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Turbidity and plant growth in large slow-flowing lowland rivers.

Progress Report: October 1989

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1. SUMMARY

The period covered by the first report was used to develop specific methodology and instrumentation for measuring turbidity, suspended solids and underwater irradiance. This second report concerns a large scale sampling programme on the River Great Ouse and its side channels during the spring, summer and early autumn. Ten sites have been sampled weekly for phytoplankton (chlorophyll-a and cell counts) and turbidity. Estimates of light penetration to the river bed have been made for photosynthetically available radiation (PAR) and specifically at 400, 450, 550 and 650nm. Mapping of the river bed topography and the distribution of macrophytes has continued at the three main river sites and in three side channels. Monthly samples of periphyton have been collected from one main river site and one side channel from Nuphar (surface and underwater leaves), Scirpus and Phragmites stems.

2. INTRODUCTION

The River Great Ouse is a highly managed large lowland river in eastern England. It drains rich arable land in the Midlands and Eastern England and over the years nutrient concentrations have increased and there is a general perception that the clarity of the water has decreased. The main river channels have been dredged a number of times partly for flood control reasons but also for recreational boating and navigation activities. The purpose of the contract is to investigate the seasonal variations and causes of turbidity and their effects on aquatic plants and the associated periphytic organisms. Particular attention is being paid to the distribution of macrophytes and the seasonal variation of periphytic organisms in relation to channel size and structure.

3. METHODS

Methods have been fully described in the first progress report (March 1989).

4. FIELD SAMPLING, RESULTS AND DISCUSSION

4.1. Phytoplankton. Phytoplankton sampling has been extended to ten sites, six of which are on the main river:

Site 1. St Neots Nat. Grid Ref. TL181602

Site 2. Offord TL217672

Site 3. Huntingdon TL243714

Site 4. St Ives TL313711

Site 5. Needingworth TL361713

Site 6. Earith TL393747

Three sites are in side channels:

Site 7. Offord TL215669

Site 8. Lees Brook TL229701

Site 9. Cookes Backwater TL257718

One site is in a freshwater boating marina

Site 10. Needingworth TL359713

At each of these sites estimates are made of turbidity, phytoplankton chlorophyll-a, species composition and cell number. At three of the sites (2, 3 and 5) estimates are made of total suspended solids and at one site the organic carbon content of the suspended solids. Since most of the season has been spent collecting data, only preliminary analyses have been carried out so far. At all sites maximum phytoplankton densities were reached in May at between 120 and 180 mg m^{-3} chlorophyll-a, corresponding to c.a. 20 FTU turbidity. High turbidities in the late winter were not associated with phytoplankton. Chlorophyll-a concentrations in the main river at Huntingdon and two adjacent side channels are shown in Fig 1 and the corresponding turbidities in Fig 2. In spite of the long, dry and warm summer phytoplankton densities were low in the late summer compared with the peak in May. Indeed there is some evidence that densities decreased downstream as illustrated for two contrasting sites in Fig 3.

4.2. Light Attenuation. The vertical attenuation coefficients have been measured weekly at site 3 (Huntingdon TL243714) using a quantum sensor (400-700nm) and a multiple sensor with four outputs at 650, 550, 450 and 400nm. Data from May to September are shown in Fig 4.

During this more limited period maximum attenuation of light in all cases occurred at periods of maximum phytoplankton growth. Minimum attenuation occurred in the "green" (550nm). Very high attenuation occurred in the "blue" (450nm) and in the violet/near UV (400nm). Throughout the summer and autumn the water gradually clarified but even during periods of relative clarity attenuation between 400 and 500nm was still high (Fig 4). Table 1 illustrates the penetration of light of different wavelengths through the water column at successive depths .

4.3. Channel morphology and light penetration. Measurements on channel morphology and the occurrence of emergent and submerged macrophytes has continued this year at the same six sites referred to in the first report. Table 2 shows the depth distribution of the bed of the River Great Ouse at these sites in mid-summer. Depth profiles are quite varied but the side channels tend to be shallower than the main river. At two main river sites over 60% of the river bed is deeper than 2m and at the third over 60% is deeper than 1.5m. In one of the side channels 60% of the river bed was less than 1.5m, in the second 60% was less than 2m while in the third 60% of the river bed was deeper than 2m and comparable to the main river. Details of macrophyte cover will be given a later report after further analysis.

4.4. Periphyton Sampling. Monthly samples have been taken from the main river channel at Huntingdon (site 3) and from a side channel at Lees Brook (site 8). Submerged and floating leaves of Nuphar were sampled together with the submerged stems of the marginal Scirpus.

For comparative purposes, periphyton was also sampled from Phragmites stems at site 3; both new growth and erect dead stems (from the previous season) were taken. These samples are in the process of analysis and will not be reported on here.

4.5. Two automated data loggers have been set up at sites 3 and 8 recording temperature, dissolved oxygen and turbidity. In addition water height ia also recorded electronically at site 8.

5. Continuation of research programme for 1989-1990

5.1. Logging of turbidity etc will continue at the two sites and will be supplemented at strategic times by automated diel sampling of water for more accurate estimates of daily fluctuations in turbidity and phytoplankton.

5.2. The general sampling programme outlined above will continue because this summer was very dry and 1990 is "reasonably likely" to offer a climatic and hydraulic contrast.

5.3. The multi-wavelength submersible irradiance sensor will be modified for use with a range of narrower band interference filters.

Table 1

Penetration of visible radiation through the water of the River Great Ouse. Data were calculated from the vertical attenuation coefficients for the complete visible spectrum (400-700nm) and at specific points in the visible range. Data are presented as percentage light transmission.

% Light Transmission

	water depth	May	June	July	August	September
400-700nm	0.5m	36	51	54	59	62
	1.0	13	26	30	35	38
	1.5	5	14	16	21	23
	2.0	2	7	9	12	14
	2.5	<1	4	5	7	9
650nm	0.5m	38	54	57	63	64
	1.0	15	30	32	40	41
	1.5	6	16	18	26	26
	2.0	2	9	10	16	17
	2.5	<1	5	6	10	11
550nm	0.5m	40	57	59	67	67
	1.0	16	32	35	45	45
	1.5	7	18	20	30	30
	2.0	3	11	12	20	20
	2.5	1	6	7	14	14
450nm	0.5m	12	25	29	34	36
	1.0	2	6	8	11	13
	1.5	<1	2	2	4	5
	2.0	<1	<1	<1	1	2
	2.5	<1	<1	<1	<1	<1

Table 2

The depth of the River Great Ouse at 6 sites. Data are expressed as the percentage of the river bed area occupied between successive 0.5 m depth increments in mid summer.

	0-0.5	0.5-1.0	1.0-1.5	1.5-2.0	2.0-2.5	2.5-3.0	>3.0
Main river							
Offord	2.7	5.5	12.6	15.2	18.5	17.0	28.4
Godmanchester	9.9	9.0	13.0	13.8	8.1	23.2	34.8
Huntingdon	6.5	6.8	23.4	36.8	26.6	0	0
Side Channel							
Offord	1.3	9.2	34.2	38.1	17.1	0	0
Lees Brook	1.6	6.2	12.5	17.2	62.5	0	0
Cookes	2.4	34.1	61.8	1.7	0	0	0

FIG 1. Seasonal variation in the Great Ouse phytoplankton chlorophyll-a

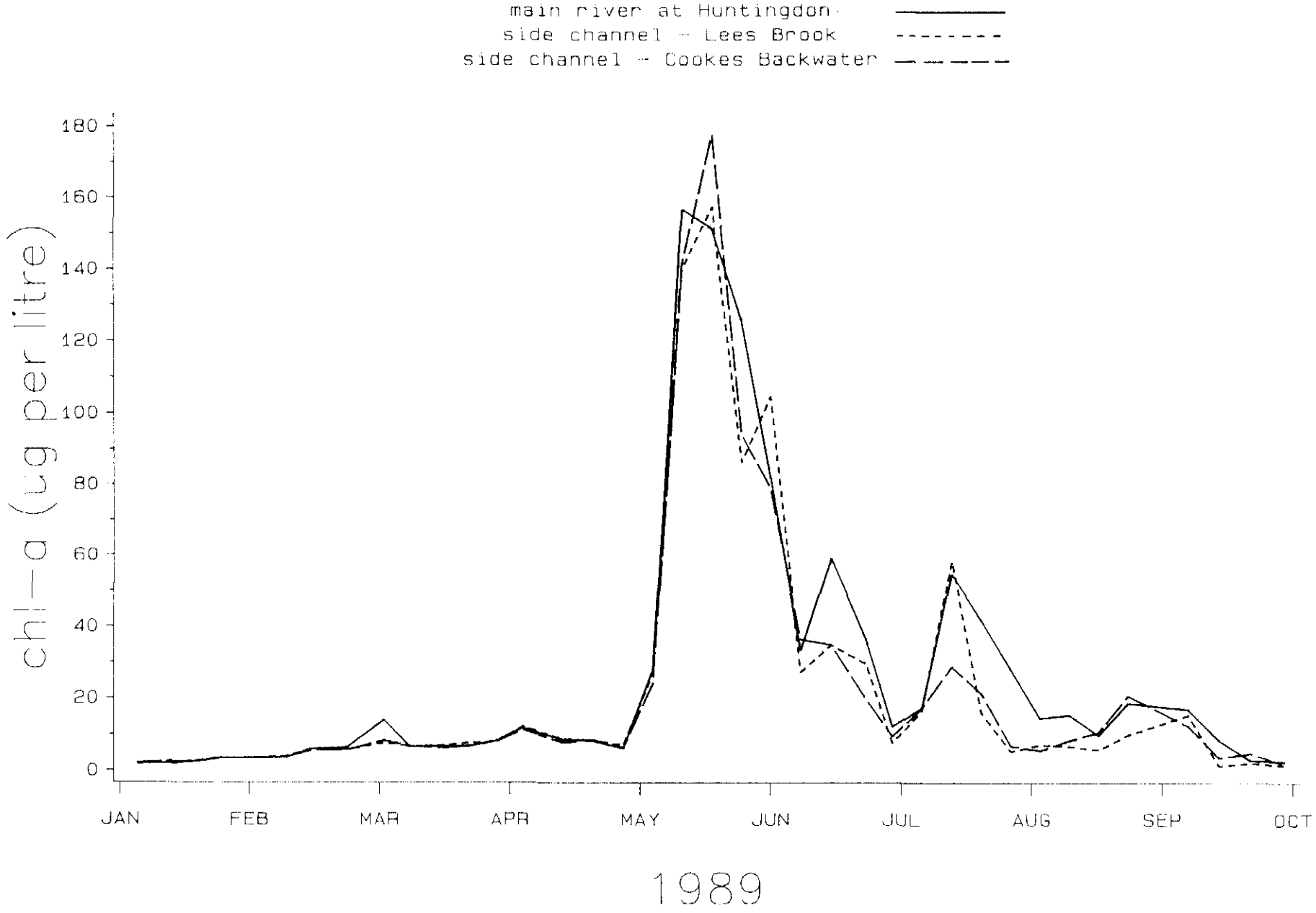


FIG 2. Seasonal variation in the turbidity of the Great Ouse

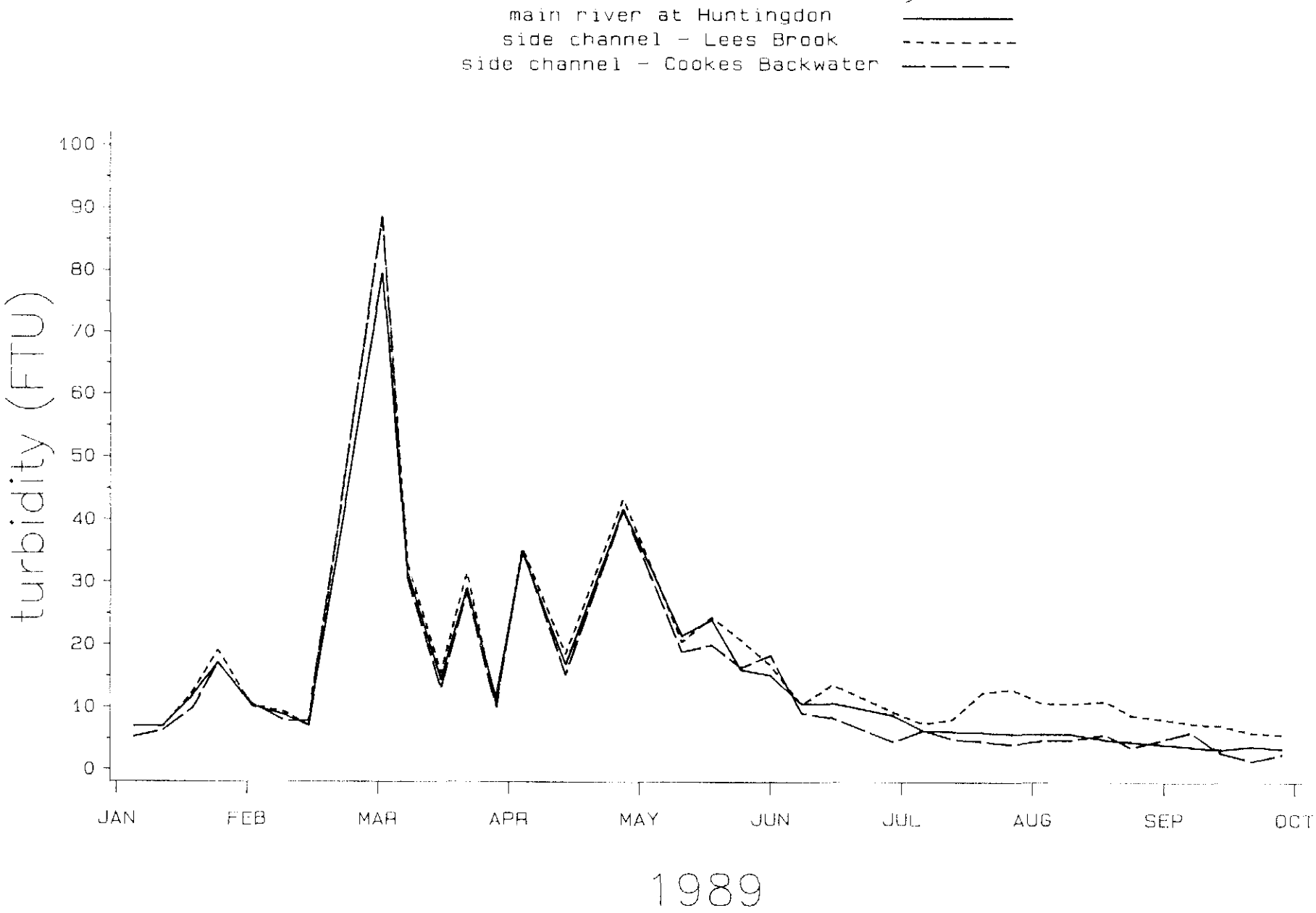


FIG 3. Variations in the Great Ouse phytoplankton chlorophyll-a

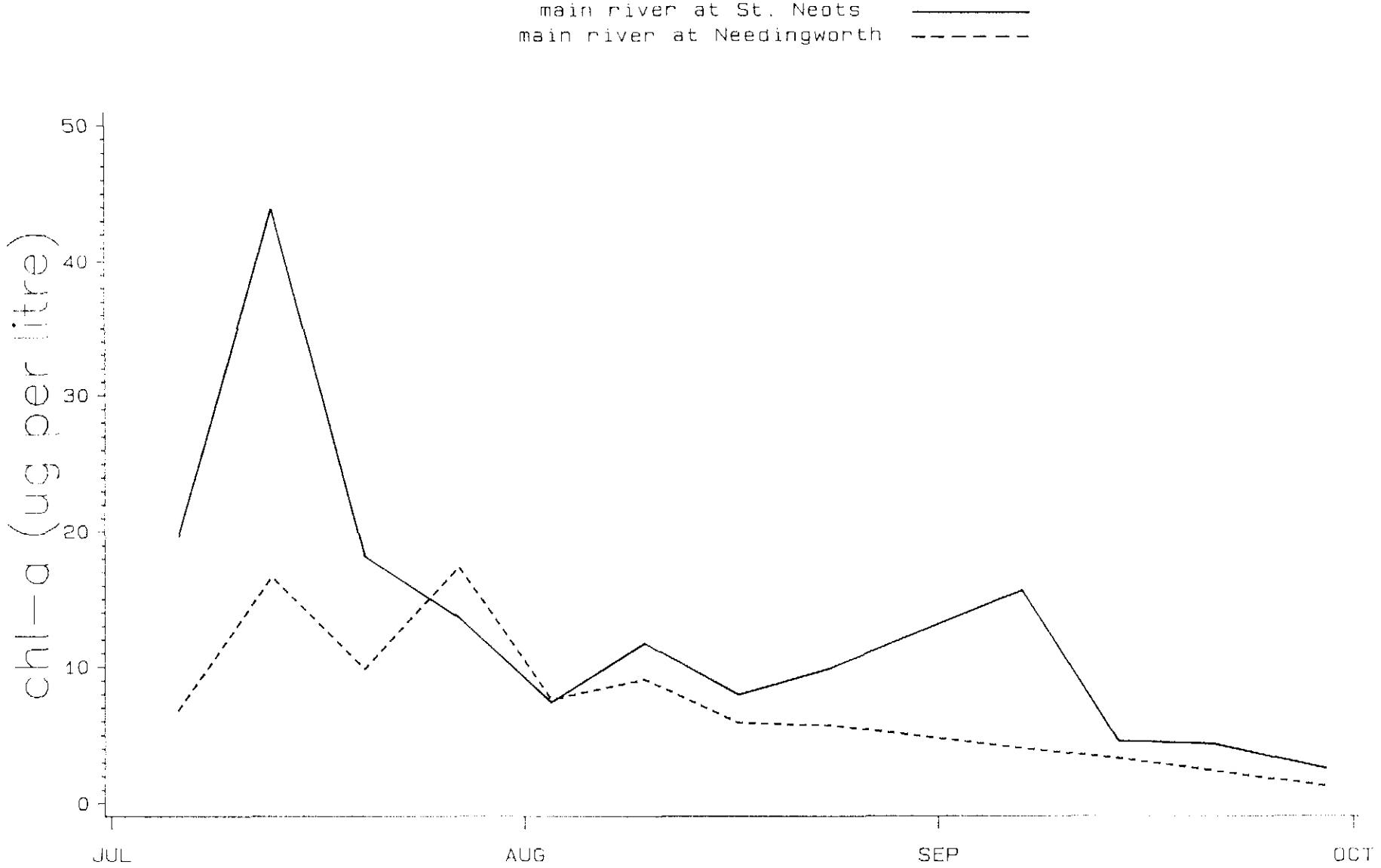
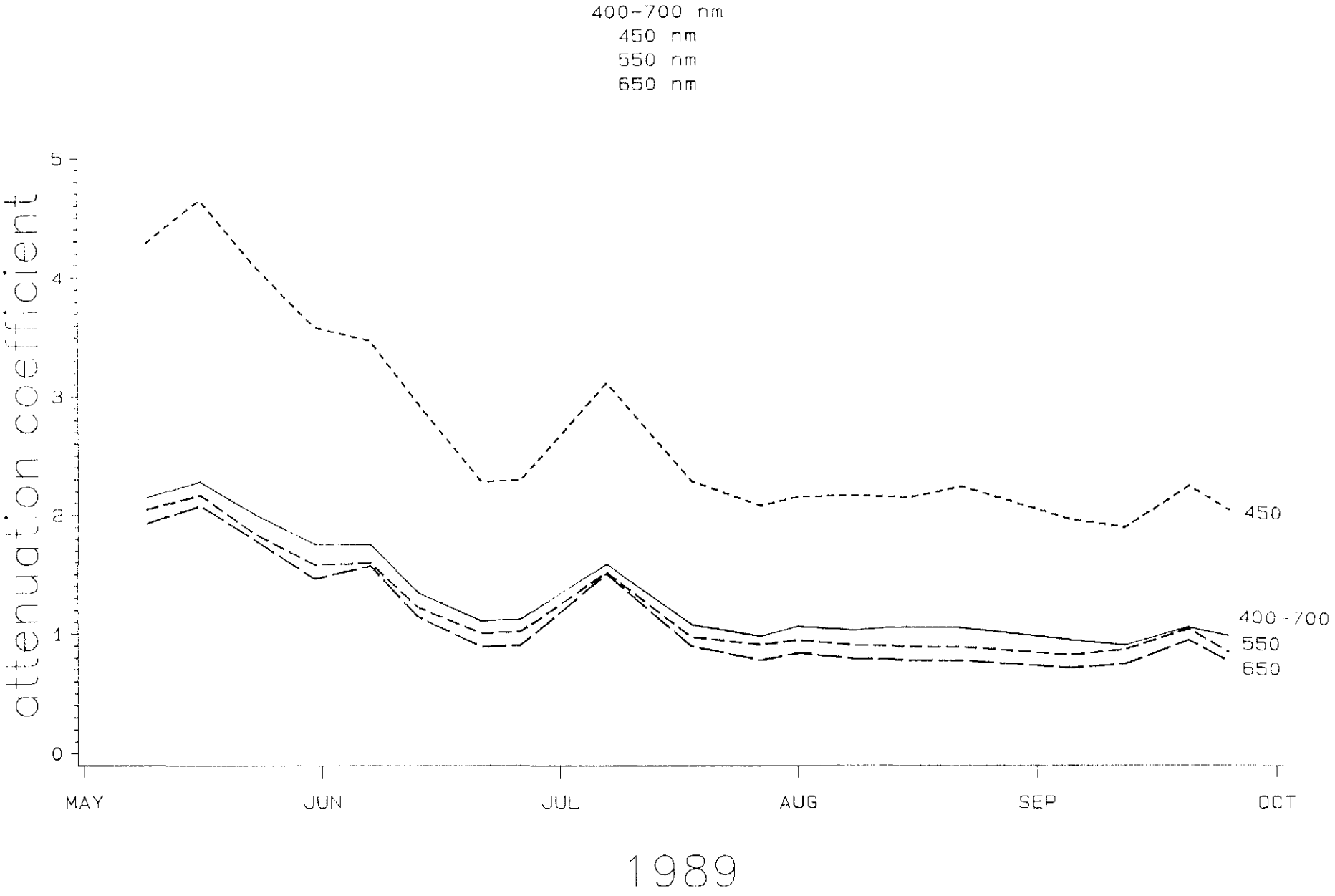


FIG 4. Seasonal variation in Light Attenuation



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