T04052 b1/3

Institute of Freshwater Ecology

Natural Environment Research Council

STRATEGIC ECOSYSTEM STUDIES OF LARGE
SLOW FLOWING, LOWLAND RIVERS

Progress Report: April 1990 to October 1990

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Report Date: October 1990
Report to NRA
IFE Report Number ERG/T04052b1/3
TFS Project Number T04052b1

1. Introduction

This interim report summarises some of the data relating to zooplankton and epiphytic invertebrates and their macrophyte substrata that were obtained from the Great Ouse during 1989 and 1990. Data on algal periphyton and phytoplankton, as well as larval and juvenile fish and their diets have been obtained over a similar period. Research on turbidity, its causes and impact on growth of algae and macrophytes is the subject of a separate report. The programme of research on fish populations is not funded by NRA, but the important conclusions from this study, in so far as they are relevant to the 2 NRA funded (or part funded) projects will be incorporated into the final report on "Strategic ecosystem studies" which is due in April 1991.

The preceding progress report in this series, which covered the period from October, 1989 to April 1990, presented some of the data arising from the 1989 sampling programme. During 1989 samples of zooplankton were taken from 5 sites. Three of these were on the main river, above and below Godmanchester lock and further downstream close to the "Pike and Eel" public house near Needingworth. The fourth site was on Lees Brook, a back channel close to the upstream Godmanchester main river site, and the fifth was the "Pike and Eel" marina at Needingworth. Samples of the fauna associated with leaves of the yellow water lily, *Nuphar lutea* were also taken at all sites except for the marina. In 1990 sampling of **N.lutea** has been confined to Lees Brook and the adjacent main river, while plankton sampling has continued at these 2 sites and in the marina.

2. Results

The following are examples, only, of the data that are being accumulated and which will be reported on fully in the final report on this project which is due in April of next year. That report will also relate the results of this study to those of the other 2 main projects being carried out concurrently.

2.1 Macrophytes

Surveys of channel profiles, bottom deposits and macrophyte distribution at several sites on the Great Ouse will be reported in some detail in the final report of the related project on turbidity and plant growth in the river. However some of the results of these surveys are relevant in a broader ecological context and are therefore briefly reported below.

In the Great Ouse the main channel is too deep and the water too turbid to permit much primary production to take place on most of the river bed where there is insufficient light for growth of either macrophytes or attached algae. Consequently, higher plants that are able to grow in marginal and other shallower areas are potentially very important substrata for the development of attached algal populations and invertebrates. They are also of importance in providing refugia for fish, especially larval and juvenile fish, from high current velocities. However, because of the needs of land drainage and navigation, growth of macrophytes is often very restricted by the shape of the channelised river bed and by dredging and weed-cutting operations.

Mapping of macrophyte distribution was carried out by means of a series of transects on 5 occasions between September, 1988 and September 1990, on 3 main river reaches and 3 side-channel reaches. In the main river transects were spaced at 20 m intervals and in side channels at 10 m intervals. Presence of macrophyte species was recorded at 1 m intervals along each transect.

In terms of the extent of river bed occupied, *Nuphar lutea*, the Yellow water lily, is the most important species of macrophyte in the Great Ouse system and it is also common in other large lowland rivers. This plant produces 2 types of leaf; rather thick, rigid, floating leaves and thin, delicate submerged leaves. In the Great Ouse, although the floating leaves are most conspicuous it is the submerged leaves that provide the greatest surface area for the development of periphyton. In situations where visibility was restricted by the depth and / or turbidity of the water the presence or absence of submerged leaves was determined by using a grapnel.

The growing season of *N. lutea* extends from April to October and area of cover was assessed on 4 sampling dates from September 1988 to September 1990 (Figure 1) The late summer, early autumn dates represent the period of maximum development of this plant. These indicate an increase in the area covered by *N. lutea* from about 5% in 1988 to approaching 10% in 1990. It seems likely that the severe floods of the winter of 1987/88 dislodged a proportion of the rhizomes of this plant with a gradual expansion in area resulting from the much more stable conditions that pertained during the ensuing very dry years.

The percentage cover of *Elodea* in the main river at Godmanchester was assessed over the same period of time (Figure

2). This species did not occur at all in Lees Brook where there are no suitable shallow areas for it to develop. However, an extensive shallow area of the main river near Godmanchester was extensively occupied by this and a number of other submerged macrophyte species in 1989. Up to 30% of the river area in this particular reach was occupied by *Elodea*. Such an extensive shallow region is unusual in the middle reaches of the main Great Ouse, although some of the shallower side streams, such as Cooke's Backwater also have the potential to support an extensive and diverse submerged flora. The lack of *Elodea* in 1988 is probably attributable to the relatively high current velocities during the spring and preceding winter which would have extensively scoured the soft marginal sediments in which this species has its roots. The mild winter and low discharge regime of the following year, coupled with the relatively clear water that prevailed over much of 1989, would on the other hand have favoured the development of submerged species. The absence of any extensive development of submerged plants in 1990 is more puzzling, but is probably related to the much more turbid conditions in the spring and early summer, caused by high phytoplankton numbers that persisted for a much longer time than was the case in 1989.

Large numbers of larval and juvenile fish were associated with *Elodea* during the period when it was abundant and the lack of this plant and other submerged plants that provide abundant shelter for both young fish and their food organisms is likely to be an important factor influencing early fish survival.

2.2 Invertebrate fauna of *N. lutea*

During 1989 the fauna of *N. lutea* was investigated at the 4 sites described above. Differences between sites were relatively slight and in 1990 only Lees Brook and the adjacent main river were investigated.

Leaf surface area varied substantially over the year and there were also significant differences in leaf size between sites. This may be seen by reference to Figures 3 and 4 which respectively show the mean area of sampled leaves during 1989 for Lees Brook and the adjacent Main River. Whereas, in the main river there was a steady decline in mean leaf area over the sampling period, the mean leaf area in Lees Brook tended to increase during the early part of the growing season and declined thereafter.

The principal components of the fauna of *Nuphar* leaves are Copepoda, Cladocera and Chironomidae, all of which are important constituents of the diet of juvenile cyprinids. Rotifera are also common but were not encountered in most of the samples that have been analysed since only the fauna retained by a sieve of 250 um has been examined so far. Other groups of invertebrates that occur more sporadically or in low numbers include Gastropoda, Naididae and Hydra.

As an illustration of the data that will be presented fully in the final report Figures 5 and 6 respectively compare the numbers of Cladocera and chironomid larvae associated with *N.lutea* during 1989 and 1990 in the main River Ouse at Godmanchester.

In 1989 similarly low numbers of Cladocera were recorded on

N. lutea at all of the sites that were investigated. The much higher densities in 1990 were also evident in Lees Brook. A similar contrast between the 2 years was also shown in the numbers of Copepoda on this plant, but, as Figure 6 indicates chironomid numbers were similar in the 2 years.

Both the main river at Godmanchester and Lees Brook had peak numbers of Cladocera in early summer and in autumn of 1989 whereas in 1990 there was an extended period, during which numbers were 1 or 2 orders of magnitude greater than in the previous year. Although numbers were also higher in the plankton these were of different species. *Bosmina* and *Daphnia* predominated in the plankton samples while on the lily leaves the dominant genera were *Chydorus* and *Pleuroxus*.

The peak in numbers of chironomids in 1989 was recorded between June and mid-July, in the main river and Lees Brook respectively. These were followed in the autumn by a further rise in numbers in both situations. In the following year there were 2 well defined peaks in numbers in both the main river and Lees Brook, during weeks at the end of May and end of June respectively. Numbers were generally higher in the main river than in Lees Brook.

2.3 Zooplankton samples.

The zooplankton is numerically dominated by Rotifera, with relatively low numbers of Copepoda and Cladocera. The low number of Rotifera in 1989 is in marked contrast to the relatively high densities that persisted for much of the spring and early summer of 1990 (Figure 7). The low densities shown in Figure 7 were repeated at all of the river sites.

3. Discussion

In terms of weather, 1989 and 1990 were very similar. Both were warm and dry with discharge continuously low from early in 1989 through to the summer of 1990. The marked differences between the 2 years in populations of certain plants and animals was not therefore expected.

Rotifers are the dominant item in the diet of recently hatched roach. During the early days after hatching only very small organisms are capable of being ingested and it is possible that the availability of rotifers at this critical time is an important factor influencing their early growth and survival. Investigations on other larval cyprinids, carried out in hatcheries has indicated that maximum intake of rotifers only occurs at densities greater than about 1500 l^{-1}. At densities less than this consumption rapidly declines. In 1989 densities only exceeded this, apparently critical, level for a very short period. This coincided with the time when roach were hatching but before the appearance of young bream. In 1990 densities of rotifers were above this critical density for most of the late spring and early summer. It is interesting to note that in 1989 numbers of young bream were found with empty guts, perhaps reflecting a scarcity of suitable food items.

Dietary studies of young roach in the Great Ouse also indicate a shift in feeding behaviour later in the summer from predominantly plankton feeding to grazing of aufwuchs, with rotifers becoming less important and Cladocera, Copepoda and other invertebrates becoming correspondingly more important. The much greater abundance of Copepoda and Cladocera on *N.lutea* in

1990 may also have aided survival during the transitional period between reliance on very small planktonic animals and progression to feeding on macro-invertebrates such as Chironomidae. If feeding conditions were limiting in 1989 it would be predicted that 1990 will have been a better year for cyprinid, especially bream, recruitment in the Great Ouse than 1989 in spite of both being very warm years with little disruption of populations through periodically high current velocities.

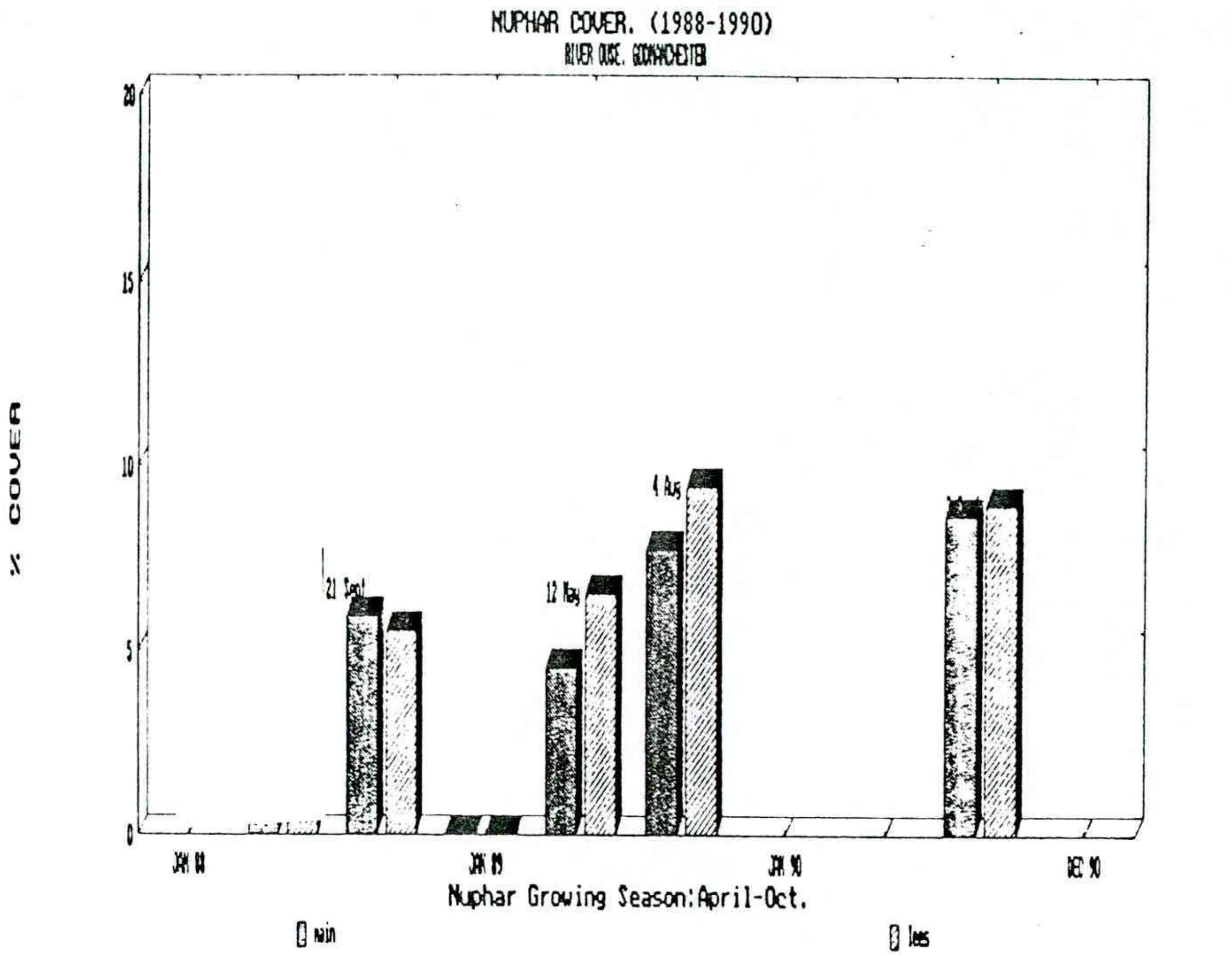

Figure 1

Proportion of river bed in the Great Ouse at Godmanchester and in Lees Brook covered by *Nuphar lutea* in September 1988, 1989 & 1990.

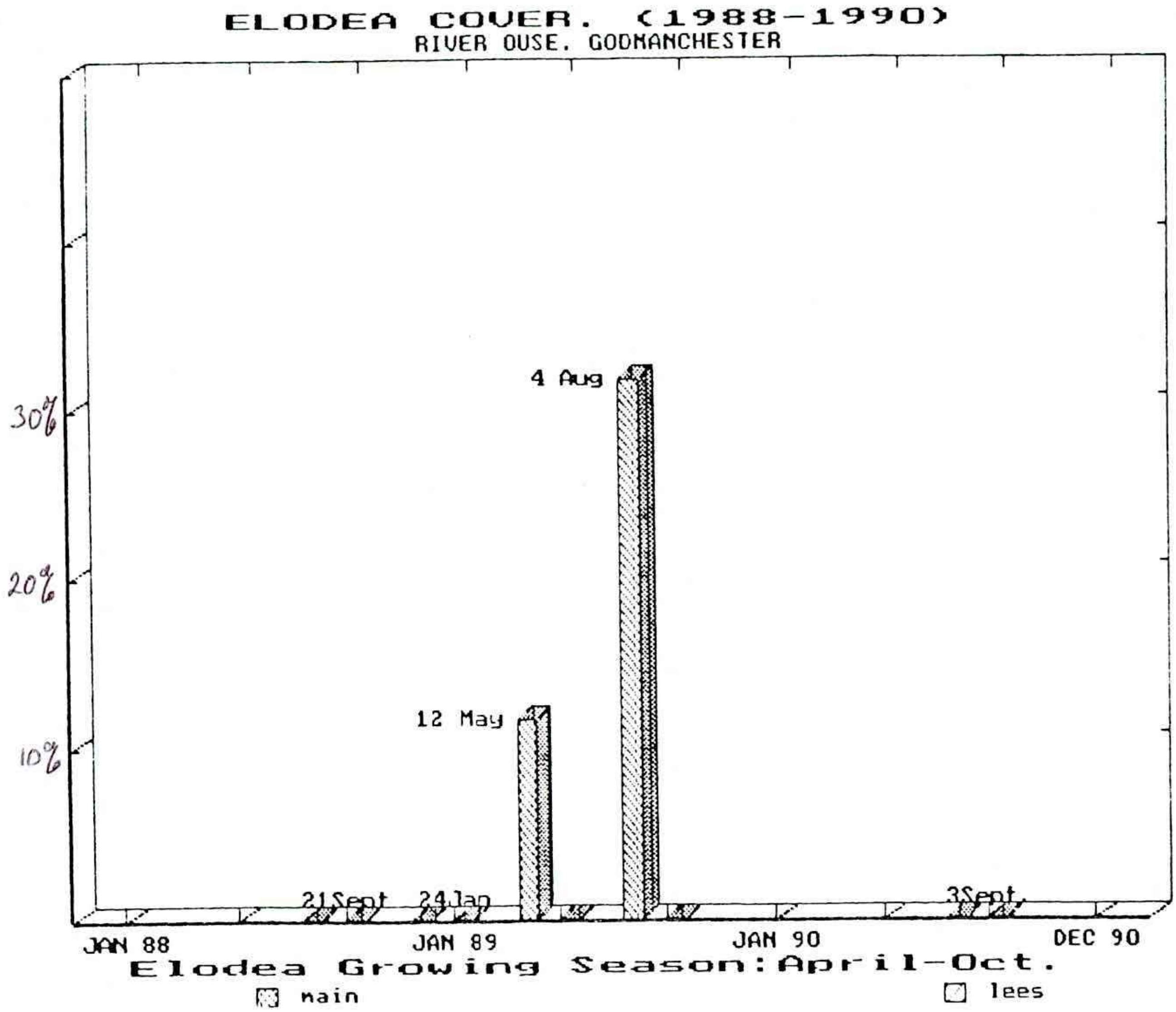

Figure 2

Proportion of river bed in the Great Ouse at Godmanchester Occupied by *Elodea* in 1988, 1989 & 1990.

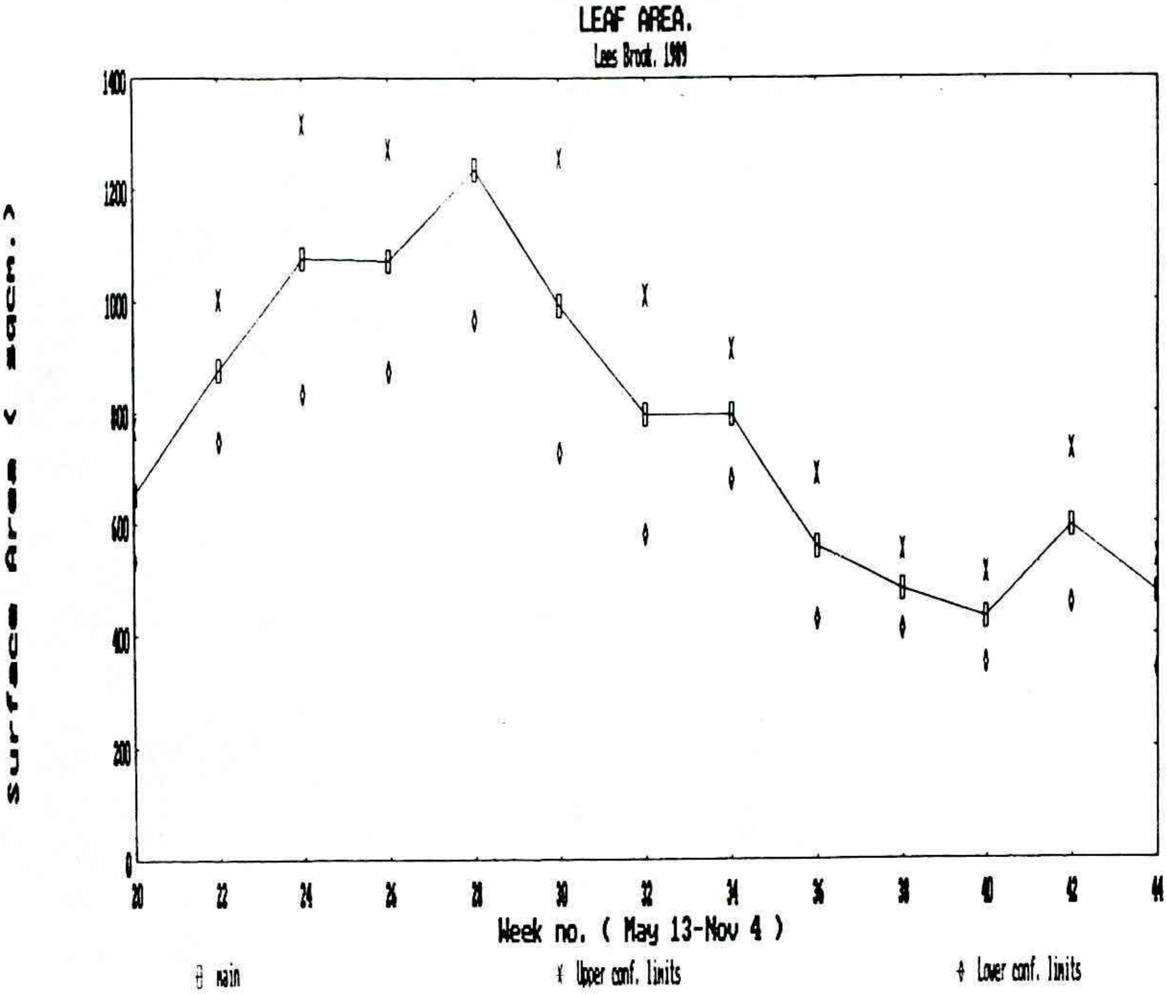

Figure 3

Mean surface area of sampled *Nuphar lutea* leaves from Lees Brook, with 95% confidence limits.

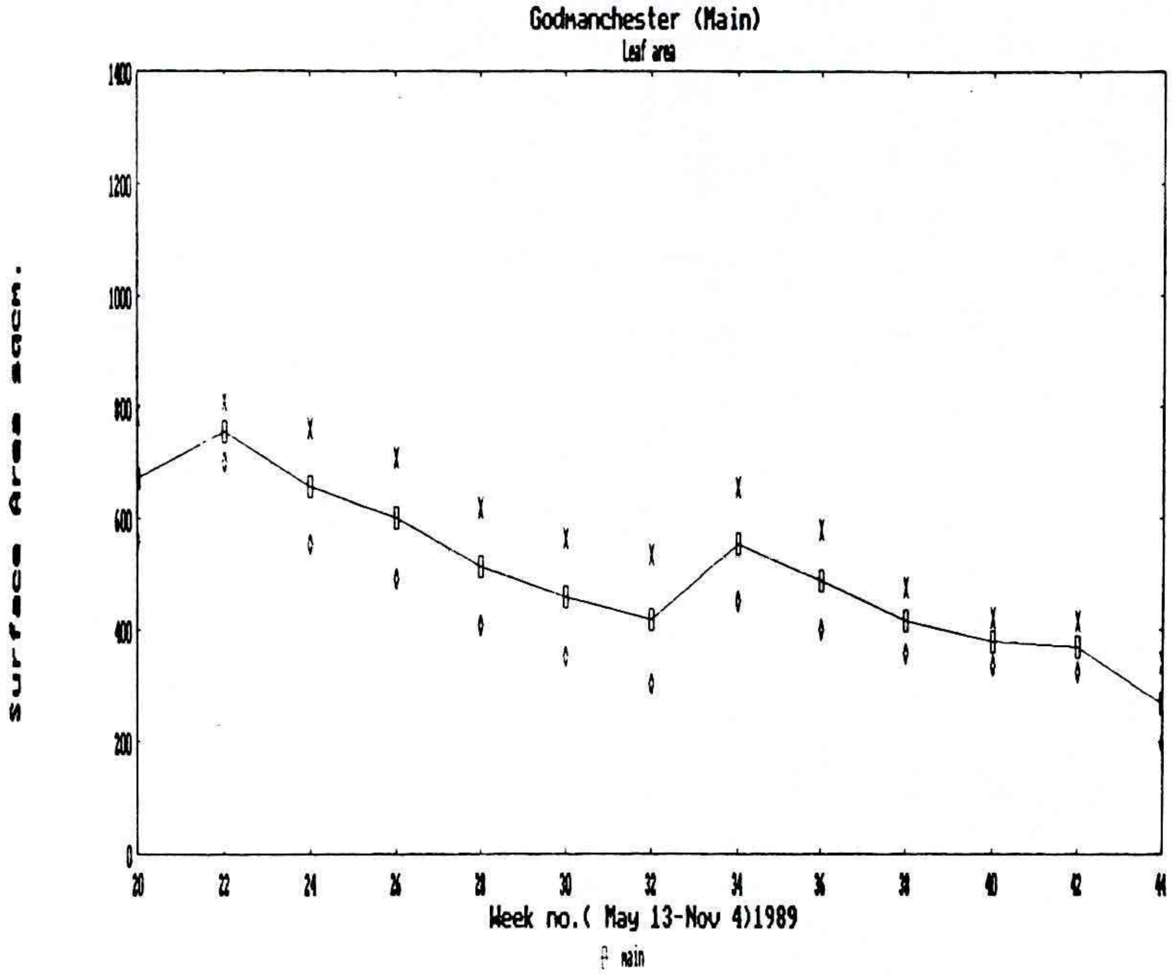

Figure 4

Mean surface area of sampled *Nuphar lutea* leaves from the main river at Godmanchester, with 95% confidence limits.

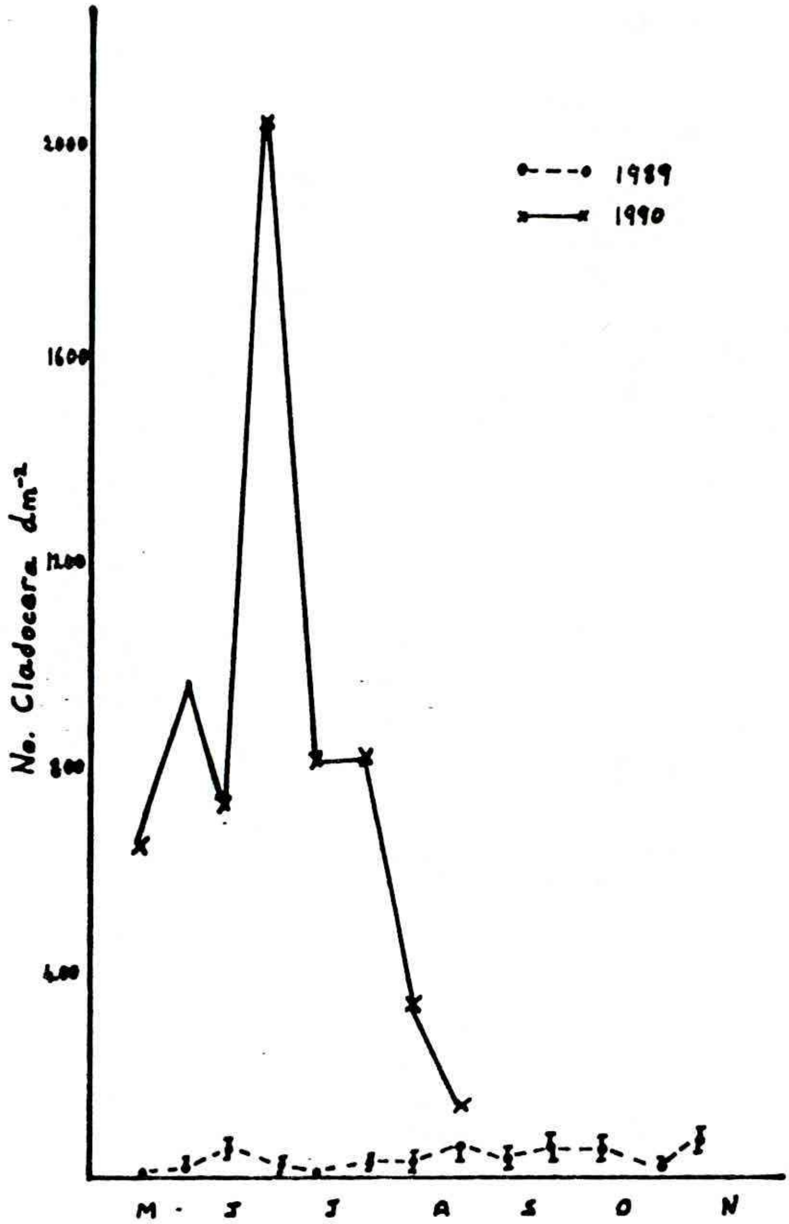

Figure 5

Mean density of Cladocera on *N.lutea* leaves from the main river at Godmanchester in 1989 and 1990.

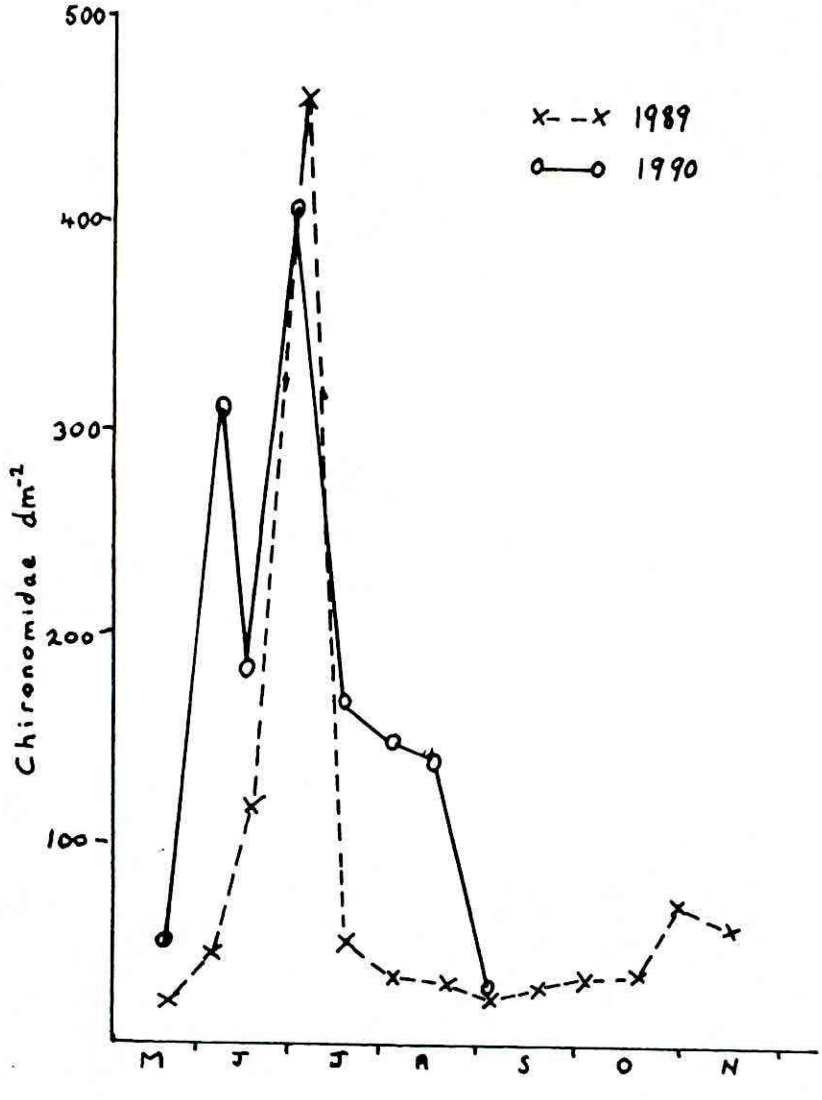

Figure 6

Mean density of Chironomidae on *N. lutea* leaves from the main river at Godmanchester in 1989 and 1990.

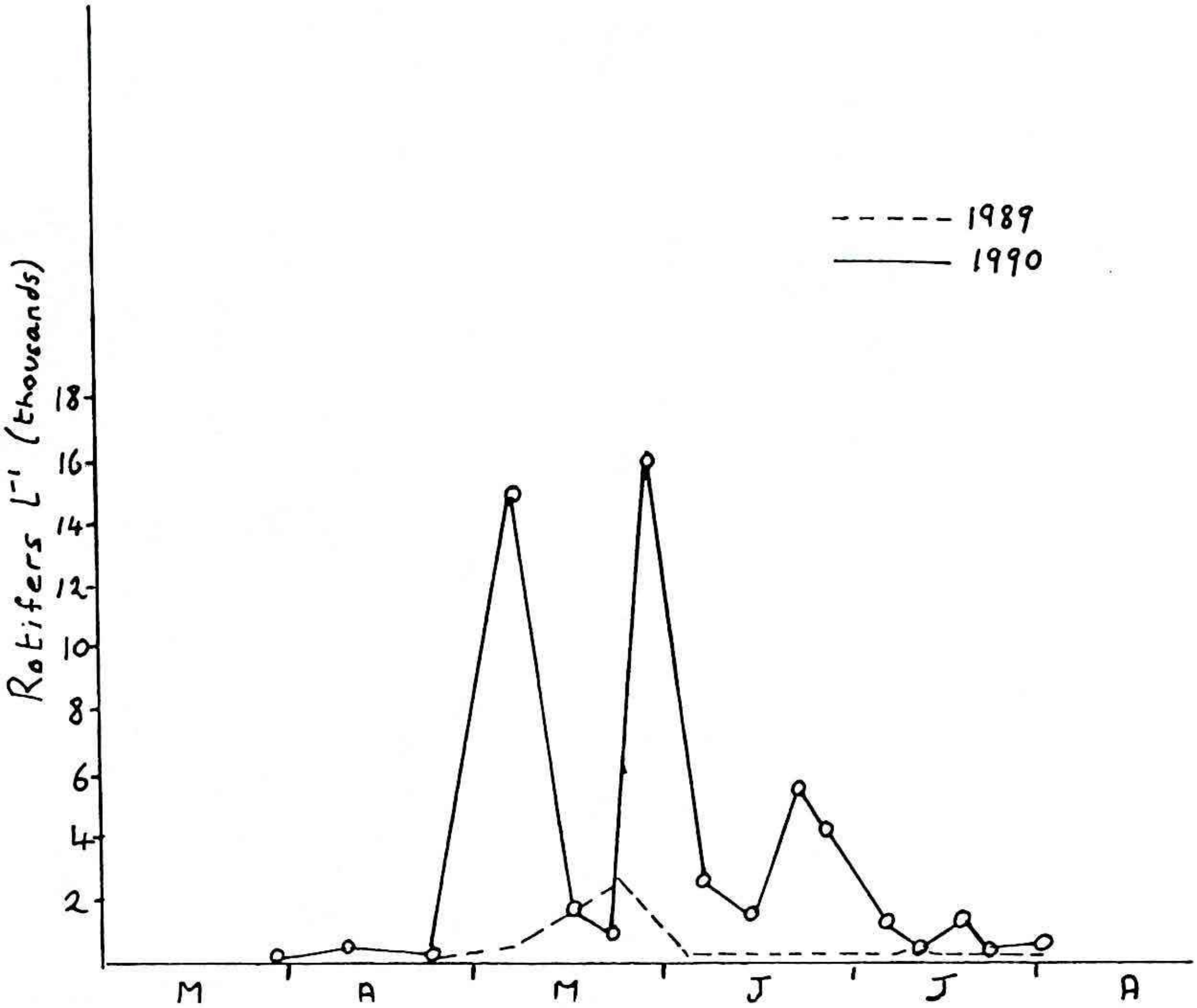

Figure 7

Mean number of Rotifera per litre of river water from the main river at Godmanchester in 1989 and 1990.

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