# Changes in aquatic macroinvertebrate communities in Bookham Common Hollows Valley Ponds from 1993 to 1998

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## Abstract

Aquatic macroinvertebrate communities in Bookham Common Hollows Valley Ponds were sampled using National Pond Survey techniques from 1993 to 1998. Drying of the ponds due to drought in the summer of 1995 resulted in low-diversity and high-abundance communities characteristic of a perturbed habitat. Analysis of community structure in Isle of Wight and Western Hollow Ponds suggests that total or partial desiccation initiated recolonization processes resulting in modification of the macroinvertebrate communities. It is suggested that these changes occurred because they are not true temporary ponds and their communities are not intrinsically adapted to persist through this type of environmental perturbation.

## Introduction

The importance of ponds as sources of biodiversity in Britain has been amply demonstrated (Nicolet 2001). In the UK, 50 per cent of all freshwater aquatic invertebrate species are likely to be found in ponds (Drake 1995). The nature of ponds as small, inherently unstable habitats renders their biota vulnerable to environmental perturbations such as drought, flood and anthropogenic influences. Bearing in mind the contribution of ponds to biodiversity at the local and national scale, there is a need to examine their response to such perturbations. This study examines changes in the composition of macroinvertebrate communities of five ponds at Bookham Common (SSSI) from 1993 to 1998 encompassing a period of drought in 1995.

Bookham Common Hollows Valley contains a chain of five ponds bordered with woodland (Figure 1). They are based on London Clay and were formed by damming Greendell Ditch and its tributaries in the valley at five points. They consist of Isle of Wight (TQ126562), Western Hollow (TQ127563), Eastern Hollow (TQ128563), Lower Eastern (TQ130563) and Upper Eastern (TQ132563). A consequence of damming Greendell Ditch to form ponds is that the water flows westward from Upper Eastern Pond through to Isle of Wight Pond in a linear sequence. According to Jones (1960) the five ponds have occupied the valley since at least 1887. The ponds and their biota have been studied and documented for many years by members of the London Natural History Society. Records indicate that the ponds have differed in their successional states over time. Two ceased to be recognizable as ponds for some

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years before being re-excavated. All have been subject to desiccation on several occasions as a consequence of drought, silting, allied successional processes or management, i.e. drainage (Table 1). Most recently, drought in 1995 resulted in all five ponds drying either completely or partially (Figures 3–5). Two ponds dried up completely forming shallow basins of wet (Upper Eastern) or dry (Lower Eastern) mud. Three others dried partially, leaving expanses of dry and wet mud exposed. Such dry episodes constitute a major ordering influence on the macroinvertebrate fauna of ponds (Jeffries 1994) and present useful opportunities to study pond colonization and successional changes over time.

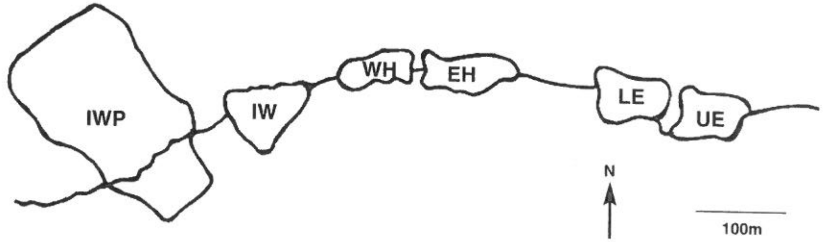


FIGURE 1. Bookham Common Hollows Valley Ponds, modified from Bookham Common Survey (*The London Naturalist* 44: 114).

**Key:** IWP Isle of Wight Plain; IW Isle of Wight Pond; WH Western Hollow Pond; EH Eastern Hollow Pond; LE Lower Eastern Pond; UE Upper Eastern Pond.

## Methods

### Aquatic macroinvertebrate samples

Isle of Wight Pond and Western Hollow Pond (Figure 2) were sampled on 22 June 1993 during a preliminary study (Kett and Kirk 1994). All ponds were sampled on 13 September 1995, 11 October 1997, 1 December 1997 and 2 May 1998. Ponds were examined prior to macroinvertebrate sampling to establish microhabitats and features present. Each pond was then sampled with an FBA standard 1.0 mm mesh pond net following National Pond Survey techniques (Biggs et al. 1989), i.e. a three-minute sample was equally divided between the number of microhabitats present. Vertebrates in samples were released before macroinvertebrates were fixed in 4.0 per cent formalin. Macroinvertebrate identification was carried out using: Gledhill et al. (1976) Malacostraca; Macan (1977) Gastropoda; Elliot and Mann (1979) Hirudinea; Miller (1987) Odonata; Elliot et al. (1988) Ephemeroptera; Friday (1988) Coleoptera; Savage (1989) Hemiptera; and Wallace et al. (1990) Trichoptera. Taxa were identified to species where possible. Macroinvertebrate data were tested for between pond and year similarity of taxa present using Jaccard's Coefficient (Stiling 1999). Pond macroinvertebrate diversity indices were calculated using Simpson's 'D' Index (Huston 1994).

### Mud samples

Mud cores were taken on 13 September 1995 during a period of drought to sample invertebrates living in the mud and to determine percentage organic matter. Wet and dry mud habitats were sampled at points approximately 50 per cent across each mud habitat zone. Each habitat was sampled to a depth of 150 mm with a 40-mm diameter sediment corer. Six core samples were taken in each mud habitat and sealed in polythene bags. Three cores from each wet mud habitat in each pond were analysed for invertebrates immediately. Cores were soaked in distilled water for thirty minutes and were washed through a sieve series of 2.0, 1.0 and 0.5 mm mesh. Material retained by each sieve was examined for invertebrate taxa. The three remaining cores from wet mud were oven dried at 80°C for twenty-four hours and analysed for percentage organic matter. Dry mud cores were soaked in distilled water for an additional two weeks to allow any resting stages to develop. After this time samples were fixed in 10 per cent formalin and were analysed for macroinvertebrates as stated for wet mud cores. Dry cores were not analysed for percentage organic matter because of possible prior oxidation of organic material.

## Results

In total 144 macroinvertebrate taxa were identified from Bookham Common Hollows Valley Ponds over the sampling period from 1993 to 1998. Four taxonomic groups predominated: Coleoptera (33 species), Hemiptera (21 species), Mollusca (18 species) and Odonata (11 species) comprising more than half the identified taxa (Table 2). Simpson's indices show a high level of macroinvertebrate diversity within the five ponds (0.71 – 0.83). Jaccard's Coefficients of Similarity (Table 3) show no major identifiable trends other than broad within-year/between-pond similarity. Coefficients show low levels of similarity between and within ponds in different years, except Western Hollow 1993 which shows similarity to itself, Eastern Hollow and Lower Eastern Ponds in 1997.

Eighteen invertebrate taxa were present in the pond water samples during the summer of 1995. Western Hollow had the highest taxon richness (13 taxa compared to 50 taxa in 1993). Eastern Hollow contained 12 taxa and Isle of Wight contained 11 taxa (compared to 44 taxa in 1993). Eight taxa were found in Upper Eastern Pond whilst Lower Eastern Pond contained no taxa as it was completely dry. In addition to macroinvertebrates, planktonic crustaceans, *Daphnia* spp., were observed in pools of standing water remaining in the three semi-dry ponds (Eastern Hollow, Western Hollow and Isle of Wight). Chironomid larvae and oligochaetes also formed dense populations in these pools. Taxon richness within wet mud was lower than in corresponding water samples and increased with percentage organic matter. Analysis of mud samples showed that percentage organic matter increased throughout the pond chain, being highest in Upper Eastern pond and lowest in Isle of Wight Pond (Table 4).

Ninety-two macroinvertebrate taxa were found in the ponds in October 1997. Lower Eastern had the highest taxon richness of 57 taxa, Eastern Hollow contained 48 taxa, Western Hollow contained 39 taxa, Isle of Wight contained 36 taxa and Upper Eastern had 21 taxa. Additional sampling in December 1997 and May 1998 (Tronchoni 1999) revealed the presence of 12 additional taxa including 10 additional species (Table 2).

## Discussion

The drought in summer 1995 had obvious effects on aquatic macroinvertebrate richness and abundance within Bookham Common Hollows Valley Ponds. Few taxa present in 1993 remained during the drought, either within remaining standing water or within wet and dry mud. Those taxa that were present were often abundant, notably oligochaetes, chironomid larvae and planktonic cladocerans. Such low-diversity and high-abundance communities are characteristic of high-stress or perturbed habitats.

Taxa remaining in standing water were notable for several characteristics. Most were flightless with the exception of *Hygrotus inaequalis*, *Sigara lateralis* and *Micronecta scholtzi*. Organisms tolerant of turbid, shallow water and low oxygen concentrations included ceratopogonid larvae, chironomid larvae and oligochaetes. The two predatory leeches present, *Erpobdella octoculata* and *Helobdella stagnalis*, are considered as 'indicator species' of organically-enriched waters (Elliott and Mann 1979) and, like *Sialis lutaria* larvae, are tolerant of a wide range of water conditions (Elliot 1977). All three taxa prey extensively on chironomid larvae and oligochaetes. *S. lateralis* may have colonized Isle of Wight



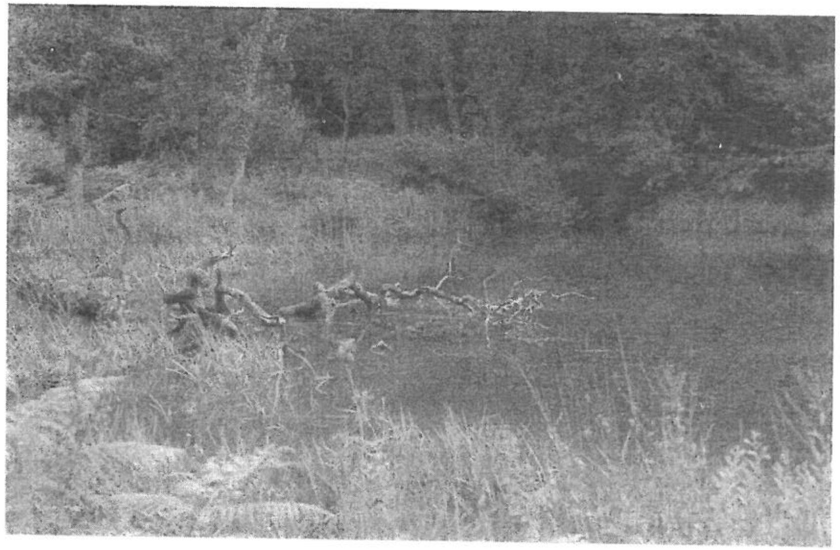

FIGURE 2. Macroinvertebrates in Western Hollow Pond (pictured) and Isle of Wight Pond were studied in 1993 by Kett and Kirk (1994).

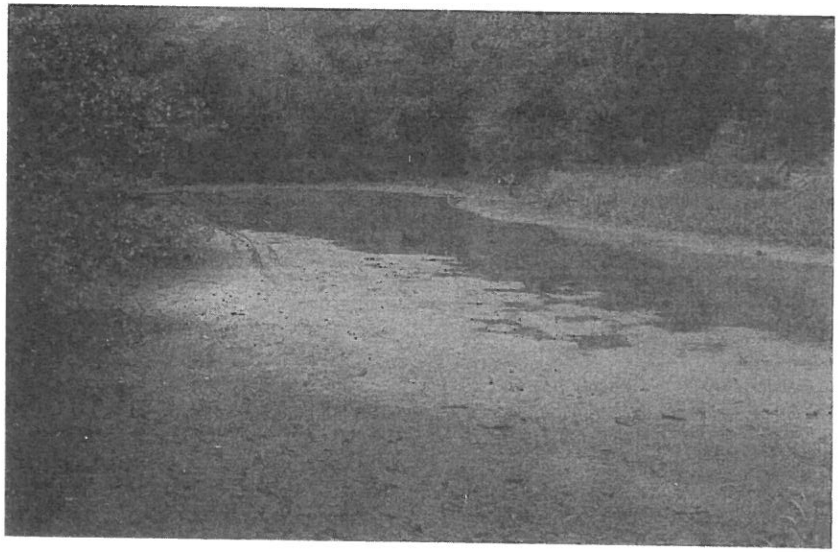

FIGURE 3. Western Hollow Pond in semi-dry condition in September 1995.

FIGURE 4. Isle of Wight Pond in semi-dry condition in September 1995.

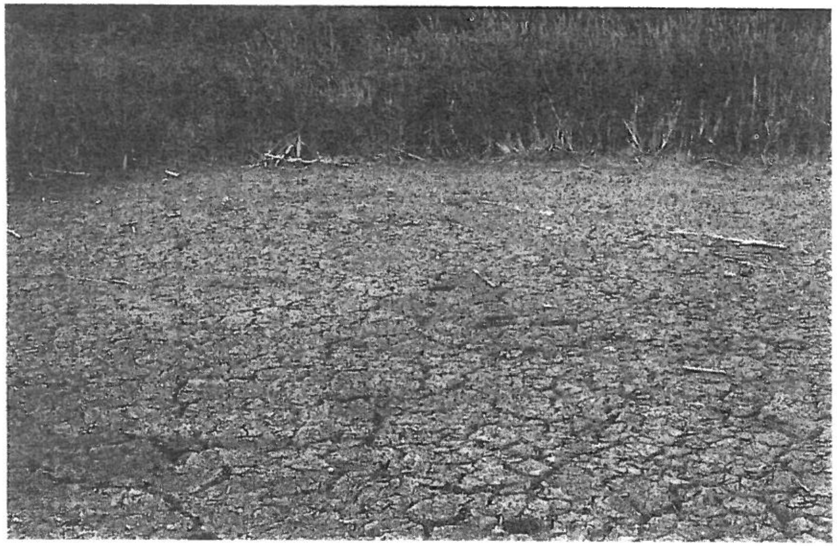

FIGURE 5. Lower Eastern Pond dried up completely in September 1995.



Pond during the drought. In urban ponds it is regarded as a 'pioneer' species, characteristic of new or perturbed pond environments (Langley et al. unpublished data). Savage (1989) also noted this species as tolerant of degraded habitats, whilst Sládaček and Sládečková (1994) list it as indicative of high levels of organic saprobity. Where standing water was absent, but mud remained wet, ponds with a greater concentration of organic matter supported a higher number of taxa. Organic material, largely composed of decomposing vegetable debris, may have offered larger, waterlogged interstitial refugia than those found in sediments composed of sand, silt and clay alone.

All of the Bookham Common Hollows Valley Ponds have dried several times in the past and have been repeatedly recolonized on cessation of drought conditions. Sources and access routes of colonization, however, are less obvious. Bensley (1952) and others have noted the rapid recolonization of ponds by specific taxonomic groups, such as the molluscs, but no workers have studied recolonization by entire macroinvertebrate communities. In the present study, the data indicate that mud formed an important drought refuge for a limited number of benthic macroinvertebrate taxa or their resting stages. Pools of standing water within ponds supported only limited biota, so they were unlikely to form effective source populations for future re-establishment of diverse aquatic macroinvertebrate communities. Other taxa, were more likely to recolonize from other, more permanent waterbodies via flight or other dispersal mechanisms. In this case it is possible that the numerous and diverse waterbodies and watercourses within and around Bookham Common will continue to encourage re-establishment of many mobile macroinvertebrate species. Lower taxa numbers in October 1997 compared to 1993 suggest that recolonization of Isle of Wight and Western Hollow Ponds was still in progress at the time of most recent sampling. Low levels of similarity between taxa sampled in different years suggest that developing macroinvertebrate communities in ponds do not follow deterministic trajectories. Colonization mechanisms are largely stochastic and do not permit re-establishment of community compositions existing prior to perturbation. Similarity values calculated within taxa pre- and post-drought (1993 versus post-1995) in the Isle of Wight and Western Hollow Ponds show no identifiable trends and do not support the operation of deterministic recolonization pathways.

Although fish were removed from Isle of Wight Pond during 1995 (Swinney 1996), there is evidence to suggest that fish were illegally returned once water levels returned to normal, as fish fry were seen in 1997. This may partially explain why fish removal appears to have had no effect on the rate of macroinvertebrate colonization in Isle of Wight Pond. It is interesting that the fish parasitic leeches, *Piscicola geometra* and *Hemiclepsis marginata*, failed to recolonize the pond by May 1998, possibly because reintroduced fish were not infected.

Bookham Common Hollows Valley Ponds represent a class of pond that is long-established and supports diverse macroinvertebrate communities, but is also influenced by occasional perturbation caused by stochastic environmental processes. Although not true 'temporary ponds' they are subject to the same processes that affect them, albeit on a much more irregular and infrequent basis. Unlike true temporary ponds they do not possess specialist fauna adapted to persist through regular desiccation. Thus when drought occurs, recolonization processes are initiated that result in establishment of macroinvertebrate communities different from those existing prior to desiccation.

## Acknowledgements

The authors are grateful to the London Natural History Society for funding this study. We are also grateful to the School of Health, Biological and Environmental Sciences, Middlesex University for providing facilities for this work, and to Merle Gwyn for confirmation of Hemiptera identification.

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TABLE 1. Previous dry episodes in the Bookham Common Hollows Valley ponds.

| Year | Isle of Wight | Western Hollow | Eastern Hollow | Lower Eastern | Upper Eastern |
|---|---|---|---|---|---|
| 1887 | Present | Present | Present | Present | Present |
| 1934 | Dry | Dry | Dry | Dry | Dry |
| 1938 | Dry | Dry | Dry | Dry | Dry |
| 1944 | Dry | | | Dry | |
| 1947 | Dry | | | | |
| 1948 | Dry | | | Drained | |
| 1949 | Dry | | | Dry | Dry |
| 1950 | | | | | |
| 1952 | Dry | | | | Semi-dry |
| 1972 | Excavated | | | | |
| 1977 | | Excavated | Excavated | Excavated | |
| 1990 | Dry | Semi-dry | Semi-dry | Dry | Dry |
| 1995 | Semi-dry | Semi-dry | Semi-dry | Dry | Dry |

Key to descriptions: present (pond recorded as present, state unknown); dry (pond dried naturally); drained (pond drained deliberately); semi-dry (partially dry, standing water remaining); excavated (pond re-excavated or enlarged).

Information collected from: Harvey (1943), Castell (1945, 1949, 1950), Harrison (1945), Bensley (1952), Jones (1960), Radcliffe (1978), Beven and Radcliffe (1978), Ashby (1991).

TABLE 2. Macroinvertebrates from Bookham Common Hollows Valley Ponds samples collected 1993–1998. × indicates presence of taxon. Abundance was measured in 1997 and 1998.

**Key:** IW (Isle of Wight Pond); WH (Western Hollow Pond); EH (Eastern Hollow Pond); LE (Lower Eastern Pond); UE (Upper Eastern Pond). 93 (22 June 1993); 95 (13 September1995); 97 (11 October 1997); 97a (1 December 1997); 98 (2 May 1998).

TABLE 2a. Platyhelminthes and Annelida.

| **Pond** | IW | WH | IW | WH | EH | LE | UE | IW | WH | EH | LE | UE | IW | WH | EH | LE | UE | IW | WH | EH | LE | UE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | 93 | 93 | 95 | 95 | 95 | 95 | 95 | 97 | 97 | 97 | 97 | 97 | 97a | 97a | 97a | 97a | 97a | 98 | 98 | 98 | 98 | 98 |
| PLATYHELMINTHES | | | | | | | | | | | | | | | | | | | | | | |
| Turbellaria | | | | | | | | | | | | | | | | | | | | | | |
| *Dendrocoelom lacteum* | | | | | | | | | 1 | | 1 | | | | | | | | | | | |
| *Dugesia tigrina* | × | | | | | | | 3 | | | | | | | | | | | | | | |
| *Dugesia polychroa* | | | | | | | | | | 1 | 2 | | | | | | | | | | | |
| *Polycelis tenuis* | | × | | | | | | | | | | | | | | | | | | | | |
| ANNELIDA | | | | | | | | | | | | | | | | | | | | | | |
| Oligochaeta | | | | | | | | | | | | | | | | | | | | | | |
| *Aulodrilus pluriseta* | × | | | | | | | | | | | | | | | | | | | | | |
| *Stylaria lacustris* | × | × | | | | | | | | | | | | | | | | | | | | |
| Other oligochaete spp. | | | × | × | × | | × | 5 | 10 | 10 | 64 | 26 | | | | | | | | | | |
| *Chaetogaster limnei* | | | | × | | | | | | | | | | | | | | | | | | |
| Hirudinea | | | | | | | | | | | | | | | | | | | | | | |
| *Piscicola geometra* | × | × | | | | | | | | | | | | | | | | | | | | |
| *Theromyzon tessulatum* | | × | | | | | | | 5 | | | | | | | | | 3 | 1 | | | |
| *Hemiclepsis marginata* | × | × | | | | | | | | | | | | | | | | | | | | 6 |
| *Glossiphonia heteroclita* | | × | | | | | | | | | | | | | | | | | | | | 6 |
| *Glossiphonia complanata* | | | | | | | | | 4 | | | | | | | | | 3 | | | 3 | |
| *Helobdella stagnalis* | × | × | × | × | | | × | 1 | 12 | 3 | | | | | | | | 42 | | 1 | 20 | |
| *Erpobdella octoculata* | | × | × | × | | | | 4 | 5 | 1 | | | | | | | 2 | 1 | | 3 | | 2 |

NB: Non-hirudine Oligochaeta and Platyhelminthes not identified in 97a and 98.



TABLE 2b. Mollusca.

| **Pond** | IW | WH | IW | WH | EH | LE | UE | IW | WH | EH | LE | UE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | 93 | 93 | 95 | 95 | 95 | 95 | 95 | 97 | 97 | 97 | 97 | 97 |
| MOLLUSCA | | | | | | | | | | | | |
| Gastropoda | | | | | | | | | | | | |
| *Lymnaea auricularia* | | × | | | | | | 2 | 1 | | | |
| *Lymnaea palustris* | | × | | | | | | 1 | 7 | 8 | 24 | 12 |
| *Lymnaea peregra* | | × | | × | | | | | | 189 | 87 | 10 |
| *Lymnaea stagnalis* | | | | | | | | | 1 | 1 | 2 | |
| *Physa acuta* | | | | | | | | 38 | 21 | 24 | | |
| *Physa fontinalis* | × | × | | × | × | | | 88 | 72 | 223 | 1 | 2 |
| *Anisus vortex* | × | × | | | | | | | 144 | 563 | 458 | 10 |
| *Armiger crista* | | | | | × | | | | | 2 | 116 | |
| *Hippeutis complanatus* | | | | | | | | | 4 | | | |
| *Planorbarius corneus* | | | | × | | | | | | | 9 | |
| *Gyraulus albus* | | × | | | | | | | 35 | 116 | 25 | 14 |
| *Planorbis planorbis* | | | | | | | | | 10 | | 19 | |
| *Segmentina complanata* | | × | | | | | | | | | | |
| *Acroloxus lacustris* | × | × | | | | | | | 1 | 6 | 13 | |
| *Ancylus fluviatilis* | × | | | | | | | | | | | |
| *Potamopyrgus antipodarum* | × | | | | | | | | | | | |
| Bivalvia | | | | | | | | | | | | |
| *Pisidium* sp. | × | × | | | | | | 45 | 5 | | | |
| *Sphaerium* sp. | × | × | | | | | | 173 | 35 | 24 | 220 | 100 |

NB: Mollusca not identified in 97a and 98.

TABLE 2c. Non-insect Arthropoda.

| Pond | IW | WH | IW | WH | EH | LE | UE | IW | WH | EH | LE | UE | IW | WH | EH | LE | UE | IW | WH | EH | LE | UE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | 93 | 93 | 95 | 95 | 95 | 95 | 95 | 97 | 97 | 97 | 97 | 97 | 97a | 97a | 97a | 97a | 97a | 98 | 98 | 98 | 98 | 98 |
| CHELICERATA | | | | | | | | | | | | | | | | | | | | | | |
| Arachnida | | | | | | | | | | | | | | | | | | | | | | |
| *Piona* sp. | × | | | | | | | | | | | | | | | | | | | | | |
| Other mite spp. | × | | × | | | | | | | | | | | | | | | | | | | |
| CRUSTACEA | | | | | | | | | | | | | | | | | | | | | | |
| Branchiopoda | | | | | | | | | | | | | | | | | | | | | | |
| *Daphnia pulex* | | | × | × | × | | | | | | | | | | | | | | | | | |
| Ostracoda | | | | × | × | | × | | | | | | | | | | | | | | | |
| Branchiura | | | | | | | | | | | | | | | | | | | | | | |
| *Argulus foliaceus* | × | | | | | | | | | | | | | | | | | | | | | |
| Malacostraca | | | | | | | | | | | | | | | | | | | | | | |
| *Asellus aquaticus* | × | × | | | | | | | 43 | 22 | 9 | 32 | 5 | 9 | 3 | 3 | | 35 | 43 | 8 | 54 | |
| *Gammarus pulex* | | | | | | | | | | | | | | | | | | 1 | | | | |
| *Crangonyx gracilis* | × | × | | | | | | 271 | 594 | 576 | 638 | 173 | 37 | 52 | 57 | 18 | 43 | 63 | 160 | | 374 | 567 |



TABLE 2d. Odonata and Ephemeroptera.

| **Pond** | IW | WH | IW | WH | EH | LE | UE | IW | WH | EH | LE | UE | IW | WH | EH | LE | UE | IW | WH | EH | LE | UE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | 93 | 93 | 95 | 95 | 95 | 95 | 95 | 97 | 97 | 97 | 97 | 97 | 97a | 97a | 97a | 97a | 97a | 98 | 98 | 98 | 98 | 98 |
| INSECTA | | | | | | | | | | | | | | | | | | | | | | |
| Odonata | | | | | | | | | | | | | | | | | | | | | | |
| *Erythromma najas* | | | | | | | | | | | 1 | | | | | | | | | | | |
| *Coenagrion* spp. | | | | | | | | | | | | | 1 | 6 | 2 | 2 | | | | | | |
| *Coenagrion puella* | × | × | | | | | | 6 | 8 | 30 | 76 | | | | | | | | | | | 2 |
| *Enallagma cyathigerum* | | | | | | | | | | | | | | | | 4 | | | | | | |
| *Ishnura elegans* | × | | | | | | | | | | | | | | | | 6 | | | | | |
| *Lestes sponsa* | | | | | | | | | | | | | | | | | | | 7 | | | |
| *Aeshna cyanea* | | × | | | | | | | | | 6 | | | | | | | | | | | |
| *Aeshna mixta* | × | × | | | | | | | | | 1 | | | | | | | 3 | 1 | | | 1 |
| *Anax imperator* | | | | | | | | | | 3 | | | | | | | | | | | | |
| *Libellula depressa* | | | | | | | | | | | 4 | | | | | | | | | | | |
| *Libellula quadrimaculata* | | | | | | | | | | | | | | | | | | | 1 | | | |
| *Sympetrum* sp. | | | | | | | | | | | 24 | | | | | | | | | | | |
| *Sympetrum striolatum* | | | | | | | | | | | | | | | | | | 1 | 4 | | | |
| Ephemeroptera | | | | | | | | | | | | | | | | | | | | | | |
| *Cloeon dipterum* | × | × | | | | | | 12 | 33 | 152 | 949 | 2 | | 3 | 7 | 1 | | 3 | 47 | | 6 | 9 |
| *Cloeon simile* | | × | | | | | | | | | | | | | | | | | | | | |
| *Caenis robusta* | × | × | | | | | | 1 | | | 2 | | | | | | | | | | | |

TABLE 2e. Hemiptera.

| Pond | IW | WH | IW | WH | EH | LE | UE | IW | WH | EH | LE | UE | IW | WH | EH | LE | UE | IW | WH | EH | LE | UE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | 93 | 93 | 95 | 95 | 95 | 95 | 95 | 97 | 97 | 97 | 97 | 97 | 97a | 97a | 97a | 97a | 97a | 98 | 98 | 98 | 98 | 98 |
| Hemiptera | | | | | | | | | | | | | | | | | | | | | | |
| *Hydrometra* nymph | | | | | | | | | | | | | | | | | | | | | 1 | 1 |
| *Hydrometra stagnorum* | | × | | | | | | | | 1 | | | | | | | | | | | | |
| *Gerris* nymph | × | × | | | | | | | | | | | | | | | | 1 | 3 | 11 | 1 | 10 |
| *Gerris lacustris* | | | | | | | | 1 | | 1 | | | | | 1 | | | | | | | |
| *Nepa cinerea* | × | × | | | | | | 1 | | | | | | | | | | | | | | |
| *Ranatra linearis* | | | | | | | | | | | | | | | | | | | | | | 1 |
| *Ilyocoris cimicoides* | × | × | | | | | | | | | 1 | | | | | | | | | | 2 | 1 |
| *Notonecta* nymph | | × | | | | | | | | | | | | | | | | 4 | 17 | 40 | 8 | 2 |
| *Notonecta glauca* | | | | | | | | 3 | | 4 | 8 | | | | | | | | 2 | | | |
| *Notonecta marmorea viridis* | | | | | | | | 4 | 1 | 12 | | | | 1 | 6 | | 4 | | | | 1 | |
| *Plea leachi* | | × | | | | | | | 10 | 7 | 49 | | | 7 | | 2 | | | 9 | 7 | 4 | 1 |
| *Micronecta scholtzi* | × | | × | | × | | | | | | | | | | | | | | | | | |
| *Cymatia coleoptrata* | | | | | | | | 24 | 1 | | | | | | | | 2 | | | | | |
| *Callicorixa praeusta* | | × | | | | | | | 3 | | | 4 | 1 | | | 2 | | | | | | |
| *Corixa punctata* | | × | | | | | | 1 | 2 | 2 | 8 | | | | | 4 | | | 1 | | | |
| *Hesperocorixa linnaei* | | | | | | | | | | | 1 | | | | | | | | | | | |
| *Hesperocorixa sahlbergi* | | | | | | | | 1 | | | 4 | | | | | | | 1 | | | | 1 |
| *Hesperocorixa moesta* | | | | | | | | | | | 11 | | | 1 | | | | | | | | |
| *Sigara* spp. | | | | | | | | | | | | | | | | 20 | 9 | | | | | |
| *Sigara dorsalis* | | × | | | | | | 2 | 3 | | 1 | | | | | | | | | | | |
| *Sigara distincta* | | | | | | | | | | 8 | | | | | | | | | | | | |
| *Sigara falleni* | × | × | | | | | | 24 | | | | | | | | | | | | 19 | | 35 |
| *Sigara fossarum* | | × | | | | | | | | 4 | | | | | | | | | | | | |
| *Sigara lateralis* | | | × | | × | | | 5 | | | | | | | | | 1 | | | | | |
| *Sigara stagnalis* | | | | | | | | | | | | | | | | | | | | | | |
| Notonectid nymphs | × | | | | | | | | | | | | | | | | | | | | | |
| Micronectid nymphs | | | | | | | | | | | | | | | | | | | | | | |
| Corixid nymphs | × | × | | | × | | × | 5 | | | | 1 | | | | | | | 11 | 22 | 2 | 62 |



TABLE 2f. Megaloptera, Trichoptera and Diptera.

| Pond | IW | WH | IW | WH | EH | LE | UE | IW | WH | EH | LE | UE | IW | WH | EH | LE | UE | IW | WH | EH | LE | UE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | 93 | 93 | 95 | 95 | 95 | 95 | 95 | 97 | 97 | 97 | 97 | 97 | 97a | 97a | 97a | 97a | 97a | 98 | 98 | 98 | 98 | 98 |
| Megaloptera | | | | | | | | | | | | | | | | | | | | | | |
| *Sialis lutaria* | × | × | × | × | × | | | | | 3 | | | | | | | | | | | 2 | 1 |
| Trichoptera | | | | | | | | | | | | | | | | | | | | | | |
| Phryganeidae | | | | | | | | | | | | | | | | | | | | | | 1 |
| *Glyphotaelius pellucidus* | | | | | | | | | 4 | 2 | | | 2 | 12 | 10 | 9 | 5 | 1 | | | | |
| *Beraea pullata* | | | | | | | | 1 | | | | | | | | | | | | | | |
| *Mystacides longicornis* | × | | | | | | | | | | | | | | | | | | | | | |
| *Athripsodes cinereus* | | × | | | | | | | | | | | | | | | | | | | | |
| Limnephilid early instar | × | | | | | | | 2 | 7 | 29 | 1 | 2 | | | | | | | | | | |
| Diptera | | | | | | | | | | | | | | | | | | | | | | |
| *Anopheles* larvae | × | × | | | | | | | | | | | | | | | | | | | | |
| Ceratopogonidae larvae | | × | × | × | × | | × | | | | | | | | | | | 1 | | | 1 | |
| *Chaoborus* larvae | | × | | | | | | | 45 | 27 | 134 | 1 | | | 1 | | | 2 | | | | |
| Chironomid larvae | × | × | × | | × | | × | 12 | 9 | 17 | 66 | 14 | 3 | 1 | | 3 | | 31 | 57 | 7 | 8 | |
| Chironomid pupae | | | | | | | | 1 | | 3 | 1 | 3 | | | | | | | | | | |
| Culicidae larvae | | | | | | | | | | | 1 | 1 | | | | | | 1 | 12 | | | |
| Dixidae larvae | | | | | | | | | | 1 | | | | | | | | | | | | |
| Psychodidae larvae | | | | | | | | 3 | | 1 | 4 | | | | | | | 1 | | | | |
| Tipulidae larvae | | | × | × | × | | × | | 3 | | 13 | | | | 1 | | | 1 | 1 | | 1 | |
| Ptychopteridae larvae | × | | | | | | | | | 24 | 1 | 9 | | | | | | 10 | 3 | | | |
| Stratiomyidae larvae | × | | | | | | | | | | | | | 1 | | 1 | | 1 | 1 | | | |
| Tabanidae | | | | | | | | | | | | | | | | 3 | | | | | | |
| Strymonidae larvae | × | | | | | | | | | | 1 | | | | | | | | | | | |

TABLE 2g. Coleoptera (Hygrobiidae, Haliplidae, Noteridae and Dytiscidae).

| Pond | IW | WH | IW | WH | EH | LE | UE | IW | WH | EH | LE | UE | IW | WH | EH | LE | UE | IW | WH | EH | LE | UE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | 93 | 93 | 95 | 95 | 95 | 95 | 95 | 97 | 97 | 97 | 97 | 97 | 97a | 97a | 97a | 97a | 97a | 98 | 98 | 98 | 98 | 98 |
| Coleoptera | | | | | | | | | | | | | | | | | | | | | | |
| *Hygrobia hermanni* | | | | | | | | | | 1 | 3 | | | | | | | | | 1 | 3 | |
| *Hygrobia hermanni* larvae | | | | | | | | | | | | | | | | | | | 2 | 4 | | |
| *Haliplus confinis* | | | | | | | | | | | | | | | | | | | | | | 10 |
| *Haliplus flavicollis* | | | | | | | | 1 | | 1 | | | | | | | | | | 1 | | |
| *Haliplus lineatocollis* | | | | | | | | | | | | | | | | | | | | | 1 | |
| *Haliplus mucronatus* | | | | | | | | | | | | | | | | | | | | | 1 | 5 |
| *Haliplus ruficollis* | | × | | | | | | | | 2 | 1 | | | | | | | | 3 | 1 | 1 | |
| *H. ruficollis* group | | | | | | | | | 5 | | | | | | | | | | | | | |
| *Haliplus* larvae | | | | | | | | 1 | | 1 | 16 | | | | | | | | | 1 | | 1 |
| *Peltodytes caesus* | | | | | | | | | | | 1 | | | | | | | | | | | |
| *Noterus clavicornis* | | × | | | | | | | 1 | 2 | 4 | | | | | | | | | 4 | 4 | 1 |
| *Acilius sulcatus* | | | | | | | | | 1 | | 1 | | | | | | | | | | | |
| *Hydaticus seminiger* | | | | | | | | | | | 2 | | | | | | | | | | | |
| *Rhantus suturalis* | | | | | | | | | | 3 | | | | | | | | | | | | |
| *Agabus sturmii* | | × | | | | | | | | | | | | | | | | 1 | 1 | | | |
| *Copelatus haemorrhoidalis* | | | | | | | | | | | 1 | | | | | | | | | | | |
| *Hydroporus angustatus* | | | | | | | | | | 1 | | | | | | | | | | 1 | | |
| *Hydroporus palustris* | | × | | | | | | | 1 | | 1 | | | | | | | | 1 | | | |
| *Hyphydrus ovatus* | | | | | | | | | | | 1 | | | | | | | | | | | |
| *Hygrotus inaequalis* | | × | | × | | | | | | 1 | 3 | | | | | | | | 1 | | | 4 |
| Dytiscid larvae | × | × | | | | | | 3 | 4 | 2 | 8 | 1 | 3 | 2 | | | | 2 | 6 | | | 3 |
| Colymbetinae larvae | × | | | | | | | | | | | | | | | | | | | | | |





TABLE 2h. Coleoptera (Hydrophilidae, Hydraenidae and Dryopidae).

| Pond | IW | WH | IW | WH | EH | LE | UE | IW | WH | EH | LE | UE | IW | WH | EH | LE | UE | IW | WH | EH | LE | UE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | 93 | 93 | 95 | 95 | 95 | 95 | 95 | 97 | 97 | 97 | 97 | 97 | 97a | 97a | 97a | 97a | 97a | 98 | 98 | 98 | 98 | 98 |
| Coleoptera | | | | | | | | | | | | | | | | | | | | | | |
| *Helophorus brevipalpis* | × | | | | | | | | | | | 1 | | | | 1 | | 2 | | | 1 | 7 |
| *Helophorus grandis* | | | | | | | | | | 2 | 1 | | | | | | | | | | | |
| *Helophorus obscurus* | | | | | | | | 1 | | | | | | | | | | | | | | |
| *Cercyon convexiusculus* | | | | | | | | | | | | | | | | | | 3 | | | | |
| *Hydrochus angustatus* | × | | | | | | | | | | | | | | | | | | 1 | | | 4 |
| *Hydrobius fuscipes* | | | | | | | | | | 1 | | | | | | | | | | | | |
| *Enochrus coarctatus* | | | | | | | | | | | 2 | | | | | | | | 2 | | | |
| *Helochares lividus* | | | | | | | | | | | | | | | | | | | | 1 | 2 | 2 |
| *Cymbiodyta marginella* | | | | | | | | | | | 1 | | | | | | | | | | | |
| *Laccobius bipunctatus* | | | | | | | | 1 | | | | | | | | | | | | | | 1 |
| *Laccobius minutus* | × | | | | | | | | | | | | | | | | | | | | | |
| *Anacaena globulus* | | | | | | | | | | | | | | | | | | 2 | | | 2 | 2 |
| *Anacaena limbata* | × | | | | | | | 9 | | 2 | | 3 | | | | | | 1 | | | 1 | |
| *Limnebius truncatellus* | | | | | | | | | 1 | | | | | | | | | | | | | |
| *Ochthebius minimus* | | | | | | | | | | | 4 | | | | | | 1 | | | | | 3 |
| *Dryops* sp. | | | | | | | | | | | | | | | | | | | | | | 1 |
| Hydrophilidae larvae | | | | | | | | | | | | | | | | | | 5 | 5 | 1 | | |

TABLE 2i. Numbers of individuals and taxa from Bookham Common Hollows Valley ponds samples 1993–1998.

| Pond | IW | WH | IW | WH | EH | LE | UE | IW | WH | EH | LE | UE | IW | WH | EH | LE | UE | IW | WH | EH | LE | UE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | 93 | 93 | 95 | 95 | 95 | 95 | 95 | 97 | 97 | 97 | 97 | 97 | 97a | 97a | 97a | 97a | 97a | 98 | 98 | 98 | 98 | 98 |
| Total individuals | | | | | | | | 756 | 1,152 | 2,119 | 3,105 | 421 | 68 | 116 | 103 | 70 | 73 | 370 | 569 | 134 | 577 | 755 |
| Total taxa | 44 | 50 | 11 | 13 | 12 | 0 | 8 | 36 | 39 | 48 | 57 | 21 | 9 | 13 | 11 | 13 | 9 | 30 | 31 | 19 | 27 | 32 |

TABLE 3. Jaccard's Coefficient of Similarity between macroinvertebrate taxa present in samples from Bookham Common Hollows Valley ponds 1993–1997. Values of 0 ≤ 0.3 indicate 'dissimilar', > 0.3 ≤ 0.6 'similar'; > 0.6 'replicate sample'.

**Key:** IW Isle of Wight Pond; WH Western Hollow Pond; EH Eastern Hollow Pond; LE Lower Eastern Pond; UE Upper Eastern Pond. 93 (22 June 1993); 95 (13 September1995); 97 (11 October 1997).

| | IW 1993 | WH 1993 | IW 1995 | WH 1995 | EH 1995 | UE 1995 | IW 1997 | WH 1997 | EH 1997 | LE 1997 |
|---|---|---|---|---|---|---|---|---|---|---|
| IW 93 | 1 | | | | | | | | | |
| WH 93 | 0.35 | 1 | | | | | | | | |
| IW 95 | 0.10 | 0.09 | 1 | | | | | | | |
| WH 95 | 0.06 | 0.13 | 0.41 | 1 | | | | | | |
| EH 95 | 0.10 | 0.09 | 0.57 | 0.41 | 1 | | | | | |
| UE 95 | 0.04 | 0.06 | 0.29 | 0.25 | 0.50 | 1 | | | | |
| IW 97 | 0.25 | 0.27 | 0.12 | 0.09 | 0.12 | 0.08 | 1 | | | |
| WH 97 | 0.19 | 0.35 | 0.11 | 0.11 | 0.09 | 0.07 | 0.34 | 1 | | |
| EH 97 | 0.20 | 0.32 | 0.09 | 0.13 | 0.07 | 0.06 | 0.36 | 0.38 | 1 | |
| LE 97 | 0.18 | 0.31 | 0.05 | 0.10 | 0.06 | 0.07 | 0.24 | 0.36 | 0.43 | 1 |
| UE 97 | 0.26 | 0.25 | 0.07 | 0.10 | 0.14 | 0.12 | 0.27 | 0.30 | 0.33 | 0.28 |



TABLE 4. Invertebrate taxa and percentage organic matter in mud samples from Bookham Common Hollows Valley ponds during drought conditions in September 1995.
× indicates presence of taxon, n.s. no sample taken.

| **Invertebrate taxa** | **Isle of Wight** | | **Western Hollow** | | **Eastern Hollow** | | **Lower Eastern** | | **Upper Eastern** | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Wet** | **Dry** | **Wet** | **Dry** | **Wet** | **Dry** | **Wet** | **Dry** | **Wet** | **Dry** |
| Oligochaeta | | | | | × | | | | × | |
| Leech cocoons | | | × | | | | | | × | |
| *Armiger crista* | | | | | × | | | | | |
| Cladoceran ephippia | | | | | × | × | | | × | × |
| Ostracoda | | | | | | | | | × | |
| Corixid nymphs | | | | | | | | | × | |
| Chironomid larvae | | | | | | | | | × | |
| Ceratopogonid larvae | | × | | × | | | | | × | |
| Tipulid larvae | × | | | | × | | | | × | |
| Total no. of taxa | 1 | 1 | 1 | 1 | 4 | 1 | n.s. | 0 | 8 | 1 |
| % organic matter in pond mud | 1.6 | | 5.2 | | 8.3 | | 11.2 | | 13.0 | |