ENGLISH NATURE

No. 56

Wannister Bog

Decline in water levels

M Newson

English Nature Research Reports

English Nature

CONTRACT NO. F72-06-23

WANNISTER BOG - DECLINE IN WATER LEVELS

by
Malcolm Newson
Professor of Physical Geography,
University of Newcastle upon Tyne,
NE1 7RU

1. INTRODUCTION

Mire ecosystems are subject to the impacts of both natural and artificial changes in their water regimes. It is perhaps tempting for conservationists to assume impacts of the latter kind, especially where (as in the case of East Durham) development pressures surround the sites in question. Many wetlands in the UK are now effectively "islands", completely surrounded by land uses which require drier conditions for success, e.g. arable farming and mineral extraction.

Nevertheless, the climate of the United Kingdom, whilst broadly supportive to wetland development and survival for 10,000 years, is inherently variable, especially east of the Pennines. Drought conditions impact on wetlands in a number of ways (Appendix A). Recent decades have been noted for droughts of varying duration and fortunately hydrological data (particularly rainfall data) are available for the region, dating back into the last century. **Unfortunately, numerical data relating to water levels in wetlands are very scarce and whilst Site Integrity Monitoring has improved the collection of routine observations at SSSI's it is not carried out in relation to quantifiable points in the climatic history and sensitivity of each site.**

This study was carried out during winter 1992-93, a relatively wet period; the working hypothesis must be that, since the site appeared healthily wet during my field inspections (allowing water samples to be taken), the drought conditions prevailing in eastern England during 1988-92 must be at least partly the explanation for the subjective impression by EN staff of hydrological change over that period. However, a secondary hypothesis must be that drought stress has potentially compounded an existing human impact, promoting a threshold change, from which recovery may or may not be possible and in which management of both human and drought impacts may play a role.

2. FIELD OBSERVATIONS AND WATER SAMPLING ON SITE

Wannister Bog is a valley mire situated on a shoulder of Middle Coal measures "hanging" above the South Burn, a tributary of the Wear, and taking seepage drainage on the two shorter sides of its broadly triangular plan from the sandstone Wannister Fell. Climatological maps reveal that the site has an annual average precipitation of 700mm and a mean annual potential evapotranspiration loss of 485mm; the surplus, draining and stored represents the wetland.

There are no direct hydrological measurements available for the site but observations in July 1976 (a drought summer) and in September 1984 show both a good wetland flora and stretches of open water, though Wheeler and Shaw (1976) remark that "the fen is no longer as wet as when described by Jeffreys....". They also speculate that the Deschampsia community may have extended over sixty years as a result of drying. In recent years, however, Site Integrity Monitoring has revealed both a more serious, protracted absence of surface water and the loss of sensitive wetland plant species, especially Eriophorum angustifolium.

On 11.12.92 surface water was sampled in the centre of the Bog and at a number of subsidence depressions nearer the periphery (the Bog is undermined by a former adit working to which a collapsed shaft - now plugged - connects). Two small streams draining the Bog to the South Burn were also running; these are not shown by the Ordnance Survey maps of the area but were recorded by Jeffreys (1916) on a map which is copied here as Figure 1. These are not traceable throughout their courses, being partly grown over. It is not impossible that they originated as deliberate drainage channels during the period of exploratory coal mining under the Bog. The northernmost channel was dammed by a "bund" (Management Plan term) and this structure is still effective (though it had recently been overtopped at the time of visit and does not very obviously control water levels beyond its immediate locality).

Interestingly, Jeffreys also refers to rushy inlet streams but, since he does not map them, these must be the present-day seeps and flushes around the edge of the Bog.

The results of chemical analyses of the samples taken (for sampling sites, see Figure 2) are shown in Table 1. It was my impression that all the water sampled related to two wet days (12mm December 6th, 4mm December 7th) in the week of the visit. However, with the exception of sample 7, the high concentrations of solutes suggest a source in the Coal Measures, in other words a response to the earlier rainfall through the seepage route from Wannister Fell. This is confirmed by the results of further samples, taken after a two-week dry period on 30.12.92 - increased ionic concentrations suggesting an even more diffuse flow route (Table 1). We may conclude, therefore, that there is a considerable source of such water in order to maintain fairly high flows for ca. 4 days after "normal" winter rainfall and to maintain wetness for two dry frosty weeks in winter. Clearly, if rainfall is regular and reliable Wannister Bog does not have a recharge problem. Jeffreys (1916) says that the Bog is at its maximum extent in May, suggesting the importance of winter recharge, and also refers to half a metre depth of standing water ("but sometimes the whole becomes dry").

Only the two outfall streams drain the Bog; standing water in all the subsidence hollows suggests that these do not leak to the adit below.

3. EXPLANATIONS FOR THE PERCEIVED DRYING OF WANNISTER BOG

3.1 General hydrological conditions, 1988-92

The 1991 Yearbook entitled "Hydrological Data UK" (IH/BGS, 1992) makes some salient points in relation to our region. After remarking that the 22-month period ending in December 1991 was the second driest for the whole of England and Wales since records began in 1767, the Yearbook concentrates a lot of attention on eastern England (extending well north - to Northumberland). It concludes that, "long term rainfall deficiencies across a large proportion of eastern Britain - already substantial at the end of 1990 - increased over 1991 as a whole".

3.2 Local hydrological conditions

Whilst the drought period in question (1988-92) has received more media attention in the south-east through its affect on groundwater supplies and surface streams fed from groundwater, it has been no less severe in the north-east; public attention in this region has been diverted from the topic because rainfall totals have increased during this period over the Northern Pennines, whence come our public water supplies from surface reservoirs, e.g. Kielder. For example the Yearbook's map of rainfall in 1991 shows 75-85% of normal for the coastal strip of the north-east but 110-120% over the Pennines (see Figure 3). Figure 4 shows the soil moisture deficits developed under grass covers in north Northumberland for the years 1987-91, bringing out the joint impacts of both reduced rainfall and increased potential evaporation towards the end of this period.

Wheeler (1990a) quantifies the effect of the "rain shadow" to the east of the Pennines in this region, suggesting that it is independent of altitude, that moisture deficits in the airstream are not made up by evaporation from the surface and that the "shadow" is at a maximum in autumn (minimum in spring and summer when convective activity can compensate).

Wheeler (1990b) analyses the very dry year of 1989 in the north-east; assigning the Sunderland rainfall total a rarity of once in 700 years he suggests that it was a return to strong south-westerly and westerly winds (a possible feature of the enhanced "Greenhouse Effect") which brought into play the rain "shadow", resulting in drought. The point must be addressed, therefore, that north-east wetlands may now be entering an era of prolonged climatic threat; ameliorative management is therefore essential.

Table 2 shows a more local breakdown of annual rainfall data for the last four to five years.

TABLE 2
ANNUAL RAINFALL FIGURES FOR NEWCASTLE AND DURHAM UNIVERSITIES, 1988-91 (and including up to November 1992)

Year	Newcastle	%long term	Durham	%long term
1988	651mm	97	655mm	101
1989	362	54	353	54
1990	513	77	508	78
1991	462	69	460	71
1992 (part)	598	98	464	96

In order to put the recent dry spell into a longer term perspective, Figure 5 uses the University of Durham's very long record of observations and a calculation of both mean and standard deviation to show that 14 of the last 22 years have been drier than average, with 1989 and 1991 beyond the standard deviation of the data. 1989 was the driest year on record in both Durham and Sunderland (Wheeler, 1992); the decade 1980-89 was the driest in a record which dates back to 1859.

Figure 5 also separates out the spring season (March-May inclusive) because dry springs are particularly harsh on wetland plant communities needing a competitive advantage over invasive species; surface water is especially useful to wetlands during spring when transpiration may not be at the potential rate. Whilst the three recent drought years have also had dry springs there is no indication from this graph that spring rainfall has had a particular impact; it is more likely to be a sequence of "good", dry, sunny summers which has exacerbated to impact of the three dry years.

The recovery shown in 1992 is remarkable; for the Newcastle record the sequence of four wetter-than-average months (August-November 1992) has not been repeated since the period February-May 1983.

4. ALTERNATIVE EXPLANATIONS FOR DRYING AT WANNISTER BOG

There is a very clear case of artificial hydrological manipulation adjacent to Wannister Bog - the Daisy Hill opencast coal-mining site to the south-west. Whilst it is almost impossible to make regional hydrological predictions for faulted, drift-covered Coal Measures, and the popular imagination therefore creates leakage and "plug-hole" hypotheses, certain observations apply against arguing an opencast impact on Wannister Bog:

a. A tributary of the South Burn intervenes between the two sites; the South Burn itself is deeply incised below the level of Daisy Hill and, together with the adit beneath the Bog is a more obvious hydrological "sink" for Wannister Bog water,

b. Drift covers in this area are impermeable in the main and the water table applying to Wannister Bog is therefore "perched" above that of the Coal Measures, even if the latter is affected by the adit or by Daisy Hill. Only if the recent drought has been severe enough to deeply fissure the boulder clay veneer will there be any leakage into the Coal Measures below.

c. The conditions at the site in December 1992 suggest that when rainfall returns to "normal", so does the hydrological regime of Wannister Bog, though there is scope for enhancing this (see below).

At the time of the Public Inquiry into the Daisy Hill proposal it was stated by NCC that "From the geological evidence....suplied it would appear that the strata run in such a way that no drainage should occur", though NCC was worried that the proposal might have involved "possible opening of old mine workings and/or disturbance of the clay base which seems to hold water in the bog". This is highly unlikely at such a distance (using the analogy of the recent Joe's Pond investigation in Co. Durham).

Of the other potential drought-related human impacts listed in Appendix A, grazing is not a feature on Wannister Bog; visitor pressure is a factor but not especially in the Bog area. Fire has been noted (e.g by Wheeler and Shaw, 1976, who write of a disastrous outbreak in 1963) but it is not linked specifically to the current deterioration of the condition of the Bog.

5. CONCLUSIONS AND RECOMMENDATIONS

It is my impression from the observations and data from the site and from the data on regional and national climatic trends that the hydrology of Wannister Bog is now recovering. Because of its uniqueness as a valley mire in County Durham it deserves some management "help" with this recovery. This should be in three forms:

a. Some form of hydrological monitoring is desirable; though the site is prone to vandalism, simple dip-wells can be secreted by the Warden and used to develop a monthly record of water levels at about three locations on the site,

b. The timing of Site Integrity Monitoring visits can be integrated more formally with climatic trends. Figure 6 illustrates the dates of SIM at Wannister and those dates which would have helped to monitor the effects of drought.

c. The "bund" across tha main outlet to the site can be made more effective if levels are surveyed; it appears to be too low at present and may have settled. During such a level survey the other outlet should be included so as to assess the value of bunding there too.

Those who support a "Global Warming" hypothesis for recent climatic trends in the UK suggest that an enhanced westerly circulation, producing a wetter regime in the Pennines but an enhanced "rain shadow" on the north-east coastal strip will continue to make agricultural and other impacts on the region. Whilst the three suggestions above cannot maintain a desirable habitat in the face of gross changes in basic controls they will help evaluate and measure the changes and, meanwhile represent a "no regrets" policy.

References

Jeffreys H 1916 On the vegetation of four Durham Coal Measure fells. 1. General description of the area and its vegetation. Journal of Ecology, 4, 174-195,

Wheeler B D & Shaw R 1976 The vegetation of Waldridge Fell, Co Durham. 2. Heathland, grassland and wetland communities. Vasculum, 61(3), 17-30.

Wheeler D A 1990(a) Modelling long-term rainfall patterns in north-east England. Met. Mag., 119, 68-74.

Wheeler D A 1990(b) Climatic change in Sunderland? Weather, 45(6), 229-231.

APPENDIX A

Potential impacts of drought conditions on wetland flora

A drought is not a drought, is not a drought! The term covers a huge variety of dry conditions of varying intensities and durations, most of which are fairly specific in relation to elements of the wetland habitat and will vary in their impact according to the main water source (i.e. especially precipitation and seepage). We may roughly delimit the following classes:

a. A dry summer season - a "farming drought" or memorable holiday season. Reduced precipitation leading to soil dessication, exacerbated by increased potential evapo-transpiration. Die-back of sensitive species, e.g. Sphagna. Surface dessication/oxidation of peat. Danger of fire. Less impact where groundwater is main supply and good recharge the previous winter,

b. A sequence of dry years - a "water-supply drought". Reduced groundwater seepage to fens and valley mires. Progressive and irreversible cracking of peats and clays and vegetative change as the result of changed competitive situation,

c. Dry spring seasons in which lack of surface water gives competitive advantage to drier-loving species whose taller canopy then increases evapotranspiration during the subsequent summer. This is a second-order effect,

d. Third-order effects brought about by increased access to wetland, visitor and grazing pressures and the danger of fires which may damage vegetation and, more seriously, peat.

APPENDIX B

Site Integrity Monitoring and hydrological change

Whilst there are clearly excellent biological reasons for choosing a particular date for Site Integrity Monitoring and even more pressing reasons of time management, access and convenience, it is suggested here that Monitoring could fairly easily be guided, for wetland sites in a hostile climatic environment, by hydrological sequences. The implications for Wannister Bog are shown in Figure 6.

As an initial proposal we might list four conditions under which Site Integrity Monitoring would be useful. Were it not possible to map standing water or measure dip-well levels monthly (as advised elsewhere in this report), these periods would also be appropriate for such measurements.

The conditions are:

a. After any three winter or summer months with less than 60% of average precipitation (autumn is less important unless it follows a dry summer),

b. After any six consecutive months with below average precipitation (no specified shortfall),

c. After any two spring months with less than 60% of average precipitation,

d. After any two consecutive months with greater than 150% of average precipitation.

The "surplus" criterion is deliberately set higher than the "deficit" because surpluses of this magnitude are approximately of the same probability over a two-month period. The two-month period is also chosen for spring because of the sensitivity of plant competitive stresses in this season.

The definition of seasons followed by hydrologists is as follows:
Winter: December, January, February,
Spring: March, April, May,
Summer: June, July, August,
Autumn: September, October, November

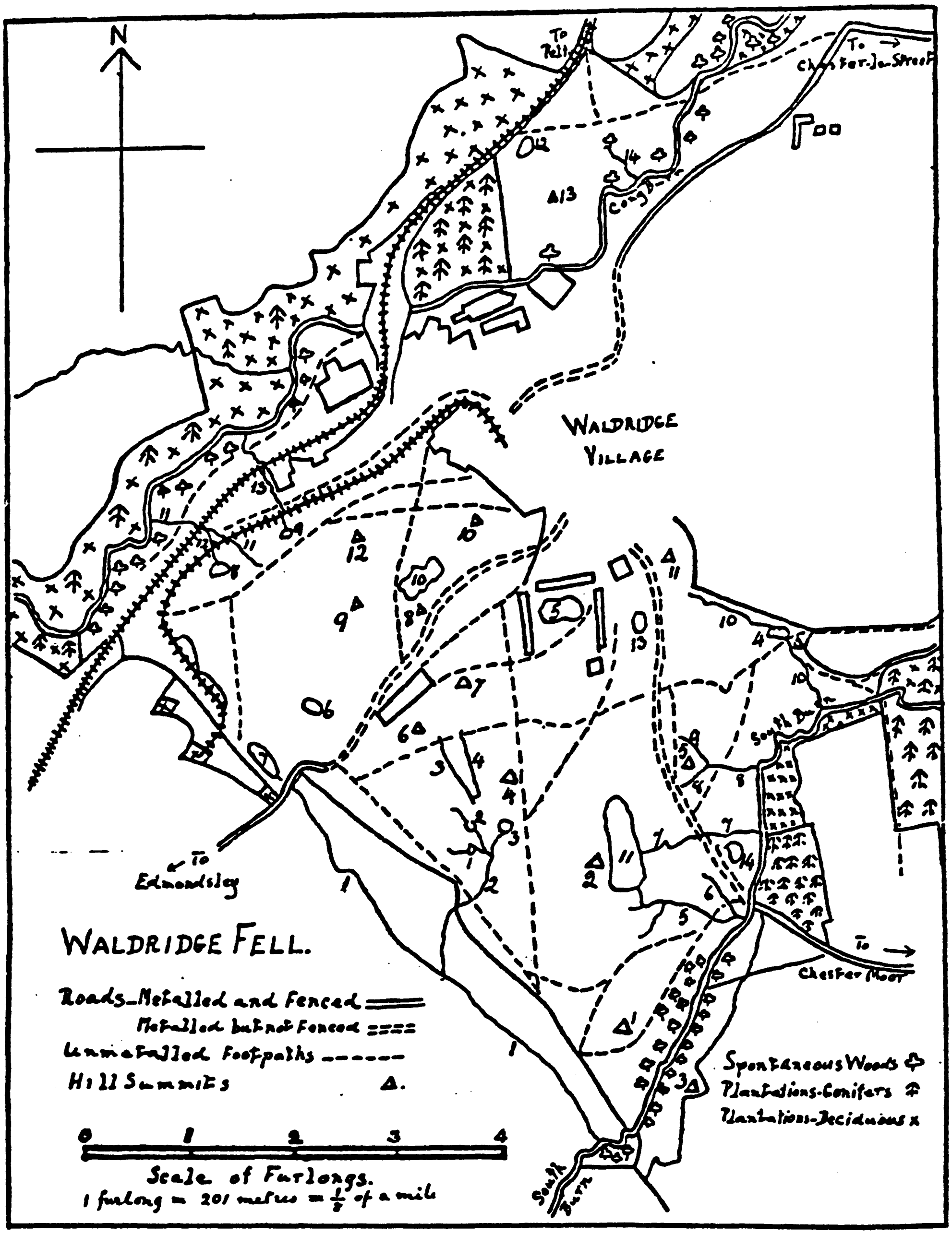


Fig. 21. Map showing the area studied on Waldridge Fell. The numbers are referred to in the text.

Figure 1: Jeffreys' (1916) map of Waldridge Fell showing (No. 11) Wannister Bog and its two outflow streams to the South Burn.

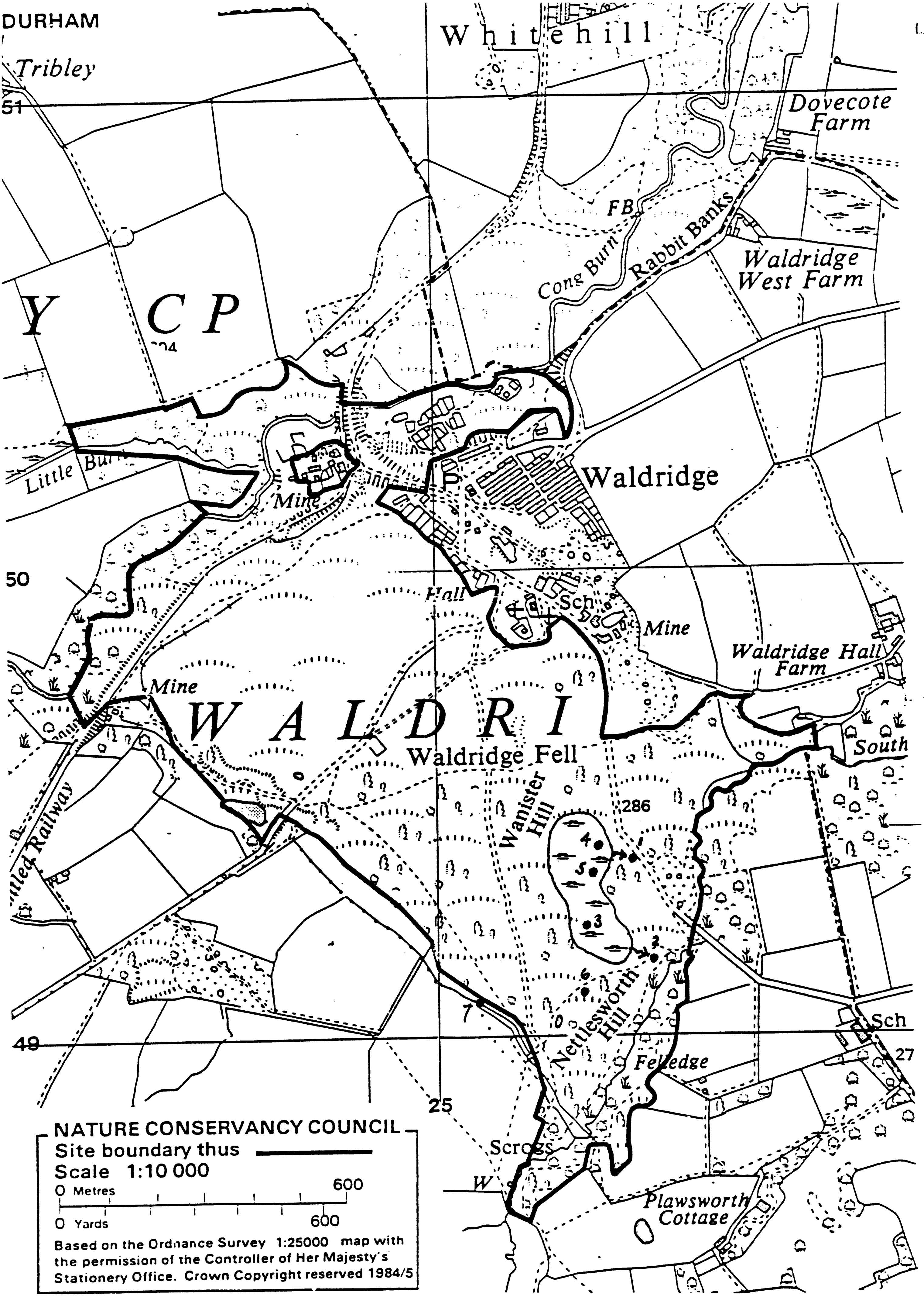
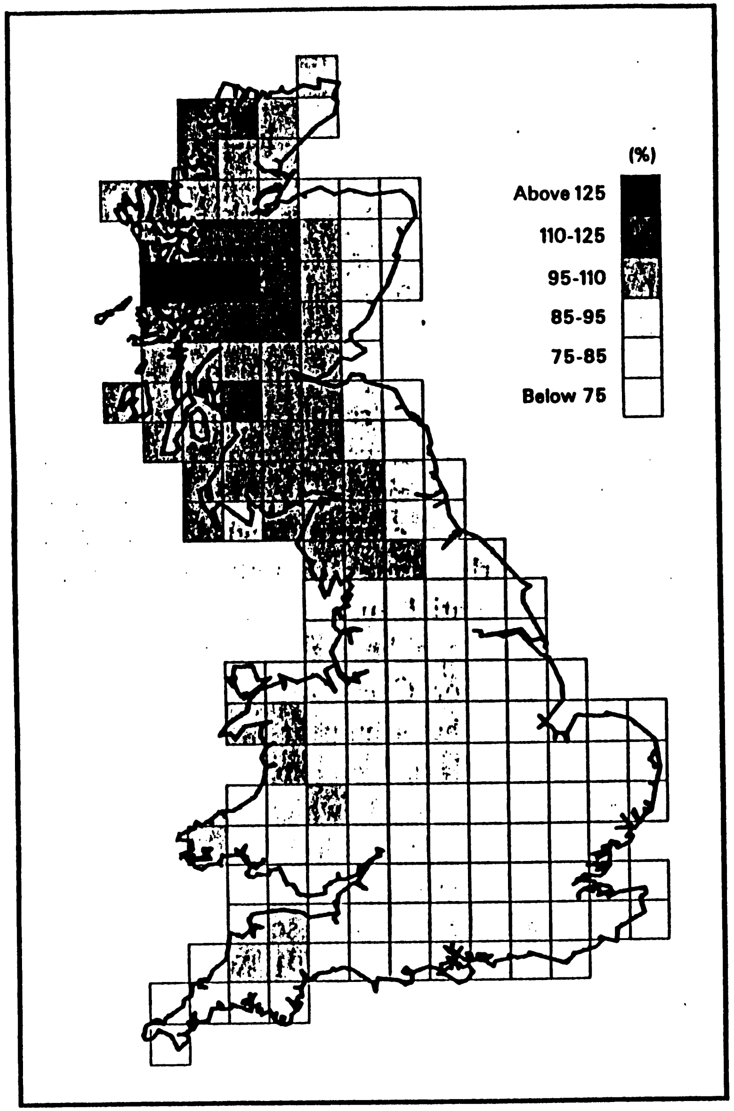


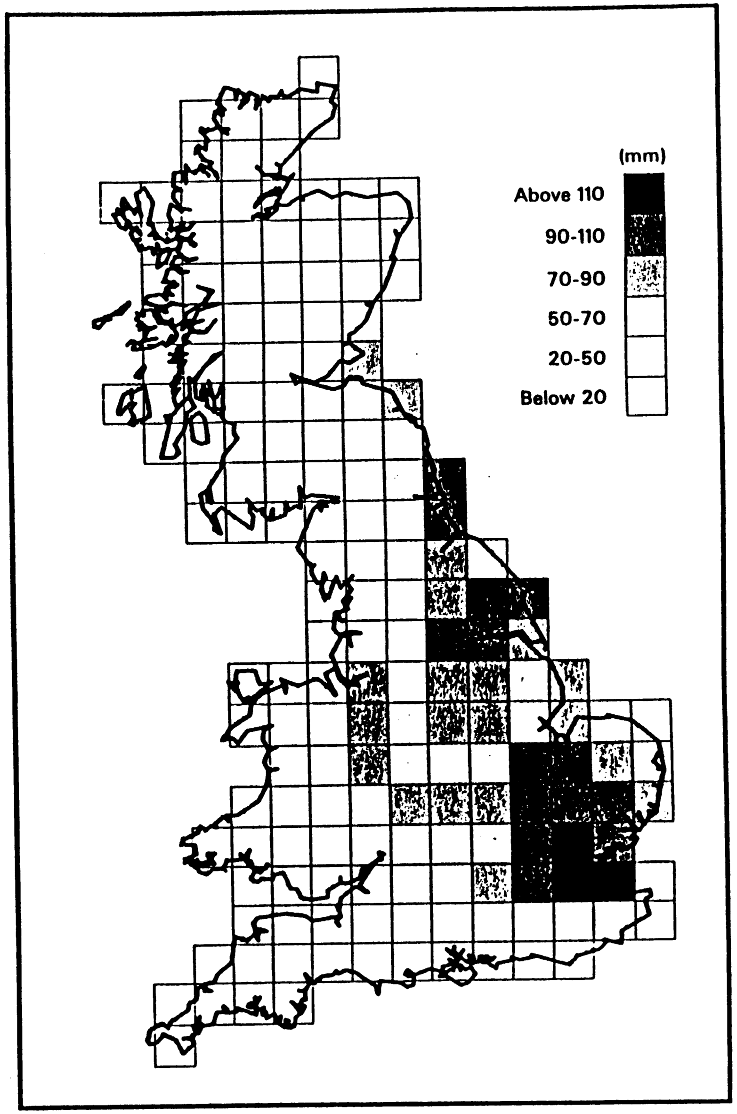
Figure 2: Water sampling sites, Wannister Bog and

TABLE 1 CHEMICAL ANALYSES OF WATER SAMPLES FROM WANNISTER BOG AND NEIGHBOURING AREA

Date	Sites (see map)	pH	Con	Ca	Mg	Na	K	Pb	Zn	Cu	Mn	Fe
11.12.92	1	5.2	1000	123	13.5	29.8	5.4	0.13	0.34	0.05	0.48	0.43
	2	5.1	1030	151	15.4	19.9	1.2	0.12	0.66	0.36	1.39	0.54
	3	5.4	840	110	12.2	17.2	1.2	0.11	0.35	0.23	1.44	1.85
	4	5.9	1600	206	14	21.3	0.3	0.14	0.16	0.2	1.02	0.68
	5	6.3	740	60.8	13.1	34.7	1.4	0.1	0.36	0.08	0.84	0.77
	6	4.9	180	7.2	3.6	13.1	2.7	0.17	0.25	0.05	0.94	3.77
	7	6.1	700	56.6	15	19.2	1.7	0.22	0.69	0.05	4.54	0.1
30.12.92	1	4.9	1300	158	17.4	29.42	1.08	0.12	0.38	0.24	1.92	1.21
	2	4.9	1400	160.3	21.4	20.35	0.85	0.1	0.32	0.12	0.79	0.97
	3	5.2	1000	85.1	17.3	32.15	1.29	0.1	0.29	0.17	0.15	0.86

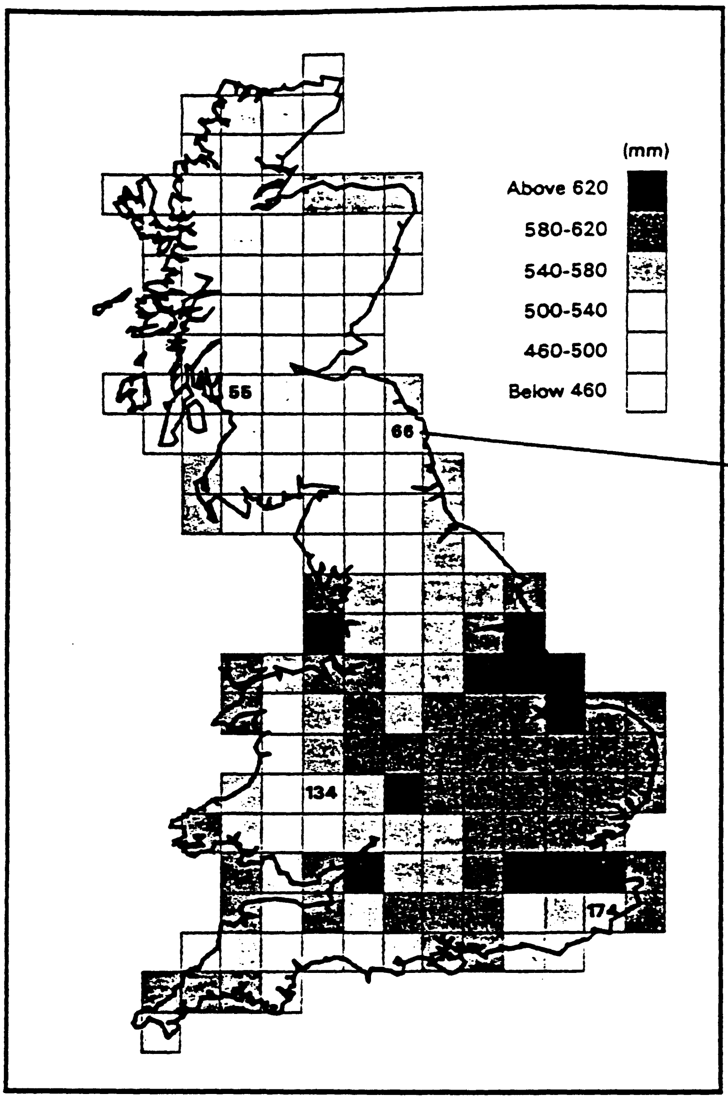


August 1988 to December 1991 rainfall as a percentage of the 1961–90 average

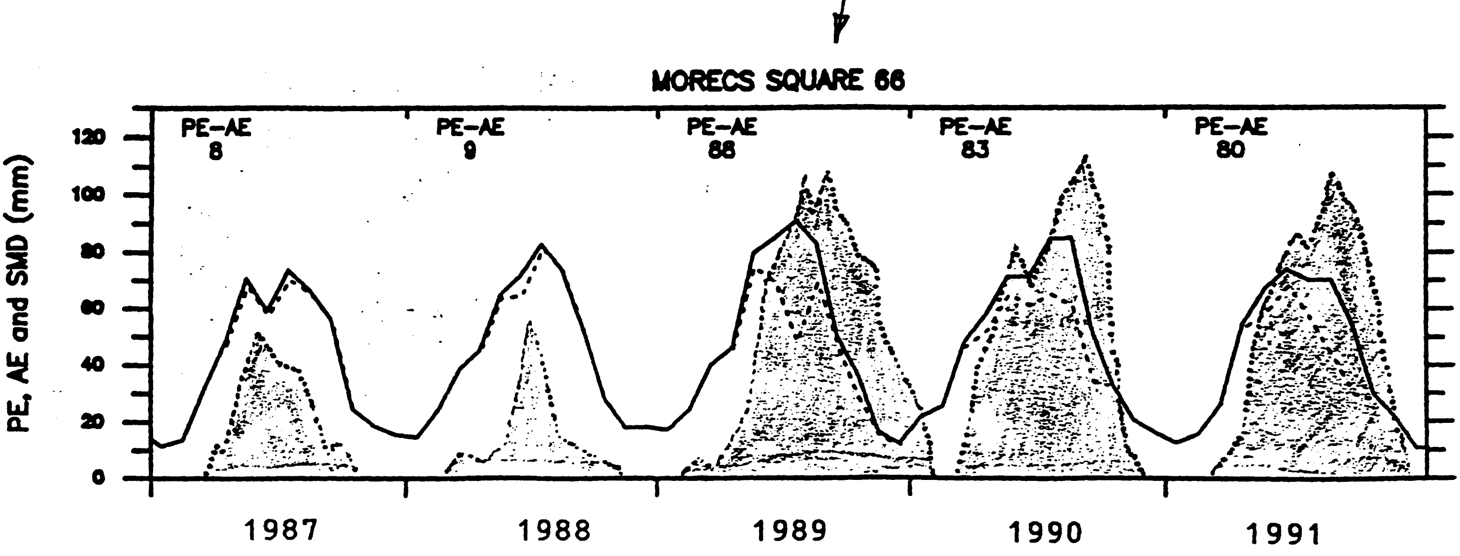


Soil moisture deficits (for a grass cover) at the end of October 1991 Data source: MORECS

Figure 3: The 1988-91 drought - rainfall and soil moisture deficits (maps from the Surface Water Archive, Institute of Hydrology, Wallingford).



Potential evaporation (for a grass cover) in 1991
Data source: MORECS



Solid line: potential evapotranspiration
Dashed line: actual evapotranspiration (as modified by deficit in soil)
Shaded area: Soil Moisture Deficit

Figure 4: Drought in north Northumberland as seen by potential and actual evaporation rates and soil moisture deficit (data from the Surface Water Archive, Institute of

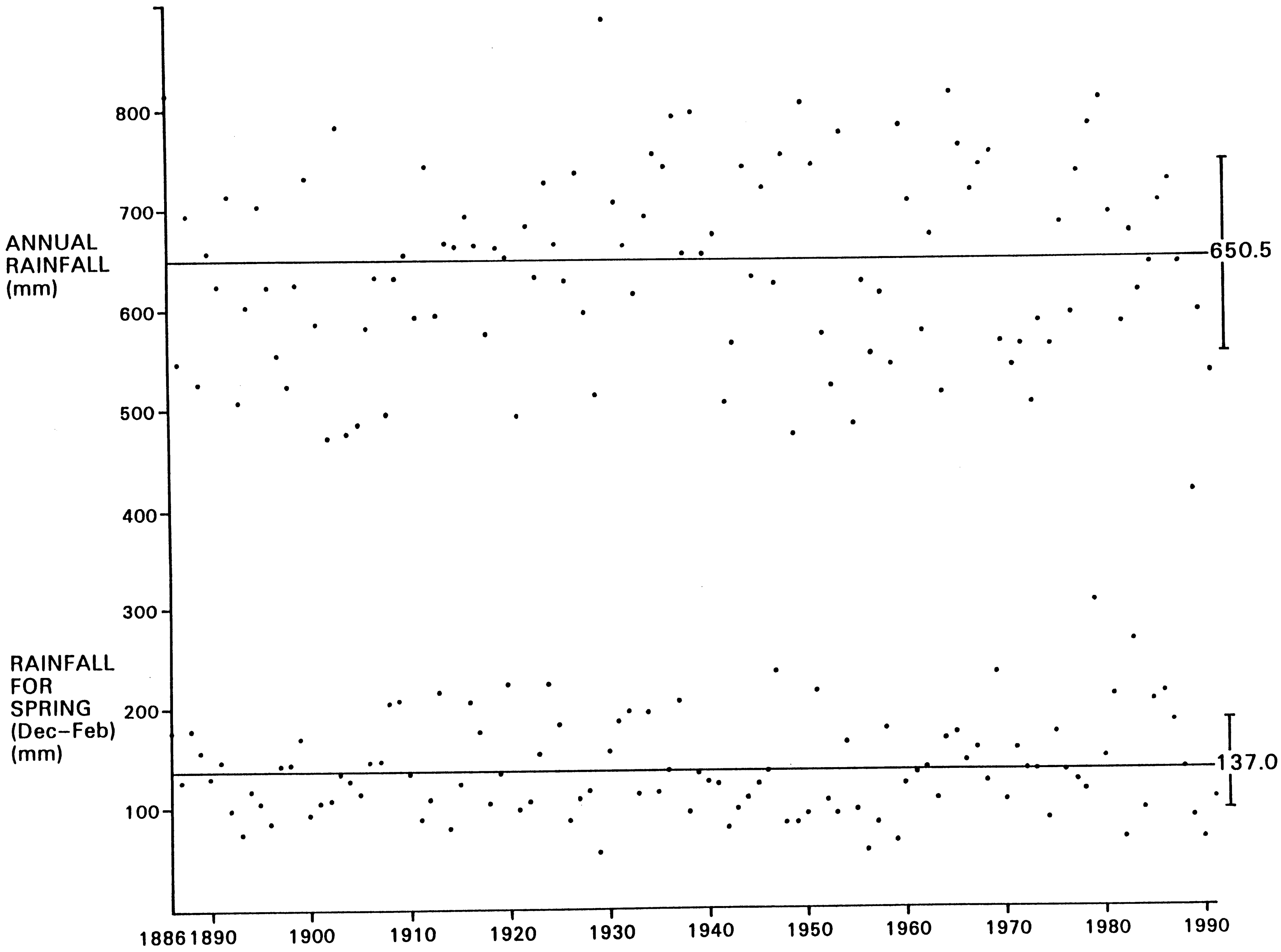


Figure 5: Rainfall totals (annual and spring season) for Durham Observatory, 1886-1990. The bars at the r.h.s. show mean and standard deviation.

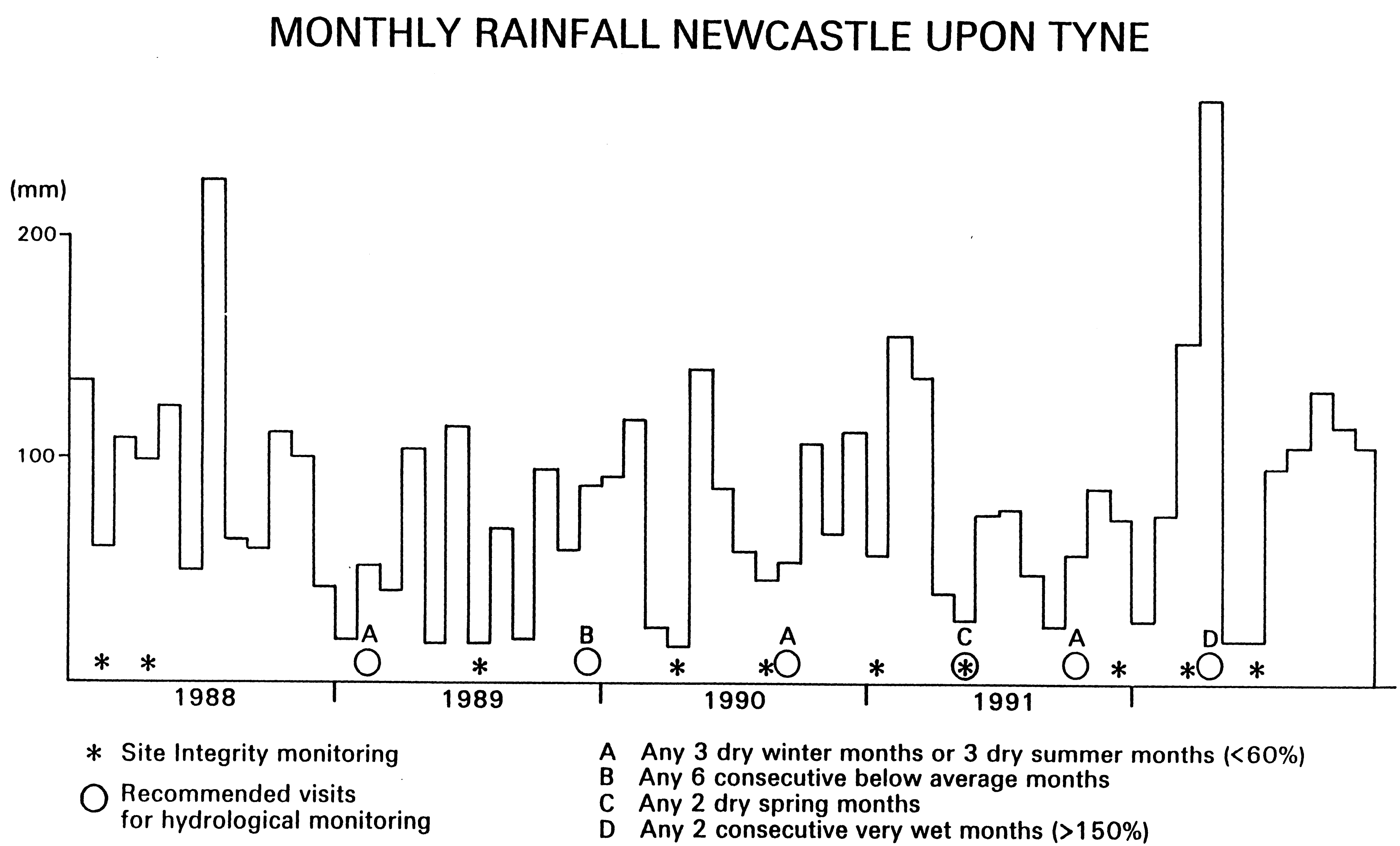


Figure 6: Newcastle University monthly rainfall figures 1988-1992, showing actual Site Integrity Monitoring visits and those suggested by a hydrological prompt scheme.