ENGLISH NATURE

Monitoring raised bogs

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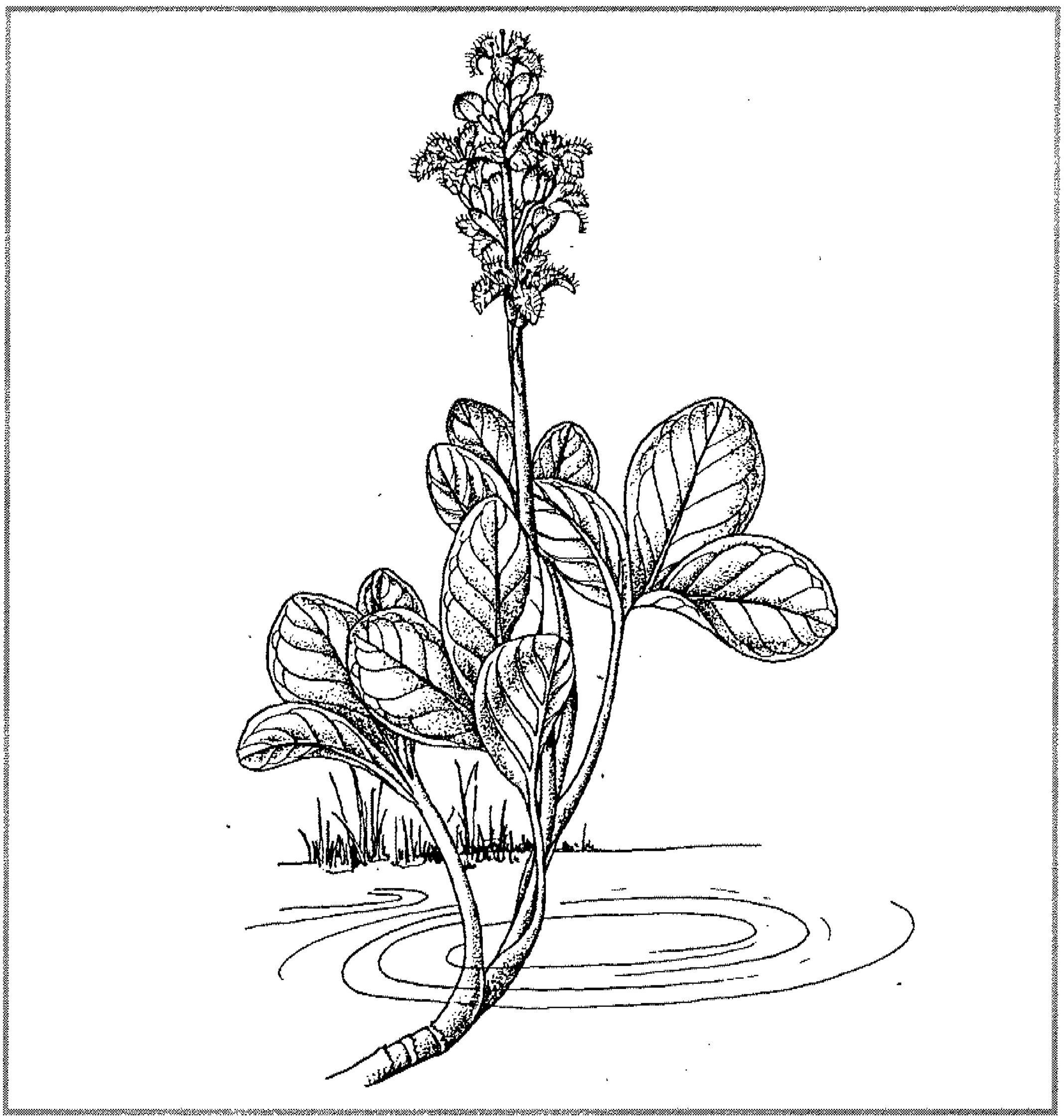

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Monitoring raised bogs

Workshop report

English Nature
and
Scottish Wildlife Trust

MONITORING RAISED BOGS WORKSHOP REPORT

SCOTTISH WILDLIFE TRUST

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Introduction to the EN/SWT Peatland Restoration Workshop on Monitoring, Workington, 1994

Dr Brian Johnson, Chair

Over the past 5 years we have witnessed changing attitudes from planners, central government and peat extraction companies towards the conservation and after-use of peatland sites, particularly raised mires. This has led to the increased availability of sites throughout the UK for rehabilitation by nature conservation bodies from both the statutory and voluntary sectors. I am pleased to welcome representatives from Scotland, England and Wales and Northern Ireland to this workshop where we will explore the issue of monitoring the conservation effort being made by your organisations on raised bogs in a variety of different localities. It is particularly pleasing to see so many site managers here, as you are the people who have to carry out the often arduous and repetitive tasks associated with monitoring.

Monitoring has had a notoriously chequered history. I am sure that we all have anecdotes of the collection of huge data sets which are destined to do nothing but insulate the walls of some long-forgotten office! Management plans almost always contain provisions for monitoring, but in my experience not all of them cater for the analysis and use of the results. If we achieve nothing else in this event, I would like to think that all of us will leave resolved never again to collect data which is not relevant and will never be used.

Can I also make a plea that we do not become entangled in debates about the differences between monitoring and research? To my mind there is no clear distinction, although some would have us believe otherwise. Much fundamental research depends on repeated survey and observation, and I would hope that, when the opportunity arises, we can design monitoring schemes which add to our knowledge of how natural systems work. Research and monitoring are complementary and closely related activities.

As natural site managers, I believe that we should monitor sites for two main, and related, reasons:

- To provide feedback on the effects of management so that we can change operations if necessary. We all recognise that rehabilitation of bogs is a pioneering and inexact science; some would say an art. Careful and focused monitoring will tell us whether we're succeeding and, perhaps more importantly, why.

- To show our sponsors, those who provide the resources for rehabilitation, that they are getting good value for money, both in terms of wildlife value and also effective and efficient management. Monitoring management practices carried out on sites is, in my view, a vital part of this exercise and one so often neglected.

We have a wide-ranging 'formal' programme arranged for you, including a preliminary paper on the review of monitoring on raised mires commissioned by English Nature, but I hope that this workshop will develop into a participatory event. Your contributions are essential if we are to leave here with a better idea of what makes a good monitoring programme. We have a unique gathering of expertise in this room and I am sure that during the next two days we will identify and document best practice, so that others outside this workshop can benefit from publication of the proceedings.

Summary of the Monitoring Review

Sue Shaw, Environmental Consultancy, University of Sheffield

Work to restore water tables to regenerate bog vegetation on cut-over lowland bogs has been in progress on a number of peatland NNRs since the early 1980's. A good base of knowledge relating to management techniques exists, but there is considerably less information about monitoring techniques and little understanding of how effective restoration work has been. Large areas of damaged bog will require restoration management within the next few years, and effective monitoring of this work will be required to measure the effects of such management and to provide evidence of value for money. The Environmental Consultancy, University of Sheffield (ECUS) were commissioned by English Nature to carry out a review and evaluation of current monitoring practices and from this to prescribe key elements to be included in future monitoring programmes.

The project involved visits to and collation of information for 9 lowland peatland NNRs: Blawhorn Moss, Cors Caron, Cors Fochno, Fenns & Whixhall Mosses, Flanders Moss, Glasson Moss, Shapwick Heath, Thorne Moors, Wedholme Flow. Information was also obtained for Astely Moss, Holcroft Moss and Roudsea Moss.

Part I of the report considers aspects of monitoring currently being carried out at these sites and provides summary details of methods and costs. The principal factors being monitored are water levels and vegetation and to a lesser degree, invertebrates and birds. The most common general problems encountered were identified. In most cases, the monitoring projects carried out have developed over time, often in response to opportunity (for example, availability of funding or personnel with specific interests) rather than with overall planning of an integrated monitoring strategy. In general, the aims of the monitoring are not set down clearly, other than perhaps simply to monitor species populations in general, or to assess responses of various factors to site management.

Monitoring is carried out on different sites for a variety of reasons, which can go much wider than simply measuring the effects or effectiveness of management measures. These can be grouped into 3 main categories: (i) directly or (ii) indirectly related to management and (iii) for public liaison purposes.

Four main levels of approach to "monitoring" are currently taken: (i) no monitoring (but possibly collation of observations and records); (ii) provision of superficial data to give broad indication of change (e.g. general photographs; "Phase I" type habitat surveys,); (iii) intensive, but infrequent monitoring: detailed, maximum information-type survey (e.g. for invertebrates), which is repeated at infrequent intervals; (iv) a focus on more specific management practices, sub-areas (types of peat cutting etc.). Types (ii) and (iii) can provide evidence of the long-term effects of a given management regime, but are unlikely to give sufficient information to measure the effectiveness of management, and to provide adequate feedback so that appropriate action can be taken, as required. For this, type (iv) monitoring is required.

A large variety of methods and techniques were identified in use in various monitoring projects on the lowland peatland reserves visited. In many cases the approaches and techniques are similar, although there are differences in the implementation. Data analysis, together with any assessment and review of the monitoring projects are at best patchy and sometimes non-existent. This may sometimes be attributable to lack of time or resources, but is also the result of the lack of clearly-defined projects, with specific objectives and targets. However, in many sites projects relating to restoration management have only been set up relatively recently, with little opportunity for data analysis and assessment of results (although often with no clear idea of how this will be done).

Part II of the report addresses some of the problems identified above, suggesting key elements and factors in a strategy for monitoring the progress and cost-effectiveness of restoration management. Different approaches to and reasons for monitoring of restoration management work are considered, and key elements for the development of a monitoring strategy are outlined and discussed.

An ideal monitoring strategy fulfils the following criteria: the approach must be practical and cost-effective; projects should be as carefully circumscribed at the outset as possible, with specific aims, targets, criteria for significance, reporting schedules etc.; the overall strategy should aim to tie as much information together as possible, for example, water level and vegetation monitoring at same locations; the strategy should facilitate inter-state comparisons; all projects should be regularly reviewed and modified (or terminated) as appropriate.

There are 9 key elements to any monitoring programme devised to assess the impacts of management: planning ; setting a baseline; setting monitoring objectives and targets; methods for data collection; data storage; data preparation and analysis; interpretation and review; feedback for management; dissemination of information. It is important that these are seen as part of the whole monitoring project, so that the project is followed through to its conclusion, and effort is not wasted.

The report attempts to give guidelines on the key factors to be monitored - it is not possible to be entirely prescriptive, as the optimum strategy will be site-dependent. In view of the long time-scales over which restoration is likely to occur, it is important that a series of targets is identified so that progress towards the goal can be assessed, and any appropriate adjustments to management operations etc. be made as necessary. In general, for the management operations considered in this report, the most immediate response is likely to be hydrological, followed by biological changes and ultimately regeneration of peat growth. It is therefore considered that the key factors to monitor for restoration management are hydrology and vegetation, although it is also desirable to monitor effects on invertebrates and birds, especially populations of any conservationally-valuable species. When detailed monitoring schemes are impractical, it should be possible to monitor simple key factors, for example, whether water levels are responding to management.

Some thoughts on monitoring raised mire hydrology

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1. Introduction

The unique vegetation of rain-fed mire systems is generally associated with high water tables. Management objectives for a degraded site may include a statement of the desired range of water table fluctuations, for example:

> *"A raised mire should have a water table at or no less than 5 cm below the surface for as long as possible during the year to allow for the active growth of Sphagnum mosses".*

Whether or not a target has been set in this way, it is becoming common practice to monitor the movements of the water table at managed sites with the intention of using the results in some way to assess achievement in improving the site's hydrological regime.

This paper will cover briefly some points arising from studies of the behaviour of the water table in more or less intact mire systems which might usefully be applied in refining management objectives, in designing effective and economical monitoring programmes, and in evaluating the resulting data.

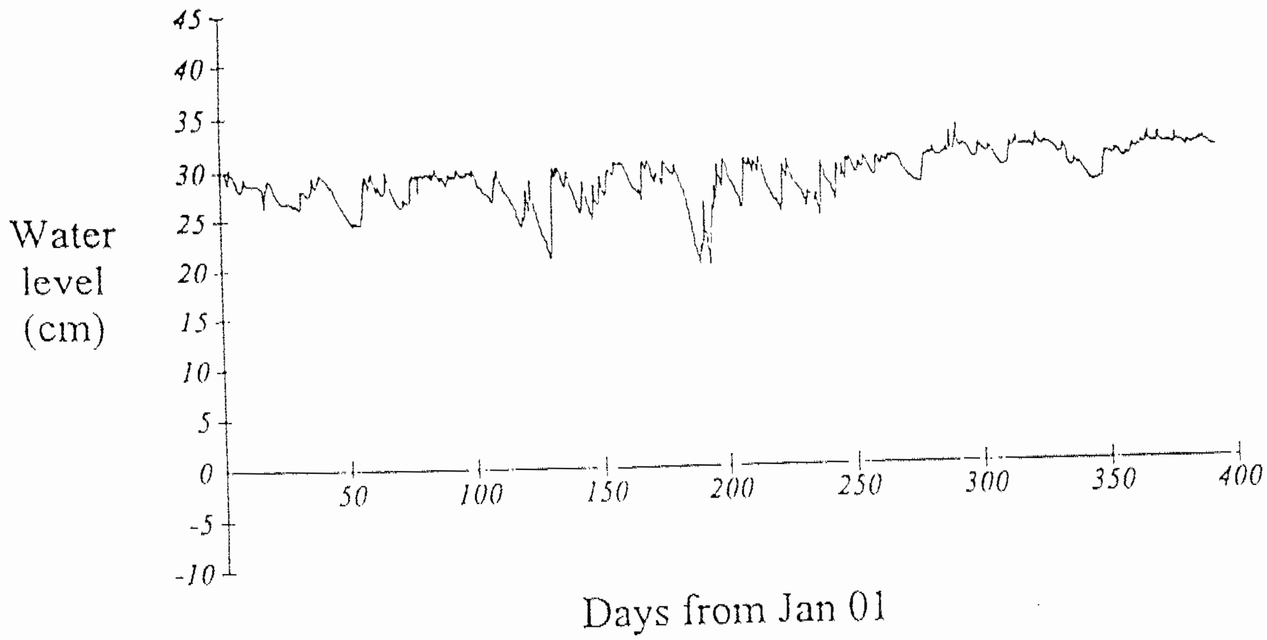
2. Behaviour of the water table in raised mires

The position of the water table reflects the amount of water stored in the system (but the quantitative relationship is complex; see Ingram 1992, Fig. 5). Water is supplied as rainfall and lost in two ways; some of it seeps through the bog until it leaves the system, and some is returned to the atmosphere as vapour, by evapotranspiration. When it rains, the rate of supply temporarily outstrips losses and the water table rises. Conversely, as evapotranspiration and seepage continue between rainfall events, the water table retreats from the surface.

Fig. 1 shows continuous water table data obtained from a single float recorder at the centre of a raised mire in Wales during two full calendar years, 1987 and 1992. In 1987 the position of the water table varied over a vertical range of 15 cm, whilst in 1992 it fluctuated by 32 cm. Between these two years, some drains on the site were dammed. Do the water table data indicate a negative management result?

We can extract from these records an account of the time spent by the water table within each 1 cm layer of the acrotelm during each year. These data are shown as water table frequency curves in Fig. 2. The peaks of the two curves coincide almost exactly, but the 1992 distribution has a long lower tail corresponding to dry spells with high evapotranspiration between May and August. In fact, the time during which the water table was within 5 cm of the top of its range was almost exactly the same (around 70%) in both years, the differences between the records arising almost entirely from differences in summer weather.

The relationship between the upper limit of water table fluctuations and the mire surface will depend upon the situation of the recorder. When the water table is closest to the surface, it tends to be at the same level beneath adjacent hummocks and hollows, whereas surface altitude may differ by 20-50 cm between microforms. Thus, a water table regime which would satisfy the above management criterion if monitored in a hollow would appear unsatisfactory if the recorder was sited on a hummock (for example, see Ingram & Bragg 1984, Fig. 7).



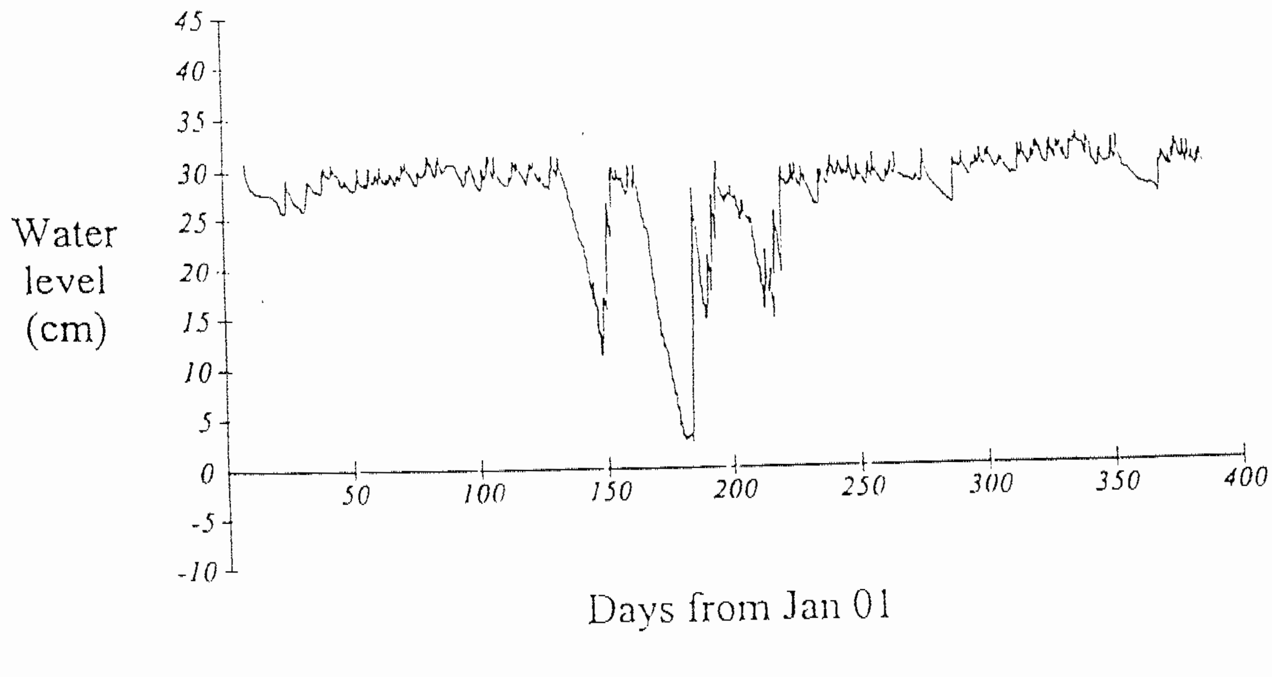


Fig. 1: Continuous water table records from the centre of a raised mire for two calendar years; upper diagram 1987, lower diagram 1992.

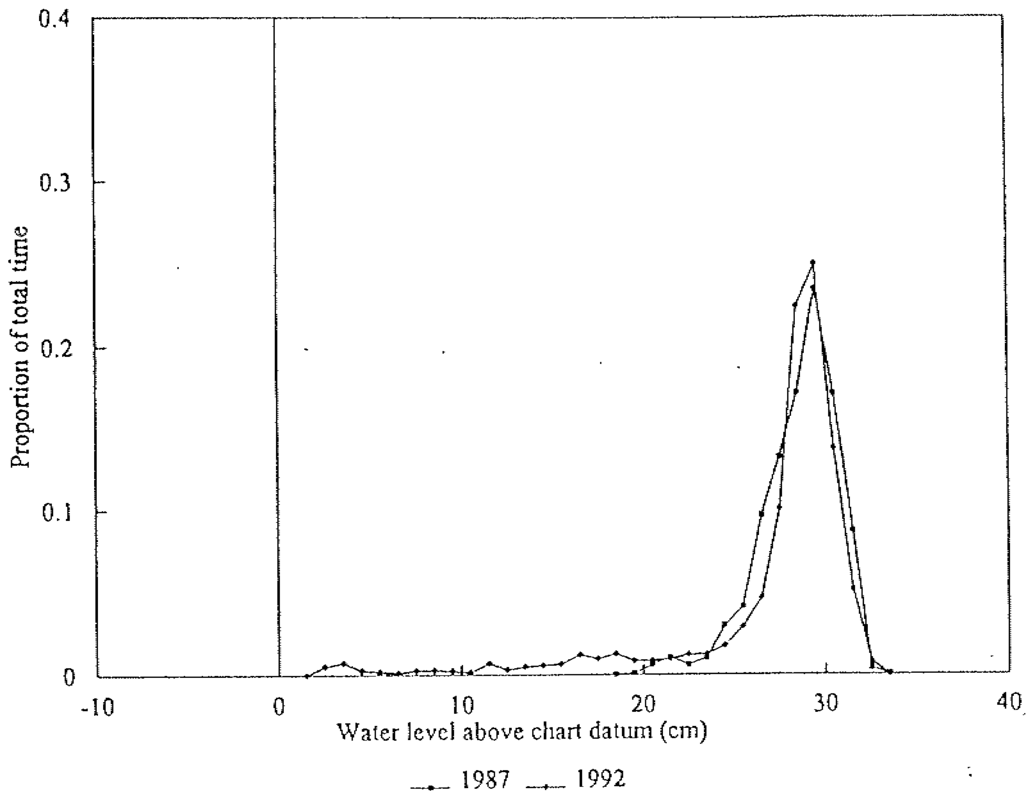


Fig. 2: Water table frequency curves constructed from the data shown in Fig. 1. These curves indicate the fraction of the year when the water table was within each 1 cm horizontal layer of the acrotelm.

It is suggested that, for monitoring purposes, the most useful feature of the water table record is the width of the peak of the water table frequency distribution. For an intact site, this has been shown to be reproducible in consecutive years. Moreover, it can be related to the structure of the acrotelm, and in particular to the layer within which the water table fluctuations are confined when seepage (rather than evapotranspiration) dominates the water balance. It also indicates the range of water table conditions occurring during the growth period of *Sphagnum*, which is curtailed during dry weather since the plants dry out as the water table retreats from the mire surface.

Although important in defining the depth of the acrotelm and significant to *Sphagnum* ecology, the degree and duration of summer drawdown varies from year to year and is accessible only as vagaries of weather allow, so that this is generally rather less useful where results are required within periods stipulated by financial budgeting timetables.

3. Instruments

Considerable capital outlay is necessary to achieve continuous water table records. An approach to the same information may be achieved using simpler and cheaper equipment. Records from maximum-minimum recorders (WALRAGs) read at different time intervals are shown in Fig. 3; the limits of the water table frequency peak were indicated even when readings could be made on only two occasions (spring and autumn) during the year. If automatic records are not practical, manual dipwell readings timed to coincide with extremes of weather might yield almost comparable information.

4. Datum levels

The most accessible datum for water table readings is the mire surface. Non-automatic data can be related directly to this datum at each reading. Where automatic instruments are used, a degree of uncertainty is introduced unless the instrument can be anchored so that its position relative to the mire surface remains fixed throughout the recording period.

If this option is chosen, the data can be interpreted to indicate exactly how long the water table spends within defined distances of the surface, and thus yield very accurate information on the water table regime experienced by the vegetation at that point. However, the data strictly apply only to the immediate vicinity of the instrument. If results from more than one instrument are to be used to construct profiles of the water table, an estimate of any difference between instrument locations in the range of seasonal movements of the mire surface (Mooratmung) will also be required.

Where absolute water table altitudes are required (e.g. to construct profiles or to calibrate a model of the whole system), the alternative approach of anchoring each instrument to a stable datum by attaching it to a post driven through the full depth of peat into the underlying mineral ground, should be considered.

The latter approach might be preferable where long-term data collection is envisaged, simply because of the sensitivity of the mire surface to disturbance. Local compression of the surface resulting from repeated visits to the instrument should not significantly influence whole-site hydrology and thus the general character of the water table regime, but data related to a local surface datum might indicate significant changes in water level under these circumstances.

If the mire system is stable, the annual water budget should be neutral, total supply being exactly balanced by losses. If the mire is growing, its storage capacity will increase very gradually, the upper limit of water table fluctuations rising by a small amount each year. Conversely, if the mire has been disturbed so that water losses are enhanced, the annual water budget may be negative so that maximum storage declines from year to year. Monitoring of changes of these types would require reference to stable datum levels.

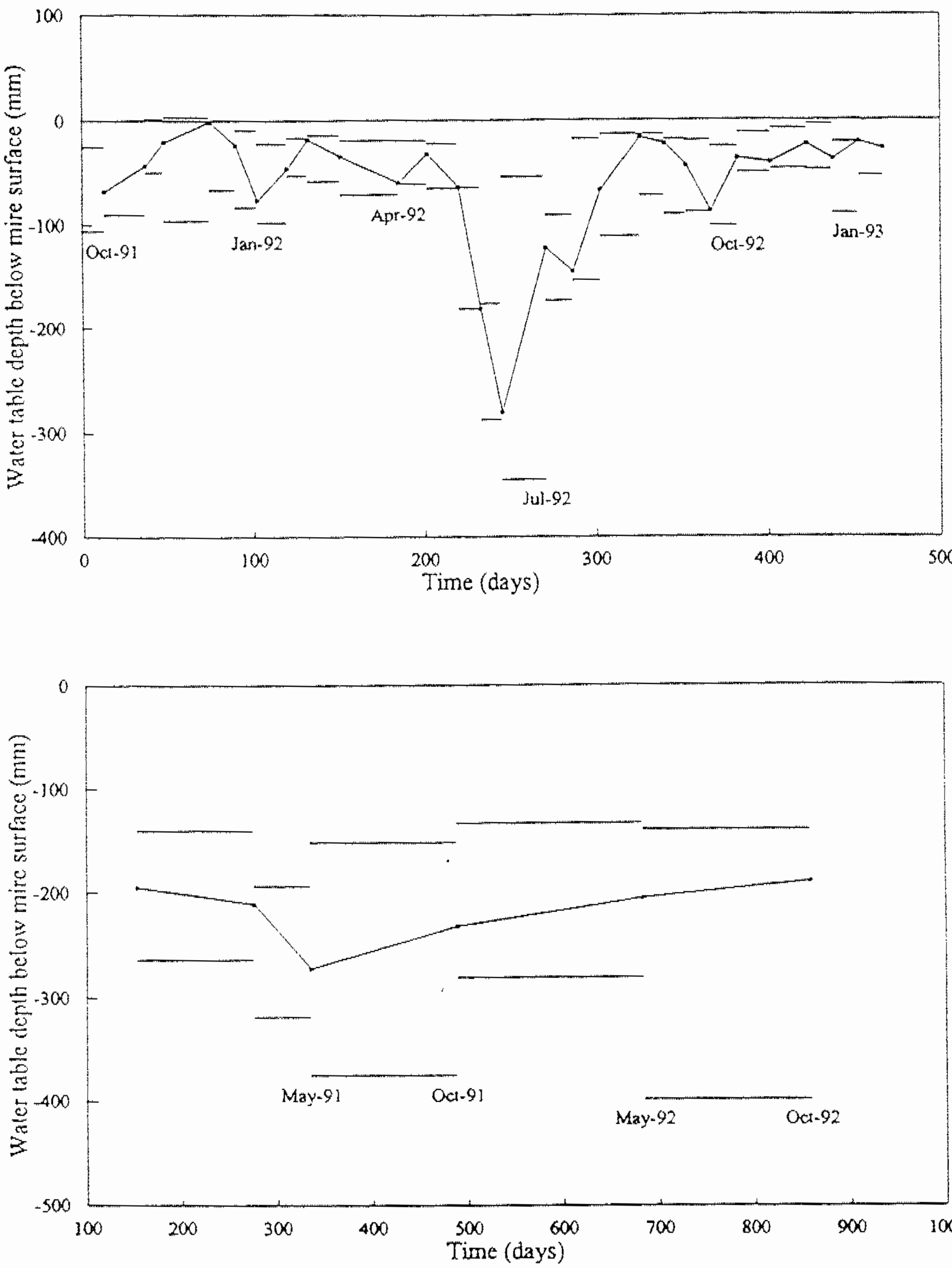


Fig. 3: Data from two maximum-minimum water table recorders (WALRAGs) read at different frequencies. Upper diagram: readings at intervals of approximately 2 weeks. Lower diagram: readings at irregular intervals, reducing to two visits per year. Joined symbols indicate water levels at times of visits; horizontal lines indicate maximum and minimum water levels occurring between consecutive visits. Data for lower diagram by courtesy of P.D. Hulme.

Thus, the most important initial design decisions for water table monitoring stations may not involve choosing between electronic loggers, maximum-minimum recorders and dipwells, but lie in the choice of datum level. The appropriate choice should, however, be obvious once monitoring objectives have been defined, and there remains much scope for inventive combination of the two approaches.

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Monitoring Cutover Bogs

Dave Butcher, University of Huddersfield

1. Overview

The restoration of watertables with a view to the regeneration of bog vegetation on cut-over lowland mires has been in progress on a number of peatland mires since the 1980's. The restoration process has involved damming and bunding; hydrological monitoring has been carried out to assess the effectiveness of these works, usually through water table monitoring using dipwells.

The collection of dipwell data is an extremely time-consuming task and significant efforts have been made at all of the sites discussed. A variety of methodologies and techniques have been utilised to monitor water table rise, although the use of some form of dipwell is most common. The location of the instrumentation, the frequency of reading and the data analysis have been highly variable. The analysis of the trends from the dipwell recordings in particular is often incomplete, frequently because of the data storage medium. Furthermore the relationship between the restoration and the monitoring programme is rarely based on any procedures normally associated with good experimental design. As a result of the lack of scientific control it is extremely difficult to evaluate the effectiveness of the restoration work other than in very general terms.

A methodology for dipwell location and data recording is discussed and an example of good practice at Wedholme is described. Whilst the original specification for the work did not demand an analysis of the data it proved necessary to analyse the results in some detail in order to evaluate the effectiveness of the monitoring programme. The results are described and the types of analysis appropriate to the data are carried out for the sites where data are available.

2. Conclusions and recommendations

1 Ground Water Mound theory as a basis for restoration is only of value in very general terms; the practical realities demand a more pragmatic solution. The creation of a substantive ground water mound is an unattainable goal for most cut-over mires. Furthermore a ground water mound may not be appropriate to satisfactory regeneration on the site. It may well be that the creation of surface water is appropriate to the regeneration of the desired species.

2 Water tables in cut-over mires are rapidly restored to levels approaching those of primary bog by blocking the free passage of rainwater away from the site in question. The range of values experienced by cut-over peat is considerably reduced and a transition period of as little as one year may be experienced between hydrological conditions before and after restorative activities.

3 The benefits of the use of transects to monitor the behaviour of groundwater is dependent on the purpose of the monitoring programme. Where the principal aim is to monitor change, rather than illustrate the difference in behaviour between 2 homogenous peat area, a stratified sampling programme of dipwell installation designed to provide a sufficient number of replicates of each type of site condition may be more appropriate.

4 While it is apparent that change in water table depth is rapid, and stable conditions can be achieved in a relatively short period, long term monitoring of site behaviour is essential if genuine change is to be identified rather than transitory fluctuation in local conditions. Wedholme flow data suggests that 5 years would generate the minimum of useful data, with the first 3 years covering ground survey and dipwell records of pre-restoration conditions, and the final 2 covering site behaviour after the installation of dams in ditches and cuttings.

5 The exact impact of the different type of dams available for ditch blocking is unclear. The efficacy of different types of dams should be monitored in order to identify the most efficient and appropriate method of achieving a reduction in water removal from a site.

6 In order that the behaviour of water levels in dipwells can be more effectively equated with genuine and lasting change in the nature of the mire ecosystem, monitoring of water table levels should be accompanied by a corresponding period of vegetation monitoring and examination of the physical properties of the peat in question.

7 The exploitation of mire sites has long been undertaken in a thorough and methodical way, with close attention paid to the appropriate sequence of extraction and drainage at each site. Effective restoration strategies demand a similarly rigours approach to maximise the effectiveness of the considerable efforts and expense involved.