s and 1990s, it was also clear that a long-term study could shed light on this important topic.

As a result, the Environment Agency drew up a Phase 2 contract for a collaborative project between the Agency and the IFE (now CEH Dorset) This provided for repeat macrophyte mapping and macroinvertebrate sampling at the four study sites in June 1998; 1999, 2000 and 2001. In this collaborative project the results of annual mapping/sampling are reported to the Agency and a scientific paper on one aspect of the results is written each year. The results of the June 1998 sampling programme are in Wright *et al.* (1999b) and the scientific paper is Wright *et al.* (2000a). The results of the June 1999 sampling programme are in Wright *et al.* (2000b) and the scientific paper is Wright *et al.* (in press a). The results of the June/July sampling in 2000 form the subject of the present report and the accompanying scientific paper is Wright *et al.* (in press b). The final sampling operation within the current contract is scheduled for June 2001, but in 2002-3 the Environment Agency requires a technical report including an overall analysis of the results and comparison with conditions in the 1970s.

A major feature of the June/July 2000 sampling season was the very high discharge regime on the R. Lambourn and R. Kennet. The gauging station at Shaw on the Lambourn registered an increase in monthly mean discharge each month from January to May, leading to high water levels and current velocities during mapping and sampling in mid-June. On the Kennet at Savernake and Littlecote, water levels were so high that they overtopped the banks in May and resulted in postponement of mapping and sampling until the sites were safe for field work. Littlecote was mapped/sampled in late June and the Savernake sites in early July.

The 50 m site on the River Lambourn at Bagnor is heavily shaded by trees on one bank and by tall marginal vegetation on the other through recent lack of management as a trout fishery. Since mapping recommenced in 1997 it has become apparent that submerged macrophytes occupy a smaller area of the riverbed than in the 1970s, whereas silt and marginal emergents

are more important. Some of these changes were thought to be due to a combination of the 1996/97 drought and lack of management. However, the higher discharge regime over the past three years has failed to reduce the area of silt substantially, and the area of instream macrophytes has remained below the percentage cover routinely observed during the 1970s.

Despite these changes at the site, there is some evidence of long-term stability in macroinvertebrate family richness between the 1970s and 1997-2000. During the 1970s, quantitative sampling of five habitats yielded 42- 47 families in June each year. Family richness also varied from 42 to 47 families in 1997-2000, with the lower richness values under drought (1997 - 42 families) and high discharge conditions (2000 - 43 families).

The densities of some important families of macroinvertebrates in chalk streams such as Baetidae (mayflies) and Simuliidae (blackflies) show a strong relationship to discharge regime, with available habitat as another relevant factor (Wright *et al.* 2000a). An analysis of macroinvertebrate response to drought events in 1976 and 1997 based on quantitative family level data revealed an extreme response during the drought itself but fairly rapid recovery after the event (Wright *et al.* in press b). A further intriguing result was that subtle changes in (mainly) faunal abundances had occurred between the 1970s and late 1990s, probably as a result of changes in management practices. Further analysis of this topic is planned.

The 100 m site on the Kennet at Littlecote remains an important trout fishery, as in the 1970s. The river is allowed to run freely, and even in the 1996/97 drought, *Ranunculus* (Water crowfoot) covered 44.2% of the site in July 1997, supplemented by emergent marginal vegetation. In the last three years, *Ranunculus* has occupied a much higher percentage cover, the actual area varying, depending on whether bar-cutting had taken place before field work. Macroinvertebrate family richness on gravel and *Ranunculus* has remained relatively stable through the mid-1970s and over the past four years, although there have been some modest changes in family composition during this period (Wright *et al.* in press a). The Littlecote site may be viewed as a 'control' against which to assess the greater changes at Savernake.

The two 50 m sites on the Kennet at Savernake suffered progressive loss of macrophytes during the 1990s and attempts at promoting re-growth failed. The drought ended in the winter of 1997/98 with unexpectedly high discharge in May 1998 and in addition, phosphate stripping commenced at Marlborough STW in autumn 1997. June 1998 mapping demonstrated the spectacular regrowth of *Ranunculus* on each site. This recovery has been maintained in 1999 and 2000, but the concurrent change in water quality and quantity has made it difficult to disentangle the role of these two factors (Wright *et al.* in press a).

Despite major changes in habitats for macroinvertebrates between the 1970s and 1997, and between 1997 and later years when *Ranunculus* assumed its former role, overall changes in family richness have been small and changes in family composition between the 1970s and 1990s have been modest. However, there have been major changes in the density of some families between the 1970s and 1990s and also between July 1997 and the later years. (Wright *et al.* in press a). These changes give some insights into the role of water quality and discharge regime. The exceptionally high discharge experienced in 2000 has provided new information on the impact of another extreme event, for comparison with the drought events examined in previous manuscripts (Wright *et al.* 2000a; in press b). Finally, the upper Savernake site was subject to some river rehabilitation in autumn 1999, and therefore the samples for 2000 and 2001 may have some relevance to an appraisal of the impact of the rehabilitation exercise.

1. INTRODUCTION

1.1 Background

In 1997, the Environment Agency, Thames Region, commissioned the Institute of Freshwater Ecology to undertake studies on the macrophytes and macroinvertebrate assemblages at four sites on the Rivers Kennet and Lambourn. These included two sites on the River Kennet (Savernake upper and lower) downstream of Marlborough, a further location on the same river upstream of Hungerford (Littlecote) and a fourth site on the River Lambourn (Bagnor – shaded site). Each one of these sites had been the focus of detailed studies by a team of freshwater ecologists in the 1970s, and valuable historical data were available for each location. The low flows of 1996 and the worsening drought conditions through the spring of 1997 provided the impetus for a re-examination of these sites.

Macrophyte mapping followed by quantitative sampling of the macroinvertebrates on major habitat types was undertaken in each of June/July 1997 and December 1997, using the 1970s protocols in order to ensure compatibility of the data. The results, including a photographic record comparing all sites in the 1970s and 1997, together with an appraisal of changes in the macrophytes and macroinvertebrate assemblages over this period were included in a comprehensive report to the Environment Agency (Wright *et al.* 1999a).

There was always an intention that this study would continue beyond the 1996-97 drought, and Environment Agency staff accompanied IFE staff during the field work of 1997 in order to gain familiarity with the techniques. When the drought ended in winter 1997/98, and spring of 1998 was notable for high rainfall, it was apparent that a resampling programme had great potential to provide valuable information on the rate at which both the macrophytes and the macroinvertebrates responded to the end of a prolonged drought. The winter of 1997/98 also marked the beginning of a programme of phosphate stripping at Marlborough sewage treatment works.

As the optimum time for sampling in June 1998 approached, it became clear that the Environment Agency would be unable to devote manpower to the mapping and sampling programme at the four sites. In view of the potential loss of valuable data, the IFE team stepped in to repeat the mapping and sampling programme for June, on the understanding that the Environment Agency would attempt to find financial resources to support the collection, processing and reporting on the samples for summer 1998. Financial help was secured, and information on the mapping and macroinvertebrate sampling programme on the four sites, together with a brief appraisal of the response of the biota to the end of the drought and recommendations for further work were presented to the Environment Agency in Wright *et al.* (1999b).

The Environment Agency recognised that natural variation occurs between years in the flora and fauna of chalk streams and that it is essential to document the scale of this variation in order to demonstrate the scale of response to extreme events such droughts and confirm any long-term changes to the chalk stream ecosystem. With this in mind, a Phase 2 contract was drawn up as a collaborative project between the Agency and the Institute of Freshwater Ecology. This allows for the mapping and sampling programme at all four sites to continue until June 2001, thereby providing a five-year run of data (1997 –2001). In addition to yearly reports which present the macrophyte and macroinvertebrate data for the year, a Technical Report, incorporating an overall analysis of the results and a comparison of the results with conditions in the 1970s will be produced at the end of the contract in March 2003. As its contribution to this collaborative project, the Institute of Freshwater Ecology will produce one scientific paper in each of five years (1999-2003) on one or more aspects of this series of surveys.

1.2 Objectives

The overall objective is:

> *'to improve the Environment Agency's knowledge of chalk stream ecology in order to increase our ability to manage chalk streams in a sustainable manner'*

The Phase 2 contract specification also lists twelve specific objectives:

1. To liaise with land agents at Bagnor, Littlecote and Savernake and get agreement to map and sample in June 1998, 1999, 2000 and 2001.

2. To map the sites at Bagnor, Savernake (lower) and Savernake (upper) each year, as in 1997, to determine change in the percentage cover of macrophytes and other habitats.

3. To undertake quantitative sampling of the macroinvertebrate fauna at the 4 sites as follows:

   Bagnor – 30 sampling units
   Littlecote – 10 sampling units
   Savernake (lower) – 10 sampling units
   Savernake (upper) – 10 sampling units

   This is the same sampling effort as used in summer 1997.

4. To take photographs of the sites to document their status and for comparison with summer 1997 and the 1970s.

5. To process the 60 quantitative macroinvertebrate sampling units at family level each year, as in 1997.

6. To input the June 1998, 1999, 2000 and 2001 macroinvertebrate data from the 4 sites into Access97 and to verify it.

7. To populate the plant database with the mapping data for June 1998, 1999, 2000 and 2001 in order to create maps and cover data for Bagnor, Savernake (lower) and Savernake (upper).

8. To analyse the macrophyte and macroinvertebrate data in relation to the data from the 1970s and 1997.

9. To compile the raw data collected in this survey and collate it so that it can be used by the Agency for future reference.

10. To produce annual progress reports on the work undertaken in each reporting period, together with information on the structure of the results database and a summary of any conclusions and recommendations (to include an evaluation of the desirability of continuing the surveys in the following year).

11. To produce a scientific paper each year (total of five) analysing the results of one or more aspects of this series of surveys.

12. To produce a technical report of this work, including an overall analysis of the results and comparison with conditions in the 1970s.

2. FLOW REGIME

2.1 R. Lambourn at Shaw

Information on the discharge regime of the River Lambourn has been supplied by the Thames Region of the Environment Agency. The nearest gauging station to the Bagnor study site was at Shaw, approximately 2 km downstream. It is important to recognise that whereas the river occupies a single channel at Shaw, it is divided into two channels at Bagnor. In the 1970s, two study sites were chosen on the northern channel at Bagnor because it was of wadeable depth and was more typical of the river as a whole, whereas much of the southern channel was deep and slow-flowing. Hence, when examining the discharge regime at Shaw it should be borne in mind that the discharge through the shaded site at Bagnor is substantially lower than at Shaw, but the seasonal regime in any given year will mimic the picture obtained at Shaw.

The discharge regime on the River Lambourn at Shaw from January 1990 to December 2000 is presented in Figure 2.1. This period included a two-year drought in 1991 and 1992, followed by a period of three years (1993-95) when the characteristic discharge regime resumed with high peak flows early in the year. Then followed a further two-year period of drought (1996-1997) in which there were no high flows in the winter of 1996/97. High rainfall through the winter of 1997/98 brought an end to the drought, but peak flows remained below those experienced between 1993 and 1995. However, the wet spring resulted in a mean discharge in May 1998 (immediately prior to sampling) that approached the monthly mean values recorded in each of 1993-96 and was over twice the discharge recorded in May 1997. In 1999, the characteristic discharge regime was observed once more, as in the period 1993-95. In contrast, in 2000, discharge increased each month between January and May, resulting in a monthly mean discharge for May of 3.3 cumecs, the highest discharge ever observed in the month prior to June sampling in either the 1990s or the 1970s.

2.2 R. Kennet at Knighton

The Environment Agency also supplied monthly mean flows for the River Kennet at Knighton, which is located approximately 8 km downstream of the Savernake study section and 2 km upstream of Littlecote.

Figure 2.2 presents the discharge regime at Knighton between January 1990 and December 2000. The protracted drought of 1991-92 and the progressively more severe drought of 1996-97 are apparent, separated by those years (1993-95) in which the characteristic discharge regime prevailed. As previously noted on the River Lambourn at Shaw, winter rains in 1997/98 marked the end of the drought but peak discharge fell short of that recorded in the mid-1990s. In spring 1998, the rainfall was sufficient to result in a monthly mean discharge in May 1998 that exceeded the values recorded in the same month in all earlier years shown in Fig. 2.2. In particular, mean discharge in May 1998 was almost four times the mean discharge recorded in May 1997. By 1999, the characteristic seasonal discharge regime, as observed between 1993 and 1995, had resumed. However, in 2000, monthly mean discharge increased progressively from February to May, and the monthly mean value of 7.2 cumecs for May exceeded all previous values for this month in either the 1990s or the 1970s, as similarly observed on the R. Lambourn.

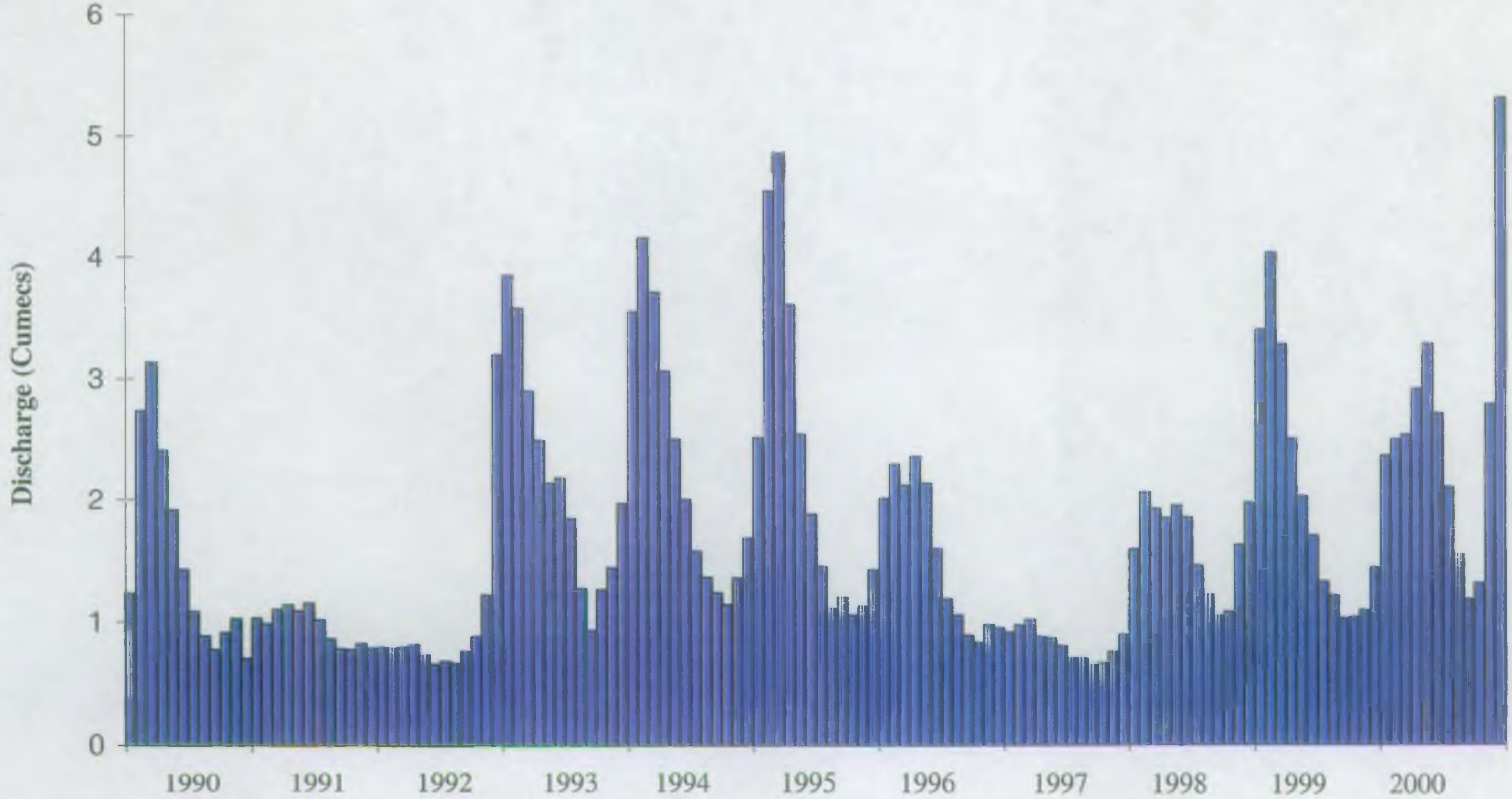

Figure 2.1 **Monthly mean discharge on the River Lambourn at Shaw, January 1990-December 2000**

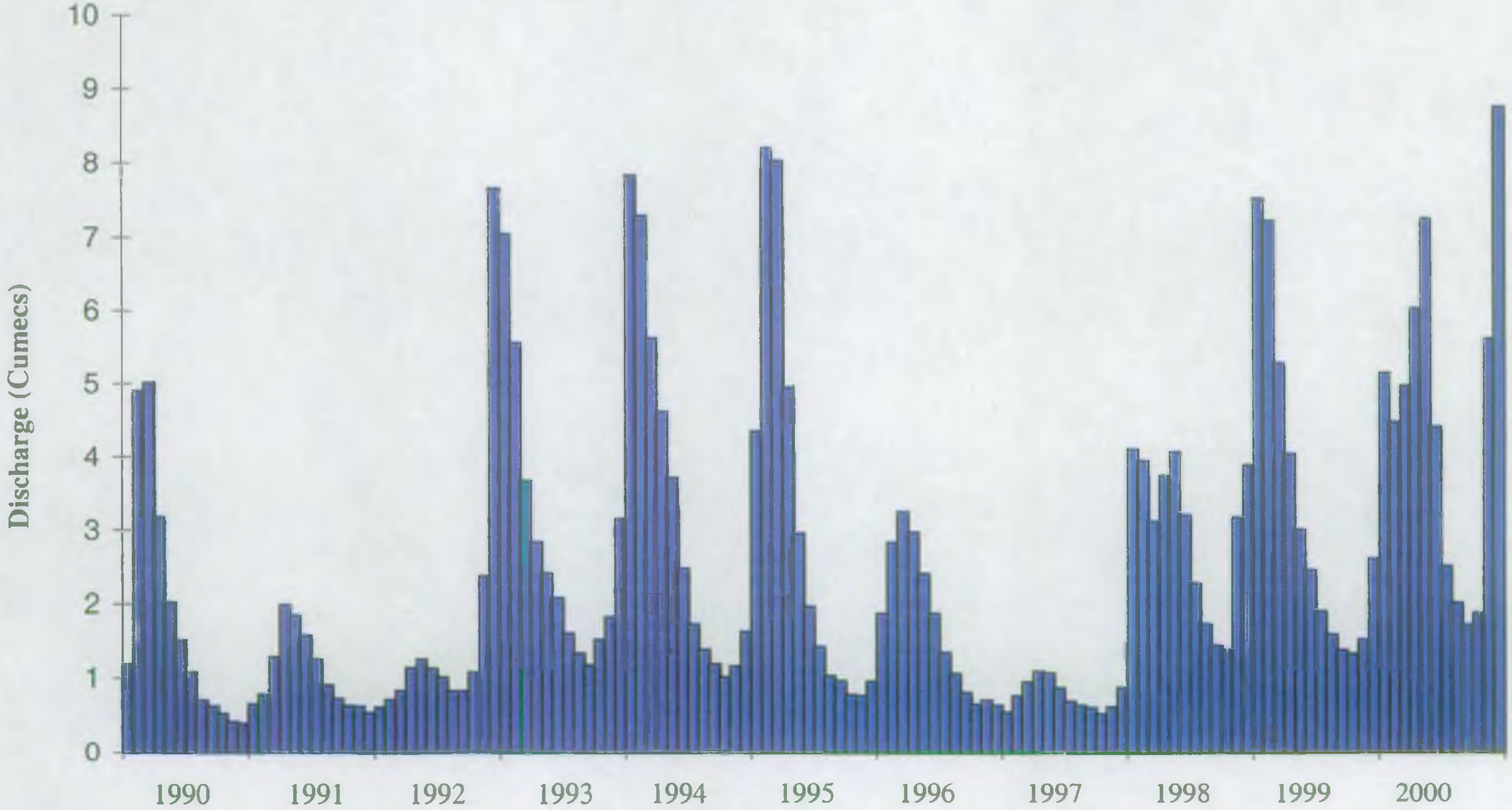

Figure 2.2 **Monthly mean discharge on the River Kennet at Knighton, January 1990-December 2000**

3. THE STUDY SITES

A comprehensive photographic record of the four study sites during the 1970s and in 1997 was given in Wright *et al.* (1999a). Additional photographs taken at each site in June 1998 and June 1999 may be found in Wright *et al.* (1999b) and Wright *et al.* (2000b) respectively. The purpose of this section is to provide further documentation of the sites in June/July 2000.

3.1 The R. Lambourn at Bagnor (shaded site), June 2000

Figure 3.1a is a view looking upstream taken in June 2000. As a result of the very high discharge regime at the time of mapping, there has been waterlogging of marginal vegetation not seen in the previous year. *Ranunculus* is growing well on this more open lower section of the study site, as would be expected under conditions of high discharge. As in 1997-99, the site remains unmanaged with overhanging trees and bushes on the left-hand side of the photograph and emergent marginal vegetation on the right hand side.

Fig.3.1b is a view looking downstream from a vantage point near the top of the 50 m site. *Berula* remains as substantial carpets of weed on the river-bed, as last year, but its overall area on this site still remains well below the mean percentage cover of 38.3% observed through the 1970s (see Table 5.1). This year, there is no evidence of riparian vegetation growing in mid-channel (see Fig. 3.1b. in Wright *et al.* 2000b).

3.2 R. Kennet at Littlecote, June 2000

Fig. 3.2a is a general view of the site in late June 2000 from the upstream limit looking downstream. In late May and early June the high velocities and water levels reported by the River Keeper, Peter Woolnough, meant that it was necessary to delay mapping and sampling by two weeks. As in the two previous years, *Ranunculus* has grown well and is flowering at the water surface in places.

Fig.3.2b was taken from the downstream limit of this 100 m site looking upstream. The photograph indicates that *Ranunculus* is growing over a substantial proportion of the river bed and has reached the water surface as a solid mass of weed in places.

3.3 R. Kennet at Savernake (lower and upper sites), July 2000

Savernake Lower

Fig.3.3a provides a general view of the site on 3 July 2000, looking upstream. In mid-May the River Keeper, John Hounslow, had reported that the river was over the banks. At the end of that month, and again in late June, weed cuts took place, and consequently water levels were only marginally higher than observed in June 1999 (see Figs 3.3a and b in Wright *et al.* 2000b). Despite the weed cuts, the site still had 43.6% cover of *Ranunculus*, including occasional patches of surface flowering weed.

Fig. 3.3b shows a view of surface *Ranunculus* on the site in July 2000, for comparison with a similar photo taken in June 1999 (see Fig 3.3b in Wright *et al.* 2000b). The logs at the river margin indicate that water depth is slightly greater in July 2000 compared to June 1999.

Savernake Upper

Fig.3.3c is a view of the upper 50 m site at Savernake on 3 July looking upstream at the site from the downstream limit. Note that in Wright *et al.* (2000b) Fig. 3.3c, taken in June 1999, was photographed looking downstream from the upstream limit. Nevertheless, it is very apparent that the character of the site has changed considerably as a result of the river rehabilitation Demonstration Project undertaken in autumn 1999. Most obvious is the loss of trees on the far bank of the river. What is less apparent in Fig.3.3c is that the effective river width has been reduced using branches etc which have been wired into position. The surface *Callitriche* near the swans in the photograph is essentially a shallow area overlying the berm with very little surface velocity, compared to mid-river. Towards the upper limit of the site on the near bank a further sub-surface berm has been created. As a result of this narrowing of the channel, coupled with the high discharge conditions, the water level is higher than in June 1999. As a consequence, the July 2000 photograph shows no signs of the two upstream current deflectors which were clearly visible in Fig.3.3c in Wright *et al.* (2000b).

Fig.3.3d was taken from just above the upstream limit of the site in July 2000, looking downstream. Again, there is no sign of the two current deflectors but a new water depth pole has been put in place. As a result of both weedcutting and higher current velocities/depth, there is very little surface weed.

Figure 3.1a River Lambourn at Bagnor (shaded site). June 2000. View upstream from the bottom of the site showing beds of *Ranunculus*

Figure 3.1b River Lambourn at Bagnor (shaded site). June 2000. View downstream from near the top of the site showing carpet of *Berula*

Figure 3.2a River Kennet at Littlecote. June 2000. View downstream from the top of the 100 m site

Figure 3.2b River Kennet at Littlecote. June 2000. View upstream from the bottom of the 100 m site

Figure 3.3a River Kennet at Savernake (Lower). Early July 2000. View upstream

Figure 3.3b River Kennet at Savernake (Lower). Early July 2000. Surface *Ranunculus* beds

Figure 3.3c River Kennet at Savernake (Upper). Early July 2000. Upstream view of the site from the lower site limit

Figure 3.3d River Kennet at Savernake (Upper). Early July 2000. Downstream view of the site from further upstream

4. METHODS

Note: The methods section, as given in Wright *et al.* (1999a), is repeated here with only minor amendment to help readers who are unfamiliar with the procedures used in this study.

4.1 Macrophyte mapping

4.1.1 Field procedures

A detailed account of the field procedures involved in the 'rectangles' method of mapping was given in Wright *et al.* (1981), but a synopsis of the approach is repeated here.

Prior to mapping for the first time, it is essential to establish a straight baseline on one bank and hammer in a series of permanent stakes at 5 m intervals. This is best achieved with a transit compass, ranging poles and a measuring tape. Additional stakes are also required at 5 m intervals on the opposite bank at known distances from the baseline.

When mapping, a temporary grid of mapping strings is set out in order to create a 1 x 1 metre grid over the water surface. First, a 5 m tape, with numbered tags at 1 m intervals is placed between the 0 and 5 m stakes on the baseline, with a similar tape on the opposite bank. Next, a series of longer tapes (often six) which are similarly marked with numbered tags at one metre intervals are positioned across the river at one metre intervals upstream, thus linking successive metre locations on the baseline with the corresponding location on the opposite bank.

The mapping operation may be undertaken by two people, but was normally carried out by a team of three individuals. One person (the caller) stands in the river in order to describe the river-bed whilst a second (the recorder) stands on the baseline bank and marks the prepared mapping sheet with information provided by the caller. A third person normally helps with repositioning the cross-river tapes when they are moved upstream.

Prior to mapping, it is essential to define the features to be distinguished. For example, decisions are required on whether macrophytes can be identified to species at all times or whether species with similar morphology are to be recorded as a single taxon. The range of substrata to be recorded must also be defined. From visual inspection, all particles greater than 2 mm were designated as gravel whilst those of 2 mm or less were termed silt. In practice, this last category included both sand and silt. The term silt was also retained in cases where decaying organic matter such as tree leaves was present at a given location. Note that all categories were as determined visually, irrespective of the composition of the substratum under the visible surface.

At the start of mapping, the caller enters the river downstream of the cross-river tape connecting 0 m on the baseline with 0 m on the opposite bank. The position of the nearside bank is determined to the nearest 0.5 m and relayed to the recorder on the bank who then marks the position of the bank on a blank map consisting of 50 x 100 cm rectangles representing the full 50 m length of river to be mapped. The caller then views the 1 m strip of river between cross-river tapes at 0 and 1 m upstream. The tapes with their numbered tags form a 1 m grid across the river, and each square of the river-bed below can be divided longitudinally, by eye, into two 1 x 0.5 m rectangles. A metal-tipped pole used by the caller was found to be particularly useful in delimiting the metre square, by holding it vertically at the corners of the square prior to assessing each rectangle. The dominant substratum or macrophyte is then determined for each rectangle, but where a macrophyte and a non-macrophyte each occupy 50%, the macrophyte is given dominance. The substratum underlying the macrophyte is also determined.

For this project the Environment Agency confirmed that only the dominant macrophyte was to be recorded, as this is the only information used in calculating the percentage cover of the habitats on each site. (In the 1970s, additional habitats within the rectangle were also recorded, although in practice this information was not used in later analyses. Collection of this additional information would have increased the time for field mapping).

Information on each rectangle is passed to the recorder until the location of the opposite bank is given. The caller then moves one metre upstream and continues the mapping process towards the baseline for the strip of river between the tapes positioned 1 to 2 m upstream. This process continues until the entire grid provided by the first positioning of the cross-river tapes has been completed. The tapes are then repositioned upstream for further mapping and this process is continued until the entire site has been mapped.

This account describes the mapping procedure on the River Lambourn at Bagnor, where the river is narrower than the River Kennet. However, the submerged and marginal emergent vegetation at Bagnor include a wide range of species, which increase mapping times. Similarly, the presence of overhanging branches and thick bushes and trees on the far bank makes the positioning of mapping strings more difficult. Once tapes have been repositioned prior to mapping, checks are made that all the 1 m tags on the mapping strings are aligned in order to avoid mapping inaccuracies.

Since the Kennet sites are wider than the River Lambourn, the need to check that tapes are in alignment is even more critical on the River Kennet. At Littlecote, where the site is a full 100 m in length, the baseline itself changes direction at 50 m in order to accommodate a change in alignment of the river. At this site, the baseline established on the mown bank in 1974 was relocated in 1997. However, for ease of mapping on this very wide site, additional stakes were located at the bottom of the bank, just above the water's edge and at known distances from the true baseline. On the River Kennet at Savernake, new stakes were required. Initially, they were positioned on the mown baseline bank and left proud, as requested by Mr Hounslow where they were in full view and could be avoided during mowing operations. More recently, most of these stakes have been removed, but the precise location of each 50 m site can still be defined at the outset of each mapping operation.

On all three Kennet sites (100 m site at Littlecote, two 50 m sites at Savernake) the greater river width coupled with the fact that the habitats on the river-bed were less complex allowed the mapping grid to be increased to 100 x 100 cm squares, as used in the 1970s. Only at the bank did the mapping regime revert to 50 x 100 cm rectangles where necessary, in order to document with greater accuracy the habitats at the waters edge.

Note that from June 1998 onwards, the decision was taken to draw a sketch–map of the weed beds on the Littlecote site, using 5 m metres strings across the river for guidance instead of undertaking the full mapping procedure outlined above. This avoided the need for three people to spend a whole day mapping a site on which *Ranunculus* was the dominant macrophyte.

4.1.2 Laboratory procedures

Within the laboratory, EXCEL spreadsheets were prepared to represent each of the four mapped sites. The baseline was numbered 0-50 m (0-100 m for Littlecote), whilst rectangles at right-angles to the baseline were numbered 0-0.5, 0.5-1, 1-1.5 m and so on, allowing sufficient space to include the full distance from the baseline to the river, the width of the river itself and the far bank for the full length of the site. Each spreadsheet was then populated with mapping information on the dominant habitat type for each 100 x 50 cm rectangle. In the case of the Kennet sites, where 100 x 100 cm squares had been designated within the river, pairs of rectangles were substituted on the map, although single 100 x 50 cm rectangles were recorded at the river margins where these had been mapped at the site.

An automated procedure was then employed for counting the rectangles of each habitat type, from which the total area (m^{-2}) and the percentage cover of each habitat was derived. The percentage cover data are presented in Chapter 5 of this report.

Please note: The computer maps are being supplied to the Environment Agency as EXCEL files and hence are not included within this report.

4.2 Sampling for macroinvertebrates

4.2.1 Field procedures

The Lambourn sampler (Hiley *et al.* 1981) was used to obtain samples of macroinvertebrates on each of the four study sites, as in the 1970s. The dimensions of the sampler were 20 x 25 cm, resulting in a sampling unit of 0.05 m^2. For each habitat, five sampling units were taken in each season.

In general, the choice of habitats to be sampled on each site was made with a view to maximising the comparisons which could be made with samples taken in the 1970s. There was one exception to this general rule on the River Lambourn at Bagnor. The recent lack of management related to fisheries interests has resulted in the development of both low growing and tall marginal emergent species, at a time when submerged macrophytes were poorly represented. Although no comparisons would be possible with the 1970s, the marginal emergents represented a potentially important habitat and warranted further investigation.

Quantitative sampling for macroinvertebrates on the major habitats took place after the mapping operation and was dependent on the availability of the map. In order to select potential locations for the five sampling units on each habitat, a series of four digit random numbers were used. The first two numbers represented distance along the baseline (0-50 or 0-100 m in the case of Littlecote) and the second two digits represented distance at right angles from the baseline. Thus, most of the four digit numbers represented locations within the mapped site and in this way sampling locations were chosen for each habitat type.

It was normal to obtain not just five sampling locations for each habitat type (representing the five sampling units required) but to have two reserve locations in case any of the original five proved to be inappropriate when sampling was underway. Ideally, mapping and sampling took place on separate days, with selection of the locations for sampling carried out in the laboratory. However, in cases where it was essential to undertake sampling on the same day after mapping, it was feasible to draw on a store of four digit random numbers and undertake the selection of sampling locations in the field.

The field procedure for taking macroinvertebrate samples was as follows. All sampling was carried out from the downstream limit of the site working upstream. Mapping tapes were positioned as required to locate the first sample on the river-bed and the Lambourn sampler was then lowered over the chosen location and forced into the substratum to a depth of 6 cm using both hand and foot pressure. The removal of all plant material and substratum to a depth of approximately 6 cm was carried out by hand, with further help from a small trowel for cutting through weed and removing substratum into the collecting net at the downstream limit of the sampler. The large collecting net was then removed from the frame of the sampler and by careful dipping of the net and its contents into the current, the contents were concentrated into the bottom of the net.

In June/July and December 1997 the following procedure was adopted. Once on the bank, the sample was transferred into a labelled polythene bag. No water or formalin was added at this time as all samples were subjected to an initial clean-up in the laboratory the following day, prior to preservation. Samples were kept cool throughout the period before preservation. This procedure was particularly relevant to the December samples in which there were large numbers of small stone-cased caddis larvae in the family Glossosomatidae that needed careful removal from larger stones. The requirement to move the mapping tapes periodically to collect samples from the river-bed and to transfer the net contents to labelled polythene bags meant that the ideal team for sampling was three or more team members. From June 1998 onwards, the decision was taken to preserve each sample in the field, in order to eliminate the additional step of an initial clean up of each sample in the laboratory. Any large stones were carefully examined and leeches, molluscs and caddis etc. carefully removed and retained with the sample before the stones were discarded.

4.2.2 Laboratory procedures

Each macroinvertebrate sampling unit taken with the Lambourn sampler included macrophyte, mineral material, detritus and macroinvertebrates, except for those taken on gravel and silt, which lacked the macrophyte component.

In 1997 the following procedure was adopted. The macrophytes were removed by flotation and carefully searched for invertebrates. Most of the invertebrates from the mineral fraction of the substratum were separated by elutriation. To achieve this, the sampling unit was placed in a bucket of water, thoroughly stirred by hand and allowed to settle until most of the mineral fraction was no longer in suspension. The water was immediately poured off through a 45 mesh sieve to collect animals and detritus. This process was repeated with clean water until no more animals were washed out. The remaining mineral material frequently contained some stone-cased caddis larvae and molluscs. Large particles were individually examined for attached caddis and molluscs, smaller particles were picked over to remove additional specimens but fine mineral material was retained and added to all previously removed macroinvertebrates before being fixed and preserved using 5% formalin in a labelled polythene bag. From June 1998 onwards, the samples were fixed and preserved in the field, as previously described.

The sorting and identification procedure for each sampling unit was as follows. The sample was placed in the upper of a pair of 45 and 12 mesh sieves and the formalin removed by thorough washing. The coarse and fine mesh fractions were then processed separately.

First, the coarse fraction was put into a series of trays and, on the basis of the amount of material and abundance of the macroinvertebrate fauna, a decision was reached on the proportion of the coarse fraction to be sorted and identified. This varied from the entire coarse fraction to a half or sometimes a quarter of the fraction. All specimens in the designated fraction were removed and identified to family level. The results were entered on a standard data sheet and a multiplication factor applied to estimate the total number of each family in the fraction.

The fine fraction was subjected to a similar procedure, except that the proportion sorted and identified normally varied from one half to one eighth of the total. Again, the number of individuals in each family were determined and entered on the same data sheet before an appropriate multiplication factor was applied. The totals from the coarse and fine fractions were then added to obtain the estimated number of macroinvertebrates in each family within the sampling unit. All sheets were independently checked for accuracy.

On completion of the processing of all the samples, the data from the five sampling units on each habitat, site and month were entered into a Microsoft Access database and verified. A query was then developed in Access for calculating the mean density of each family from a set of five sampling units on a given habitat type.

The macroinvertebrate data for the shaded site on the River Lambourn in the 1970s had already been transferred to an Access Database in a separate IFE project. However, all the 1974 and 1975 data for the River Kennet at Littlecote and Savernake was also entered in order to be able to undertake selected comparisons with the results from the 1990s sampling programme.

One major group of macroinvertebrates, the Oligochaeta, was treated differently in the 1970s and in the late 1990s research programme. In the 1970s, no attempt was made to count the total number of oligochaetes per sampling unit. During the first twelve months of the study at Bagnor (March 1971 – February 1972), the view was taken that because some oligochaetes undergo fission and others are damaged during the processing of samples, the oligochaetes would be picked out and then weighed as a group. The one exception to this was the Lumbricidae which, being large, were counted individually and kept separate from all other Oligochaeta. In later years at both the River Lambourn and the River Kennet sites, the Lumbricidae were still counted individually, but no numerical information was available on other oligochaetes.

In the late 1990s, the decision was taken to count the Lumbricidae as before, but also to count all other Oligochaeta and input both categories to the database, in order to have more comprehensive information for future reference. However comparison of densities observed in the 1990s and the 1970s were limited to the Lumbricidae and when comparisons were made of macroinvertebrate ‘family’ richness between years, the Oligochaeta and Lumbricidae counted as one ‘family’ and all 1970s samples were assumed to include Oligochaeta.

5. RESULTS OF MACROPHYTE MAPPING

5.1 R. Lambourn at Bagnor (shaded site)

The results obtained by mapping the site in June 2000 have been inserted into Table 5.1 for comparison with the equivalent results for June of 1999 and 1998 and both June and December 1997. This table also presents the maximum, minimum and mean percentage cover of the major habitat types for the site over the period January 1971 to December 1979 and information on the total wetted area of the study site, expressed in square metres (m^2).

Table 5.1 R. Lambourn at Bagnor (shaded site). Total wetted area of the 50 m site and the % cover of the major habitat types in June and December 1997, plus June 1998, 1999 and 2000 (latter in bold). Historical data for January 1971 - December 1979 is presented as maximum, minimum and mean values.

Date(s)	Total Area	Percentage Cover					
	m^{-2}	Berula	Call	Gravel	Ran	Silt	Other
June 2000	**475.5**	**12.8**	**2.7**	**30.2**	**7.5**	**23.7**	**23.1**
June 1999	397	20.0	3.5	35.8	7.7	22.0	10.9
June 1998	439	9.6	2.3	51.7	1.9	26.8	7.8
Dec 1997	372	9.3	1.6	44.2	2.6	31.2	11.1
June 1997	387	5.8	24.9	29.3	6.2	17.6	16.2
71-79: Max	454	65.9	48.1	79.0	44.2	48.8	16.5
71-79: Min	336	0.5	0.0	5.7	0.1	2.8	0.0
71-79: Mean	409	38.3	10.3	26.3	13.7	9.7	1.5

In June 2000, the total wetted area for the site of 475.5 m^2 exceeded any values recorded during the 1970s or the 1990s. This was the result of a very wet spring in which the monthly mean discharge for the R. Lambourn, as recorded at the Shaw gauging station, increased progressively each month from January to May, when the monthly mean discharge was 3.3 cumecs. In consequence, much of the riparian vegetation on the nearside bank was flooded out. Of the 23.1% 'other' category which is essentially this marginal emergent vegetation, 14.6% was the emergent umbellifer *Oenanthe crocata*. In the absence of this flooding of marginal emergents, the genuine in-stream habitats would all have had somewhat higher recorded percentage cover values for June 2000.

The site continues to be unmanaged in terms of any control of the farside tree cover, nearside emergents or instream macrophytes. Hence, the light reaching the river surface remains less than that typical of the 1970s and the potential for in-stream macrophytes to resume the percentage cover seen during that period would appear to be low. *Berula*, the dominant in-stream macrophyte for most of the 1970s, retains that position, but with a much lower percentage cover compared to the mean for the 1970s when it was 38.3%. The lower percentage cover for 2000 (12.8%) compared to 1999 (20.0%) is only partly due to the higher total wetted area of the site in 2000.

Callitriche retained only a very modest area during the high discharge of 2000, mainly associated with the marginal emergents on the nearside bank where the light regime was more favourable.

Ranunculus occupied 7.5% cover in June 2000 (7.7% in June 1999) and was probably unable to exploit the favourable discharge regime due to the limited areas of in-stream habitat at which the tree canopy was open, thereby allowing more light reach the water surface.

Although the percentage cover of gravel decreased marginally from the previous year, as might be expected due to the increase in total area of the site, the area of silt increased, despite the high discharge regime. This feature was also observed in June 1998 when the percentage cover remained high at 26.8% despite the relatively high discharge in May 1998. Much of the silt is associated with the far bank and occurs under the cover of bankside trees. In fact, some of it is associated with collapsing banks which are unstable as a result of the lack of marginal vegetation under the trees

5.2 R. Kennet at Littlecote

Mapping of the 100 m site at Littlecote is a full day's work for a team of three. In view of the fact that, under high discharge conditions, the river bed is largely *Ranunculus* and gravel, it was apparent that a good approximation of percentage cover could be obtained by making a sketch map on the date of sampling, thereby saving valuable time. Hence, in Table 5.2, the estimate for the total area of the site and percentage cover of the major habitat types in June of 1998, 1999 and 2000 is given within brackets.

Table 5.2 · R. Kennet at Littlecote. Total wetted area of the 100m site and the % cover of the major habitat types in July and December 1997. Estimated values for June 1998, 1999 and 2000 are given within brackets. Historical data for April 1974 - June 1976 is presented as maximum, minimum and mean values.

Date(s)	Total Area m^{-2}	Percentage Cover Gravel	Ran	Silt	Others
June 2000	(1363)	(18.6)	(77.5)	(0.1)	(3.8)
June 1999	(1362)	(37.9)	(61.2)	(0.5)	(0.4)
June 1998	(1245.5)	(27.7)	(71.5)	(0.0)	(0.7)
Dec 1997	1310	30.5	38.9	0.9	29.7
July 1997	1244.5	35.9	44.2	3.1	16.8
74-76: Max	1395	71.7	84.0	11.6	3.4
74-76: Min	926	12.2	16.2	0.3	0.0
74-76: Mean	1225	38.8	57.2	2.4	1.6

This years estimate for the total area of the site was made on 28 June 2000, the field work having been delayed by two weeks on the advice of the River Keeper, Peter Woolnough, due to high velocities and water levels. By late June, the total area of the site was very similar to the previous year. *Ranunculus* was dominant with an estimated 77.5% cover, higher than recorded in the two previous years. However, the percentage cover observed is highly dependant not only on the discharge regime but also on the cutting regime prior to field studies.

An inevitable consequence of high cover of *Ranunculus* was that the percentage cover of gravel was lower than in recent years. The amount of silt was also very low, as anticipated given the very high discharge regime. The 'others' category was dominated by marginal *Carex*, which had been flooded out by the high water levels.

5.3 R. Kennet at Savernake (lower and upper sites)

5.3.1 Savernake (Lower site)

The results obtained by mapping this site on 3 July 2000 are given in bold in Table 5.3 and can be seen alongside the equivalent information for June of 1999, 1998 and 1997 (also December 1997). The summarised data for the period from April 1974 to April 1976 has also been included to provide a broader context.

The total wetted area of the site increased still further in July 2000 from the values noted in June of 1999 and 1998. The very high monthly mean discharge values of 7.2 cumecs in May and 4.4 cumecs in June 2000 were largely responsible for this. Indeed, in the absence of major weedcuts in late May and late June, the total area of the site would have been greater.

Table 5.3 R. Kennet at Savernake (Lower). Total wetted area of the 50 m site and the % cover of the major habitat types in July and December 1997, June 1998, June 1999 and July 2000 (latter in bold). Historical data for April 1974 - April 1976 is presented as maximum, minimum and mean values.

Date(s)	Total Area m^{-2}	Percentage Cover				
		Gravel	Ran	Schoen	Silt	Other
July 2000	**676**	**28.9**	**43.6**	**5.2**	**3.0**	**19.3**
June 1999	653.5	23.6	53.7	6.3	9.3	7.2
June 1998	617.5	26.8	43.6	7.3	5.6	16.7
Dec 1997	536.0	53.6	0.2	11.8	14.1	20.3
July 1997	569.5	61.2	0.9	17.4	18.2	2.5
74-76: Max	686.0	38.6	19.3	66.5	23.5	3.2
74-76: Min	553.0	14.5	0.0	55.0	1.0	0.0
74-76: Mean	661.3	25.9	4.3	60.0	8.6	1.2

Ranunculus, which first underwent a remarkable resurgence in spring and summer 1998, has retained this dominant position ever since. The lower percentage cover data for July 2000 compared to 1999 is largely a result of this years cutting regime.

Schoenoplectus, which occupied 17.4% of the site in July 1997 has continued to decrease in area each year, probably as a result of the strong resurgence of *Ranunculus*, following the end of the 1996-97 drought and the start of phosphate stripping at Marlborough STW.

The area of 'other' macrophytes increased again in July 2000 as a result of the high water levels and both submerged *Callitriche* and emergent *Carex* were in evidence.

The area of gravel increased slightly in July 2000 compared with June 1999, mainly due to the reduced area of *Ranunculus*, but the area of silt dwindled still further as might be expected, given the high discharge regime.

5.3.2 Savernake (Upper site)

Table 5.4 presents information on the total area and percentage cover of the major habitats on the upper site at Savernake on 3 July 2000, together with the equivalent information for June 1999, 1998, July and December 1997, and summary data for 1974-76.

In July 2000, the total wetted area of the site was substantially lower than in June 1999 as a result of the rehabilitation demonstration project undertaken at this site in autumn 1999 involving a narrowing of the channel. In practice, there was some standing water on the far side of the river overlying a newly-created berm that would normally be above water level under typical discharge conditions. This was not included in the area mapped and sampled.

Table 5.4 R. Kennet at Savernake (Upper). Total wetted area of the 50 m site and the % cover of the major habitat types in July and December 1997, June 1998, June 1999 and July 2000 (latter in bold). Historical data for April 1974 - April 1976 is presented as maximum, minimum and mean values.

Date(s)	Total Area m^{-2}	Percentage Cover				
		Gravel	Ran	Schoen	Silt	Other
July 2000	**513**	**33.4**	**41.4**	**1.8**	**5.0**	**18.4**
June 1999	605	23.1	56.5	2.1	15.0	3.2
June 1998	604.5	36.2	48.8	1.7	4.1	9.2
Dec 1997	541.5	52.5	8.1	2.2	19.2	17.9
July 1997	551.0	64.5	6.5	2.7	22.0	4.4
74-76: Max	806.0	70.9	45.2	28.5	28.3	9.1
74-76: Min	597.0	23.4	0.0	12.5	1.4	0.0
74-76: Mean	766.0	49.5	19.1	21.8	7.0	2.5

The combination of high current velocities through this recently narrowed channel plus the weed cutting regime meant that area of *Ranunculus* on this upper site was somewhat lower than in June of 1999 and 1998.

Schoenoplectus was still present (1.8% cover) but in view fact that *Ranunculus* is heavily favoured at this site, it is unlikely to increase its area under the current flow regime. The area of 'other' macrophytes also increased, as on the lower site at Savernake, largely as a result of marginal growth of *Callitriche*.

Similarly, the percentage cover of gravel increased and the percentage cover of silt decreased on this site, for the same reasons as observed on the lower site at Savernake.

6. RESULTS OF MACROINVERTEBRATE SAMPLING

Please note: Information on the abundance of each macroinvertebrate family in each of the five sampling units for each habitat and study site is held in an Access Database being made available to the Environment Agency. In consequence, the raw data will not be presented within this report.

6.1 R. Lambourn at Bagnor (shaded site)

6.1.1 Family richness

The number of families of macroinvertebrates recorded on each habitat type (i.e. total number of families from 5 sampling units) in June 2000 is shown in Table 6.1 in bold. This table also gives the equivalent information for June 1999, 1998 and 1997 and the maximum, minimum and mean number of families recorded per habitat during the detailed studies undertaken in the 1970s. (**Note**: the 1970s data-set is restricted to seven years data comprising 1971 plus 1974-79 when the laboratory processing technique was the same as that used in 1997 and 1998. In 1972 and 1973, it was necessary to pool and then sub-sample the five sampling units from a given habitat). No macroinvertebrate samples were taken from emergent macrophytes during the 1970s because they rarely occupied a significant area of the river-bed. However, from 1997 onwards, they did warrant additional sampling to determine their characteristic fauna.

Table 6.1 R. Lambourn at Bagnor (shaded site) in June of 1997, 1998, 1999 and 2000 (latter in bold). Number of families of macroinvertebrates recorded on each habitat (total from 5 sampling units). Maximum, minimum and mean values derived from 7 years (1971+1974 to 1979) are also given.

Date(s)	Ber	Call	Grav	Ran	Silt	Emerg.
June 2000	**34**	**33**	**31**	**21**	**24**	**25**
June 1999	40	34	24	31	28	35
June 1998	37	32	24	26	27	34
June 1997	30	32	25	31	24	33
1970s: Max	41	39	36	41	33	No data
1970s: Min	22	30	27	29	23	No data
1970s: Mean	33.1	33.0	31.9	33.9	28.2	No data

The unusual pattern of increasing discharge from January to May, coupled with high discharge in June was expected to have an impact on the macroinvertebrate fauna. This proved to be the case, although a thorough analysis of the results in an attempt to understand the pattern of change is beyond the remit for this report. Overall family richness on *Berula* decreased from the high value of 40 families in June 1999 to 34 families whereas family richness on *Callitriche* remained remarkably stable at 33 families. The increase in family richness on gravel to 31 families from 24/25 of the previous three years was unexpected, and reflected the long-term mean of the 1970s for the first time since sampling recommenced. The decrease in family richness on *Ranunculus* was also very unexpected. The low of just 21 families has never been surpassed in either the 1970s or late 1990s. Family richness on the emergent vegetation was also substantially lower at 25 families than in any of the previous three years (range 22-35).

Finally, family richness on silt was low, but similar values have been recorded in both the 1970s and the late 1990s.

Despite these substantial changes on individual habitats, it is also important to take an overall view on family richness, as determined by pooling the information from all habitats. The total number of families recorded on all six habitats (i.e. including the emergents) has varied as follows: June 1997- 46 families, June 1998 - 52, June 1999 - 48 and June 2000 - 45 families. The years with the lowest richness values have therefore been years of hydrological extremes i.e. in the 1997 drought (46 families) and the current very high discharge year (45 families). If just the five habitats originally sampled in the 1970s are considered, then family richness varies as follows: June 1997- 42 families, June 1998 - 45, June 1999 - 47 and June 2000 - 43 families. Thus once more, the lowest richness values are recorded under drought (1997) and high discharge (2000) conditions. Note that in the seven years 1971 plus 1974-79, the total number of families from five habitats varied from 42 to 47, and hence the values obtained in the last four years have not varied beyond these boundaries.

6.1.2 Family composition and abundance data for June 1999

Table 6.2 presents a list of the 45 families of macroinvertebrates and their mean densities on each of the six habitat types sampled in June 2000. Note that the Oligochaeta and Lumbricidae, although presented separately, are counted as a single 'family' in this report. See section 4.2.2 of this report for an explanation of the need for this protocol. The faunal list for June 2000 includes 17 'families' of non-insects and 28 families of insects compared to 17 and 31 in June 1999, 17 and 35 in June 1998 and 16 and 30 in June 1997.

Overall, 39 families of macroinvertebrates were recorded at this site in both June 1999 and June 2000. However, the following differences were noted between the families recorded in these two years.

June 1999 only

Mollusca:	Valvatidae
Coleoptera:	Dytiscidae
	Scirtidae
Megaloptera:	Sialidae
Trichoptera:	Hydropsychidae
	Lepidostomatidae
Diptera:	Psychodidae
	Ptychopteridae
	Syrphidae

June 2000 only

Crustacea:	Astacidae
Ephemeroptera:	Heptageniidae
Plecoptera:	Nemouridae
Hemiptera:	Corixidae
Trichoptera:	Hydroptilidae
	Odontoceridae

In general, it would appear that a number of the families present in samples in June 1999 but absent from samples in June 2000 would be regarded as families characteristic of slower flowing conditions. In contrast, at least some of the families present in June 2000 but not June 1999 are characteristic of fast flowing conditions. These include some Ephemeroptera, Plecoptera and Trichoptera. However, it is worth reiterating that families that occur at low density on the site may or may not be picked up by the sampling programme in any one year, and hence it is unwise to read too much into an absence for a single year.

Table 6.2 **R. Lambourn at Bagnor (shaded site), June 2000. Mean densities of macro-invertebrate families (nos per 0.05 m^{-2}) based on 5 sampling units for each habitat type**

Family name	Berula	Callitriche	Emergents	Gravel	Ranunculus	Silt
Planariidae	4.00	0.40	0.80	2.40	0.00	0.40
Dendrocoelidae	1.20	0.00	0.00	0.00	0.00	0.00
Hydrobiidae	57.40	81.60	69.60	33.60	13.80	29.60
Physidae	0.00	0.00	1.60	0.00	0.00	0.00
Lymnaeidae	0.00	0.40	0.00	0.00	0.00	0.00
Planorbidae	1.60	0.00	0.00	0.20	0.00	0.00
Ancylidae	16.20	0.80	0.40	6.60	1.80	0.00
Sphaeriidae	4.00	14.80	9.60	0.80	0.00	12.40
Oligochaeta	193.40	222.00	159.20	37.60	57.40	43.60
Lumbricidae	6.80	0.40	1.60	2.60	3.80	1.00
Piscicolidae	0.40	0.00	0.00	0.00	0.00	0.00
Glossiphoniidae	2.80	1.60	0.00	0.20	0.00	0.00
Erpobdellidae	0.00	1.20	0.80	0.20	0.00	0.00
Hydracarina	40.20	9.60	7.60	5.40	35.40	0.80
Astacidae	2.40	0.60	0.00	0.00	0.00	0.00
Asellidae	1.60	2.80	20.00	0.80	0.20	0.40
Gammaridae	246.60	82.80	60.80	143.20	144.80	65.20
Niphargidae	0.00	0.00	0.00	0.00	0.00	0.40
Baetidae	87.20	32.40	8.80	18.60	144.80	2.20
Heptageniidae	0.20	0.00	0.00	0.00	0.00	0.00
Leptophlebiidae	0.00	0.00	0.00	0.00	0.00	0.80
Ephemeridae	0.80	1.60	0.80	0.40	0.00	1.00
Ephemerellidae	16.20	50.00	14.00	1.00	31.60	3.60
Caenidae	31.60	17.60	8.80	2.60	10.60	1.80
Nemouridae	0.00	0.80	0.00	0.00	0.00	0.00
Leuctridae	3.20	0.40	0.00	1.00	1.20	0.00
Veliidae	0.00	0.00	0.40	0.00	0.00	0.00
Corixidae	0.00	0.80	0.00	0.00	0.00	0.40
Elmidae	11.60	4.00	2.80	7.80	8.00	1.80
Rhyacophilidae	0.40	1.20	0.00	1.00	2.20	0.00
Glossosomatidae	27.20	1.60	0.80	105.20	15.80	21.00
Hydroptilidae	0.60	1.60	0.00	0.00	0.00	0.00
Psychomyiidae	0.00	0.00	0.00	0.40	0.40	0.00
Polycentropodidae	1.60	2.80	0.80	0.00	0.00	0.00
Limnephilidae	5.80	5.60	7.20	1.20	0.80	1.80
Goeridae	0.80	0.40	0.00	4.60	0.00	0.40
Beraeidae	0.00	0.00	0.00	0.20	0.00	0.00
Sericostomatidae	0.40	0.00	0.00	0.60	0.00	0.00
Odontoceridae	0.00	0.00	0.00	0.40	0.00	0.00
Leptoceridae	5.00	0.80	0.00	12.20	1.00	6.80
Tipulidae	2.80	3.20	2.40	9.00	4.60	2.80
Dixidae	0.40	0.40	3.20	0.00	0.00	0.00
Ceratopogonidae	18.80	14.00	12.00	2.00	2.40	3.40
Simuliidae	206.40	20.80	9.60	0.20	248.80	2.40
Chironomidae	277.00	196.40	245.20	17.40	389.60	47.60
Empididae	9.00	0.80	0.80	2.40	3.40	0.20

6.2 R. Kennet at Littlecote

6.2.1 Family richness

The River Kennet at Littlecote is characterised by *Ranunculus* growing on a gravel substratum and hence the results for the 1970s and the more recent sampling programme has been confined to these habitat types. In Table 6.3, the June 2000 results (in bold) have been placed alongside the data for June 1999, 1998 and July and December 1997 plus the available data for 1975 and 1974.

Table 6.3 R. Kennet at Littlecote. Number of families of macroinvertebrates recorded on *Ranunculus* and gravel in July and December 1997, June 1998 June 1999 and July 2000 (latter in bold). Historical data for 1975 (June and December) and 1974 (June only) are also given.

Year	June/July		December		Total for Year
	Ranunculus	Gravel	Ranunculus	Gravel	(Ran + Grav)
2000	**30**	**32**	No data	No data	No data
1999	30	34	No data	No data	No data
1998	31	29	No data	No data	No data
1997	32	31	43	34	47
1975	30	33	35	33	42
1974	30 (29)*	28	No data	No data	-

* Figure in brackets refers to data from 5 replicate samples taken on recently cut *Ranunculus*.

In June 2000, the number of families recorded on *Ranunculus* was the same as in June 1999 and family richness on gravel was marginally lower than in the previous year but slightly higher than in 1998 and 1997. Clearly, the high discharge regime was not having a major effect on family richness on individual habitats.

6.2.2 Family composition and abundance data for 1998

Table 6.4 lists the 35 families of macroinvertebrates captured at Littlecote in June 2000 together with their mean densities on gravel and *Ranunculus*. These 35 families include 14 non-insect and 21 insect families, compared to 36 families (14/22) in June 1999, 32 families (12/20) in June 1998 and 35 families (12/23) in July 1997.

Overall, there were 34 families recorded at the site in both June 1999 and June 2000. However, the following minor differences were noted between the listing for the two years:

June 1999 only		June 2000 only	
Ephemeroptera:	Leptophlebiidae	Coleoptera:	Dytiscidae
Trichoptera:	Psychomyiidae		

Thus, the high discharge regime appears to have had a very minor impact at this site in terms of overall family richness as documented by this sampling programme.

Table 6.4 **R. Kennet at Littlecote, June 2000. Mean densities of macroinvertebrate families (nos per 0.05 m^{-2}) based on 5 sampling units for each habitat.**

Family name	Gravel	Ranunculus
Planariidae	13.00	5.20
Dendrocoelidae	1.20	0.40
Physidae	0.40	0.00
Planorbidae	1.40	1.20
Ancylidae	36.20	3.20
Sphaeriidae	3.40	13.20
Oligochaeta	72.40	52.00
Lumbricidae	0.20	2.00
Piscicolidae	0.20	1.20
Glossiphoniidae	3.60	3.60
Erpobdellidae	2.20	0.00
Hydracarina	0.00	2.80
Asellidae	0.20	0.00
Gammaridae	442.20	552.80
Niphargidae	0.20	2.40
Baetidae	95.20	127.60
Heptageniidae	0.40	0.00
Ephemerellidae	34.60	161.60
Caenidae	25.20	7.20
Leuctridae	6.00	3.20
Dytiscidae	0.20	0.00
Elmidae	22.00	10.00
Rhyacophilidae	7.00	9.60
Glossosomatidae	12.60	3.60
Polycentropodidae	0.40	0.80
Hydropsychidae	3.00	4.40
Lepidostomatidae	0.80	14.00
Limnephilidae	0.60	4.40
Goeridae	4.60	1.60
Sericostomatidae	0.00	1.20
Leptoceridae	8.60	5.60
Tipulidae	3.20	2.00
Ceratopogonidae	2.80	18.40
Simuliidae	9.00	213.80
Chironomidae	23.80	244.40
Empididae	0.00	0.40

6.3 R. Kennet at Savernake (lower and upper sites)

6.3.1 Family richness

At the lower site at Savernake, it was necessary to abandon the normal procedure of sampling *Schoenoplectus* because very little of this macrophyte remained at the site. In addition, it was in deep and inaccessible water. Instead, five replicates were taken on *Ranunculus*, the macrophyte which was probably outcompeting *Schoenoplectus* in the present discharge and current velocity regime. Gravel was also sampled in early July 2000, for comparison with results obtained in June 1999, 1998, July and December 1997 and in the 1970s (Table 6.5).

Table 6.5 R. Kennet at Savernake (Lower site). Number of families of macroinvertebrates captured on *Schoenoplectus* and gravel in July and December 1997, June 1998, June 1999 and July 2000 (latter in bold). Historical data for 1975 (June + December) and 1974 (June) is also given.

Year	June/July		December		Total for Year
	Schoenoplectus	Gravel	Schoenoplectus	Gravel	(Schoen+Grav)
2000	**25***	**27**	No data	No data	-
1999	31	31	No data	No data	-
1998	26	30	No data	No data	-
1997	31	27	33	32	39
1975	27	24	32	29	35
1974	26	28	No data	No data	-

Ranunculus rather than ***Schoenoplectus*** sampled in July 2000.

In July 2000, the number of families recorded on *Ranunculus* was 25, marginally lower than the previous lowest value of 26 families recorded on *Schoenoplectus* in both the 1970s and late 1990s (June 1998) to 31. On gravel, 27 families were recorded, the same number as in July 1997, during the last drought, but lower than the 30/31 families recorded in 1998/99. A total of 31 families was recorded on the site in early July 2000, compared to 34 in June 1999, 32 in June 1998 and 33 in July 1997.

Data on family richness for the upper site at Savernake is presented in Table 6.6. Remarkably, the family richness on each of *Ranunculus* and gravel was the same in 1997, 1999 and 2000.

Table 6.6 **R. Kennet at Savernake (Upper site). Number of families of macroinvertebrates captured on *Ranunculus* and gravel in July and December 1997, June 1998, June 1999 and July 2000 (the latter in bold). Historical data for these habitats plus *Schoenoplectus* in 1975 is also given.**

Year	June/July			December			Total for Year
	Schoen	Ran	Gravel	Schoen	Ran	Gravel	(All habitats)
2000	No data	**28**	**29**	No data	No data	No data	-
1999	No data	28	29	No data	No data	No data	-
1998	No data	27	23	No data	No data	No data	-
1997	No data	28	29	No data	32	27	38
1975	29	No data	29	32	31	31	37
1974	No data	29	27	No data	No data	No data	-

A total of 33 families were captured on the site in early July 2000, compared to 34 families in June 1999, 32 families in June 1998, and 33 families in July 1997.

6.3.2 Family composition and abundance data for 1999

A list of the 31 families of macroinvertebrates recorded on the lower site at Savernake in July 2000, together with their mean densities on gravel and *Ranunculus* is presented in Table 6.7. The 31 families include 14 non-insects and 17 insect families compared to 34 families (14/20) in June 1999, 32 families (13/19) in June 1998 and 33 families (14/19) in July 1997.

Overall, there were 28 families recorded at this site in both June 1999 and July 2000. However, the following differences were noted between the listing s for the two years:

Lower Savernake - June 1999 only

Tricladida:	Dendrocoelidae
Mollusca:	Physidae
Megaloptera:	Sialidae
Trichoptera:	Hydropsychidae
	Lepidostomatidae
	Goeridae

Lower Savernake – July 2000 only

Mollusca:	Hydrobiidae
Mollusca:	Lymnaeidae
Plecoptera:	Leuctridae

Once again, it is important to emphasise that the absence of a family in the samples for a given year does not necessarily imply that a family was absent from the site, merely that it was sufficiently uncommon to be absent from the samples. However, the appearance of the stonefly family Leuctridae is of interest given that it has not previously been recorded in the 1970s or 1990s during this study. Note also that Leuctridae was absent at Littlecote in the 1970s but appeared in samples taken in the late 1990s.

A listing of the 33 families of macroinvertebrates and their mean densities on gravel and *Ranunculus* on the upper site at Savernake in early July 2000 is given in Table 6.8. It includes 13 non-insect and 20 insect families compared to the 13/21 families in June 1999, 15/17 families in June 1998 and 15/18 families in July 1997. Overall, there were 30 families recorded at this site in both June 1999 and July 2000. However, the following additional families were recorded on one sampling occasion only.

Upper Savernake - June 1999 only

Mollusca:	Physidae
Coleoptera:	Haliplidae
Trichoptera:	Hydroptilidae
Trichoptera:	Lepidostomatidae

Upper Savernake – July 2000 only

Mollusca:	Lymnaeidae
Plecoptera:	Leuctridae
Megaloptera:	Sialidae

Notice that several of the between-year changes noted on the lower Savernake site are repeated here on the upper site. They include the gastropod molluscs Physidae and Lymnaeidae, the caddis family Lepidostomatidae and also the first appearance of Leuctridae.

However, the capture of the megalopteran Sialidae in 1999 but not 2000 at the lower site and in 2000 but not 1999 at the upper site clearly demonstrates the need for caution when flagging 'changes' in families which only occur at low densities.

Table 6.7 **R. Kennet at Savernake (Lower site) July 2000. Mean densities of macroinvertebrate families (nos per 0.05 m^{-2}) based on 5 sampling units for each habitat.**

Family name	Gravel	Ranunculus
Planariidae	0.00	2.40
Hydrobiidae	0.80	0.00
Lymnaeidae	0.20	0.00
Planorbidae	0.00	0.80
Ancylidae	12.80	6.80
Sphaeriidae	4.20	12.80
Oligochaeta	18.80	44.40
Piscicolidae	0.80	4.40
Glossiphoniidae	0.40	7.60
Erpobdellidae	0.60	2.40
Hydracarina	3.20	9.60
Asellidae	0.80	1.60
Gammaridae	256.80	315.20
Niphargidae	1.80	2.00
Baetidae	35.20	167.60
Ephemerellidae	40.60	158.80
Caenidae	0.00	2.80
Leuctridae	1.00	0.00
Dytiscidae	2.00	1.20
Elmidae	5.20	4.80
Rhyacophilidae	2.20	0.80
Glossosomatidae	0.00	0.80
Polycentropodidae	1.80	5.20
Limnephilidae	1.60	2.00
Sericostomatidae	0.20	0.00
Leptoceridae	0.20	0.00
Tipulidae	1.60	0.80
Ceratopogonidae	2.80	3.60
Simuliidae	8.20	228.00
Chironomidae	83.40	389.20
Empididae	0.80	0.00

Table 6.8 **R. Kennet at Savernake (Upper site), July 2000. Mean densities of macroinvertebrate families (nos per 0.05 m^{-2}) based on 5 sampling units for each habitat.**

Family name	Gravel	Ranunculus
Planariidae	6.00	5.20
Dendrocoelidae	0.80	1.60
Lymnaeidae	0.80	0.00
Ancylidae	41.40	4.80
Sphaeriidae	0.40	0.00
Oligochaeta	101.40	69.60
Lumbricidae	2.60	1.20
Piscicolidae	0.40	2.40
Glossiphoniidae	2.40	1.60
Erpobdellidae	6.20	4.00
Hydracarina	0.00	12.00
Asellidae	2.00	2.00
Gammaridae	136.60	250.20
Niphargidae	0.00	3.20
Baetidae	88.60	207.20
Ephemerellidae	75.80	190.40
Caenidae	0.00	2.40
Leuctridae	0.20	0.00
Dytiscidae	0.80	0.40
Elmidae	12.80	3.60
Sialidae	0.00	0.40
Rhyacophilidae	1.20	3.20
Glossosomatidae	0.20	0.00
Polycentropodidae	3.40	3.60
Hydropsychidae	0.20	0.40
Limnephilidae	3.20	4.40
Goeridae	3.00	0.80
Sericostomatidae	1.00	2.00
Leptoceridae	1.20	0.40
Tipulidae	0.40	0.00
Ceratopogonidae	2.80	2.00
Simuliidae	12.40	426.00
Chironomidae	67.60	195.60
Empididae	1.80	0.80

7. CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

7.1.1 R. Lambourn at Bagnor

Background information on this site throughout the 1970s and during the first year of resampling in 1997 was given in Wright *et al.* (1999a). In 1997, it was apparent that the shaded site had undergone substantial change since the 1970s due to the lack of the river management for trout fishing and also due to the effects of the prolonged drought of 1996-97. Lack of management allowed the initial encroachment of marginal emergents on the baseline bank, and this process increased during the drought. In addition, lack of control of the bank-side trees and bushes on the far bank increased shading with some potential for restricting the growth of submerged vegetation.

In 1997, the poor growth of *Ranunculus* and the progressive build-up of silt was thought to be largely due to the drought. The reason for the limited area of *Berula* was less clear, but in view of the large areas of clean gravel, it was anticipated that both macrophytes would increase in area quite rapidly following the end of the drought. Although the discharge over the winter of 1997/98 was unexceptional, heavy rainfall in spring 1998 provided what appeared to be favourable conditions for the progressive recovery of the macrophytes and macroinvertebrate assemblages.

The results of the mapping programme in June 1998 (Wright *et al.* 1999b), June 1999 (Wright *et al.* 2000b) and June 2000 (this report) demonstrate that, so far, there is little sign of the site returning to the high macrophyte cover of the 1970s and that a new pattern seems to be emerging. Although *Berula* remains the dominant macrophyte with *Ranunculus* subdominant, the overall percentage cover of macrophytes is substantially lower than in the 1970s, most likely as a result of limited light penetration through the water surface due to the present cover of trees, bushes and marginal vegetation. More puzzling is the high percentage cover of silt which remains on site despite a succession of high flow years. However, this is largely associated with the far bank where tree cover, bush cover and associated trailing vegetation influences the pattern of water flow through the site.

The very high discharge regime of spring/summer 2000 appeared to reduce the overall percentage cover of each instream macrophyte in relation to June 1999, and in view of the predicted high discharge regime for 2001, this site should yield valuable information on the longer-term impacts of prolonged high flows in June 2001.

The long-term macroinvertebrate sampling programme is also a unique record which is now starting to provide answers to a number of important questions. These are currently being addressed in a series of scientific publications and the reader is referred to these for detailed information. Only a brief synopsis is provided below.

When considering ecosystem functioning it is very important to take account of the densities of macroinvertebrates on the various habitat types. Some characteristic families of fast-flowing chalk streams such as mayflies in the Baetidae and blackfly larvae (Simuliidae) are very sensitive to the prevailing discharge regime. In a recent paper, Wright *et al.*(2000a) calculated the 'weighted' mean densities of these families on the site in June for the period 1971-79 and also for 1997. Weighted mean densities take account of the densities of the families on each habitat but also the area of each habitat on the site, thereby giving the best estimate of the density of the family on the site as a whole. In general, low discharge for the three-month period March to May prior to sampling resulted in low densities of Baetidae and Simuliidae but in years of progressively higher discharge, densities increased. More recent data for 1998 onwards also follows the same pattern, although it is also noticeable that in years when macrophyte cover is low in both the 1970s or the 1990s, then weighted mean densities of Baetidae and Simuliidae are somewhat lower than in years of high macrophyte cover. Thus, flow regime has a crucial role to play in the functioning of the system.

In a more recent paper, Wright *et al.* (in press b) examined the response not just of individual families but of the entire macroinvertebrate assemblage to the prevailing discharge regime. The particular focus was on the drought of 1976 (using data for 1974-79) and the drought of 1997 (using data for 1997-2000). Macroinvertebrate family richness was shown to be significantly lower on *Berula* in the year of each drought and recovery was only partial in the following year. On *Berula* during the 1976 drought (but not in the 1997 drought) the total numbers of individuals were significantly higher than in other years. Thus there were more individuals of fewer taxa (i.e. diversity decreased) during the drought. Ordinations based on abundance data at family level demonstrated very effectively the manner in which the fauna changed in each of the drought years 1976 and 1997 in relation to all non-drought years. These same ordination diagrams also illustrated that there had been some subtle changes in the fauna between the 1970s and the 1990s. Preliminary analyses suggest that any changes in family composition are of very minor significance compared with changes in the densities of many macroinvertebrate families. These changes are believed to be related to the move from management of the site as a trout fishery in the 1970s to the current lack of management on the site. This topic is of considerable interest in the context of river management and conservation and will be the topic for the next scientific paper.

7.1.2 R. Kennet at Littlecote

This site appears to be very much as it was in the 1970s and the same regime of bar-cutting and bankside maintenance has continued with the interests of the trout fishery in mind. In summer 1997, the discharge regime at Littlecote was greater than in the severe drought of 1976 and although the growth of *Ranunculus* was slower than normal, nevertheless, it covered 44.2% of the 100 m site in July 1997. In subsequent years growth of *Ranunculus* has been good, as expected under conditions of high discharge.

The macroinvertebrate sampling programme on *Ranunculus* and gravel in the mid-1970s and from 1997 onwards demonstrated that family richness has remained remarkably stable under a range of different discharge regimes. There have, however, been some relatively minor changes in family composition at this site between the 1970s and 1990s (Wright *et al.* in press a). This site is proving to be of considerable value as a 'control' against which to assess the more substantial changes in the flora and fauna observed further upstream at Savernake.

7.1.3 R. Kennet at Savernake

The River Kennet at Savernake suffered progressive loss of *Ranunculus* below Marlborough for some years and in an attempt to promote regrowth, a combination of management techniques were used by the River Keeper in the 1990s. These included allowing the river to run freely, use of current deflectors, removal of vertical boarding and reduction of channel width through the planting of marginal emergents etc. Despite his best efforts, these procedures were largely unsuccessful.

At sites on the River Lambourn, there is observational evidence that in years of low discharge, growth of *Ranunculus* is restricted by the accumulation of epiphytic algae and associated detritus on the surface of the plants (Ham *et al.* 1981, Wright and Berrie 1987). At Savernake, the potential for this problem to be compounded in low flow years by the presence of nutrients from Marlborough STW, and other diffuse sources resulting from agricultural activities within the catchment was raised in Wright *et al.*(1999a). In the same report it was noted that in summer 1997, the Littlecote study site was capable of supporting good growth of *Ranunculus* but a relatively similar discharge regime failed to promote growth of *Ranunculus* at Savernake, despite the various management protocols listed above. The question therefore arose as to whether water quality, in addition to water quantity, was relevant to this problem.

In 1997, *Schoenoplectus* was dominant at the lower site, as it had been in the mid-1970s but the total area of this macrophyte (17.4%) was much reduced compared to the 1970s. On the upper site *Ranunculus* occupied just 6.5% cover and *Schoenoplectus* only 2.7%. On each site silt occupied around 20% of the riverbed.

Prior to mapping in June 1998, some significant changes occurred. First, phosphate stripping commenced in autumn 1997 at Marlborough sewage treatment works. Second, the two-year drought came to an end and although winter discharge was not unusually high, the month before mapping in June 1998 was notable for heavy rain and increased discharge.

In June 1998, it was apparent that a remarkable change had taken place on this section of river. *Ranunculus* had undergone spectacular growth on both study sites and this, in combination with the discharge regime meant that water levels were very high. In 1999 and 2000 this position has been maintained and *Ranunculus* has often dominated with percentage cover values exceeding those recorded in the mid-1970s. In contrast, *Schoenoplectus*, appears to continue its slow decline in area, probably because it cannot compete with *Ranunculus* on sites where discharge is high and the river is now allowed to run free.

A full account of changes in the cover of instream habitats (including the macrophytes) at both Littlecote and Savernake through the mid-1970s and since mapping recommenced in summer 1997 is given in Wright et al. (in press a).

A superficial examination of macroinvertebrate family richness on the gravel and macrophyte habitats at the two Savernake sites in the mid 1970s and the late 1990s suggests a high level of stability. In practice, there have been some relatively minor changes in family composition between these two sampling periods. Ordination techniques using information on family composition and abundance demonstrate this feature (Wright *et al.* in press a). Ordination also indicates that on both Savernake sites the fauna underwent a notable change between summer 1997, when macrophyte growth was poor, and the following two years after the end of the drought, and the start of phosphate stripping. Further analysis showed that this was mainly due to changes in faunal abundance and that, for example, in 1997 there were high densities of three families of leeches, Asellidae and Chironomidae. In 1998, under high flow conditions these families normally occurred at significantly lower densities, whereas in the case of

Baetidae, the high densities were associated with the high flow conditions. Unfortunately, the relative roles of flow regime and changes in water quality, as influences on the density of particular macroinvertebrates, are sometimes difficult to disentangle in that they operated over the same winter period of 1997/98 (Wright *et al.* in press a).

7.2 Recommendations

The general recommendation is that it is important to complete the current mapping and sampling programme at these sites because:

A) Long-term monitoring is necessary in order to record the extent of natural between-year variation and interpret biotic response to extremes including droughts and high discharge events.

B) Following the 1996/97 drought, completion of the current mapping and sampling programme will help to establish whether some sites return to their 1970s baseline condition or establish a new equilibrium.

C) Continued monitoring of these sites can provide important information on the value of particular management practices at some sites and the lack of management at others.

D) With each additional year of macroinvertebrate sampling, coupled with the opportunity to interrogate the 1970s database, there are many scientific opportunities to examine the persistence of species, variation in the structure of faunal assemblages and the impact of invasive species (e.g. signal crayfish). All these topics are relevant to the conservation of the chalk stream ecosystem and the retention of biodiversity.

Some specific recommendations related to the individual study sites are given below:

R. Lambourn at Bagnor.

1. At this site it is important to monitor the submerged macrophyte community to confirm whether a new equilibrium is being established with lower levels of instream macrophytes than observed in the 1970s. The current non-interventionist management strategy at Bagnor has undoubtedly influenced the flora and further mapping will yield information of wider relevance to river management and conservation.

2. The area of silt remains high, despite increased flows since the end of the drought in the winter of 1997/98. Continued monitoring will help to determine whether this is due to a slow rate of wash-out after the 1996-97 drought or whether lack of active management of the site is a contributory factor.

3. With each additional year of macroinvertebrate sampling, our understanding of the way in which the *ca.* 60 individual families of macroinvertebrates respond to the flow regime increases. The availability of weighted mean densities for each family means that the dataset can provide particularly valuable information for many characteristic chalk stream macroinvertebrates.

4. Continued monitoring at Bagnor will provide an opportunity to keep a watching brief on the signal crayfish and whether it has a long-term impact on the site.

5. There would be merit in having the capacity to determine the proportion of the total discharge which flows through the north and the south channels of the river at Bagnor.

R. Kennet at Littlecote

6. The management strategy adopted at this site has been maintained over a long period of time, and it offers a useful 'baseline' against which to monitor the more complex changes that have occurred at Savernake. Hence it would be valuable to continue to monitor both the macrophytes and macroinvertebrates at this site as a control.

R. Kennet at Savernake

7. The long-term decline of *Ranunculus* at Savernake was reversed in spring 1998 and *Ranunculus* remained the dominant macrophyte over the next three years. Continued mapping is advisable to confirm the new equilibrium and document the fate of *Schoenoplectus*, assuming that the river is allowed to run freely and that water quality remains high.

8. Continued monitoring of the macroinvertebrates is recommended to confirm long-term recovery following the 1996/97 drought and commencement of phosphate stripping at Marlborough STW. If the current management practice of allowing the river to flow freely is maintained, then the fauna may start to have more in common with the Littlecote site downstream, rather than Savernake as it was in the 1970s, when the river was managed as a deep, slow-flowing channel.

9. Finally, some river rehabilitation on the Upper Kennet was initiated as a Demonstration Project in autumn 1999 by Alconbury Environment Consultants with the approval of the Environment Agency. The work, which involves measures to increase velocities on the right hand side of the channel by a series of manipulations on the left hand side will reduce velocities on that side to encourage siltation and marginal vegetation encroachment. The demonstration section directly involves the upper site at Savernake, and hence the current research programme can provide information on changes in both instream habitats and macroinvertebrate assemblages at this site.

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