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Biological indicators of the dehydration and changes to East Anglian fens past and present

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Biological indicators of the dehydration and changes to East Anglian fens past and present

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CONTENTS

		Page
PART A: Valley Fens in East Anglia		
Introduction		4
The nature and occurrence of East Anglian valley fens		5
Collation of site information		9
A brief and recent history of valley fens in East Anglia		10
Perceptions of change and causes of change		29
Conclusions: assessment of causes of vegetation change		32
Acknowledgements		35
References		35
Table 1:	The occurrence of selected fen vegetation-types within different hydromorphological categories of fen.	38
Table 2:	List of East Anglian valley fen sites for which vegetation dossiers have been prepared.	39
Table 3:	Summary table of apparent changes in the floristic composition and other features in valley fen sites in East Anglia.	43
PART B: The Vulnerability of Plant Species to Dehydration		
Introduction		48
Part I	The vulnerability of plant species to dehydration of valley-fen ecosystems	51
Part II	Use of fen plant species as "indicators" of water level conditions	61
References		67
Table 1	Ranges and categories of water-table (cm) and fertility in British fens.	68
Table 2	Values of water table of valley fens in Eastern England compared with values in valley fens examined elsewhere in Britain and with all fen hydrotopographical types examined elsewhere in Britain.	68
Table 3	Mean values (±SE) of water table and fertility associated with stands of rich-fen vegetation in Eastern England sites and other lowland British sites.	69
Table 4	Summer water levels associated with plant species recorded from valley fen systems in lowland Britain.	70
Table 5	Summer water levels conditions associated with fen plant species recorded from valley fen systems in East Anglia.	75

Table 6	Summer water levels conditions associated with poor-fen plant species recorded from valley fen systems in East Anglia.	78
Table 7	Summer water level conditions associated with fen plant species in valley fen systems in East Anglia. Mean values of fertility (phytometric assay) and % summer managed are also given.	80
Table 8	Summer water level conditions associated with selected rich-fen plant species in valley fen systems in East Anglia. Species included are those that tend to occupy drier valley fen sites in Eastern England than in valley fens elsewhere in lowland Britain (mean EE value more than 5cm less than UK mean). Mean values of fertility (phytometric assay) and % summer managed are also given.	82
Table 9	Summer water level conditions associated with selected rich-fen plant species in valley fen systems in East Anglia. Species included are those that have fairly similar mean water table conditions in Eastern England valley fens and in valley fens elsewhere in lowland Britain (mean values are within 5cm of one another). Mean values of fertility (phytometric assay) and % summer managed are also given.	83
Table 10	Summer water level conditions associated with selected rich-fen plant species in valley fen systems in East Anglia. Species included are those that have a considerably higher (>5 cm) mean summer water table in Eastern England valley fens compared with valley fens elsewhere in lowland Britain. Mean values of fertility (phytometric assay) and % summer managed are also given.	85
Table 11	Plant species of valley fens in East Anglia that may be particularly vulnerable to dehydration.	86
Table 12	Possible indicator species for assessing dehydration in East Anglian valley fens.	89
Appendix A:	Acquisition of information on the past and present condition of East Anglian valley fens and of their floristic and vegetational resource.	91
Appendix B:	Main community-types referred to in the text, their synonymy and equivalents (Wheeler, 1984; National Vegetation Classification).	104

PART A

VALLEY FENS IN EAST ANGLIA

INTRODUCTION

East Anglia has a larger concentration of fen ecosystems than any other part of lowland England of comparable area. Yet until comparatively recently fen was far more widespread here than it is today. A glance at the 1:250,000 scale *Soil Map of England and Wales* (Soil Survey of England & Wales, 1983) shows not only the very extensive deep peats and silts of the Norfolk Broadland and the Fenland basin, but also numerous, sinuous strings of wetland soils penetrating the drier uplands along the valleys of rivers and streams, as revealed perhaps most comprehensively by the distribution of the peaty gleys of the Isleham 2 and Hanworth Associations. Many of these once ill-drained sites have been reclaimed for agriculture, but others have remained. These are often of great biological value and some have been designated as Sites of Special Scientific Interest. Some of them, such as most of the fens in the Norfolk Broadland, are flood-plain mires, where proximity to sluggish rivers helps to maintain a high water table, year-round. But many, if not most, of the remainder are sites which are thought to depend strongly upon water supply from the adjoining mineral ground, from deep-seated artesian sources as well as from more superficial seepages and runoff. These are here referred to as 'valley fens'.

The extant examples of valley fens are by no means undisturbed ecosystems. Many of them have a history of considerable, if low-intensity land use, for peat extraction, for grazing and for mowing (of various products). Far from damaging the sites, these activities have generally shaped their character and are responsible for much of their present biological interest.

The most distinctive feature of wetland ecosystems is that they are wet. If their high water tables are substantially, or continuously, lowered the sites cease to be wetlands. In East Anglia the extant valley-fen sites have sometimes been subject to destabilisation of their water tables as a result of natural phenomena, such as droughts, or occasional attempts to improve their agricultural utility by some form of drainage. More recently the water supply to some of the sites has been subject to a more pervasive threat, in terms of the depletion of groundwater reserves by abstraction boreholes and groundwater development schemes. These include the Great Ouse Groundwater Scheme, parts of which were implemented in 1989 and the Lodes-Granta Scheme (Rushton, 1991). In principle, at least, such operations may compete with the valley fens for a shared groundwater resource. In practise, however, their actual effects on the hydrology and vegetation of the fens are not at all well known. Thus whilst it seems well possible that the vegetation of a large number of valley fen sites in East Anglia is being adversely affected by water abstraction, apart from anecdotal observations that some fen sites seem to be getting drier and that their vegetation is declining in quality, there is rather little direct information. This is because water levels of most sites have not been systematically monitored over a long period of time; because changes in the vegetation of most sites has not been systematically documented; and also because water supply is not the only variable to influence the composition of fen vegetation (Shaw & Wheeler, 1991). Changes in land use practices, and especially dereliction of sites, can also lead to profound floristic change.

There is clearly a need to examine the condition of East Anglian fens; to determine whether there is evidence of vegetation deterioration, and to try to pin-point its cause. Here we contribute to this on-going analysis by marshalling existing information concerning the vegetation and 'condition' of the valley-fen sites; and by assessing past changes, to provide a base-line against which future changes can be judged.

THE NATURE AND OCCURRENCE OF EAST ANGLIAN VALLEY FENS

The hydrotopographical concept of "valley fens"

Terminological confusion

In this study, the term "valley fen" is used following the now quite widely-adopted concept of Goode (1972) and Wheeler (1984). However, in some respects the term is a rather unfortunate one, particularly in the East Anglian context, as the concept of "valley fens" *sensu* Goode and Wheeler is almost exactly opposite to the concept of "valley fens" *sensu* Haslam (1960, 1965) and as was used in her studies on East Anglian fens. As Haslam's work is widely quoted in the present study, it is necessary to clarify the meaning of the various terms as used here. In essence, "valley fens" *sensu* Haslam are virtually synonymous with "flood-plain fens" *sensu* Goode and Wheeler, whilst "valley fens" *sensu* Goode and Wheeler largely correspond to the "headwater fens" of Haslam, except that they also include some spring-fed sites that are not located at or near the headwaters of streams.

Valley fens

The difference between valley fens (as used here) and flood-plain fens is essentially a hydrological one; however, it is not absolute and the two types undoubtedly intergrade. Valley fens can be seen as essentially *soligenous* fens - that is, fens that are irrigated primarily by groundwater and occur in association with springs and seepages. However, they occur in two rather different topographical situations which are here distinguished, for want of any better terms, as 'valleyside (*"sloping"*) valley fens' and 'riverside (*"flat(tish)"*) valley fens', though there are transitions between these types.

Valleyside valley fens

This is, in a sense, the most "pure" form of valley fen, which typically occupies sloping valley sides kept wet by groundwater discharge, together with surface runoff. In this situation, whilst the fens are usually associated with a stream along the valley bottom, this serves mostly to collect and remove water draining from the fen and has but a rather limited direct effect upon its water budget, which is primarily determined by rates of water input along the top of the slope. Some such sites are completely independent of the drainage stream into which they discharge.

Riverside valley fens

These sites are most usually located on flattish ground alongside rivers and streams. They are still primarily irrigated (at least at the margins) by soligenous inputs, but their water balance is more strongly regulated by the stream or river, in the sense that the proximity of the watercourse helps to impede drainage and thus indirectly helps maintain a high water table in the fen. In some situations it may even directly contribute to the water balance, in at least the lower parts of the fen, by occasional direct inundation in times of flood. This latter situation corresponds to the "transition fens" of Haslam (1960) which, as her name suggests, serve to link valley fens with flood-plain fens. It is not always obvious if some sites are best considered as valley fens or flood-plain fens.

Flood-plain fens

In their purest sense flood-plain fens are essentially *uberschwemmungmoor*, that is, fens which have developed along the badly drained flood-plains of (usually mature) rivers and where the high water level in the mires is *primarily* maintained by the river water, both by episodic inundation and by impeded drainage. In many sites artificial dykes help to extend the influence of river water well away from the natural channel. Those sites that experience frequent riverine inundation are often heavily silted, but by no means all flood-plain fens are flooded directly by river water and many do not experience any substantive silt deposition. Flood-plain fens may or may not also receive some groundwater inputs. It seems highly likely that many East Anglian flood-plain fens do receive some seepage and spring inputs. However, in comparison with valley fens, this contributes a much smaller proportion of the water budget.

It can be seen that valley fens and flood-plain fens represent two extremes of an intergrading hydrological spectrum. Some sites are of apparently intermediate character, with both active soligenous slopes and a lower flood-plain fen (e.g. Swangey Fen, Barnby Broad). In other situations, changes in the principal source of water supply has effectively changed the hydromorphological status of mires, such in situations where drainage has caused former flood-plain fens to become increasingly dependent upon groundwater inputs to maintain any semblance of wetness, as is apparently the case, for example, at Lakenheath Poor's Fen.

Basin fens

Basin fens are *par excellence* mires found in glacial hollows in north and west Britain and are often ignored in the East Anglian context. The hollows are occasionally completely closed, but more usually have some sort of outfall, either natural or artificial. Compared to valley fens, rates of water movement are thought to be rather slow, though little study has been made of this. Even so, such mires may have soligenous groundwater inputs, as well as inputs of surface water etc. Whilst basin fens comparable to the examples in the north and west of Britain are scarce in East Anglia, small topogenous fens in shallow, wet, ground hollows are quite frequent, especially in the pingo fields of West Norfolk and Suffolk. Here such ground hollows sometimes occur intermingled with more obviously-soligenous, flushed areas of fen (e.g East Walton Common, Norfolk) and, despite their ostensibly topogenous character, may in many cases be similarly dependent upon spring and seepage water for their wetness. Moreover, basin-like hollows not infrequently occur on the floors and sometimes even slopes of valley fen sites. In some instances these have been produced artificially by turf extraction (see below), but in other cases, such as in South Cambridgeshire (e.g. Chippenham Fen), they seem to be examples of periglacial ground ice hollows located within the main soligenous areas of fen. Because of these obvious inter-connections, such topogenous basins within areas of upwelling water are included in this study.

The Vegetational Concept of Valley Fens

One further reason for considering spring-fed topogenous hollows within the overall compass of "valley fens" in East Anglia is because of their floristic similarities: they often support vegetation comparable to that of some soligenous valley fens.

Although spring-fed fen sites are ostensibly defined on a hydrotopographical basis, a number of distinctive vegetation types are so strongly associated with such systems (Haslam, 1965; Wheeler, 1984; Shaw & Wheeler, 1991) that they often almost form part of an integral, if informal, concept of "valley fen". Indeed, in the absence of more rigorous hydrological evidence, sites are sometimes suspected as being spring-fed because of the occurrence of certain specific plant communities (as, for example, at Thelnetham West Fen, Suffolk (Ausden & Harding, 1991)). And whilst, if carried too far, such an approach can be misleading, it does accurately reflect the specificity of certain vegetation-types to soligenous situations within fens.

Table 1 shows the occurrence of selected vegetation-types in different hydromorphological categories of fens. It is based on data derived from a survey of fen sites throughout lowland Britain (Shaw & Wheeler, 1991), and thus does not specifically refer to East Anglia, but East Anglian fens formed an important part of the survey. There is only a small number of samples for some community-types, but it is considered that the Table mostly provides a fair reflection of the occurrence of the vegetation-types in different types of fen.

The community-type most specific to valley fens in the *Schoeno-Juncetum* (M13). This community is also of very great conservational importance (Wheeler, 1988) and is strongly localised in Britain (Wheeler, 1980b), so that East Anglia supports the majority of its occurrences. Thus, not only is this community-type a good indicator of valley-fens, but valley-fens are crucial to its survival.

Fen meadow (M22) vegetation is much more widespread than the *Schoeno-Juncetum* (Wheeler, 1980c) but is also especially found in soligenous circumstances. Along with certain other community-types, such as the *Cirsio-Molinietum* (M24) and *Cladio-Molinietum*, it is more specific to spring-fed sites in East Anglia than in wetter parts of Britain, where the retention of moist conditions is not so critically dependent upon ground water sources.

For similar reasons poor-fen[1] communities are even more specifically confined to valley fens in East Anglia than they are nationally. Some of these (e.g. M21 *Narthecium ossifragum - Sphagnum papillosum* valley mire) are extremely uncommon within Eastern England and the (few) East Anglian examples are of considerable conservational importance.

In East Anglia, *Carex rostrata - Calliergon cuspidatum* mire (M9) is represented only as the M9b subcommunity (*cf Acrocladio-Caricetum diandrae* (Wheeler, 1980b)). This latter community is most widespread in basin mires in north and west Britain and its (rather few) occurrences in East Anglia have high conservational importance. These are exclusive to topogenous hollows, mostly to flooded peat-pits within valley fens.

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1 "Poor-fens" are sites irrigated by relatively base-poor water, with pH values typically < 5.5.

A wide variety of other fen community-types may occur in East Anglian valley fens, but are much less specific to them. In some cases, some of these communities (e.g. *Phragmites communis - Eupatorium cannabinum* fen (S25)) have long occurred in valley fens, partly because, as discussed above, not all parts of valley-fen sites are strongly soligenous in character. However, other examples (such as *Phragmites-Urtica* fen (S26) and some other tall herb communities) are not at all characteristic of undisturbed valley fens (Haslam, 1965). They are generally common, adventive community-types of negligible conservational value and their increased prevalence within East Anglian valley fens is because various forms of site deterioration have permitted their establishment and increase, as the former constraints upon vegetation composition and distribution have changed or disappeared.

Distribution of Valley Fens in East Anglia

East Anglia

For the purposes of this study, "East Anglia" is comprised of the Watsonian vice-counties 25 (East Suffolk), 26 (West Suffolk), 27 (East Norfolk), 28 (West Norfolk) and 29 (Cambridge). These have long formed the basis for much botanical recording and, although artificial units, they corporately encompass a fairly coherent area in which valley fens are generally quite frequent. The north and east boundaries of the area are fixed by the coastline. The western limit approximates to the broken outcrop of Lower Greensand, beyond which (in this area) is the Fenland basin (which does not support valley fens). The southern limit of the vice counties is the border of Suffolk and Cambridge with Essex, but in Suffolk the southern limit of the valley-fen region is effectively truncated around the upper reaches of the R. Lark in the west and the Waveney in the east.

Occurrence of valley fens

The occurrence of numerous spring-fed valley-fen sites in this region is a function of its low-lying relief relative to extensive local and regional aquifers. The whole area is almost entirely underlain by water-bearing bedrock (Greensand, Chalk and Crag) and some valley-fen sites appear to be directly irrigated from these deep groundwater sources. However, much of the higher ground is extensively capped by superficial fluvioglacial deposits. These include glacial and river sands and gravels and drift deposits; the latter include quite heavy boulder clays (which may serve to confine, at least partially, the Chalk aquifer) as well as horizons of sands and sandy clays. The more permeable of these various superficial deposits may form a local aquifer. Where valley fens occur in association with substantial superficial deposits it is often far from clear whether irrigation of the fens derives from the superficial deposits or from the underlying Chalk aquifer, as not only may superficial sands sustain a local aquifer but they may also have direct hydraulic continuity with a partially confined underlying regional aquifer.

The Chalk and Crag bedrock extends beneath most of Suffolk, but it is notable that valley fen systems are (or were) only well developed in the more northern parts of Suffolk, in the area adjoining Norfolk. There are few known examples of spring-fed fens elsewhere in Suffolk and none of them

support the sort of low-productivity, calcareous fen vegetation that is so much a feature of the Norfolk valley fens. This seems to be because such systems have not occurred (at least in recent, recorded times) rather than because they have been destroyed. The reason for the widespread absence of valley fens over much of Suffolk is not known, but one possible explanation is that it reflects a more widespread and perhaps thicker occurrence of heavy boulder clays than is often found in Norfolk, and that these help to confine more completely the Chalk aquifer.

In Cambridge, the small number of extant valley fens are associated with springs emerging from the Melbourn Stone and Totternhoe Rock.

COLLATION OF SITE INFORMATION

Sites examined

Table 2 lists the sites for which dossiers have been prepared. These may be categorised:

i) *valley fen SSSIs* - particular attention has been given to collating information for these;

ii) *valley fen non-SSSIs* - these include a variety of sites, including some that largely just support areas of fen meadow; these are included partly on account of their "fenny" interest, but also because they may represent the degraded remnants of once more important fen sites;

iii) *lost sites* - where appropriate information has been available, details are given of sites that have completely or all-but disappeared. In the case of some of the most interesting examples an attempt has been made to determine their present condition, even if it is not fen. This has not always been possible, as details tend to be sparse and, in some cases, the exact location of the former sites is not known with certainty.

With hindsight, some of the sites examined here may be more appropriately considered to be flood-plain fens with some soligenous inputs than characteristic valley fens. As there is no clear demarcation between 'riverside valley fens' and 'flood-plain fens', where sufficient information has been available, dossiers have been prepared for these sites.

Information has also been collected for several sites that are not listed in Table 2. However, these are sites for which, in general, very little information has been uncovered and in these cases, dossiers have not been produced. In addition there are undoubtedly numerous fen sites, some of which may still exist, for which no data have been collected, and which currently just remain as tantalizing references in *Floras* or other sources. If a full picture is to be established of the magnitude of wetland loss in East Anglia, it would be desirable to take some cognizance of some of these sites, though in many cases it is probable that few relevant data exist.

Sources and Information examined

Wheeler & Shaw (1992) have already provided details of the main sources of information that have been examined and used in this collation, and of some of the difficulties associated with the use of some of this material. An updated account of this is given in Appendix A of this Report and is referred to below, in a historical perspective.

A BRIEF AND RECENT HISTORY OF VALLEY FENS IN EAST ANGLIA

The Contributors

The information collected in the preparation of the dossiers for individual valley-fen sites provides a valuable over-view of the recent history and current status of valley fens in the East Anglia region. Although a full picture has yet to emerge from this, some of the insights which can be gained, as well as some of the loose ends, have provided the basis for a synthesis of a brief and recent (and necessarily tentative) history of valley fens in East Anglia.

The information available (or, at least, located) for establishing the former character of valley-fen sites, and of the changes that have taken place, is both disparate and incomplete. It is particularly difficult to assess the character of the sites as they were in the nineteenth century, as most of the vegetational information available is just species records in *Floras* and other plant catalogues; and these have numerous limitations, not least those of knowing the dates of records; whether the species were still present at the time of publication; and, very often, the exact location of the sites referred to[2]. Some considerable insight into the former character of the sites can be gained by careful interpretation of older maps (especially the 1st edition 6" and 25" Ordnance Surveys produced in the latter part of the nineteenth century, but also from the surprisingly accurate 1" maps produced by Faden for Norfolk and Suffolk at the end of the eighteenth century). Other valuable sources include the Reports of the Commissioners for Charities, made for each parish in the 1830s, essentially to determine how well provision for the poor was being made, though the level of information these provide varies considerably, and to some extent unaccountably, between parishes. In addition, doubtless further useful information on the 19th Century state of the fens could be collected for at least some sites by examination of other various documents (such as Inclosure and Tithe Awards), manuscripts and herbaria, but for the most part, because of the breadth of the present survey, it has not yet been possible to do this.

A growing interest in natural history led, towards the end of the nineteenth century, to an increase in information from various sites of natural history interest. Norfolk and Suffolk were particularly well served with the publication of the *Transactions of the Norfolk & Norwich Naturalists' Society* and the *Transactions of the Suffolk Naturalists Society*, journals which have continued to the present day. In those early days the *Trans N.N.S.* in particular was, for a "local" natural history journal, a rather prestigious publication and contained some excellent papers, some of which referred to specific fen sites (e.g. Bird, 1909) . However, perhaps the most propitious publications, for our present purposes, were the extremely valuable contributions made by W.G.

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2 Citations are frequently just as parishes.

Clarke (with or without the collaboration of his close colleague W.H. Burrell). Clarke wrote mostly in the 1910s and early 1920s and the value of his studies stems partly from their synoptic, systematic and comprehensive approach (which has rather few parallels in the general natural history literature of that time); and partly because he was asking then similar questions to those we ask today (and which are the focus of this compilation). Thus he was particularly interested in the Norfolk "commons" - where they were, what they were like and (in very broad terms) what sort of vegetation they supported (Clarke, 1910, 1918). He was also concerned to locate some of the "lost" sites of former botanical importance, including some old fen sites (Clarke, 1922). And he annotated copies of some of his publications, which, as they still survive, give a useful additional source of information. In view of his knowledge of Norfolk sites it is particularly regrettable that he did not record (or at least keep) much information on their flora. There are glimpses of his knowledge in an annotated copy of Nicholson's (1914) *Flora of Norfolk* that has been kept[3] and, perhaps most tantalizing of all, is his preliminary, but ultimately still-born, contribution to a vegetation survey of Norfolk (Burrell & Clarke, 1914).

This bout of descriptive activity by Clarke seems to have had few parallels in Suffolk and Cambridge. In Norfolk also, it largely ceased after the early 1920s, as far as fens were concerned at least. The valley-fen flag only flew occasionally in the inter-war years and little was published, though doubtless records were made - and in some cases doubtless subsequently lost. The lack of readily-accessible information from this period is particularly regrettable as, in many fen sites, this was exactly the time that large changes were taking place in consequence of abandonment of time-honoured management practices and, in the latter years, as a result of some agricultural improvement. This makes the (rather few) relevant publications (e.g. Petch, 1944) of especial value. It is possible that persistent enquiries of botanists who were active at the time (and extant examples of these are now rather few and far between, though in some cases notebooks may have survived their authors) would help shed some light on the inter-war years. But this has yet to be done.

There was a post-war resurgence of interest in East Anglian valley fens, expressed, for example, in West Norfolk by some of the studies and publications of C.P. Petch and E.L. Swann. Even Cambridge ecologists (who in general had largely ignored the valley fens on their doorstep) developed some active research interest, initially expressed most tangibly by the work and publications of M. Kassas on Chippenham Fen. However, much of our knowledge of the post-war condition of fens in East Anglia stems from the activities of one individual, F. Rose, who examined a large number of the valley fens in Norfolk and Suffolk from the late 1940s onwards, including a number of sites from which there is little other contemporary information. Rose had the fortunate habit of making (and retaining) quite detailed field notes and species-lists. He also appreciated (at a time when various other botanists apparently didn't!) that the Bryophyta were important constituents of fen vegetation and he recorded these as well. His records (of which he has supplied transcripts) are thus of great value. He also effectively founded a minor ecological dynasty of fen research. In the late 1950s, a research student of his, D.J. Bellamy, made detailed quadrat records in a number of East Anglian valley fens as part of a floristic and ecological overview of European mire vegetation. These records are still accessible (Bellamy, 1967) and, because of their rigorous and quantitative character, have provided subsequent ecologists with an excellent, and exceptional, opportunity to assess floristic change in some of the valley-fen systems that he studied.

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3 Held at the Norfolk & Norwich Record Office.

At about this same time, studies were also being made in some of the other Breckland valley fens by S.M. Haslam. Haslam's interest was principally in developing an understanding of the overall ecology of the Breck Fens, and particularly in the reasons for the differences between "headwater fens" and "valley fens". Because of this she tended not to record highly detailed floristic information from her sites, but her floristic data are nonetheless important, not least because she studied some sites which escaped the attentions of Rose and Bellamy.

Also in the 1950s the statutory conservation authorities were themselves beginning to appreciate the value of the valley fens, some of which were, by then, showing distinct signs of wear-and-tear as a result of dereliction, drainage improvements etc. A number of surveys were made of important sites, prior to their notification as SSSIs, some by the Nature Conservancy staff, others by outside personnel, such as a youthful A.C. Jermy and a rather less youthful A.G. Tansley. Many of these early reports were of quite high quality - and in some instances they have survived better than have the sites.

Throughout the 1960s, Rose, and other botanists, visited Norfolk valley fens, and along with reports from NC staff, they have provided a considerable, but patchy, amount of information. Roydon Common (Norfolk) received particularly detailed attention, principally because it provided the University of Nottingham with the site for two Ph.D. studies (R J Summerfield and R E Daniels) and in consequence considerably more is known about the ecology of this important fen site than just about any other valley fen in East Anglia.

Even so, despite the early endeavours of Burrell & Clarke, there had been no serious attempt even to try to describe and categorise the vegetation of valley fens in East Anglia (or, indeed, elsewhere). A.G. Tansley had completely ignored East Anglian valley fens (along with most other examples) in his monograph *The British Islands and their Vegetation*, even eschewing honorary mention of the nearby Chippenham Fen. This gaping deficiency was partly remedied, for the rich-fen examples at least, in the early 1970s by B.D. Wheeler, a postgraduate satellite of D.J. Bellamy. Like various other workers, Wheeler failed to appreciate the historical value of his synoptic survey and, whilst collecting detailed floristic data relevant to his specific enquiry, omitted to record information which, with hindsight, would have had substantial historical value. This is particularly unfortunate as a number of the sites visited by Wheeler were by then more or less on their last legs and he seems to have been one of the last people to have made systematic records from some of the sites (e.g. East Ruston Common, Norfolk) in anything like their former condition.

Through the latter 1970s and 1980s there was a burgeoning of interest in valley fens, both from individual botanists and from the Conservation organisations. Some of the individuals who made records then have contributed information and comments to the present collation and are identified in the Acknowledgements (below). Rose continued to make sporadic visits (and records), often accompanied by P.W. Lambley. SSSI re-notification forced a most valuable re-examination and survey of a large number of sites, though constraints of time and methodology meant that in some cases only superficial data were collected. An increased awareness of the need for vegetation management in valley fens has been associated with the production of various Management Plans and, in some cases, even with vegetation management. Conservationists have become more aware of the need, not only to do some management, but to record what they have done. Unfortunately in most cases they have not also been able to record the *results* of what they have done, except in gross

terms. Monitoring has yet to find its proper place in the conservation ecology of fens: its problem is not so much that it has been tried and found wanting but that it has been tried and found difficult!

However, perhaps the most curious omission in the recent history of valley fens in East Anglia is the general absence of much recent *detailed* information or survey from a quite large number of sites. Apart from a small number of fen examples included in the England Field Unit *Commons Surveys* of the early 1980s, until relatively recently, often the only fen sites to have had, say, quite detailed quadrat data collected were those rather degraded examples which, as surrogate grasslands, were included in Grassland Surveys! This lack of detailed recent information has presented a considerable problem in the present collation of data, but has, more importantly, also exposed the near-impossibility of assessing the vulnerability of these fens to hydrological change, or of their response to it, in the absence of adequate base-line data. However the appointment of W. Fojt (also from the House of Rose) to the post of fen specialist within the Nature Conservancy Council in 1986 meant that fens were no longer regarded as unpleasantly wet grasslands or as base-rich bogs but as important ecosystems in their own right. Fojt (1990) has systematically collected floristic data from a number of valley-fen sites in East Anglia, some of which will form the basis of on-going monitoring. But comprehensive and rigorous surveys of entire fen sites are still available only for a handful of valley-fens, mostly those examples in the Waveney-Ouse valley.

The lack of up-to-date floristic information for many sites is paralleled by a paucity of environmental data. Wheeler & Shaw (1987) and Shaw & Wheeler (1991) included a number of East Anglian valley fens in a national survey of "habitat conditions" in fen ecosystems. This study however was both broad in scope and community-based and so did not attempt to acquire comprehensive, and not even necessarily representative, data from individual sites. Water levels have been monitored at a small number of sites (e.g. Chippenham Fen, Redgrave Fen) but such information is lacking for the majority. Workers from the University of Birmingham have prepared dossiers on the hydrodynamics of a considerable number of East Anglian valley fens (Gilvear *et al*, 1989). These provide a valuable collation of the hydrochemical data that were available at the time, but in so doing exemplify the essential lack of site-specific information, and the concomitant difficulties of assessing the likely effects of water abstraction boreholes upon the water budgets of these fens. Moreover, they concluded that even with quite detailed hydrological information it was still difficult to model the likely effects of groundwater abstraction on one of the two valley fens that they studied in some depth.

It is thus clear that the database available for reconstructing the "history" of East Anglian valley fens, or for establishing their present condition, is far from complete.