

BELLAMY'S PLOTS RECORDED 1999

THE LNETHAM FEN

1. INTRODUCTION

Suffolk Wildlife Trust commissioned the re-survey of monitoring plots first established on Old Fen by Bellamy in 1959 (Bellamy 1967, Bellamy and Rose 1961) and re-recorded in 1991 by M. Harding and W. Fojt. An additional Plot first established on Middle Fen by Harding (1992) was also re-surveyed. The plots are shown on the attached map.

2. METHODS

For the plots on Old Fen, methods were the same as in Fojt and Harding (1995). The plots are all 10m x 10m, and in 1991 were relocated as accurately as possible from Bellamy's drawings (Bellamy and Rose 1961). Where there was any ambiguity, plots were placed in areas that were the best quality and most resembled Bellamy's floras, and thus represented the minimum floristic change. In 1991, the plots were permanently marked so they are relocated with perfect accuracy. Within each plot, 50 x 50cm quadrats were located using random numbers, and in each quadrat all vascular plants and bryophytes were recorded and % cover estimated by eye. The following numbers of quadrats were recorded in each plot:

Plot 1: 20 quadrats
Plot 2: 20 quadrats
Plot 2a: 15 quadrats

This is the same as Bellamy's original methods except that he recorded cover using the Braun-Blanquet scale and derived percentage cover as the mid-point of each cover-class.

For the plot on Middle Fen, the methodology was similar except that here, the plot was 20 m x 20 m and that only presence-absence of species was recorded as in the original method (Harding 1992). Plots were re-sampled in July 1999. Because of the long time between monitoring events, the effect of trampling arising through multiple random samples is not thought to be significant. Nomenclature is according to Stace (1991) for vascular plants, and Smith (1978, 1990) for bryophytes.

3. RESULTS

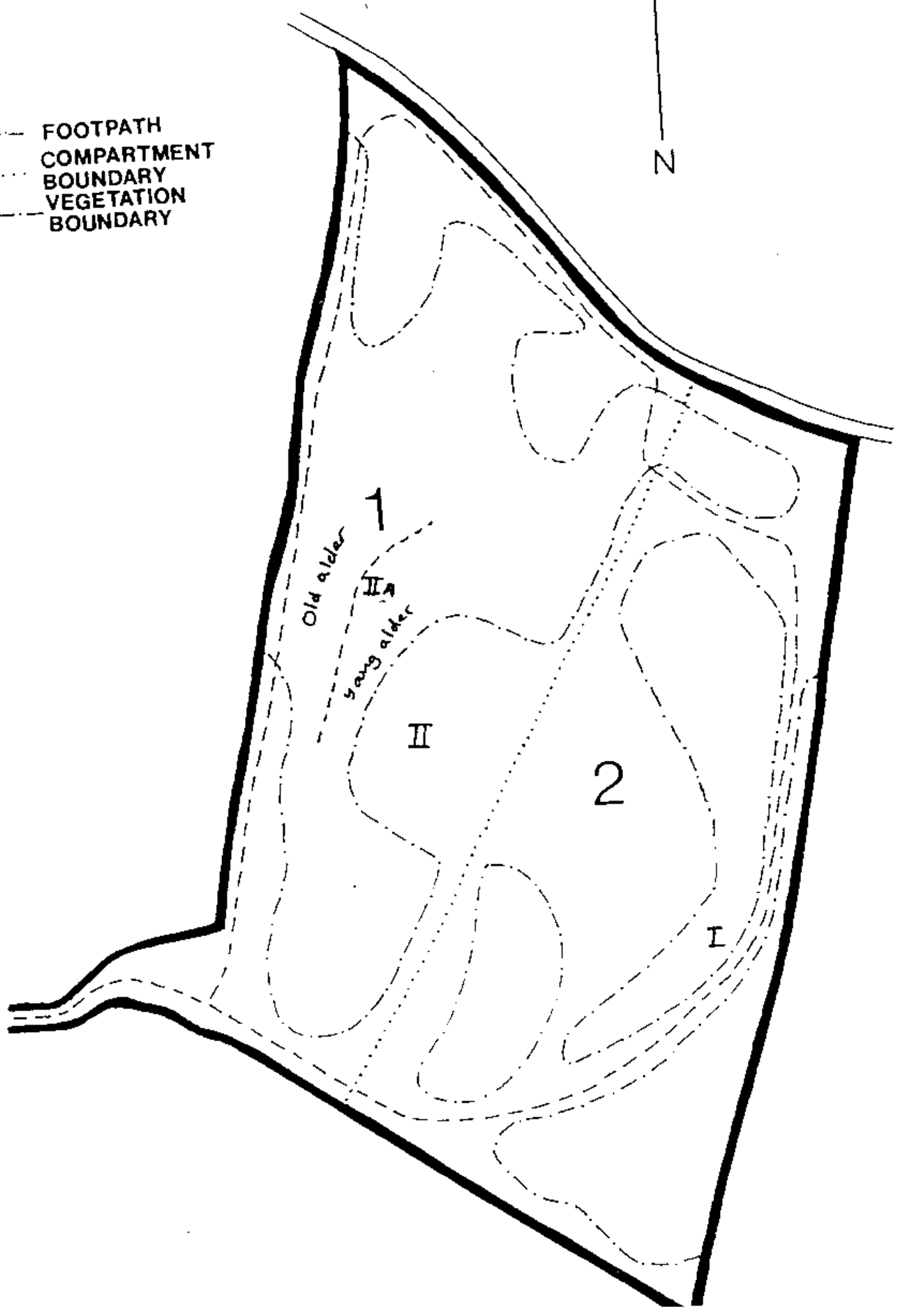
Results for 1999 are presented in the following tables. Mean cover and frequency were derived for each plot. Note that the accuracy of estimates of % cover by eye may be highly variable between recorders, and variable between growth forms (e.g. compare sedges, rushes, bryophytes and dicots) with the same recorder. Such estimates must therefore be treated with caution. Frequency estimates are more reliable, and were the only quantitative measure established for Middle Fen. Equivalent NVC communities described below are approximate as the NVC system would use much larger quadrat sizes (2 x 2m or 4 x 4m), making frequency comparisons very difficult (Rodwell 1991, 1995).

THELNETHAM FEN, OLD FEN



KEY

- FOOTPATH
- - - - - COMPARTMENT BOUNDARY
- BOUNDARY
- - - - - VEGETATION BOUNDARY

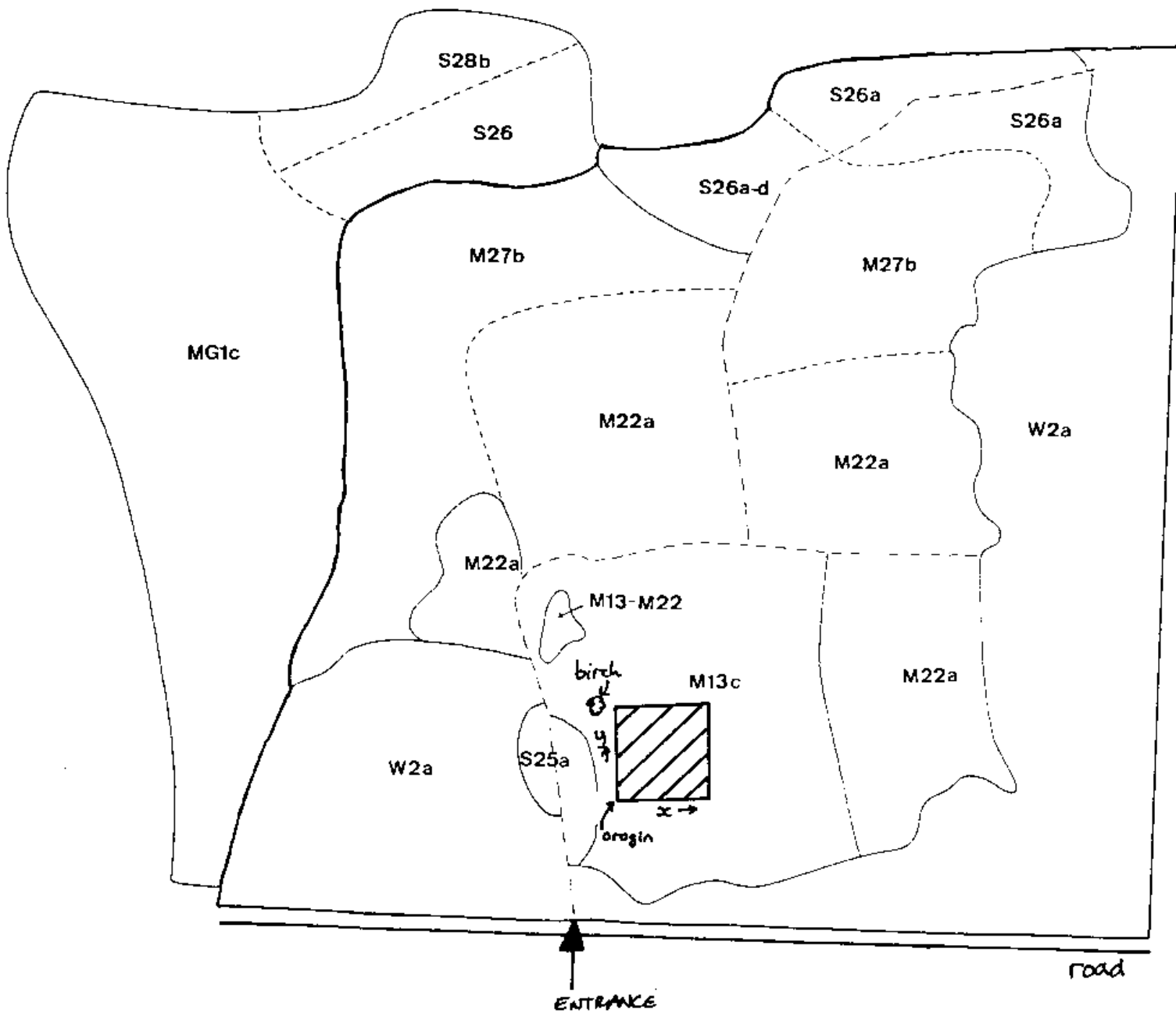




Map 1: Location of Monitoring Plot at Thelneham Middle Fen
TMD14788

Hatched area shows location of 20x20m plot, marked on the ground with posts

SCALE: 1:1250



Plot 1, Old Fen

This is a short, low productivity sward dominated by a mixture of small sedges, grasses and herbs. A dense matrix of *Molinia caerulea*, *Festuca rubra*, *Agrostis stolonifera* and *Carex panicea* is shot through with sparse shoots of *Juncus subnodulosus*. Small tussocks of *Schoenus nigricans* provide structural diversity. More bulky dicots are represented by abundant *Succisa pratensis* and patches of *Centaurea nigra*, *Valeriana dioica* and *Sanguisorba officinalis*. Finer herbs, such as *Galium palustre* and *Polygala serpyllifolia*, are frequent in the turf but never achieve much cover. *Calliergon cuspidatum* and *Pseudoscleropodium purum* dominate a diverse ground layer of bryophytes, with many rich-fen bryophytes at much lower cover and frequency. There are a number of uncommon plants, of which *Carex pulicaris* is the least frequent in the valley fens.

The sward was quite dry, with pits up to 30cm deep not holding water, despite the heavy recent rain. It is therefore surprising so many species normally considered intolerant of low water levels persist, and there are so few non-fen species indicative of low water levels. Similarly, the vegetation is clearly still low in productivity. Plants such as *Phragmites australis*, *Holcus lanatus*, *Filipendula ulmaria* and *Carex acutiformis*, which often suggest elevated nutrients, are all infrequent and of low cover. The sward is short and supports many species typical of infertile fens, such as *Schoenus*. Mineralisation of the peat which underlies the plot does not appear to have taken place to the same degree as on other nearby fens affected by lowering of water levels. Undoubtedly, the annual mowing regime helps maintain low productivity.

In NVC terms, the plot is probably still M24 *Molinia caerulea*-*Cirsium dissectum* fen meadow. Although *Schoenus nigricans* is still present, the sward does not have the rich assemblage of sedges, other herbs and bryophytes indicative of very wet, base rich conditions which normally characterises stands of M13 *Schoenus nigricans*-*Juncus subnodulosus* mire.

Plot 2, Old Fen

This plot is at a lower elevation than Plot 1 and at the time of survey had standing water in hollows and between tussocks across most of the area. It consists mostly of very tall and dense *Cladium*, mixed with sparse shoots of *Phragmites* and *Juncus subnodulosus*. Under the dense sedge canopy, there is always some *Filipendula*, only attaining high cover when the sedge canopy thins. There is usually a thatch of thick *Cladium* litter. The combination of dense canopy and dense thatch suppresses other species so that the stand is very species poor. Bryophytes are almost absent, being restricted to a few strands of *Eurynchium praelongum* and *Calliergon cuspidatum* on litter, plus some remnant rich fen bryophytes on *Carex flata* tussocks. The latter are present in the swampier areas.

Along the western margin of the stand, nearest the trees, there are some raised areas which are quite dry. Here, *Cladium* is much thinner, and *Calamagrostis canescens* becomes dominant. *Agrostis stolonifera* and *Lythrum salicaria* are more typical in this area. In NVC terms, the plot is the *Cladium mariscus* sub-community of S25 *Phragmites australis*-*Eupatorium cannabinum* fen.

Plot 2a, Old Fen

Permanent markers do not mark this plot. However, the young alder fringe is quite homogenous and a 10x10m plot was marked out in approximately the same area as in 1991.

The ground flora beneath the continuous canopy of alder is dominated by *Carex acutiformis* in an open and very species poor community. There is often some *Filipendula ulmaria* and some poorly grown *Rubus fruticosus*, but rarely other species. Bryophytes are absent except plants epiphytic on tree boles or branches.

The topography is very uneven, with pits filled with water mosaiced with raised, dry areas.

Middle Fen

Only one plot has been established, near to the southern edge of the fen. In 1999, this plot was dominated by *Schoenus nigricans* with *Juncus subnodulosus*, *Molinia caerulea*, *Carex panicea*, and *Succisa pratensis* all abundant. The vegetation is quite short and open with a very rich ground layer of bryophytes, dominated *Calliergon cuspidatum* and *Campylium stellatum*. Topography is very important to the distribution of species; shallow peat cuttings with water up to 5 cm deep has a moss layer dominated by *Calliergon cuspidatum*, with *Drepanocladus revolvens* and in places, *Calliergon giganteum*. Such hollows, where there is almost permanent standing water late into the summer, can be surprisingly species-poor. The tops of *Schoenus* tussocks are perhaps the most diverse with the rarer bryophytes such as *Ctenidium molluscum*, *Aneura pinguis*, *Riccardia chamedryfolia*, *Cratoneuron commutatum* and *Plagiomnium elatum* all being preferential here. The tussock tops and sides, and the hollows between them, provide a varied range of ecological niches, while the annual management prevents *Schoenus* and *Molinia* becoming over-dominant. The result is overall, a very diverse sward.

The sward is clearly very low in nutrients, with plants *Phragmites*, where present, restricted to a few stunted shoots. Vigorous grasses indicative of mesotrophic conditions, such as *Festuca rubra*, *Agrostis stolonifera*, and *Holcus lanatus*, which are abundant on the other annually mown area (Plot 1), are very reduced here. Overall, the Plot is more reminiscent of Bellamy's 1959 data, with a few dominants, a range of associate dicots and a long list of infrequent and rare fen herbs and bryophytes.

With such wet conditions, it is perhaps surprising that a greater range of semi-aquatic plants were not found. However, the site appeared wetter than for very many years, due to regular and heavy summer rainfall. The peat pits are normally surface dry by mid-July. It is likely wet conditions do not persist long enough to support such plants. In addition, the bottom of the pits were brown with ochre. It is likely that the wetting and drying associated with dry periods followed by ponded heavy rain not produce suitable water quality in the depressions, especially when compared with constant re-supply of laterally moving groundwater. In situations where shallow flooded depressions are fed by calcareous groundwater rather than ponded rainfall, the fen type is very rich indeed.

Table 1 : Results of 1999 Monitoring For Old Fen Plot 1

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	X	F	
<i>Molinia caerulea</i>	10	20	40	20	20	30	40	35	40	30	20	20	40	20	10	20	30	30	25	20		26	100
<i>Festuca rubra</i>	10	15	30	40	40	40	20	15	20	20	25	25	20	25	30	30	20	30	20	40		26	100
<i>Carex panicea</i>	15	10	5	10	15	20	30	40	15	25	15	1	15	10	15	10	15	10	25	20		16	100
<i>Fissidens adianthoides</i>	10	5	10	1	10	2	2	2	10	10	1	1	1	1	5	5	5	5	20	2		8	100
<i>Juncus subnodulosus</i>	10	5	10	10	20	1	5	10	5	5	1	1	1	1	5	5	5	3	5	5		6	100
<i>Lotus pedunculatus</i>	5	10	5	5	5	5	5	5	5	10	10	5	5	5	5	5	5	5	5	5		6	100
<i>Galium uliginosum</i>	3	3	1	5	15	5	5	2	5	10	5	5	4	5	5	5	5	5	5	5		5	100
<i>Succisa pratensis</i>	30	20	20	5	30	40	40	25	15	10	30	20	20	10	30	30	15	20	30	30		21	95
<i>Calliergon cuspidatum</i>	5	5	20	10	30	10	2	40	20	5	5	5	30	20	40	20	20	20	10	5		16	95
<i>Cirsium palustre</i>	5	5	5	10	5	5	10	5	5	10	2	2	2	10	10	5	10	5	1	1		6	95
<i>Hydrocotyle vulgaris</i>	25	10	15	15	40	2	5	10	10	25			1	10	20	20	10	5	15	1		12	90
<i>Pseudoscieropodium purum</i>	15	5	20	10	10	20	25	5		5	20	40	20	10	5	1	2	5		5		11	90
<i>Potentilla erecta</i>	5	5	5	10	1	5	5	2	5	5	5	5	5	5	5		5	5	1			4	90
<i>Vicia cracca</i>	3	2		1	2	2	1	2	1	1	1	1	1	1	2	3	3	3		2		1	90
<i>Agrostis stolonifera</i>	5	10		20	5	20	10	25	10	10			10	20	10	25	20	20	15	10		12	85
<i>Briza media</i>	5		5	5	5	5		2	5	2	5	10	5					5	5	1		3	70
<i>Campyllum stellatum</i>	1	2	10	5	2		1	5				1	1	1	1	1		1	1	20		3	70
<i>Sanguisorba officinalis</i>	5	5		5	5		5	10	5	10	5	1		1	5	10	10	10		5		4	65
<i>Schoenus nigricans</i>	5		20		15		15	10	5	5	5	25		10		10	10	10	20			7	60
<i>Polygala serpyllifolia</i>	5				1		1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	50
<i>Valeriana dioica</i>		1	1		1	10	2				2			1					10	5		2	45
<i>Centaurea nigra</i>				15	20				5	10	5	1		5	30							5	40
<i>Holcus lanatus</i>	5					10				10	5	5	1					5	1			2	40
<i>Carex flacca</i>				5			5	2		10			1	1		5		5				2	40
<i>Ctenidium molluscum</i>	1				1		1				1		1	5				1	10			1	40
<i>Luzula campestris</i>	2					5		5			2				1	1	1	1		1		1	40
<i>Lophocolea bidentata</i>	5	5			1		1				1			1								1	30
<i>Angelica sylvestris</i>		1		1	1						1	1						1				0.3	25
<i>Phragmites australis</i>				1	1			1	1		1	1				1	1					0.3	25
<i>Dactylofiza praetermissa</i>	1				1									5			1					0.4	20
<i>Filipendula ulmaria</i>				1						1				1				1				0.2	20
<i>Eurhynchium praelongum</i>	5			5				2														1	15
<i>Carex acutiformis</i>	2						1	5														0.4	15

Table 2 : Plot 2, Old Fen, Results From 1999 Monitoring

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	X	F	
<i>Cladium mariscus</i>	50	1	15	80		60	70	20	80	40	50	100	80	20	70	100	60	30	100	100		56	95
<i>Calamagrostis canescens</i>	40	60	30	20	70		5	20	5		1											13	45
<i>Filipendula ulmaria</i>	5	5	5	10	10	10	15	30	5	10	50	5	10	5	30	20	15	5	10	30		14	100
<i>Sanguisorba officinalis</i>	5	5						5			5											1	25
<i>Phragmites australis</i>	1	1	5		1	1	1	1	5	1	1	1	5	10	5		5	1				2	80
<i>Juncus subnodulosus</i>	1	1		5	1	5	10	1	5	20	5	1	1	10	6	1	10	5		5		5	90
<i>Vicia cracca</i>			5								2											0.4	10
<i>Lythrum salicaria</i>			1					1														0.1	10
<i>Humulus lupulus</i>																1				1		0.1	10
<i>Agrostis stolonifera</i>			10	10											5							1	15
<i>Eurychium praelongum</i>			1		1	1		1			1			1	1		1					0.4	35
<i>Carex elata</i>										60								70				6	10
<i>Plagiominium elatum</i>										1												0.1	5
<i>Gaium uliginosum</i>										1			1	1								0.1	15
<i>Calliergon cuspidatum</i>										5				15			1					1	15
<i>Campylium stellatum</i>										1												0.1	5
<i>Molinia caerulea</i>															10							0.5	5
height (m)	1.2	1.4	1.4	1.6	1.0	1.8	1.8	1.4	1.6	1.2	1.0	1.8	1.8	1.0	1.4	1.5	1.6	1.9	1.7	1.8			
Depth of water (cm)	0	0	0	0	0	5	3	0	5	8	0	0	0	5	0	0	10	1	0	0		1.5	
Litter (%)	100	100	90	100	100	100	90	95	80	60	100	100	100	80	100	100	80	100	100	100		94	
Total number of species	6	6	6	6	5	5	5	8	5	9	8	4	5	8	7	4	5	2	2	4		6	

Species not recorded in quadrats: *Viburnum opulus*, *Carex acutiformis*, *Mentha aquatica*, *Eupatorium cannabinum*, *Valeriana officinalis*.

Table 3 : Plot 2a, Old Fen, Results From 1999 Monitoring

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	X	F
<i>Ainus glutinosa</i>	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
<i>Carex acutiformis</i>	60	70	50	30	20	80	40	30	30	20	30	40	20	20	40	52	100
<i>Filipendula ulmaria</i>	10	5	5	10	10		10				20	10	10	5	10	7	73
<i>Rubus fruticosus</i>	5				5	1			5	5	5	5	5	5	5	3	60
<i>Phalaris arundinacea</i>	1											5				1	0.2
<i>Fraxinus excelsior</i> seed.		1			5		5									1	0.2
<i>Carex elata</i>							70									5	0.06
<i>Phragmites australis</i>					5						3					0.5	0.13
<i>Viburnum opulus</i>										20						1	0.06
Height (m)	0.6	0.6	0.4	0.6	0.4	0.7	0.5	0.6	0.6	0.5	0.5	0.7	0.6	0.6	0.5	0.6	
Depth of water (cm)	0	0	2	2	5	3	6	0	0	0	0	2	5	10	5	3	
Litter (%)	5	0	50	30	50	40	30	50	80	20	30	30	20	20	30	19	
Total number of species	3	5	4	3	6	3	5	2	3	4	5	4	4	5	4	4	

Species not recorded in the quadrats: *Lythrum salicaria*, *Dryopteris dililitata*, *Carex paniculata*.

4. TRENDS OVER TIME

Summary data for 1959, 1991 and 1999 are summarised in Tables 5-7 for the Old Fen plots. Summary data for 1992 and 1999 for the Middle Fen plot are shown in Table 4.

Plot 1, Old Fen

In 1959, this plot was a very wet and very chalky fen of great species richness and very high conservation value. Dominated by *Schoenus nigricans*, it supported a variety of small fen herbs at low cover and frequency, and a carpet of bryophytes. The latter was particularly rich, and like the herbs indicated a good supply of base-rich and low nutrient groundwater. By 1991, the discharge of groundwater had ceased, and many of the most distinctive species indicating groundwater inputs had declined or disappeared. The sward became dominated by *Molinia caerulea*. Although still quite diverse, all of the species which had entered the sward were dryland species, or those normally associated with fens with low water tables. The changes in the flora also indicated a slight increase in nutrients, although this was still a low nutrient system. All measures of fen quality declined significantly.

Changes between 1991 and 1999 are not easy to interpret. The plot has been mown and raked each summer, which was not always achieved prior to 1991. *Molinia*, *Schoenus*, *Succisa*, *Juncus* and a number of fen herbs have stayed about the same. Some distinctive fen bryophytes and herbs have increased (*Fissidens adianthoides*, *Calliergon cuspidatum*, *Campylium stellatum*, *Hydrocotyle vulgaris*, and *Mentha aquatica*) or re-appeared from 1959 (*Valeriana dioica*, *Bryum pseudotriquetrum*, *Angelica sylvestris*, and *Equisetum palustre*). *Carex pulicaris*, a rare fen sedge and very rare in Suffolk, has appeared in the plot for the first time, albeit a small patch. These are positive changes and probably reflect the improved mowing regime.

However, there are negative changes. Two important species have been lost or have declined (*Parnassia palustris*, *Oenanthe lachenalii*), and new species to the plot are mostly indicative of increasing nutrients, lower water tables or both – colonisation by *Holcus lanatus*, *Agrostis stolonifera*, *Arrhenatherum elatius* and *Festuca pratensis* are of particular concern. There are substantial increases in *Festuca rubra*, *Cirsium palustre*, and *Pseudoscleropodium purum*, indicating the same processes.

Thus although there is a greater number of species in the plot than in 1991, the number of Principal Fen Species is almost the same and the RWPFSS only slightly greater. The increases in grasses indicative of dryer, more mesotrophic conditions indicate long-term trends that may be more significant than the occasional gain in one or two prime species. Despite optimal management for at least the last 10 years, there is no sign of substantial recovery similar to that seen at Market Weston Fen, and certainly no established trend towards the quality of vegetation recorded in 1959. Nevertheless, management has without doubt maintained the residual fen flora, mitigating the effects of continued low water levels and elevating nutrient levels.

Plot 2, Old Fen

In 1959, this plot was a very rich, very wet mire where no species was particularly dominant. The upper canopy was a mixture of *Cladium*, *Schoenus*, *Molinia*, *Phragmites* and *Juncus subnodulosus*. There was a rich assemblage of small fen herbs, and a very

rich ground layer of wetland bryophytes indicating water tables above surface, at least in shallow hollows or peat cuttings. Nutrient levels would have been very low and the water base-rich and calcareous. This is typical of floating rafts of vegetation over watery marl, as described by Bellamy and Rose (1961). The number of rare fen plants was reflected in the very high RWPFSS. Indeed, this plot has more Principal Fen Species and a very much higher RWPFSS than any plot recorded by Bellamy in 1959, including all of the plots on Redgrave and Market Weston Fens.

By 1991, the flora showed a disastrous decline. The watery marl had more or less disappeared. *Cladium* doubled in abundance and *Filipendula* had colonised and become co-dominant. Most other species declined, and the very rich assemblage of small herbs and bryophytes all but disappeared. Species recruited to the plot indicated increases in nutrients, much dryer conditions or lack of management. It appears to have been mown once since, in 1996.

Since 1991, changes have been mixed. *Cladium* has increased further, with reed and *Juncus subnodulosus* remaining about the same. *Schoenus*, *Fissidens adianthoides* and several more common fen species appear to have disappeared, while *Filipendula* has greatly declined. Some fen bryophytes have been re-found, and some small fen plants have been lost. Such changes are difficult to interpret because they are all small plants at low frequency, and may have simply been missed in either recording period. Most notably, *Calamagrostis canescens*, *Agrostis stolonifera* and *Eurynchium praelongum* have invaded, the former becoming dominant in about 25% of the plot. Overall, the plot appears to be showing signs of drying out and lack of management.

With the dominance of *Cladium* and decline of *Filipendula*, the plot has shifted towards the *Cladium* sub-community of S25 *Phragmites australis-Eupatorium cannabinum* fen in NVC terms. Conservation quality, as measured by RWPFSS, has shown a slight improvement but this reflects the invasion by *Calamagrostis* and the re-finding of a couple of fen bryophytes. The very dense vegetation, combined with dry conditions and the absence of the watery marl layer, suggests recovery of the 1959 flora to be unlikely.

Plot 2a, Old Fen

When Bellamy recorded the plot, it was quite similar to the previous two plots. Very species rich with a wide range of rich-fen plants, many of them rare and dependent on very high levels of chalky, low nutrient water. Dominated by *Juncus subnodulosus* and *Phragmites australis*, there was a high proportion of *Typha* spp. and other plants which indicate swamplier conditions than the other plots. *Schoenus* was not recorded. Bellamy and Rose (1961) note the plot was part of the floating raft over the watery marl, as for Plot 2, but the current plot may also have been located in an old shallow peat cutting or other hollow as the vegetation shows significant differences with Plot 2. It was adjacent to an alder carr, and already, alder seedlings were recorded in nearly half of the samples. The plot received no management between 1959 and the present day.

By 1991, the alder had developed into a tall and very dense alder canopy. This shaded out very many of the species originally recorded by Bellamy. Changes to the soil consequent on development of woodland, will also have contributed to the very substantial changes in flora. Underneath the canopy, the sward was dominated by *Carex acutiformis* and *Filipendula ulmaria* with all other species rare and of low cover. Botanical value as measured by the RWPFSS was very low indeed.

In 1991, the situation was similar, except that *Carex acutiformis* has increased at the expense of *Filipendula*. A few tussocks of *Carex elata* and *C. paniculata* were also recorded, and the woodland is taking on the characteristics of more mature swamp alder woodland. In addition, there are indications of succession in the tree canopy with *Fraxinus excelsior* colonising. Botanical quality has not significantly improved and is not likely to without tree clearance and removal of oxidised and eutrophic surface peat layers.

Middle Fen

This plot was first recorded in 1992. Comparison of frequency of species for then and 1999 is made in Table 4. Visually, the vegetation looked very similar, and overall, the data confirms this. It is still dominated by a mixture of *Juncus subnodulosus*, *Molinia* and *Schoenus nigricans* at about the same or slightly higher frequency. The plot has been mown annually whereas prior to 1992 this was not always achieved. Management has been slightly increased, but perhaps more significantly, the timing is now always in late summer whereas it was sometimes cut in the winter.

Perhaps surprisingly given the annual mowing, *Cladium* is still almost constant although always very low in abundance. *Phragmites* has been significantly reduced, possibly resulting from the emphasis on summer mowing.

Species which have significantly decreased or been lost from the sward are: *Cirsium palustre*, *Hydrocotyle vulgaris*, *Phragmites australis*, *Lophocolea bidentata*, *Pseudoscleropodium purum*, *Festuca rubra*, *Mentha aquatica*, *Plagiomnium elatum*, *Bryum pseudotriquetrum*, *Oenanthe lachenalii*, *Angelica sylvestris*, *Carex flacca*, *Arrhenatherum elatius*, *Eupatorium cannabinum*, *Valeriana officinalis*, *Brachythecium rutabulum*, *Eurynchium speciosum*, *Quercus robur* and *Eurhynchium praelongum*.

Species which have significantly increased or recruited to the plot are: *Fissidens adianthoides*, *Filipendula ulmaria*, *Galium uliginosum*, *Vicia cracca*, *Lythrum salicaria*, *Chiloscyphus polyanthos*, *Equisetum palustre*, *Festuca arundinacea*, *Taraxacum officinalis*, *Carex viridula brachyrrhyncha*, *Sanguisorba officinalis*, *Drepanocladus revolvens*, *Cratoneuron commutatum*, *Dactylorhiza incarnata/praetermissa*, *Cirsium dissectum*, *Rhytidadelphus squarrosus*, *Fraxinus excelsior*, *Viburnum opulus* and *Epipactis palustris*.

Other species appear to be more or less stable. Interpreting these changes is difficult but the following seems likely:

Tall-herb species and those indicative of more mesotrophic conditions have declined, while those typical of shorter swards or less nutrient-rich conditions are more frequent. However, there are exceptions to both and the generalisation is not strong. The decline of the rich fen bryophytes *Plagiomnium elatum* and *Bryum pseudotriquetrum* is odd, while the increase in *Festuca arundinacea*, *Taraxacum officinale*, and *Lythrum salicaria* are also counter to the trend. Changes in scrub species are not conclusive; all are very small plants, mostly seedlings, and reflect the degree of open ground rather than lack of management.

Table 5: Comparison of Change Over Time for Plot 1, Old Fen

SPECIES	1959		1991		1999	
	Mean Cover ¹	Frequ ¹	Mean Cover ²	Frequ ²	Mean Cover	Frequ ³
<i>Schoenus nigricans</i>	18	100	10	55	7	60
<i>Juncus subnodulosus</i>	4	100	5	95	6	100
<i>Molinia caerulea</i>	11	95	31	100	26	100
<i>Valeriana dioica</i>	3	95			2	45
<i>Cladium mariscus</i>	3	80	1	45	0.1	5
<i>Fissidens adianthoides</i>	10	75	1	40	8	100
<i>Drepanocladus revolvens</i>	7	75				
<i>Succisa pratensis</i>	4	75	18	80	21	95
<i>Ctenidium molluscum</i>	17	70	5	40	1	40
<i>Campyllum stellatum stellatum</i>	9	65	0.9	20	3	70
<i>Calliergon cuspidatum</i>	4	65	8	100	16	95
<i>Riccardia chamedryfolia</i>	1	55				
<i>Phragmites australis</i>	0.55	55			0.3	25
<i>Potentilla erecta</i>	2	50	4	85	4	90
<i>Parnassia palustris</i>	0.45	45	0.1	10		
<i>Bryum pseudotriquetrum</i>	0.4	40			0.1	5
<i>Angelica sylvestris</i>	0.35	35			0.3	25
<i>Oenanthe lachenalii</i>	0.35	35	0.1	5		
<i>Riccardia multifida</i>	0.35	35				
<i>Aneura pinguis</i>	0.35	35				
<i>Anagallis teneilla</i>	0.30	30				
<i>Sanguisorba officinalis</i>	0.25	25	4	85	4	65
<i>Chiloscyphus pallescens</i>	0.65	20			0.1	10
<i>Carex panicea</i>	0.2	20	13	100	26	100
<i>Alnus glutinosa</i>	0.15	15	0.8	15	0.1	5
<i>Equisetum palustre</i>	0.15	15			0.2	10
<i>Eupatorium cannabinum</i>	0.15	15	1	45		
<i>Briza media</i>	0.1	10			3	70
<i>Filipendula ulmaria</i>	0.1	10	0.5	15	0.2	20
<i>Galium uliginosum</i>	0.1	10	4	100	5	100
<i>Rhizomnium pseudopunctatum</i>	0.1	10				
<i>Plagiomnium elatum</i>	0.1	10	0.1	10	0.1	10
<i>Cirsium dissectum</i>	0.5	5				
<i>Cephalozia bicuspidata</i>	0.5	5				
<i>Carex diandra</i>	0.05	5				
<i>Euphrasia sp</i>	0.05	5				
<i>Hydrocotyle vulgaris</i>	0.05	5	6	80	12	90
<i>Vicia cracca</i>	0.05	5	2	55	1	90
<i>Calypogeia azurea</i>	0.05	5				
<i>Cratoneuron commutatum commutatum</i>	0.05	5				
<i>Philonotis calcarea</i>	0.05	5				
<i>Rhytidiadelphus squarrosus</i>	0.05	5				
<i>Carex viridula brachyrrhyncha</i>	+					
<i>Dactylorhiza praetermissa</i>	+		0.8	25	0.4	20
<i>Drosera anglica</i>	+					
<i>Epipactis palustris</i>	+					
<i>Gymnadenia conopsea</i>	+					
<i>Lotus pedunculatus</i>	+		11	80	6	100
<i>Mentha aquatica</i>	+		0.1	5	0.4	15

<i>Thelypteris palustris</i>	+						
<i>Brachythecium salebrosum</i>	+						
<i>Calypogeia muelleriana</i>	+						
<i>Campyllum elodes</i>	+						
<i>Sphagnum subnitens</i>	+						
<i>Cirsium palustre</i>			4	85	6	95	
<i>Festuca rubra</i>			12	70	26	100	
<i>Pseudoscleropodium purum</i>			0.8	30	11	90	
<i>Carex flacca</i>			0.6	30	2	40	
<i>Polygala serpyllifolia</i>			0.3	15	1	50	
<i>Hypnum cupressiforme</i>			0.5	5			
<i>Quercus robur</i> seedling			0.1	5	0.1	5	
<i>Lathyrus pratensis</i>			0.1	5	0.1	5	
<i>Amblytegium riparium</i>			0.1	5			
<i>Eurynchium speciosum</i>			0.1	5			
<i>Brachythecium rutabulum</i>			0.1	5			
<i>Agrostis stolonifera</i>					12	85	
<i>Centaurea nigra</i>					5	40	
<i>Holcus lanatus</i>					2	40	
<i>Luzula campestris</i>					1	40	
<i>Lophocolea bidentata</i>					1	30	
<i>Eurhynchium praelongum</i>					1	15	
<i>Carex acutiformis</i>					0.4	15	
<i>Festuca pratensis</i>					0.1	5	
<i>Carex pulicaris</i>					0.1	5	
<i>Arrhenatherum elatius</i>					+		
Total number species recorded	54		35		44		
Mean species richness	13.4 ³		15.5 ²		22		
RWPFSS ⁴	17.41 ⁵		4.66 ⁵		5.86		
Total number PFS ⁴	41 ⁵		20 ⁵		21		
Fraction of PFS in flora	77% ⁵		61 ⁵		48%		
NVC Community	M13 ⁵		M24 ⁵		M24		

¹ Data from Bellamy and Rose (1961). Note there must be some errors in Bellamy's original calculations as with 25 quadrats in Plot 1, frequencies must be in multiples of 4.

² Data derived from summary quadrat tables, unpublished SWT/EN, from the fieldwork for Fojt and Harding (1995).

³ Derived from original quadrat data in Bellamy (1967).

⁴ PFS = Principle Fen Species. RWPFSS = Rarity Weighted Principle Fen Species Score (Wheeler 1988)

⁵ Data given in Fojt and Harding (1995).

Table 6: Comparison of Change Over Time for Plot 2, Old Fen

SPECIES	1959		1991		1999	
	Mean Cover ¹	Frequen ¹	Mean Cover ²	Frequen ²	Mean Cover	Frequen ³
<i>Cladium mariscus</i>	16	100	29	100	56	95
<i>Molinia caerulea</i>	15	85	0.8	20	0.5	5
<i>Phragmites australis</i>	11	85	2	75	2	80
<i>Juncus subnodulosus</i>	9	80	3	90	5	90
<i>Succisa pratensis</i>	0.85	80	0.5	5		
<i>Valeriana dioica</i>	3	70				
<i>Schoenus nigricans</i>	13	65	2	10		
<i>Fissidens adianthoides</i>	5	65	0.1	5		
<i>Calliergon cuspidatum</i>	13	55			1	15
<i>Eupatorium cannabinum</i>	1	55	1	15	+	
<i>Campylium stellatum stellatum</i>	2	50	0.1	5	0.1	5
<i>Oenanthe lachenalii</i>	1	45				
<i>Mentha aquatica</i>	0.35	35			+	
<i>Parnassia palustris</i>	0.35	35				
<i>Hydrocotyle vulgaris</i>	3	25				
<i>Rhizomnium pseudopunctatum</i>	2	25				
<i>Drepanocladus revolvens</i>	2	20				
<i>Aneura pinguis</i>	1	20				
<i>Campylium elodes</i>	0.95	20				
<i>Carex panicea</i>	0.2	20	0.3	5		
<i>Alnus glutinosa</i>	5	15				
<i>Plagiomnium elatum</i>	3	15			0.1	5
<i>Calliergon giganteum</i>	2	15				
<i>Philonotis calcarea</i>	2	15				
<i>Typha angustifolia</i>	1	15				
<i>Equisetum palustre</i>	0.15	15				
<i>Galium palustre</i>	0.15	15				
<i>Galium uliginosum</i>	0.15	15			0.1	15
<i>Sanguisorba officinalis</i>	0.15	15	2	40	1	25
<i>Riccardia multifida</i>	0.15	15				
<i>Chiloscyphus pallescens</i>	0.55	10				
<i>Caltha palustris</i>	0.1	10				
<i>Carex viridula</i>	0.1	10				
<i>brachyrrhyncha</i>						
<i>Lythrum salicaria</i>	0.1	10			0.1	10
<i>Bryum pseudotriquetrum</i>	0.1	10				
<i>Pellia endiviifolia</i>	0.1	10				
<i>Dactylorhiza praetermissa</i>	0.05	5				
<i>Vicia cracca</i>	0.05	5	0.1	15	0.4	10
<i>Anagallis tenella</i>	+					
<i>Calamagrostis canescens</i>	+				13	45
<i>Carex diandra</i>	+					
<i>Carex elata</i>	+				6	10
<i>Carex pulicaris</i>	+					
<i>Cirsium palustre</i>	+					
<i>Dactylorhiza incarnata</i>	+					
<i>Epipactis palustris</i>	+					
<i>Equisetum fluviatile</i>	+					
<i>Lotus pedunculatus</i>	+		0.1	5		
<i>Pedicularis palustris</i>	+					
<i>Pinguicula vulgaris</i>	+					
<i>Taraxacum (paludosum)</i>	+					

<i>Triglochin palustris</i>	+						
<i>Brachythecium salebrosum</i>	+						
<i>Campylium stellatum protensum</i>	+						
<i>Cratoneuron commutatum commutatum</i>	+						
<i>Cratoneuron commutatum falcatum</i>	+						
<i>Cratoneuron filicinum</i>	+						
<i>Drepanocladus vermicosus</i>	+						
<i>Lophocolea bidentata bidentata</i>	+						
<i>Marchantia polymorpha</i>	+						
<i>Plagiomnium ellipticum</i>	+						
<i>Moerckia hibernica</i>	+						
<i>Pseudoscleropodium purum</i>	+						
<i>Riccardia chamedryfolia</i>	+						
<i>Scorpidium scorpioides</i>	+						
<i>Filipendula ulmaria</i>			39	100		14	100
<i>Eurynchium speciosum</i>			4	35			
<i>Lythrum salicaria</i>			0.4	20			
<i>Carex acutiformis</i>			0.6	15		+	
<i>Brachythecium rutabulum</i>			0.4	15			
<i>Potentilla erecta</i>			0.5	10			
<i>Humulus lupulus</i>			0.1	5		0.1	10
<i>Centaurea nigra</i>			0.3	5			
<i>Valeriana officinalis</i>			0.1	5		+	
<i>Carex flacca</i>			0.1	5			
<i>Eurhynchium praelongum</i>						0.4	35
<i>Agrostis stolonifera</i>						1	15
<i>Viburnum opulus</i>						+	
Total number species recorded	65		23			22	
Mean species richness	12.2 ³		6 ²			6	
RWPFSS ⁴	24.75 ⁵		3.25 ⁵			4.17	
Total number PFS ⁴	55 ⁵		13 ⁵			15	
Fraction of PFS in flora	86% ⁵		52% ⁵			68%	
NVC Community	M13 ⁵		S25/M27 ⁵			S25(c)	

¹ Data from Bellamy and Rose (1961). Note there must be some errors in Bellamy's original calculations as with 25 quadrats in Plot 1, frequencies must be in multiples of 4.

² Data derived from summary quadrat tables, unpublished SWT/EN, from the fieldwork for Fojt and Harding (1995).

³ Derived from original quadrat data in Bellamy (1967).

⁴ PFS = Principle Fen Species. RWPFSS = Rarity Weighted Principle Fen Species Score (Wheeler 1988)

⁵ Data given in Fojt and Harding (1995).

Table 7: Comparison of Change Over Time for Plot 2a, Old Fen

SPECIES	1959		1991		1999	
	Mean Cover ¹	Frequency ¹	Mean Cover ²	Frequency ²	Mean Cover	Frequency
Juncus subnodulosus	25	92				
Phragmites australis	16	79	0.13	0.06	0.5	0.13
Cladium mariscus	2	73				
Caltha palustris	0.46	46				
Alnus glutinosa	5	40	100	100	100	100
Equisetum palustre	0.39	40				
Mentha aquatica	0.39	40				
Oenanthe lachenalii	0.39	40				
Typha angustifolia	7	40				
Valeriana dioica	0.39	40				
Berula erecta	0.26	26				
Carex flacca	0.26	26				
Eupatorium cannabinum	0.83	26				
Molinia caerulea	0.26	26				
Succisa pratensis	0.26	26				
Hydrocotyle vulgaris	0.19	20				
Hypericum tetrapterum	0.19	20				
Calliergon cuspidatum	4	20				
Rhizomnium pseudopunctatum	0.78	20				
Plagiomnium elatum	1	20				
Aneura pinguis	1	20				
Epilobium palustre	0.13	13				
Epipactis palustris	0.13	13				
Filipendula ulmaria	1	13	34.3	80	7	73
Galium uliginosum	0.13	13				
Pedicularis palustris	0.13	13				
Typha latifolia	0.13	13				
Valeriana officinalis	0.13	13				
Bryum pseudotriquetrum	0.13	13				
Chara spp.	2	13				
Cratoneuron filicinum	2	13				
Drepanocladus revolvens	0.13	13				
Riccardia multifida	0.1	10				
Anagallis tenella	0.66	7				
Angelica sylvestris	0.06	7				
Carex elata	0.06	7			5	0.06
Carex nigra	0.06	7				
Carex panicea	0.06	7				
Dactylorhiza praetermissa	0.06	7				
Galium palustre	0.06	7				
Lotus pedunculatus	0.06	7				
Lychnis flos-cuculi	0.06	7				
Oenanthe fistulosa	0.06	7				
Ranunculus flammula	0.06	7				
Calliergon giganteum	3	7				
Ctenidium molluscum	0.06	7				
Pellia endiviifolia	0.06	7				
Riccardia chamedryfolia	0.05	5				
Betula pubescens	+					
Carex viridula	+					
brachyrhyncha						
Cirsium palustre	+					
Parnassia palustris	+					

<i>Pinguicula vulgaris</i>	+						
<i>Brachythecium rivulare</i>	+						
<i>Brachythecium rutabulum</i>	+		2	0.13			
<i>Campylium elodes</i>	+						
<i>Carex acutiformis</i>			20.5	93	52	100	
<i>Eurhynchium speciosum</i>			1.3	13			
<i>Humulus lupulus</i>			0.33	0.06			
<i>Scutellaria galericulata</i>			0.2	0.06			
<i>Phalaris arundinacea</i>			1.67	0.06	1	0.2	
<i>Viburnum opulus</i>			0.33	0.06	1	0.06	
<i>Rubus fruticosus</i>			0.33	0.06	3	60	
<i>Fraxinus excelsior</i> seedling					1	0.2	
<i>Lythrum salicaria</i>						+	
<i>Dryopteris dilatata</i>						+	
<i>Carex paniculata</i>						+	
Total number species recorded	56		11		11		
Mean species richness	10.3 ³		3.4 ²		4		
RWPFSS ⁴	16.22 ⁵		1.12 ²		1.74		
Total number PFS ⁴	47 ⁵		7 ⁵		7		
Fraction of PFS in flora	84%		64%		64%		
NVC Community	M9/M13 ³		W5 ³		W5		

¹ Data from Bellamy and Rose (1961).

² Data derived from summary quadrat tables, unpublished SWT/EN, from the fieldwork for Fojt and Harding (1995).

³ Derived from original quadrat data in Bellamy (1967).

⁴ PFS = Principle Fen Species. RWPFSS = Rarity Weighted Principle Fen Species Score (Wheeler 1988)

⁵ Data given in Fojt and Harding (1995).

There is no clear trend in the species that indicate hydrological change. Plants that are typical of high water tables or low water tables are present in the both groups of declining and increasing species. There is no suggestion in the data that the plot is suffering from reduced water levels.

Number of species per sample is not significantly different. In 1999, 54 species were recorded, whereas in 1992, 56 were recorded. This may reflect the increased number of quadrats recorded in 1992 (50 samples as opposed to 30 in 1999). Examining the original 1992 data (Harding 1992) shows that three species were only added in the last 20 samples.

However, the plot appears to have improved in terms of quality. Species lost from the plot are either non-fen species or common species, whereas those recruited include *Cirsium dissectum*, *Dactylorhiza praetermissa/incarnata*, *Epipactis palustris* and *Cratoneuron commutatum*, which are all rare in Suffolk. In 1992, there were 29 principal fen species, or 52% of the flora. In 1999, there were 32 principal fen species, or 59%. In 1992, the rarity weighted principle fen species score (RWPFSS) was 8.91, whereas in 1999 it was 10.38. Thus in the intervening period, there has been a small improvement in the quality of the plot. This is reflected in the average height of vegetation and the amount of litter, both of which declined by 1999. Whether or not this will be sustained or reflects temporary fluxes in species, remains to be seen.

The plot on Middle Fen is of much higher quality than any of the Plots on Old Fen in 1999. It is, however, substantially poorer than any of the Old Fen Plots as they were in 1959. It lacks very many of the rarest and most valuable species that Bellamy recorded in those plots, many of them indicating high levels of very chalky and low nutrient groundwater. No monitoring data exist for the plot in Middle Fen prior to 1992. Anecdotal information suggests this area had a floating raft of vegetation over watery marl decades ago, similar to that at Old Fen where Bellamy recorded. This is now very restricted in area and does not occur within the monitoring plot. It is likely that vegetation has declined between 1959 and 1992 (for instance, *Liparis loeselii* has been lost in this time), but the degree of decline cannot be assessed. The plot may originally have been as good as Old Fen, but it is also possible that Bellamy recorded on Old Fen simply because it was the best tract of fen in the area. In any case, it appears quite likely that any decline has been halted and perhaps reversed.

5. CONCLUSIONS

Plot 1 at Old Fen, where management has been increased, has shown an improvement between 1991 and 1999, with an increase in fen quality. The increase is not huge, however, and it is unlikely that the plot will ever approach the richness and value of the same area in 1959 without substantial changes to hydrology. Indeed, probably of more significance is the increase in non-fen species or plants typical of dryer conditions and higher nutrients. The increase in richness is attributed to improved management, while the increase in undesirable species is attributed to continuing and fundamental decline in hydrological state of the plot. In the very long term, management will not arrest the gradual increase in undesirable species. Improvements to the hydrological regime is the most important measure in ensuring the conservation of this Plot.

Management of Plot 2 has not been increased. Although there is a slight increase in quality, this has come about through recruitment or increase in species at very low frequency and may thus be due to variation in recording rather than reflecting a true ecological trend. Of more significance is the recruitment and great increase in species indicative of dry conditions and elevated nutrients. Trends in this plot corroborate trends in Plot 1, particularly useful as the two plots have differing management regimes.

Plot 2a, already an alder carr in 1991, showed comparatively little change.

The single plot at Middle Fen showed a different pattern to Old Fen. Here there was a genuine increase in the quality of the plot in response to improved management, which was not accompanied by increases in species indicative of dryer or more elevated nutrient conditions. It is concluded that improvements to quality will continue into the long term, if the management is maintained. Even so, the plot in 1999 is not nearly as rich as the plots on Old Fen were in 1959. Anecdotal evidence suggests that there has been a deterioration in hydrological condition of Middle Fen, with substantial decline in the floating raft over watery marl. Some key species, such as *Liparis*, have also been lost, and a wide range of species indicative of discharge of calcareous groundwater is not recorded. Whether this reflects genuine and substantial ecological decline between 1959 and the 1980's, or reflects the fact that Middle Fen has never been as good as Old Fen, cannot be determined from the monitoring data alone.

Under the current management regime, Middle Fen appears to be stable or improving. Old Fen needs urgent remedial measures to its hydrology if the long-term decline suggested by the monitoring is to be prevented.

6. REFERENCES

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