FRESHWATER BIOLOGICAL ASSOCIATION

River Laboratory, East Stoke, Wareham, Dorset BH20 6BB, UK

Nitrates in surface water, inputs and seasonality

by

H. Casey, M.Phil., C.Chem., FRSC
Ralph T. Clarke, M.Sc
S.M. Smith

Nitrates in surface water,
inputs and seasonality

Project Leader: H. Casey
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Summary

Because of the widespread concern over increasing nitrate concentrations in river water, the Freshwater Biological Association has undertaken a study to investigate seasonality, nitrate concentrations and loads in the River Frome catchment in relation to land use and compare the results for 1984/86 with data obtained in 1970/71.

Information on land use changes and fertiliser applications were obtained both from MAFF and individual farmers.

Whereas the MAFF fertiliser application values were average figures and showed an increase from 83 kg ha^{-1} in 1970 to 131 kg ha^{-1} in 1983/84, individual farmers information on nitrogen applications to grassland (in 1984) varied from 85 kg ha^{-1} to 300 kg ha^{-1}.

Nitrogen inputs from rainfall have not increased from 1970/71 to 1984/86 and were approximately 3 kg ha^{-1} annum.

The amount of nitrate entering the River Frome and its tributaries from sewage effluent has increased by 27.8% (or 51%) depending upon the type of information used for calculating these values. However the percentage of the nitrate load due to sewage effluent has not altered because of the increase in nitrate loading from 1970/71 to 1984/86. Nitrate concentrations in the river have increased at every site, the increase varying from 31% to 123% in mean values and at the River Hooke site the maximum value found in 1984/86 was 135% higher than the maximum value found in 1970/71.

Increases in mean nitrate loading (tonnes per week) varied from -8% to 114%. Also the minimum nitrate weekly load had increased at every site. At three sites there has been a reduction in the correlation coefficient of nitrate concentrations plotted against discharge. These reductions could suggest possible changes in farming practices. Nitrate concentrations in the 1984/86 survey also tend to be much more variable than those found in 1970/71.

Conclusions

1. Input of nitrogen from rainfall to the River Frome catchment had not significantly changed between 1970/71 and 1984/86 (results summarised in Table 5).
2. Because of changes in methodology and parish boundaries it is very difficult to obtain estimates of land use changes over a long time scale.
3. Because the values given by MAFF for nitrogen fertiliser applications are only average figures they will only provide a very rough guide for calculating changes in fertiliser applications.
4. If a more accurate value for increases in fertiliser application are required, individual farmers will have to be contacted, e.g. applications to grassland in the River Frome catchment varied between 85 to 300 kg ha^{-1} depending upon whether the grassland was to be used for grazing or silage. Also the application of nitrogen fertiliser was found to vary with the stocking rate of cows (CAS Report No. 9 1986 found this variation could be as large as 55 kg ha^{-1} to 232 kg ha^{-1}).
5. In 1983 62.1% of agricultural land in Dorset was grassland and because grass yields can be increased by increasing nitrogen fertiliser applications up to 600 kg ha^{-1} (for cutting) and 800 kg ha^{-1} for grazing, there is a distinct possibility that nitrogen fertiliser applications in Dorset will increase.
6. Whereas the Royal Society Study Group Report (1983) concluded only a small proportion of nitrogen fertiliser applied to grassland is leached out, recent work by Ryden et al. (1984) found that leaching of nitrate from an intensively managed grazed grassland to be five to six times higher than comparable swards cut for hay or silage.

7. In 1972 the amount of nitrate entering the River Frome catchment from sewage effluent was calculated to be 37.0 tonnes $NO_3N\ a^{-1}$ (out of a total load of 596 tonnes a^{-1} at East Stoke) whereas in 1983 it was 47.3 tonnes $NO_3N\ a^{-1}$ (calculated using dry weather flows from all sewage works). However if more accurate monthly flows obtained at Dorchester sewage works (the largest sewage works in the catchment) plus dry weather flows from the other stations are used to calculate the impact of sewage effluent, this value is 55.9 tonnes $NO_3N\ a^{-1}$ out of a total load of 834 tonnes $NO_3N\ a^{-1}$ at East Stoke (overall results summarised in Table 7).
8. The results for 1970/71 and 1984/86 showed that there had been an increase in mean and maximum nitrate concentrations at all sites, the highest values being found at the River Hooke where mean value showed a 123% increase and the maximum value found showed a 135% increase. The highest value found was 9.56 mg l^{-1} NO_3N at Tadnoll Brook. A small ditch draining agricultural land into the headwaters of Tadnoll Brook had nitrate concentrations varying between 3 to 15.8 mg l^{-1} NO_3N (overall changes in nitrate concentrations are summarised in Table 14).
9. Increases in mean weekly nitrate loading (tonnes/week) varied from -8% (River Cerne) to 114% (Sydling Water) where the mean load increased from 0.432 to 0.925 tonnes/week. Also at every site sampled the minimum weekly nitrate load had increased; the largest increase found was again at Sydling Water (106%).
10. Because of large seasonal and annual variations of climatic conditions, discharges and therefore nitrate loads, Table 23 was prepared using the FBA long-term sampling data. This compares two four-year periods, 1969/72 and 1982/85 when the average discharge of the River Frome (East Stoke) was very similar (6.32 $m^3\ s^{-1}$ for the 1969/72 period and 6.40 $m^3\ s^{-1}$ for the 1982/85 period). The mean weekly load for these

periods shows an increase of 47.4% from 11.68 tonnes/week in 1969/72 to 17.22 tonnes/week in 1982/85. The maximum load in any one week in 1969/72 was 38.55 tonnes/week but in 1982 and 1984 there were weekly loads of over 57 tonnes, an increase of nearly 50%.

11. At three sites for the 1984/86 data there were large reductions in the correlation coefficient between nitrate concentrations and discharge compared with the 1970/71 results. These sites were the River Cerne (1970/71 r = 0.86 and 1984/86 r = 0.66), Tadnoll Brook (Broomhill Bridge) (1970/71 r = 0.64 and 1984/86 r = 0.35) and the River Frome (Dorchester gauging weir) (1970/71 r = 0.69 and 1984/86 r = 0.47). This reduction could suggest that there have been changes in farming practices resulting in relatively lower nitrate runoff during the high autumn and winter flow periods. Perhaps less fertiliser is now applied during these periods of higher runoff of rainfall. Information from the 1985 Fertiliser Review (Fertilisers Manufacturing Association) shows that from a peak usage in April 1979 of just over 600,000 tonnes, more than 1.2 million tonnes was applied in April 1984 and that 50% of the total nitrogen usage in 1983/84 took place in a single month. However in 1982/83 the peak nitrogen usage was spread over three months, March, April and May. Obviously the peak usage will change from year to year depending on crops and weather conditions but even so, in the year 1982/83 60% of the nitrogen fertiliser was applied in just three months of the year. However this peak usage could possibly cause problems for water authorities using river water as a supply. If there was very heavy rainfall after the peak application there is a possibility of very high nitrate concentrations in runoff water.
12. Seasonal variations will be dependent on rainfall pattern and vary from year to year, for example in the October to December period 1970 for the River Frome at East Stoke the mean load was 13.21 tonnes per week

and the maximum load was 20.08 tonnes per week. In the same three monthly period in 1971 the corresponding values were 4.75 tonnes per week and 6.84 tonnes per week (summarised in Table 21). These results emphasize the necessity of having a long time series of observations extending over ten or more years before you can confidently detect any slow long-term changes in water parameters.

13. At almost every site in the 1984/86 survey the highest quarterly mean nitrate concentrations and the maximum nitrate concentrations occur in the January to March period (summarised in Table 22).

14. In 1971 the annual nitrate load at Dorchester was 155 tonnes and at East Stoke 477 tonnes. Therefore the input between Dorchester and East Stoke was 322 tonnes NO_3N. In 1985 the annual nitrate load at Dorchester was 343 tonnes and at East Stoke 864 tonnes with a difference of 521 tonnes NO_3N. These figures demonstrate the extremely large increases found in the annual nitrate loads since the 1970/71 survey.

1. Objectives

To investigate nitrate concentrations and loads and their seasonality in the River Frome catchment in relation to land use and compare the results for 1984/86 with data obtained from the major tributaries and the main river in 1970/71.

2. Introduction

DoE Standing Technical Advisory Committee on Water Quality Report No. 37 states that there has been a general and substantial increase in surface water nitrate concentrations over the last 30 to 40 years. Also the available evidence supports the conclusion of the Royal Commission on Environmental Pollution (1983) that changes in agricultural practice, including fertiliser use, are a major contribution to the rising trends in nitrate concentrations in the source of public water supply.

Long nitrate data runs, especially for better quality rivers, had proved difficult to locate and changes in analytical techniques, allied to the often sporadic nature of sampling regimes, limited the usefulness of some historic data.

The River Frome (Dorset) has been studied extensively by the Freshwater Biological Association River Laboratory since 1965, thereby providing an excellent data base to investigate any trends and changes in nitrate seasonality, concentrations and loads.

3. Catchment description

3.1 Rainfall

Precipitation occurs mainly as rain, snow being experienced for only a short period (1-3 days in the lower catchment and 1-2 weeks in the upper catchment), but the catchment with regard to rainfall can be divided into two main areas, above and below Dorchester. The

upper catchment had a 35 year average rainfall of 1016 mm, whereas the lower catchment had a 35 year average of 889 mm.

3.2 Geology

A generalised map of the catchment geology is shown as Fig. 1. More detailed information is available from a previous paper by Paolillo (1969).

3.3 Sampling sites

Details of the sites sampled in 1970/71 are given in Casey & Newton (1973) and Fig. 2 is a map of the sites sampled in 1984/86. Table 1 gives map references and details of geology of sampling sites in 1970/71 and 1984/86.

Table 1. Details of sampling points in 1970/71 and 1984/86.

Name and National Grid Reference	Sampling Point Number 1970/71	1984/86	Geological data of catchment
R.Hooke SY593976 at Maiden Newton	1	1	Upper Greensand (Cretaceous)
Wraxall Brook ST584004	2		Chalk (Cretaceous)
R.Frome SY596976 at Maiden Newton		2	Upper Greensand and Lower Cretaceous
Sydling Water SY637947 at Viaduct	3	3	Chalk (Cretaceous)
R.Cerne SY678935	4	4	Chalk (Cretaceous)
R.Frome SY708903 at Dorchester Gauging Weir	5	5	Chalk (Cretaceous)
R.Frome SY769909 at Woodsford	6	6	Chalk, sand and gravel (Cretaceous and Tertiary)
R.Frome SY806893	7	7	Sand and Gravel (Tertiary)
Tadnoll Brook SY770862 at Owermoigne	8		
Tadnoll Brook SY763874 at Empool		8	Lower Chalk and Greensand (Cretaceous)
Tadnoll Brook SY811881 at Broomhill Bridge	9	9	Sand and Gravel (Tertiary)
R.Frome SY867868 at East Stoke	10	10	Sand and Gravel (Tertiary)
R.Frome ST586004 at Sandhills	11		Upper Greensand and Lower Cretaceous
R.Frome SY624949 Southover	12		Chalk
R.Hooke ST537000 Gauging Weir	13		Lower Chalk and Greensand
R.Win SY827868 at Winfrith	14		Middle Jurassic Limestone and Tertiary

GENERALISED GEOLOGY OF THE RIVER FROME CATCHMENT AND SURROUNDING AREA

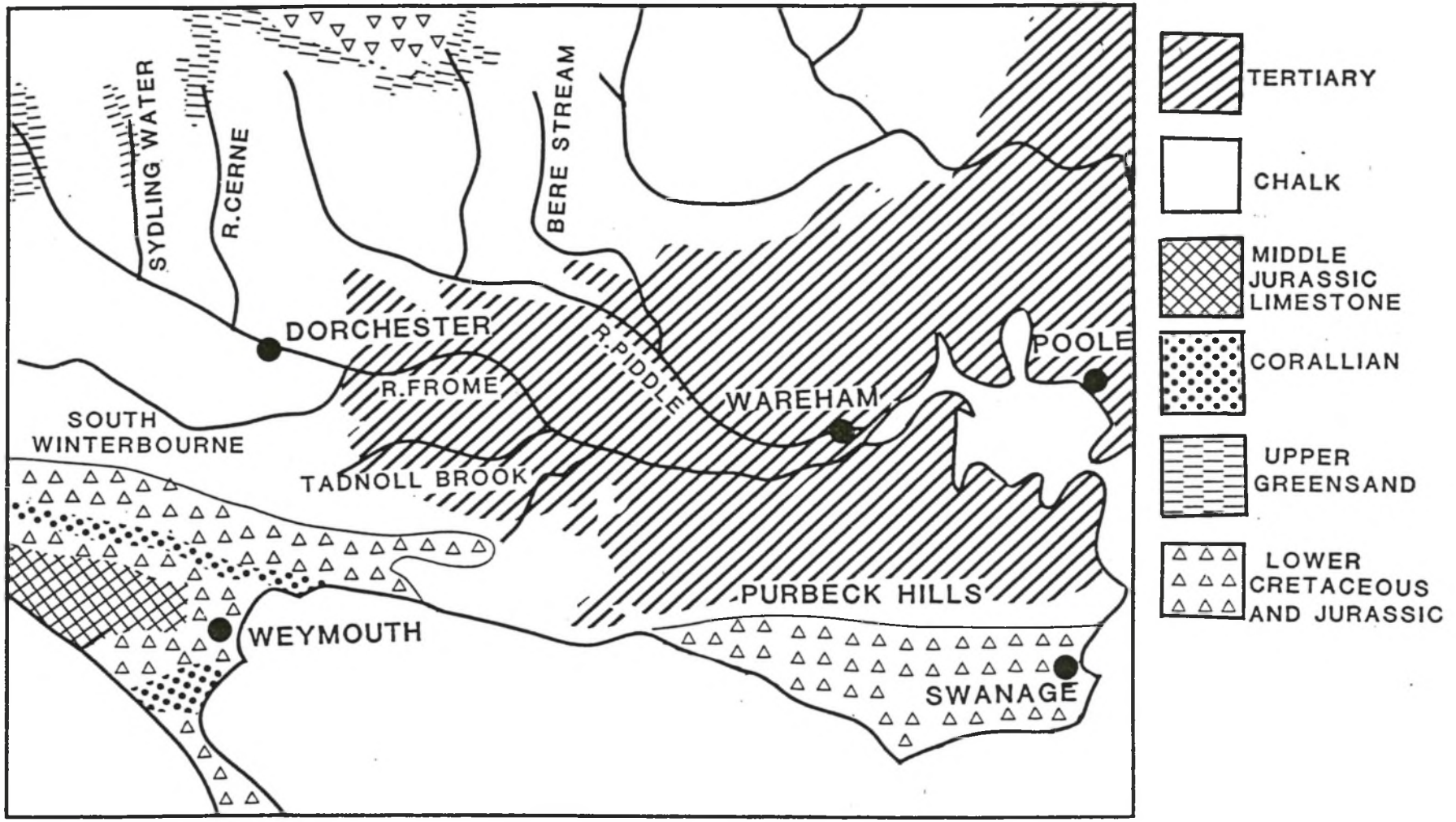

Figure 1. Generalised map of the geology of the R. Frome catchment

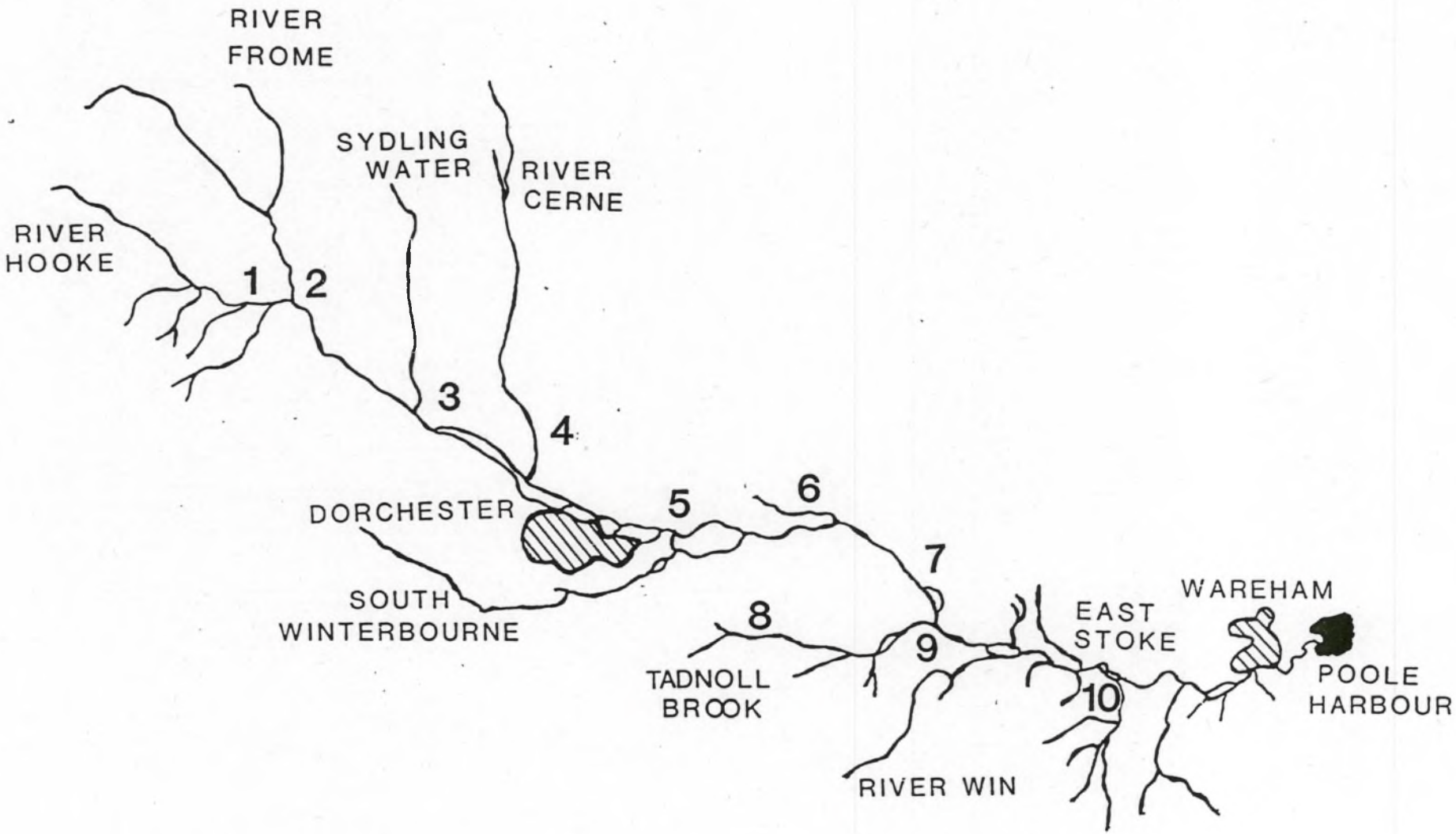

Figure 2. Details of sampling sites on R. Frome catchment 1984-86

3.4 Chemistry and discharge

The River Frome is the westernmost major chalk stream in England and the chemistry, biology and discharge have been described in previous papers (Casey 1969, 1975, 1976, 1977; Casey & Clarke 1979, 1986; Casey, Clarke & Marker 1981; Casey & Downing 1976; Casey & Farr 1982; Casey & Ladle 1976; Casey & Newton 1972, 1973; Casey & Walker 1983; Casey & Westlake 1974; Pinder et al. 1982; Westlake et al. 1972). The most relevant papers to this report are Casey & Newton (1972, 1973) who prepared a chemical budget for the River Frome catchment by measuring chemical composition and discharge at 14 sites.

Casey (1977) described nitrate concentrations in rainfall, boreholes, springs, streams and the main river in order to determine the sources of nitrate to the river system; also the range and variation of nitrate concentrations at times of increased flow and the utilisation of nitrate by higher plants. Casey & Clarke (1979) showed that at one sampling site (East Stoke) there had been a trend over the period 1965-1975 with nitrate concentrations increasing by 0.11 mg l^{-1} NO_3N per year. A predictive model for 1976 was made and even though discharge conditions were extreme, the mean predicted value was very close to the mean observed value.

3.5 Sewage effluents entering the River Frome and its tributaries

Details of dry weather flow sewage effluents for the main sewage works for the years 1972 and 1983 were obtained from the Wessex Water Authority.

3.6 Land use in the catchment area

The area of the R. Frome catchment is 41440 ha with an estimated population of 327,000 giving a population density of 8 people/ha. Dorchester is the largest centre of population estimated at 13,736 in 1970 and 14,293 in 1985. Land use in the catchment was obtained from the parish records supplied by MAFF. Since 1973 some

parishes have been combined and some boundaries have been altered; therefore any comparison of changes in land use has to take parish areas into account. For the purpose of this study only the following statistics were abstracted.

MAFF

Land Use Code Number and Name:

1. Total area
2. Total crops and fallow
3. Grasslands 1978 or later
6. Other grasslands exclusive of rough grazing
11. Wheat
12. & 13. Barley
14. Oats
15. Mixed corn
16. Rye
17. Maize
92. Total cattle and calves
111. Total pigs
119. Total sheep
139. Total poultry
201. Total vegetables grown in open
226. Total orchards and small fruit

Because of alterations in the way information was gathered in the years 1973, 1975 and 1982 by MAFF on numbers 1-17 no detailed information on land use changes could be calculated. Details of the total numbers of cattle and calves, pigs, sheep and poultry in 1975 and 1982 are given in Table 2 below.

Table 2. Changes in livestock numbers in the Frome catchment between 1975 and 1982.

	1975	1982
Total cattle and calves	24,580	22,779
Total pigs	9,240	11,634
Total sheep	13,804	20,855
Total poultry	89,631	160,358

Using the information on nitrogen excretion given by MAFF (1976) the nitrogen equivalents for the years 1975 and 1982 are given in the Table 3 below.

Table 3. Changes in nitrogen content of livestock excrement in the Frome catchment between 1975 and 1982.

	1975		1982	
	Tonnes	Kg ha	Tonnes	Kg ha
Cattle and calves	1839.2	44.4	1704.4	41.1
Pigs	60.7	1.5	63.7	1.5
Sheep	206.6	5.0	312.1	7.5
Poultry	80.5	1.9	144.0	3.5
Total	2187.0	51.8	2224.2	53.6
Increase			37.2	1.8

As can be seen from the above tables there have been increases in poultry, pigs and sheep and a reduction in cattle and calves.

3.7 Fertiliser applications to the R. Frome catchment

The increased use of nitrogen fertilisers in England and Wales has been reported elsewhere (The Royal Society Group Report, 1983; CAS Report 9, 1985; DoE Pollution paper No. 26, 1986).

Figure 3 shows the overall use of nitrogen fertilisers on 2-7 year leys for the period 1940 up to 1985.

In 1960 average application of nitrogen fertilisers to grassland was 26.3 kg ha^{-1} N. However, only 60% of temporary grass and 54% of permanent grass received any fertiliser at all.

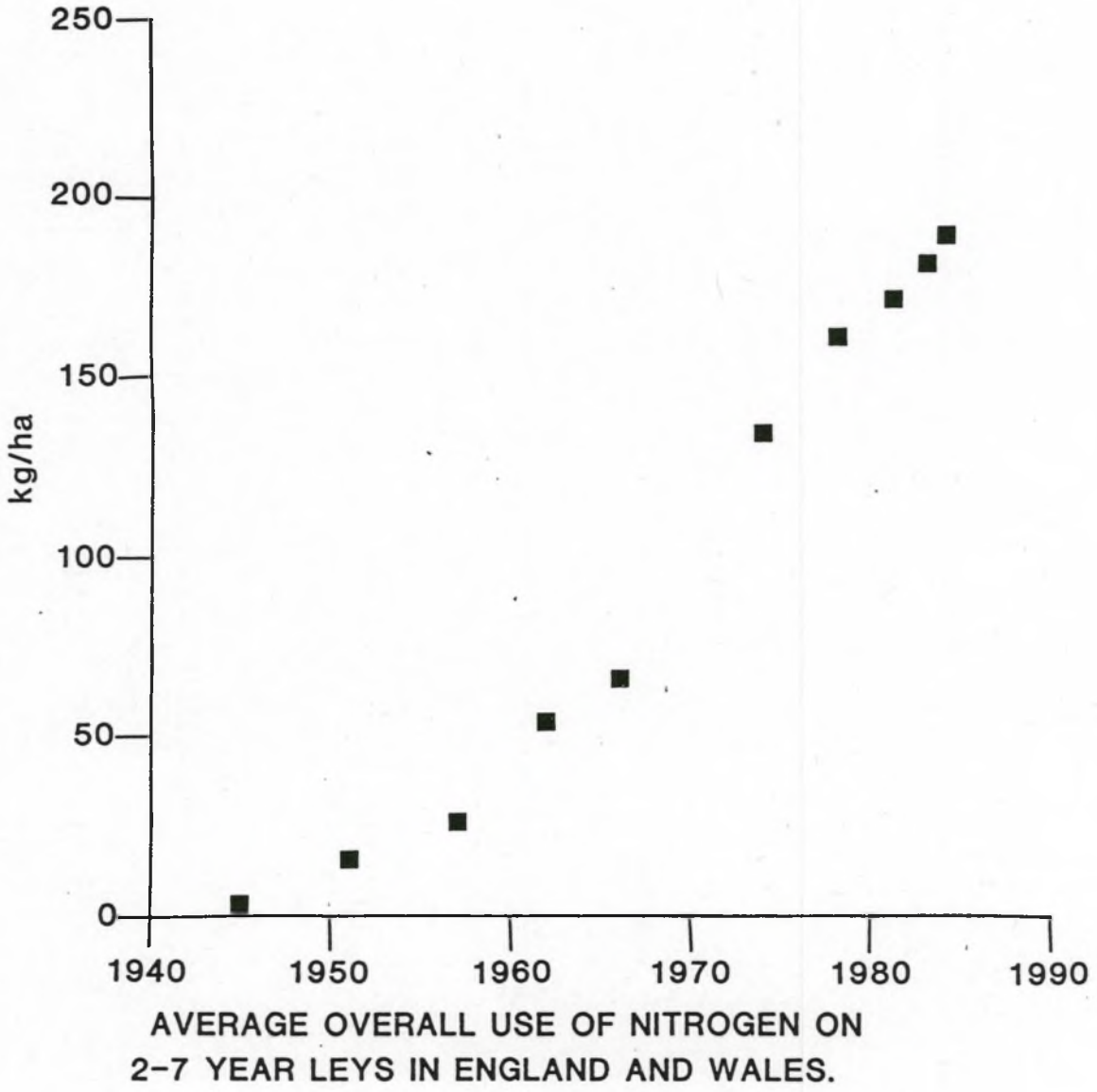

Figure 3. Average overall use of nitrogen on 2-7 year leys in England and Wales

By 1971 average application was 66.5 kg ha^{-1} N and 84% of leys and 60% of permanent grassland were receiving fertiliser applications.

In a written communication with MAFF (Dorset) the following rates of fertiliser applications were given as general values.

1955 12 kg ha^{-1} N.

1965 33.2 kg ha^{-1} N.

1972 74.8 kg ha^{-1} N.

MAFF data from the "Surveys of Fertiliser Practice for Wales and England" show the following values.

	1970
Arable land	88 kg ha^{-1} N
Leys	108 kg ha^{-1} N
Permanent grass	53 kg ha^{-1} N
Total	249
Average	83 kg ha^{-1} N

It can be seen that the overall average for 1970 is fairly close to the figure of 74.8 kg ha^{-1} N given for Dorset.

Fertiliser application rates for 1982/83 and provisional figures for 1983/84 are given in Table 4 below.

Table 4. MAFF data for all England and Wales of the total areas under the major crops and grass, and their nitrogen fertiliser rates.

	1982/83 (actual)		1983/84 (provisional)	
	Area 000 ha	Nitrogen kg/ha	Area 000 ha	Nitrogen kg/ha
Wheat	1691	180	1965	188
Winter barley	912	152	1027	155
Spring barley	1240	101	940	94
Other cereals	122	88	121	94
Potatoes	194	188	199	199
Sugar beet	200	155	200	148
Oilseed rape	222	272	269	280
Other crops	557	66	485	60
Grass	6956	105	6930	114
All crops and grasses	12094	122	12136	131

In 1983 Dorset had the following distribution of main crops (percentage of agricultural land).

Cereals	25.2
Feeding stock	1.6
Others	0.6
Grassland	62.1

During our survey in 1984/85 individual farmers were contacted about their applications of fertilisers. As grassland dominated the land use they were particularly asked about applications to grassland. The rate of application varied considerably from 85 kg ha^{-1} N to 300 kg ha^{-1} N depending upon whether the grass was to be used for grazing or silage.

Also on dairy farms the rate of application depended upon the stocking rate of cows per hectare. CAS Report No. 9 (1985) found that on low stocked farms (0.94 cows per foraged ha) fertiliser use was 55 kg ha^{-1} N, whereas on high density stocked farms (2.7 cows per foraged ha) fertiliser use was 232 kg ha^{-1} N.

Therefore the use of the MAFF average figure for calculating increased fertiliser usage will only provide a very rough guide depending on land use.

In the R. Frome catchment what was rough pasture land in the 1970 survey is now intensively farmed grassland with over 300 kg ha^{-1} N being currently applied. Also in 1971 approximately 7% of grassland was strip grazed, this aspect of grassland management has changed completely.

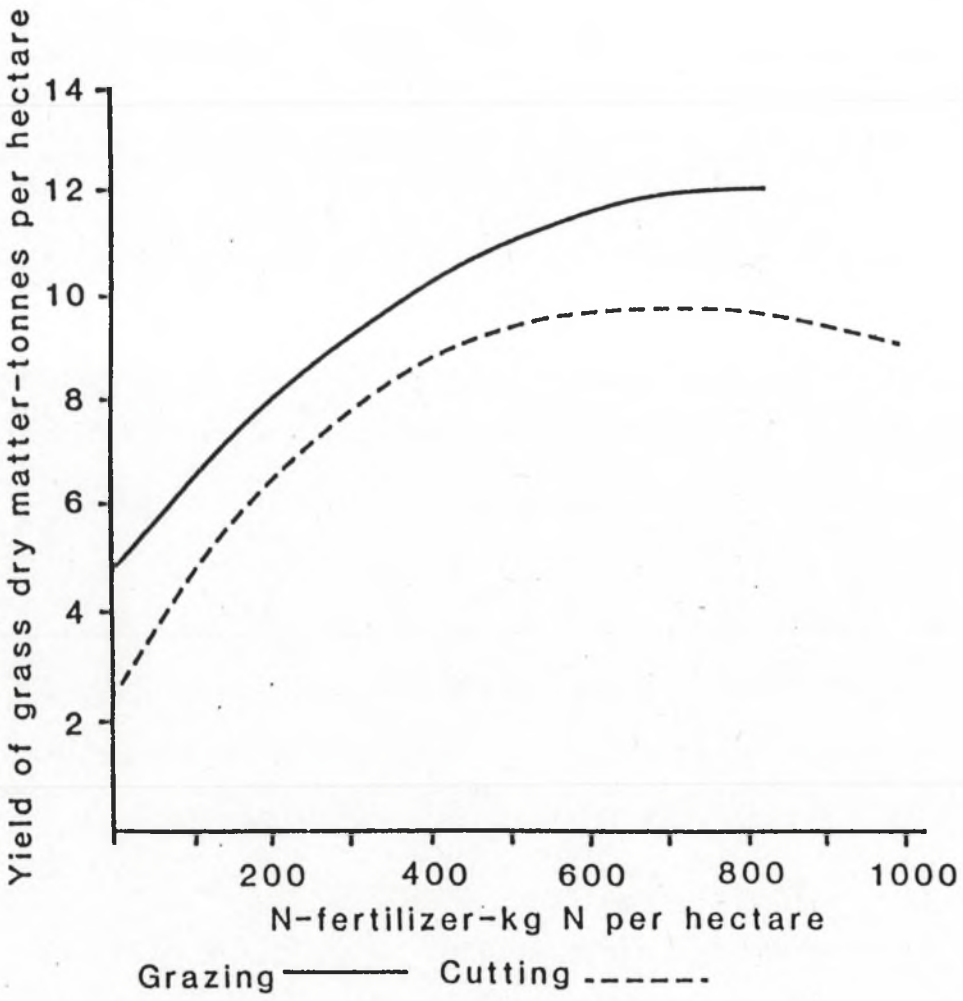

Fig. 4. Yield of dry grass matter plotted against kg ha^{-1} N (CAS Report No. 9 1985).

From the above figure 4 it can be seen that grass yields can be increased by increasing fertiliser application up to 600 kg ha^{-1} N for cutting and 800 kg ha^{-1}N for grazing. Therefore there is a possibility that grassland fertiliser treatment could increase substantially, if it is still economically profitable.

Fertiliser application values obtained from Devon varied between 200 and 400 kg ha^{-1} N for grassland.

The Royal Society Study Group Report (1983) concluded that most of the nitrate leached from farmland comes from arable land and represents approximately one third of the fertiliser applied annually to that land. The report also states that of the 900,000 tonnes of

fertiliser N applied to grassland very little is leached out and no major problem is likely to arise even when the application rates reach 250 kg ha^{-1} a^{-1}. However, Ryden et al. (1984) found that the loss of nitrate by leaching from an intensively managed grazed grassland may be five to six times higher than losses from comparable swards cut for hay or silage. The average annual loss from the grazed sward was 162 kg ha^{-1} a^{-1} when the sward fertiliser application rate was 420 kg ha^{-1} a^{-1}. Therefore this rate of loss far exceeds that of 52 to 93 kg ha^{-1} a^{-1} NO_3 reported by the Royal Society report for nitrate leached from arable land.

Haigh & White (1986) found losses by leaching of 17.5 and 48.7 kg ha^{-1} in 1982/83 and 1983/84 respectively, which was equivalent to 9 and 43% of the fertiliser added to a small, underdrained, grassland, clay catchment.

4. Methods

Many of the historical runs of data statistically analysed by the DoE (1984) were not completely accurate because of changes in methods of chemical analysis. In this study the 1984/6 samples were analysed using the same method of analysis as that used in 1970/71 (Casey & Newton 1973).

4.1 River discharge and nitrate data collected

1970-71

Between 28th October 1970 and 8th December 1971 14 sites (Table 1) in the Frome catchment were sampled at weekly intervals. At each site, on each sampling occasion, a sample of river water was taken for laboratory determination of nitrate concentration. In addition, for all sites except Dorchester and East Stoke, the discharge at the time of sampling was recorded by measuring the stream depth profile, cross-sectional area and measuring the distribution of current

velocities with an Ott current meter. For these 12 sites the nitrate load for a particular week

(tonnes/week) was then estimated as:-

= discharge (cumecs) x nitrate concentration (mg/l) x 0.6048

1984-86

Between 11th April 1984 and 30th September 1986 10 sites (Fig. 2 and Table 1) in the Frome catchment were sampled at weekly intervals. At each site on each sampling occasion, a water sample was taken to determine nitrate concentration. At two sites (Sydling Water and River Cerne) discharge was also measured using the previously described method. At Tadnoll Brook water level was recorded continuously. The nitrate load at these three sites was then estimated as for the 12 sites in 1970-71.

4.2 River Frome gauging stations at Dorchester and East Stoke

Wessex Water Authority (WWA) have discharge gauging stations on the River Frome at East Stoke and Dorchester.

At East Stoke the River Frome is divided into two separate channels, the main channel monitored as station number 44001 (East Stoke Flume), and the secondary Mill Stream channel monitored as station number 44201 (East Stoke Weir). Daily mean discharge is available for East Stoke Flume from 1962 and for East Stoke Weir from 1966, which include both our 1970-71 and 1984-86 nitrate sampling periods. Throughout this study, the flows for the two channels were summed to give the total Frome daily mean discharge passing East Stoke. This combined site is referred to as site (10) East Stoke Flume in all the analyses.

Throughout the two study periods nitrate concentration was sampled weekly at just the main East Stoke Flume channel as part of the general nitrate sampling program. Nitrate concentrations are the same in both branches of the river.

The Frome nitrate load, passing East Stoke, was calculated by first using linear interpolation between successive weekly nitrate concentration values to give estimated nitrate concentration levels for each of the intervening days. The resulting daily estimates of nitrate concentration were multiplied by the above WWA daily mean discharges to give estimates of the nitrate load for each day. These were then summed to give estimates of the total nitrate load passing East Stoke each week. (Note: the load for each sampling date in the tables and figures refers to the load over the seven days up to and including the sampling day.)

Around Dorchester the River Frome is also divided into two separate channels, the main channel monitored by WWA as station number 44004 (Dorchester Louds Mill), and the secondary channel monitored as station number 44204 (Frome at Stinsford). Daily mean discharge is available for Dorchester Louds Mill from mid 1969, and hence for both our 1970-71 and 1984-86 nitrate sampling periods.

Daily mean discharges are only available for Stinsford from 1st October 1971, towards the end of the first study period. The missing Stinsford flows for the sampling period 28.10.70-30.9.71 were estimated simply as the average (0.27 cumecs) of the Stinsford flows available for October to December 1971. Because the flow at Stinsford was usually less than 25% that in the main Dorchester Louds Mill channel, the precision should be adequate. Throughout this study, the flows for the two channels were then summed to give the total Frome daily mean discharge passing Dorchester. This combined site is referred to as 'site (5) Dorchester Louds Mill' in all the analyses.

Throughout the two sampling periods weekly nitrate concentration samples were taken at just the main Dorchester Louds Mill site. Weekly total nitrate loads passing Dorchester were then calculated using derived linear daily interpolated nitrate concentrations as explained above for East Stoke.

4.3 Nitrogen in the catchment

Rainfall

The amount of nitrogen entering the lower catchment due to rainfall was calculated by multiplying the rainfall for each year by the catchment area by the average nitrate concentration of 0.31 mg/l found in the rain. From the available data the upper catchment on average received 1.14 times as much rain as the lower catchment. Therefore the annual inputs of nitrogen from rainfall in the upper catchment were estimated by multiplying the lower catchment value by this factor.

5. Results

5.1 Nitrogen inputs from rainfall

Details of the rainfall in the lower catchment area for the years 1970-74 and 1980-85 are given in Table 5 below.

Table 5.

	Rainfall (lower catchment)	Lower Catchment Kg ha^{-1} N	Upper Catchment Kg ha^{-1} N
1970	911.4	2.72	3.13
1971	704.4	2.11	2.43
1972	984.5	2.94	3.38
1973	629.3	1.88	2.16
1974	1125.3	3.36	3.86
Average 1970-74	870.8	2.60	2.99
1980	540.3	1.61	1.85
1981	1006.4	3.00	3.45
1982	1009.2	3.02	3.47
1983	793.0	2.36	2.71
1984	884.2	2.64	3.04
1985	838.3	2.50	2.88
Average 1980-85	845.2	2.52	2.90

The input of nitrogen in kg ha^{-1} for each year due to rainfall is given, value one using the rainfall in the lower part of the catchment below Dorchester and the other the rainfall above Dorchester. The correct concentration is probably somewhere between these values but is impossible to calculate. However the difference is not very large and the input of nitrogen from rainfall has not changed between the two periods.

5.2 Sewage effluents

The amount of nitrogen entering the River Frome from sewage effluents was calculated by multiplying the approximate dry weather flows in m^3 d^{-1} for each station by a typical analysis of total oxidised nitrogen for that station as provided by the Wessex Water Authority (Table 6).

Also a more detailed estimate was made for Dorchester sewage works (the largest in the R. Frome catchment) by using monthly flows and TON values (Table 6a).

In 1972 the amount of nitrate entering the River Frome from sewage effluent was calculated to be 37.0 tonnes N a^{-1} (Casey 1975). In 1983 using the dry weather flows from Wessex Water Authority it had increased to 47.3 tonnes N a^{-1} (A). If we use the more accurate monthly flow values from Dorchester sewage works the result is 55.9 tonnes N a^{-1} (B). Thus the increase in nitrates due to sewage effluent can be calculated as 27.8% or 51.0% depending upon which value is used.

Table 7 summarises the nitrate input from sewage effluents.

Table 6. Sewage works effluents discharged to River Frome and tributaries 1972 and 1983.

Works	Grid Ref of Outfall	Approx dry weather flow 1972 m^3/d	Approx dry weather flow 1983 m^3/d	Total nitrate and soluble orthophosphate concentrations in 1983: NH_3 mg/l as N	TON mg/l as N	NO_2 mg/l as N	Tonnes/yr
Wool	SY825874	1135	1730	10	6	0.25	3.789
Warmwell	SY765874	N.A.	280	8	15	0.3	1.533
Broadmayne	SY734867	N.A.	300	0.1	18	0.25	1.971
Dorchester	SY712903	4010	6500	1.5	14	0.3	33.215
Bradford Peverell	SY666927	534	650	3	15	0.3	3.558
Cerne Abbas	SY668998	N.A.	145	2	18	0.25	0.953
Maiden Newton	SY602972	227	200	2	34	0.25	1.314
Sydling St Nicholas	SY633984	N.A.	65	0.1	25	0.1	0.593
Toller Porcorum	SY567979	N.A.	30	0.3	13	0.4	0.142
Evershot	SY579044	N.A.	35	0.5	20	0.5	0.255
Total		5906	9935				47.324

Table 6a. Effluent values from Dorchester sewage works.

Month	Mean Flow m^3/d	Monthly means TON	NH_3	NO^2 mg/l	No. of samples	Tonnes/ month
April 83	7835	17	1.2	0.28	3	3.996
May	431	16	1.9	0.29	3	4.182
June	6567	13	1.2	0.25	3	2.561
July	5910	13	1.5	0.24	2	2.382
August	6707	12	1.3	0.22	3	2.495
September	7208	11	1.2	0.30	4	2.379
October	-	13	0.1	0.15	1	2.942
November	7490	16	0.8	0.44	1	3.595
December	8772	14	1.4	0.31	5	3.807
Jan. 1984	10327	15	1.9	0.34	3	4.802
February	10726	13	0.9	0.30	5	3.904
March	8489	18	1.7	0.33	7	4.737
Mean Flow	8042					
Total tonnes/yr						41.78

Table 7. Summary of nitrogen entering R. Frome catchment from sewage effluents.

	1969	1972	1984 (A)	1984 (B)
$m^3\ d^{-1}$	5482	6208	9935	11477
$t^{-1}\ a^{-1}$	33.7	37.0	47.3	55.9
kg ha^{-1}	0.81	0.89	1.14	1.35
Total N load at East Stoke	493.5	596	834	834
% of total N load due to sewage effluent	6.8	6.2	5.7	6.7

5.3 Nitrate concentration, discharge and nitrate loading data

Table 8 gives the nitrate concentration on each sampling date for all 14 sites sampled in 1970-71.

Tables 9 and 10 show the weekly discharge values and nitrate loads in 1970-71 for the 12 sites where discharge was measured or available from Wessex WA, as described in sections 4.1 and 4.2. The number of samples taken at each site, the mean, standard error, minimum and maximum values are given for each site at the bottom of each table.

During 1984-86 sites 1, 3, 4, 5, 6, 7, 9 and 10 were re-sampled. Site 2 in 1970-71 (Wraxall Brook) was replaced by sampling Wraxall Brook and the R. Frome below their confluence at Maiden Newton. In addition, because of the high nitrate concentrations found in the Tadnoll Brook at Broomhill Bridge (site 9) during 1984, a second site on the Tadnoll Brook at Empool (site 8) was also sampled from April 1985 onwards.

Tables 11a and 11b show the nitrate concentrations on each sampling date for all 10 sites sampled during 1984-86. Nitrate concentrations of over 7 mg/l were found on several occasions in the Tadnoll Brook.

Tables 12a and 12b show the weekly discharge values for sites 3, 4, 5, 9 and 10 where data were collected or available, and Tables 13a and 13b give the weekly nitrate loads for these sites. Again the number of samples taken, the mean, standard error, minimum and maximum value for each set of results are given for each site at the end of Tables 12b and 13b.

(1) River Hooke at Maiden Newton (2/12/70 - 8/12/71)
(2) Wraxall Brook (top Frome) (28/10/70 - 8/12/71)
(3) Sydling Water (Grimstone Viaduct) (28/10/70 - 8/12/71)
(4) River Cerne (28/10/70 - 8/12/71)
(5) River Frome Dorchester Gauging Weir (18/11/70 - 8/12/71)
(6) River Frome Woodsford (9/12/70 - 8/12/71)
(7) River Frome Moreton (28/10/70 - 8/12/71)
(8) Tadnoll Brook at Owermoigne (28/10/70 - 8/12/71)
(9) Tadnoll Brook at Broomhill Bridge (28/10/70 - 8/12/71)
(10) River Frome at East Stoke Flume (18/11/70 - 8/12/71)
(11) River Frome head Sandhills (28/10/70 - 8/12/71)
(12) Southover (28/10/70 - 8/12/71)
(13) River Hooke Gauging Weir (28/10/70 - 8/12/71)
(14) Winfrith Stream (28/10/70 - 8/12/71)

Nitrate Concentration (mg/l)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
1970 OCT 28		2.28	1.65	2.30			3.14	4.62	3.38	2.74	1.36	1.58	1.16	1.25
1970 NOV 4		4.01	1.75	2.54			3.40	3.95	3.10	2.94	1.93	2.42	1.17	2.10
1970 NOV 11		2.66	1.98	2.68			3.24	5.80	3.84	3.17	1.64	1.73	1.40	1.96
1970 NOV 18		4.74	3.02	2.84	2.41		2.41	3.02	3.34	3.33	2.58	3.18	1.74	5.66
1970 NOV 25		2.74	3.10	3.54	4.46		3.72	4.38	3.80	2.50	2.04	2.37	2.00	4.24
1970 DEC 2	1.58	2.09	3.14	3.14	2.74		3.90	4.30	4.36	3.34	1.76	2.28	2.00	3.95
1970 DEC 9	1.53	2.34	2.74	3.28	3.17	4.04	4.16	4.89	4.84	3.22	1.96	2.12	2.17	3.40
1970 DEC 16	1.74	1.92	3.32	3.56	3.38	4.02	3.76	5.22	4.58	3.56	1.80	1.74	2.00	2.98
1970 DEC 23										3.92				
1970 DEC 30	1.35	1.80	2.84	2.85	2.48	3.56	3.43	3.94	3.59	3.82	1.82	1.70	1.54	2.20
1971 JAN 6	1.49	1.91	2.73	3.62	2.86	3.76	4.40	4.86	4.18	3.78	1.95	2.00	1.96	2.14
1971 JAN 13	1.53	2.24	2.66	3.28	2.60	3.33	3.42	4.54	3.88	3.48	2.10	1.86	1.76	2.38
1971 JAN 20	1.21	2.63	2.52	3.06	2.50	3.09	3.16	4.03	2.94	2.95	2.25	2.00	1.80	3.32
1971 JAN 27	2.26	3.08	4.49	4.20	3.11	3.75	4.22	4.68	4.02	3.32	2.88	2.71	2.54	3.84
1971 FEB 3	2.14	2.46	3.72	4.10	3.34	3.90	4.24	5.12	4.68	3.60	2.03	2.81	2.83	3.70
1971 FEB 10	2.20	2.28	3.04	3.76	3.04	3.60	3.64	4.98	4.68	3.70	2.18	2.22	2.34	2.84
1971 FEB 17	1.78	2.11	2.57	3.48	2.68	3.56	3.64	4.90	4.46	3.56	1.86	2.02	2.02	3.10
1971 FEB 24	1.90	2.14	2.71	3.45	2.99	3.65	3.66	4.73	4.40	3.56	1.92	2.14	2.35	3.00
1971 MAR 3	1.59	2.20	2.36	3.16	2.68	3.32	3.24	4.46	3.60	2.81	1.92	1.90	2.20	2.89
1971 MAR 10	1.82	1.93	2.61	3.38	2.83	3.64	3.84	4.90	4.62	1.99	1.52	2.11	2.04	2.80
1971 MAR 17	1.64	2.00	2.30	3.14	2.54	3.22	3.14	4.41	3.90	3.15	1.86	1.79	1.84	2.32
1971 MAR 24	1.60	2.08	2.24	3.40	2.50	3.31	3.38	4.27	4.10	2.96	2.06	1.86	1.92	2.43
1971 MAR 31	1.64	1.98	2.21	3.18	2.64	3.18	3.34	4.50	4.16	3.08	2.07	1.92	1.84	2.23
1971 APR 7	1.70	1.98	2.38	3.18	2.59	3.69	3.69	4.58	4.58	3.21	1.79	1.98	1.83	2.04
1971 APR 14	1.18	1.50	1.79	2.74	2.17	2.89	2.90	4.26	3.91	2.71	1.73	1.57	1.42	1.74
1971 APR 21	1.48	1.38	1.48	2.30	1.64	2.20	2.34	4.56	3.34	2.61	1.69	1.38	1.39	1.38
1971 APR 28	1.26	1.83	2.02	2.88	2.36	2.97	3.10	4.33	3.76	2.87	1.71	1.74	1.38	2.10
1971 MAY 5	0.96	1.70	1.79	2.36	1.66	2.55	2.62	4.20	3.31	2.62	1.74	1.36	1.44	1.50
1971 MAY 12	1.10	1.51	1.35	2.38	1.69	2.70	2.64	4.16	3.60	2.54	1.60	1.33	1.38	1.26
1971 MAY 19	1.28	1.80	1.92	2.70	2.21	2.96	3.08	4.44	4.00	2.77	2.08	1.74	1.38	1.28
1971 MAY 26	1.26	1.87	1.96	2.79	2.28	3.01	3.12	4.44	4.00	2.90	2.02	1.82	1.58	1.39
1971 JUN 2	1.14	1.53	1.66	2.45	2.10	2.83	2.80	4.36	4.08	2.61	1.90	1.69	1.15	0.96
1971 JUN 9	0.90	1.64	1.90	2.72	2.02	2.90	2.48	4.40	4.04	2.58	1.84	1.58	1.30	1.10
1971 JUN 16	0.90	1.66	1.99	2.48	1.88	2.64	3.06	4.41	3.72	2.29	1.44	1.59	1.09	1.65
1971 JUN 23	1.10	1.70	1.80	2.42	2.04	2.65	2.81	3.82	3.55	2.29	1.60	1.54	1.49	1.62
1971 JUN 30	1.05	1.90	1.97	2.64	2.08	2.89	3.09	3.94	3.90	2.11	1.74	1.74	1.77	1.49
1971 JUL 7	1.19	1.82	1.66	2.27	1.84	2.46	2.63	3.99	3.07	2.12	1.82	1.62	1.32	1.04
1971 JUL 14	1.30	2.02	1.68	2.57	2.02	2.62	2.61	4.03	2.83	2.44	1.97	1.69	1.68	0.84
1971 JUL 19	1.15	1.38	1.74	2.29	1.82	2.68	2.78	4.22	3.62	2.66	1.92	1.94	1.39	0.61
1971 JUL 28	1.07	1.25	1.66	2.35	1.96	2.78	2.72	4.16	3.50	2.33	1.82	1.59	1.30	1.00
1971 AUG 4	0.98	1.45	1.59	2.11	1.76	2.44	2.58	3.88	3.14	2.14	1.58	1.38	1.06	0.78
1971 AUG 11	0.84	1.88	1.50	2.00	1.58	2.14	2.24	3.98	3.20	2.10	1.58	1.55	1.14	0.86
1971 AUG 18	1.16	1.72	1.40	2.20	1.78	2.45	2.56	4.20	3.26	2.14	1.76	1.56	1.76	0.96
1971 AUG 25	1.15	2.02	1.66	2.33	1.84	2.36	2.70	4.08	3.06	2.20	1.48	1.49	1.48	0.90
1971 SEP 1	1.29	1.70	1.46	1.96	1.68	2.46	2.41	4.02	3.00	2.26	2.08	1.58	1.42	0.84
1971 SEP 8	1.04	1.74	1.30	1.90	1.58	2.30	2.34	3.96	2.82	1.94	1.70	1.36	1.08	0.80
1971 SEP 15	1.26	1.70	1.46	2.18	1.96	2.94	2.76	3.80	3.04	2.24	1.90	1.52	1.16	1.80
1971 SEP 22	1.17	1.63	1.38	2.04	1.84	2.74	2.64	3.79	2.98	2.26	1.96	1.58	1.13	1.13
1971 SEP 29	1.23	1.81	1.42	1.81	1.90	2.80	3.43	3.18	3.15	2.40	1.76	1.51	1.07	1.11
1971 OCT 7	1.42	1.91	1.82	2.32	2.14	3.03	3.24	4.10	3.58	2.58	1.82	1.85	1.16	1.40
1971 OCT 13	1.32	1.57	1.34	2.22	1.54	2.72	2.96	3.62	3.00	2.42	1.67	1.38	1.20	1.29
1971 OCT 20	1.04	4.50	1.67	1.98	2.21	2.72	2.84	3.65	2.77	2.34	1.38	1.82	1.18	1.06
1971 OCT 27	1.07	1.64	1.80	2.00	1.98	2.95	2.93	4.02	3.05	2.48	1.75	1.73	1.19	1.04
1971 NOV 3	1.04	1.55	1.54	2.03	1.80	2.78	2.80	3.68	2.88	2.52	1.64	1.54	1.16	1.04
1971 NOV 10	1.16	1.82	2.25	2.48	2.18	2.99	3.16	4.80	3.58	2.82	1.82	1.73	1.54	1.45
1971 NOV 17	1.48	1.76	2.67	2.52	2.44	3.32	3.48	4.74	3.59	3.02	1.98	1.80	1.48	1.70
1971 NOV 24	1.48	4.26	2.36	2.46	2.67	3.06	3.32	4.63	3.76	3.10	2.06	2.68	1.70	1.64
1971 DEC 1	1.73	4.49	2.35	2.46	3.09	3.25	3.08	4.54	3.63	2.66	2.10	2.82	1.78	1.26
1971 DEC 8	1.24	2.38	2.22	2.61	2.52	3.27	3.43	4.58	3.87	2.80	1.76	2.06	1.60	1.80
N	53	58	58	58	55	52	58	58	58	59	58	58	58	58
Mean	1.36	2.13	2.13	2.71	2.32	3.02	3.14	4.31	3.67	2.79	1.86	1.85	1.59	1.91
S.E.	0.05	0.10	0.09	0.08	0.08	0.07	0.07	0.06	0.07	0.07	0.03	0.05	0.05	0.14
Min.	0.84	1.25	1.30	1.81	1.54	2.14	2.24	3.02	2.77	1.94	1.36	1.33	1.06	0.61
Max.	2.26	4.74	4.49	4.20	4.46	4.04	4.40	5.80	4.84	3.92	2.88	3.18	2.83	5.66

Table 8. Nitrate concentrations for all sites in 1970-71

(1) River Hooke at Maiden Newton (2/12/70 - 8/12/71)
(2) Wraxall Brook (top Frome) (28/10/70 - 8/12/71)
(3) Sydling Water (Grimstone Viaduct) (28/10/70 - 8/12/71)
(4) River Cerne (28/10/70 - 8/12/71)
(5) River Frome Dorchester Gauging Weir (18/11/70 - 8/12/71)
(6) River Frome Woodsford (9/12/70 - 8/12/71)
(7) River Frome Moreton (28/10/70 - 8/12/71)
(8) Tadnoll Brook at Owermoigne (28/10/70 - 8/12/71)
(9) Tadnoll Brook at Broomhill Bridge (28/10/70 - 8/12/71)
(10) River Frome at East Stoke Flume (18/11/70 - 8/12/71)
(11) River Frome head Sandhills (28/10/70 - 8/12/71)
(12) Southover (28/10/70 - 8/12/71)
(13) River Hooke Gauging Weir (28/10/70 - 8/12/71)
(14) Winfrith Stream (28/10/70 - 8/12/71)

Daily Flow (cu.m/s)

	(1)	(2)	(3)	(4)	(5)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
1970 OCT 28		0.18	0.14	0.11	0.71	0.28	0.35	2.19	0.12	0.60	0.08	0.02
1970 NOV 4		0.34	0.17	0.19	1.12	0.37	0.45	2.87	0.17	1.05	0.09	0.04
1970 NOV 11		0.27	0.17	0.13	1.24	0.38	0.48	3.55	0.14	1.05	0.09	0.05
1970 NOV 18		0.49	0.31	0.40	3.13	0.97		6.54	0.49	2.74	0.19	0.26
1970 NOV 25		0.58	0.49	0.77	4.24	0.59		9.73	0.24	2.17	0.21	0.17
1970 DEC 2	0.65	0.34	0.51	0.69	3.96	0.65	1.03	8.10	0.23	1.88	0.17	0.17
1970 DEC 9	0.60	0.34	0.34	0.56	3.31	0.61	0.92	7.18	0.21	1.52	0.23	0.12
1970 DEC 16	0.53	0.23	0.25	0.53	2.67	0.62	0.84	5.94	0.14	1.46	0.19	0.08
1970 DEC 23					2.42			5.50				
1970 DEC 30	0.67	0.27	0.14	0.42	2.18	0.65	0.95	5.15	0.17	1.53	0.20	0.08
1971 JAN 6	0.61	0.25	0.35	0.40	2.03	0.60	0.77	4.80	0.23	1.37	0.20	0.05
1971 JAN 13	0.67	0.31	0.55	0.60	3.66	0.52	0.82	7.68	0.18	1.75	0.20	0.07
1971 JAN 20	1.17	0.76	0.59	0.69	3.22	0.74	1.65	7.17	0.41	2.79	0.24	0.32
1971 JAN 27	2.03	0.92	1.33	1.95	7.72	0.82	1.51	16.74	0.43	5.45	0.41	0.29
1971 FEB 3	1.29	0.78	0.73	1.67	6.14	0.90	1.20	14.53	0.25	3.62	0.48	0.16
1971 FEB 10	0.97	0.38	0.45	1.20	4.24	0.88	1.15	10.60	0.20	2.93	0.28	0.11
1971 FEB 17	1.47	0.45	0.45	1.03	3.47	0.94	1.14	9.05	0.26	2.60	0.46	0.10
1971 FEB 24	0.95	0.30	0.32	0.83	2.70	0.75	0.94	8.05	0.23	2.09	0.36	0.08
1971 MAR 3	0.97	0.46	0.23	0.72	3.34	0.72	1.15	8.06	0.23	2.35	0.33	0.14
1971 MAR 10	0.77	0.26	0.35	0.61	2.78	0.62	0.86	6.31	0.29	1.81	0.31	0.08
1971 MAR 17	0.82	0.33	0.36	0.58	3.07	0.65	0.85	6.32	0.23	1.97	0.29	0.07
1971 MAR 24	0.76	0.29	0.37	0.59	3.40	0.60	0.80	7.49	0.18	1.81	0.33	0.07
1971 MAR 31	0.72	0.18	0.30	0.54	2.46	0.61	0.72	5.60	0.19	1.67	0.21	0.06
1971 APR 7	0.67	0.18	0.29	0.49	2.25	0.56	0.70	5.03	0.23	1.57	0.26	0.04
1971 APR 14	0.67	0.22	0.23	0.39	2.17	0.57	0.69	4.95	0.14	1.55	0.24	0.05
1971 APR 21	0.53	0.20	0.20	0.29	1.82	0.50	0.58	4.51	0.21	1.46	0.18	0.05
1971 APR 28	0.62	0.19	0.35	0.36	2.02	0.57	0.64	6.05	0.23	1.52	0.23	0.06
1971 MAY 5	0.52	0.15	0.36	0.49	1.53	0.53	0.57	4.58	0.11	1.26	0.23	0.03
1971 MAY 12	0.48	0.22	0.39	0.33	1.34	0.51	0.48	3.88	0.11	1.21	0.24	0.04
1971 MAY 19	0.46	0.14	0.35	0.31	1.18	0.44	0.46	3.55	0.10	1.15	0.20	0.04
1971 MAY 26	0.48	0.18	0.32	0.24	1.11	0.45	0.45	3.28	0.17	0.92	0.17	0.03
1971 JUN 2	0.45	0.19	0.32	0.25	1.34	0.41	0.44	3.24	0.14	0.99	0.17	0.04
1971 JUN 9	0.45	0.19	0.27	0.26	1.12	0.38	0.40	3.01	0.12	0.99	0.17	0.04
1971 JUN 16	0.52	0.30	0.30	0.29	1.96	0.43	0.55	6.02	0.15	1.24	0.17	0.05
1971 JUN 23	0.54	0.22	0.31	0.31	1.72	0.44	0.51	5.45	0.17	1.13	0.19	0.06
1971 JUN 30	0.47	0.21	0.29	0.31	1.36	0.42	0.47	4.52	0.12	1.01	0.14	0.05
1971 JUL 7	0.33	0.15	0.25	0.26	1.05	0.38	0.35	3.08	0.12	0.84	0.12	0.04
1971 JUL 14	0.29	0.10	0.23	0.22	0.87	0.33	0.34	2.78	0.12	0.66	0.12	0.03
1971 JUL 19	0.33	0.09	0.23	0.22	0.80	0.37	0.38	2.75	0.10	0.63	0.14	0.03
1971 JUL 28	0.41	0.11	0.18	0.20	0.95	0.37	0.36	2.81	0.12	0.86	0.12	0.03
1971 AUG 4	0.38	0.14	0.21	0.13	0.96	0.39	0.36	2.84	0.12	0.81	0.14	0.03
1971 AUG 11	0.53	0.20	0.21	0.16	1.04	0.27	0.33	2.93	0.18	0.85	0.14	0.02
1971 AUG 18	0.38	0.15	0.20	0.14	1.14	0.33	0.32	3.05	0.16	0.67	0.14	0.02
1971 AUG 25	0.35	0.08	0.21	0.15	0.99	0.30	0.33	2.90	0.13	0.67	0.13	0.02
1971 SEP 1	0.41	0.10	0.22	0.14	0.85	0.34	0.33	2.44	0.12	0.70	0.13	0.03
1971 SEP 8	0.42	0.08	0.19	0.11	0.79	0.31	0.33	2.41	0.12	0.60	0.10	0.02
1971 SEP 15	0.36	0.11	0.18	0.13	0.71	0.30	0.29	2.35	0.10	0.63	0.11	0.03
1971 SEP 22	0.34	0.09	0.18	0.10	0.69	0.24	0.24	2.26	0.12	0.57	0.10	0.02
1971 SEP 29	0.32	0.12	0.17	0.12	0.71	0.32	0.29	2.25	0.10	0.58	0.11	0.02
1971 OCT 7	0.32	0.13	0.16	0.09	0.68	0.25	0.25	2.18	0.11	0.63	0.10	0.03
1971 OCT 13	0.37	0.14	0.17	0.10	0.68	0.28	0.31	2.16	0.12	0.57	0.12	0.03
1971 OCT 20	0.42	0.20	0.17	0.13	1.20	0.35	0.40	2.45	0.12	0.87	0.11	0.03
1971 OCT 27	0.35	0.11	0.16	0.10	0.56	0.28	0.29	2.15	0.11	0.59	0.11	0.03
1971 NOV 3	0.28	0.13	0.15	0.09	0.42	0.32	0.32	2.08	0.10	0.63	0.11	0.03
1971 NOV 10	0.31	0.11	0.13	0.07	0.64	0.34	0.35	2.43	0.09	0.73	0.11	0.03
1971 NOV 17	0.28	0.11	0.15	0.08	0.63	0.33	0.30	2.47	0.09	0.68	0.09	0.03
1971 NOV 24	0.43	0.21	0.16	0.11	1.13	0.32	0.42	3.32	0.14	1.20	0.14	0.04
1971 DEC 1	0.58	0.32	0.17	0.10	1.28	0.38	0.47	3.07	0.11	1.32	0.11	0.04
1971 DEC 8	0.38	0.12	0.20	0.12	1.16	0.33	0.40	3.32	0.12	0.94	0.10	0.04
N	53	58	58	58	59	58	56	59	58	58	58	58
Mean	0.59	0.25	0.29	0.39	1.93	0.48	0.59	4.87	0.17	1.37	0.19	0.07
S.E.	0.04	0.02	0.02	0.05	0.19	0.02	0.04	0.39	0.01	0.12	0.01	0.01
Min.	0.28	0.08	0.13	0.07	0.42	0.24	0.24	2.08	0.09	0.57	0.08	0.02
Max.	2.03	0.92	1.33	1.95	7.72	0.97	1.65	16.74	0.49	5.45	0.48	0.32

Table 9. Discharge values for each site in 1970-71

(1) River Hooke at Maiden Newton (2/12/70 - 8/12/71)
(2) Wraxall Brook (top Frome) (28/10/70 - 8/12/71)
(3) Sydling Water (Grimstone Viaduct) (28/10/70 - 8/12/71)
(4) River Cerne (28/10/70 - 8/12/71)
(5) River Frome Dorchester Gauging Weir (18/11/70 - 8/12/71)
(6) River Frome Woodsford (9/12/70 - 8/12/71)
(7) River Frome Moreton (28/10/70 - 8/12/71)
(8) Tadnoll Brook at Owermoigne (28/10/70 - 8/12/71)
(9) Tadnoll Brook at Broomhill Bridge (28/10/70 - 8/12/71)
(10) River Frome at East Stoke Flume (18/11/70 - 8/12/71)
(11) River Frome head Sandhills (28/10/70 - 8/12/71)
(12) Southover (28/10/70 - 8/12/71)
(13) River Hooke Gauging Weir (28/10/70 - 8/12/71)
(14) Winfrith Stream (28/10/70 - 8/12/71)

Nitrate Load (tonnes/week)

	(1)	(2)	(3)	(4)	(5)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
1970 OCT 28		0.241	0.136	0.153		0.782	0.715	4.316	0.099	0.573	0.056	0.016
1970 NOV 4		0.825	0.182	0.296		0.874	0.846	6.202	0.197	1.543	0.062	0.047
1970 NOV 11		0.434	0.201	0.212		1.319	1.124	8.376	0.137	1.099	0.078	0.062
1970 NOV 18		1.410	0.561	0.690	1.806	1.779		16.249	0.768	5.270	0.202	0.890
1970 NOV 25		0.966	0.913	1.659	9.015	1.574		20.080	0.292	3.115	0.256	0.436
1970 DEC 2	0.621	0.427	0.969	1.314	9.544	1.698	2.711	17.022	0.242	2.591	0.202	0.406
1970 DEC 9	0.559	0.487	0.570	1.107	6.320	1.801	2.690	16.478	0.249	1.953	0.299	0.243
1970 DEC 16	0.555	0.264	0.492	1.139	5.795	1.967	2.332	14.249	0.148	1.537	0.231	0.141
1970 DEC 23					2.508			14.610				
1970 DEC 30	0.547	0.299	0.237	0.726	0.734	1.549	2.069	14.504	0.192	1.572	0.186	0.109
1971 JAN 6	0.545	0.292	0.575	0.874	3.685	1.752	1.944	13.199	0.265	1.661	0.235	0.067
1971 JAN 13	0.623	0.417	0.890	1.192	6.586	1.425	1.920	19.447	0.224	1.967	0.211	0.107
1971 JAN 20	0.856	1.212	0.902	1.279	5.390	1.794	2.934	16.124	0.559	3.375	0.266	0.641
1971 JAN 27	2.776	1.717	3.623	4.943	13.346	2.312	3.659	34.094	0.742	8.934	0.625	0.683
1971 FEB 3	1.664	1.156	1.636	4.146	12.413	2.775	3.394	33.047	0.308	6.156	0.813	0.349
1971 FEB 10	1.288	0.525	0.824	2.738	8.777	2.635	3.249	25.988	0.270	3.934	0.396	0.184
1971 FEB 17	1.587	0.569	0.704	2.159	6.525	2.783	3.086	22.607	0.295	3.176	0.566	0.182
1971 FEB 24	1.089	0.388	0.518	1.740	5.043	2.146	2.509	19.199	0.272	2.699	0.513	0.151
1971 MAR 3	0.930	0.612	0.331	1.380	6.216	1.942	2.497	17.155	0.264	2.696	0.443	0.246
1971 MAR 10	0.852	0.306	0.552	1.253	5.066	1.840	2.395	11.147	0.270	2.305	0.381	0.132
1971 MAR 17	0.817	0.405	0.494	1.105	5.434	1.723	2.012	11.595	0.256	2.133	0.322	0.098
1971 MAR 24	0.737	0.364	0.497	1.213	5.600	1.549	1.974	16.099	0.222	2.037	0.380	0.110
1971 MAR 31	0.715	0.220	0.406	1.033	4.232	1.660	1.819	11.809	0.237	1.944	0.231	0.077
1971 APR 7	0.685	0.218	0.417	0.939	3.998	1.565	1.939	11.390	0.249	1.881	0.290	0.049
1971 APR 14	0.479	0.199	0.245	0.643	3.573	1.469	1.629	10.993	0.149	1.469	0.203	0.051
1971 APR 21	0.472	0.169	0.175	0.403	2.463	1.379	1.182	9.053	0.211	1.221	0.150	0.043
1971 APR 28	0.470	0.209	0.425	0.627	2.682	1.482	1.460	12.299	0.241	1.600	0.188	0.080
1971 MAY 5	0.305	0.157	0.385	0.705	2.243	1.339	1.137	8.933	0.112	1.033	0.202	0.031
1971 MAY 12	0.317	0.198	0.322	0.482	1.630	1.293	1.047	7.354	0.107	0.972	0.200	0.027
1971 MAY 19	0.353	0.157	0.401	0.513	1.679	1.168	1.123	6.840	0.131	1.206	0.164	0.028
1971 MAY 26	0.366	0.201	0.378	0.403	1.870	1.198	1.086	6.802	0.205	1.015	0.161	0.026
1971 JUN 2	0.308	0.171	0.317	0.372	2.148	1.073	1.096	6.737	0.165	1.014	0.118	0.021
1971 JUN 9	0.247	0.187	0.315	0.431	1.738	1.009	0.975	5.532	0.132	0.943	0.133	0.027
1971 JUN 16	0.286	0.301	0.365	0.427	2.652	1.150	1.231	11.155	0.134	1.192	0.113	0.055
1971 JUN 23	0.357	0.227	0.337	0.451	2.342	1.010	1.095	9.177	0.160	1.052	0.169	0.063
1971 JUN 30	0.296	0.238	0.342	0.489	2.023	0.991	1.104	6.929	0.127	1.063	0.151	0.044
1971 JUL 7	0.239	0.164	0.256	0.358	1.579	0.919	0.652	4.486	0.136	0.821	0.099	0.028
1971 JUL 14	0.226	0.117	0.233	0.345	1.325	0.799	0.589	4.273	0.138	0.678	0.121	0.016
1971 JUL 19	0.232	0.077	0.238	0.307	1.257	0.952	0.823	4.521	0.110	0.745	0.114	0.013
1971 JUL 28	0.264	0.081	0.185	0.291	1.393	0.931	0.766	4.577	0.129	0.827	0.093	0.021
1971 AUG 4	0.228	0.119	0.201	0.166	1.390	0.906	0.687	4.112	0.112	0.672	0.093	0.013
1971 AUG 11	0.268	0.227	0.188	0.198	1.329	0.662	0.644	4.013	0.176	0.794	0.099	0.012
1971 AUG 18	0.263	0.156	0.168	0.190	1.417	0.831	0.635	4.184	0.168	0.628	0.147	0.015
1971 AUG 25	0.243	0.101	0.207	0.207	1.375	0.733	0.611	4.291	0.117	0.605	0.120	0.011
1971 SEP 1	0.323	0.099	0.194	0.162	1.202	0.817	0.608	3.713	0.151	0.666	0.108	0.014
1971 SEP 8	0.265	0.087	0.145	0.130	1.050	0.747	0.561	3.382	0.121	0.496	0.068	0.010
1971 SEP 15	0.272	0.110	0.160	0.167	1.037	0.699	0.537	3.107	0.110	0.575	0.074	0.028
1971 SEP 22	0.239	0.088	0.146	0.128	1.107	0.543	0.434	3.258	0.147	0.549	0.065	0.017
1971 SEP 29	0.240	0.127	0.146	0.136	1.101	0.619	0.556	3.358	0.102	0.526	0.072	0.015
1971 OCT 7	0.276	0.149	0.177	0.121	1.039	0.615	0.539	3.535	0.123	0.707	0.070	0.025
1971 OCT 13	0.294	0.134	0.135	0.136	0.957	0.617	0.572	3.692	0.121	0.474	0.085	0.023
1971 OCT 20	0.266	0.542	0.169	0.151	1.545	0.773	0.677	4.424	0.098	0.957	0.081	0.021
1971 OCT 27	0.226	0.108	0.170	0.120	1.118	0.678	0.539	3.725	0.121	0.622	0.082	0.018
1971 NOV 3	0.179	0.123	0.139	0.112	0.903	0.703	0.561	3.651	0.097	0.586	0.080	0.019
1971 NOV 10	0.220	0.121	0.182	0.109	1.104	0.999	0.756	4.396	0.100	0.762	0.103	0.025
1971 NOV 17	0.252	0.114	0.242	0.116	1.143	0.940	0.656	4.367	0.108	0.744	0.081	0.028
1971 NOV 24	0.383	0.541	0.224	0.167	2.174	0.890	0.953	6.840	0.176	1.948	0.145	0.043
1971 DEC 1	0.608	0.872	0.242	0.147	2.718	1.035	1.038	6.587	0.142	2.251	0.119	0.033
1971 DEC 8	0.286	0.168	0.267	0.194	2.641	0.920	0.936	6.288	0.123	1.174	0.093	0.045
N	53	58	58	58	56	58	56	59	58	58	58	58
Mean	0.528	0.355	0.432	0.748	3.339	1.278	1.381	10.094	0.199	1.668	0.197	0.111
S.E.	0.063	0.046	0.067	0.121	0.390	0.073	0.117	0.942	0.017	0.197	0.020	0.023
Min.	0.179	0.077	0.135	0.109	0.734	0.543	0.434	3.107	0.097	0.474	0.056	0.010
Max.	2.776	1.717	3.623	4.943	13.346	2.783	3.659	34.094	0.768	8.934	0.813	0.890

Table 10. Weekly nitrate loads (tonnes/week) for each site in 1970-71

(1) River Hooke at Maiden Newton (11/4/84 - 30/9/86)
(2) River Frome at Maiden Newton (11/4/84 - 30/9/86)
(3) Sydling Water (Grimstone Viaduct) (11/4/84 - 30/9/86)
(4) River Cerne (11/4/84 - 30/9/86)
(5) River Frome Dorchester Guaging Weir (11/4/84 - 30/9/86)
(6) River Frome Woodsford (11/4/84 - 30/9/86)
(7) River Frome Moreton (11/4/84 - 30/9/86)
(8) Tadnoll Brook at Empool (17/4/85 - 30/9/86)
(9) Tadnoll Brook at Broomhill Bridge (11/4/84 - 30/9/86)
(10) River Frome at East Stoke Flume (11/4/84 - 30/9/86)

Nitrate Concentration (mg/l)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1984 APR 11	3.14	3.22	3.22	3.60	3.48	4.46	4.64		5.31	4.46
1984 APR 18	3.06	3.08	3.16	3.30	4.64	4.10	4.24		4.89	3.86
1984 APR 25	2.64	2.86	2.84	3.32	2.98	4.02	3.91		4.36	3.76
1984 MAY 2	3.10	2.96	2.96	3.28	3.06	4.20	4.22		4.50	3.90
1984 MAY 9	3.14	3.14	2.85	3.78	3.42	4.45	4.50		4.50	3.97
1984 MAY 16	3.14	2.93	3.45	3.58	3.58	4.73	4.47		4.51	4.01
1984 MAY 23	2.21	3.31	3.76	3.01	3.08	3.88	4.17		4.13	3.78
1984 MAY 29	2.60	2.76	4.02	3.54	3.00	4.40	4.40		9.56	3.50
1984 JUN 4	2.40	2.80	2.80	2.96	3.32	3.70	3.56		3.78	3.16
1984 JUN 13	2.53	2.67	3.08	3.47	3.82	4.52	4.20		4.33	3.36
1984 JUN 20	2.76	3.07	2.93	3.47	3.39	3.97	3.45		4.09	3.08
1984 JUN 27	2.79	3.05	2.93	2.90	3.05	3.44	3.61		3.83	3.57
1984 JUL 4										
1984 JUL 11	2.92	2.43	2.55	2.92	3.08	3.78	3.47		4.24	3.56
1984 JUL 18	2.71	3.22	2.75	2.72	3.51	3.78	3.94		4.51	4.25
1984 JUL 25	2.35	2.89	2.75	2.72	2.92	3.83	3.37		4.40	3.33
1984 AUG 1	2.67	2.39	2.88	2.84	3.00	3.53	3.12		4.45	2.93
1984 AUG 8	2.21	2.57	3.00	2.79	3.41	3.67	3.70		4.68	3.39
1984 AUG 15	2.74	2.85	2.67	2.77	3.20	3.89	3.60		4.53	4.38
1984 AUG 22	2.75	2.63	2.84	2.36	2.90	3.56	2.99		2.78	3.31
1984 AUG 29	2.83	2.71	2.88	2.85	3.15	4.23	3.43		4.79	3.55
1984 SEP 5	2.63	2.25	2.38	2.16	2.48	2.98	2.85		4.19	2.82
1984 SEP 12	2.83	2.52	2.82	2.59	3.03	2.52	3.22		4.80	3.54
1984 SEP 19	2.17	2.40	2.30	2.05	2.60	3.70	3.20		4.22	3.37
1984 SEP 26	2.35	3.27	2.60	2.62	3.12	3.57	3.35		3.60	3.35
1984 OCT 3	2.05	3.27	2.37	2.47	2.35	2.95	2.75		2.75	2.50
1984 OCT 10	2.13	2.66	2.94	2.47	2.52	4.16	3.77		3.73	3.38
1984 OCT 17	2.24	2.60	2.97	2.36	3.03	3.80	3.49		3.99	3.23
1984 OCT 22	2.45	3.70	2.44	2.50	3.28	4.78	4.40		3.48	3.54
1984 OCT 31	2.19	3.66	2.95	2.91	3.14	4.06	3.77		4.43	3.60
1984 NOV 7	1.98	4.08	2.78	3.06	3.18	4.01	3.77		4.21	3.68
1984 NOV 14	2.22	3.78	3.00	4.09	3.11	4.20	4.23		7.36	4.59
1984 NOV 21	2.04	4.60	2.80	2.89	2.79	3.75	3.98		7.68	4.25
1984 NOV 28	2.18	2.99	3.76	4.51	3.94	4.41	4.67		7.20	4.85
1984 DEC 5	2.64	3.87	3.70	4.51	3.84	4.41	4.60		6.76	4.85
1984 DEC 12	3.73	3.36	3.99	4.57	4.10	4.63	4.96		5.85	4.29
1984 DEC 18	3.13	3.80	4.08	4.49	4.00	4.59	4.45		7.10	4.60
1984 DEC 25										
1985 JAN 3	4.04	3.72	4.11	4.65	4.38	5.58	5.68		6.44	5.85
1985 JAN 10	3.95	3.55	3.92	4.77	3.81	5.20	5.05		6.02	5.33
1985 JAN 16	4.12	3.46	3.67	4.66	4.12	5.16	5.12		5.76	5.42
1985 JAN 23	4.14	4.19	4.05	4.98	4.60	5.83	5.94		6.68	5.74
1985 JAN 30	3.81	3.51	7.02	4.90	3.80	4.78	4.33		5.67	4.25
1985 FEB 6	3.91	3.92	3.99	5.00	4.32	5.23	5.31		6.15	5.07
1985 FEB 13	4.77	4.03	4.26	4.73	4.73	5.56	5.73		6.05	5.59
1985 FEB 20	4.38	3.92	4.13	4.84	4.84	5.60	5.94		6.58	6.40
1985 FEB 27	4.14	3.46	3.95	4.95	4.68	5.32	5.26		5.79	5.45
1985 MAR 6	3.48	3.46	4.51	4.51	4.13	5.21	5.26		5.75	4.87
1985 MAR 13	4.51	3.56	3.77	4.68	4.25	5.11	5.26		5.74	4.95
1985 MAR 20	4.14	3.90	3.73	4.78	4.36	5.40	5.43		5.54	5.29
1985 MAR 23	2.86	3.78	3.54	3.72	3.72	4.31	4.45		5.16	4.26
1985 APR 3	3.17	4.17	3.55	4.21	4.21	4.79	4.74		4.99	4.39
1985 APR 10	3.17	3.86	3.59	4.10	3.83	4.77	4.91		5.47	4.68
1985 APR 17	3.18	4.00	3.74	4.26	3.78	4.60	4.15	6.18	5.04	4.01
1985 APR 24	3.92	3.78	3.71	3.98	3.98	4.50	4.64	6.08	5.17	4.51
1985 MAY 1	3.34	3.13	3.37	4.18	3.76	3.97	4.42	5.03	4.32	4.19
1985 MAY 8	3.07	6.24	3.04	3.76	3.48	4.01	4.88	5.50	4.73	3.82
1985 MAY 15	3.41	3.41	3.39	3.68	3.66	4.68	4.47	5.80	5.01	4.25
1985 MAY 22	2.20	2.84	3.23	4.19	3.82	4.46	4.42	5.38	4.91	3.92
1985 MAY 29	2.81	3.13	3.06	3.33	3.33	4.41	4.13	4.74	4.57	3.90

Table 11 A. Nitrate concentrations for all sites in 1984-85

1985 JUN 3	3.01	2.97	2.89	3.40	3.40	4.33	3.92	4.94	4.44	3.99
1985 JUN 12	3.08	3.22	3.38	3.77	3.60	5.14	4.28	5.56	4.99	3.91
1985 JUN 19	3.44	3.15	3.06	3.46	3.50	4.45	4.02	5.16	4.64	3.95
1985 JUN 26	2.78	2.90	3.08	3.42	3.46	6.76	4.36	4.98	4.64	4.58
1985 JUL 3	2.92	2.99	3.04	3.33	3.16	3.85	3.79	4.89	3.91	3.30
1985 JUL 9	2.99	2.82	3.07	2.99	3.12	3.93	3.54	4.68	3.88	3.28
1985 JUL 17	2.52	2.48	2.70	2.80	3.04	3.73	3.44	4.15	4.10	3.19
1985 JUL 24	2.41	2.35	2.80	3.00	3.11	3.60	3.56	4.72	4.05	3.20
1985 JUL 31	2.08	2.46	2.79	2.87	2.75	3.50	3.27	4.64	4.23	2.82
1985 AUG 7	1.90	2.51	2.72	2.84	3.09	3.68	3.55	4.76	3.76	3.05
1985 AUG 14	1.99	2.25	2.78	2.45	2.84	3.72	3.66	5.02	4.21	3.16
1985 AUG 21	2.46	2.82	3.37	3.34	3.28	3.78	3.82	4.98	4.02	3.55
1985 AUG 27	2.18	3.32	2.92	3.08	3.48	4.10	4.00	6.20	4.58	3.88
1985 SEP 2	2.66	3.02	3.02	2.90	3.26	4.02	4.12	5.36	4.00	3.20
1985 SEP 11	2.74	2.90	3.05	2.77	3.42	3.98	3.87	4.48	3.66	3.43
1985 SEP 18	2.90	2.83	3.18	3.24	3.48	4.19	3.99	5.22	4.33	3.79
1985 SEP 25	2.40	2.95	2.51	3.16	3.40	3.88	3.87	4.95	4.10	3.44
1985 OCT 2	3.21	2.92	2.81	2.99	3.50	4.13	3.99	4.85	4.43	3.75
1985 OCT 9	3.34	3.56	3.45	3.21	3.33	4.51	4.20	5.06	3.31	3.51
1985 OCT 16	2.84	3.14	3.24	3.14	3.82	4.48	4.52	5.40	4.36	3.92
1985 OCT 21	2.88	3.00	3.13	3.52	3.62	4.98	4.58	5.16	4.46	4.40
1985 OCT 30	2.95	3.12	3.15	3.63	3.82	4.62	4.66	5.45	4.77	4.13
1985 NOV 6	2.95	3.21	3.49	3.60	3.90	4.79	4.64	5.48	4.50	4.10
1985 NOV 11	2.25	2.78	3.04	3.34	3.51	4.46	4.20	5.45	4.57	3.75
1985 NOV 20	2.24	3.12	3.59	3.38	3.41	4.82	4.37	5.62	4.60	4.12
1985 NOV 27	3.32	3.60	3.67	4.04	4.20	5.18	5.94	5.50	5.00	4.52
1985 DEC 4	2.78	4.12	3.58	3.61	4.50	4.84	4.65	6.07	6.31	4.17
1985 DEC 11	2.34	3.68	3.86	4.26	3.65	4.60	4.53	6.17	6.33	4.84
1985 DEC 18	2.96	3.77	3.76	4.32	3.99	4.60	4.67	5.80	5.92	4.78
1985 DEC 25										
1986 JAN 2	2.73	3.22	4.26	4.60	3.66	3.88	3.82	5.52	5.06	4.65
1986 JAN 8	3.44	3.79	4.65	4.67	3.45	3.85	4.03	6.20	4.50	4.09
1986 JAN 15	5.32	4.52	5.05	5.81	5.33	6.29	6.07	7.28	6.70	5.95
1986 JAN 22	4.77	4.49	4.76	5.79	5.17	6.00	5.82	7.20	6.46	5.63
1986 JAN 29	2.12	2.72	4.14	3.90	2.40	3.82	4.32	5.17	3.44	4.74
1986 FEB 6	5.11	4.02	4.58	5.40	4.72	5.36	5.64	6.64	6.02	5.54
1986 FEB 10	4.83	4.09	4.24	5.29	4.81	5.85	5.65	6.88	6.19	5.46
1986 FEB 19	4.58	3.98	4.11	5.35	4.63	5.57	5.58	6.40	5.89	5.28
1986 FEB 26	4.90	3.92	4.08	5.18	4.68	5.45	5.50	6.66	5.93	5.45
1986 MAR 4	4.54	4.03	3.91	4.85	4.66	5.71	5.42	6.14	5.83	5.54
1986 MAR 12	3.93	3.76	3.95	5.11	4.25	5.01	4.87	6.06	5.47	4.96
1986 MAR 19	3.36	3.60	3.90	4.40	4.36	5.28	5.58	6.34	5.22	5.54
1986 MAR 26	3.90	4.41	4.10	4.44	4.50	5.08	5.12	6.32	5.17	5.00
1986 APR 2	3.86	4.09	3.86	4.19	4.04	5.08	4.98	6.00	5.48	5.00
1986 APR 9	3.13	4.25	4.02	4.20	4.21	5.05	4.99	6.07	5.07	4.51
1986 APR 16	2.28	4.60	3.48	3.44	4.32	4.35	4.50	5.51	3.97	4.36
1986 APR 22	2.83	4.13	3.66	4.25	3.72	4.51	4.40	5.70	4.49	4.30
1986 APR 30	3.55	3.76	3.97	4.50	3.82	4.37	4.32	5.56	4.80	4.37
1986 MAY 7	3.53	3.70	3.65	3.54	3.49	3.79	4.24	5.55	4.47	3.92
1986 MAY 14	2.75	3.44	3.44	3.58	3.43	4.10	4.05	5.26	4.40	3.60
1986 MAY 20	0.93	2.57	2.70	2.54	2.94	4.36	4.00	3.98	3.50	3.91
1986 MAY 28	3.34	3.59	3.88	4.36	3.69	4.60	4.32	5.22	3.53	4.39
1986 JUN 4	3.30	3.34	3.27	4.00	3.69	4.31	4.12	5.24	4.47	4.03
1986 JUN 11	2.62	3.44	3.42	3.97	3.44	4.35	3.90	4.78	4.56	4.00
1986 JUN 18	3.36	3.20	3.00	3.93	3.32	4.10	3.81	5.17	4.55	3.86
1986 JUN 25	3.18	3.00	3.38	3.70	3.70	4.50	4.30	5.22	4.84	3.76
1986 JUL 2	3.40	3.49	3.07	3.42	3.73	4.22	4.27	5.42	4.51	3.85
1986 JUL 9	2.80	3.18	3.33	3.96	3.50	4.16	3.93	5.23	4.85	4.13
1986 JUL 16	2.93	3.21	2.89	3.43	3.37	4.09	4.14	4.94	4.16	3.46
1986 JUL 22	3.51	3.03	3.09	3.45	3.62	4.13	4.57	4.81	4.14	3.77
1986 JUL 30	2.75	2.55	3.18	3.33	2.99	3.81	3.76	4.64	4.29	3.33
1986 AUG 6	2.74	2.66	2.71	2.72	2.99	3.78	3.81	5.06	4.04	3.38
1986 AUG 13	2.98	2.51	2.89	3.36	2.91	3.88	3.93	4.96	3.88	3.29
1986 AUG 20	2.62	2.37	2.94	2.92	3.30	4.26	3.99	5.09	3.56	3.56
1986 AUG 26	2.02	4.13	2.19	1.73	1.59	2.75	2.67	4.30	2.80	2.77
1986 SEP 3	2.65	2.79	3.02	2.88	3.49	4.09	4.12	4.77	3.84	3.60
1986 SEP 10	2.79	2.46	2.77	3.15	2.85	3.93	3.85	4.73	3.91	3.47
1986 SEP 15	2.33	2.46	2.76	3.09	3.18	4.09	3.87	4.80	4.21	3.33
1986 SEP 22	2.90	2.72	2.80	3.04	3.26	3.90	4.08	4.88	4.20	3.76
1986 SEP 30	3.26	3.40	3.26	3.34	3.70	4.60	4.70	4.90	4.58	4.10
N	127	127	127	127	127	127	127	76	127	127
Mean	3.03	3.31	3.36	3.65	3.59	4.39	4.31	5.39	4.82	4.10
S.E.	0.07	0.06	0.06	0.08	0.06	0.06	0.06	0.08	0.09	0.07
Min.	0.93	2.25	2.19	1.73	1.59	2.52	2.67	3.98	2.75	2.50
Max.	5.32	6.24	7.02	5.81	5.33	6.76	6.07	7.28	9.56	6.40

Table 11 B. Nitrate concentrations for all sites in 1985-86

(1) River Hooke at Maiden Newton
(2) River Frome at Maiden Newton
(3) Sydling Water
(4) River Cerne
(5) River Frome Dorchester Guaging Weir
(6) River Frome Woodsford
(7) River Frome Moreton
(8) Tadnoll Brook at Empool
(9) Tadnoll Brook at Broomhill Bridge
(10) River Frome at East Stoke Flume

Daily Flow (cu.m/s)

	(3)	(4)	(5)	(9)	(10)
1984 APR 11			1.93	0.58	5.56
1984 APR 18	0.45	0.30	1.69	0.55	4.91
1984 APR 25	0.46	0.32	1.76		4.49
1984 MAY 2	0.46	0.20	1.75	0.50	4.41
1984 MAY 9	0.45	0.30	1.80	0.54	4.60
1984 MAY 16	0.38	0.20	2.33	0.57	5.24
1984 MAY 23	0.34	0.20	1.97	0.53	8.45
1984 MAY 29	0.30	0.20	1.62	0.56	7.26
1984 JUN 4	0.30	0.18	1.87	0.47	4.68
1984 JUN 13	0.26	0.18	1.33	0.38	3.38
1984 JUN 20	0.30	0.10	1.13	0.31	3.00
1984 JUN 27	0.20	0.10	1.05	0.31	2.69
1984 JUL 4			1.03		2.53
1984 JUL 11	0.20	0.10	1.06		2.50
1984 JUL 18	0.20	0.10	1.03	0.37	2.52
1984 JUL 25	0.20	0.10	1.06	0.38	2.61
1984 AUG 1	0.20	0.10	0.95	0.40	2.45
1984 AUG 8	0.20	0.10	1.06	0.39	2.84
1984 AUG 15	0.20	0.10	0.89		2.40
1984 AUG 22	0.20	0.10	0.87	0.60	2.32
1984 AUG 29	0.20	0.10	0.80	0.40	2.34
1984 SEP 5	0.20	0.10	0.84	0.39	2.42
1984 SEP 12	0.20	0.10	0.82	0.39	2.28
1984 SEP 19	0.20	0.10	0.81	0.44	2.28
1984 SEP 26	0.20	0.10	1.20	0.40	3.11
1984 OCT 3	0.20	0.10	1.03	0.44	2.83
1984 OCT 10	0.20	0.10	1.04	0.39	2.80
1984 OCT 17	0.20	0.10	0.82	0.42	2.42
1984 OCT 22	0.22	0.20	2.47	0.42	4.20
1984 OCT 31	0.22	0.20	1.44	0.43	3.51
1984 NOV 7	0.22	0.20	2.51	0.50	4.24
1984 NOV 14	0.30	0.30	2.33	0.59	5.13
1984 NOV 21	0.36	0.40	4.00		7.84
1984 NOV 28	0.68	0.54	4.73		7.89
1984 DEC 5	0.70	0.56	5.48	0.55	9.28
1984 DEC 12	0.72	0.58	3.98		7.06
1984 DEC 18	0.62	0.58	4.56		8.87
1984 DEC 25			5.33		10.40
1985 JAN 3	0.70	0.60	5.13		10.04
1985 JAN 10	0.70	0.46	4.33		8.77
1985 JAN 16	0.54	0.46	3.65		7.76
1985 JAN 23	0.68	0.54	5.64		12.37
1985 JAN 30	0.78	0.64	6.29		13.06
1985 FEB 6	0.76	0.70	5.40		11.13
1985 FEB 13	0.78	0.64	5.37		11.48
1985 FEB 20	0.74	0.55	4.69		10.11
1985 FEB 27	0.56	0.50	4.07		8.96
1985 MAR 6	0.48	0.46	3.88		8.38
1985 MAR 13	0.46	0.42	3.39		7.43
1985 MAR 20	0.46	0.42	3.15		6.75
1985 MAR 23	0.46	0.46	3.51		7.77
1985 APR 3	0.44	0.58	3.84		8.20
1985 APR 10	0.48	0.80	4.66		8.04
1985 APR 17	0.59	0.69	3.97		7.42
1985 APR 24	0.58	0.69	3.63		6.71
1985 MAY 1	0.50	0.36	3.00		6.34
1985 MAY 8	0.50	0.36	3.04		5.96
1985 MAY 15	0.52	0.36	2.48		5.91
1985 MAY 22	0.50	0.36	2.78		6.80
1985 MAY 29	0.50	0.28	2.16		6.39

Table 12 a. Discharge values for sites during 1984-85

1985	JUN 3	0.50	0.30	1.73		4.99
1985	JUN 12	0.50	0.20	1.66		3.93
1985	JUN 19	0.53	0.20	1.63		4.13
1985	JUN 26	0.40	0.22	1.50		3.70
1985	JUL 3	0.36	0.20	1.30		3.17
1985	JUL 9	0.32	0.20	1.25		2.92
1985	JUL 17	0.32	0.20	1.23		2.85
1985	JUL 24	0.30	0.20	1.16		2.89
1985	JUL 31	0.30	0.22	1.32		3.30
1985	AUG 7	0.32	0.24	1.64		3.82
1985	AUG 14	0.34	0.20	1.77		4.43
1985	AUG 21	0.37	0.24	1.39		3.62
1985	AUG 27	0.29	0.24	1.83		3.76
1985	SEP 2	0.30	0.24	3.09		4.29
1985	SEP 11	0.38	0.20	1.56		3.46
1985	SEP 18	0.37	0.20	1.41		3.17
1985	SEP 25	0.37	0.20	1.28		3.07
1985	OCT 2	0.37	0.22	1.34		2.87
1985	OCT 9	0.38	0.18	2.23		4.65
1985	OCT 16	0.28	0.19	1.26		3.12
1985	OCT 21	0.27	0.22	1.36		3.00
1985	OCT 30	0.24	0.21	1.16		2.90
1985	NOV 6	0.24	0.18	1.14		2.85
1985	NOV 11	0.28	0.19	1.35		3.55
1985	NOV 20	0.28	0.18	1.30		3.32
1985	NOV 27	0.28	0.16	1.21		3.03
1985	DEC 4	0.32	0.18	3.04		6.15
1985	DEC 11	0.58	0.20	3.66		7.17
1985	DEC 18	0.51	0.20	2.57		5.13
1985	DEC 25			9.35		13.49
1986	JAN 2	0.84	0.44	10.29	1.15	16.07
1986	JAN 8	1.10	0.50	11.76	1.00	22.53
1986	JAN 15	1.10	0.65	8.42	0.78	15.87
1986	JAN 22	0.84	0.65	8.47	1.11	14.98
1986	JAN 29	1.00	2.00	10.94	1.11	20.31
1986	FEB 6	0.90	0.34	5.88	0.84	11.45
1986	FEB 10	0.73	0.42	5.22	0.82	10.29
1986	FEB 19	0.58	0.38	4.15	0.75	8.55
1986	FEB 26	0.62	0.35	3.52	0.74	7.34
1986	MAR 4	0.44	0.40	3.58	0.63	7.34
1986	MAR 12	0.40	0.30	3.08	0.67	6.49
1986	MAR 19	0.38	0.30	3.12	0.66	6.41
1986	MAR 26	0.38	0.26	3.36	0.59	6.91
1986	APR 2	0.38	0.20	3.08	0.67	6.32
1986	APR 9	0.46	0.18	2.99	0.62	6.28
1986	APR 16	0.38	0.18	5.04	0.73	9.48
1986	APR 22	0.40	0.18	3.73	0.68	8.03
1986	APR 30	0.38	0.18	3.04	0.61	5.96
1986	MAY 7	0.37	0.18	3.04	0.60	5.93
1986	MAY 14	0.36	0.17	3.32	0.63	6.00
1986	MAY 20	0.96	0.50	6.64	0.93	11.41
1986	MAY 28	0.50	0.18	3.43	0.63	6.62
1986	JUN 4	0.46	0.18	3.22	0.66	6.49
1986	JUN 11	0.42	0.16	3.44	0.68	7.63
1986	JUN 18	0.38	0.16	2.56	0.50	6.43
1986	JUN 25	0.36	0.15	2.53	0.52	6.96
1986	JUL 2	0.36	0.12	1.98	0.55	5.06
1986	JUL 9	0.37	0.12	1.80	0.50	4.08
1986	JUL 16	0.35	0.10	1.70	0.47	3.82
1986	JUL 22	0.37	0.12	1.63	0.43	3.54
1986	JUL 30	0.35	0.10	1.70	0.36	3.94
1986	AUG 6	0.34	0.10	1.52	0.37	4.46
1986	AUG 13	0.34	0.10	1.41	0.35	4.37
1986	AUG 20	0.34	0.08	1.58	0.35	2.52
1986	AUG 26	0.43	0.20	5.50	0.52	8.11
1986	SEP 3	0.34	0.08	1.82	0.40	2.89
1986	SEP 10	0.28	0.08	1.54		2.30
1986	SEP 15	0.28	0.09	2.22		3.56
1986	SEP 22	0.36	0.09	1.49		2.42
1986	SEP 30	0.32	0.09	1.43		2.26
	N	126	126	130	65	130
	Mean	0.43	0.28	2.87	0.57	5.98
	S.E.	0.02	0.02	0.19	0.02	0.32
	Min.	0.20	0.08	0.80	0.31	2.26
	Max.	1.10	2.00	11.76	1.15	22.53

Table 12 B. Discharge values for sites during 1985-86

(1) River Hooke at Maiden Newton
(2) River Frome at Maiden Newton
(3) Sydling Water
(4) River Cerne
(5) River Frome Dorchester Guaging Weir
(6) River Frome Woodsford
(7) River Frome Moreton
(8) Tadnoll Brook at Empool
(9) Tadnoll Brook at Broomhill Bridge
(10) River Frome at East Stoke Flume

Nitrate Load (tonnes/week)

	(3)	(4)	(5)	(9)	(10)
1984 APR 11			4.294	1.863	15.822
1984 APR 18	0.860	0.599	4.188	1.627	13.245
1984 APR 25	0.790	0.643	4.377		10.809
1984 MAY 2	0.823	0.397	2.576	1.361	10.089
1984 MAY 9	0.776	0.686	3.265	1.470	10.628
1984 MAY 16	0.793	0.433	4.207	1.555	11.583
1984 MAY 23	0.773	0.364	3.735	1.324	14.356
1984 MAY 29	0.729	0.428	3.353	3.238	16.837
1984 JUN 4	0.508	0.322	3.639	1.074	11.597
1984 JUN 13	0.484	0.378	3.042	0.995	7.076
1984 JUN 20	0.532	0.210	2.719	0.767	6.155
1984 JUN 27	0.354	0.175	2.157	0.718	5.683
1984 JUL 4					
1984 JUL 11	0.308	0.177	1.921		5.500
1984 JUL 18	0.333	0.165	2.129	1.009	6.090
1984 JUL 25	0.333	0.165	1.986	1.011	5.751
1984 AUG 1	0.348	0.172	1.702	1.077	4.618
1984 AUG 8	0.363	0.169	2.464	1.104	5.682
1984 AUG 15	0.323	0.169	1.883		5.780
1984 AUG 22	0.344	0.143	1.577	1.009	5.617
1984 AUG 29	0.348	0.172	1.530	1.159	4.956
1984 SEP 5	0.288	0.131	1.406	0.988	4.623
1984 SEP 12	0.341	0.157	1.371	1.132	4.443
1984 SEP 19	0.278	0.124	1.403	1.123	4.714
1984 SEP 26	0.314	0.158	1.845	0.871	5.471
1984 OCT 3	0.287	0.149	2.060	0.732	5.445
1984 OCT 10	0.356	0.149	1.312	0.880	4.463
1984 OCT 17	0.359	0.143	1.383	1.014	4.976
1984 OCT 22	0.325	0.302	2.690	0.884	5.947
1984 OCT 31	0.393	0.352	3.692	1.152	9.747
1984 NOV 7	0.370	0.370	3.370	1.273	8.166
1984 NOV 14	0.544	0.742	5.330	2.626	14.621
1984 NOV 21	0.610	0.699	4.318		14.372
1984 NOV 28	1.546	1.473	10.332		28.755
1984 DEC 5	1.566	1.527	11.292	2.249	24.732
1984 DEC 12	1.737	1.603	10.473		22.246
1984 DEC 18	1.530	1.575	11.764		23.176
1984 DEC 25					
1985 JAN 3	1.740	1.687	14.857		38.959
1985 JAN 10	1.660	1.327	11.706		31.669
1985 JAN 16	1.199	1.296	9.450		26.819
1985 JAN 23	1.666	1.626	15.481		41.070
1985 JAN 30	3.312	1.897	16.659		42.179
1985 FEB 6	1.834	2.117	13.983		32.929
1985 FEB 13	2.010	1.831	17.215		44.658
1985 FEB 20	1.848	1.610	14.228		37.886
1985 FEB 27	1.338	1.497	12.625		34.700
1985 MAR 6	1.309	1.255	11.218		28.515
1985 MAR 13	1.049	1.189	9.487		24.300
1985 MAR 20	1.038	1.214	8.300		21.420
1985 MAR 23	0.985	1.035	8.517		21.891
1985 APR 3	0.945	1.477	9.686		22.220
1985 APR 10	1.042	1.984	10.311		22.572
1985 APR 17	1.335	1.778	10.486		23.654
1985 APR 24	1.301	1.661	8.814		18.077
1985 MAY 1	1.019	0.910	7.771		17.438
1985 MAY 8	0.919	0.819	6.555		15.069
1985 MAY 15	1.066	0.801	5.691		14.155
1985 MAY 22	0.977	0.912	5.405		14.375
1985 MAY 29	0.925	0.564	5.293		15.765
1985 JUN 3	0.874	0.617	4.053		14.620
1985 JUN 12	1.022	0.456	3.690		9.797
1985 JUN 19	0.981	0.419	3.369		8.927
1985 JUN 26	0.745	0.455	3.720		10.601

Table 13 A. Nitrate loads in tonnes per week during 1984-85

1985 JUL 3	0.662	0.403	2.806		8.416
1985 JUL 9	0.594	0.362	2.436		6.083
1985 JUL 17	0.523	0.339	2.338		5.652
1985 JUL 24	0.508	0.363	2.386		5.790
1985 JUL 31	0.506	0.382	2.546		6.077
1985 AUG 7	0.526	0.412	3.253		7.577
1985 AUG 14	0.572	0.296	3.133		7.496
1985 AUG 21	0.754	0.485	2.625		7.389
1985 AUG 27	0.512	0.447	4.212		9.854
1985 SEP 2	0.548	0.421	3.542		7.846
1985 SEP 11	0.701	0.335	3.539		8.263
1985 SEP 18	0.712	0.392	3.215		7.168
1985 SEP 25	0.562	0.382	2.811		6.910
1985 OCT 2	0.629	0.398	2.740		6.363
1985 OCT 9	0.793	0.349	3.783		8.575
1985 OCT 16	0.549	0.361	2.948		7.474
1985 OCT 21	0.511	0.468	2.858		7.649
1985 OCT 30	0.457	0.461	2.635		7.492
1985 NOV 6	0.507	0.392	2.714		7.221
1985 NOV 11	0.515	0.384	3.225		8.266
1985 NOV 20	0.608	0.368	3.104		8.511
1985 NOV 27	0.621	0.391	2.776		8.053
1985 DEC 4	0.693	0.393	6.467		14.275
1985 DEC 11	1.354	0.515	11.384		24.739
1985 DEC 18	1.160	0.523	6.413		16.489
1985 DEC 25					
1986 JAN 2	2.164	1.224	17.493	3.519	34.346
1986 JAN 8	3.094	1.412	21.130	2.722	45.219
1986 JAN 15	3.360	2.284	25.298	3.161	54.253
1986 JAN 22	2.418	2.276	23.676	4.337	49.535
1986 JAN 29	2.504	4.717	16.997	2.309	44.552
1986 FEB 6	2.493	1.110	13.127	3.058	37.970
1986 FEB 10	1.872	1.344	16.563	3.070	37.279
1986 FEB 19	1.442	1.230	12.876	2.672	29.819
1986 FEB 26	1.530	1.097	10.757	2.654	25.519
1986 MAR 4	1.040	1.173	9.703	2.221	23.791
1986 MAR 12	0.956	0.927	8.995	2.217	22.195
1986 MAR 19	0.896	0.798	7.871	2.084	19.656
1986 MAR 26	0.942	0.698	8.614	1.845	22.448
1986 APR 2	0.887	0.507	9.226	2.221	21.881
1986 APR 9	1.118	0.457	7.490	1.901	17.547
1986 APR 16	0.800	0.374	8.998	1.753	17.878
1986 APR 22	0.885	0.463	9.909	1.847	21.303
1986 APR 30	0.912	0.490	7.494	1.771	17.002
1986 MAY 7	0.817	0.385	6.892	1.622	15.255
1986 MAY 14	0.749	0.368	6.695	1.677	13.769
1986 MAY 20	1.568	0.768	8.475	1.969	17.793
1986 MAY 28	1.173	0.475	7.114	1.345	17.799
1986 JUN 4	0.910	0.435	7.508	1.784	16.912
1986 JUN 11	0.869	0.384	6.942	1.875	16.356
1986 JUN 18	0.689	0.380	5.686	1.376	15.927
1986 JUN 25	0.736	0.336	5.379	1.522	15.731
1986 JUL 2	0.668	0.248	4.920	1.500	13.684
1986 JUL 9	0.745	0.287	4.236	1.467	12.199
1986 JUL 16	0.612	0.207	3.738	1.183	9.409
1986 JUL 22	0.691	0.250	3.478	1.077	7.936
1986 JUL 30	0.673	0.201	3.269	0.934	7.842
1986 AUG 6	0.557	0.165	3.004	0.904	9.082
1986 AUG 13	0.594	0.203	2.646	0.821	8.840
1986 AUG 20	0.605	0.141	2.971	0.754	8.184
1986 AUG 26	0.570	0.209	3.680	0.881	7.179
1986 SEP 3	0.621	0.139	2.866	0.929	6.102
1986 SEP 10	0.469	0.152	3.175		5.380
1986 SEP 15	0.467	0.168	3.262		5.549
1986 SEP 22	0.610	0.165	3.175		5.681
1986 SEP 30	0.631	0.182	2.969		5.353
N	126	126	127	65	127
Mean	0.925	0.690	6.359	1.635	15.762
S.E.	0.054	0.058	0.437	0.098	1.004
Min.	0.278	0.124	1.312	0.718	4.443
Max.	3.360	4.717	25.298	4.337	54.253

Table 13 B. Nitrate loads in tonnes per week during 1985-86

5.4 Changes in nitrate concentration and nitrate loadings between 1970-71 and 1984-86

Figures 5-9 give graphical comparisons of the nitrate concentrations for 1970-71 (in red) and 1984-86 (in black) for 10 sites. The 1970-71 data is superimposed on the 1984-86 data with the months aligned so as to give the most meaningful visual comparison. Note that sites 2 and 8 are slightly different but roughly comparable sampling points for the two periods. At every site, the nitrate concentrations are clearly seen to have increased. The seasonal pattern at each site appears to be unchanged.

For completeness, Figs 10 and 11 show the 1970-71 nitrate concentrations for the River Frome at Sandhills and Southover, the River Hooke gauging weir and Winfrith stream which were not re-sampled during 1984-86.

Changes in nitrate loadings could only be obtained for five sites because of the restricted sampling for discharge in 1984-86, but these sites give us a picture of the pattern of changes down the catchment. The two major sampling sites were at Dorchester gauging weir and at East Stoke gauging weir 20 km downstream. The nitrate loads passing these two sites in 1970-71 (in red) and 1984-86 (in black) are shown in Fig. 12. At both sites the loads are seen to have increased throughout the seasonal cycle. Loadings were, and still are, higher during the November-May period, peaking in January or February. The increase and seasonal pattern of the loadings was similar at the other lower-load sites.

Table 14 summarises the nitrate concentrations for the eight sites sampled in both periods, together with the nitrate loads for the five of these sites for which discharges and hence loads were available for both periods. It gives the percentage increase or decrease in mean value at each site between the two sampling periods. The increases

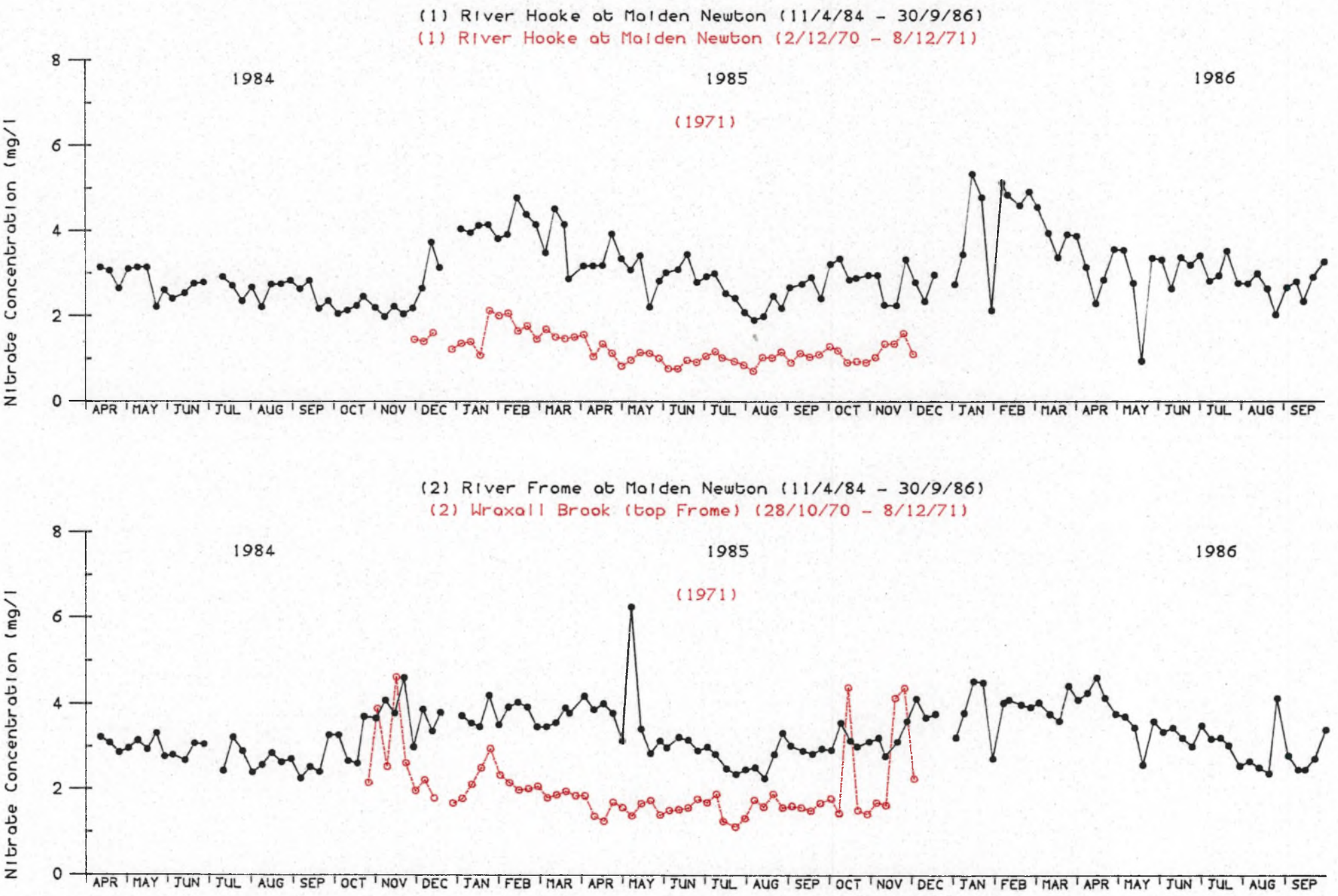

Figure 5 : Changes in river Nitrate Concentration (NO3-N mg/l) between 1970-71 and 1984-86 at sites in the River Frome Catchment.

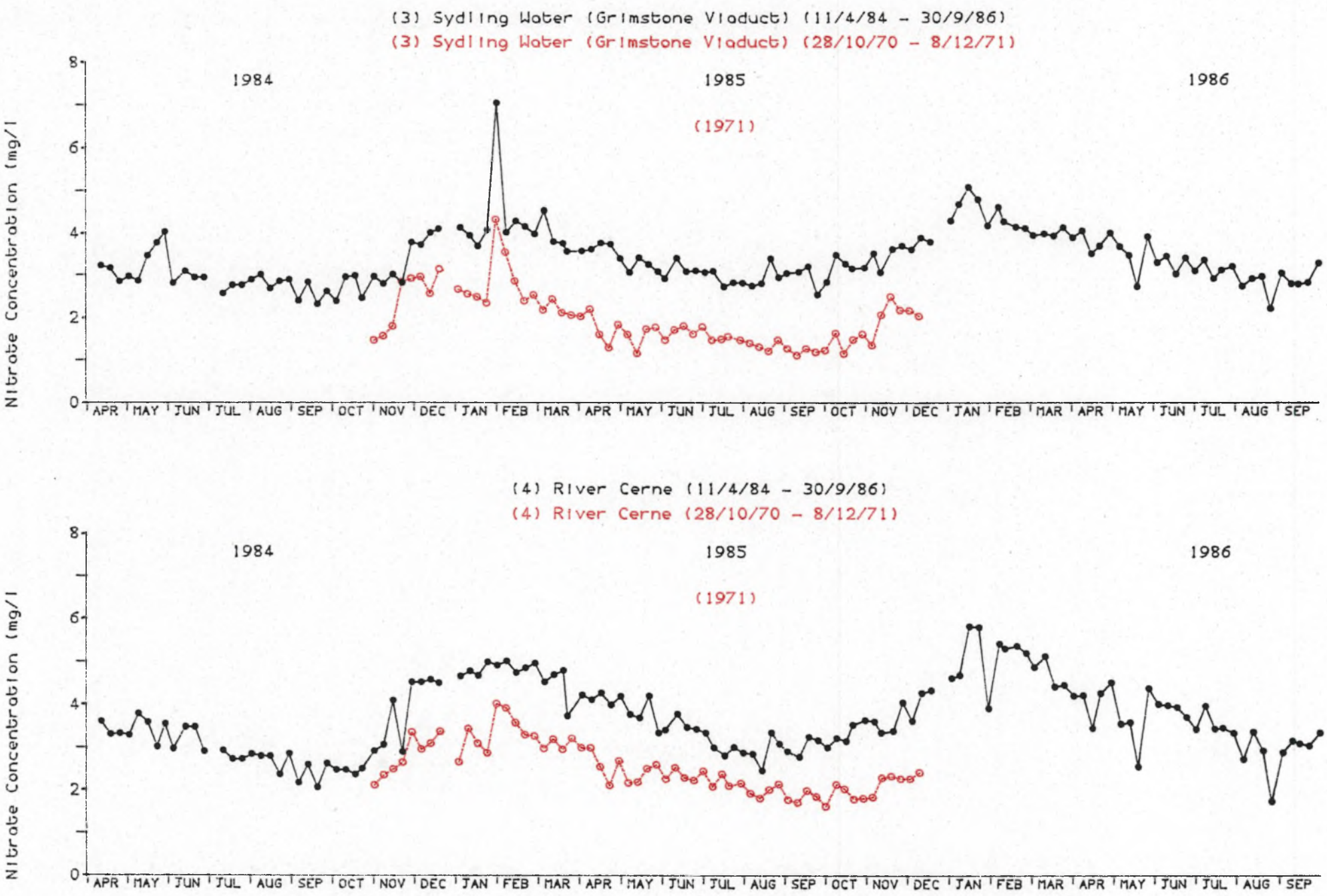

Figure 6 : Changes in river Nitrate Concentration (NO3-N mg/l) between 1970-71 and 1984-86 at sites in the River Frome Catchment.

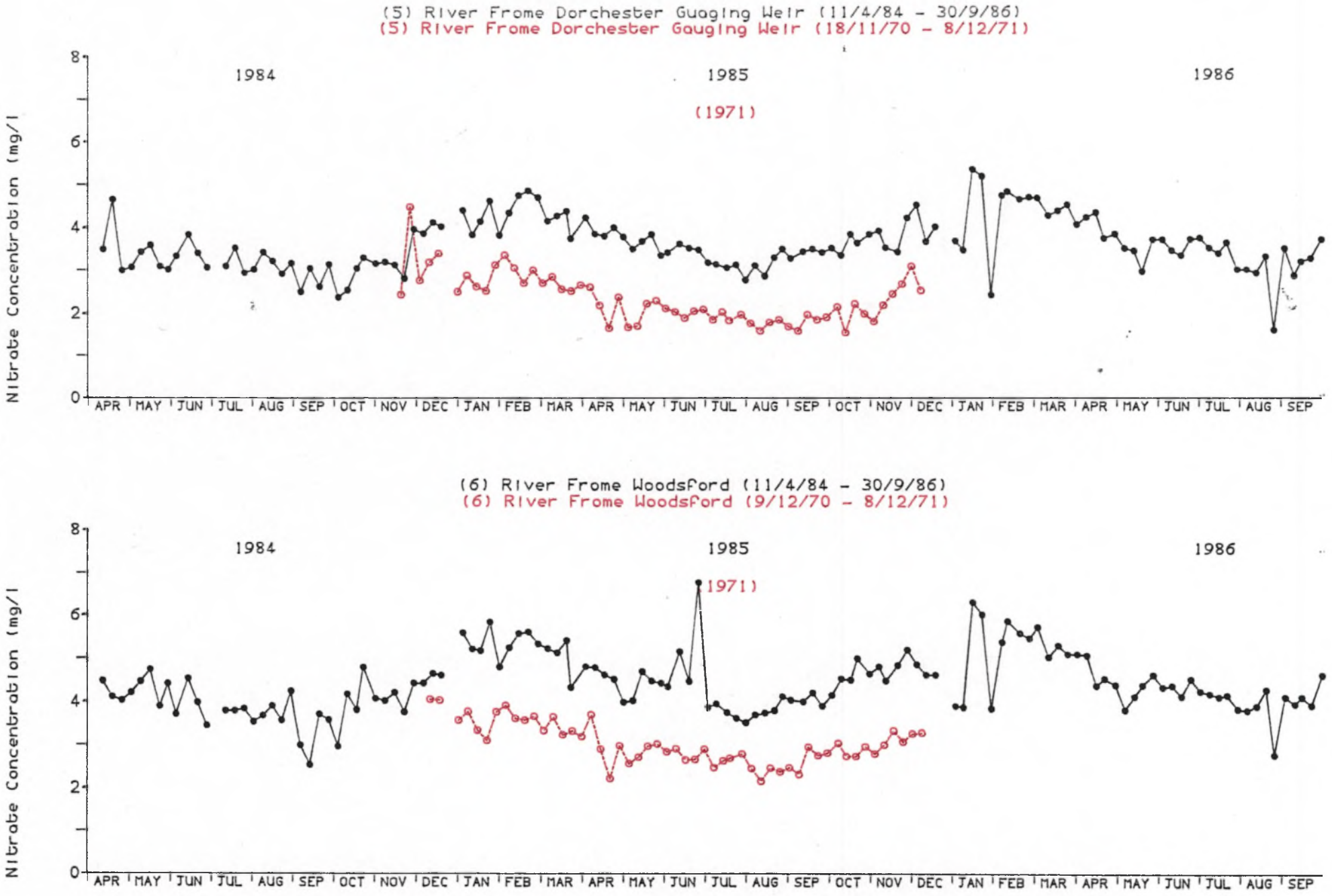

Figure 7 : Changes in river Nitrate Concentration (NO3-N mg/l) between 1970-71 and 1984-86 at sites in the River Frome Catchment.

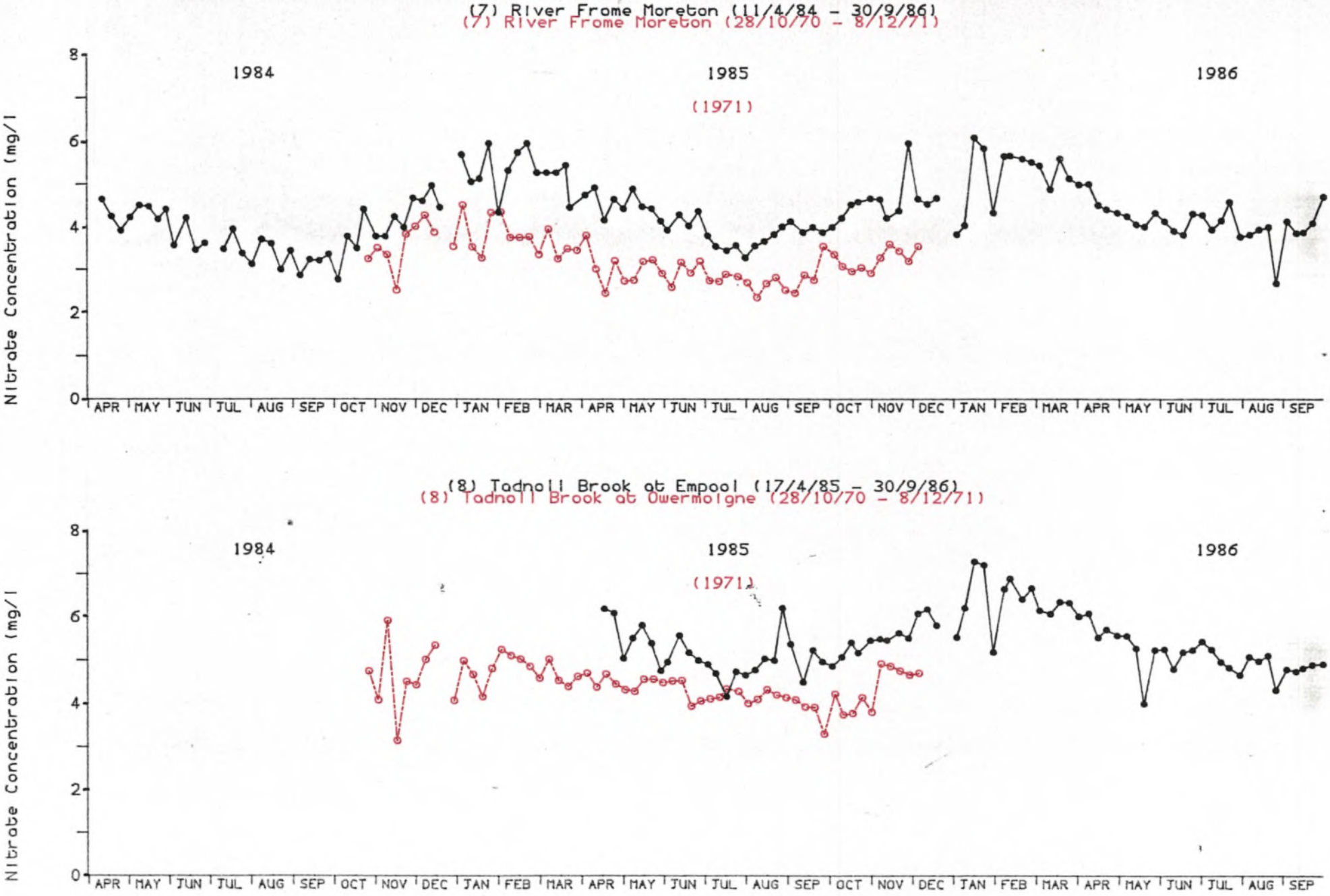

Figure 8 : Changes in river Nitrate Concentration (NO3-N mg/l) between 1970-71 and 1984-86 at sites in the River Frome Catchment.

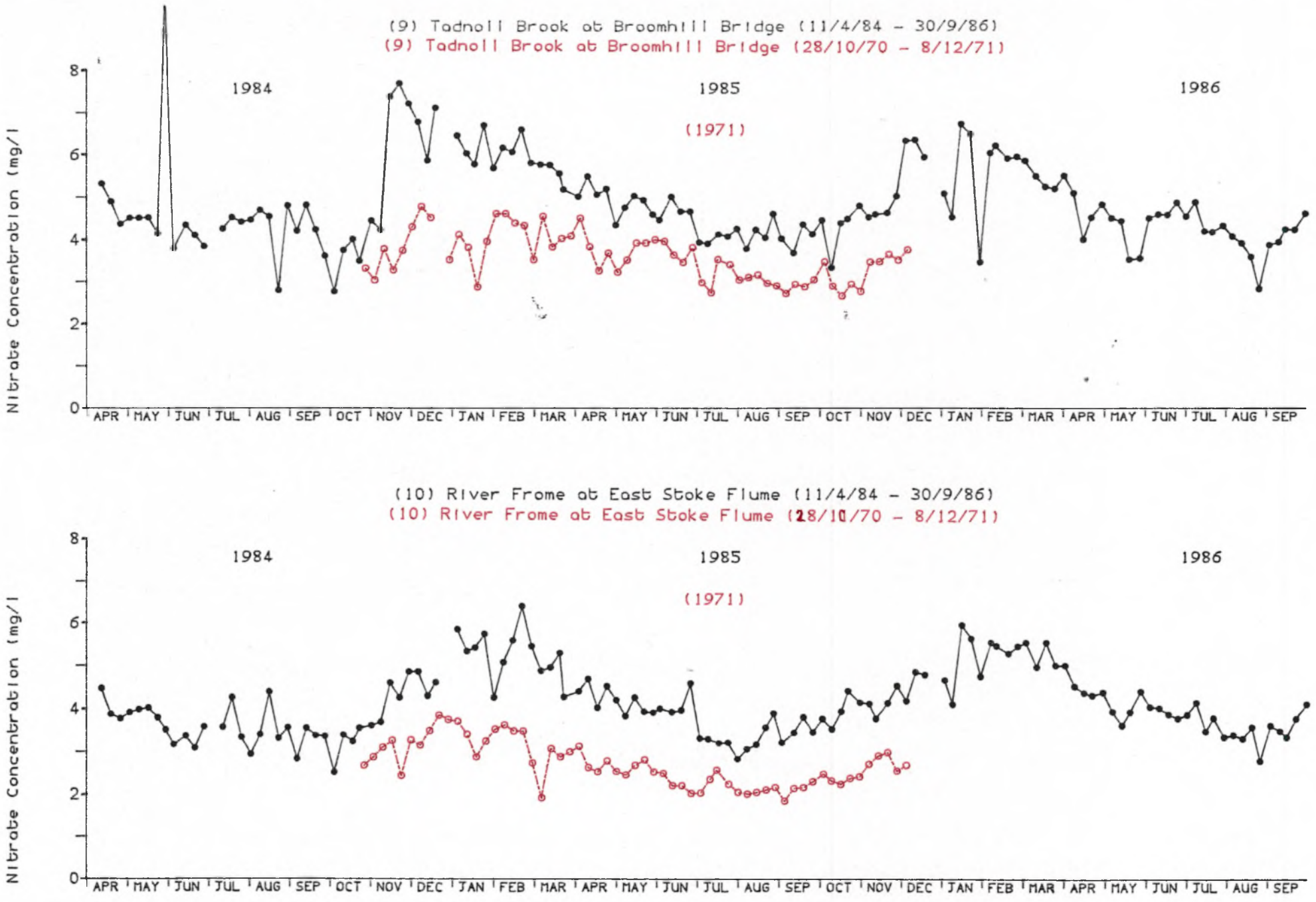

Figure 9 : Changes in river Nitrate Concentration (NO3-N mg/l) between 1970-71 and 1984-86 at sites in the River Frome Catchment.

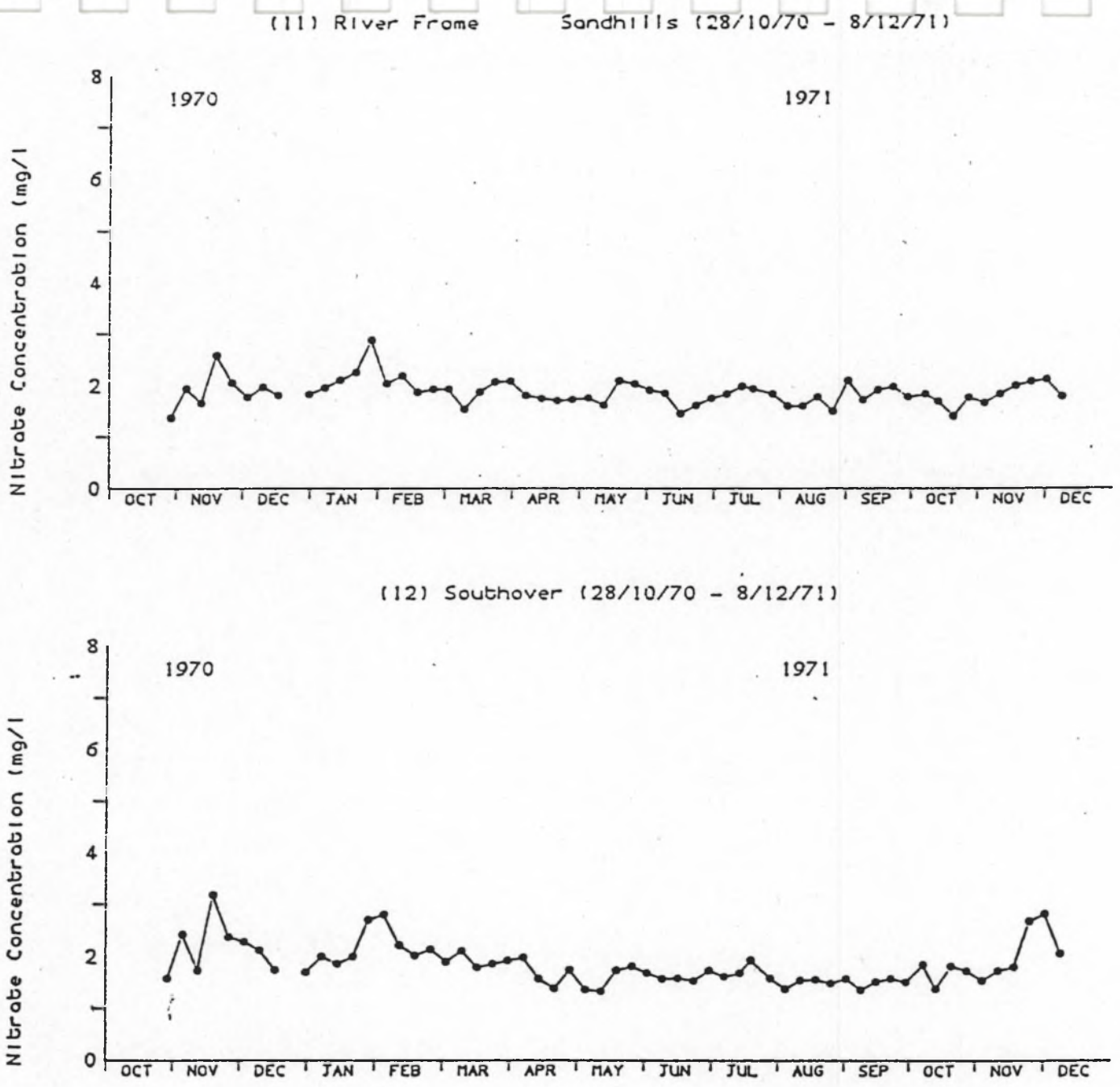

Figure 10. Nitrate concentrations in 1970-71 for sites not re-sampled in 1984-86

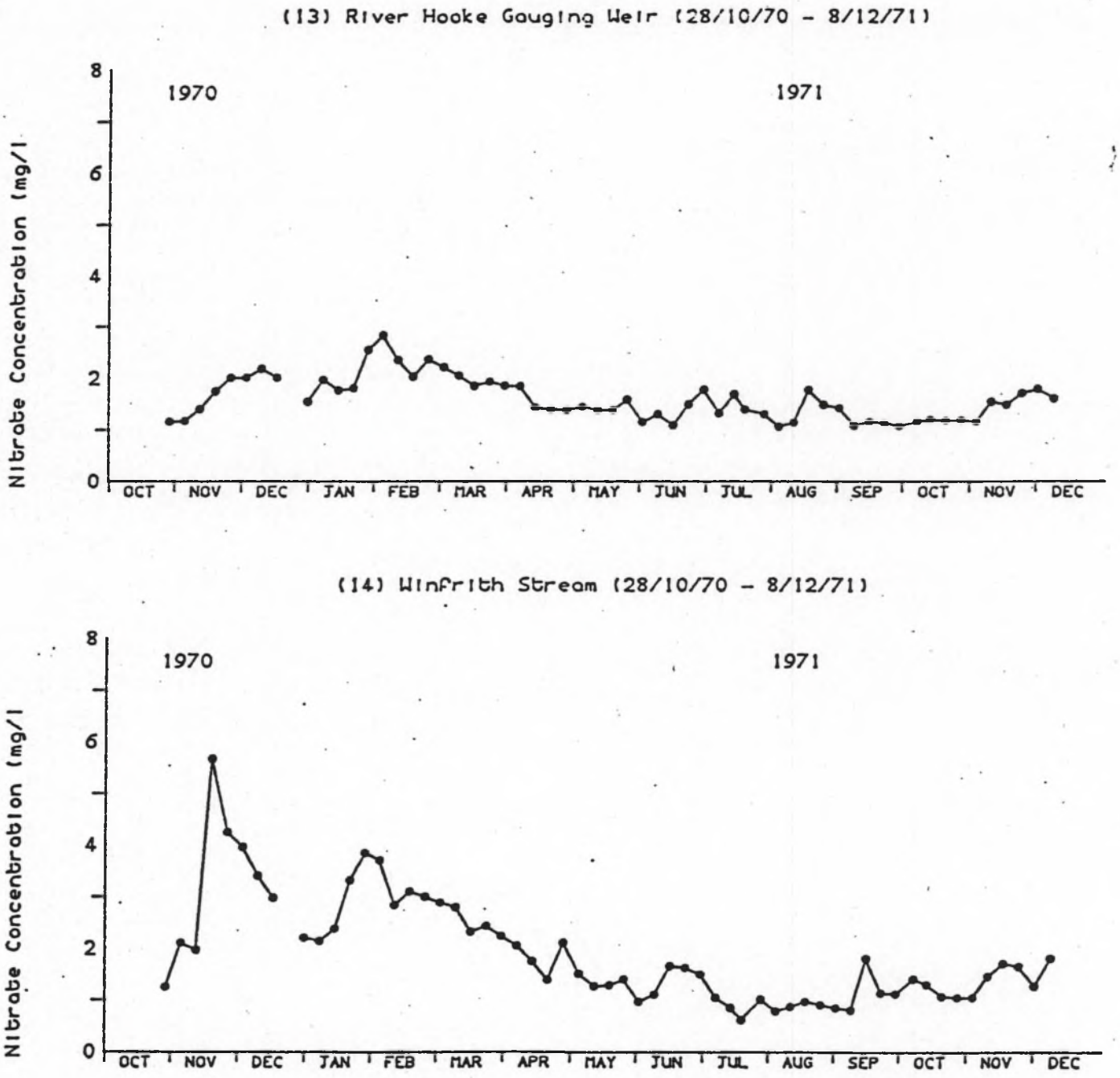

Figure 11. Nitrate concentrations in 1970-71 for sites not re-sampled in 1984-86

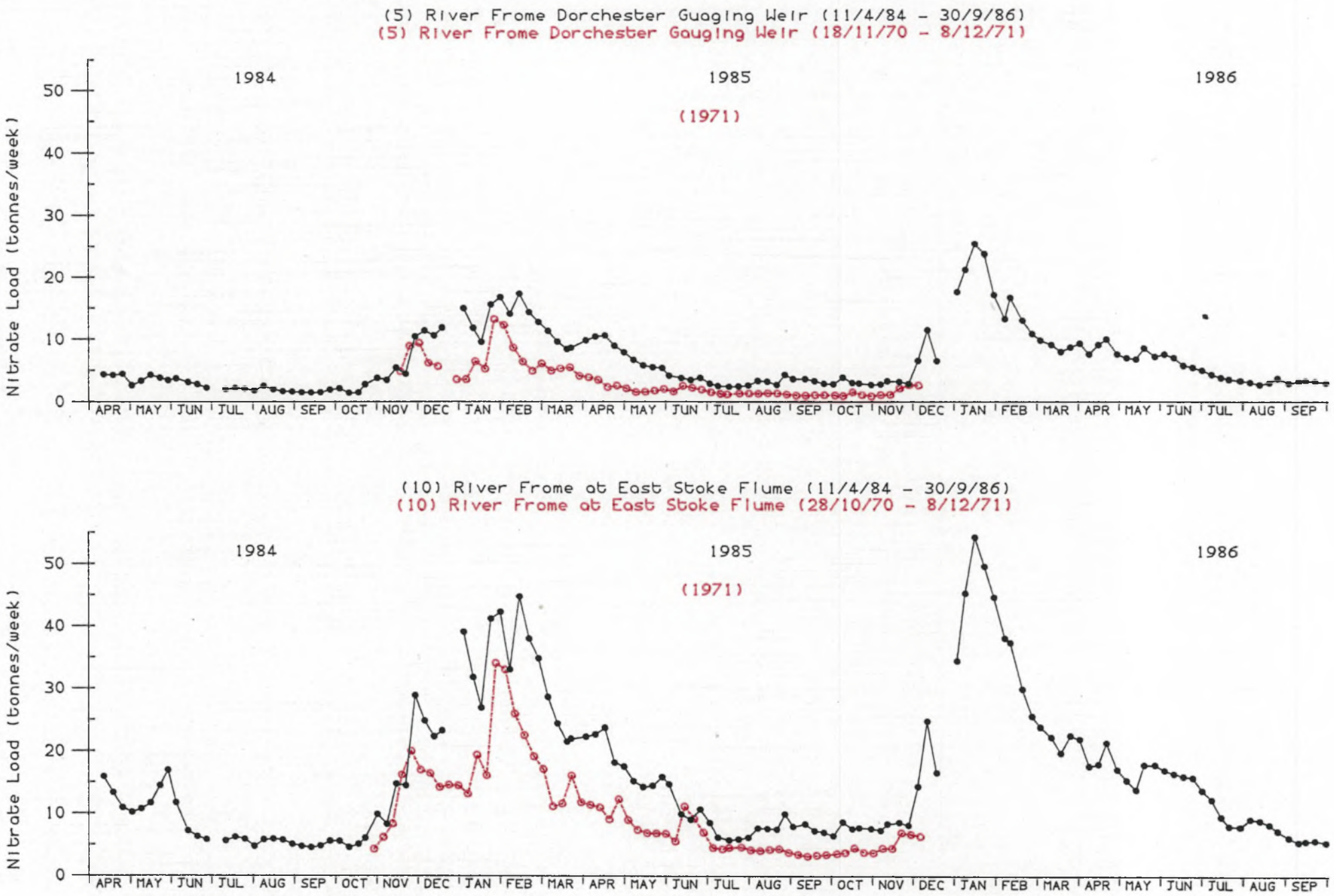

Figure 12 : Changes in river Nitrate Concentration (NO3-N mg/l) between 1970-71 and 1984-86 at sites in the River Frome Catchment.

Table 14. Overall changes in nitrate concentration (mg/l) and load (tonnes/week).

Sites	(1) R.Hooke		%	(3) Sydling Water		%	(4) R.Cerne		%	(5) R.Frome (DGW)		%
Dates	1970-71	1984-86	Increase	1970-71	1984-86	Increase	1970-71	1984-86	Increase	1970-71	1984-86	Increase
NO_3N concentration												
Mean	1.36	3.03	+23	2.13	3.36	+58	2.71	3.65	+35	2.32	3.59	+55
Minimum	0.84	0.93	+11	1.30	2.19	+68	1.81	1.73	-40	1.54	1.59	+3
Maximum	2.26	5.32	+35	4.49	7.02	+56	4.20	5.81	+38	4.46	5.33	+20
Tonnes/week												
Mean	0.528	-	-	0.432	0.925	+114	0.748	0.690	-8	3.645	6.359	+74
Minimum	0.179	-	-	0.135	0.278	+106	0.109	0.124	+14	0.903	1.312	+45
Maximum	2.776	-	-	3.623	3.360	-7	4.943	4.717	-5	13.346	25.298	+90

Sites	(6) R.Frome (Woodsford)		%	(7) R.Frome (Moreton)		%	(9) Tadnoll Brook (Broomhill Bridge)		%	(10) R.Frome (East Stoke)		%
Dates	1970-71	1984-86	Increase	1970-71	1984-86	Increase	1970-71	1984-86	Increase	1970-71	1984-86	Increase
NO_3N concentration												
Mean	3.02	4.39	+45	3.14	4.31	+37	3.67	4.82	+31	2.79	4.10	+47
Minimum	2.14	2.52	+18	2.24	2.67	+19	2.77	2.75	-1	1.94	2.50	+29
Maximum	4.04	6.76	+67	4.40	6.07	+38	4.84	9.56	+98	3.92	6.40	+63
Tonnes/week												
Mean	-	-	-	-	-	-	1.381	1.635	+18	10.094	15.762	+56
Minimum	-	-	-	-	-	-	0.434	0.718	+65	3.107	4.443	+43
Maximum	-	-	-	-	-	-	3.659	4.337	+19	34.094	54.253	+59

from 1970-71 to 1984-86 in mean nitrate concentrations vary between 31% and 123%. The increase in maximum recorded nitrate concentration varied between +20% and +135%. In both cases the largest increases were found in the River Hooke (site 1), which in 1970-71 had the lowest nitrate concentration in the River Frome catchment (Table 8). Information available from MAFF on this catchment showed a 22% increase in improved grassland and a large increase in sheep production.

In 1984-86 Tadnoll Brook had the highest individual recorded nitrate concentration of 9.56 mg/l NO_3N. Further investigation on this tributary showed that a small side stream draining agricultural land showed large fluctuations in nitrate concentrations ranging from less than 1 mg/l NO_3N to 12.9 mg/l NO_3N.

5.5 Relationship between nitrate concentration and discharge

In general, at any one sampling site, the concentration of a solute or suspended material is often found to be higher during periods of higher rainfall and hence discharges. This occurs as the rain washes in more material off and through the land. Figures 13 and 14 give plots and correlation coefficients of nitrate concentration against discharge for the 1970-71 sites where discharge data were available. In these and all subsequent plots and correlations of nitrate concentration or load with discharge, a logarithmic scale was used for both axes. The figures show that the relationships are all roughly linear on a log-log scale, as is commonly assumed and found for these 'rating-curve' type relationships (Walling, 1977). The discharge values used for these relationships were either the spot values at the time of nitrate sampling or where available, the Wessex WA mean value for the day of sampling. The correlation coefficients vary between 0.32 at Tadnoll Brook (Owermoigne) and 0.87 for the River Cerne.

Figure 15 gives similar plots for the 1984-86 data. Comparing the correlation coefficients for the same sites over the two time periods shows that while Sydling Water (1970-71 r = 0.61 and 1984-86 r = 0.70) and River Frome (East Stoke) (1970-71 r = 0.63 and 1984-86 r = 0.67) have not changed, the River Cerne (1970-71 r = 0.86 and 1984 r = 0.66), Tadnoll Brook (Broomhill Bridge) (1970-71 r = 0.64 and 1984-86 r = 0.35) and the River Frome (Dorchester gauging weir) (1970-71 r = 0.69 and 1984-86 r = 0.47) all show large reductions in their correlation oefficients. This reduction could suggest that there have been changes in farming practices resulting in relatively lower nitrate runoff during the high autumn and winter flow periods. Perhaps less fertiliser is now applied during these periods of higher runoff of rainfall. The nitrate concentrations now also tend to be more variable, with possibly less influence being due to groundwater.

Figures 16 and 17 show plots of nitrate loads against discharge in 1970-71 and their correlation coefficients. In every case the correlation coefficient is very high as one might expect with the values varying between 0.93 to 0.99.

Figure 18 shows plots of the nitrate loads against discharge for 1984-86 and their correlation coefficients. In this case the Tadnoll Brook correlation is now only 0.85.

5.6 Seasonal variations in nitrate concentrations, discharges and nitrate loads

Seasonal variations during 1970-71 for nitrate concentrations, discharge and nitrate loads are summarised in Tables 15-17. It is important to notice that, for the October to December period, both nitrate concentrations (Table 15) and discharge (Table 16) are higher in 1970 than for the same period in 1971, at all the sites. In 1970 the annual rainfall total (at East Stoke) was 868 mm, of which 273 mm fell in the period from October to December with 207 mm falling in

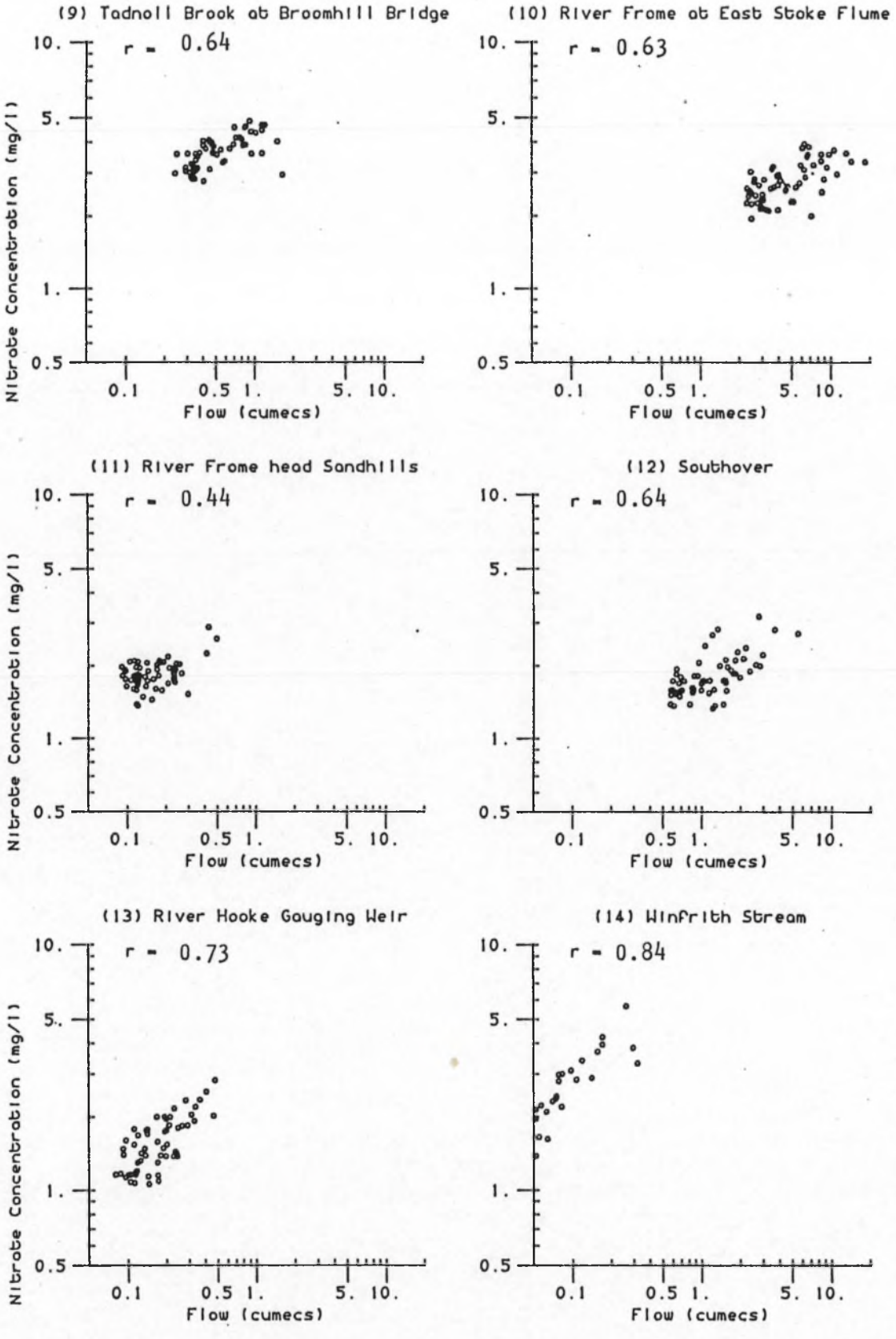

Figure 14. Plots of nitrate concentration against discharge for 1970-71 together with their correlation coefficient r.

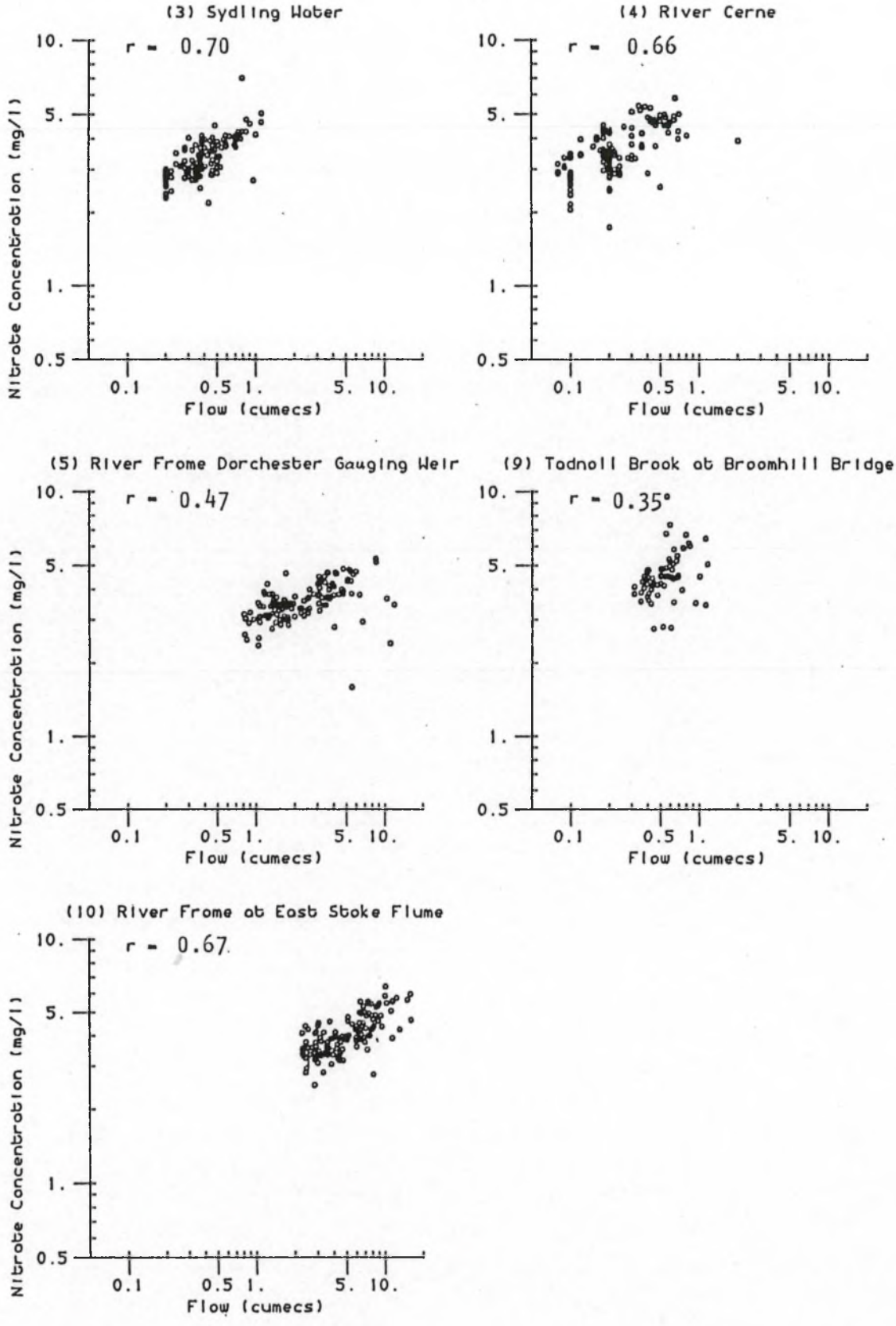

Figure 15. Plots of nitrate concentration against discharge and their correlation coefficient r for each available site during 1984-86.

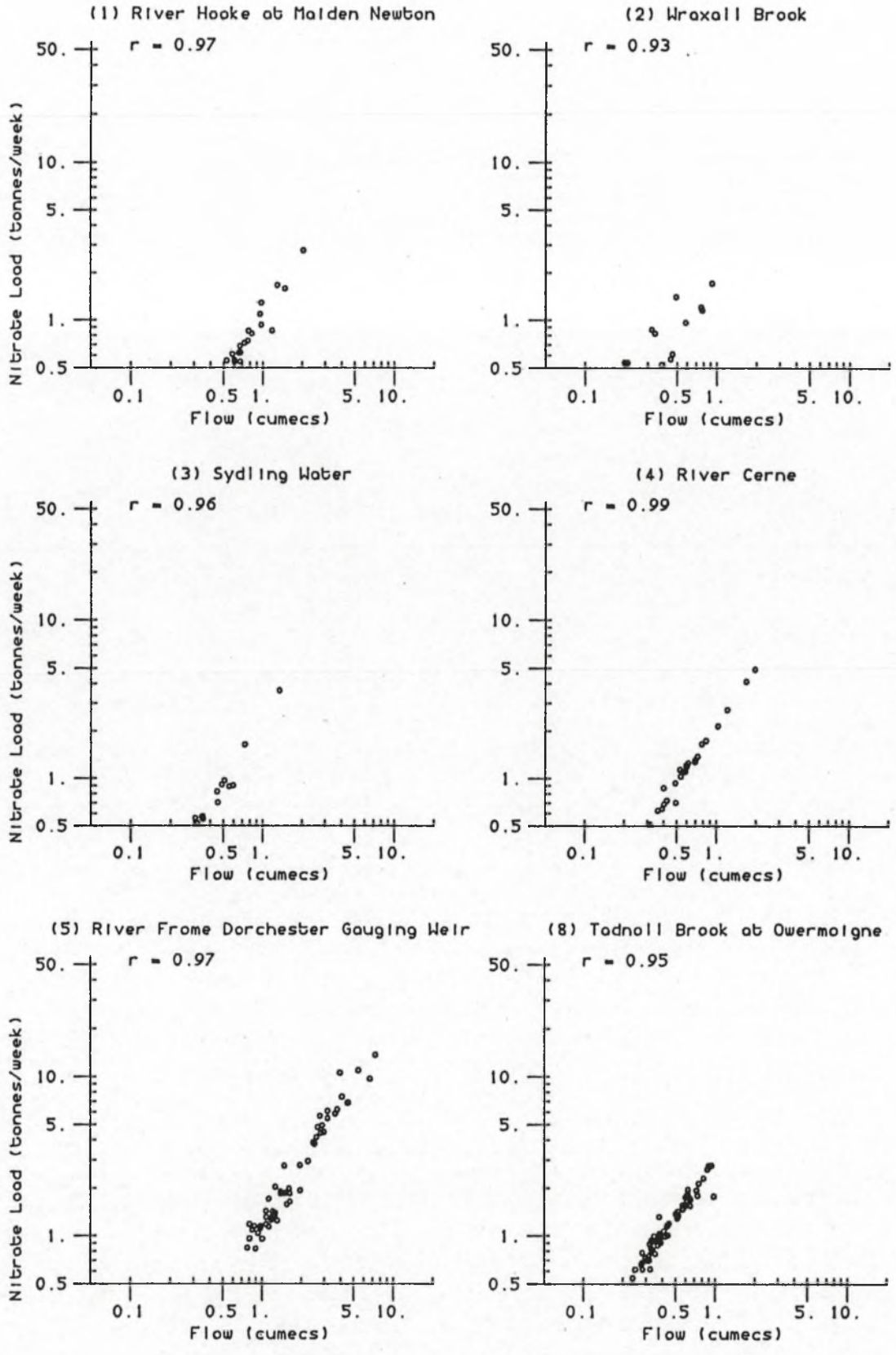

Figure 16. Plots of nitrate loads against discharge in 1970-71 and their correlation coefficient.

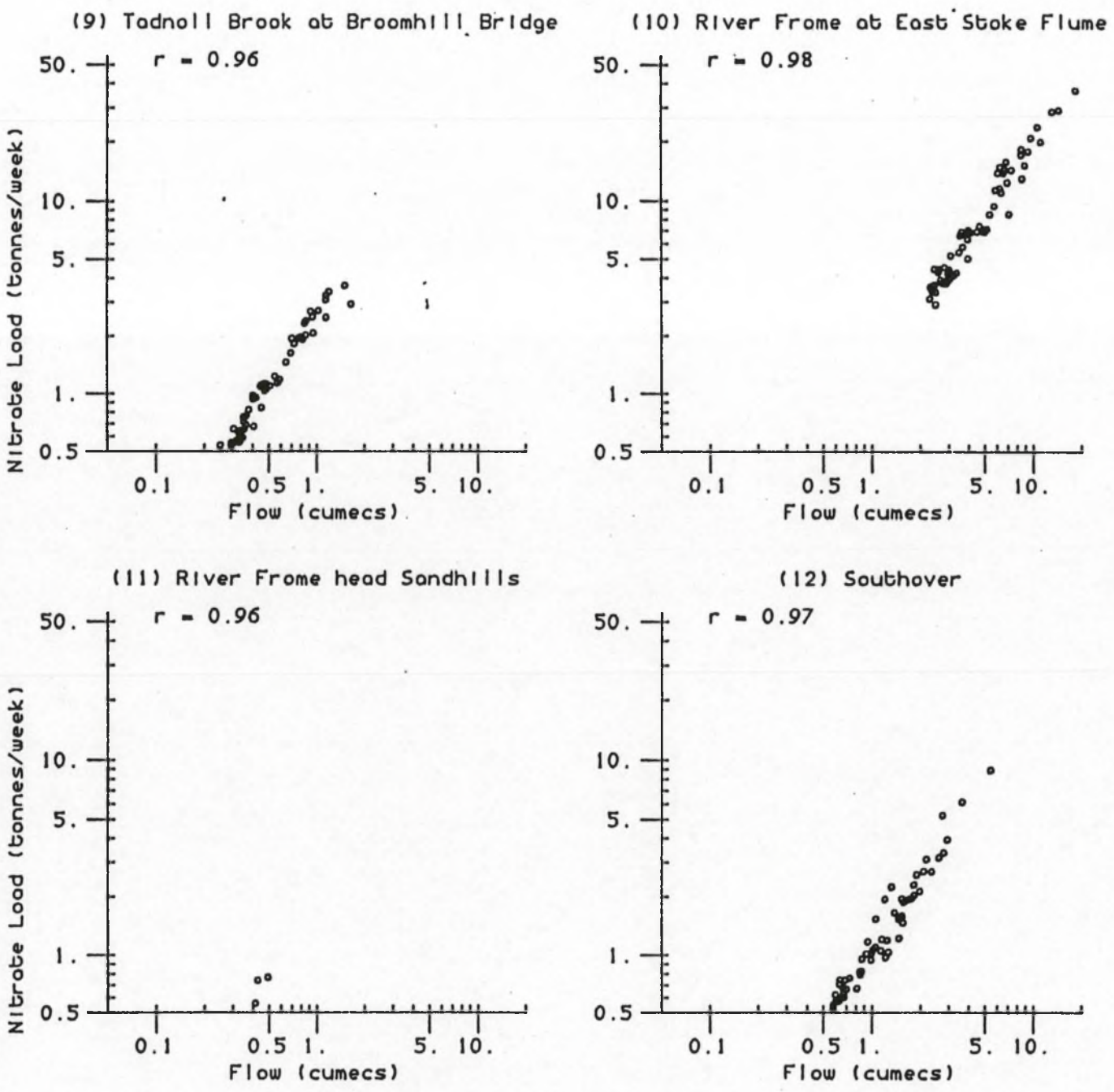

Figure 17. Plots of nitrate loads against discharge in 1970-71 and their correlation coefficient

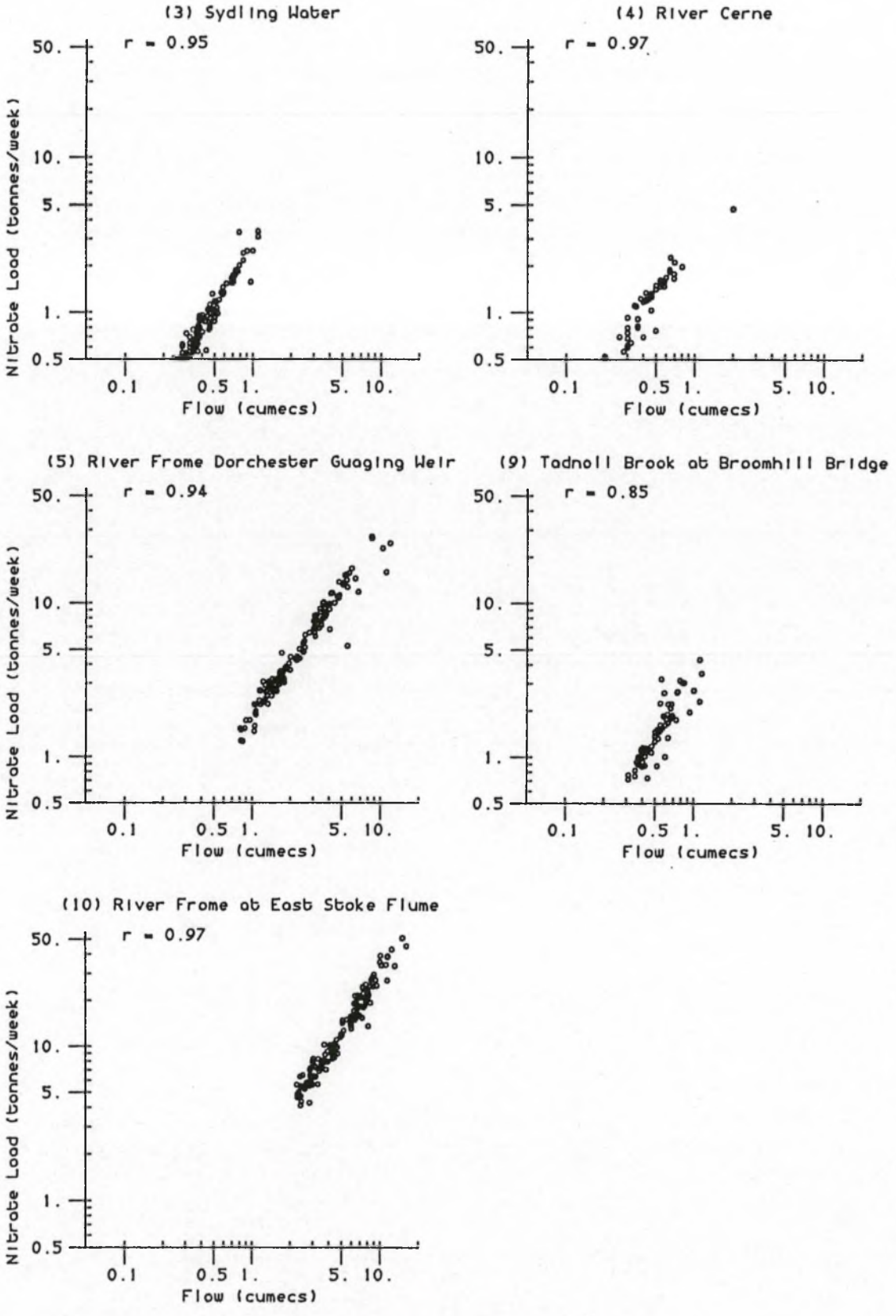

Figure 18. Plot of nitrate load against discharge together with their correlation coefficient r for each available site in 1984-86.

November alone. In contrast, in 1971 the total annual rainfall was only 612 mm with 151 mm falling in the October to December period and only 71 mm falling in November, which is only 34% of the previous November's rainfall.

It is obvious that when looking at seasonal patterns the between-year differences in rainfall and discharge must be carefully examined.

The seasonal pattern of nitrate loads also varies from year to year. Using the River Frome at East Stoke (site 10) as an example, Table 17 emphasises the large year to year differences found for the same season. In the period October to December 1970, the mean load at site 10 was 13.21 tonnes per week and the maximum load was 20.08 tonnes per week. In the same three monthly period in 1971 the corresponding values were 4.75 tonnes per week and 6.84 tonnes per week.

These results emphasise the necessity of having a long time series of observations extending over 10 or more years before you can confidently detect any slow long-term changes in water parameters. In this study, we are fortunate in having two fairly intensive sampling periods 14 years apart.

Although there are two data sets for the period October to December in the 1970-71 data, because of the large differences in both nitrate concentrations and discharge between the years, caution should be exercised in making detailed comparisons with the equivalent seasonal values obtained in 1984-86.

Tables 18-20 show the seasonal variations in nitrate concentration, discharge and nitrate loads respectively during 1984-86. In almost every site the highest quarterly mean nitrate concentrations and the maximum nitrate concentrations occur in the January to March period. (The only exceptions were sites 2 and 9 in

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1970 OCT-DEC	N	4	9	9	9	6	3	9	9	9
1970 OCT-DEC	Mean	1.55	2.73	2.62	2.97	3.11	3.87	3.46	4.46	3.87
1970 OCT-DEC	S.E.	0.08	0.33	0.21	0.15	0.31	0.16	0.17	0.27	0.20
1970 OCT-DEC	Min.	1.35	1.80	1.65	2.30	2.41	3.56	2.41	3.02	3.10
1970 OCT-DEC	Max.	1.74	4.74	3.32	3.56	4.46	4.04	4.16	5.80	4.84

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1971 JAN-MAR	N	13	13	13	13	13	13	13	13	13
1971 JAN-MAR	Mean	1.75	2.23	2.78	3.48	2.79	3.49	3.64	4.64	4.12
1971 JAN-MAR	S.E.	0.08	0.09	0.18	0.10	0.07	0.07	0.12	0.09	0.14
1971 JAN-MAR	Min.	1.21	1.91	2.21	3.06	2.50	3.09	3.14	4.03	2.94
1971 JAN-MAR	Max.	2.26	3.08	4.49	4.20	3.34	3.90	4.40	5.12	4.68

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1971 APR-JUN	N	13	13	13	13	13	13	13	13	13
1971 APR-JUN	Mean	1.18	1.69	1.85	2.62	2.06	2.84	2.90	4.30	3.83
1971 APR-JUN	S.E.	0.06	0.05	0.07	0.07	0.08	0.09	0.10	0.06	0.09
1971 APR-JUN	Min.	0.90	1.38	1.35	2.30	1.64	2.20	2.34	3.82	3.31
1971 APR-JUN	Max.	1.70	1.98	2.38	3.18	2.59	3.69	3.69	4.58	4.58

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1971 JUL-SEP	N	13	13	13	13	13	13	13	13	13
1971 JUL-SEP	Mean	1.14	1.70	1.53	2.15	1.81	2.55	2.65	3.95	3.13
1971 JUL-SEP	S.E.	0.04	0.06	0.04	0.06	0.04	0.06	0.08	0.07	0.06
1971 JUL-SEP	Min.	0.84	1.25	1.30	1.81	1.58	2.14	2.24	3.18	2.82
1971 JUL-SEP	Max.	1.30	2.02	1.74	2.57	2.02	2.94	3.43	4.22	3.62

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1971 OCT-DEC	N	10	10	10	10	10	10	10	10	10
1971 OCT-DEC	Mean	1.30	2.59	2.00	2.31	2.26	3.01	3.12	4.24	3.37
1971 OCT-DEC	S.E.	0.07	0.41	0.14	0.07	0.14	0.07	0.08	0.15	0.13
1971 OCT-DEC	Min.	1.04	1.55	1.34	1.98	1.54	2.72	2.80	3.62	2.77
1971 OCT-DEC	Max.	1.73	4.50	2.67	2.61	3.09	3.32	3.48	4.80	3.87

Table 15. Seasonal statistics of nitrate concentrations (mg/l) in

(10)	(11)	(12)	(13)	(14)
10	9	9	9	9
3.25	1.88	2.12	1.69	3.08
0.14	0.11	0.17	0.13	0.46
2.50	1.36	1.58	1.16	1.25
3.92	2.58	3.18	2.17	5.66

(10)	(11)	(12)	(13)	(14)
13	13	13	13	13
3.23	2.05	2.10	2.11	2.85
0.13	0.09	0.09	0.09	0.15
1.99	1.52	1.79	1.76	2.14
3.78	2.88	2.81	2.83	3.84

(10)	(11)	(12)	(13)	(14)
13	13	13	13	13
2.62	1.76	1.62	1.43	1.50
0.08	0.05	0.05	0.06	0.09
2.11	1.44	1.33	1.09	0.96
3.21	2.08	1.98	1.83	2.10

(10)	(11)	(12)	(13)	(14)
13	13	13	13	13
2.25	1.79	1.57	1.31	0.97
0.05	0.05	0.04	0.06	0.08
1.94	1.48	1.36	1.06	0.61
2.66	2.08	1.94	1.76	1.80

(10)	(11)	(12)	(13)	(14)
10	10	10	10	10
2.67	1.80	1.94	1.40	1.37
0.08	0.07	0.15	0.08	0.09
2.34	1.38	1.38	1.16	1.04
3.10	2.10	2.82	1.78	1.80

(1) River Hooke at Maiden Newton
(2) Wraxall Brook
(3) Sydling Water
(4) River Cerne
(5) River Frome Dorchester Gauging Weir
(6) River Frome Woodsford
(7) River Frome Moreton
(8) Tadnoll Brook at Owermoigne
(9) Tadnoll Brook at Broomhill Bridge
(10) River Frome at East Stoke Flume
(11) River Frome head Sandhills
(12) Southover
(13) River Hooke Gauging Weir
(14) Winfrith Stream

1970-71

		(1)	(2)	(3)	(4)	(5)	(8)	(9)	(10)
1970 OCT-DEC	N	4	9	9	9	10	9	7	10
1970 OCT-DEC	Mean	0.61	0.34	0.28	0.42	2.77	0.57	0.72	6.80
1970 OCT-DEC	S.E.	0.03	0.04	0.05	0.08	0.38	0.07	0.11	0.85
1970 OCT-DEC	Min.	0.53	0.18	0.14	0.11	0.98	0.28	0.35	2.60
1970 OCT-DEC	Max.	0.67	0.58	0.51	0.77	4.51	0.97	1.03	11.13

		(1)	(2)	(3)	(4)	(5)	(8)	(9)	(10)
1971 JAN-MAR	N	13	13	13	13	13	13	13	13
1971 JAN-MAR	Mean	1.02	0.44	0.49	0.88	3.98	0.72	1.04	9.75
1971 JAN-MAR	S.E.	0.11	0.06	0.08	0.13	0.43	0.04	0.08	1.00
1971 JAN-MAR	Min.	0.61	0.18	0.23	0.40	2.30	0.52	0.72	5.74
1971 JAN-MAR	Max.	2.03	0.92	1.33	1.95	7.99	0.94	1.65	18.10

		(1)	(2)	(3)	(4)	(5)	(8)	(9)	(10)
1971 APR-JUN	N	13	13	13	13	13	13	13	13
1971 APR-JUN	Mean	0.53	0.20	0.30	0.33	1.88	0.48	0.53	5.40
1971 APR-JUN	S.E.	0.02	0.01	0.01	0.02	0.11	0.02	0.03	0.36
1971 APR-JUN	Min.	0.45	0.14	0.20	0.24	1.38	0.38	0.40	3.52
1971 APR-JUN	Max.	0.67	0.30	0.39	0.49	2.52	0.57	0.70	7.47

		(1)	(2)	(3)	(4)	(5)	(8)	(9)	(10)
1971 JUL-SEP	N	13	13	13	13	13	13	13	13
1971 JUL-SEP	Mean	0.37	0.12	0.20	0.16	1.16	0.33	0.33	2.92
1971 JUL-SEP	S.E.	0.02	0.01	0.01	0.01	0.04	0.01	0.01	0.10
1971 JUL-SEP	Min.	0.29	0.08	0.17	0.10	0.96	0.24	0.24	2.39
1971 JUL-SEP	Max.	0.53	0.20	0.25	0.26	1.41	0.39	0.38	3.51

		(1)	(2)	(3)	(4)	(5)	(8)	(9)	(10)
1971 OCT-DEC	N	10	10	10	10	10	10	10	10
1971 OCT-DEC	Mean	0.37	0.16	0.16	0.10	1.10	0.32	0.35	2.94
1971 OCT-DEC	S.E.	0.03	0.02	0.01	0.01	0.10	0.01	0.02	0.19
1971 OCT-DEC	Min.	0.28	0.11	0.13	0.07	0.78	0.25	0.25	2.36
1971 OCT-DEC	Max.	0.58	0.32	0.20	0.13	1.57	0.38	0.47	3.83

Table 16. Seasonal statistics of discharges (m^3/s) in 1970-

(11)	(12)	(13)	(14)	(
9	9	9	9	
0.21	1.56	0.16	0.11	
0.04	0.21	0.02	0.03	
0.12	0.60	0.08	0.02	
0.49	2.74	0.23	0.26	

(11)	(12)	(13)	(14)	(
13	13	13	13	
0.25	2.48	0.31	0.12	
0.02	0.30	0.03	0.02	
0.18	1.37	0.20	0.05	
0.43	5.45	0.48	0.32	

(11)	(12)	(13)	(14)	(
13	13	13	13	
0.15	1.23	0.20	0.04	
0.01	0.06	0.01	0.00	
0.10	0.92	0.14	0.03	
0.23	1.57	0.26	0.06	

(11)	(12)	(13)	(14)	(
13	13	13	13	
0.12	0.70	0.12	0.03	
0.01	0.03	0.00	0.00	
0.10	0.57	0.10	0.02	
0.18	0.86	0.14	0.04	

(11)	(12)	(13)	(14)	(
10	10	10	10	
0.11	0.82	0.11	0.03	
0.00	0.08	0.00	0.00	
0.09	0.57	0.09	0.03	
0.14	1.32	0.14	0.04	

(1) River Hooke at Maiden Newton
(2) Wraxall Brook
(3) Sydling Water
(4) River Cerne
(5) River Frome Dorchester Gauging Weir
(6) River Frome Woodsford
(7) River Frome Moreton
(8) Tadnoll Brook at Owermoigne
(9) Tadnoll Brook at Broomhill Bridge
(10) River Frome at East Stoke Flume
(11) River Frome head Sandhills
(12) Southover
(13) River Hooke Gauging Weir
(14) Winfrith Stream

		(1)	(2)	(3)	(4)	(5)	(8)	(9)	(10)	(11)
1970 OCT-DEC	N	4	9	9	9	7	9	7	10	9
1970 OCT-DEC	Mean	0.570	0.595	0.473	0.811	5.103	1.483	1.784	13.209	0.258
1970 OCT-DEC	S.E.	0.017	0.131	0.104	0.177	1.324	0.138	0.328	1.626	0.067
1970 OCT-DEC	Min.	0.547	0.241	0.136	0.153	0.734	0.782	0.715	4.316	0.099
1970 OCT-DEC	Max.	0.621	1.410	0.969	1.659	9.544	1.967	2.711	20.080	0.768

		(1)	(2)	(3)	(4)	(5)	(8)	(9)	(10)	(11)
1971 JAN-MAR	N	13	13	13	13	13	13	13	13	13
1971 JAN-MAR	Mean	1.114	0.630	0.919	1.927	6.793	2.026	2.569	19.347	0.322
1971 JAN-MAR	S.E.	0.169	0.125	0.244	0.354	0.826	0.129	0.176	2.130	0.042
1971 JAN-MAR	Min.	0.545	0.220	0.331	0.874	3.685	1.425	1.819	11.147	0.222
1971 JAN-MAR	Max.	2.776	1.717	3.623	4.943	13.346	2.783	3.659	34.094	0.742

		(1)	(2)	(3)	(4)	(5)	(8)	(9)	(10)	(11)
1971 APR-JUN	N	13	13	13	13	13	13	13	13	13
1971 APR-JUN	Mean	0.380	0.203	0.340	0.530	2.388	1.240	1.239	8.707	0.163
1971 APR-JUN	S.E.	0.033	0.011	0.019	0.044	0.198	0.054	0.076	0.609	0.013
1971 APR-JUN	Min.	0.247	0.157	0.175	0.372	1.630	0.991	0.975	5.532	0.107
1971 APR-JUN	Max.	0.685	0.301	0.425	0.939	3.998	1.565	1.939	12.299	0.249

		(1)	(2)	(3)	(4)	(5)	(8)	(9)	(10)	(11)
1971 JUL-SEP	N	13	13	13	13	13	13	13	13	13
1971 JUL-SEP	Mean	0.254	0.120	0.190	0.214	1.274	0.781	0.623	3.944	0.132
1971 JUL-SEP	S.E.	0.007	0.012	0.010	0.023	0.046	0.036	0.028	0.144	0.006
1971 JUL-SEP	Min.	0.226	0.077	0.145	0.128	1.037	0.543	0.434	3.107	0.102
1971 JUL-SEP	Max.	0.323	0.227	0.256	0.358	1.579	0.952	0.823	4.577	0.176

		(1)	(2)	(3)	(4)	(5)	(8)	(9)	(10)	(11)
1971 OCT-DEC	N	10	10	10	10	10	10	10	10	10
1971 OCT-DEC	Mean	0.299	0.287	0.195	0.137	1.534	0.817	0.723	4.750	0.121
1971 OCT-DEC	S.E.	0.038	0.085	0.015	0.009	0.224	0.050	0.060	0.413	0.008
1971 OCT-DEC	Min.	0.179	0.108	0.135	0.109	0.903	0.615	0.539	3.535	0.097
1971 OCT-DEC	Max.	0.608	0.872	0.267	0.194	2.718	1.035	1.038	6.840	0.176

Table 17. Seasonal statistics of nitrate loads (tonnes NO_3N/week

(12)	(13)	(14)	(
9	9	9	
2.139	0.175	0.261	
0.465	0.030	0.094	
0.573	0.056	0.016	
5.270	0.299	0.890	

(12)	(13)	(14)	(
13	13	13	
3.309	0.414	0.233	
0.573	0.049	0.057	
1.661	0.211	0.067	
8.934	0.813	0.683	

(12)	(13)	(14)	(
13	13	13	
1.205	0.172	0.042	
0.078	0.013	0.005	
0.943	0.113	0.021	
1.881	0.290	0.080	

(12)	(13)	(14)	(
13	13	13	
0.660	0.098	0.016	
0.031	0.007	0.002	
0.496	0.065	0.010	
0.827	0.147	0.028	

(12)	(13)	(14)	(
10	10	10	
1.022	0.094	0.028	
0.191	0.007	0.003	
0.474	0.070	0.018	
2.251	0.145	0.045	

(1) River Hooke at Maiden Newton
(2) Wraxall Brook
(3) Sydling Water
(4) River Cerne
(5) River Frome Dorchester Gauging Weir
(6) River Frome Woodsford
(7) River Frome Moreton
(8) Tadnoll Brook at Owermoigne
(9) Tadnoll Brook at Broomhill Bridge
(10) River Frome at East Stoke Flume
(11) River Frome head Sandhills
(12) Southover
(13) River Hooke Gauging Weir
(14) Winfrith Stream

) in 1970-71

(1) River Hooke at Maiden Newton
(2) River Frome at Maiden Newton
(3) Sydling Water
(4) River Cerne
(5) River Frome Dorchester Guaging Weir
(6) River Frome Woodsford
(7) River Frome Moreton
(8) Tadnoll Brook at Empool
(9) Tadnoll Brook at Broomhill Bridge
(10) River Frome at East Stoke Flume

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1984 APR-JUN	Mean	2.79	2.99	3.17	3.35	3.40	4.16	4.11		4.82	3.70
1984 APR-JUN	S.E.	0.09	0.06	0.11	0.08	0.14	0.11	0.11		0.45	0.11
1984 APR-JUN	Min.	2.21	2.67	2.80	2.90	2.98	3.44	3.45		3.78	3.08
1984 APR-JUN	Max.	3.14	3.31	4.02	3.78	4.64	4.73	4.64		9.56	4.46
1984 JUL-SEP	Mean	2.60	2.68	2.70	2.62	3.03	3.59	3.35		4.27	3.48
1984 JUL-SEP	S.E.	0.07	0.09	0.06	0.08	0.08	0.13	0.09		0.16	0.13
1984 JUL-SEP	Min.	2.17	2.25	2.30	2.05	2.48	2.52	2.85		2.78	2.82
1984 JUL-SEP	Max.	2.92	3.27	3.00	2.92	3.51	4.23	3.94		4.80	4.38

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1984 OCT-DEC	Mean	2.41	3.53	3.15	3.40	3.27	4.15	4.07		5.38	3.95
1984 OCT-DEC	S.E.	0.15	0.17	0.17	0.27	0.17	0.14	0.18		0.52	0.21
1984 OCT-DEC	Min.	1.98	2.60	2.37	2.36	2.35	2.95	2.75		2.75	2.50
1984 OCT-DEC	Max.	3.73	4.60	4.08	4.57	4.10	4.78	4.96		7.68	4.85
1985 JAN-MAR	Mean	4.02	3.73	4.20	4.71	4.29	5.25	5.29		5.95	5.27
1985 JAN-MAR	S.E.	0.13	0.07	0.25	0.09	0.10	0.11	0.14		0.12	0.17
1985 JAN-MAR	Min.	2.86	3.46	3.54	3.72	3.72	4.31	4.33		5.16	4.25
1985 JAN-MAR	Max.	4.77	4.19	7.02	5.00	4.84	5.83	5.94		6.68	6.40
1985 APR-JUN	Mean	3.12	3.60	3.31	3.83	3.68	4.68	4.41	5.40	4.84	4.16
1985 APR-JUN	S.E.	0.11	0.25	0.08	0.10	0.07	0.19	0.09	0.14	0.09	0.08
1985 APR-JUN	Min.	2.20	2.84	2.89	3.33	3.33	3.97	3.92	4.74	4.32	3.82
1985 APR-JUN	Max.	3.92	6.24	3.74	4.26	4.21	6.76	4.91	6.18	5.47	4.68
1985 JUL-SEP	Mean	2.47	2.75	2.92	2.98	3.19	3.84	3.73	4.93	4.06	3.33
1985 JUL-SEP	S.E.	0.10	0.09	0.06	0.07	0.06	0.06	0.07	0.14	0.07	0.08
1985 JUL-SEP	Min.	1.90	2.25	2.51	2.45	2.75	3.50	3.27	4.15	3.66	2.82
1985 JUL-SEP	Max.	2.99	3.32	3.37	3.34	3.48	4.19	4.12	6.20	4.58	3.88

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1985 OCT-DEC	Mean	2.84	3.33	3.40	3.59	3.77	4.67	4.58	5.50	4.88	4.17
1985 OCT-DEC	S.E.	0.11	0.12	0.09	0.12	0.10	0.08	0.14	0.11	0.26	0.12
1985 OCT-DEC	Min.	2.24	2.78	2.81	2.99	3.33	4.13	3.99	4.85	3.31	3.51
1985 OCT-DEC	Max.	3.34	4.12	3.86	4.32	4.50	5.18	5.94	6.17	6.33	4.84
1986 JAN-MAR	Mean	4.12	3.89	4.29	4.98	4.36	5.17	5.19	6.37	5.53	5.22
1986 JAN-MAR	S.E.	0.27	0.14	0.10	0.16	0.22	0.23	0.20	0.17	0.24	0.14
1986 JAN-MAR	Min.	2.12	2.72	3.90	3.90	2.40	3.82	3.82	5.17	3.44	4.09
1986 JAN-MAR	Max.	5.32	4.52	5.05	5.81	5.33	6.29	6.07	7.28	6.70	5.95
1986 APR-JUN	Mean	2.97	3.62	3.52	3.86	3.68	4.42	4.30	5.33	4.47	4.15
1986 APR-JUN	S.E.	0.21	0.15	0.11	0.14	0.10	0.10	0.10	0.15	0.15	0.10
1986 APR-JUN	Min.	0.93	2.57	2.70	2.54	2.94	3.79	3.81	3.98	3.50	3.60
1986 APR-JUN	Max.	3.86	4.60	4.02	4.50	4.32	5.08	4.99	6.07	5.48	5.00
1986 JUL-SEP	Mean	2.80	2.89	2.90	3.11	3.14	3.93	3.92	4.89	4.03	3.52
1986 JUL-SEP	S.E.	0.11	0.14	0.08	0.15	0.15	0.11	0.12	0.08	0.14	0.09
1986 JUL-SEP	Min.	2.02	2.37	2.19	1.73	1.59	2.75	2.67	4.30	2.80	2.77
1986 JUL-SEP	Max.	3.51	4.13	3.33	3.96	3.73	4.26	4.57	5.42	4.85	4.13

Table 18. Seasonal statistics of nitrate concentrations (mg/l) in 1984-86

(1) River Hooke at Maiden Newton
(2) River Frome at Maiden Newton
(3) Sydling Water
(4) River Cerne
(5) River Frome Dorchester Guaging Weir
(6) River Frome Woodsford
(7) River Frome Moreton
(8) Tadnoll Brook at Empool
(9) Tadnoll Brook at Broomhill Bridge
(10) River Frome at East Stoke Flume

		(3)	(4)	(5)	(9)	(10)
1984 APR-JUN	Mean	0.35	0.21	1.67	0.48	4.87
1984 APR-JUN	S.E.	0.03	0.02	0.09	0.03	0.39
1984 APR-JUN	Min.	0.20	0.10	1.10	0.31	2.86
1984 APR-JUN	Max.	0.46	0.32	2.04	0.58	7.60
1984 JUL-SEP	Mean	0.20	0.10	0.97	0.42	2.51
1984 JUL-SEP	S.E.	0.00	0.00	0.04	0.02	0.05
1984 JUL-SEP	Min.	0.20	0.10	0.81	0.37	2.25
1984 JUL-SEP	Max.	0.20	0.10	1.29	0.60	3.00
		(3)	(4)	(5)	(9)	(10)
1984 OCT-DEC	Mean	0.39	0.32	2.90	0.47	5.86
1984 OCT-DEC	S.E.	0.06	0.06	0.48	0.03	0.82
1984 OCT-DEC	Min.	0.20	0.10	0.84	0.39	2.48
1984 OCT-DEC	Max.	0.72	0.58	5.33	0.59	10.65
1985 JAN-MAR	Mean	0.62	0.53	4.81		10.16
1985 JAN-MAR	S.E.	0.04	0.03	0.31		0.63
1985 JAN-MAR	Min.	0.46	0.42	3.19		6.95
1985 JAN-MAR	Max.	0.78	0.70	6.48		13.99
1985 APR-JUN	Mean	0.50	0.42	2.88		6.30
1985 APR-JUN	S.E.	0.01	0.06	0.28		0.46
1985 APR-JUN	Min.	0.40	0.20	1.57		3.76
1985 APR-JUN	Max.	0.59	0.80	4.55		8.84
1985 JUL-SEP	Mean	0.33	0.21	1.55		3.56
1985 JUL-SEP	S.E.	0.01	0.01	0.07		0.14
1985 JUL-SEP	Min.	0.29	0.20	1.25		2.88
1985 JUL-SEP	Max.	0.38	0.24	2.07		4.41
		(3)	(4)	(5)	(9)	(10)
1985 OCT-DEC	Mean	0.34	0.19	2.01		4.38
1985 OCT-DEC	S.E.	0.03	0.01	0.31		0.55
1985 OCT-DEC	Min.	0.24	0.16	1.16		2.89
1985 OCT-DEC	Max.	0.58	0.22	4.49		9.26
1986 JAN-MAR	Mean	0.72	0.54	5.83	0.83	11.07
1986 JAN-MAR	S.E.	0.07	0.13	0.69	0.05	1.13
1986 JAN-MAR	Min.	0.38	0.26	3.03	0.59	6.24
1986 JAN-MAR	Max.	1.10	2.00	9.93	1.15	18.50
1986 APR-JUN	Mean	0.45	0.20	3.35	0.65	6.81
1986 APR-JUN	S.E.	0.04	0.03	0.14	0.03	0.18
1986 APR-JUN	Min.	0.36	0.15	2.55	0.50	6.02
1986 APR-JUN	Max.	0.96	0.50	4.39	0.93	8.13
1986 JUL-SEP	Mean	0.35	0.11	1.81	0.43	3.86
1986 JUL-SEP	S.E.	0.01	0.01	0.08	0.02	0.27
1986 JUL-SEP	Min.	0.28	0.08	1.48	0.35	2.51
1986 JUL-SEP	Max.	0.43	0.20	2.60	0.55	5.96

Table 19. Seasonal statistics of discharges (m^3/s) in 1984-86

(1) River Hooke at Maiden Newton
(2) River Frome at Maiden Newton
(3) Sydling Water
(4) River Cerne
(5) River Frome Dorchester Gauging Weir
(6) River Frome Woodsford
(7) River Frome Moreton
(8) Tadnoll Brook at Empool
(9) Tadnoll Brook at Broomhill Bridge
(10) River Frome at East Stoke Flume

		(3)	(4)	(5)	(9)	(10)
1984 APR-JUN	Mean	0.675	0.421	3.463	1.454	11.157
1984 APR-JUN	S.E.	0.052	0.050	0.213	0.209	1.038
1984 APR-JUN	Min.	0.354	0.175	2.157	0.718	5.683
1984 APR-JUN	Max.	0.860	0.686	4.377	3.238	16.837
1984 JUL-SEP	Mean	0.327	0.158	1.768	1.048	5.270
1984 JUL-SEP	S.E.	0.007	0.005	0.096	0.028	0.162
1984 JUL-SEP	Min.	0.278	0.124	1.371	0.871	4.443
1984 JUL-SEP	Max.	0.363	0.177	2.464	1.159	6.090
		(3)	(4)	(5)	(9)	(10)
1984 OCT-DEC	Mean	0.802	0.757	5.668	1.351	13.887
1984 OCT-DEC	S.E.	0.172	0.177	1.181	0.247	2.535
1984 OCT-DEC	Min.	0.287	0.143	1.312	0.732	4.463
1984 OCT-DEC	Max.	1.737	1.603	11.764	2.626	28.755
1985 JAN-MAR	Mean	1.614	1.506	12.594		32.846
1985 JAN-MAR	S.E.	0.171	0.089	0.852		2.179
1985 JAN-MAR	Min.	0.985	1.035	8.300		21.420
1985 JAN-MAR	Max.	3.312	2.117	17.215		44.658
1985 APR-JUN	Mean	1.012	0.989	6.526		15.944
1985 APR-JUN	S.E.	0.044	0.152	0.726		1.324
1985 APR-JUN	Min.	0.745	0.419	3.369		8.927
1985 APR-JUN	Max.	1.335	1.984	10.486		23.654
1985 JUL-SEP	Mean	0.591	0.386	2.988		7.271
1985 JUL-SEP	S.E.	0.024	0.014	0.155		0.332
1985 JUL-SEP	Min.	0.506	0.296	2.338		5.652
1985 JUL-SEP	Max.	0.754	0.485	4.212		9.854
		(3)	(4)	(5)	(9)	(10)
1985 OCT-DEC	Mean	0.700	0.417	4.254		10.426
1985 OCT-DEC	S.E.	0.081	0.017	0.759		1.571
1985 OCT-DEC	Min.	0.457	0.349	2.635		6.363
1985 OCT-DEC	Max.	1.354	0.523	11.384		24.739
1986 JAN-MAR	Mean	1.901	1.561	14.854	2.759	34.352
1986 JAN-MAR	S.E.	0.234	0.295	1.627	0.188	3.189
1986 JAN-MAR	Min.	0.896	0.698	7.871	1.845	19.656
1986 JAN-MAR	Max.	3.360	4.717	25.298	4.337	54.253
1986 APR-JUN	Mean	0.932	0.448	7.524	1.743	17.319
1986 APR-JUN	S.E.	0.065	0.031	0.369	0.067	0.620
1986 APR-JUN	Min.	0.689	0.336	5.379	1.345	13.769
1986 APR-JUN	Max.	1.568	0.768	9.909	2.221	21.881
1986 JUL-SEP	Mean	0.606	0.195	3.417	1.045	8.236
1986 JUL-SEP	S.E.	0.022	0.013	0.171	0.082	0.696
1986 JUL-SEP	Min.	0.467	0.139	2.646	0.754	5.380
1986 JUL-SEP	Max.	0.745	0.287	4.920	1.500	13.684

Table 20. Seasonal statistics of nitrate loads (tonnes NO_3N/week) in 1984-86

1984, when the maximum nitrate concentrations were higher in the October to December period than in the January to March period in 1985.)

As the mean and maximum discharge values are also highest for the January to March period in all years (Table 19), the nitrate loads are also highest during these months (Table 20).

Again if we look at site 10 East Stoke, the largest site and furthest downstream in the Frome catchment, the October to December loads in 1984 and 1985 are more similar than for the two autumn quarters in 1970 and 1971. The mean value for 1984 was 13.89 tonnes per week with a maximum value of 28.76 tonnes per week, while in 1985 the corresponding values were 10.43 tonnes per week and 24.74 tonnes per week (Table 20). The January to March periods were also similar in average throughput in 1985 and 1986 at all five sites.

5.7 Changes in total nitrate loadings between 1970-71 and 1984-86

Table 21 shows the quarterly total nitrate loads in tonnes for all available sites in 1970-71. (Note: occasionally, where one or more week's loads were not available in a quarter, the observed total load has been multiplied up to estimate the total load for the thirteen week period.) The catchment can be conveniently divided into two main areas, that above Dorchester gauging weir (area = 205.9 sq km) and the complete catchment (area = 414.4 sq km).

Table 21 shows that the annual nitrate load at Dorchester (site 5) was 155 tonnes in 1971 and the annual load at East Stoke (site 10) was 477 tonnes. At both sites, and throughout the catchment, just over half the 1971 annual load was in the winter quarter January-March. In 1971, the increase in nitrate inputs to the River Frome between Dorchester and East Stoke was therefore 322 tonnes NO_3N.

Table 22 shows the equivalent nitrate loads for sites 3, 4, 5, 9 and 10 for 1984-86. In 1985 the annual nitrate load at Dorchester had increased to 343 tonnes (a 121% increase since 1971) and the annual load at East Stoke had increased to 864 tonnes (an increase of 81% since 1971). At both sites, just under half the annual load passed through during the winter quarter, similar to 1971.

The mean annual discharge at Dorchester gauging weir in 1971 was 2.03 m^3s^{-1} and in 1985 was 2.81 m^3s^{-1} (an increase of 38%). Equivalent values at East Stoke were 5.25 m^3s^{-1} in 1971 and 6.10 m^3s^{-1} in 1985 (an increase of only 16%).

Tables 21 and 22 together show the extremely large increases in nitrate loading that have occurred over the whole of the River Frome catchment since 1971.

Figure 19 summarises the three monthly mean data for the River Frome at East Stoke (site 10) for nitrate concentration, discharge, nitrate load and rainfall for both 1970-71 and 1984-86 and illustrates the large seasonal variations found. Again, it demonstrates the large difference in nitrate loadings between the 1970-71 and 1984-86 results.

Because of the large seasonal and annual variations of climatic conditions, discharges and therefore nitrate loads, Table 23 has been prepared from the FBA long-term sampling data using the four-year periods 1969-1972 and 1982-1985 when the average discharge at R. Frome (East Stoke) was very similar (6.32 $m^3\ s^{-1}$ for the 1969-72 period and 6.40 $m^3\ s^{-1}$ for 1982-85). The mean weekly nitrate load for these periods shows an increase of 47.4% from 11.68 tonnes/week in 1969-72 to 17.22 tonnes/week in 1982-85. The maximum load in any one week in 1969-72 was 38.55 tonnes/week but in 1982 and 1984 there were weekly loads of over 57 tonnes, an increase of nearly 50%. The mean kg/ha/annum loading has increased from 14.6 to 21.6, a 48.1% increase.

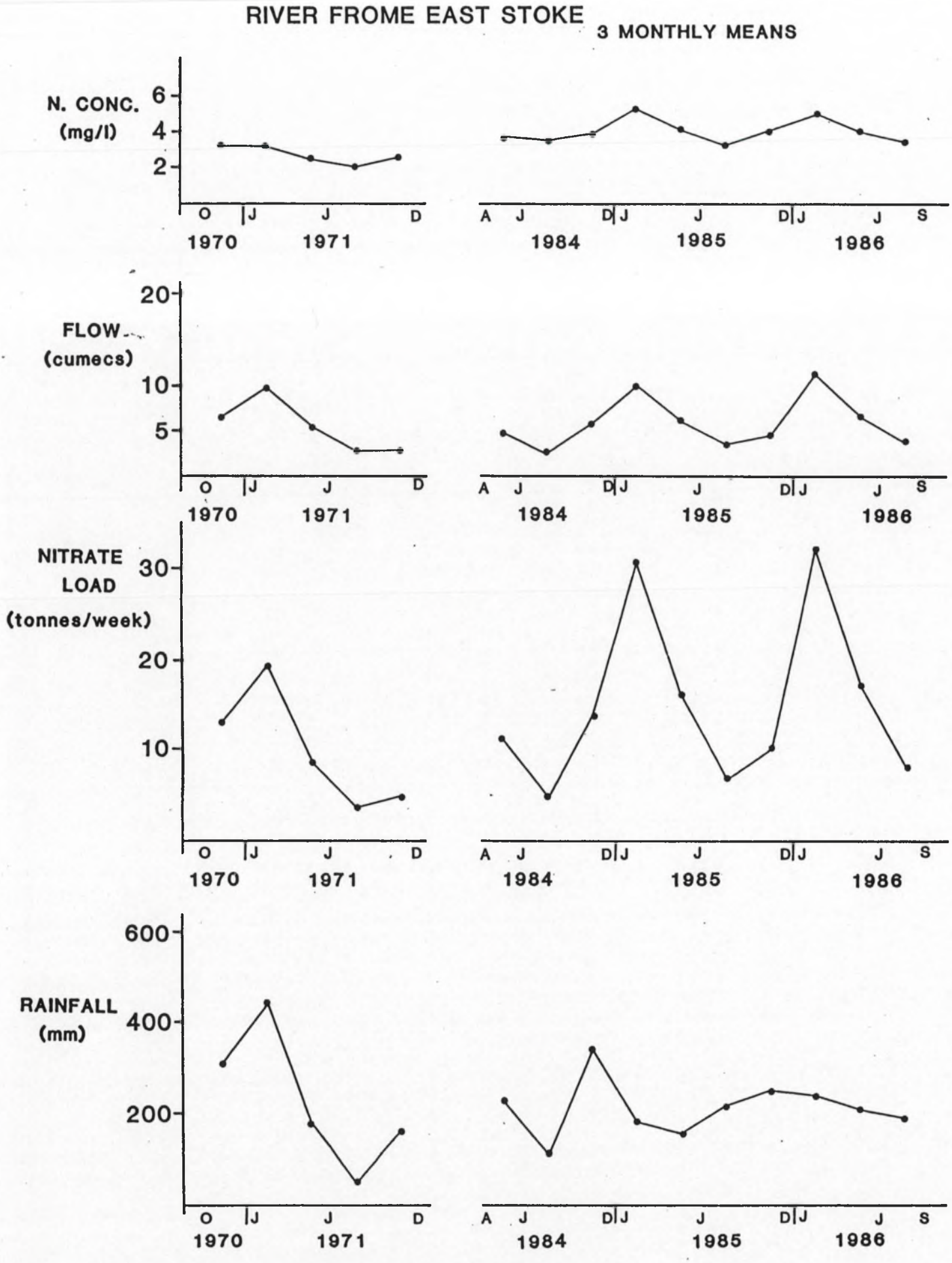

Figure 19. Comparisons of 3 monthly means of nitrate concentration and load, discharge and rainfall getween 1970-71 and 1984-86

Table 21. Quarterly and annual nitrate loadings (tonnes NO_3N) in 1970-71.

Site	(1)	(2)	(3)	(4)	(8)	(9)	(11)	(12)	(13)	(14)	Dorchester (5)	East Stoke (10)	Increase between Dorchester and East Stoke
1970 Oct-Dec Total	7.415	7.733	6.154	10.541	19.274	23.191	3.356	27.809	2.272	3.393	85.183	171.712	87
1971 Jan-Mar Total	14.481	8.185	11.951	25.056	26.337	33.392	4.184	43.016	5.381	3.026	88.313	251.510	163
1971 Apr-Jun Total	4.940	2.634	4.425	6.885	16.125	16.103	2.123	15.662	2.241	0.545	31.040	113.193	82
1971 Jul-Sep Total	3.303	1.554	2.466	2.788	10.158	8.104	1.719	8.582	1.273	0.213	15.562	51.273	36
1971 Oct-Dec Total	3.886	3.733	2.530	1.784	10.622	9.394	1.572	13.291	1.222	0.362	19.946	61.756	42
1971 Annual load (tonnes)	27	16	21	37	63	67	9	80	10	4	155	477	322

Table 22. Quarterly and annual nitrate loadings (tonnes NO_3N) in 1984-86.

Site	(3)	(4)	(9)	Dorchester (5)	East Stoke (10)	Increase in load between Dorchester and East Stoke
1984 Apr-Jun Total	8.773	5.477	18.898	45.016	145.038	100
1984 Jul-Sep Total	4.248	2.058	13.628	22.985	68.515	46
1984 Oct-Dec Total	10.425	9.843	17.565	73.684	180.534	107
1985 Jan-Mar Total	20.986	19.581	0.000	163.726	426.995	263
1985 Apr-Jun Total	13.151	12.852	0.000	84.844	207.270	122
1985 Jul-Sep Total	7.679	5.019	0.000	38.843	94.520	56
1985 Oct-Dec Total	9.096	5.420	0.000	55.300	135.534	80
1985 Annual load	51	43		343	864	521
1986 Jan-Mar Total	24.711	20.291	35.868	193.100	446.581	253
1986 Apr-Jun Total	12.114	5.823	22.662	97.808	225.153	127
1986 Jul-Sep Total	7.883	2.539	13.583	44.419	107.067	63

Table 23. Nitrate loads mean value in tonnes/week for R. Frome (East Stoke site 10) 1969-72 and 1982-85.

Year	Mean discharge $m^3 s^{-1}$	Mean tonnes/week	S.E.	Minimum tonnes/week	Maximum tonnes/week	Mean kg/ha/annum
1969	6.59	11.39	1.06	3.35	31.02	14.3
1970	6.64	12.36	1.21	3.69	38.55	15.5
1971	5.29	9.83	1.03	3.29	34.83	12.3
1972	6.78	13.13	1.23	3.78	35.72	16.5
Average	6.32	11.68		3.53	35.03	14.6
1982	7.49	19.59	1.89	4.19	57.03	24.6
1983	6.13	15.77	1.27	4.36	39.82	19.8
1984	5.82	16.64	1.85	3.27	57.26	20.9
1985	6.17	16.88	1.59	5.35	47.08	21.2
Average	6.40	17.22		4.29	50.30	21.6

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